Effects of Forest Cover on Catchment Water Balances and Runoff Dynamics

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Abstract

There is now broad agreement amongst researchers that forestry activities have the potential to alter catchment water balances and thus change the amount and timing of catchment streamflows. Paired catchment experiments from around the world have provided a robust data base on which to found theories about the effects of forest cover on catchment water balances and runoff dynamics. However, it has been shown that different catchments respond to changes in forest cover in a variety of ways. Climate, topography, soils and the forest type each exert particular influences on the hydrologic function of catchments and their response to forest cover change. This review examines the findings of a variety of studies and seeks to develop generalisations about the effects of forest cover on catchment water balance and runoff dynamics. We focus on water yield or the amount of streamflow, streamflow seasonality and flow frequency, and the magnitude of peak flows.

There is strong evidence to show that forest cover tends to enhance evapotranspiration and reduce water yields, relative to what would arise from catchments under grass or crop cover. The extent to which yields are affected by forest cover change seems to vary primarily as a function of annual rainfall and forest type, and to a lesser extent by local climatic conditions. The greatest changes in water yield following forest disturbance tend to occur in the wettest areas, primarily because of the important effect of rainfall interception by forest canopies. Generally speaking, the lowest yields are generated by conifer forests, followed by evergreen hardwoods and then deciduous hardwoods. These differences are attributable to differences in the amount of leaf area and the effect that this exerts on transpiration and rainfall interception. There are some special types of forest in low radiation environments which tend to yield very high amounts of runoff, relative to the rainfall they receive, because of low evapotranspiration rates. Examples include tropical cloud forests and temperate native forests in the uplands and coastal areas of New Zealand. Alternatively, on the coastal margins in tropical areas, evapotranspiration rates are higher than normal because of advection of energy from the ocean, leading to lesser runoff from forests sited in these areas.

Some studies indicate that forest age also affects evapotranspiration and water yield, with old growth forests tending to produce more runoff than actively regenerating forest. Whilst the occurrence of this phenomena has only been conclusively demonstrated for some Australian eucalypt forest catchments, recent north American research has shown that photosynthesis and water use per unit leaf area decline as forest ages. These findings imply that catchment water yields should increase as forests age.

We review the fledgling literature linking forest cover to runoff seasonality and flow frequency. This is an important issue as the temporal distribution of flows has important consequences for the security of water for downstream enterprises (in the case of low flows), and the safety of dams, roads, culverts and bridges (in the case of high flows). Almost all catchment studies have noted that low, median and high flows decrease as a consequence of afforestation, and increase as a result of forest clearance. However, low flows and high flows do not always change by the same amount as annual flows, with different parts of the streamflow range being more affected than others, depending on site factors such as soil depth and properties, and forest type.

We conclude our review by highlighting gaps in the field of research linking forest cover to catchment water balance and runoff dynamics.

Keywords: Forest cover, Water catchment, Runoff dynamics.

Hydrological Flowpaths and Water Chemistry in Key Forested Environments

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Abstract

With the expansion of forest hydrology research from mid-latitudinal areas to tropical and boreal forests, a diversity of hydrological process patterns began to emerge that has since been tentatively explained along geographical lines. Our much improved knowledge of runoff generation processes, however, allows us to discard geographical straitjackets and explain the quite diverse hydrological functioning of forests world-wide in terms of those soil, meteorological, and geomorphological factors that control the movement of water on landscapes. Hence, we propose a functional approach to the classification of forest ecosystems based on those factors.

This approach entails a two-tiered screening of forested catchments based on adequate data. We first differentiate according to geomorphological criteria between catchments with low relief or wide valley floors and catchments of high relief that are deeply incised (e.g., small or no valley floors).

The basic tenet underlying this differentiation is that groundwater plays a more important role in the former than in the latter. Next, we differentiate according to the interaction between soil and rainfall characteristics that controls the partitioning of rainfall into vertical and horizontal hillslope flowpaths, and therefore determines the degree of hillslope-channel coupling. High rainfall intensities, normalized to soil saturated hydraulic conductivity, or high rainfall amounts, normalized to depth to an impermeable layer, favor horizontal, near-surface hillslope flowpaths, and hence a tight hillslope-channel coupling; the reverse is true for low rainfall intensity or rainfall amount environments. This functional classification based on flowpaths that are controlled by soil, landscape and meteorological factors has necessary implications for stream water chemistry as it implies different kinds of water-regolith interactions in hydrologically different environments.

Our proposed evaluation and classification scheme is consistent for forested catchments across the spectrum of humid tropics, mid-latitudes, and boreal regions. In each case, we weigh our classification in each case by the quality of the published data. To avoid scaling issues, we restrict our survey to 'small' catchments; this restriction excludes hillslope- and landscape-scale studies.

We conclude our review by highlighting previously under-studied forest ecosystems and gaps in our process knowledge.

Keywords: Forest environment, Water chemistry, Hydrological flowpaths

Effects of Forestry Activities on Surface Erosion and Slope Stability

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Abstract

High levels of sediment discharge into forest streams and rivers as well as resulting degradation of aquatic habitat have widely been blamed on intensive and extensive forest management activities. Additionally, reductions in site productivity of forest lands can also be related to accelerated erosion processes, both surface erosion and mass

wasting. The burden of these environmental impacts that has been placed on forestry management may be overstated in many cases but, depending on the particular practice and region, may be partially or totally justified. In assessing the potential impacts of forest management activities, an important distinction needs to be drawn between surface erosion processes and mass wasting or landslide processes. This paper will attempt to link particular management activities with each of these erosion processes. We will focus on the Pacific Rim region because of its steep terrain, predominant forest cover, regionally active tectonics, high precipitation (total amounts and intensities) associated with mountainous and maritime zones, past and recent patterns of settlement, and widespread land use changes over the past few centuries.

In managed forest terrain where the infiltration capacity of soils is maintained, surface erosion is generally not a problem. Infiltration capacity of forest soils is reduced when soils are compacted or if organic horizons are removed in certain environments allowing the mineral soil to be exposed to forces of high intensity raindrop impact. Soil compaction related to forestry operations occurs on skid and haul roads, trails, landings, and other areas where heavy machinery operates. Excessive disturbance that exposes large areas of forest soil can be associated with certain types of ground skidding and site preparation practices. Other significant contributors to soil compaction and disturbance include intense grazing, recreational use, and residential development in forested areas. These impacts are magnified if they occur near stream channels and can generate increased peak flows, channel instability, and resultant high sediment loads. Riparian forest buffers around streams can minimize the sediment delivery to channels, promote infiltration and subsurface flow, and provide exchange sites for nutrients and pollutants. Forest roads and drainage systems in particular provide efficient conduits (as well as sources) for sediment delivery to streams during storm events. Short-term increases in surface erosion can result from burning and the creation of a hydrophobic layer in the surface soils. Surface erosion becomes a particular concern in steep terrain when agricultural or intense forestry practices are conducted which result in the removal or destruction of significant portions of the soil organic horizon. Such anthropogenic actions expose the more erodible underlying mineral soils to raindrop impact and, depending on soil and site conditions, may initiate rill and gully erosion on steep slopes. Modeling surface erosion in steep managed forest terrain is difficult because most databases used in the development of empirical models (e.g., USLE) have not historically included such sites and complex topography complicates the application of more theoretical models.

Factors that control the stability of steep forested terrain may be in a tenuous state of equilibrium that can easily be upset by human activities. Steep hillslopes with shallow soil mantles are typically unstable especially in regions of high precipitation and recent tectonic activity. In many of these areas worldwide, shallow landslides are the dominant erosion and sediment delivery processes. Timber harvesting activities in steep terrain can affect the stability of hillslopes by reducing the cohesion associated with tree roots. Rooting strength is typically at a minimum 3 to 15 years following clearcutting, however the recovery of rooting strength is dependent on the regeneration techniques used at the site, available soil nutrients and moisture, and a host of other environmental and cultural factors. Additionally, the probability of a landslide occurring in a harvested site is partly controlled by local hydrogeomorphic and topographic attributes as well as influenced by silvicultural methods. All of these factors act together in establishing the conditions of site stability; however, an episodic rainstorm or snowmelt event must occur that generates a critical pore water pressure in the soil mantle to trigger the landslide. Deep-seated slope failures, such as rotational slumps and earthflows, are typically less associated with timber harvesting because tree roots rarely penetrate deep into the unstable soil mantle.

However, effects of roads and road drainage have been known to trigger or accelerate deep-seated mass movements by short-circuiting water to the failure surface. Progress is being made on developing predictive methods for landslides, especially for shallow mass movements, that are physically based and distributed. However, such models require

rather intensive data inputs and may be difficult to apply in remote areas. Alternative approaches to landslide hazard assessment in more remote areas have been developed using digital terrain data, geological information, climatic data, land use maps, and other remotely sensed data. Successful application of such GIS-based models is contingent upon using terrain indicators that are closely linked with processes that control slope stability.

Keywords:Forestry activities, Surface erosion, Slope stability

Sediment Delivery Pathways in Managed Forestry Environments

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Abstract

Forest harvesting activities, such as road construction and the associated disturbance of soil and vegetation on logged hillslopes are widely considered as potential 'non-point sources' (NPS) of stream water pollution. Research over the past three decades has been conducted with the general aim of improving our ability to protect water resources in forested catchments. In many instances our knowledge is restricted because much of this work has focused on plot scale on-site soil erosion processes or subcatchment monitoring of turbidity or suspended sediment concentrations before and after a specific treatment. Both approaches have serious limitations that are commonly overlooked in our interpretation of the research findings and in assessing the most effective pollution control practices. The major aim of this chapter is to introduce a framework that investigates the potential impacts of forestry activities on water resources using concepts of sediment delivery and connectivity. The framework explicitly considers the transfer and delivery of material from a sediment/pollutant source to the stream network via processes of overland and channeled flow.

A state-of-the-art review of the international literature points to an abundance of data on processes and rates of sediment detachment and related on-site erosion impacts. These studies are unanimous in their findings; forest activities, in particular roading, track construction, cause increased soil compaction, decreased hydraulic conductivity, increased runoff and soil erosion at the point of disturbance. Roads and tracks are recognised as the dominant sources of both runoff and sediment and the general logged area occupying much of the catchment by area, is both a localised source and sink depending upon such factors as the degree of soil disturbance and the intensity and duration of rainfall. Studies on off-site impacts present no consistent message regarding post-logging sediment loads or the precise relationship to forestry-related disturbances on the hillslopes. In-stream data from paired catchment studies is best viewed as the summation of sediment detachment, delivery, storage and transfer processes and rates from the specific catchment outlet. The missing link between these two types of research approaches is quantification of the connection or delivery pathway between sources of sediment and the stream network.

In developing this conceptual framework, we propose that the delivery and routing of sediment and associated pollutants from key sources such as roads, tracks, and general harvesting areas to streams depends upon, and reflects the interaction of two key factors. These are; (1) surface runoff rates at source, and (2) the characteristics of the delivery pathway, including the distance between runoff source and the stream network. Proximity to the stream network is well-represented using 'available hillslope length' as an index of overland flow path length. Recognition of the dominant runoff pathway over the dominant sediment source is an important distinction over previous approaches. The characteristics of the delivery pathway are broadly categorised as extensions of the stream network (new gullies) and diffuse

overland flow pathways on vegetated hillslopes.

The second part of this chapter provides a structured consideration of source to stream connection by introducing a design approach that guides road or track drainage spacing for the combined inputs of rainfall intensity, distance to stream and road/track outfall gradient. This framework provides guidelines for road and track design in forestry environments with the objective of minimising the connection of road, tracks and other compacted areas to streams.

Keywords: Managed forest, Environment, Sediment delivery pathways.

New Remote Measurement Tools in Forest Hydrology

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Abstract

Remote sensing data has traditionally been difficult to use directly for management purposes, or as inputs to hydrologic models. Correlation models are often required for the conversion from remotely sensed data to key variables used in forest hydrology applications, such as terrain attributes, vegetative cover, vegetation function, aerodynamic or canopy resistances, increasing the cost of data acquisition by remote measurement. The density of information provided by these instruments, however is unequalled, when compared to other spatial representations of landscape variables, often derived from point measurements. Onboard aircraft or satellite platforms, they provide catchment-scale or regional measurements with 100-percent coverage. Sensors used in aircraft usually offer higher spatial resolution, while their larger, satellite-borne counterparts are used for wider coverage and routine revisits.

A number of hydrologic models, are currently using remotely sensed data as inputs in their vegetation cover sections. With further refinements, these types of models will soon be able to include more accurate forest cover information, such as the spatial distribution of the different forest regrowth stages, currently being produced from multi-spectral satellite data. In addition, new systems are coming online, which offer more direct measurements of variables of interest and a capability for 'precision forest measurement'. These new sensors are also better calibrated and more sensitive for detection of increasingly subtle changes in the environment below.

Topographical data can now be collected by laser scanning systems and radar interferometers at sub-metre resolution and with high geopositional accuracy. Operational airborne laser systems in use today, measure the distance between the aircraft and the ground directly, using very accurate measurements of aircraft position and fast digitising of the return light pulse, thus creating three-dimensional descriptions of the terrain below. In addition, prototype systems, developed by NASA are now capable of very high frequency digitisation of the return signal, hence providing the opportunity for detailed vegetation structure and biomass mapping. Spaceborne missions with laser profiling sensors onboard are already planned for deployment within the next 12 months. In addition to laser systems, radar interferometers allow for 'all-weather' topography, and soon vegetation structure mapping, using analogous methods to stereo photogrammetry, but using the microwave part of the electromagnetic spectrum. A spaceborne radar interferometer was deployed in early 2000 on the NASA Space Shuttle for global topographic mapping.

New imaging spectrometer systems, on the other hand, allow for more detailed chemical analysis of the objects below, and derivation of aspects of vegetation function. Using the principles of spectroscopy, traces of light reflectance from the vegetation or soil (termed spectral signatures) are matched against a 'spectral library' for pure specimens (termed 'endmembers'). This allows for use of new 'Imaging Specrometers' (also termed hyperspectral imagers), to create 2-dimensional maps of the presence and relative concentration of different compounds on the surface below. In other uses, specific regions of the plant reflectance spectrum are used for

quantification of the composition of the samples, including nitrogen and water content. A number of narrow-band 'spectral indexes' have also been recently proposed, which are closely linked to pigment dynamics in plants, and in turn can be associated to their photochemical efficiency and stress levels. New forest growth and function models are expected to use this type of data as input or as validation of their sub-daily plant function predictions.

In addition to highlighting new methodologies applied to traditional remote sensors, this review provides a technical background of new remote sensing systems, techniques and some examples of their use.

Keywords: Remote sensing, Forest hydrology

The Use of Stable Isotopes of Water and Carbon for Investigating Plant Water Use Strategies

by
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Abstract

There has been an increase in the use of isotopes in determining the sources of plant water and the water use efficiencies of species and genotypes. Studies have encompassed a variety of plants including agronomic species (wheat, alfalfa, wheatgrass), mangroves, halophytes, deciduous trees and evergreen species. Increasingly, studies are integrating isotopes into ecological and water balance studies, of which the isotope component is only one part. Isotopes can provide information that can not be supplied by other techniques, provided appropriate care is taken with the errors and vagaries of isotopic techniques.

The principle of the stable isotope technique for sourcing plant water is the isotope composition in the plant conducting tissue is the same as that of the sources. Perhaps, the greatest potential source of the error with the technique is the extraction of water from soils. This can exceed the variation in δ^2H and $\delta^{18}O$ of water sources and hence make the technique unworkable. It is important that extraction procedures are verified, and inexperienced personnel receive training in specialist laboratories or alternatively have analyses done in those laboratories. It is also important how and where the plant sample is collected to minimise sampling errors and temporal changes must be considered in any sampling regime. There is a need to avoid evaporation on all soil, groundwater, rain and plant sampling. An intensive field study in SE Australia found that the difference between expected isotopic values of sources and that found in the plant xylem was less than 5 ‰ for δ^2H and 1 ‰ for ^{18}O. This experiment was conducted over a range of extreme conditions and hence we believe that the method is robust.

Isotopes in the wood cellulose of tree rings can also provide a historical chronology of water use for trees. This can be useful in attempting to understand hydrological dynamics throughout the life span of the forest or understanding land use change impacts within the catchment. Unlike isotopic investigations of environmental and plant waters, there are small errors associated with the extraction of isotopes from the wood sample. However, there are a number of other limitations in using this approach, such as 1) the degree of variability between plant physiological processes and the environmental variation of isotopes, 2) not all tree rings are grown annually, and 3) what are the age and population effects with regard to isotopic variability? These issues will be discussed in this chapter along with specific examples related to plant water sources and plant water use. Despite the possible limitations of this technique, it can provide a valuable insight into the longterm dynamics of forest hydrology.

The isotope method is an inverse method i.e. the isotopic composition in the plant is used to infer information about the sources. It should be remembered that there is limited information contained in the isotope measurements. Hence, isotopes used by themselves represent a relatively blunt

instrument. The integration of isotopes with other data such as piezometric data, transpiration fluxes, soil and leaf water potential, etc allows more sophisticated interpretations of plant water use strategies. In particular, the use of isotope data to test the calibration and assumptions in a model that has been calibrated independently of the isotope data brings forth many possibilities. Models, whether conceptual or quantitative is a means of bringing prior knowledge into the interpretation of plant processes.

With the experimental basis described in this chapter, there are no reasons why isotopes can not be used more in agronomic, forestry and ecological studies. Isotopes allow measurements of processes that can not be obtained in any other way, provided some of the difficulties with the method are not underestimated. The advances in soil moisture monitoring and transpiration measurements, as well as vegetation-soil models, together with isotopes, should see large advances in our understanding of plant water strategies over the next ten years.

Keywords: Water and carbon isotope, Plant water use.

Hydro-Ecological Modelling of the Impacts of Environmental Change on Forested Ecosystems at the Watershed Scale

by
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Abstract

The past few decades have seen unprecedented public concern for the sustainability of terrestrial ecosystems over a range of scales. Remote sensing has alerted us to the extent to which we are changing the usage and cover of the land surface, and through both experiments and modelling at local scales, it is clear that these changes significantly affect water resources. Current concerns about watersheds have gone beyond water yield, and now include issues of water quality, sedimentation, wood production, fisheries, nutrient cycling, recreation, and biodiversity. Understanding human impacts on watersheds, including land use change, direct addition or extraction of water and chemicals, and flow path alteration, is critical. Most of our current knowledge about forest ecosystem processes is derived from plot scale studies, and models which look at one dimensional water, carbon, and nutrient cycling. However, most of our knowledge and experience in hydrology are based on applications at the hillslope to watershed scale, and on models which focus on runoff production and routing. The issues which we have defined require interactions between these two approaches. A convenient intersection of plot level and watershed scales occurs at the hillslope level. Hillslopes have closed boundaries (drainage divides), a lower absorbing boundary (stream channel), and fairly uniform slope and aspect.

In this paper, we review current approaches which tightly couple carbon/water/nutrient cycling with hydrologic routing at the hillslope to watershed level. Such approaches address a range of watershed management issues including the effects of riparian buffer strips, silvicultural practices, road construction, forest senescence, acid deposition, and global climate change on water quantity, water quality, sedimentation, productivity, and nutrient cycling. Coupled approaches usually rely on established, pre-existing models as their basic components. Therefore, we also review the key lines of model evolution in the component areas of watershed hydrology, ecosystem growth, biogeochemical cycling, and sediment and nutrient transport. Linkages between these areas occur over varying spatio-temporal scales. A spatio-temporal framework is erected, and each modelled process and linkage is located within this framework. This facilitates a better understanding of the importance of coupled hydro-ecological modelling, particularly with respect to interactions which are only observed at long time scales (> 10 years).

Case studies selected for closer examination include modelling the effects of forestry on water yield, modelling the effects of land use / land cover change on water quality and quantity, and modelling the effects of global

environmental change on large-scale hydro-ecological and biogeochemical cycles.

A number of important conceptual limitations to the advance of hydro-ecological modelling are discussed. Many long-term studies are limited by the lack of a universal, mechanistic understanding of the processes governing forest ageing. Scaling issues are also pertinent. Many established models do not adequately address the gap between the experimental scale at which physical governing equations were derived, and the scale at which they are used to make predictions of watershed behaviour. There are also practical limitations, which do not necessarily require a fundamental advance in knowledge, just better technology. These include the low standard of software engineering in many models, restrictive spatial structures (e.g. grid cells), and a reluctance to apply existing landscape partitioning technology.

In our discussion, we look to the future of hydro-ecological modelling. A greater level of model integration seems certain, but this must be accompanied by concomitant elucidation of the dominant governing forces if it is not to be lost in a miasma of improperly combined equations and computer code.

Keywords : Environmental change, Modelling forested ecosystem, Watershed.

The Fire and Smoke Episodes of 1983 to 1998 in South East Asia: Ecological Background, Socio-Economic and Environmental Implications, and Challenges for Regional and Global Fire Research Programmes

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Abstract

The environmental and socio-economic consequences of application of fire in land-use systems and occurrence of wildfires in forests and other vegetation in South East Asia have long been ignored. Long-lasting regional smoke-haze episodes during the extreme droughts associated with the El Niño-Southern Oscillation (ENSO) phenomenon have occurred repeatedly between 1983 and 1998. The situation in 1998 triggered unprecedented awareness of the science community and on the political arena at national and international levels. This paper summarizes the state-of-knowledge on the fire environment in South East Asia, particularly basics of fire ecology, fire occurrence, and fire-generated smoke problems in SE Asia. It also provides a summary of international research and development projects and programmes.

Keywords: Fire ecology, Wildfire, Land-use fire, Forest conversion, Climate variability, El Niño-Southern Oscillation (ENSO)

Forest Fires in Tropical America: Challenges for Research

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Abstract

Natural forests covers 47% of the total land area of Central and South America, almost all (95%) being tropical. Forest cover continues to decrease due to clearance for cropland, cattle raising, and the construction of roads, dams and other infrastructure. More recently, fire has become a major threat to natural forests throughout the region. In 1997-1998 fires raged through the forests of Brazil, Colombia, Mexico

and many countries in Central America. Tropical forests are burning due to a number of interdependent natural and human-related factors that are often obscured by lack of information. Undisturbed rain forest is highly resistant to burning, but will burn during severe droughts, principally after it has been logged or otherwise disturbed. In the Brazilian Amazon a combination of logging and drought are increasing the flammability of large tracts of forests. Fire research in the Amazonia is in its infancy, and has eluded the priority-setting processes of the region's government research institutions. Economic and policy studies are urgently needed to document the costs of fire to landholders and society at large, to identify how land users can be encouraged to control and prevent fire damages, and to propose mechanisms by which the disparate public policies that influence deforestation could be integrated to favor a more sustainable and less fire-prone development pathway. Research is needed to determine which kinds of production systems are most likely to use fire, and which ones invest most in fire control and prevention both for fire risk assessment and for targeting governmental initiatives to reduce fire. Field studies of the causes of forest flammability could provide the basis for a regional early warning system of forest fire risk. One of the most serious impediments to fire risk assessment in tropical forests is the insufficiency of rainfall data collection. In the short term, an *El Niño Early Warning System* indicating impending drought episodes, could act as an effective substitute for a comprehensive fire risk warning system, giving landholders time to incorporate the prospect of severe drought into their land management planning. In the long term, research on fire behavior and its impacts on ecosystem processes, biodiversity, biogeochemical cycles, atmospheric quality, and local and global climate, as well as evaluation of damages and losses, are needed to establish management practices for the forests of tropical America. The probability of future forest fire disasters can only be reduced if the causes of hazard and risk are well understood and comprehensive strategies devised to address these causes.

Keywords: Forest fire; Rain forest; Brazil; Amazonia

Forest Fire Research in North America and Russia: Building on Past Accomplishments to Address Current and Future Needs

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Abstract

National forest fire research programs have enjoyed a long and productive history in Canada, the United States, and Russia. These programs have traditionally addressed major and topical fire management issues, so have evolved in concert with, and in support of, changing fire management practices. Although fire research activities are carried out at academic and regional institutions in these three countries, research at the federal government level has been dominant, providing the much-needed stability and continuity required to build relevant and adaptable research programs. The recent collapse of the Soviet Union presented the first opportunity for Russian and western fire research scientists to interact openly and productively. Since 1992 organizational structures have been put in place to facilitate this cooperation, joint meetings and experiments have been undertaken, and a great deal of progress has been made on many fronts. With the growing trend toward international, cross-disciplinary approaches to global fire problems, it is anticipated that this cooperative approach to fire research between Russia and North America will continue to flourish.

Keywords: Forest fire research, Research institutions, Research history, Mandates, International collaboration.

Fire in the Mediterranean Basin: Towards an Interdisciplinary Science Program

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Abstract

This paper discusses and presents the underlying factors and the need for a coherent research campaign concerning forest fires in the Mediterranean Basin. With a very long history of human settlements and land use coupled with the climatic and topographical conditions, Mediterranean Basin has very distinct landscape patterns shaped by biotic and abiotic factors. Of the factors involved, forest fires - human made or natural - are among the most important ones. Fire in the region is of social, cultural, economical, historical and psychological origin. Yet, fire research has mainly concentrated on the prediction of fire behaviour and ecology, i.e., the immediate effects of fires on fauna, flora and soil. No genuine effort has been made to relate resulting landscape patterns with typical fire regimes to historical land use practices, and socio-economic, cultural, historical and political backgrounds of fires, nor is it clear how the changing land-use pattern would affect the vegetation types and fire regime, overall land management planning and the contribution of wildland fires to regional atmospheric chemistry.

To overcome the problems in such a complex region as Mediterranean Basin, a multi-national, interdisciplinary research effort dealing with a broad range of interlinked aspects of the fire problem is vital. Here, the concept and tentative framework of a such research exercise is presented.

Keywords: Forest fire, Mediterranean basin, Research

Fire Occurrence in Relation to Weather Conditions

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Abstract

This paper presents and evaluates the effects of fine fuel moisture content of forest floor fuels on fire occurrence in mediterranean ecosystems of Turkey. Fine fuel moisture contents were measured in an even-aged, fully stocked red pine (Pinus brutia) stand near Izmir. Three fuel samples were taken daily in the early fire season in june and once or twice a week thereafter. Fuel samples were weighed and oven-dried at 100 oC for 12 hours or until no change in weight was attained. Moisture contents were determined based on the weight difference between before and after oven-drying. Weather measurements were taken daily at noon local standard time from a nearby weather station located at Menderes Interantional airport. Measurements included temperature, relative humidity, wind speed and direction, and precipitation. Fire occurrence data during the study period was obtained from the Regional Forest Directorate in Izmir. Analyses showed that a close relationship exists between weather conditions and fire occurrence. Indexes generated from this study

should be invaluable for fire managers in the region and other places having similar conditions.

Keywords: Fine fuel moisture content; Weather; Fire occurrence; Turkey

Performance of the Monte Alegre Formula on Fire Danger Evaluation in Different Regions of Brazil

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Abstract

The occurrence of forest fires is highly influenced by weather conditions. For that reason, fire danger rating indices based on meteorological variables are important tools to aid in planning and supervising fire control activities in fire protection units. Besides presenting a good performance, an index must be adapted to the local conditions, mainly to the available data for its calculation. That is why sophisticated indices that require data that is not easy to obtain cannot be used in developing countries, where meteorological and other necessary information are seldom available. The "Monte Alegre" formula (MAF) was developed in 1972 using meteorological and fire occurrence data of the central part of the State of Paraná , and has since been used by most forest institutions and companies in Brazil and other South American countries to predict fire danger. It uses only three variables: relative humidity (directly), number of days without rain and amount of precipitation (both indirectly), and can be easily calculated every day through the following equation:
MAF = 100 SUM FROM { n=1 } TO { n } 1 OVER H
where n is the number of days without rain and H is the relative humidity measured at 1:00 PM. The performance of the MAF was evaluated in three deferent forest districts in the southeastern and southern regions of Brazil. Firstly, using a data set from the region where the index was developed (Cfa climate, according to Koppen's classification), its performance was checked. Results showed that 52.5% of the fires registered in that period occurred when the index indicated a very high danger; 31.7% when the danger was high; 13.8% when the danger was medium; 2.0% when the danger was low; and no fire was recorded when the index indicated no danger. Secondly, using data from a forest district in the southern State of Santa Catarina (Cfb climate), the MAF was compared to the locally used index, developed by the South Carolina State Department of Forestry, USA, (SCI) in the 1960s. By the MAF, 13.0% and 87.0% of the recorded fires occurred when the index indicated high and very high danger, respectively. When the SCI was used, 43.5% of the fires occurred when the danger was low, 26.1% when the danger was medium, and 30.4% when the danger was high; and no fire was recorded when the index was very high. Thirdly, using data from a forest district in the central region of the southeastern State of S o Paulo (Cwa climate) the performance of the MAF was compared to three other indices: Nesterov, Tellysin, and the Canadian Fire Weather Index (FWI). Three methodologies were used to test the efficiency of the indices: Mahalanobis distance, Friedman's test, and distribution of the occurrences through the danger scale of the indices. According to the Mahalanobis distance and Friedman's test, the FWI was more efficient but when the distribution of the occurrences through the danger scales was used, the MAF was more efficient in estimating the fire danger of the region.

Keywords: Fire occurrence; Fire causes; Brazilian tropical forest/savannas

Wildfire Occurrence in a Forest District and Other Brazilian Protected Areas

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Abstract

Wildfire is a permanent threat to native and planted forests in most part of the Brazilian territory. Periodical dry seasons and abnormal weather conditions have induced to large and destructive fires from time to time. In 1998, for instance, an extremely large fire burned about 13,000 km2 of tropical forest and savanna vegetation in the State of Roraima, located in the Amazonian region. Despite the preoccupation with the tropical forests, data on fire occurrence in that ecosystem are not sufficient to make a good description of fire occurrence in Brazil. This paper presents the history of fire occurrence in the Agudos region, State of Sao Paulo, southeastern Brazil, from 1984 to 1995 and other protected areas throughout the country. The center of the forest district area is located approximately at 22 28'S, 48 59'W and 526m above sea level. The fire season in the region goes from June to November. There was statistical difference among the months of the year for both, number of fires and burned area. August, with 21.60%, presented the higher number of occurrences, and 76.36% of the fires occurred from June to November. September presented the largest burned area (28.49%), and 80.41% of the total area affected by wildfires burned from August to November. There was no statistical difference in the number of fires or burned areas among the days of the months and the weekdays, although Sunday, with 17.36% of the occurrences and Monday, with 24.86% of the total burned areas had presented the highest numerical values. However, significant difference was observed both, in the number of fires and burned areas, among the hour of the day. About 85.17% of the fires and 91.97% of the burned areas were recorded between 10:00 AM and 06:00 PM. The hour that presented the highest occurrence was 02:00 PM, with 17.20% of the recorded fires. Precipitation was the weather variable that presented the best correlation with fire occurrence. About 42.1% of the annual precipitation and 82.41% of the recorded fires occurred between April and October. August was the month with lower precipitation and higher number of fires. Data collected from protected areas in the Brazilian territory in 1994 and 1995 presents similar results showing that the history of forest fire occurrence is similar all over the country. September, with almost 30% of the recorded fires, was the leading month in fire occurrence, and 84.61% of the fires and 97.85% of the burned area were observed between July and October. Arson (41.40% of the fires and 11.81% of the burned area), Debris burning (32.26% of the fires and 79.55% of the burned areas), and Smoking (10.21% of the fires and 1.13% of the burned area) were the leading causes of forest fires.

Keywords: Fire danger rating; Fire occurrence prediction; Brazil fires

An Analysis of Forest Fire Behavior Based on Estimation of Wind Direction and Wind Velocity at the Time of the Fire

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Abstract

Wind direction and wind velocity data are necessary to analyze the behavior of forest fire and its propagation. It is possible to obtain prevailing wind data from weather stations but not the characteristics of fire whirlwind at the site of the forest fire unless we measure it at the time of the fire.

This paper presents a procedure of estimation of wind direction and wind velocity from the stem-bark char remained at the forest fire damaged area. In this investigation, in order to clarify the relation among the factors affecting fire-scar of stem, wind tunnel experiments

were carried out. And in order to establish how to predict the forest fire behavior, field experiments were carried out using opportunities of prescribed fire.

In the wind tunnel experiments, it was observed that the height of stem-bark char registered at the windward face of a stem is smaller than that of the opposite face of a stem under all the experimental conditions. Therefore, an estimate of wind direction from the remaining stems in a burned field can easily be done.

Further it was found that, the height of stem-bark char of windward face of a stem decreased as the wind velocity increased. The height of stem-bark char of a stem opposite the windward direction increased as the diameter of the stem increased. It was derived from these results that the magnitude of the difference in height of stem-bark char of windward face and opposite face of a stem was an important factor for estimation of wind velocity. From a viewpoint of field application, stem-bark char ratio of both faces of a stem tends to be significant as well as the difference in height of stem-bark char of both faces, because of the dissimilarity of scale in wind tunnel experiment and actual phenomena in the field. Dimensional analysis was carried out for the factors affecting the stem-bark char using the observations mentioned above. Based on the results of the study, the equations for estimation of wind velocity were proposed when the stem partially burned.

In the field experiments, first, the wind velocity calculated by experimental equations was compared with wind velocity observed in two prescribed fire sites. It was observed that the wind velocity could be expressed with a high accuracy by the above-proposed equations.

When the fire behavior was an upslope fire, the fire whirlwind directions estimated from the stem-bark char showed a fixed direction. Fire whirlwind direction agreed approximately with slope azimuth, in spite of a prevailing opposite wind direction. Further relationship between fire whirlwind velocity estimated by experimental equations and maximum slope gradient was investigated. However, it was not possible to recognize a relationship between them using individual data of slope angles and wind velocities estimated, which could be due to the differences in on-site condition of experimental logs. But, dividing the slope into ranges and taking mean values for gradient instead of individual values, it was observed that fire wind velocity increased as maximum slope gradient increased.

Keywords: Forest fire; Fire behavior; Wind direction; Wind velocity; Stem-bark char

Forest Plantation Fire: the SAFODA Experience (Sabah Forestry Development Authority)

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Abstract

The Sabah Forestry Development Authority (SAFODA) was enacted in December 1976, its objectives are to convert wasteland and marginal agricultural land to a highly productive forest plantation and to uplift the living standard of inhabitant through employment in reforestation and afforestation work related to forest plantation establishment. SAFODA has allotted 118,756 ha. of land throughout the state of Sabah for that purpose. By the end of July 1998, SAFODA has planted about 31,417 ha. of trees mainly *Acacia mangium* and 8,356 ha. of rattan. Other than pest and disease problems, fire is still the most dangerous phenomena due to its extensive negative impact toward certain ecosystems and has long been the major treat in forest plantation project. In 1983, it is recorded that about 5,565 ha. of the SAFODA forest plantation throughout the state of Sabah had been burnt and the latest occurrence was during El Nino 1998 period, which 3,818 ha. of plantation were totally burnt. The objectives of this paper are to highlight and share the experience of forest fire occurred in the Bengkoka Forest Plantation Project in Sabah, its also discuss the problems encountered, annual budget, fire fighting technique, material and equipment used as well

as the future direction of research needs. Since 1983-1998 there were 124 fire cases in Bengkoka Forest Plantation Project caused by mainly farm burning, smokers, campfires and incendiary. Most of the fire occurred in March to October each year. It is also noted that one to five years old forest plantation is very severe to fire. Therefore, an effective forest fire management system is really needed to lessen these problems.

Keywords: SAFODA; Reforestation; Afforestation; Plantation fires

Natural Regeneration of Tectona Grandis and Gmelina Arborea After Fire in Ikrogon Forest Reserve, Cross River State, Nigeria

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Abstract

Ikrigon Forest Reserve is a dry lowland rainforest, surrounded by a Derived Savannah and located between latitude 6.17 degrees north and longitude 8.36 degrees east. The total forest reserve area is about 600 hectares. The soil is loam to loamy sand with rock composition of mainly granite, quartzo-feldspathic biotite and hornblends-bearing gneisses, schists and magmites (Wright *et al* 1985).

Since the forest reserve is within a derived savannah, there is yearly fire occurrence which affects the natural and artificial forest in the area. At the plantation forest edge, bordering the savannah where principally *Gemlina arborea* (Gmelina) and *Tectona grandis* (Teak) are the planted reserve boundary species, there is annual seed dropping on the forest floor and the adjoining savannah area. This annual seed dropping has led to the natural establishment of seedlings of these plantation species on the frontiers of the adjoining savannah woodland. Over the years, the seedlings have grown under the strong competition induced by annual fire, spatial distribution of seedlings, nutrients, soil, water and sunlight.

The result of this situation is natural selection in which some seedlings have grown to poles and trees while others remain stunted as perpetual understory species due to lack of adequate sunlight and persistent annual fire. The litter drop of *T. grandis* is heavier than that of *G. arborea* and the leaves of the former wider in area than the latter. The leaves of *G. arborea* decay faster than those of *T. grandis*. The result is that there are more *G. arborea* seedlings on the forest floor than those of T. grandis. The perpetual persistent litter of Teak does not support profuse seedling production in Teak.

Data collected in mini-quadrats of 10 m by 10 m show an average spread of about 8,900 seedlings per hectare in Teak and 8,547 in Gmelina. There are also 494 trees established in one hectare of Teak and 567 in Gmelina. This means that the trees naturally establish themselves at an average espacement of 4.5 m by 4.5 m for Teak and 4.2 m by 4.2 m for Gmelina. It is also deduced that in Teak area, over 8,406 seedlings lose the competition battle due to annual fire, heavy leaf litter, root competition, and canopy closure of dominant trees. The maturity survival percentage of the species under natural and untended conditions is 5.6%. Similarly, in the Gmelina area 7,980 seedlings lose the attainment of mechartable size due to fire, competition for nutrients, sunlight, and weeds. The maturity survival percentage of Gmelina in the area is 6.6%. The heavy litter and canopy in the Teak area neither permits weed growth nor speedy development of seedlings. In the Gmelina area however, canopy is almost open thereby allowing for more Gmelina seedlings and weed growth. This is proved by the tree survival in the two plots assessed. The Teak plot does not therefore allow for encroachment of many indigenous species while the Gmelina plot does - especially weeds (Cromolena odorata).

Recruitment and survival is therefore based on the annual severity and time of occurrence of fires, competition for nutrients, sunlight, weeds, and canopy effects. Natural espacements for Teak and Gmelina seedlings on the forest floor are 1.06 m by 1.06 m and 1.2 m by 1.2 m, respectively. Also natural espacement for mature teak and Gmelina are 4.5 m by 4.5 m and 4.2 m by 4.2 m, respectively. The espacements exhibited by

these tree species can scientifically influence espacement decision in plantation silviculture.

Keywords: Nigeria; Plantation fires; Regeneration; Fire severity and timing

Impact of Fire on Forest Insect Species Diversity: A Study in the Silent Valley National Park, India

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Abstract

The Western Ghats of India, which is the most imposing, but extremely threatened topographical, floristic and faunistic feature of the Indian subcontinent is one of the 18 biodiversity 'hotspots' of the world. Spread over an area of 175,000 sq.km. in six States, this mountain range extends more or less parallel to the west coast of Indian Peninsula from Kerala to Gujarat traversing a length of 1600 km. The Silent Valley National Park is situated in the Palghat District of Kerala State, between latitudes 1103' and 11015'N and longitudes 76023' and76030'E. As per the world classification of Udvardy, the area falls under the Malabar Rainforest Realm.

The total area of this forest is 90 sq.km. and accessibility to this area is restricted due to the steep slopes on all sides. The region is characterised by heavy summer rains and the mean annual rainfall is 4400 mm. The major forest disturbance is fire which frequently occurs during the summer season in the grasslands and spreads to the adjacent natural forests. As a result, several patches of natural forests get degraded leading to disappearance of many evergreen species. The 'gaps' thus formed in the forest due to burning are subsequently colonised by various secondary species that are found in the adjacent moist deciduous forests and grasslands.

The impact of fire on insect species diversity was studied in representative plots. Altogether. eight plots were taken along a transect in such a way that four plots were in the fire affected zone and the remaining in the unaffected forest patch. Plot size was fixed as 625 m2 and the distance between plots was 25 m. Data on vegetation and insects were collected from all the plots and from this, the species composition as well as the indices of diversity, dominance, evenness, species richness etc., were computed separately for plots in the fire affected and unaffected zones.

There were 3951 plants belonging to 130 species in the study area, of which 1608 plants belonging to 81 species were found in the undisturbed area and 2343 plants belonging to 109 species in the disturbed area. The diversity index for the undisturbed area was 3.66 and the value for the disturbed area was 3.55.

The floral composition in the disturbed and undisturbed areas was also interesting. While the undisturbed areas had good representation of primary species like Palquium ellipticum, Aglaia sp., Myristica dactyloides, Mesua ferrea, Cullenia exarillata, Holigarna arnottiana, Casearia bourdiloni and Persea macrantha, the disturbed areas had only poor represention of these species. More over, there was an invasion of various secondary species like Olea dioica, Scolopia crenata, Macaranga peltata, Zizyphus rugosa, Walsura trifolia, Celtis sp., Albizia chinensis and weeds like Clerodendron viscosum, Mikania micrantha and Lantana sp.

Altogether. 10451 insects belonging to 578 species under 13 Orders and 67 families were collected from the study area. Of these, 5781 insects belonging to 449 species were from the undisturbed area and 4670 species belonging to 417 species from the disturbed area. Thirteen Orders and 61 families were represented in the undisturbed area and 12 Orders and 60 familiesin the disturbed area. The species diversity index was 4.76 in the former and 4.65 in the latter.

Consequent to the changes in plant composition following forest disturbance, there was a higher representation of arboreal feeding insect families (Geometridae, Saturnidae, Cossidae etc.) in the undisturbed area where as herbaceous feeding families like Pyralidae, Noctuidae, Chrysomelidae etc., were very abundantly found in the disturbed area. The

Orders Diptera, Lepidoptera, Coleoptera and Hymenoptera were the most dominant groups in both the areas.

The implications of forest fire on insect species diversity in the tropical forests are evident from the reduction in species diversity. As a result, several rare and endemic species are seriously affected and many are likely to be phased out unless urgent corrective measures are undertaken. A critical examination of species collected from the study area has shown a steady loss of arboreal feeding forms and abundance of weed feeding forms. Conservation strategies based on the findings of this study will be discussed.

Keywords: Western Ghats; India; Biodiversity; Fire impacts; Succession

Growth and Development of A Maritime Pine Stand After Fire

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Abstract

Three permanent plots, each with 1000 m2 were laid out in 1989 in a State managed pine forest in the northwest of Portugal. The plots, installed in 1989, are located on a natural regenerated pure even-aged stand of Maritime Pine (Pinus pinaster Ait.), after a forest fire in 1975. To decide about the most appropriate degree of thinning for this kind of stands two degrees of intermediate thinning were performed in 1992. In August 1993 a forest fire attained the three plots but it was decided to keep it to evaluate the impact of the fire on tree vigour, tree mortality, tree growth and yield and the occurrence of natural regeneration of maritime pine and other forest tree species.

At the first measurement, in 1989, each plot contained six tree rows, approximately four meters apart. Diameter measurements, at 1,3 meters above ground level, were collected for all trees within each plot, by taking the average of two caliper measurements. Tree height measurements were performed for sample trees only, ca. 40 in each plot, using an extending measuring pole. At the second measurement in 1992 tree height and breast height diameter were measured in the same manner. The height of the beginning of the crown was measured for all sample trees using a pole. The crown was considered to begin at the point on the tree stem where the first two green branches were detected. Furthermore, for all trees within the central four rows of each plot, four crown radii measurements, considering the greatest extension of tree crown, were made at approximately 90 degrees to each other. The overall plot dimensions and the spatial arrangement of the trees within each plot were measured using a extending tape. The corrected distance measurements, for the slope, together with crown radii measurements were utilised to construct crown maps of each plot.

In 1994, 1996 and 1998 tree height, breast height diameter and the height of the beginning of the crown were measured in the same manner, all the trees were examined in relation with the occurrence of pests or diseases and classified according their vigour. In 1998 new crown maps were realised and the natural regeneration was identified and counted in ten square plots randomly located , each with 1m2, in each plot.

The effect of fire on all the above-described parameters and their evolution in the last five years are reported in the paper/poster.

Keywords: Portugal fires; Regeneration; Growth rates

Assessment of Forest Fire Impacts in East Kalimantan Using Satellite Remotely Sensed Data

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Abstract

It is difficult to assess and get general view of large scale forest fire with ground survey alone. Satellite remote sensing technique, which enable monitoring over a large area multi-temporally, were employed to map the extent and degree of the large scale forest fire occurred in East Kalimantan Province, Indonesia, between mid 1997 and early 1998. According to the report of Indonesian Government, this fire damaged more than 520,000ha of forest in this Province. Southern part of Samarinda, the capital city of East Kalimantan Province, was selected as a study site. The study site covers 24,1000ha, including Bukit Soeharto Education Forest (BSEF) and Sungai Wain Protection Forest (SWPF). Although BSEF and SWPF are both protection forests, they have different degree of protection level and different types of vegetation management.

Two change detection analysis methods, Normalized Difference Vegetation Index (NDVI) analysis method and Change Vector Analysis (CVA) method, were introduced to map vegetation cover changes caused by the forest fire, using 5 scenes of Landsat TM data (acquired on 1997/4/13, 1997/8/3, 1998/1/26, 1998/2/11, and 1998/3/31) and 3 scenes of JERS-1 OPS VNIR data (acquired on 1996/9/27, 1997/8/1, and 1998/6/5). Maps of detected change derived from NDVI analysis represented suitable results compared to CVA when using limited ground information, and were adopted as the maps of vegetation cover change in this study. From this satellite remote sensing data analyses, 26.8% of land area in the study area showed vegetation decrease from February to March 1998, which probably caused by the forest fire, and 11.8% showed vegetation increase from March to June 1998 by regeneration of vegetation after the forest fire.

A GIS database of this study area was newly constructed to find out the relationship between human activities and forest loss due to the fire. The database comprises spatial data such as 1) slope model, 2) basin/ridge model, 3) buffer zones representing human activity area, 4) boundary of the BSEF and SWPF, and 5) land cover map of the study area before the forest fire obtained from RS data classification. By overlaying vegetation cover change layers with other GIS layers, it was possible to assess the scale and degree of the forest fire in relation to human impact and vegetation management condition.

From February to March 1998, 54.8% of forest area in BSEF, where protection of vegetation by university had been not carried out sufficiently, showed vegetation decrease caused by the forest fire. While in SWPF, where sufficient vegetation protection by Indonesian Government had been carried out, 31.5% of forest area showed vegetation decrease in the same period. Furthermore, SWPF showed 6.1 times large vegetation regeneration area compared with BSEF after forest fire, from March to June 1998. By using 1 kilometer buffer zone of human activity area, where human impact to vegetation environment thought to be large, 65.1% in BSEF and 50.2% in SWPF showed vegetation decrease from February to March 1998. They suggest that the vegetation change of the study site caused by forest fire have strong relation to the conditions of vegetation management.

Keywords: Remote sensing; Indonesia fires; Fire impact assessment

Sustainable Management of Natural Resources: Fire and Forests

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Abstract

Forests are not merely an economic resource but constitute an essential life support system, especially for the people living in mountainous or rural areas, Recurring forests fires cause considerable damage and degradation to forests and environment every year and more so in a cycle of four to five years. Ministry of Environment and Forest, Govt. of India, appointed a committee to assess the damage from forest fires in Uttar Pradesh (U.P.) and Himanchal Pradesh (H.P.) in 1995. This committee assessed direct economic losses to the tune off 139.3 million rupees, in U.P. alone during the Fire season of 1995. It also recommended that studies to make a scientific and comprehensive assessment of damage resulting from forest fires should immediately be undertaken by the Indian Council of Forestry Research & Education (ICFRE) and then the result of those studies applied in all states in evaluating the loss from the fire damage. These recommendations clearly reveal that research on Forest fires has seriously been neglected.

It is paradoxical that fire protection was one of the first tools of scientific forest management in India, yet research in forest fires has been a neglected field in this country. Although research on two other injurious agencies off forest viz. Diseases and Insect pests started long time ago, limited studies have been made on forest fires so far.

To estimate the true extent of fires losses, quantitative value has to be assigned to various impacts of forest fires. Forest fires are known to bring down considerably the various values e.g. productive, wildlife, aesthetic-recreational grazing, socio-economic & others. It is also essential to have a reliable data base to generate the desired type of information. Expenditure on fire control can be justified only up to an amount representing the savings or loss reduction which results from that expenditure. The more valuable the forest, the greater is the amount that it is worth spending to control fires. Research has to encompass all aspects of forest fire from pre suppression, prevention, detection, control, reporting, quantification and monitoring of losses. In the Himalayan region specific research is required towards cost effective & environment friendly hazard reduction methods e.g. some economically viable use for chir pine needles or some process to hasten its rate off decomposition. A modest beginning towards forest fire research has been made during the past two decades by adopting fire danger rating system for different type of forests, evaluating direct fire losses, designing statistical format for fire reporting for subsequent use in fire damage analysis. In view of the importance of the forests in Himalayan ecosystem forest fire problems of this area need prioritisation in the Forestry research agenda.

Keywords: Indian forest fires; Economic impact; Sustainability; Fire research

Prognosis of Emergency Situations under Wildland Fires

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Abstract

It is proved that climate changes occur with extreme declination of seasonal weather variations and may cause large scale fire emergency situations (Stocks, 1993; Wein, Groot, 1996; Fosberg, Stocks, Linham, 1996). In the last years climate changes are vividly seen in the South of Siberia and the Far East and they are the cause of intensified spring and summer droughts. Due to these droughts such emergency situations often occur when forest and steppe fires become dangerous for inhabited localities and even inflict casualties. This work analyses the peculiarities of dangerous wildland fire development, the

forecasting and possibilities of prevention emergency situations on the basis of vegetation fuel maps. Emergency situations take place when a strong fire threatens an inhabited locality or some valuable object.

The dangerous fire intensity depends on the mass of vegetation fuel burning down in flame regime in time unit per long meter (but not per square meter!) of fire edge. This mass depends on two factors: a) the stock of such vegetation fuel per unit of area and b) the speed of fire edge spread. If the speed of spread is large, the intensity of fire can be very high even under small stock of vegetation fuel. The presence of considerable stock of vegetation fuel burning down in the regime of smoldering (litter, peat, duff) decreases the intensity of flame burning. Fires become of high intensity and, therefore, of danger if they reach the so called phase of self development Firstly, it happens at the expense of their speed increase under potted spread with throwing about burning particles in front of the fire front. It is especially characteristic of explosive fires.

Ignitions in inhabited localities and industrial objects occur because of burning particles which are thrown about in front of a strong forest or steppe fire front. This usually happens in dry windy weather, therefore, ignition of separate dwelling houses and industrial buildings can spread over other buildings and objects. Burning particles can spread up to 500 meters distance and more. Due to this, strong vegetation fires can get over the rivers, unburned bogs and other obstacles.

The main way of protection objects against an approaching strong fire is preliminary backfiring. The history of very large forest fires (for example, fires in the Northern China in 1987) shows that such fires are able to spread freely over the area for a long time destroying inhabited localities and crossing the rives and roads which could be the best initial line for preliminary backfiring.

The list of problems on prevention of loss under the emergency situations, connected with wildland fires close to inhabited localities and others valuable objects, includes the following tasks: 1) showing up of inhabited localities which can be damaged under wildland fire (forest, steppe and so on); 2) elaboration of prophylactic measures on protection of such objects from wildland fires; 3) prognosis of possibility of wildland fire dangerous development, active near the inhabited locality or near the industrial object; 4) prompt, safe and reliable stoppage of dangerous fires with the least expense of strength and means.

The solution of enumerated tasks is possible on the basis of vegetation fuel maps usage and method on vegetation fires behavior prediction. Technology of vegetation fuel maps creation on the basis of forest inventory data and air-space information and method of fire behavior prediction are elaborated (Volokitina, Klimushin, Sofronov, 1995).

Keywords: Russian fires; Climate change; Vegetation mapping; fire behavior

Seedling Survival, Mortality and Regeneration After Fire in A Tropical High Forest in Ghana

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Abstract

Tropical high forests were previously thought to be immune to fire. However, studies and empirical evidence have suggested that fire might have played an important role in their evolution. Following the extensive bush fires throughout the tropics in 1982-3, fire has become a major issue impacting on the management of dry semi deciduous forest types of the tropical high forest of Ghana. Several hectares of intact forest have been degraded due to the combined effects of recurrent fires and logging.

Studies including prescribed burning have been conducted elsewhere with the aim of reducing the detrimental effects of fire on the forest, whilst promoting regrowth of woody vegetation. However, most of these studies have focused more on the savanna woodlands and transition zones and least on the tropical

high forest itself. At present, data is not available for a systematic study of the influence of fire on seedling survival, regeneration and tree mortality following fire in the tropical high forest.

This study attempts to quantify the effects of early and late burning on the survival and mortality of seedlings and trees and regeneration after fire in a tropical high forest in Ghana. It has been observed that tree seedling survival and mortality and regeneration thereafter are greatly influenced by the time of burning,. Early or late burning is rather subjective and is determined by the prevailing weather conditions at the time of burning.The implications for forest management in the dry zone of the tropical high forests are discussed.

Keywords: Ghana tropical forest; Regeneration; Early/late burning

About the Necessity of a New Approach to Estimating Forest Potential Pyrological Forests

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Abstract

Principles of forest protection from fires, the evaluation of their consequences and their elimination, as has been shown by the catastrophic fires 1998 in Khabarovsk Territory, Russia, are no longer the matter of any separate country or any of its regions alone. Catastrophic forest fires periodically appear in this or that region and not only in Russia. No atrocious forest exploitation can be compared with the pyrogenic consequences, because only due to fires in a very short period are possible irreversible disturbances and destructions of formed many centuries ecological connections and trophic chains on the vast territories. Besides, as a result of fires, the indirect consequences are possible which it is impossible to take into account immediately. For example, soils destruction on mountain slopes in the result of burned stand decomposition which could happen after 10 or more years after the fire.

Experience shows that no country having large forest volumes located in insufficiently accessible areas (due to weakly developed road networks) is not indemnified from the development of fires up to catastrophic sizes with all ensuing global ecological consequences. The world community is not so much worried by the loss of raw potential of the forest lands as by those ecological consequences which follow mass deforestation of the territories. Among the most meaningful ecological consequences are soil erosion, low river water, the loss for a long period carbon sequestration functions and, as a consequence, contravention of climatic situation on the planet. Evidently, it is necessary to improve all facilities of forest protection from fires - from their forecast and inventory to elimination of their consequences.

One of the important aspects is the determination of fire cause needed both for current and retrospective analysis of succession dynamics. If earlier it had a specifically administrative meaning, then today the role of cause in determination of priorities in pyrologic territory organization, prophylactic work with the population, improvement of legislative and regulatory bases becomes more actual.

It is evident, that both physically and economically there are no possibilities to fight all forest fires. In other words, it must be discriminatory relating territory and relating the value of forests. Such experience has been accumulated, particularly, by Canada. For Russia conditions, with its mammoth and hardly accessible territories, it is necessary to zone areas on a new basis - first of all according to forests ecological value, not only formally stated in the regulatory documents, but also actual, for example, according to carbon sequestration ability. The last could be estimated on green mass production and not only by the stand, but forest coenosis on the whole. According to these signs, the territory must be differentiated by zones according to prioritization of fire control active methods use under mass ignitions, similar to fires 1998, and

according to the necessary expenditures for prophylactic measures.

To prevent fires and decrease their destructive impact, especially in the forests of high ecological and social value, it is necessary to introduce a system of prescribed burnings with the elaborations of corresponding technologies and regimes relating to the concrete forest formations or even to economic groups of the forest types. Similar experience also has been accumulated by a number of countries.

One of the most important moments of a pyrological situation estimation is forest fires registration system improvement. It must be not only forehanded and independent from any interests but accessible both for professional use and for informing of population. This will permit to exclude disinformation, and also will be a good foundation for arranging global monitoring of forest fires dynamics and their consequences. Realisation of this thesis is possible with the use of satellites. Besides all, it will permit to advance sufficiently the formed system of land and airplane protection of forests.

Keywords: Russian Far East; 1998 fires; Biodiversity; Protection strategies

Influence of Bush Fires on the Dynamics of Dry Forest:Case of Degraded Forests in North-Benin

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Abstract

The North-Benin is in the dry part of the country where dry season covers 6 to 7 months of the year with a rainy season of 5 to 6 months. The average temperature is about 27°C with the rainfall oscillating between 900 and 1200 mm annually. The vegetation is savannah type with low density of large trees. The main activities are agriculture, breeding and hunting. In this part of the country, bush fires are widely used by farmers, breeders and hunters for their activities. So, every year, many hectares of forests are burnt with consequence of gradual degradation of forestland. This attitude of populations has a sociological foundation, which is not easy to overcome. In order to appreciate the real impact of fires on natural regeneration of forest, an experiment was initiated in 1990 with objective to determinate the appropriate periods for fires use as a tool for forest management. For this purpose, five treatments have been applied on six different sites as following: a) use of "Early fires" (EF) on 11 November and 11 December; b) use of "Late fires" (LF) on 11 January and 11 February; c) no fire use (NF) as control. After some years of observation, the tests have been evaluated in 1996 and 1997 in order to appreciate the evolution of plots. The results appear that the LF is very damaging for young regeneration with about 95% seedling burnt causing in fact progressive genetic erosion and the destabilization of soil. On the other hand, the EF of 11 November stimulated more the natural regeneration with appearance of new species in the experimental plots. With this treatment, it has been observed a natural pruning of trees with best development of trunk. Concerning the protected plots, grass has grown with high concurrence to young regeneration and natural sowing and seedling. On these plots, it also appeared that the renewal of grass is low comparing to EF, the trees have developed large crown with big branches and the high accumulation of dead vegetation. The conclusion is that, fire is a real tool for forest management in dry regions when its use is well analyzed. For now, fire appears as the best tool to fight against the risks of uncontrolled bush fires in dry regions in regard to the context of socio-economic conditions of the populations concerned. The EF applied just at the beginning of dry season has a positive influence on natural regeneration and the reconstitution of dry forests for wood and fodder production as well for biodiversity conservation.

Keywords: Benin; Bushfires; Early fires; Late fires; Regeneration; Dry forests; Natural forests; Forest management.

Monitoring and Assessing Forest Fires Using NOAA AVHRR Data With Special Emphasis on Borneo

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Abstract

Forests are managed not only for the production of wood, but also as a safeguard for environment. One of the main factors effecting forest degradation is forest fires and uncontrolled burning. Asean countries especially Malaysia and Indonesia were most affected by forest fires during July-November, 1997. The worst haze occurred in Sarawak, Malaysia when the Air Pollution Index (API) reached 800, exceeded the 500 danger level. Consequently the state was declared emergency by the government. This paper will highlight the capabilities of satellite image (NOAA-AVHRR and SPOT image) in monitoring forest fires. Observation and studies showed that the haze was caused by fires and burning. This paper also assessed the burned forest areas and the relationship between the number of hot spots and the severity of haze occurrence i.e. affected areas. The causes of forest fires were highlighted and management plan of forest fire control was proposed.

Keywords: Indonesian fires; Remote sensing; Smoke/haze; Fire management

Effect of Fire on Soil Properties in Pine and Natural Forest in Sri Lanka

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Abstract

Forest fires have become regular events in Sri Lanka due to intentional burning by livestock owners and hunters and practice of slash and burn agriculture (shifting cultivation). The foresters as a tool to eliminate undesirable weeds or dominant species in forests also use burning. In Sri Lanka other than the natural forest, part of the hill country is reforested using exotic species as Pinus and Eucalyptus. Much information is available on the regeneration of forests and regarding the change of the composition of vegetation after forest fires, its effect on soil properties have not been studied in detail. By studying the effect of forest fires on soil properties will help in understanding forest regeneration patterns and help in efficient management of natural and plantation forests. Therefore the objective of this study was to study the effects of fires on soil physical and chemical properties in a natural and pinus forest in Sri Lanka. These were studied at three stages, namely before the occurrence of fire, one day after fire, one and three months after fire.

This study was conducted in adjoining pinus and natural forest in the mid country of Sri Lanka. The soil profiles of the two sites were described using the FAO guidelines and the major soil horizons were identified. Soil properties as soil texture, acidity, total nitrogen, available phosphorus, organic matter and aggregate stability were measured. The area were burnt as usually done at the end of the dry season before the rains and similar measurements were conducted for soil samples obtained one day and three months burning.

More emphasis in this study was given to the determining of dry and wet soil aggregate stability, as soil erosion is one of the major problems in these sloppy lands. The dry

aggregate stability was determined using dry sieving with a nest of sieves. The mean weight diameter and log standard deviation was obtained as aggregate indexes reflecting resistant to erosion by wind. Wet aggregate stability was determined by wet sieving using a single sieve technique. The percentage of the initial sample remaining after 18 minutes of sieving was used as the index showing the resistance to erosion by water.

The results showed that the soil pH increased just after burning and again decreased to the original value after about three months. The increase was higher in the pinus plantation than in the natural forest. The increase was from 4.6 to 5.1 and is mainly due the basic nature of ash remaining after burning. Afterwards these bases are easily leached due to rainfall and the soil becomes strongly acidic as before. The soil organic matter content nitrogen decreased with burning which the most damaging effect related to the loss of biomass to the atmosphere. The available phosphorus increased significantly in the surface layers of natural forest due to burning. The available P increase from 40 to 62ppm in just after burning and decreased to 50 ppm after three months. The change in available P in pinus plantation was not significant.

The dry aggregate stability and wet aggregate stability decreased in the pinus forest with burning. In the natural forest the decrease in soil aggregate stability were not significant. These aggregates developed to the original size after three months of burning. This shows the vulnerability to soil erosion by wind and water in the pinus plantations during the first three months of burning.

This study shows how the soil property change after burning in natural and pinus forests in the mind country of Sri Lanka. In both forest types the chemical properties changed significantly after burning. In natural forest the properties attain the pre-burning values in three months after burning while in pinus forest it took longer times. In the pinus forest the susceptibility to soil erosion increased during the first three months after burning when compared with the natural forest.

Keywords: Sri Lanka fires; Fire severity; Soil properties

Forest Fires in Russia

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Abstract

The area of the forest stock in Russia, including forests transferred to the permanent use, according to the calculation made in January 1,1993 is 1180,9 million hectares. Burned-out forests, cuttings, swamps and hayfields are also included into this territory. Forests proper take the area of 705,8 million hectares; 507,7 million hectares are covered by coniferous species: larch (52%), pine (22,5%), spruce and fir (17,8%), and cedar(7,7%). Acerous leaves(needles) and timber of these species contain essential oils and colophony, that is why they are too flammable(susceptible to fire). Russian forests have a multiple-aged structure: undergrowth-22%, middle-aged-33%, maturing-11%, mature and overmature-34%. Formation of such forest structure was influenced by industrial cuttings; but the main factor of taiga forests formation is forest fires. According to the official statistics their number varies from 13,4 thousand (1987) to 31,3 thousand(1997); the area of forests, subjected to fires -from 569(1987) to 2450(1998) thousand hectares. Pine and larch forests of the North, Siberia and Far East, growing on the drained, rising grounds are mostly subjected to fires.

The average temporal interval, during which these forests may undergo low fires is 30 years. In the course of this period the critical amount of combustibles, able to catch fire in hot dry weather and keep burning, is accumulated under the forest canopy. Spruce young growth, which is a constant competitor to pine and larch, burns out in low forest fires. Dark-colored spruce-fir forests grow on the low areas with damp(moist) soils close to subsoil waters. That is why fires can hardly occur in these forests even in the short-term periods of drought. In case of fierce droughts, occurring every 70-90 years, when caught by fire spruce-fir forests burn out completely, without any young growth left. Due to this

reason their further reforestation goes, as a rule, through the change of species, that is, at first, the process of regeneration of cutover stands by broad-leaved species (birch and aspen) takes place, and only then young spruce and fir sprouts start growing. In the light-colored coniferous 30 year-old forests low fires, which do not cause damage to them, prevail. These fires play the role of thinnings, by means of taking away weakened trees and those falling behind in growth, providing the rest of trees with optimum light condition and space for roots development. In the permafrost region of light-colored coniferous forests low fires destroy the mossy cover, warming overburden layers.

After fires the level of permafrost goes down, but the power of root layer increases, providing conditions for significant increment of trees. It is found out that successful reforestation of pine and larch can be possible only as a result of low fires, destroying thick mossy cover and debris layer. With the average interval between fires of 30 years and the mean age of mature and over-mature forest crops in the boreal forests of 150-200 years, every crop is subjected to low fire as many as 4-7 times during the period of its growth before it is completely replaced by young growth. Only top fires may happen on the areas covered by coniferous young growth, but they lead to the complete damage of the latter. By the way, pine undergrowth is mostly subjected to fires. Dead larch undergrowth cover burns out only in the periods of drought, accompanied by strong wind. Artificially planted even-aged coniferous crops seldom happen to grow till their natural decomposition.

On the contrary, wild multiple-aged forests, formed by fire during millions of years, not only survive in the temporal fire weedings, but even improve, becoming more fire-resistible. We have a powerful overland and aviation forest service, which protects forest stock territory on the area of more than 700 million hectares. With the help of aviation, tele-and infrared equipment, and data obtained from artificial Earth satellites, forest service detects and eliminates considerable number of forest fires in proper time. But we should admit, that these activities do not exert great influence upon the general amount of forest fires. On the contrary, eliminating forest fires we favor the accumulation of combustibles under the forest canopy, which may cause destruction of the crop in case of fire. Every year in two or three regions of the country fire passes through the area of 1-2 million hectares. Coordinates of these regions, time of fires origin, their number and extent of the burned out territory are programmed by nature itself, but it is still beyond our capacity to make a prediction in advance. Specialists in the field of fire fighting assure, that fire behavior in the forest is unpredictable. It is necessary to carry out a thorough and detailed research of this natural phenomenon, to reconsider our hostile attitude to the fire and to start using it as an ally.

Keywords: Russian forest fires; Light forest; Dark forest; Succession

Management and Conservation of Forest Gene Resources: Social and Economic Considerations

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Abstract

This paper discusses social and economic aspects of management and conservation of forest gene resources. The goal is defined as sustainable use and development of forest gene resources toward sustainable improvement in the human condition through wise self management and wise environmental stewardship. A review of the kinds of human values that may be associated with or dependent on forest gene resources, including economic value, leads to identification of the boundaries of economic value as a necessary but not sufficient criterion. Social and ecological complexity, bounded human rationality, and institutional dysfunction stand as obstacles to achievement of the sustainability goal. The policy and management choices we make now will determine Homo sapiens' long-range alternative futures. Our choices include (1) guiding cultural and institutional evolution

through a "new social contract for science," public education, and wise political leadership and (2) allowing the invisible hand of the macro processes of nature to take us where they will. The first is the recommended course, but governmental interventions must be evaluated carefully to ensure that the "cure" is not worse than the "disease." The paper closes with the proposition that while social dysfunction may be the proximate cause of our erosion of natural capital, it poses a more immediate threat to our well-being.

Keywords: Human values, Economic, Social, policy, Management

International Action in the Management of Forest Genetic Resources: Status and Challenges

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Abstract

The paper describes some work carried out at international level in the field of forest genetic resources. It points to the urgency to translate general principles and international agreements into operational national programmes aimed at the wise management of these valuable resources, the need to review national forest genetic resources programmes within the framework of regional plans and activities, and the desirability to develop an action oriented, country driven framework to ensure complementarity of action at global level.. Special reference is made to recent efforts by FAO and international and national partners to support and facilitate the elaboration and implementation of regional and sub-regional action plans for the conservation and sustainable use of forest genetic resources.

Keywords: Biological diversity, Forests, Forest genetic resources, Genetic conservation

Guidelines for Gene Conservation Based on Population Genetics

by
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Abstract

The current levels of genetic variation, and the distribution of that variability within and between tree populations is due to hundreds of millions of years of interaction between the different evolutionary factors, mutation, migration, recombination, genetic drift and natural selection. Artificial selection, breeding, and silviculture have so far had minor genetic effects on most tree species. The same evolutionary forces go on dynamically changing the genetics of the populations.

We should not strive to maintain the current status, but the goal of gene conservation, be it *in situ* or *ex situ* will need to be to allow these evolutionary processes to continue. The biological characteristics of species will to a large degree dictate the possible approaches to gene conservation .While there is much variation between species of trees in their genetic characteristics, most tree species are characterised by an outcrossing mating system and high levels of inbreeding depression. This means that care must be taken to control and monitor the potential level of inbreeding in breeding and production populations. Most species also have high level of variability in the genome in general, and in important quantitative traits, even if the distribution of this variability may differ between traits. When the gene pools of the species are actively managed through breeding or silviculture, it will be important to be aware of the influence of the different evolutionary factors. These principles will be illustrate with examples mostly from temperate tree species.

Keywords: Gene conservation, Population genetics, Forestry.

Impacts of Silviculture and Forest Management on Genetic Diversity of Trees

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Abstract

Most forests must be used to satisfy the requirements of a growing human population wanting a better life. Forest management and silviculture affect gene diversity, positively or negatively, but almost all diversity may be maintained through a suitable combination of conservation areas and managed production forests. As long as due consideration is given to regeneration, most forms of harvesting have a limited effect on long-term diversity.

Regeneration is the key silviculture activity that determines the diversity of future forests and their capacity for sustainable production. Both natural regeneration and cultivation can produce new stands with acceptable diversity. Well-planned and implemented tree improvement helps maintain diversity and at the same time can provide more productive reforestation materials. Diversity patterns typically differ between production forests and conservation areas. Production forests have a simpler structure, less species and age class variation within stands. Much of the variation instead is among stands.

Many foresters do not fully understand the value of the genetic resources they handle. The scientific community must take the responsibility for making foresters more aware.

Keywords: Silviculture, Management, Genetics, Diversity, Regeneration

In situ Conservation, Genetic Management and Sustainable Use of Tropical Forests: IPGRI's Research Agenda

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In dedication to the late Dr. Abdou-Salam Ouédraogo, who established and led IPGRI's Forest Genetic Resources Programme with remarkable vision, professional dedication, and a contagious enthusiasm from 1993 to 1999.

Abstract

The research programme of the International Plant Genetic Resources Institute (IPGRI) on *in situ* conservation of forest genetic resources (FGR) in the tropics is discussed. The introduction highlights the value of forest genetic resources, stresses the importance of their dynamic conservation and opportunities for fulfilling basic human needs, and refers to constraints and challenges encountered in tropical environments. In the context of IPGRI's overall objectives and modes of operation, the FGR research agenda in relation to *in situ* conservation is described and illustrated with recent findings and on-going research activities. Selected priority areas for research include: 1) finding methods to prioritise species, populations, and conservation activities, 2) assessing patterns of genetic diversity and threats, 3) understanding biological processes regulating genetic diversity, 4) assessing the impact of human activities on genetic processes, 5) understanding local use patterns and devising participatory FGR conservation schemes. I*n situ* conservation is a complex task, requiring a multidisciplinary approach integrating socio-economic, ecological and biological aspects. The need for additional technical and scientific knowledge, regional collaboration, appropriate

policies, public awareness, and commitment at national, regional and international levels to enable more effective *in situ* conservation programmes and promote sustainable livelihoods is emphasised.

Keywords: *Insitu* conservation, Tropical forest, IPGRI

Impacts of Air Pollution and Climate Change on Forest Tree Populations

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Abstract

Globally, anthrogenically-linked atmospheric pollution by the greenhouse gases, such as carbon dioxide, ozone, nitrogen oxides and methane, are increasing in phase with increasing human population. In addition, the global climate is being impacted by the greenhouse-gas-induced changes in the balance between solar radiation absorbed by the earth and the radiation re-emitted into space. The increased radiative forcing caused by the greenhouse gases is causing a general global warming. In this paper, I will document previous air pollution-induced changes in forest tree populations, review the current predictions for genetic consequences of rising atmospheric pollution and climate change, and propose some genetic management strategies to minimize future impacts.

Keywords: Genetic structure, Gene conservation, Air pollution, Climate change

Forest Insects and Forest Sustainability in the Next Millennium

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Abstract

Forest sustainability refers to a forest's long term, unfailing capacity to grow, reproduce, and to deliver all of the essential ecological and economic services that human expect from it, while coping with myriad environmental vicissitudes, not the least of which are rapid global climate change and chronic herbivory. As global temperatures rise along with carbon dioxide, there will be inexorable and unpredictable changes in the community structure of native insects which live on and in trees. This will very likely lead to new "pests", more frequent outbreaks, and higher ambient levels of herbivory. Throwing yet another wildcard into the mileu, the continuing influx of exotic herbivores caused by expanding world trade and travel, are leading to an ever burgeoning list of exotics inforests.

Their impacts on forest sustainability are particularly worrisome because they have historically had substantial and long-lasting negative impacts on biodiversity and forest productivity. The next millennium will bring many new challenges to land managers whose responsibility it is to ensure sustained outputs from the world's forests.

Keywords: Forest sustainability, Forest insects.

Bioecology and Management of the Pine Wilt Disease-Its Epidemics and Environment-

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Abstract

Pine wilt caused by pine wood nematodes, which is endemic to North America. In 1999, pine wood nematode, is a devasting epidemic disease of pine forests in Japan and which has already spread to East Asia, including China, Taiwan, and Korea, and *Bursaphelenchus xylophilus*, was discovered in Portuguese forests. If it were to become established in the pine forests in Europe, it could become one of the most serious threats to coniferous forests worldwide. The objectives of this paper are to clarify the wilting mechanism of the disease and to consider control measures.

Keywords: Pine wilt disease, *Bursaphelenchus xylophilus*, Pine wilt mechanism, Epidemic disease, Disease control programme

Potential Roles of Global Change in Forest Health During the 21st Century

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Abstract

The atmospheric environment in many forested regions of the world is changing. Levels of tropospheric O_3 are generally increasing and higher seasonal sums of O_3 are anticipated with warmer summers. In developed countries, anthropogenic emissions of SO_x have decreased dramatically in the past decade while emissions of NO_x are stable or increasing. The acidification potential from acidic deposition remains nearly constant. Nitrogen saturation is an increasing threat to the sustainability of some essential ecosystem processes. In developing regions of the world, emissions of SOx and NOx are expected to increase dramatically within the next 50-100 years. Coincidentally, the global climate is changing. The frequency of extreme climatic events appears to be increasing against a backdrop of a general global warming trend. Concentrations of atmospheric CO_2 continue to increase with modelled predictions suggesting significant forest fertilization while empirical evidence points strongly to a significant offset due to O_3 and N saturation. Stratospheric ozone depletion has resulted in large increases in biologically-effective UV-B radiation reaching forests. Reports and predictions of

increasing forest growth due to increasing CO_2 should be considered a shorter-term phenomenon. Investigation of forest air pollution case histories reveals indications of increased levels of environmental stress on forest growth and essential cycles such as water, carbon and nutrients. Current research indicates that climate change may lessen or enhance air pollution effects. In this paper, we review the evolution of approaches used to investigate air pollution effects on forested ecosystems and propose the essential elements of a new integrative concept.

Keywords: Forests, Forest health, Global change, Air pollution, Climate change

Smoke Emissions from 1997 Forest Fires in Southeast Asia

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Abstract

The widespread bush and forest fires that occurred in Indonesia between April and October 1997 caused extensive episodes of haze or smoke throughout the region, particularly in Indonesia, Malaysia, Singapore, Brunei and parts of the Philippines and Thailand. Satellite imagery analysis has revealed that most of the fires started in the plantation areas in Borneo and Sumatra as a result of burning for land clearing and preparation for agricultural practices. The dry conditions in Southeast Asia resulting from the 1997 El Niño - Southern Oscillation (ENSO) climate phenomenon exacerbated the problems and made forest fire control more difficult. At least three combustion processes with specific characteristics were identified, namely, flaming, smoldering and mixed. More than 1,000 fires affected an estimated 300,000 ha or more, with some estimates extending to 800,000 ha. The question of biodiversity loss has yet to be assessed. The severity and extent of the smoke haze pollution were unprecedented and the region experienced extended periods of high particulate levels and severe reductions in visibility. The haze pollution also resulted in considerable health impacts to the people although the long-term health effects are yet to be determined. Long- and short-term implications of visibility reductions during the haze period on the survival of light-demanding and shade-tolerant species on the forest floor and their potential to shift species compositions in forest ecosystems due to changes in ecophysiological processes are also discussed.

Keywords: Forest fire, Haze, Health Impact, Haze particle, Forest Ecosystem, Ecophysiological processes.

Forest Pathogens, Forests and Society

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Abstract

Tree diseases have greatly influenced the activities of humans. This is commonly experienced in forestry where the occurrence of fungal diseases limits the planting range of a specific species or clone. In agriculture, tree diseases have necessitated the use of expensive chemicals and the development of complicated management and quarantine practices to limit losses. Diseases have greatly influenced trade and export routes, with many countries not accepting any fruit or plant material from countries where a specific disease occurs. Diseases have also had a devastating impact on native forests. Examples such as Chestnut blight and Dutch Elm Disease in Europe and the U.S.A. and Phytophthora root rot in Australia are but three examples. As our environment is placed under more pressure from the increasing human population and its activities, so the impact of tree diseases is likely to increase in importance and severity. Only with careful management and a strong vision for forest protection will we be able to ensure the survival of this important resource.

Keyword: Forest pathogens, Forest protection.

A Look At The World's Timber Resources And Processing Facilities

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Abstract

Sustainable development has become the umbrella objective for forest management in many countries of the world, and managers are increasingly faced with the challenges of balancing environmental and economic health in their forest management and resource utilization decisions. It can no longer be assumed that abundant raw materials are available simply for the taking. Changing times require that we change how the forest resource is managed and used. As we look to the future, we must develop a better understanding of the complex interactions of wood use and the resultant social and ecological considerations. This paper addresses the value of wood in human societies, provides a brief review of the world's forest cover, discusses worldwide links and expectations, makes the case for forest products technology, discusses global trends in forest products, discusses future supply and demand for industrial roundwood and wood products, and examines ways to meet future challenges.

Keywords: Forest management, Sustainable development, Forests, Value, Forest products technology

Principles of Timber Harvest Planning

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Abstract

The purpose of timber harvest planning is to anticipate the future in a systematic way and threby reduce uncertainty. Numerous techniques have been proposed for ensuring sustainable timber yields and for evaluating alternative scenarios of forest development. Some of the techniques are limited to applications in simple forest production systems while others are suitable for any type of forest management, including selective harvesting systems. An important aspect of sustainable forest management is risk analysis which involves the evaluation of potential hazards for a given forest area and reference period.

Keywords: Risk analysis, Continuous cover forest.

Sustainable Production of Forest Products in the Humid Tropics of Southeast Asia: Latest Developments

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Abstract

A few Southeast Asian countries, particularly those from the everwet region like Indonesia and Malaysia that are endowed with timber-rich dipterocarp forests, dominate the

international tropical timber trade. Many of these countries are quite dependent on the timber revenues, and so managing these natural resources on a sustainable basis is of high national importance. In this brief review, the state of forest management and product development in the region is given.

Attempts at sustainable management of natural forests have had a long but variable history in the region. The management systems were based on systems developed in European forests and subsequently tested in India and Burma. In the early part of the century the demand for timber was mainly domestic, and only the heavy and durable hardwoods were exploited. Management systems were developed to improve the poles, and subsequently the young regeneration of such species. With development of preservatives and mechanization of saw-milling, the number of species that can be utilized expanded, and the need to harvest large volumes in a unit area increased. A well renowned uniform tropical silvicultural system was developed to manage these timber-rich forests. Today, most of these forests have been exploited or converted to agricultural use. Forestry was relegated to the hills which are poorer in timber, and management problems more complex. Selective felling systems based on diameter limits became standard practice throughout the region. However, heavy logging damage to the residuals makes the system bicyclic instead of being sustainable. This, and concern for loss of these species rich ecosystems has brought about new ideas in management of tropical forests. There has been a departure from the concentration on yield management to practices that are holistic, and which encompass concern for biodiversity, socio-economic issues, environmental protection, etc. Today, foresters in the region are grappling with certification matters, "green timber" issues, carbon sequestration, minor forest products, and benefits to forest dwellers. The future of natural forest management would probably give less emphasis to timber production.

With the forecast that natural forests will play a lesser role in timber production, interest in plantations has grown in recent years. While there has been a long history of plantation trials, few successful models exist in the everwet region of Southeast Asia. Earlier attempts to produce fast growing exotic hardwoods for general utility timber saw massive failures. But small pockets of successes do exist and are now being expanded. There has been a swing in favor of planting indigenous species and mixtures of such species, out of consideration for biodiversity and pest problems in plantations. Research into high yielding clones, mass propagation using biotechnology, appropriate silvicultural practices, etc. are paving the way rapidly. All these spell a bright future for timber plantations in the region. In the next decade or so, the dream of capturing the high productivity in the everwet tropics may be fulfilled.

Product development is critical in furthering the effort towards achieving sustainability of resources. This area too has progressed with great strides and bounds since the beginning of the century. From utilizing a narrow group of highly durable heavy hardwoods, research in preservation techniques have made the majority of the big trees in the forests potentially usable. This saw the utilization swing from a handful of species at the beginning of the century to almost 300 species at the end of it. Other improvements in technology too have totally changed the processing and utilization of wood. Development of panel products, utilization of wood waste, developing technology with low environmental impact, laminating technology, etc. have resulted in better utilization of wood resources, leading to reduction in resource demands, and sustainability of the resource.

Keywords: Humid tropics, Sustainable production, Natural forest, Plantation forest, Forest products

Sustainability of Raw Material Supply - Research Perspectives of an International Forestry Corporation

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Abstract

Consumption of paper products will increase along with worldwide population growth and economic development. This will inevitably lead to increased use of raw materials within the industry. In the foreseeable future wood fibre (primary or recycled) will remain the main raw material source for the expanding paper and board industry. Stora Enso is one of the largest forest products companies in the world. Stora Enso's target is to grow and expand its production particularly in the paper and board industry, and the sustainable supply of raw material is therefore a major concern for the company. Stora Enso conducts various research and development (R&D) activities at its research centres, mills, forest departments and plantation projects. Most of the R&D resources are assigned to the development of industrial processes and new products. The efficient use of raw materials and the reduction of environmental effects are also important subjects. The contents of actual forestry R&D programmes are assessed separately for each country of operation and are based, among other things, on the existing scientific knowledge, magnitude of the company's forestry operations, forest conditions, forest ownership, and social, economic and natural environment. In Europe and North America national forest research is highly advanced and therefore Stora Enso mainly seeks low-cost collaborative arrangements for its specific forestry R&D needs. Consequently only modest R&D resources are assigned for forestry issues, and most efforts are focused on improving harvesting, storage and transport logistics. Stora Enso is presently involved in forest plantation projects in Brazil, Indonesia, Portugal and Thailand. Practically oriented R&D programmes are substantial parts of these projects. The main justifications for high research inputs are prospects for great productivity and quality improvements through genetic tree improvement, genotype-site matching and appropriate silviculture. Securing sustainable site productivity and control of pests and diseases over successive rotations are also fundamental R&D topics. Social and environmental issues are important in each project and require appropriate R&D activities. Collaborative research between companies and institutions in these countries is often difficult to practise, and therefore efficient, individual R&D programmes are necessary.

Key words: Stora Enso, Pulp raw material, Research, Fast-growing plantations.

Current Timber Supply and Demand in Taiwan Compared to that in Major Asian Countries

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Abstract

With the ever-increasing concern for environmental protection, it has become necessary for governments, resource managers, and forest industry to implement a reasonable forest establishment and utilization policy to ensure that environmental goals are met. This "Eco-management" has strongly influenced the supply of forest products in Asia, where people experienced a very fast economic growth from 1992 to 1996. The forest area in Asia in 1995 was about 565 million ha. There was a net loss of 16.6 million ha. between 1990 and 1995 due to the conversion of land to non-forest uses, representing an annual decrease of 3.3 million ha. Annual decrease was slightly less than one half of that rate from 1980 to 1990. While the area of the Asian forest has been steadily decreasing, the FAO data indicate that the consumption of roundwood in this region increased by 6.6% between 1992 and 1996. At the same time, the production of roundwood

increased 6.1%. Exports of industrial roundwood from Asia decreased dramatically in 1993, resulting in an average annual decrease of 9.2% from 1992 to 1996, while world exports maintained an average increase of 1%. The unit value of the exports from Asia was one third higher than the world average, while those from Myanmar, Cambodia and Singapore were even three times the world average. Although world sawnwood exports increased 17.7% from 1992 to 1996, the amount from Asia decreased steadily from 9.6% to 5.9% of the world total. The unit value of the goods exported from Asia was nearly 70% higher than the world average ($US 223 thousands). Sawnwood products from Indonesia were valued almost three times the world mean value. Timber production has, for many decades, played an important role in support of economic development in Taiwan. Recent forest policy has emphasized conservation, sustainable management and multiple uses of forest resources. Imported sawnwood, on a log basis, totaled 5.02 million m^3 . Recycling of wastepaper provides 3.1 million tons of the fiber needs of the paper industry. The promotion of wastepaper recycling has increased domestic recovery from 2.30 to 2.79 million tons from 1992 to 1997. The total use of wastepaper in 1997 was 4.1 million tons. Four major factors more efficient processing, diversifying raw material sources, increased recycling and expanding the use of residues have enabled the forest industry in Taiwan to reach her goals for value-added processed products.

Keywords: Timber supply, Demand in Taiwan.

Sustainable Roundwood Supply in the Republic of Korea

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Abstract

The timber market of the Republic of Korea can be characterized as being 1) import-oriented supply and 2) domestic-oriented demand. Recently, import patterns have also been changing as follows: 3) from hardwood to softwood, 4) from high to low quality, and 5) from roundwood to wood products. These 5 characteristics indicate that the Republic of Korea is a typical country importing wood-based raw materials, and today faces difficulties in securing a sustainable supply of roundwood through both domestic production and imports. As a method meeting the needs of environmental protection while securing a stable supply of wood based materials, the establishment of overseas plantations of fast-growing tree species has been decided upon by Korean companies and government. It is primarily aimed at ensuring a sustainable supply of wood materials. The Korean Government also aims to avoid disadvantages as a log consumer country and to gain a good reputation as a country that contributes to preserve the global environment. In establishing plantations, there are basic principles proposed by government. Fast-growing tree species would be favoured and countries which are geographically close would be preferred to other countries farther afield. In any case, the political and economic safety of investments should be secured. To ensure the security of investment, a series of security pacts with partner countries have been concluded. For investment safety from the economic viewpoint, reports detailing the investment environments of various countries such as Malaysia, Vietnam, Myanmar, New Zealand, Australia, Solomon, PNG, Chile and China have been issued. The Government also finances corporations or personal investors who plan to establish plantations overseas. 90-100% of the cost of establishing plantations is financed with a low interest rate of 3%. The financing period is 10-20 years for fast-growing tree species and 28 years for tree species of long rotation.

Keywords: Timber market of Republic of Korea, Environment protection, Export restriction, Sustainable supply of roundwood, Establishment of fast-growing plantations, Support policies.

Criteria and Indicators For Sustainable Forest Management at The U.S.A. National and Regional Level

by
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Abstract

At a variety of scales, and in a number of arenas, efforts are underway to define "sustainable forest management" and to measure it (or progress toward it) using criteria and indicators. The purpose of this paper is to use readily available information to describe several broad scale measures that can be used both to describe the state of ecological and social conditions and in a discussion of joint consequences of various management actions. Here we develop an index of timberland integrity that is a combination of six measures of various indicators of forest condition and status. We used growing stock value as a measure of the various economic and social criteria, i.e., a broad proxy for timberland wealth. These broad-scale composite measures helped us to look at the notion of tradeoffs, compatible production, and the integrative nature of ecosystems. Our experience suggests that scientists can contribute to both developing individual broad scale measures and composite indexes and the process for aggregation to higher spatial scales and thus make the discussion about sustainable forest management more productive.

Keywords: Sustainable forest management, Criteria and indicators

Assessing State and Change in Global Forest Cover: 2000 and Beyond

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Abstract

The United National Food and Agriculture Organisation (FAO), at the request of the member nations and the world community, regularly reports on status and trends in the world's forest resources. This paper briefly describes the methods used in past surveys, describes the data and methods to be used to complete the 2000 Forest Resource Assessments, and proposes a follow-on continuous world forest survey system to enable FAO to provide the necessary information on a permanent basis. This paper is based on a background document and on the results of an Expert Advisory Meeting on FRA 2000 held in Rome, Italy on March 6-10, 2000.

Keywords:Inventory, Assessment,Monitoring, Global, Satellite, Tropical

The Determinants of Silvicultural Investment in British Columbia: An Economic and Policy Perspective

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Abstract

Being a key link in the chain of sustainable forest management practices, silviculture occupies an important place in British Columbia's forest policy considerations. This poster aims at providing an economic and policy analysis of the silvicultural investment in BC's public forestlands. First, a brief historical overview of the Province's silviculture programs is presented to outline the institutional context in which the silviculture sector has evolved. Next, silvicultural activities and expenditures are reviewed statistically. Then, a regression analysis is undertaken in an attempt to reveal the effects of several explanatory variables such as harvest areas, timber prices, non-timber values and government stumpage revenues on the levels of silvicultural investment. Finally, the policy implications of the research findings are discussed from the perspective of sustainable forestry. The paper ends with a comment on the emerging trends of BC's forest policy regarding silvicultural operations in the Province.

Keywords: British Colombia, Silvicultural investment, Economic and policy perspective.

Détermination de la Productivité des Jachères dans Cinq Régions du Mali

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Abstract

La filière bois-énergie au Mali permet de couvrir 91 % des besoins énergétiques natinaux. Le bois est issu des formations naturelles et des formations "hors forêt" ou diffuses des espaces agro-sylvo-pastoraux. Pour mettre en place une gestion durable et raisonnée de la ressource ligneuse, le Mali s'est doté d'une politique énergétique : la Stratégie Energie Domestique. La production de la biomasse ligneuse des formations forestières est connue, alors que celles des jachères (formations forestières diffuses) sont tout à fait empiriques.

Pour mieux appréhender sa production, la Cellule Combustibles Ligneux (volet offre de la Stratégie Energie Domestique) en liaison avec l'Institut Polytechnique Rural de Katibougou, a installé des sites d'étude dans cinq régions du Mali d'Ouest en Est : Négala, Ouéllésebougou, Fana, Cinzana et Koutiala. Les sites choisis doivent permettre une meilleure connaissance des formations "hors forêt" du pays.

'inventaire des arbres (de jachères et de parc), de la régénération, le cubage par classes (0- 5 ans, 6-10 ans, 11-15 ans, 16-20 ans et plus de vingt ans) ont été réalisés dans ces sites. La répartition par classes d'âge a été obtenue par enquêtes auprès des paysans exploitants de ces jachères.

La productivité annuelle de ces formations est fortement liée à l'anthropisation, elle varie de 0,06 m3/ha/an à Koutiala (fortes occupations des terres pour la production du coton) à plus de 0,25 m3/ha/an dans les régions de Fana et Négala. Ces résultats n'incluent pas les arbres dits de "parc" tel que Vitellaria paradoxa, Parkia biglosa, et Lannea spp..
Les essences caractéristiques de ces formations "hors forêt" sont pour l'étage dominant les

arbres de parcs cités au pargraphe précédent, pour l'étage dominé : Combretum nigricans, Acacia macrostachya, Combretum glutinosum ; la régénération est caractérisée par des espèces pionnières : Piliostigma reticulatum, Acacia macrostachya, Guiera senegalensis.

Ces données partielles seront utilisées pour la réactualisation des Schémas Directeurs d'Approvisionnement des principales villes du Mali (Bamako, Ségou, Mopti et Koutiala).

Keywords: Mali, Productivité des jachéres.

Under-Canopy and Preliminary Forest Cultures as A System of Forest Growing in Conditions of Smooth Natural Generation Change in The Boreal Forests of Russia

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Abstract

Natural spruce forests of the boreal taiga are usually presented by multiple-aged forest stands. Spruce reforestation under the canopy of such crops is a natural process, corresponding to the natural peculiarities of the zonal (area) forests. However, in the considerable area of the exploitable crops of the European part of Russian boreal forests it is quite difficult to run a forestry, orientated to the conservation and further utilization of the young growth during the cutting of the mature forest stand.

During the last 35 years in the north-western and central parts of Russia there were probated new methods of planting and conditions of artificial growing of spruce and other shade-requiring species under the canopy. Depending on their purpose these cultures are subdivided into preliminary and under-canopy.

Common to both types is the fact they are planted under already existing (growing) canopy; while the difference is that preliminary cultures are planted under the canopy of maturing and mature crops (approximately 10-12 years before cutting), but under-canopy cultures- under the canopy of open undergrowth(I-II age class).

The technological system of preliminary cultures provides for preventing unfavorable succession of spruce species and gradual(progressive) replacement of old generations by young, ecologically stable forests. Planting and growing of preliminary cultures, unlike the clear cutting forestry management and further reforestation, has a number of technological, ecologically-silvicultural and economic advantages.

The purpose of under-canopy cultures is slightly different and consists in planting structurally and compositionally complex forest crops on the basis of open unsuccessful or damaged forest stands.

Young spruce growth in the open cutting usually suffers greatly because of the late frosts and sun burns. Besides, its growth is greatly restrained by grassy vegetation and broad-leaved sprouting. Microclimatic conditions are much softer and more favorable for survival and growth of young plants under the parent canopy. In particular, there is no competitive pressure on the crops from grassy vegetation and broad-leaved sprouting, the fact that greatly decreases care costs.

Moreover, under the canopy of forest crops the processes of bogging are weakened as here, in contrast to clear cuttings, water regime(condition) is regulated by growing forest crops.

We can't help mentioning a most important ecological effect of the under-canopy reforestation system, that is reduction of the amount of open forests peculiar to clear cutting forestry.

Nowadays, when forests suffer immensely from air emissions and other technogenic(industrial) pollutions, under-canopy "covered" system of forest growing considerably reduces the probability and degree of salvage.

The under-canopy system of forest growing essentially reduces and prevents CO_2 release into atmosphere owing to unproductive temporal interval (10-15 years), until the territory of cutting is planted by new crops.

The long-tem researches of the stationary plots showed that during the processes of planting and growing of preliminary cultures. The latter accelerate their growth abruptly when the upper canopy is cut or thinned. Their biometric parameters and productivity become similar to those of the cultures planted earlier in the open areas.

In all its technological and forestry components the under-canopy system of reforestation and forest growing will favor ecologolization of the forestry management system in the boreal forests.

Keywords: Russia, Boreal forest, Natural regeneration.

The Application of Growth and Yield Models for Yield Regulation and to Assess Indicators of Sustainable Forest Management for Mixed Tropical Forests.

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Abstract

Yield regulation has been identified as a key constraint to sustainable management of natural tropical forests. Growth and yield simulation models are being developed as tools for growth prediction and yield regulation using data from permanent sample plots and forest inventory. This paper illustrates the application of an individual-based (single-tree spatial) model for simulation of the growth and yield of moist tropical forest systems. SYMFOR is a modelling framework that has been principally designed to study and predict the effects of different silvicultural treatments for sustainable yield management of natural Dipterocarp forests in Indonesia.

The current version of SYMFOR has been applied to illustrate the utility of both empirical and process-based growth and yield models for three applications: (1) growth and yield prediction, (2) evaluation of alternative silvicultural systems and (3) evaluation of indicators of sustainable forest management. Predictions of growth and yield are presented for an area of lowland dipterocarp forest in East Kalimantan (Indonesian Borneo). These predictions are used to describe and predict the recovery of the forest following logging compared to its pre-logging condition. This analysis is then extended for the same dataset to determine the effect of altering the silvicultural system applied to the forest through alterations in either diameter cutting limits or length of cutting cycle. These results are then further analysed to illustrate simple indicators of sustainable forest management. The analysis of these simulation runs demonstrated the importance of appropriate statistical analysis of model simulations.

The paper concludes that growth and yield models will become an increasingly important tool for the management for sustained yield of tropical forests and can be further applied to develop and implement effective criteria and indicators for sustainable forest management. These applications will require the development of appropriate analytical procedures to utilise output from simulation models and to make their results readily available for application by forest managers.

Keywords: Mixed tropical forest, Growth yield models, Sustainable forest management.

Tropical Forests Management Based on Tree Populations Dynamics:The Example of Moabi in The Dja Forest (Cameroon)

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Abstract

Though Central African rain forests contain a wide diversity of tree species, present logging practices are extensive and mining, and focus on a relatively restricted range of valuable timber species Considering the complexity of management practices aimed at controlling global stand dynamics, we propose an approach based on ecological characteristics and demography of particular timber species and we assume that forest management mainly consists in the management of timber tree populations living in their natural environment. This approach is illustrated with the example of moabi (*Baillonella toxisperma* Pierre, *Sapotaceae*), a timber species from Cameroon.

For two and a half years (1994-1997), we measured survival, growth, fecundity and spatial distribution of every class of seedlings and trees of this species in permanent plots covering 347 ha, located in the Réserve de Faune du Dja and in the adjoining logging concession (South-East Cameroon).
After a description of the Dja's floristic diversity (chapter 1), we present the phenology and germination of moabi (chapter 2), seed dispersal and predation by mammals as well as impact of hunting on its natural regeneration (chapter 3), and then seedling growth in the understorey related to light availability (chapter 4) and finally the demographic parameters of its adult population: diametrical structure, growth, mortality and spatial distribution (chapter 5). Moabi start fruiting from 70 cm DBH, some individuals reach 280 cm DBH as maximum size and trees are cut over the legal limit diameter which is 100 cm. The density of adult trees is 0.1 stem/hectare. The specific growth curve is calculated by mean of three different methods: measurement of 273 living individuals for a period of 2,5 years analysed with both Gompertz's model and a polynomial model; annual growth rings counting for 10 trees; and carbon dating for 4 trees.

On the basis of these observed values of fecundity, survival and growth, we build a matrix model (Lefkovitch 1965, Usher 1966, Favrichon 1995) which reproduces the evolution of class sizes of moabi over a period of time (chapter 6). This demographic model is a management tool which can be used for predictive simulations.

On the one hand (chapter 7), we quantify the impact of the present logging practices on moabi population dynamics. Thirty years after first logging, moabi population will recover 27% of the initial number of adult stems and this reconstitution level will be 83% after 300 years.

On the other hand (chapter 8), the matrix model enables to assess the impact of forest management scenarios designed by changing management parameters. We successively simulate (1) the elevation of limit diameter from 100 to 130 and 160 cm, (2) the lenghtening of rotation period from 30 to 60 years; (3) the reduction of impact of logging from 10 to 5% of the ground area and (4) the increase of growth speed due to the implementation of selective thinning. These simulations enables to compare the cumulative timber production yielded over a period of 480 years by the present logging practice *vs* an extremely conservative management scenario (limit diameter = 160 cm; rotation time = 60 years; reduced impact logging; selective thinning).

This approach based on tree population dynamics with regard to their natural regeneration logically fits into the classical scheme of natural forest management plans in Central Africa baesd on selection system. It enables quantitative recommandations for long term timber production from these forests to be formulated and, consequently, contributes to their sustainability.

Keywords: Cameroon, Tree population dynamics, Management

Using Forest Inventory, Remote Sensing, GIS and Growth Models to Monitor Some Sustainability Indicators at Management Level

by
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Abstract

Criteria and indicators for the sustainable management of forests have emerged as a central element of international and domestic forest policy discussions. The Third Ministerial Conference on the Protection of Forests in Europe, that took place in Lisbon, Portugal, in June 1998, adopted the six Pan-European criteria for sustainable forest management. The European countries involved in this conference committed themselves to promote the development and implementation of national criteria and indicators, taking into account specific country conditions, as well as to improve the quality and promote the necessary adaptations of national data collection systems, to fulfill the needs of information to assess sustainable forest management. In Portugal, the definition and implementation of adequate indicators to be used at a practical level in the assessment and monitoring of forest management sustainability at management area level have attracted particular interest since then. The implementation, in practice, of the proposed indicators strongly rely on the availability of forest inventory and mapping of forest resources over time, seldom available in Portugal at the management area level. In this context, a management area is a forest area, subdivided into management units (stands) that is subject to the same management plan. The objective of this poster is to analyse alternative methodologies of up dating forest resources information, including spatially specified information. Data from the continuous forest inventory of the National Forest of Leiria are the basis for this study. The National Forest of Leiria is a state property with an area of 11,000 ha located in the coastal dunes of Marinha Grande in central Portugal. Most of the area (8,700 ha) is made up of pure maritime pine stands managed for high quality timber production. A relative small percentage along the coast is protection forest with the maritime pine as dominant species (2,000 ha) and a little more than 300 ha are devoted to other land uses. The forest is subdivided into 342 management units approximately rectangular that are sometimes subdivided into 2 or more stands. For management purposes, a continuous forest inventory systematically covers the forest since 1979 with an intensity of one 500-1,000 m^2 plot per ha (two plots per ha till 1988) and a periodicity of 5 years. Alternative methodologies of up-dating forest information were simulated on the basis of these data, including the use of traditional forest inventories of different intensity, combined or not with the use of growth models, as well as the use of remotely sensed information and other ancillary data available in a GIS system that is available for the area.

Keywords: Remote sensing, GIS, Forest inventory.

Growth Models to Control Sustainability of Forests in Transition

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Abstract

In Central Europe there is an increasing trend to convert even-aged to uneven-aged forests, aiming at a *Dauerwald* (permanent forest) forest management system. Under this situation the former age class methods, derived from the "normal forest model", or from the dbh-class models based on de Liocourt's negative exponential dbh-class distribution, are appropriate to both, determine and control sustainable annual cut with respect to age classes or dbh-classes and the way how to best

approach the *Dauerwald*-structure of the forests.

Two developments in European forest science help this situation: (i) individual tree growth models have been developed, aiming at the substitution of classical yield tables, and (ii) forest inventory designs have shifted to permanent sampling methods in order to more accurately identify changes in forest structures and damage.

This presentation will demonstrate that combining both, permanent inventories based on angle count sampling and the distance independent individual tree growth model PROGNAUS, will enable foresters to choose harvesting strategies, appropriate to achieve both high value sustainable yield and uneven-aged forest structures.

The example presented is a forest management area of 1270 ha, where more than 40 years ago the clear cut system was abandoned and replaced by target diameter harvest. In 1988 permanent plots were established. Sample trees were selected using Bitterlich's angle count method with a basal area factor of 4 m²/ha. The first remeasurement in 1998 served to calibrate the growth model PROGNAUS. With the calibrated model, different harvesting scenarios are calculated for a 40 year period. Stocking volume, dbh- and stem quality distributions are compared .

Keywords: *Dauerwald* management, Individual tree growth models, permanent forest inventory

Nutrient Management Guidance for Enhancing Sustainable Forest Productivity

by
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Abstract

Guidance on the nutrient management requirements to support enhanced productivity goals for new plantations of loblolly pine (*Pinus taeda*) in the southeastern United States or of Douglas-fir (*Pseudotsuga menziesii*) in the northwestern United States is developed. Sustainable forest management with enhanced productivity is needed on commercial forestland as opportunities for timber harvests from public forests declines in the United States. A suite of Excel spreadsheet "models", derived by simplification of simulation models, is provided at two Internet websites for use by the Forest Industry in their stand management planning. A three-step procedure is designed for use with personal computer systems.

First, the productivity goal for a new plantation is estimated for the specific soil and climate conditions of a field site to be planted with selected planting stock and managed with practices that enhance productivity (e.g., planting density, vegetation control, fertilization, thinning). The target biomass projection for each year of the new plantation is determined from growth and yield models available to the forest company or from the 3PG spreadsheet model calibrated for plantation growth. The 3PG model was developed by Landsberg and Waring (1997, Forest Ecol. and Manage. 95:209-228).

The nutrients required to support the target growth are next estimated with the REMSS spreadsheet model. This code determines nutrient requirements from empirical relationships established from the nutrient content of stems, branches, foliage and roots of the two tree species. These calculations determine the time course of nutrient requirements for the target plantation growth.

In the third step, the soil supply of nutrients for the specific soil and climate characteristics of a selected site is determined with the NuCSS spreadsheet model. Soil data from forest company measurements or from estimates provided from soil databases are used to determine the annual nutrient supply from the soil to the vegetation. The difference between the REMSS vegetation nutrient demand and the NuCSS soil nutrient supply provides guidance on the fertilizer requirements to meet the target productivity.

Repeated simulations with the spreadsheet models provide insight on the nutrient management requirements for sustaining enhanced forest productivity through several rotations. The procedures also estimate changes in soil carbon sequestration due to nutrient management.

Supplemental features are included at the Internet websites. The nutrient status at a field site may be evaluated prior to planting by foliar vector analysis with the DIAGNOSIS spreadsheet model. This analysis can be made if foliar mass and nutrient data are available from the previous forest stand. Further, the Crystal Ball software may be used with all Excel spreadsheet models for conducting sensitivity and uncertainty analyses. Sensitivity analysis shows the important variables that contribute significantly to the outputs at each step. Sensitive variables need to be accurately determined. However, variability (uncertainty) of soil, climate and vegetation attributes is often large at field sites. If this variability is known, uncertainty analysis may be undertaken with Crystal Ball to estimate plantation nutrient requirements with statistical confidence intervals.

Keywords: Forest productivity, Nutrient management

Modelling Norway Spruce Young Stand Development Based on IUFRO International Stem Number Experiment

by

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Abstract

There are an expectation of new plantation and regeneration on abandoned agricultural land in Europe. These new plantations should be ecologically stable and sound. The models for regeneration and young stand development are sought as one of the tool to reach the above given goals.

The presented model is based on the IUFRO international stem number experiment for Norway spruce where radical reduction of the number of trees per hectare in the juvenile stage has been done. The experiment was established in 1971 in eight years old spruce thicket originated from planting in regular spacing with density 2 500 trees per hectare. The series consists of five obligatory treatments with two replications. The stand is situated on previously cultivated agricultural land in 5th (spruce-beech) vegetation degree on elevation of 600 m above sea level. The pattern of experiment includes control plot 1 without thinning. All other programmes are based on first heavy thinning (top height 10 m). Thinning regime 2 represents heavy treatment in young age (top height 12.5 and 15 m). The regimes 3 and 4 (fully mechanised selection) are similar treatments planned later when the stands achieve top height 20 and 22.5 m.. Thinning along with treatment 5 (commercial thinning) is to be done only when 80 m^3 of stem wood can be removed on trees with DBH over 12 cm excluded 400 crop trees.

The data set gives detailed information on every tree growth including the stem and crown shape and the position of the tree within

the stand. The data are recorded since 1971 and represent high quality long time period for juvenile growth stand. The higher volume of stem wood (474.7 m^3 per hectare) is accumulated (last survey in 1998) in the control stands 1, but total production (together with volume removed by thinning) is the highest on plot 2 (541,1 m^3) as well as the volume of selected trees - 217.5 m^3. Various thinning programmes affected stability of experimental stands in favour of tended stands.

The model could help with the formulation of the growth process of young Spruce stands under very new silviculture regimes which should create the stable stems with low value of stem sliminess coefficient and long and vital crowns. It is expected that these silvicultural regimes could increase the vitality of the stands suffering in Central Europe by the air pollution and other climate stress.

Keywords: Norway spruce, IUFRO, Modelling.

Sustainable Forest Management by The Private Sector In Malaysia

by
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Abstract

Forest management in Malaysia, including in the State of Sabah, has always been carried out by the public sector, viz. the Forestry Department, even though forest harvesting and the processing of forest products is usually managed by the private sector. Semi-governmental organizations also exist which are responsible for managing some areas of forest lands. Concessions are usually given for harvesting as logging concessions after which the responsibility of "management" reverts back to the Forestry Department. In 1997, the Sabah State Government made a major and bold decision to "privatise" forest management in the state by establishing ten Forest Management Units (FMUs), whereby, the private sector is given considerable areas of logged over or currently being logged forests, to be managed over a concession period of 100 years. The FMUs cover an area of about one million hectares or about a third of the land area of Sabah, with each FMU ranging between 60,000 to 160,000 hectares. The FMU Agreement requires the agreement holder to prepare a Forest Management Plan (FMP) within two years after signing the FMU Agreement. The Forestry Department of Sabah sets certain criteria for development of the FMUs, and they must approve the FMP before any developmental activities can be carried out. For the preparation of the FMP, a forest inventory must be carried out to assess the quantity and quality of the standing timber stands while a social survey must also be carried out to assess the status of the communities living within and around the FMUs.

As most of the areas have been logged, some more than once, the FMU owner has no other option but to invest into reforestation and afforestation activities, in order to increase and improve the forest stands. However, as forestry is a long term investment with returns taking considerable periods of time, the FMU owners are faced with raising capital for these purposes. One option considered is to seek approval for developing a small portion of the FMU for agro-forestry and forest plantations, but no decision has yet been made by the authorities. International funding is also an option being examined.

It is too early to make a conclusion on the wisdom of the State in forming the FMUs, but this has offered an excellent opportunity for the private sector to be involved in forest management on a long term basis. It is also the hoped that these FMUs will ultimately be managed on a sustainable basis.

Keywords: Malaysia, Private sector, Sustainable forest management

Key Issues in the Application of Criteria and Indicators for Sustainable Forest Management

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Abstract

Sustainable forest management (SFM) integrates social, economic and environmental factors, and must reflect the goals and outcomes negotiated between those with legitimate interests in forests. The relative weightings given to these factors will vary substantially depending on local circumstances. Thus a working definition of SFM must capture 'local' issues and values and on-going dialogue is needed to refine management objectives and targets over time. Stakeholders must be prepared to state their objectives and preferred outcomes in a transparent manner. Increasingly, communities are demanding a capacity for adaptive forest management based on assessment of the outcomes of forest management activities. The application of Criteria and Indicators (C&I) at appropriate (management unit) scales can assist with measuring such outcomes. Criteria describe the components of sustainability and indicators are being developed to measure aspects of each criterion.

Consideration of scale issues is critical to the application of C&I, and this issue was addressed at an international conference in Australia in 1998 organised by IUFRO, CIFOR and FAO. To provide a useful basis for adaptive management, they will generally need to be applied to a sample of representative forest management units (coupes, compartments). Information collected at finer scales often needs to be synthesized or aggregated for interpretation at larger (Regional, State or National) scales. The relevant scale for data collection and interpretation will vary for different forest values (Criteria) and management goals (e.g. soil and water values at the site scale; social values at larger scales).

Practical application of C&I requires that the steps of indicator selection, monitoring, and evaluation of trends be addressed as linked processes. Insufficient attention has been paid to monitoring and evaluation, which are critical steps in adaptive forest management.

Establishing clear and shared forest management goals is essential to guiding application of C&I. The goals should be expressed in measurable terms enabling agreed indicators and associated performance measures or targets to be established. Thus forest management plans will reflect expectations, how they will be measured, and how evaluation, review and communication of findings will be conducted. The scientific underpinning for indicator selection, monitoring and evaluation should provide guidance to these decisions.

Monitoring must address spatial and temporal scale issues. A stratification of the forest environment is needed to guide sampling and scaling-up from point measurements where this is required. Risk assessment can be used to guide monitoring of those areas where there is a perceived threat to SFM. The frequency of temporal monitoring should be varied according to the likelihood of important temporal change in the indicator being used. The key point is that monitoring should be thoughtful and strategic if it is to be cost-effective.

The science and application of sustainability indicators in forestry is still in its infancy. C&I have the potential to help track temporal change in forest values and to facilitate adaptive management, but expectations need to be kept realistic. Much could be learned from initial efforts to apply a modest 'core-set' of indicators at the forest management unit level. Close linking of research, monitoring and forest management will facilitate progress.

Keywords: Sustainable first management, Criteria and indicators.

Criteria and Indicators for The Assessment of Sustainability at The Forest Management Unit Level – A Neotropical Perspective

by
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Abstract

The contribution of forestry to GDPs in the neotropics is small, but market trends and extensive natural forests indicate significant potential for sustainable forest management (SFM). The growth of forest certification and a number of C & I development processes demonstrate willingness and capacity to adopt SFM in the region, and a IUFRO Sustainability Task Force Conference/Workshop in Costa Rica reviewed C & I development for SFM in the neotropics in 1999. Public sectors may see the adoption of C & I as an advance, but for the private sector and communities, current concepts of sustainability may lean too far towards environmental rather than financial and economic aspects; all sectors are concerned about the lack of financial incentives for SFM rather than logging or land use change. Arguments for more people-centred approaches to SFM emphasize the lack of participation of certain stakeholders in C & I development and the likely benefits of assessing the sustainability of livelihoods. The technical and scientific basis for C & I for production in natural neotropical forests is well established, but assessment of ecosystem health and integrity in general, and soil, water and biodiversity in particular, continues to require precautionary approaches; indicators for contributions to climate change mitigation, and SFM for plantations, largely remain to be developed. Much more effective information transfer by scientists, research on both socioeconomic and biophysical aspects, the inclusion of sustainability assessment in higher education curricula, progress towards a concept of SFM which is less restrictive to the forest manager – probably based on an explicitly adaptive concept of management – and a more inclusive focus on scale are priorities for C & I development and adoption in the neotropics.

Keywords: Sustainable forest management, Bolivia, Costa Rica, FSC, ITTO, Lepaterique, Tarapoto

About Criteria and Indicators for Sustainable Forest Management

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Abstract

In this paper, we report on the main conclusions elaborated through presentations and discussions at the Nancy meeting, March 22nd – March 25th. We recall that Criteria and Indicators are at this fringe between so called hard science and social science. C & I are as well a tool for reaching a consensus as a set of guideline for making decisions, i.e. C&I reflect as well the state of consensus/conflict with a society. We then recall some issues which have emerged as crucial, such as scaling and harmonization. Some hints have been proposed on how to rely C&I and biodiversity, as biodiversity may be taken as a surrogate for sustainability. Some emphasis is put on the necessity to develop the usefulness of C&I as decision making tools. Finally, an hierarchical framework derived by Tropenbos is presented in the setting of harmonization.

Keywords : Criteria and indicators – Sustainable forest management – Tropenbos hierarchical framework

Role of Forestry in Landscape Rehabilitation: Malaysian experience

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Abstract

Malaysia, like many tropical countries worldwide, is faced with the serious problem of forest land degradation. Due primarily to agricultural development, including shifting cultivation, the forests of Malaysia have been seriously depleted and degraded. Assuming that a third of every hectare harvested would become degraded (including those areas currently under active logging, the previously mined land and those areas under shifting cultivation in Sarawak and Sabah), the extent of degraded forest land in the country will be over 1.5 million hectares. Hence, to sustain the economic, environmental, social and cultural benefits derived from the forests there is a need to repair the damage resulting from deforestation. Consequently, previous efforts towards this direction had involved restoration, rehabilitation and reclamation. Forest rehabilitation is expected to improve, if not to restore, the natural productivity as well as the environmental and aesthetic values of the degraded forested land. Traditional approach of forest rehabilitation usually involve planting a mixture of agronomic crops, particularly legumes and trees with erosion control capabilities, as the primary objective. Recent rehabilitation projects though have more demanding objectives, such as re-establishing a commercial forest. Most of the previous rehabilitation projects that were carried out in Malaysia primarily involved the planting of exotic species. However, the planting of indigenous tree species using different techniques has been recently emphasised. By using these different techniques of forest rehabilitation, it is expected that landscape rehabilitation technology can be applied to different land use and types of forests including urban areas, degraded coastal and hill forest and mangrove forest. Hence, to promote the role of forestry in landscape rehabilitation, forest rehabilitation issues must also be given appropriate recognition in policy and legislation by applying the principles through the recommended actions. This paper discusses the current status of reforestation in the country and the main techniques used in forest rehabilitation, such as line planting, gap planting, and enrichment planting. Moreover, in as much as policy matters significantly affect the success or failure of the rehabilitation/reforestation projects, the latter part of the paper includes issues related to government policy on forestry.

Keywords: Malaysia, Forest rehabilitation, Gap planting, Line planting, Forest policy

Strategies for the Recovery of Biodiversity in Deforested Landscapes

by
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Abstract

Depending on the degree of degradation, size, and distance to forest, physical and biological barriers can significantly delay natural regeneration in degraded ecosystems. Tropical plantations can fulfill a variety of services including restoration of soil fertility and acceleration of natural regeneration. In a long-term program on ecosystem rehabilitation in the Latin American humid tropics, about half the species tested had positive effects on soils and good growth, making them attractive to farmers for reforestation. In studies of natural regeneration in plantations with indigenous species in the humid lowlands of Costa Rica, forest tree invasion was higher under plantations than in surrounding abandoned areas. Higher plant species richness accumulated under *Vochysia guatemalensis, Virola koschnyi, Terminalia amazonia*, *Hyeronima alchorneoides* and *Vochysia*

ferruginea, all species commonly planted by farmers. Natural regeneration was high under mixed-species plantations, with values sometimes equal or higher to those found under pure plantations. The open pastures had the highest proportion of wind-dispersed seeds, while bird and bat seed dispersal was predominant in the plantations. High accumulation of litter on the plantation floor contributed to diminish grass growth and thus encouraged woody invasion.

In regions with larger agricultural fields and farther from sources of propagules, windbreaks and remnant trees in pastures may be important reservoirs of native tree species. Tree recruitment may be higher in windbreaks that are connected to forests. Windbreaks could be made more attractive to birds by including native, fruit-producing trees, by increasing their species and structural complexity, and by positioning them between forest patches to facilitate bird movement.

Examination of the role of strategies for recovery of biodiversity necessitates integrative approaches that consider factors influencing tree regeneration, other potential effects on the ecosystem, and economic, social and environmental constraints.

Keywords: Ecosystem restoration, Mixed plantations, Soil fertility, Succession, Tree species choice, Winbreaks

Multifunctional Rehabilitation of Forest in Central Europe

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Abstract

In the densely populated area of Central Europe (Germany), landscape in general and forests in particular are faced by an increasing number of different, partly contrary demands of society that can be summarised by the keynotes: wood production, nature conservation and leisure time activities. Besides that, the Central European Forestry has to struggle with political-economic and structural characteristics in the international wood market. Therefore some examples of new research activities are given to outline solutions and effects in multifunctional rehabilitation of forests at different scales: Summarising the results of the studies, a varied afforestation planning and a concept of forest use, which integrates the aspects of aesthetic values and of nature conservation with management systems, in combination with a selected net of total reserves and the creation of biotope-network structures would play an important role in an intelligent, sustainable land-use system for the future - following the intention of AGENDA 21 and the declaration of Rio.

Keywords: Nature conservation, Integrated land-use, Biodiversity, Afforestation, Germany

Restoring Protection Against Natural Hazardsin European Mountain Forests After Wind Disturbance:How much Human Interference?

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Abstract

Protection forests are forests on steep slopes that have the primary function of protecting people or assets against natural hazards such as snow avalanches and rockfall. In this paper, the current state of protection forests in central Europe, and an approach to managing these

forests are presented. If large-scale wind disturbance occurs in a protection forest, fast recovery is needed to restore effective protection. Since silvicultural measures often do not cover their costs with the socio-economic conditions that prevail in central European mountain forests, natural forest dynamics are increasingly being relied since this often ensures sufficient protection. The old view that doing is better than leaving is increasingly being questioned. Decision-making about dealing with wind-disturbed forest areas needs to take into account the decreasing effect of the thrown or snapped trees in preventing natural hazards. Moreover, the increasing effect of the recruitment, especially the advance regeneration, the risk of a bark beetle outbreak when thrown or snapped trees are left lying, and the effects of harvesting on regeneration need to be considered. To choose among different management options, checklists based on the current state of knowledge are used. Since many protection forests are currently far from having the small-scale target stand structure, wind disturbance can also be seen as an opportunity to create forests that will be more resistant to future disturbances, and that will be able to recover from them faster.

Keywords: Protection forest, Windthrow, Regeneration, Silviculture, Central Europe

Landscape Visualization in Rural Land-Use Planning

by
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Abstract

Landscape conservation and management are increasingly important goals in rural land-use planning. Integration of landscape management into natural resource planning is tied to possibilities of illustrating the impacts of activities. The different approaches to include scenic values to forest and land-use planning include landscape preference studies, preference modeling and participatory planning. In all approaches visualization can be a good instrument.

For routine planning efficient and inexpensive tools are needed. Today digital image editing and virtual landscape simulators offer the most sophisticated means of visualization. Digital image editing enables public evaluation of forest management alternatives for example in recreational areas or in urban forests. However, forest landscape simulators are less labour-intensive than image editing and offer flexible movement between different viewpoints. The greatest advantage of landscape simulators is that they can be linked to actual planning systems and to different type of forest data. In the future, participatory planning calls for more realistic illustrations , integration of visualization with different sources of spatial data as well as high interactivity of planning tools. Furthermore, additional research is needed to evaluate and compare the usability of different visualization media in forest planning.

Keywords: Digital image editing, Forest landscape simulators, Landscape planning, multimedia GIS, Visualization.

The Social and Economic Impacts of Plantation Forests

by
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Abstract

The rapid increase of plantation forests is an important phenomenon. Fifty years ago plantation forests for wood production were quite rare. Most regeneration was natural, not planted. Since that time planted forests have become common throughout much of North and South America, the Nordic countries, and increasingly in parts of Asia. The onset of industrial forest plantations as a major component in the world's industrial wood supply can probably be dated from about the 1960s.

Planted forests now account for an estimated 34 percent of the world's industrial wood production . The portion coming from planted forests will certainly increase over the next few decades as more natural forestlands are set aside for environmental purposes and harvesting restrictions become increasingly stringent, thereby driving up the costs of wood from natural forests. Thus, the economic advantages of forests, which are planted in desirable, accessible locations, and in selected species will become increasingly attractive vis-a-vis wood obtained from natural forests and difficult sites in marginally accessible areas.

The social and economic impacts of plantation forests become increasingly important as the contribution of plantation forests to the timber supply continues to grow.

Keywords : Forest plantation, Social and economic impact.

Plantations For Fuelwood Production

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Abstract

The aims of this paper are 1) to understand the production and consumption of fuelwood over the world and the need of plantations for fuelwood production, and 2) to estimate the amount of CO_2 absorption by the world's forests and 3) to provide status of fuelwood plantation and forest biomass with its contribution to CO_2 absorption in Korea. In 1995 world fuelwood consumption was amounted to 1.7 billion m^3. India, the Peoples' Republic of China, Brazil and Indonesia – all developing countries with large population – had occupied the highest shares. Tropical regions accounted for three quarters of both production and consumption of world fuelwood and charcoal in 1994. By 2000, deficit amount of fuelwood production was expected about one billion m^3; 500 million m^3 in Asia, 300 million m^3 in Africa, 140 million m^3 in Latin America and 60 million m^3 in other countries. To meet the deficit, about 25 to 105 million ha of fuelwood plantation is required in developing region for the next 10 years. The total amounts of CO_2 absorbed by world's forests (above-ground biomass only) and its annual growth were 226.3 billion tons and 16.3 billion tons, respectively. In Korea, the total and annual CO_2 absorptions in the forests were 516.8 million tons and 37.2 million tons in 1990, respectively. Present biomass of forest in Korea was estimated at 317 million tons with 22 million tons of annual growth.

Keywords: Fuelwood, CO_2 Absorption, Biomass, Plantation

Plantation Grown Wood and the Environment

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Abstract

Although many of the issues raised about forest plantations are non-trivial, there are a number of significant environmental advantages of plantation establishment that appear to outweigh concerns, *if* plantation management practices can be developed to address concerns regarding sustainability. Foremost among the advantages is that establishment of highly productive forest plantations can provide large quantities of wood and fiber from relatively small land areas, raising the possibility that pressures for harvesting within natural forests can be markedly reduced. Moreover, assuming that forest plantations are carefully established and managed, they have the potential to produce a continuous, renewable stream of industrial raw materials that results in less overall environmental impact than other types of raw materials. Assessment of total environmental impacts over product life cycles show that structural and non-structural wood and wood fiber products made from plantation-derived raw material yield markedly lower impacts than similar products made from metals, cement, petroleum, or other raw materials. Similarly, examination of total environmental impacts of papermaking fiber production in forest plantations versus fiber production using annual agricultural crops shows significant advantages to wood fiber. Thus, forest plantations can yield environmental benefits that extend well beyond the geographic location in which they are located.

Keywords Environment, Tree plantations, Forest plantations, Wood

World View of Plantation Grown Wood

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Abstract

The world's natural forests are under increasing pressure to meet demands for wood and fibre, while continuing to provide a vast array of environmental and social services. Future increases in demand for wood are likely to be met largely from forest plantations. This paper reviews the current extent of the global forest plantation resource, provides an assessment of the key wood production parameters (species, growth rates, rotation lengths), identifies a range of priority areas for future plantation research, and provides discussion and assessment of likely future wood supplies from plantation forests.

Keywords: Plantation forests, Resources, Wood production, Scenarios.

Production and Utilization of Bamboo, Rattan and Related Species:Management and Research Considerations

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Abstract

Non-wood forest resources particularly bamboo, rattan and other related species, form a very important source of livelihood for the rural folks, especially those who are at the bottom of the economic level. This is

particularly true for large segments of the population in many Asian countries. In the last few decades, the accelerated rate of forest conversion and logging has led to a decimation of these non-wood resources, sometimes to the point of their disappearance. Despite their importance in the socio-economic and cultural contribution to the marginalised people, little effort has been given to manage these resources on a sustainable basis through proper harvesting, restocking, and artificial propagation. The lack of scientific knowledge of these non-wood forest resources especially the taxonomy, silviculture, technological properties and processing methods, has partly resulted in their desultory development. With more concerted efforts, backed by deeper scientific investigations, it should be possible for industries based on these underdeveloped resources to supersede the timber industry in several parts of the Asian region. There is considerable opportunity for further development in furniture manufacturing and other novelty items. This paper presents a summary of some of the important findings and the ongoing research efforts, with particular reference to production and utilization of some selected non-wood resources and products in Peninsular Malaysia.

Key words: Non-wood - management - research - developmental considerations

Managing National Forests Of The Eastern United States For Non-Timber Forest Products

by
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Abstract

Over the last decade, there has been a growing interest in the economic and ecological potential of non-timber forest products. In the United States, much of this increased interest stems from drastic changes in forest practices and policies in the Pacific Northwest region, a region that produces many non-timber forest products. The forests of the eastern United States, however, also produce many non-timber forest products. This analysis focuses on the status of non-timber forest products in management plans of the national forests in eastern United States. Of the thirty-one national forest plans examined for coverage of non-timber forest products, only seven plans addressed the management of these resources. A review of national legislation that affects national forests reveals that non-timber forest products are not recognized as a management objective. But, they are considered as "special products" in key policy documents. There is legislation under consideration that could significantly change how these products are managed. This paper identifies and discusses key issues that could affect decisions to manage for non-timber forest products.

Keywords : Non-timber forest products, Eastern United States, U.S. forest service, Forest management.

Hiccups/Problems with Inequitable Distribution of Profits from Non-Wood Forest Products and Their Remedies

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Abstract

The nonwood products, or nontimber forest products (NTFPs), have become important forestry outputs as their economic significance is being perceived by forestry experts and policymakers at large, all over the world. For example, some US$ 90 billions worth of NTFPs are extracted worldwide every year. And, more than 300 million people, specially tribal and underprivileged, are dependent primarily upon them for earning their livelihood. This has initiated, and enhanced where initiation had already taken, the process of commercialization of NTFPs. Commercialization has augmented the values of NTFPs on one hand but has also added to the rapid extraction of NTFPs on the other.

The enhanced process of extraction of NTFP resources has thus generated large profits for large corporate companies but at the same time have heightened the concerns about subsistence and livelihood for a large poor tribal and low income earning population. The commercialization of NTFPs has thus engendered more inequity and has raised concerns about the sustainable use of the resource in the future.

In the wake of this unequal and unsustainable development, the policy questions that loom large are: How should we develop this resource and how can we benefit the most poor and unprivileged people of the world? Are there some remedies on hand or need to be invented? This paper would attempt to answer these questions and highlight the issues of commercialization of NTFPs and its impact upon the distribution of profit between poor tribal population and the large profit-seeking enterprizes. The paper would delve into various aspects of inequity generated as a result of commercialization and its implications for social welfare. One of the various remedies that can be proposed to attenuate the escalating inequity is to promote NTFP-based small-scale enterprizes in the rural areas. The paper hypothesizes that small-scale enterprises generate income and employment in the local village economy and thus reduce poverty, unlike large companies which export jobs from villages to cities and big business centers of the country or world. The small-scale enterprizes thus generate economic growth with equity, and are also sustainable in terms of scale of operation, and have spill-over effects in promoting entrepreneurship skills among tribal people. The paper would emphasize upon the development of NTFP-based small-scale enterprises, document their characteristics and constraints, and finally list the benefits and costs of developments of small-scale economic institutions. The study would identify various types of constraints and discuss ways to relax them in order to promote small enterprise development, and would explain how to promote entrepreneurship skills among tribal people in rural areas. The study would be based upon the cross-country review of various enterprises and data. Various countries that would be reviewed are India, Pakistan, Indonesia, South Africa, countries covering the Amazon region, Malaysia, and others. Finally, the paper would provide a framework to develop NTFP resource without jeopardizing the welfare of tribal and underprivileged people in rural areas of much of the Third World countries.

Keywords: Non-wood products, Non-timber forest products, Small-scale enterprise, Sustainability

Non-Timber Forest Product-based Enterprise in Forest Conservation and Community Development: India's Evolving Institutional Context

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Abstract

Non-timber forest product-based enterprises have been viewed as possible vehicles for reconciling the livelihood needs of forest dependent populations with the larger societal goal of sustainable forest management. In India, village-initiated efforts and state-sponsored programs for collective forest protection during the past decades are reconfiguring the context and institutional landscape for such enterprise. Increasingly, local institutions for forest management are becoming focal points for village development and resource governance. Proceeds from NTFP sales, fines and fees from a variety of products from village protected forests are also creating pools of common funds which are becoming significant sources of liquidity and investment capital for rural enterprise.

Despite their appeal and considerable promise, experience in India and other countries has shown that relatively few conservation-oriented NTFP enterprises have become viable. It takes time and in most cases, subsidies, especially during the early years for an enterprise to achieve viability. Fewer still have demonstrated significant equity and poverty alleviation impacts and for many, their conservation benefits remain unproven. In many cases, economic success has resulted in

resource over-exploitation since generally low levels of capital and skills requirement often make them contestable. High returns tend to invite new entrants and increase pressure on NTFP resources unless rights of access are clear and enforceable. For these enterprises to achieve their multiple goals, complementary developmental inputs and strong policy support are essential.

Keywords: NTFP enterprise, Conservation, Collective action, Cooperatives, Community and economics

The Potential of Non-wood Forest Products in Sub-Saharan Africa: Towards a Better Assessment of Forest Resources Providing NWFP

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Abstract

Rural and urban people in Africa are heavily dependent on non-wood forest products (NWFP) for a wide range of needs including food, medicines and construction materials. Many of these NWFP are important sources of income and employment at the local level, with some being traded at the international level.

In order to determine the sustainable level of any commercial utilization of a given NWFP, accurate information is needed on the status and regenerative capacity of the resource providing the product, in addition to information on the socio-economic and cultural aspects affecting the use of the NWFP. Practical methodologies for assessing socio-economic and biological factors of NWFP utilization are not widely available. Such methodologies are needed to collect information both at the forest management unit level as well as at the national level.

This paper analyses the factors to be taken into consideration when planning an assessment of the forest resources providing NWFP. It discusses current gaps in knowledge and presents some of the main activities of the FAO Forestry Department aimed partly to fill these gaps at the local and national scale.

Keywords: NWFP, Forest inventory, Assessment methodologies, Africa.

The Recreational Functions of European Forests

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Abstract

This paper discusses cultural differences and similarities in forest recreation and other amenity uses between a Northern (Finland), a Central (The Netherlands) and a Southern (Italy) European country. The behavior, meanings and values related to forests for different European populations are discussed in order to understand the future demand on forests and other natural resources for recreation and nature-based tourism. Nature-based tourism is predicted to become one of the major, increasing, uses of forest resources

in the future. It is important for a host country to know how it should deal with visitors that have varied cultural backgrounds.

Different types of recreational forest uses are described in terms of participation rates and the intensity of participation in different activities, as well as in terms of time-use patterns and the types of areas used for recreation. Attention is also paid to the differences in meanings and values of forest and nature between countries and regions. The effects of differences in the supply of natural resources for recreation are also discussed.

In the North, there are many natural areas available for recreation, and there is much interest in also providing those resources as a basis for nature-based tourism for other European peoples. In Central Europe, people are interested in increasing the amount of nature in their residential areas. The total participation rate in outdoor recreation is as high in the South as in the North, but people make fewer visits to forests. In Southern Europe, there is a growing pressure to use nature protection areas for recreation, which causes serious problems for the protection of nature.

Keywords: Outdoor recreation, Ecotourism, amenities, Service functions

Social Functions of North American Forests

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Abstract

Forests of North American provide many social benefits and services for people. These range across a wide range of leisure, environmental, amenity, and economic benefits and services including recreation and leisure, water and wildlife, cultural and spiritual, and employment and income services. Resulting from these interests has been intense interest in parks, wilderness, wild rivers and other special places, exploitation of forests for a variety of services, a preservation orientation to counter exploitation, and clashes between interests. The result has been development of a mosaic of land uses and classes to provide opportunity for realizing a variety of services from North American forests and a constant tension among competing interests to have their service needs met. Clearly, North Americans recognize that forests provide many and diverse social and environmental services.

Keywords: Benefits, Services, Leisure, Environment, Amenity, and economic.

Amenity Resources and Other Services of Asian Forests

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Abstract

The various social services provided by the forests of industrialized Japan and Malaysia, a developing country, are discussed. The large population, increasing urbanization, diversity of cultures and geography, distinct national environmental policies and administration in the region have influenced the location of forests and their conservation, their socio-economic uses and recreation preferences and demand. The discussion is based on themes such as types of amenity forests and facilities

available, recreation policies, use and demand statistics, growing demands for nature/ ecotourism opportunities, impacts of use and issues arising. Several suggestions are given for sustainable management and utilization of forests for recreation, ecotourism and conservation in light of the socio-political and economic conditions of the three countries. Common trends in both countries are highlighted.

Keywords: Amenity resources; Forest recreation; Sustainability; Ecotourism; Asia

Sustainable Development – Transferring the Concept to the Levels of Technology and Operations

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Abstract

Since the Rio Earth Summit of 1992, sustainability has been widely accepted as a concept for future development. However, rigorous applications of the underlying principles and goals at the level of production and distribution are notably rare. Two paths of developments have emerged. At the political-programmatical level, different sets of criteria and indicators have been developed that mainly address 'best policy' issues. At the technical-operational level, newly evolved environmental management concepts consider primarily the aspects of 'best practices'. These two approaches contain many gaps, and a general framework to guide future thinking and the development of tools is still missing. The goal of this paper is to describe the process for implementing sustainability goals at the operational level. A brief analysis of the sustainability concept has uncovered three major challenges at the levels of technology and operations: 1) environmental soundness of systems requires improved technologies and more efficient technical systems; 2) the careful deployment of technology relies on a more effective institutional framework; and 3) minimizing energy and matter flow per service unit is the main goal of future efficiency improvements. The proposed framework for implementation considered four main aspects: 1) Eco-efficiency is a general principle that makes environmental performance of products and processes measurable, and that is strongly related to the well-established principle of operational efficiency; 2) Environmental management systems provide a set of management, analysis, and assessment tools to achieve ecological goals within overall business processes; 3) New policy tools consider public involvement, independent private inspections, self-responsibility, and communication of environmental performance to consumers and the public; and 4) Life Cycle Assessment (LCA) and Risk Analysis (RA) provide the methods and tools needed to model the flow of matter and energy through a bounded production system, while assessing potential environmental damages and risks. To be able to adapt these options to the "real world" of forestry, planners must rethink the essence of engineering work, and management tools must be modified to meet the special requirements of forestry operations. Engineering is no longer an isolated technical task. It must now integrate technical processes with public involvement, environmental performance assessments, and public choice. A main challenge in future research and development activities will be to integrate Eco-efficiency philosophy with the well-established concept of operational efficiency. Engineering professions should also collaborate actively in the development and improvement of policy tools, as well as in the process of establishing scientifically based environmental standards for forest operations. Emerging tools, such as LCA or RA, must be tailored to foresters' specifications.

Keywords: Development needs; Eco-efficiency; Environmental analysis; Environmental performance; Environmental management; Policy tools; Research; sustainability.

Technological Advances - Autonomous Systems as the Basis for Future Wood-Harvesting Operations

by
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Abstract

Autonomous systems are broadly defined as functions and chains of functions carried out independently, without direct human control. This narrow definition excludes partly automated systems, e.g., remote-controlled machines, unless they are able to work independently. This presentation concentrates on current wood-harvesting operations that use the most advanced technology. The possibilities for implementing autonomous systems are greater in the silvicultural sector, but the approach and needs are very different. As a rule, an autonomous machine is easily connected with machine movements, and is designed to solve problems associated only with those movements. The dilemma, however, in wood harvesting is larger than that. Wood harvesting is a part of a forest-industry chain of processes. Replacing human supervision and decision-making will be a demanding task. The vision is probably very remote for a present-day forest harvester - forwarder combination chain to act autonomously, especially for silvicultural practices in natural forests. If management trends are toward controlled, cultivated forests, the possibilities for an autonomous system are much better. Progress will be incremental, with partial automation for subfunctions expected to be available soon.

Keywords: Automation, Harvesting operation

Strategies and Methods for Choosing Technology: Perspectives for Development Projects Based on Scandinavian Experiences

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Abstract

Sundberg's model, work studies, and cost calculations were compared to select the most appropriate technology for a wood-harvesting project. The main criterion was cost–effectiveness, to be met within the limits of environmental and ergonomic requirements, and within the historical role of Scandinavian logging technology in a forest cluster. Cost-effectiveness appears to be a good basis when choosing technology, but future perspectives also must be contemplated. In an open, global economic system, development is also dictated by new demands placed on the forest cluster. Cost-effectiveness has become an extensive indicator that must now consider the total costs and benefits of logging practices, industrial processing, and marketing. Continued progress in this direction will depend on environmental, societal, social, and cultural sustainability. In many countries with special forested areas, environmental aspects dominate forestry decision-making. There, the impacts of technology on the environment may be the main criteria when choosing a level of technology. The market economy, together with a functioning national innovation system, provides additional creative material for the selection process. Production is still viable at the local level (within suitable areas), but the most significant advances within the forest cluster seem to be made primarily within large global companies. This process is best supported by directing funds toward research and development activities, and by promoting the appropriate circumstances under which companies can compete.

Keywords: Choosing technology; Development project; Timber harvesting.

An Analysis of the Economic Impacts of Information Technology Research on Forest Management in Southern Brazil

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Abstract

The objective of this research was to evaluate the economic benefits derived from public investments in research and development of a computer system. This system, SISPLAN, is designed to perform simulations on growth and productivity for afforestation and reforestation of *Pinus* in southern Brazil. Criteria can be generated for production planning and reforest management, thereby reducing the uncertainties associated mostly with forest activity planning. This is especially important in cases of technical-scientific knowledge that are not incorporated in production means, because it is generated during field-research activities involved with the ordering, handling, and management of the forest. The methodology consists of identifying the costs and economic benefits derived from the generation, utilization, and maintenance of the SISPLAN technology. The framework of this research is to provide the estimated economic impact, using the cost-benefit technique. Utilization of this system generates information that contributes to improving efficiency in the productive sector and effectiveness in public policies. Economic gains to Brazil were estimated at $77.2 million in 1997 (net present value), with a cost-benefit ratio of 55.7. This indicates that the research is an attractive economic investment.

Keywords: Forest management; Information technology; *Pinus* spp.; Research evaluation.

Methods for Environmental Assessment of Forestry Operations – An Overview

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Abstract

This overview presents some assessment methods for communicating environmental performance in forestry. Perspectives are also offered for the development of Life Cycle Assessment, LCA, in forestry. Several methods, such as Substance Flow Analysis, Risk Analysis, and LCA use static models and predominantly quantitative elements to assess environmental performance. Certification and an Environmental Impact Assessment, EIA, also include qualitative elements and public involvement. Examples of LCA-related studies in forest operations and two possible developments for LCA will be presented here. Although LCA comprises more qualitative elements, difficulties arise when it is linked to dynamic models for biological processes. An important issue is whether to include land use in this method of forestry modeling. Other methods might be preferable, e.g., when handling topics with qualitative values or political priorities. The alternative is to restrict the use of LCA in forestry to principally a technosphere, and use other means, e.g., EIA or certification, for analysing issues that affect qualitative values. Regardless of the direction chosen, the basic concerns when developing

LCA are the quality of the data, the building of models, and the development of tools that are sufficiently simple, relevant, and robust to provide support in the decision-making process.

Keywords: Environmental management; Energy use; Forest management; Forest operations; LCA.

Role of Wood Procurement-Related Environmental and Quality Management Systems in Meeting Stakeholder Interests

by
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Abstract

Finland has been active in promoting sustainable forest management (SFM) at both the international and national levels. National criteria and indicators for SFM have been developed and reported on to describe and monitor society needs. The nature conservation and forestry legislation has been completely rewritten during the past few years in order to safeguard the key biotopes in Finnish forests, which are mainly owned by families and other non-industrial small-scale woodlot owners. Forest management guidelines have been improved to comprehensively include management of valuable biotopes, and protection of biodiversity trees, soil and water, as well as issues related to recreation, game management, and other socio-cultural values. A National Forestry Program (NFP) was developed as a transparent and open-ended process, and has recently been approved by the Government. The NFP incorporates economical, ecological, social and cultural aspects, and related actions as well as establishing the mechanisms to continue the process. In addition, Forest Certification issues have been investigated in an open manner. To support these activities at a company level, the forest industry has been active in developing environmental and quality management systems (EMS and QMS, respectively). These have been not only for the manufacturing side but also for wood procurement. The three main companies, Stora Enso Metsä, UPM-Kymmene Forest, and Metsäliitto, which together procure 80% of the domestic timber in Finland, all have certified QMS and EMS for wood procurement. Furthermore, based on the long-term work carried out by the Trade Association of Finnish Forestry and Earth Constructing Contractors, forest machine contractors are increasingly establishing their own QMS and EMS. Because of the small scale of the contracting companies, certification of these systems may not be economically viable. However, auditing mechanisms by either the forest industry or an independent party are being developed and, to some extent, are already in use. Both QMS and EMS, as addressed in the international standards ISO 9000 and ISO 14000 series, respectively, concentrate on management issues such as procedures, organization, responsibilities, competence, information flow, records, etc. The principle of continual improvement is clearly stated in ISO 14000, and will probably be included in the upcoming, revised version of ISO 9000. The main purpose of QMS and EMS is to help companies improve their own practices. The existence of such systems, however, especially the certified ones, also generally improves the public image of the company and is definitively an asset in business relations. Practically all nationally important issues related to ecological, social, and cultural aspects have been included or referred to in the QMS and EMS of forest industry. Environmental issues must be considered at all levels of the organizations. Thus, the systems have an important role in bringing theory and ideas into practice at the local level.

Keywords: Contractors; Environmental management systems; Forest industry; Quality management systems; Sustainable forest management; Wood procurement.

Forestry Work and Its Impact on Human Factors: The Perspective from Developing Countries

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Abstract

Throughout the world, approximately 1 to 2% of the tropical forests (about 1.700 million ha) are cleared each year for wood and non-wood products, and to give way to agricultural activities, infrastructure, and settlements. The increasing number of forest users and pressure groups on this environment has forced timber-harvesting companies in several countries to adopt harvesting systems that attempt to guarantee sustainability. Forests and forest product industries provide employment to the local population and habitats for various animal and plant species, but only a small proportion of the forests are under proper management. Many factors contribute to the lack of economically, environmentally, and socially acceptable harvesting systems, including the unavailability of trained manpower, an absence of laws and regulations governing forest operations, and a lack of capital for undertaking proper forest operations. Mechanization has reduced the use of manual labour in developed countries, but most of the forest operations in developing countries depend on human power. Because much of that labour is untrained, the result is usually low productivity, rapid turnover rates for employees, and high accident rates among forest workers. Likewise, the inherent differences in body size and physical working environment means that some tools and machines designed for forest workers in developed countries do not properly fit workers in developing countries. This may cause both physical and mental stress, accidents, and injuries. Therefore, data must be gathered on anthropometric parameters, as well as on workplace conditions and workers' physical capacity in these developing countries. Appropriate employee training also should precede the transfer of technology, and must accommodate the existing infrastructure and socio-economic conditions of a particular area. As the forest industry becomes globalized, developing countries are faced with challenges in training forest workers in how best to operate and maintain equipment, and in providing them with protective gear to reduce accident risks and injuries. Rural living and working conditions also must be improved in order to attract and retain a young and educated labor force. This paper presents an analysis of forest working conditions and harvesting problems in developing countries, and the ergonomic and technological interventions required for improving productivity. These measures may also ensure that forests meet the needs of the present without compromising the ability of future generations to continue fulfilling these objectives.

Keywords: Appropriate logging technology; Ergonomic intervention; Manual versus mechanized logging methods; Logging in tropics; Tropical forest workers.

Fulfilling Societal Needs through Participatory Silviculture - An Evaluation

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Abstract

A revolutionary development in forest management took place in India in the late 1980s, when participation of local, forest-dependent communities was sought for the management and protection of State forests under the umbrella of the Joint Forest Management (JFM) program. This new approach has now been adopted by 21 of the 25 Indian States. Approximately 3.5 million ha of forestland have been regenerated by more than 35,000 forest protection groups in different parts of the country. This has been accomplished through indigenous and innovative methods and approaches. The

Latest Report on the State of Indian Forests (in 1997) shows that, although the amount of new forest cover is small in regions where JFM has been implemented, there have been marked increases in biodiversity, biomass productivity, tree basal area, and other ecological parameters in these areas.

As the phenomenon of JFM has strongly taken root, managers have realized that classical silvicultural systems and operations are not adequately equipped to address the newly emerging needs and demands of the society. The JFM program considers the dependence of local, forest-dwelling communities as well as those living on the forest fringes. Thus, intermittent yields of locally valuable, multiple forest products become critical to the sustainability of this co-management concept. This also conforms to the emerging global consensus regarding the vital role of forests in facilitating the anti-poverty crusade, which is high on national agendas around the world.

Forest management is now recognized as being more than just protection. The local community should be involved in the manipulation of trees and other forest vegetation if total and effective co-management is to be achieved. Thus has evolved the practice of Participatory Silviculture, which is the new thrust area in the JFM-practicing States of India. The techniques and operations implemented under Participatory Silviculture incorporate local knowledge and use perceptions, temporal and spatial dimensions of local needs, and institutional setup. Additional factors include aspects of a wider socio-economic environment apart from forest types, the history of forest management, and other vegetation-related characters. Beginning with species selection and through to silvicultural operations, local needs and aspirations are considered supreme. These silvicultural methods, though simpler, are evolved jointly and continuously by the technically skilled foresters and the forest-dependent community. Local communities now conduct their own operations, such as lopping for fodder and fuelwood, rotational blocking for NTFP collection, multiple shoot (MS) cutting, stump dressing, pruning, etc.

This poster attempts to answer the following questions regarding the potential role of Participatory Silviculture in the sustainable management of community forests:

1) Are community forests being managed effectively to respond to the needs of the user groups?
2) What kind of silvicultural manipulations are being carried out by the forest user groups, and how do both scientific and local knowledge come into play in determining such practices?
3) Is there any need and/or scope for further strengthening and improvement of these silvicultural interventions to address both social and environmental needs?

The poster highlights and analyzes the results obtained from field studies in Central India (Harda Forest Division), Bihar (Singhbhum Forest Division), West Bengal (Bankura Forest Division), and Nepal (Kavre Forest District). Ecological factors have been re-examined that limit natural forest recovery on degraded areas under co-management. The studies also evaluated various management options and the socio-economic and policy issues that influence silvicultural decisions for restoring and rehabilitating degraded natural forests.

Keywords: India, Societal needs, Participatory silviculture.

Transfer of Timber Harvesting Technology to Societies in Economic Transition – The Taiga Model Forest Project in Northwestern Russia

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Abstract

A dramatic economic transition in Russia has caused difficulties for Russian forest industries. Annual cuts have been drastically

decreased, and numerous sawmills and pulp mills are experiencing hardships because of a shortage of raw material. At the same time, exports of roundwood make up the core of forestry income. Reliance on earlier timber-harvesting systems has been very difficult, because Russia's own machine production is also struggling in the transition. Therefore, redesigning the harvesting systems is proposed as a solution. Western machine manufacturers consider Russia a potentially strong market, but the lack of capital hinders transactions. In addition, unemployment is a serious problem among forest workers.

A Taiga Model Forest (TMF) project was launched to establish a model forest area for demonstration and experimental purposes. One objective of this project was to find profitable and cost-effective technological applications for forest operations in northwestern Russia. Technology transfer within the project itself was mainly an exchange of scientific knowledge among scientists. Nevertheless, one purpose of the project was to demonstrate Scandinavian timber harvesting and to compare it with local Russian methods in a large thinning experiment. Shortcomings of this approach included the Russian counterparts' lack of knowledge in the actual planning of forest operations, as well as the unstable situation in Russian society. Both of these situations have caused serious problems with the realization of the TMF project's goals. In this paper, the TMF project was analyzed in a Samli's framework of technology transfer. One aim was to examine international transfer of forest technology by observing an on-going case. The Samli's model used in this study was improved upon by attaching outside motives to the framework. These outside motives (from non-governmental environmental organizations) had been one of the driving forces when the TMF project was established.

Comparative studies based on unit-cost calculations indicate that, economically, an intermediate technology would be the most profitable method in this case. This is because of a low level of salary in relation to the price of advanced technology. An intermediate timber-harvesting technology would also be more profitable for the economics of northwestern Russia because of its positive influence on employment and its smaller demand for foreign currency when procuring harvesting equipment.

The best results from the TMF were obtained in the training and advising of forest workers, who quickly adopted the principles of the new methods. In the TMF, Scandinavian forest road-construction methods also were demonstrated in cooperation with Russian road-construction companies. The local machinery labor was suitable for forest-road construction when the Scandinavian methods were used.

Intermediate technology practices in timber harvesting seem to be the most promising way to help northwestern Russian forestry in this difficult situation. However, because the current need for forest worker education is so great, the transition to more cost-effective Scandinavian systems may be slow.

Keywords : Timber harvesting, Taiga model forest project, Northwestern Rusia.

Using the Delphi Method to Forecast Priorities in Forest-Engineering Technology

by

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Abstract

Forest engineering technology must be promoted as a pivotal component in sound management of Japan's forests. Using the Delphi method, we conducted a technology-forecast survey to gain a long-term perspective on the future of forest engineering. Survey results were consolidated through two questionnaires. We selected respondents who were experts with extensive knowledge of forest engineering: 20% from the forestry

sector, 19% in machine manufacturing, 26% university-related, 29% in public research institutes, and 6% in other areas. For the first part of the survey, we sent questionnaires to 79 respondents, of whom 50 were then sent the second questionnaire. We excluded those who withdrew from the survey after the first questionnaire. The rate of response was 63% for the first part and 90% for the second.

The preliminary questionnaire was used to determine the forecast topics. We divided forest-engineering technology into four categories: machinery, operations, ergonomics, and roads. Within each category, the respondents were asked to state topics of concern that could be addressed, or ”realized”, in Japan by 2030. Predictions for the technological stage of fulfillment for each topic were made with one of three phrases: ‘in development’, ‘in practical use’, or ‘in widespread use’. The respondents proposed more than 100 topics. After all topics were prioritized according to importance and generality, 37 were selected for special consideration (14 in machinery, 13 in operations, 5 in ergonomics, and 5 in roads).

The respondents forecast the time for realization of half the topics by 2010, 90% by 2015. The earliest two topics forecasted (in 2007) were ”Widespread use of the instruction manual of forest operations for voluntary workers” and ”Widespread use of non-clear cutting operations using mobile tower yarders”. The topic ”Development of unmanned harvesting machines” was forecasted for realization after 2020.

Based on results from the second survey, an importance index was calculated for each topic; the overall average was 59.7. The topics with the three highest indexes (all >80) were related to environmentally aware technology: ”Widespread use of the evaluation and management methods of environmental conservation in forestry”, ”Widespread use of near-natural road construction methods”, and ”Widespread use of the accurate predicting methods of environmental impact through forest operations”. We also asked for ‘Effective measures the government should adopt for realization’ of each topic. Among the choices, ”Increase in government funding for research” was most frequent (average 50.5%). ”Personal exchange between the industrial, academic and government sectors” was chosen in 39.9% of the replies.

The forecasted realization time for each topic will be referred to during development of technology strategies in the forestry sector. Environmental concerns should be emphasized more in the future as R&D is promoted in the field of forest engineering technology. In particular, financial support for R&D and collaboration between industry, university, and government are expected to be considered when forest technology policies are proposed.

Keywords: Effective measures for realization; Forest-engineering technology forecast; Forecasted realization time; Importance index; The Delphi method.

A Practical Approach to Prioritizing Forestry Research Projects

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Abstract

Various approaches have been proposed for prioritizing forestry research programs. Evaluating the merits and demerits of each approach may provide a means for ranking individual programs. Unfortunately, all of the current methods are rooted in agricultural environments, with the primary focus only on prioritizing particular species in annual crops. In contrast, the man-made models that are designed for studying natural systems in forestry consider species to be but one of many components in the system. Therefore, a practical approach is needed, which is applicable to the unique requirements of forestry. Our proposed method comprises two phases: Phase I -- prioritization of forestry projects; and Phase II --prioritization of research programs. This approach reduces

subjectivity by introducing objective questions whenever judgments must be made.

The process of Phase I begins by identifying the relevant issues in forest management, viz., Geographical Cover of forests; Conservation of Bio-diversity; Protection of forest resources from all kinds of destabilizing factors; Restoration of the degraded forests; Production of material goods; and Extension of forestry for practice by the public. These are the primary objectives in tropical forest management. Forests are categorized, based on both biotic and abiotic characteristics, by the amount of ground they cover. At this stage, judgments are made according to the relevance or importance of each objective in various forest categories. Grades are assigned as Absent, Poor, Low, High, and Highest.

The subjectivity inherent with making judgments can be reduced by using objective questions. The graded judgments carry scalar values of 0, 1, 3, 6, or 10. Direct or inverse weights are introduced that account for the extent to which a forest is impacted by each objective. The total scores earned by the various combinations of forests and objectives are ranked in descending order. Rankings are improved by introducing the level of impact that each objective has on Economic, Environmental, Political, and Sociological aspects. The final ranking, which includes the improved, combined scores, provides the priority for forestry projects.

Phase II commences with identifying the chief components involved in technological activities. These components are ranked according to their contributions toward fulfilling forestry objectives. The technological activities are assigned to one of five levels: 0, 1, 2, 3, or 4, with 'Level 0' referring to rudimentary or absent, meaningful technology; and 'Level 4' indicating the highest level of technology that is feasible for a particular component. Technological Levels are scored as 0, 10, 30, 60, or 100%, respectively.

The goal of all research programs is to progress from some lower level to higher technological levels. Each upgrade is a gain toward fulfillment of the objectives. The gains from technological upgrade are estimated for all the components of Prioritized Forestry Programs. This is followed by an estimate of the final score, which is the product of both the expected gains from the technological upgrade and the score of the Prioritized Forestry Programs that was estimated under Phase I. Using this method results in the identification of Prioritized Forestry Research Programs, with final scores listed in descending order.

Keywords: Forestry; Prioritizing; Research programs; Step-by-step procedures.

Impacts of Forest Harvesting Operations on Soil Properties

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Abstract

Forest operations in northeastern China include planning for harvest systems, logging, transport, road-network design and construction, slash disposal, and planting after harvesting. These activities are significantly correlated with soil disturbance, which can be measured in terms of the degree of break and compaction as well as the loss of soil nutrients. Four sub-projects were conducted to study the effects of forest operations on physical and chemical soil properties at the operation sites. The study variables included such factors as cutting system, skidding traffic, layout and construction of forest-road networks, and slash disposal. In general, the degree to which soil physical properties were affected was closely related to the level of energy input, i.e., how much timber was removed from the forest, during operations at the harvest site.

Three cutting systems were employed: selective cutting, thinning, and small-area clear-cutting. Of these, selective cutting has been the most commonly used system over the past 10 years, and will probably be the best harvesting method in the near future. However, soil physical properties were affected most significantly by this method, as measured by the degree of disturbance associated with the

volume of timber removed per ha. This is because more movements and greater energy inputs were required for executing the operations on each tree. Clear-cutting and thinning were ranked second and third, respectively. In terms of disturbance per unit area, however, the clear-cutting system had the most significant impact on both physical and chemical properties of soil, accounting for approximately 15% of the variation. This was because of the more-concentrated operations involved with this system.

Timber was moved from the site by tracked crawler, wheeled skidder, cable-yarding, or animal skidding. During the winter, ground-skidding traffic did not significantly influence soil physical properties, even after six to eight passes by the machinery. However, the opposite was true when the ground was not frozen. The wheeled skidder then had a greater impact than did any other means of log transport. Field investigations showed good natural regeneration in the areas disturbed by crawlers, but not at the landings or in the main skidding-track ruts. Animal skidding was an environmentally sound technique, with moderate operating costs. Because no soil damage is inflicted during winter operations and only slight amounts during the other seasons, the use of animals has increased to about 90% of all the skidding done in the last 5 years.

Three slash-disposal methods -- burning, piling, and spreading -- have been employed during the last 10 years of harvesting. Although the burning method has impacted the soil more because of nutrient losses, it has been beneficial in improving soil acidification. The other two slash methods have had moderate influences.

A well-planned forest-road network can reduce soil erosion. To lessen the impact of forest-road construction on soil properties, we are presenting a new mathematical model for optimal layout of forest roads. Both economical and ecological benefits are considered in this plan.

Keywords: Forest operations; Impacts on soil properties; Regeneration quality.

The Historical Development of Forest Operations in China and a Look Ahead 10 Years

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Abstract

The history of forest operations in China since ancient times (more than 2000 years ago) has included developments in operation technology, equipment, organization, and professional education. We used the Entropy Growing Analysis method for studying the dynamics of these developments, particularly with regard to the interaction between human society and forest ecosystems in a given region. In China, the deforestation rate is highly correlated with an increasing population rate i.e., each era of great population explosion has resulted in large-scale deforestation.

Forestry activities have changed greatly in the last century because of the fast development of science and new technology, unbelievable population growth, and rapidly changing social structures and market systems. In the first half of the 20th century, large forests were destroyed during continuous wars, mad land-grabbing by invaders, and unanticipated establishment of farms by immigrants. The main goal of forest operations during that period was to extract as much timber and farmland from the forest as possible. Machinery, such as a forest railway transportation system powered by steam engines, significantly improved operational efficiency. Unfortunately, this new trend toward mechanization increased the capacity for human interference in the forest. However, the rest of the work was done manually, and contracted teams were a popular means for organizing forest operations.

Since 1949, and particularly in the past 20 years, forest operations in China have been

greatly modified. Not only have the science and technology of forest operations been developed significantly; the environmental aspects, profitability, and economic efficiency have also been emphasized. Forests are now recognized as important suppliers of non-wood forest products such as water and soil protection, climate adjustment, and an assortment of flora and wildlife. These factors are considered when decisions are made about harvesting, timber extraction, and civil engineering in forests. In integrated forestry, planning is done from the viewpoint of sustainability for both timber and non-timber forest products. All activities, e.g., forest resource surveying and harvesting planning, road planning and construction, harvesting, post-harvest site disposal, and planting and protection must now serve these key purposes. As well, forest-operations technology and techniques have been converted from manual- to machine-driven, and are now part of an environmentally sound complex. Planning and organization has been changed from that of small, manual working groups to large-machinery operations. The working system now involves many contracted groups at different levels.

"The Natural Forest Conservation Project", begun in 1998, identified the challenges and opportunities in Chinese forest operations. The market for small- and mid-sized machines, with multi-functions, will be the most dominant in the near future, depending on the forest resources available in China. Environmentally sound, low-cost, and highly efficient forestry technology and techniques will be in the spotlight of both research and practice in the next 10 years. Forest operations will also play quite an important role in the management of sustainable forestry.

Keywords: Forest operations in China; Historical development; 21st century; 10-year look ahead.

Carbon Sequestration In The Global Forest Sector

by
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Abstract

In this paper we describe why carbon is an issue in forestry: forests and forestry have an important role in the global *and regional* carbon cycle and therefore provides connection to the global climate and climate change. The role of forests in carbon cycle has been emphasised in the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and more recently in conferences of the parties to the UNFCCC in Kyoto and Buenos Aires.

The first part of this paper deals with commercial forestry: what are the specifics of intensive versus extensive forestry in relation to carbon sequestration. This includes comparisons between natural forests and plantations, previous land-use, forest management (available mechanisms for optimising production and C storage), and to what extent management for maximum C competes with / complements other management objectives (for example timber supply, biodiversity, aesthetic). The contribution of forest products as a temporary reservoir, but with human control, in the carbon cycle is also included. Finally, the role of wood in products that avoid energy emission in their manufacture and as a source of energy to replace fossil fuels is addressed.

The second part deals with these issues at the regional/biome level - in boreal, temperate and tropical forests – examining differences in carbon stocks and fluxes, as well as differences in timescales. This section consider the unique properties in each biome, i.e. forest fires in boreal regions, intensive forest management in temperate forests, land use change in tropical regions. Several case examples are described,

including a discussion of the relative role of wood products/bioenergy and the future role for forest sector carbon offsets.

As a conclusion, potential environmental and economic changes with environment and new values associated with carbon are discussed. Past changes, present fluxes and future possibilities (risk and opportunities), scientific challenges, gaps in data and understanding, as well as recommendations for research and development are highlighted.

Keywords: Global forest , Carbon sequestration

The Combined Challenge of Forestry and Terrestrial Carbon Management

by
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Abstract

Forests are a critical element in the global carbon cycle. While forests are currently a small net carbon sink worldwide, there is the risk that this trend will change, significantly increasing the accumulation of greenhouse gases in the atmosphere. The forest sector must become engaged in the process of using forests as a key instrument in addressing climate change. There is a need for large scale reforestation and the protection of remaining primary forests as part of the global efforts to achieve a safe level of atmospheric carbon dioxide. The design of large scale reforestation programs should consider social and economic factors and should incorporate other environmental benefits related to watershed management and biodiversity enhancement. A system of environmental credits could be used to stimulate such a new approach to forest management.

Keywords: Carbon sequestration, Kyoto Protocol, Watershed management, Environmental credits

Perspectives for Environmentally-Friendly Management Systems in Tropical Forestry

by
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Abstract

At CATIE, long-term research has focused on development of technologies for sustainable management of natural tropical forests and their biodiversity. Forests cut using sustainable practices can have higher seedling regeneration, and also higher understory biodiversity than forests cut using conventional methods. Post-harvest silvicultural treatments increase the diameter growth of potential crop trees though the consequences for sustainability of their effects on forest composition, through the elimination of non-commercial competitors, remain to be evaluated. Different management operations affect plant diversity in different ways, over different time scales, but there is no evidence for drastic changes of diversity during the first felling cycle even in stands whose structure is radically altered by refinement/liberation treatments. Patterns of seed dispersal and germination can also be affected as a result of defaunation and changes in the forest microenvironment.

CATIE researchers are also involved in the design of systems of diversified forest management, involving studies on the ecology and management of non-timber forest species. Many forest management practices are best suited to small farmers, farmer cooperatives, or to community forest users. Some farmers'cooperatives in Costa Rica manage the forests for eco-tourism and non-timber forests products, while they cultivate other portions of their land, and reforest degraded land with native species, often in mixed-species designs. Tropical plantations can supply wood products, contribute to carbon accumulation,

land reclamation and acceleration of natural regeneration. Domestication of promising species for plantation forestry involves selection of outstanding trees, evaluation of genetic variability, trials of seed germination and storage, evaluation of the performance of species under different silvicultural systems, and the development of seed orchards for the production of genetically improved seeds.

Keywords: Biodiversity, Diversified forest management, Ecosystem restoration, Genetic improvement, Mixed plantations

The Kyoto Protocol and Forestry Practices in the United States

by
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Abstract

Forestry may play an important if not critical role in the ability of the U.S. to meet its greenhouse gas emissions target under the terms of the Kyoto Protocol. Given the low rate of change in the U.S. forest land area, the major anthropogenic influences on the current net forest carbon flux are forest management and protection activities that have resulted in continuing increases in forest carbon storage. Natural disturbances such as fire, insects, and diseases are locally important factors, but when all U.S. forests are considered, they are small relative to the effects of harvesting and growth. Carbon in U.S. forest ecosystems, wood products, and landfill wood was estimated to account for an annual net sequestration of about 300 TgC/yr during the 1980's, and are projected to comprise at least 200 TgC/yr over the next several decades. Proposed accounting rules under the Kyoto Protocol article 3.3 may render most of this C sequestration unaccountable towards the U.S. emission reduction target unless additional activities are accepted under article 3.4. Forestry practices that are likely to result in a positive C sequestration in the U.S. include afforestation of marginal cropland and pasture, improved forest management, adjustments in harvest timing, establishment of short-rotation biomass plantations, improved utilization of harvested biomass, and tree planting in urban and suburban areas.

Keywords: Kyoto protocol, Forestry, Carbon sequestration

New Public Management and the Change of Forest Institutions

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Abstract

The forestry sector, public forest policy and forest administration in many countries are currently involved in a process of change. Public budget crises, inefficient and obsolete administrative structures, changes in social requirements with respect to forests and low timber prices have all given rise to persistent requests for fundamental administrative reform in the forestry sector. New Public Management (NPM) has been gaining acceptance as the most common concept in this context. Originally developed in New Zealand, this concept has been the inspiration behind widespread reform in all kinds of countries in East Asia, North America and Europe. We would like to present reforms implemented by forest authorities in Germany and Switzerland as examples of such authorities which have already gained experience with elements of New Public Management. By doing this, we will show that the concept of NPM can cover a wide range of proposals and that the projects in Germany and Switzerland are examples of

how different aspects of this approach have been implemented. With respect to the outcome of these reforms, at this point in time, it is only possible to put forward hypotheses on their efficacy and efficiency as the evaluation of effects will be the subject of further research.

Keywords: New public management, Reorganisation, Administrative reform, Forest administration

The Dynmic of International Forests Regime by the Example of the Intergovernmental Forum on Forests

by
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Abstract

Despite the failure of the United Nations Conference on Environment and Development and the Intergovernmental Panel on Forests to reach a consensus for a global forests convention, by the start of the twenty-first century a global forests regime is in place. The paper uses regime theory as a tool to explain the formation of the regime. It is argued that the formation of the regime can be traced to 1994 when actors involved in intergovernmental negotiations sought to engage in integrative bargaining rather then the distributive bargaining that characterised forest negotiations in the early 1990s.

The forest regime does not however embrace solely governments and intergovrnmental actors. The normative framework of the regime, which is best seen as a mix of hard provisions (namely international legal instruments with a forest-related mandate) and soft provisions (namely non-legally binding options) both shapes and is shaped by non-governmental organisations and business actors.

Keywords: International forest regime, Intergovernmental forum.

Fragmentation of Forest Resource Agencies and Programs: Challenges Facing State and Federal Governments in the United States

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Abstract

Confirming the integrity of large forest ecosystems and ensuring their ability to provide for a sustained and integrated set of goods and services is of increasing concern to managers and users of forests. Troublesome, however, is the reality that public programs focused on forest ecosystems are often fragmented among many levels of government and among many agencies within any one level of government. To appreciate the nature and extent of this fragmentation, one need only look at the large number of government agencies (state and federal level) in the United States that have influence over the use and management of forests. Needed is research that will enable the diverse landscape of government agencies to better connect in a holistic sense with the forests they are attempting to sustain and the services they seek to provide.

Keywords: Forests, Organization, Government, Agency, Coordination

Forest Policy Development between Globalisation and Localisation

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Abstract

Forest policy development is presently caught between two contradictory tendencies. On the one hand forest issues are increasingly becomiong globalised with concomitant calls for global governance through international conventions, regulations and programmes. At the other hand there is put much emphasis on the need to enhance local participation in the management of forest resources and to formulate location-specific forest management plans on the basis of negotiated consensus of the various stakeholders concerned.. At a first glance these tendencies seem to be inconsistent. In this paper it can be argued that the two tendencies can be reconciled. The paper summarizes the major developments concerning global forest policies and indicates how these incorporate the principle of local community involvement. Such involvement is predicated on the creation and empowerment of local institutions for governance and control over forest resources. Forest policy makers often assume that the implementation of the global policies proceeds in a linear process, but forest policy researchers increasingly consider that in transferring policy decisions to local levels interface situations occur. Such interfaces are often of a conflicting nature with policies being reshaped into new meaning by the local actors. In order to understand the nature and outcome of such interface situations, forest policy researchers should focus on empirical reality rather than define normative principles as well as develop new theories for better understanding the processes involved.

Keywords: Global forest policies, Decentralisation, Institutional change, Policy interfaces

Changes in Forest Work in the Nordic Countries

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Abstract

The mechanization of agriculture during the 1950s resulted in rural depopulation and a subsequent shortage of human labour and work horses in forestry. It therefore became necessary to develop working methods in the forest. The introduction of chainsaws was poorly controlled and resulted in occupational diseases and accidents. Ergonomic research, the development of better equipment and work methods, and mechanization eased these problems.

The fully mechanized cut-to-length system is today the globally known trade mark of Nordic forest technology. Independent highly-motivated entrepreneurs, typically owning a harvester and a forwarder, or one or two heavy trucks, have become responsible for the implementation of timber procurement to the industries. Consequently, the number of wage earners has diminished radically, but the remaining work force enjoys a greatly improved working environment, and the rate of accidents is only a fraction of the former level. As capital-intensive technology has replaced labor-intensive technology, the physical strain on workers has decreased but the mental strain on machine owners and operators has increased.

The efficiency and cost of logging and trucking has been reduced substantially, and work methods have also been developed successfully with respect to the demands of environmentally sustainable forestry and good management practices. However, Nordic forestry has not fully met the requirements of social sustainability with respect to job opportunities in rural communities.

Keywords: Forest work, Harvesting, mechanization, Productivity, Forest energy, Nordic countries

Ergonomic Research in Developing Countries as a Contribution to Increase Productivity and Social Development

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Abstract

This paper is part of a research carried out by a team which also includes Manuel Gutiérrez, Silvia Lagos, Fabiola Maureira, Felipe Meyer and Jorge Espinoza. The purpose of this communication is to illustrate how appropriate technologies aimed at improving safety, health and wellbeing of the workers leads to higher productivity and to show that when a certain technique for forest work is adopted, ergonomics research can help to highlight how much a worker can produce according to the characteristics of the ground, the climate, the stand and the level of physical work load that he should not exceed to avoid fatigue. Examples are discussed of a proposal to calculate salaries and incentives using tables of standard performance based on this criteria. Finally, a case study is presented in which it is shown how the use of these concepts helps global work organisation with beneficial effects for contractors and workers

Keywords: Ergonomics, Productivity, Physical work load, Rest pauses, Job rotation, Working sequences, Organization of labour.

Forestry in Urban and Urbanizing Areas of the United States: Connecting People With Forests in the 21st Century

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Abstract

Resource managers worldwide face challenges in responding to expanding urbanization and its effects on forest resources. These challenges can be met head on if managers work toward: (1) comprehensive management of forest resources in urban and urbanizing areas, and (2) connection of urban people with forests and their management. Opportunities exist for accomplishing both of these goals through involvement of a broad spectrum of urban residents and organizations in collaborative management of forest resources in urban and urbanizing areas. Comprehensive and adaptive management of forests in urban and urbanizing areas is outlined, and efforts to involve individuals and groups in that management are discussed with examples from the Chicago, Illinois, area. Involving urban citizens in resource management can have implications for forest resource management across the urban to wilderness landscape.

Keywords: Urban residents, Forests, Collaboration, Involvement, Partnerships.

The Urbanisation of Forestry: Towards Better Incorporation of Urban Values Into a Once Rural Profession or: The Good City, the Bad City, and the Forest

by
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Abstract

Urban values have become increasingly dominant in today's society. The share of the world's population living in urban areas has now bypassed that of those living in rural settings. Moreover, the socio-economic, cultural and ecological footprint of urban areas extends far beyond their physical boundaries. The world's rural and nature areas have become 'backyards' for the world's cities, primarily aimed at delivering goods and services to them. Forests and forestry are among those areas affected by the process of urbanisation. Forestry has typically been characterised as a rural profession. However, forestry today, to an increasing extend, has to deal with the dynamics of urban society. This paper features city and forest as both the Romeo and Juliet, and Cain and Abel. It describes how forests can be used in the continuous effort to create liveable cities, where the bad sides of urban life are minimised, while the positive aspects are optimised. As a recent study on urban woodland policy-making, planning and management in major European cities has shown, forests do in fact have potential to contribute to better cities through a wide range of social, economic and environmental values. Most importantly, they are crucial tools for keeping urbanites in contact with nature and natural processes. Some of the values of urban woodlands within an urban context will be elaborated, following an elaboration of the dichotomy of the city as being both 'good' and 'bad'.

Keywords: Forests, Cities, Urbanisation, Social values, Urban forestry

Urban Social Forestry Programme (USFP) Development and Management: Greening Our City through Community Participation

by
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Abstract

The underlying concept of urban social forestry (USF) is active public participation in urban forest resources management. Community participation can enhance the quality of community life through a strong partnership among government officials, non-governmental/voluntary organizations, foresters and local people. Public involvement is strongly encouraged, with community members viewed as the most reliable motivation force for implementing USF programme. As a developing concept of public participation in urban ecosystem management, this program needs exploration of its principles, setting, development of strategy, and application. Sensitization of the community people toward tree resources is important and their attitude toward the USF programme can be measured. Public agencies, neighborhood groups, academic institutions, business establishments, PVOs/NGOs are brought to make a coalition of an effective organization for USF implementation. The strategy of developing an USF programme includes organizing community assembly/group meetings to determine local priorities, identifying viable options to address its prospects and aspiration, developing action plans and schedules, and mobilizing members, non-members and local resources. People feel encouraged with the empowerment of working side by side with government/municipal agency. Community understanding and realization about the importance of tree resources in urban area and their active participation in tree resources management can strengthen and materialize USF programme.

Keywords: Urban social forestry, Community participation, Neighborhood groups, Sensitization, Resource mobilization

How Do People Love Their Forests? Let Me Count the Ways

by
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Abstract

This paper presents empirical estimates of the many non-market economic values forests provide to people in United States and Australia. These values include a wide range of recreation values and passive use or existence values of forest protection from logging, insect damage and fire. The paper provides estimates of the absolute and relative magnitude of the recreation and existence values for old growth forest and wilderness protection in the United States and Australia. These studies demonstrate that passive use values such as existence and bequest are normally larger than recreation benefits.

Keywords: Recreation, Existence, Forest protection, Endangered species, Fire

Regional Differences in the Demand for and Supply of Nature-Based Recreation within the Netherlands

by
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Abstract

A model was developed to estimate the local demand for nature-based recreation, taking into account the composition of local populations. This composition was assessed in terms of a segmentation designed to maximise differences in demands between segments. The model has been applied on a nation-wide scale to generate a detailed spatial map. At the same time GIS-technology was used to create a database with characteristics of the local supply for each residential area within the Netherlands. Finally a nation-wide survey has been conducted, in which data were gathered on the individual's perception and evaluation of this local supply, and his recreational behaviour. The relationships between physical characteristics of the local supply of forests on the one hand, and subjective judgements as well as recreational behaviour on the other hand, were analysed. The main conclusions are that spatial differentiation in demand (based on the composition of the local population) tends to be rather small. With regard to the local supply, subjective judgements regarding forests are clearly related to physical characteristics of this supply. As for behaviour, it seems that in the Dutch case personal circumstances mainly influence participation level and intensity, whereas the local supply situation mainly influences the distance travelled in order to participate in activities or to visit certain types of natural environment. In other words, a bad local supply situation does not lead as much to a reduced participation, as to an increase in leisure mobility.

Keywords: Recreation, Demand, Supply, GIS, Regional differences

A Framework for Relating Aesthetics and Perception for Advancing Research

by
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Abstract

A framework for relating different approaches to landscape perception and aesthetics is presented. This considers 2 aspects, the means and the nature of the aesthetic response. Each of these is elaborated and connected, using 4

types of aesthetic response, the sensory, the formal, the expressive and the symbolic, to the work of a range of different perception psychologists and aesthetic philosophers. This framework is then developed to propose a number of areas for research, especially in the field of forestry in general and urban forests in particular. As well as research into perceptions and aesthetics, links to other key areas are suggested, including applied landscape ecology and environmental ethics.

Keywords: Landscape, Perception, Aesthetics, Psychology, Philosophy

Long Term Nutrient Budgets in Forests: Lessons from Chronosequence Studies.

by
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Abstract

Variations in nutrient budgets with forest age are compared in two chronosequence studies of conifer plantations. Over the rotation, nutrient budgets are negative at both sites, but the variation with stand age is quite different in relation to soil fertility, stand health and past land use. These variations with stand age demonstrate the need for such studies for forcasting long term soil fertility changes in forests.

Keywords: Forest age, Nutrient cycling, Deposition, Leaching, budgets

Chronosequence Studies of Forest Ecosystem Development on Post-lignite Mining Sites

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Abstract

The development of pine ecosystems was studied at 2 - 60 years old mine spoils on two typical substrates of the lignite mining area of Lusatia/Germany in a “false-time series” approach. Pyrite contents of varying amounts in the original overburden material can result in extremely phytotoxic site conditions. Soil solutions are often characterized by low pH, high electrical conductivities and high element concentrations. Reclamation of these sites was traditionally carried out using large amounts of bottom or fly ash from lignite power plants.

The temporal development of soil solution composition along the ”false-time series” can be explained as a combined effect of intensive weathering of primary minerals including pyrite oxidation, transformation and precipitation of secondary salt and mineral phases, and leaching of salts. Additionally, ash amelioration affects soil chemical properties at least in the topsoils. The element outputs from the systems on pyritic substrates can reach extraordinary high amounts and are manifold increased to comparable sites on natural soils of the region. The chronosequence approach to study post-mining sites has proven to be a very useful tool to identify dominating processes on the ecosystem level.

Keywords: Element budgets, Leaching, *Pinus sylvestris* L., *Pinus nigra* Arnold, Pyrite oxidation, Reclamation, Secondary minerals, Soil solution chemistry

Canopy and Soil Modification of Precipitation Chemistry in a Clonal Eucalypt Stand in Congo.Comparison with an Ajacent Savanna Ecosystem.

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Abstract

The dynamics of nutrients are compared in a clonal eucalypt plantation and in a native savanna in Congo. This paper focuses on the changes of the precipitation chemistry during the transfer of solutions in both ecosystems. During the rainy and the dry seasons rainfall was on average respectively 151 mm and 7 mm per month. Chemical analyses performed during 17 months show that the concentration of all the elements in rainfall increases sharply during the dry season. Precipitation solutions are acid with a dominance of Ca^{2+} and Cl^-. Throughfall and stemflow are enriched for most of the elements but a N foliar uptake was observed in both stands.

The concentration of the majority of elements increases during the transfer of the solutions through the litter. This enrichment is particularly marked for H^+ and DOC in both stands. A severe water repellency observed at the surface of the soil in the eucalypt stand increases the time of contact between the solution and the forest floor and a net uptake of Ca^{2+} is observed. In the savanna, a net uptake of $N\text{-}NH_4^+$, K^+ and Mg^{2+} is also measured. The soil solutions are collected by ceramic cups connected to a succion of -600 hPa, between the depths of 15 cm and 6 m. The concentrations of all the elements are very low in these "capillary solutions", excepted for Si and DOC. These results show a very efficient uptake of the elements by both stands and losses by deep drainage very low in this poor ferrallitic soil.

Keywords: Eucalyptus, savanna, biogeochemical cycles, precipitation, soil solution.

Nutrient Cycling in a Chronosequence of Norway Spruce (*Picea abies* Karst.) on Shallow Calcareous Soils in the Northern Limestone Alps (Austria)

by
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Abstract

On a heavily karstified site in the Northern Limestone Alps (Austria) water- and nutrient household of Norway spruce stands was investigated along a chronosequence (clearcut, 10 year old artificial regeneration, mature stand).

Both nutrient stores in soil and in biomass were calculated. Bulk deposition, throughfall and seepage were sampled weekly during three growth periods (4-5 months each) and analyzed for main chemical constituents. Water fluxes were calculated using the BROOK90 model (Federer et al., 1995). The soils (lithic Leptosols) consisted of moderhumus overlaying a very pure limestone. Only in the regeneration plot signs of a mineral soil horizon could be dedected. In the mature stand twenty percent of nitrogen, thirty percent of phosphorus, nineteen percent of sulfur and fifty-eight percent of potassium pools were stored in biomass. Assuming an utilization of eighty percent of stemwood with bark, conventional harvest removed approximately four percent of the nitrogen, seven percent of the phosphorus, seven percent of sulfur and twenty-three percent of the potassium pools. Despite inorganic nitrogen inputs during these periods between 5 and 10 $kg.ha^{-1}$ with precipitation, inorganic nitrogen output with seepage from the mature stand and the regeneration plot was only 0.5-1.2 $kg.ha^{-1}$. In the first and second growing season after clearcut, inorganic N fluxes with seepage

increased to 20 and 30 kg.ha^{-1} respectively, declining in the third growth period to 8 kg.ha^{-1}. DON output was between 3 and 6 kg.ha^{-1} in the mature stand and 7 to 11 kg.ha^{-1} at the clearcut and the regeneration plot. Therefore, DON is an important fraction of the N-cycle of this ecosystem. Total differences between nitrogen stores of the mature stand and the regeneration were 270 kg.ha^{-1} of N. Less than half of the difference can be attributed to biomass removal, the rest may be attributed to leaching losses. However, total annual N-input is high at this site and will over-compensate losses. The P-stores were only affected by biomass removal, not by leaching of inorganic P-compounds. The mature stand seems to be S-saturated, input and output rates of sulfate are balanced. Regeneration is a net sink for inorganic S, as can be seen from declining fluxes with seepage for both the clearcut and the regeneration with time. K losses were between 30 kg.ha^{-1} in the first, 20 kg.ha^{-1} in the second and 9 kg in the third growth period after clearcut while output rates were less than 2 kg in the mature stand and the regeneration plot. K pools in the humus layer were only 150 to 200 kg.ha^{-1}, total pools in the mature stand were 360 kg.ha^{-1}. With annual input rates of less than 2 kg.ha^{-1} of K, harvesting and post harvesting losses may cause problems. Since precipitation is high in this area, forest growth is rather limited by nutrient than by water supply. Needle analyses show already deficient potassium supply. Harvesting and post harvesting losses of K, in combination with elevated nitrogen deposition may have negative influences on the stability of forest stands on these sites. Subsequently, negative influences on water supply from such areas are possible. As the demand on drinking water resources from karst regions is increasing, a careful evaluation of forest management practices on vulnerable sites in the limestone Alps is necessary.

Keywords: Nutrient cycling, Nitrogen, Potassium, Harvest, Spruce.

FLORES: Helping People to Realize Sustainable Futures…

by
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Abstract

People usually know *how they want their situation to change* to secure a better future – but they do not always know *how to change their situation*. Initiatives intended to secure a better future do not always work as intended, and may have unintended side effects. Computer models can help advocates explore consequences of proposed initiatives, so they can make informed selections of alternatives, secure in the knowledge that consequences have been thoroughly investigated. By encouraging people to explore scenarios, models empower people to be more innovative and less dependent on technocrats. New software solves technical limitations, but the real issue is not software, but rather the provision of a supportive framework within which people can express and experiment with ideas. FLORES, the Forest Land Oriented Resource Envisioning System, provides such a framework to stimulate interdisciplinary collaboration between researchers, practitioners and clients. A recent prototype demonstrated the feasibility of FLORES. However, FLORES is not about software; it is about providing the means to explore the consequences of alternative scenarios. Ultimately, FLORES is not a physical package, but a user group and the interactions they have amongst themselves, and with the people involved in policy-making. Fostering this emerging network through workshops and technical support will enhance FLORES by

offering a better understanding of the concept, and by allowing more people, especially those from developing countries, to influence the development of FLORES and the issues that can be explored within it.

Keywords: Decision support system, Adaptive modelling, Land use alternatives, Policy analysis

Ecological Scales and Use Rights: the Use of Multiagent Systems

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Abstract

The interactions between natural forest dynamics and social dynamics have to be taken into account when managing the use of forest resources. We have developed simulation models to improve our understanding of this complex system of interactions. Models of multiagent systems are effective tools for studying the dynamics of complex adaptive systems. We have developed several simulation models in order to study the use of forest resources. This paper presents a model designed to understand the interaction between fuelwood consumption and landscape dynamics. The hypothesis put forward suggests that fuelwood consumption can explain the landscape changes that occur in the Kayanza region of Burundi. The second hypothesis is that a sustainable use of resource must keep steady the fuelwood consumption level per capita over time. A preliminary map was outlined: agents use fuelwood, have access to different parts of space and have the capacity to exchange use rights. The population increases and agent migration — from overpopulated areas to unoccupied plots — is simulated. The impact of changing rules on foraging, exchange and access is then observed on a landscape level. The model describes here the behaviour of different agents (farmers, local consumers, exporters and traders). The impact of their behaviour and interactions are evaluated on different scales, ranging from the individual plot to the forest and the landscape. Models and multiagent systems can effectively represent processes that occur at levels of varying complexity and simulate their interactions so that landscape dynamics can be understood from the bottom up.

Keywords: Multi-agent systems, Fuelwood, Access rights, Social exchanges, Spatial scales

The Interactive Role of Fodder Trees in Hillside Landscapes: Using Fuzzy Sets to Combine Farmers' Knowledge with Science

by
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Abstract

In many developing countries, tree fodder is important for increasing protein supplies for livestock and improving the utilisation of poor quality straws during dry seasons when little feed is available. Farmers in Nepal possess a considerable breadth of indigenous knowledge (IK) to assist them in making effective use of tree fodder. Attempts by researchers to support the development of tree fodder resources need to account for this IK in order to both avoid re-inventing the wheel and to ensure the acceptability of any innovations. This paper describes the use of model, based on fuzzy logic, for integrating the Nepalese tree fodder IK system with quantitative descriptions of the biological processes associated with tree fodder use in order to facilitate this process. In Nepal, farmers describe tree fodder quality using two scales, *posilopan* and *obanopan*. *Posilo* fodder is said to promote milk and butter fat production in lactating animals, rapid

liveweight gain and animal health. *Obano* fodder "fills the animal", is highly palatable, particularly during colder months, and is eaten voraciously, although causing constipation if fed in excess. An earlier study examined the nutritional implications of these farmers' terms and suggested that the *obanopan* criterion relates to a fodder's digestibility and the *posilopan* criterion to its ability to supply protein. These observations were consistent with the characteristics assigned by farmers. The model described here used these associations to examine the outcomes of feeding strategies for dairy cattle formulated with reference to farmers' criteria and based on the information available to them regarding the quality of tree fodder. The model's predictions were consistent with farmers' expressed objectives of optimising milk production whilst ensuring that animals remained adequately fed in times of feed shortage.

Keywords: Tree fodder, Indigenous knowledge, Fuzzy logic, Dairy cow, Nutrition

The Future of Trees is on Farm: Tree Domestication in Africa

by
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Abstract

Current levels of deforestation suggest that the rising demand for tree products will have to be met by increased levels of tree planting. While traditional forest plantations will satisfy some of this demand, it is likely that there will be a substantial increase in the planting of trees on farmland. Farmers in areas of increased population density are already motivated to plant trees on their land because of the benefits they bring and this trend will continue. However, a great deal of potential exists to improve the tree species cultivated on farmland through a process of tree domestication, which involves not only tree breeding but species priority setting, nursery work, tree management, extension, marketing and policy interventions, and it is important that farmers participate in this process. Domestication of trees with high value products (timber, fruit, medicinal products) will provide small-scale farmers with income and an entry point to the commercial marketplace.

Keywords: Farmers, Tree products, High value

Trees on Farms in Industrialised Countries: Silvicultural, Environmental and Economic Issues

by
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Abstract

In industrialised regions, there is at present a trend towards a reduction of the areas devoted to intensive agricultural land-use. Many farmers maintain trees on their properties, while others innovate, by updating traditional agroforestry techniques. One main difference between silvicultural management of small- or large-scale forestry and farm forestry is the presence of a farm (and tree) manager within the system, available for supervising and tending the trees, due to differences in time scales between agricultural and forestry components. Trees are often considered by the general public as a panacea for reducing the adverse effects of industrial development, and even in the scientific literature, the virtues of agroforestry are often described with little reliable scientific background. However a number of well documented scientific studies show the ability of trees to enhance the environmental value of an area. The

contribution of trees and agroforestry systems to sustainable management of the natural resource base has been widely proven, in particular to combat widespread land degradation including salinity, soil erosion, soil acidification and soil structure degradation. Despite the difficulties faced when studying the economics of trees on farms, due to the self-consumption of woody products, and to the difficulty in studying the non-commercial value of environmental benefits, many farmers adopt agroforestry for motivations other than financial or direct environmental benefits, such as the social and cultural value of trees within a landscape.

Keywords: Farm forestry, Agroforestry, Sustainable management, Landscape, Multiple-use

Timber Production in Tropical Agroforestry Systems of Central America

by
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Abstract

Two of the most important changes in the agroforestry research agenda over the last 20 years have been with respect to the attention given to perennial rather than just annual crops, and the commercial productivity of trees in addition to their service functions. Interest in the potential of timber trees on tropical farms has increased, and in the humid tropics more emphasis is now given to agroforestry systems with perennial crops. Partially as a result of this shift of focus, agroforestry is now widely studied and promoted for diversifying and sustaining productivity of high quality agricultural land in addition to the previous emphasis on the recovery of degraded land or making productive use of marginal land. Interest in alley cropping systems has been reduced drastically, especially in the dry tropics, while there is an increasing recognition of the existing role and potential of silvopastoral systems and agrisilvicultural timber plantations, both for diversified production (in order to improve cash flow and reduce risk) as well as a means to improve site conditions; i.e., the potential contributions of trees to both ecological and economical sustainability of Central American farms has been recognized. In this paper, three examples of tropical agroforestry systems, which produce timber products, are discussed: multistrata agroforestry systems with perennial crops (e.g., coffee, cocoa); small woodlots on private farms, established with the Taungya systems; and silvopastoral systems which include a timber component. After presenting data from case studies, emphasizing the regional importance of timber productivity from these systems, some of the lessons learned from these medium-long term experiences are discussed. These include research methods (both experimental and survey approaches) and the selection of components and systems. The integration of socioeconomic and biophysical research, and of the results obtained at different scale levels, is also discussed.

Keywords: *Cordia alliodora*, Research methodologies, Selection criteria, Shade trees, Silvopastoral systems, Taungya

The Importance of Forest Patches, Isolated Trees and Agricultural Windbreaks for Local and Regional Biodiversity: the Case of Monteverde, Costa Rica

by
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Abstract

In Central America, most landscapes consist of a mosaic of pastures, agricultural fields, and forest fragments interspersed with residential and urban areas. Although these landscapes are highly fragmented and altered, they often retain a remarkable diversity of tree species within forest patches, isolated trees, and planted windbreaks. The forest patches, isolated trees and windbreaks are important for conserving both local and regional biodiversity because they provide important food sources, nesting sites and habitat for a variety of animal species (particularly birds), and may serve as stepping stones or corridors that facilitate animal movement across the agricultural landscape. They also help conserve plant diversity, both because the trees themselves often represent forest species that would otherwise be absent from the landscape and because the trees serve as hosts for numerous epiphytic plants. By acting as foci for seed dispersal and seedling establishment, the trees also facilitate the regeneration of forest plant species within the agricultural landscape. We present a case study of the importance of forest fragments, isolated trees and agricultural windbreaks for the conservation of both local and regional biodiversity in Monteverde, Costa Rica, summarizing and synthesizing the work of more than 20 years of ecological research in the region.

Keywords: Altitudinal migrations, Biodiversity, Forest patches, Isolated trees, Windbreaks

Why are Mountain Forests Important for Sustainable Development?

by
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Abstract

Mountains and uplands occupy a quarter of the Earth's land surface. About one tenth of humankind lives in them, and they affect the lives of over half the world's population. The global significance of mountain forests is recognised by the inclusion of a specific chapter in "Agenda 21", endorsed at the 1992 Earth Summit. The values of mountain forests to mountain people, those living downstream, and much of the remainder of humanity, including their roles as centres of biodiversity; the storage and supply of water; the provision of fuelwood and many other wood and non-wood products; essential complements to agriculture; sites for recreation; and protection against natural hazards and soil erosion. These values are underlined in documents resulting from regional meetings around the world, and emphasised in many recent and ongoing projects. They are the focus of the Task Force on Forests in Sustainable Mountain Development of the International Union of

Forestry Research Organizations (IUFRO), which has prepared a state-of-knowledge report for the XXI IUFRO Congress.

Keywords: Mountains, Forests, Sustainable development, IUFRO.

Resistance and Elasticity: Useful Concepts in the Sustainable Management of Mountain Forest Ecosystems

by
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Abstract

Ecological stability properties are attributes characterising the dynamics of an ecosystem. They include the concepts of resistance (staying essentially unchanged despite the presence of disturbance agents) and elasticity (speed of return to reference states or dynamics after a temporary disturbance). In the management of mountain forests that protect against natural hazards such as snow avalanches, resistance and elasticity are already intuitively used. However, traditional silvicultural approaches have focused on stand dynamics and considered the forest as a "stable" system. This is insufficient in the long-term since driving factors, be they external to the forest ecosystem such as atmospheric inputs, or internal such as browsing, have the potential to affect stand dynamics and thus effective protection, especially since they may exhibit long-term trends. Potential changes in, for example, chemical soil properties, need to be considered in forest management, and an ecosystem-based view adopted. Ecological stability properties that are crucial for long-term effective protection need to be identified, monitored with suitable indicators, and integrated into the sustainable management of these forests. The concept of ecological stability properties is so flexible that is not only a promising conceptual tool to sustainably manage protection forests, but also forests delivering other products and services.

Keywords: Sustainable forest management, Natural hazards, Mountain forests, Resilience, Resistance.

Indigenous Agroforestry Technologies for Sustainable Himachal Himalayan Development

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Abstract

The traditional agroforestry systems in the Himachal Himalayas have shown that the local farmer is aware of the benefits of mixed cultures and grows at least three to six types of trees in and around his fields. The overall prevalence of trees under traditional agroforestry concept at each farmer's field showed an increase from 47% in the lower hills to 67% in the middle hills. In general, 35-60% of farmers' fields have trees in traditional agroforestry, ranging from 35 to 46 different species from the lower hills to the middle hills. In the lower hills, the focus was on timber and horticulture trees whereas in the middle hills the prime aim was to integrate fuelwood and fodder trees in the system. Keeping in view the indigenous knowledge of the architectural shape of the tree in which the farmer manages a particular type of species, various tree prototype models were developed and tested. These canopy architecture prototype models depict the type of the tree for lopping practice, the extent, and the zone of the canopy management done by the farmers. In this work, the human perception in adoption of a particular prototype of an agroforestry tree in a system was highlighted. The concept of conserving the biodiversity increased from the lower to the middle hills. The indigenous

practice of coppicing, lopping, and pollarding the trees for crop compatibility with respect to the size of the field was traditionally adopted by farmers because it both improves the productivity of land in terms of fuel and fodder and reduces the stress on village forests.

Keywords: Agroforesty, Indigenous technology, Prototype, Tree Architecture

Forest and Mountain Development in Taiwan

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Abstract

Taiwan, with a total area of 35,915 km^2 and a population of 23 million is rich in forest resources. 58.5% of Taiwan is covered by forest, which plays an important role in soil and water conservation, timber production, and recreation. From 1914 to 1945, mountain development was concentrated on forest exploitation, railway and forest road construction. From 1946 to 1975, timber production, agriculture, and horticultural practices became the main scheme of mountain development. In 1976, the government passed the Forestry Management Innovation Act. Mountain development shifted from timber production to recreation and horticultural production for increasing the income of mountain communities. In 1989, timber harvesting was banned in natural cypress stands of national forests. In 1992, cutting was completely banned in natural forests. Since then, forest management has concentrated on sustainable forest ecosystem management. Culture and recreation have become the main thrust of mountain development. In recent years, the cultivation of crops has caused serious soil erosion disasters. Integrated forest management has great potential to ensure stability and sustainability in timber production and to provide ecological and economic security to mountain development.

Keywords: Forest; Environment; Mountain development; sustainability

Mountain Forests and Forest Policies in Europe: Basic Considerations and Results from Case Study Comparisons

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Abstract

Conditions in mountainous regions are distinctive as regards ecological as well as socio-economic aspects. However, while ecological features, which set mountain regions apart from other areas, are quite similar among all mountain regions, socio-economic conditions differ quite highly between different types of mountain areas in Europe. Consequently there also exist different approaches to mountain forest policies. Based on national studies, which were undertaken in the framework of COST action E3 (Forestry in the Context of Rural Development), information on mountain forest policies in 11 mountain regions in Europe have been compiled for analysis. The comparative analysis is performed using a Boolean approach to comparative analysis which allows the comprehensive analysis of qualitative and quantitative information without having to rely on random sampling of cases. From the analysis, the cause of conflicts as being ultimately a result of struggle for scarce resources is revealed. The choice of political instruments, too, reflects power structures in a society as well as its general political culture.

Keywords: Policy analysis, mountain forests, qualitative comparative analysis

Forest Science-Policy Interface

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Abstract

In this paper we share some of the experiences we have had in integrating science and policy. We have been discussing this topic and developing appropriate roles for scientists and policy makers for several years in IUFRO.

In our paper we focus on the following five points:

1. Science helps policy makers create new visions and new possibilities for forest management.
2. Policy makers have visions too, and science can help convert their visions into reality.
3. Science helps bring organization and logic to debates among policy makers.
4. The role of a scientist and scientific processes are unique and should not be compromised.
5. Science administrators have a distinct role and it is not the same as the role of a scientist.

Keywords: Forest science; Forest policy

Using Scientific Uncertainty to Shape Environmental Policy

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Abstract

Environmental management and policy formulation are increasingly characterized by conflict. Issues concerning natural resources, land-use practices, and global climate change have been fraught with debate and indecision. Some argue that the required information and levels of certainty fall short of scientific standards for decision making; others argue that science is not the issue and indecisiveness merely reflects a lack of sufficient political willpower. In the case of global climate change, even such unprecedented efforts as the IPCC appear to provide insufficient scientific guidance to formulate decisive environmental policy. Nonetheless, science remains the foundation for informing, evaluating, and shaping policy. Yet perhaps more than ever, science is subjected to keen scrutiny; scientists are required not only to report but also infer and substantiate this inference in a range of decision-making contexts. One of the most difficult and confusing aspects of translating science to policy is the interpretation of scientific uncertainty as embodied in statistics, model output, and opposing scientific opinions. Whereas scientists are familiar with uncertainty and complexity, the public and policy makers often seek certainty and deterministic solutions. We assert that environmental policy is most effective if scientific uncertainty is incorporated into a rigorous decision-theoretic framework as *knowledge*, not ignorance. Policies that best utilize scientific findings are defined here as

those that accommodate the full scope of scientifically-based predictions.

Keywords: Environmental policy, Global climate change, Uncertainty, Risk, Decision making

Forestry Research in Sub-Sahara Africa: Time for Reflection

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Abstract

Despite the great social, economic and environmental diversity in countries of Africa South of Sahara (SSA), forestry research issues and advances are quite similar. This is partly influenced by historical facts relating to forest resource ownership and management. In most countries, governments own and manage forest resources. Forestry research institutes are in many countries very tiny departments or units tucked under huge ministries or agricultural research organizations. Their visibility, much less their effectiveness in that position is barely significant, because they are also poorly staffed and financed.

The little available forestry research capacity is poorly managed. The few competent researchers are increasingly getting involved in administrative functions and also looking out for greener pastures. Economic policies imposed by global financial institutions constrain the recruitment of young scientists to take up forestry research now and in the future. Although universities are by far better resourced, their efforts are rarely linked with national research issues. They seem to operate independently, far removed from real world issues.

Through the intervention of some global stakeholders, some research institutes have developed their research agendas, but these have largely remained on the shelf for lack of resources to implement them. Most on going work is largely donor–driven. There is a serious gap between forestry research and development. Research institutes do not have the capacity to extend their findings. At the same time, they are not properly linked with agricultural extension services or NGOs in order to get their messages to stakeholders, especially farmers. This delimits the usefulness of the little that could trickle from forestry research.

In this paper, we have briefly discussed the above-mentioned issues, and made some recommendations. It is clear that SA countries and the global community have a role to play to redress the situation. We think that unless affirmative action is taken SSA and the world stand to loose the opportunity to benefit from SSA forestry resources.

Keywords: Forestry research, Sub-Sahara Africa.

Forest Discussion Forums as Modern Policy Means: Bridging Research, Practice and Policymaking

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Abstract

Issues and problems relating to forests have become increasingly interdisciplinary and global. Subsequently, there is increased recognition that many problems related to forestry cannot be resolved by the forest sector in any country or any region alone. Instead, dialogue and co-operation between various

sectors of society, and various regions is needed. Indeed, the forest sector has lately been concerned about the sufficient incorporation of various interests in its policymaking. However, an equally important question is whether the forest sector is itself sufficiently involved in decision-making in issues that are taking place outside the forest sector but which still have major importance to the sector. Moreover, while participatory policies are gaining increasing support within forest policy, the participation of scientists in policymaking is typically regarded as undesirable, or at least limited to science policy administrations. In this paper, both these challenges are discussed through the examination discussion forums as modern forest policy means. Ass all illustration, experiences from a new type of discussion-forum known as the Forest Forum for Decision-Makers in Finland (FFDM) are presented. During only a few years of action, FFDM has succeeded not only in improving the interface between science and policymaking, but also in increasing dialogue between decision-maker in forestry and other sectors of society. Finally, the question of the applicability of this new concept internationally is discussed.

Keywords: Forest,Research, Practice, Policymaking

Priority Themes In Tropical America For Agricultural/Forestry Development: Importance Of Networking

by
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Abstract

The main potential advantages of networking, for agricultural, agroforestry and forestry development in Tropical Latin America, are: 1) synergy and complementarity among national research institutions; 2) improvement of the bargaining position of producers; 3) support for biotechnology development; 4) protection of germplasm and intellectual property rights; 5) upgrading postgraduate education; 6) recognition of institutional capabilities; and 7) exchanging and managing information.

The main limitations to networking in the region are: 1) weak national information transfer structures; 2) slow development/adoption of electronic media, 3) inappropriate choice of network activities; 4) low network sustainability due to weak commitments from members; 5) inflexibility of networks; 6) dispersal of participants (larger countries); and 7) insufficient donor coordination. Eight research/development priorities are suggested for the region: 1) accelerated recovery of degraded pastures (e.g., using agroforestry and forestry technologies); 2) policy issues, regulations and practices that affect land use (e.g., impact of reforestation incentives); 3) increased quality of products (e.g., "organic" markets/"green" labelling and certification criteria); 4) development and massification of biotechnology and biocontrol techniques (e.g., coffee or cocoa shade systems); 5) demand and quality requirements (i.e., market intelligence and prospection) along with the development, valuation and marketing of new products, goods or services (e.g., certified tradeable offsets [CTO´s], water, recreation); 6) diversified sustainable use of natural resources in flexible production systems that can adapt to changing market prices and other demands (e.g., timber-coffee combinations, annual crops and fruit trees); 7) silviculture of secondary forests (bio-physical and socio-economic analyses); and 8) protection of improved and natural germplasm, and intellectual property rights.

Keywords: Agroforestry, Extension, Information transfer, Institutional development, Planning

Operational Networking: An Effective Mechanism To Promote Tropical Forest Management Promising Experiences In Central America

by
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Abstract

The Ongoing processes of deforestation are rapidly diminishing primary tropical forests in Central America. Tropical forest conservation requires that these forests be integrated into the local economies of rural communities and indigenous groups. The achievement of this integration is a complex endeavor involving diverse technical, sociological, cultural, biological, economic and political concerns. To better address the complexities involved, over 75 entities with interests in tropical forest management and conservation have joined together in three operational networks in Honduras and Nicaragua. Network members include public sector entities, NGO, communities and producer groups, universities and technical schools, projects and private companies. Networks collaborate in technical aspects of forest management, in research, in training and higher education, in industry and commerce, in community development, in information dissemination and recently in policy dialogue. This paper discusses progress to date, initiatives to achieve network sustainability, problems and future directions.

Keywords: Tropical forest management, Operational networks.

Global Expertise for Solving Local Problems – Web-based Distance Learning Technology in the Transference of Know-how and the Construction of Expert Networks

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Abstract

Recent information technology has opened up fascinating new visions for global networking, cooperation, and exploiting expert services and education through the use of the Internet. Web-based learning environments and distance learning offer one of the most promising areas for taking advantage of the new technology. As the new technology shifts from pilot projects to every-day use it is likely to cause remarkable structural changes in the education markets, changes which will lead toward new expertise and globalization.

Keywords : Expert Networks, Distance learning, Website

IUFRO's New Era of Scientist Communication

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Abstract

The development of IUFRO's communication to utilize Internet based technologies is reviewed. During the past quinquennial a WWW based information system was built for IUFRO and its working units. A task force (IUFRO Task Force on Internet Resources) was established to coordinate and facilitate this work. The information system now covers most of IUFRO's activities and a user study helps to plan future development.

Keywords: Research communication, Information system, Internet

ITTO Initiatives for Networking in Forestry

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Abstract

This paper begins with a discussion of the term 'network'. In the context of this paper, it is taken to mean the flow of information between individuals, institutions and nations.

The International Tropical Timber Organization (ITTO) has been developing networks since it commenced operation in 1987. Not all such networks have not been created from 'scratch'; ITTO has been able to tap into existing networks and in many cases strengthened them. These networks extend in all directions – from the international arena to the field level and back again.

ITTO's networks extend to the field level primarily through its project program. In its 13 years, ITTO has distributed funds to about 400 projects in its member countries, predominantly those in the tropics. This creates a natural flow of information: projects consistent with ITTO objectives are proposed by member countries and vetted by an international team of experts. They are then submitted to the International Tropical Timber Council; if approved they may attract funding, which is provided in the form of grants rather than loans. Once a project is implemented, information exchange continues – between ITTO and the implementing agencies, and between the ITTO Secretariat and field staff associated with the project. Thus, networks are established or maintained that link the international arena (at the Council level), through national governments, to national and sub-national agencies and non-government organisations, and to field staff.

Complementing this approach are two projects aimed at developing a more structured information network: one produces a newsletter, the Tropical Forest Update, and the other a tropical timber market information bulletin. The newsletter has evolved considerably since its beginnings in 1991, but its aim has remained constant: to promote the exchange of information on the conservation and sustainable development of tropical forests. It has a circulation of about 7,000 and is distributed in English, French and Spanish. It publishes basic information such as the availability of short courses and scholarships and information on recent publications, meetings and other events. But it also provides analyses of the tropical timber trade and sustains a global-level dialogue on the role of forestry in conservation and development. It also feeds back into the ITTO project program by publishing reports about such projects, usually co-written by project field staff and

members of the ITTO Secretariat. This affords project personnel the chance to articulate and communicate the outcomes of their work and to learn about the activities of their counterparts in other countries and regions.

The Tropical Timber Market Information Service is aimed specifically at tropical timber traders and trade analysts and operates principally via the internet. It carries price data on over 300 tropical timber items and has developed a price database to service specific trade inquiries and for the production of price trend data. These data are also provided to other international agencies for their own reports on the tropical timber trade.

ITTO has never seen itself as the sole institution with responsibilities in the field of tropical forest conservation and sustainable development. It currently contributes around $20 million a year to field projects; these, on their own, will not solve the tropical forests crisis. But other institutions – global, regional, national and local – and the individuals within them can learn from our experiences and we can learn from theirs. This is the value of networks.

Keywords: ITTO, Networking, Forestry.

FAO Initiatives for Networking in Forestry

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Abstract

The paper reviews examples of networking efforts by FAO in forestry, within different regional or global framework, and with broad or more specific objectives. Factors of success and issues in operating the networks are presented. Relatively less complex to operate, theme-specific networks generally achieved good results although inadequate capacity of some collaborating institutions can be a constraint. A stepwise approach was successfully applied for some more complex networks with broader objectives. Generally, regional technical cooperation networks, established to common regional issues, well fulfilled their role in exchange of information and experience. They have created, over the years, competent resource groups, which however need external support to be maintained. Efforts in support to regional networks of forestry research institutions, to enhance national and regional capacities to prioritise and undertake research in an effective way, are presented. Cooperation with other regional or international programmes and institutions has constantly been an important factor of success in all the networking efforts facilitated by FAO.

Keywords : FAO, Networking, Forestry.

Forest Resources Management in Southeast Asia: New Directions

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Abstract

Over the last decade clear trends have emerged with the management of forest resources in Southeast Asia. Some countries have ceased timber production from natural forests, and are now net importers. Others are beginning to perceive declines in production. While these have serious economic implications to many countries in the region, concern for the rapid degradation and loss of some of the world's greatest species diverse forests has been turned into international issues. A number of international initiatives were made to bring about improvement in the management of these ecosystems and to ensure they are not totally degraded. Forest management has ceased to be mere pursuit of yield increments. It now has to address an array of issues collectively described under the principles of sustainable forest management. They encompass socio-economic considerations, environmental issues, and biodiversity conservation matters. Currently, there are

approaches to enforce such measures by introducing certified "green" timber only to be traded in the international markets. There are calls to have independent assessment of the forest management as well. Since natural forest management is undergoing heavy scrutiny and greater controls, there are now moves to overcome the decrease in production by investing heavily in timber plantations. As a consequence, the private sector is beginning to participate in an industry that was once the domain of the public sector. Overall, forestry in Southeast Asia is facing considerable challenges ahead. Some future directions for achieving sustainable forest management in the region are discussed.

Keywords: South East Asia, Forest resources, Management

Regional Scenarios in Management of Forest Resources: Latin America

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Abstract

The paper will present some general figures of the forest resources and its dynamic: amount and evolution of resources, deforestation and its causes, the general forest management situation. The paper will also emphasis on natural tropical forests.

Through selected examples like forest management by the Chiquitanos communities in Bolivia, the extractive reserves in Brazil, forest management by farmers associations in Costa Rica, forest management together by a company and a Mayagna tribe in Nicaragua, the community forest management in the Atlantic coast of Honduras, the community concessions in Guatemala and the ejidos management in southern Mexico, the impacts of forest management oriented to the markets over indigenous peoples and local communities, will be analyses. Lessons will be also extracting about the potential of forest management through local communities. It will also give a perspective of forest management by private companies in some examples like Mil Madereira Itacoatiara in Brazil, private companies in Santa Cruz with the Bolfor Project in Bolivia, forest management by PORTICO in Costa Rica, etc. The paper will analyse some of the most important changes in the communities and in business as a consequence of forest management.

The paper analyses also the general perspectives of forest management in Latin America and will project different scenarios and assume the different consequences that some global initiatives and policies may have, like the Intergovernmental Panel on Forestry and the Intergovernmental Forum on Forestry, the World Commission on Forestry and Sustainable Development, the Global Forestry Programme of UNDP, the forest policy of the World Bank, the Forest for Life Initiative of the WWF/WB, international certification and the Convention on Climate Change. The paper will state the basic assumptions about conditions needed to radically improve the situation of management of forest resources.

Keywords: Forest resources, Management, Latin America.

Sustainable Forest Management In Africa : The Challenges And Issues At Stake

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Abstract

Africa has about 1084 million hectares of forests and woodlands, which for decades have been a reservoir of genetic diversity providing on a continuous basis, the needed supplies of forest products , non-timber forest products, ecological benefits and a wide range of services required by the people inhabiting the region. The regional total of forest plantations raised in Africa towards the end of the last century was about 3.64 million hectares; a

figure much lower than those recorded for Asia (15.86 million hectares), and South America (6.9 million hectares). With the current rate of forest depletion at 4.0 million hectares per annum, and increasing demographic pressures and human impacts; an era of chronic wood famine is imminent in Africa before the end of the 21st century. The sustainable management of the natural forest resources in Africa can be achieved through well structured research and development programmes. Potential areas of research studies demanding attention include: studies on natural ecosystem; forest resources assessment; harvesting and utilisation of wood and non-wood forest products; and management of watershed and mangrove forests. Proper execution of the research programmes highlighted above, would ensure continuous provision of the economic and social benefits of the natural forests in the region for the present and future generations.

Keywords: Africa, Sustainable forest management, Challenges and issues.