Book of Abstracts

Multipurpose Forest Ecosystem Management in a Changing Environment

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Forest Carbon Management in a Changing Enviornment

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It is widely recognized that forests play an important role in mitigating global climate change with expanding reforestation and afforestation activities to increase carbon sequestration in forest ecosystems. However, there has been much less effort has been placed on effects of forest management on soil carbon stock and soil carbon stability, which have greatly constrained forest practitioners to implement appropriate management measures to enhance forest carbon sink capacity and forest adaptive capacity to climate change.

Based on the recent literatures, this paper makes an overview on effects of forest management on soil carbon and carbon stability. We discusses how forest cover change, such as from natural forest to natural regenerated secondary forests to plantation forest, affect soil organic carbon stock, composition and carbon emission as well. In addition to forest cover change, the impacts of several other silvicultural approaches, such as forest logging, continuous cropping of short rotation monoculture, species specific plantation as well as tree mixing option aimed at facilitating species diversity and multi-ecosystem services, are also discussed and assessed. In the case of plantation forests, close-nature forest management by combining indigenous valuable tree species for large diameter timber production with fast-growing and high yielding conifer trees of short rotation, at stand and landscape levels, is strongly encouraged and advocated for future forest management option in China. This management offers adaptation opportunities that help forest ecosystems not only contribute to enhancing forest carbon sink capacity but also improve forest adaptive capacity by maintaining forest biodiversity, forest health and ecosystem stability.

Climate change is changing forest ecosystems and thereby traditional forest management has to adjust to changing climate and fulfill carbon-regulating service while providing existing goods and other ecosystem services at the same time. Therefore, there is still a need to study new measures of forest management and the integration of forest management options for developing forest management system adapting to climate change. Mainstreaming carbon management into current sivlcultural practices and forest planning programs would create new opportunities and challenges towards developing carbon forestry by taking climate change mitigation and adaptation into consideration.

Keywords: Climate change, soil carbon, forest management, forest adaptation.

Multipurpose Forestry – an option for the future?

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Multipurpose forestry or segregated single purpose forestry - how should we manage our forests in the future? We observe world wide different approaches: In many European countries multipurpose forestry has been introduced long time ago after a phase of forest re-establishment being exposed to extended abiotic and biotic disturbances as well as new needs of society. More recently, similar transformation processes can be observed in various parts of the world. In other parts like in New Zealand or South Africa forest areas generally are separated to serve specialized aims such as optimizing wood production or optimizing nature protection. Both forest-based land-use options the segregation and the integration can provide ecosystem services in a sustainable way on the landscape level. The choice depends on the specific ecological, economic and social conditions as well as on the aims of the decision maker. Decisions have to consider various ecosystem services provided by forests and their valuation by the societies. As the environmental and the economic conditions as well as societal expectations from forests are changing substantially over time and space forestry has to be able to adapt to these changes.

This paper discusses under which conditions which option should be preferred.

Keywords: multipurpose forestry, segregation, ecosystem services, adaptive forestry

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Trends in forest management with special focus on wood supply

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Currently Chinas forest land area is about 206 Mio ha, accounting in 22 % of the land area of China (FAO, 2010). Most of these forests are young, planted forest stands which can not provide wood for the wood processing industry yet (BULL & NILSSON, 2004). But soon these stands will be in focus of the forest management, due to required maintaining on the silviculuture side and rising wood demand on the consumer side.

Therefore questions can be arise, what has to be done to maintain these forest stands, which concepts fit best with the new aim of multi-purpose forestry and which techniques will lead to low damages on soil and the remaining stand. Nevertheless it is important to be cost efficient in the end.

Based on experiences in Germany of mechanization of forest work, possible future trends in forest operations will be described, reflecting positive and negative effects of using forest machinery.

References

BULL, G. Q., NILSSON, S. (2004), An assessment of china's forest resources, in Forestry in China - policy, consumption and production in forestry's newest superpower: special issue, vol. 6, edited by J. Xu, G. Q. Bull, S. Nilsson, A. White, and A. J. Pottinger, pp. 210–220,
Commonwealth Forestry Association.

FAO, 2010, Global forest resources assessment 2010: Main report, FAO forestry paper, vol. 163, Food and Agriculture Organization of the United Nations, Rome.

Differences in plant species diversity between forest plantations and secondary forests of *Castanopsis hystrix* in Guangxi province, South China

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To achieve ecologically sustainable forest management, it is widely recognized that the mission of plantation should be not only providing wood, but also serving various functions (e.g. biodiversity conservation). Therefore, to protect biodiversity in forest plantation ecosystems, it is necessary to fully clarify the effects of forest management practices in plantations. We compared the differences in plant species diversity between forest plantations (26 years of age) and secondary forests (30-40 years of age) of Castanopsis hystrix in Guangxi province, to elucidate the effects of differences in forest management, focusing on the composition and functional types of plant species occurring in each. The abundance and species richness in secondary forests (3887±999 individuals/1000m^2; species richness: 84±3.2 species/1000m$_2$) were significantly greater than in forest plantations (923±242 individuals/1000m^2; species richness: 24±2.9 species/1000m^2; p=0.007-0.000); there were, however, fewer abundance of arbor layer species in secondary forests than in forest plantations. There were significant differences in functional types of woody plant between two types of stands (p=0.008-0.000), while the functional types of herbaceous plant (including grasses, ruderal and fern plant) had no significant differences (p=0.170-0.284). These results suggest that differences in management practices cause various responses according to species type and affect the ecological process of seed dispersal.

Keywords: Forest plantation; Secondary forest; Forest ecosystem management; Plant functional type; Seed dispersal

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Effects of continuous cropping system on biomass and species diversity of *Eucalyptus* plantations, South China

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The continuous cropping system (CCS) is common practices in Eucalyptus plantations in southern China. In order to clarify the effects of such practices on biomass, species compositions, species diversity and functional types of forest plantations, a field trial was installed in first rotation (FR), second rotation (SR) and third rotation (TR) of Eucalyptus plantations. The three types of plantations were adjacent and were established at the same time in April, 1998 using clonal seedlings of a Eucalyptus hybrid (E. urophylla x E. grandis). The treatments were replicated three times (each of 600m^2) and arranged in a simple completely randomized design. The plot of 600m^2 was divided into 6 subplots, each of 100m^2. Within each subplot, the DBH (diameter at breast height) and stem heights of all canopy trees was measured and the biomass of arbor layer of stands was calculated by the relative growth model, all plants were identified by species, and the density of each was counted and recorded, and the biomass of understory vegetations was measured by harvest method, in 2005 following the treatments.

To do so, although the CCS had no significant effect on the biomass of the arbor layer, there were significant differences in the biomass of the shrub layer and herbaceous layer in understory among three types of stand. The CCS reduced the biomass of the understory vegetation remarkably, and was also particularly unfavorable for the biomass of shrub layer (or woody plants) in understory vegetation. In addition, the CCS also reduced woody plant abundance, richness, Shannon-Wiener index of the understory vegetation, woody plant abundance, richness, Shannon-Wiener index in the FR was significantly greater than in SR and TR. Furthermore, the CCS seems to reduce not only species diversity, but also change composition of plant functional types with decrease tall tree diversity and increase herbaceous diversity. However, the changes of composition of plant functional types will affect the forest plantation stability and ecological functions.

The management practices of the CCS to repeated disturbances to soil and vegetation including clear-cutting followed by prescribed burning and mechanical plowing were the leading cause of changes in biomass, species richness and abundance of understory vegetation on those sites.

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The canopy gap and leaf area index as indicators of forest response to ice storm damage

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A damaging ice storm struck southern China in January 2008, affecting 19 provinces of China and nearly 17.65 million hm^2 of forests. Although disturbance of this scale occurred rarely (once in a century), it provided a unique opportunity to study short- and long-term impacts on the compositions, structure and succession of forest ecosystem. A 3.2 hm^2 plot was set up in the ice storm-damaged montane evergreen broad-leaved forest in Damingshan National Nature Reserve. The plot was divided into 80 subplots, each of $400m^2$. The canopy gap and leaf area index were studied on the evergreen broad-leaved forest. This storm resulted in forest canopy gaps of various sizes, which was especially serious and affected the forest far more than the sum of the previous 40 years. The density of gaps was 26.6 per hectare in the forest. The area of canopy gaps were ranged from 28 to 928 m^2 （average：$199.3m^2$），while the area of expanded gaps were ranged from 67 to 1149 m^2 (average: $258.2m^2$). The canopy gaps and expanded gaps accounted for 52.9% and 71.7% of the total forest area, respectively. LAI declined 50.79% of post-storm in 2009 than pre-storm in 2006. However, resilience of canopy cover to disturbance was great, as indicated by 55.40% increase in LAI of the forest from 2009 to 2010. Sixty subplots showed the increasing LAI and twenty subplots showed decreasing LAI in the 80 subplots measured. Decreasing LAI was primarily due to 776 dead trees in 2010. LAI change was more significantly related to damage than canopy gaps, indicating that LAI response is a better indicator of ice storm damage than canopy gaps.

Keywords: Ice storm damaged; Forest canopy gaps; Leaf area index; Evergreen broad-leaved forest; Subtropics

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Woody understory plant diversity in pure and mixed native tree plantations at Guangxi Daqingshan mountain, South China

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Tree plantations can be an important tool for restoration of degraded ecosystem in the tropics and subtropics. Plantations can help speed up secondary forest succession by improving soil conditions, attracting seed-dispersal agents, and providing necessary shade for understory growth. In this study, the abundance and richness of understory regeneration were measured in pure and mixed native tree plantations of 26 years at Guangxi Daqingshan mountain, South China. The greatest abundance of regeneration was found in the understory of mixed stands of Castanopsis hystrix ×Pinus massoniana (872±401.0 individuals/1000m^2) and the middle was found in the broad-leaved pure forest of C. hystrix (501±239.2 individuals /1000m^2), while the lowest was found in the needle pure forest of P. massoniana (136±804.1 individuals /1000m^2). However, the needle pure forest showed the greatest understory species richness (27±2.92 species/1000m^2), while the broad-leaved pure and needle broad-leaved mixed forest showed the lower species richness (14 species in pure and 24 species in mixed forest).There was a significant negative correlation between the percentage of canopy cover and species richness of regeneration in the understory, in contrast, there was a significant positive correlation between the percentage of canopy cover and abundance of regeneration in the understory. The lack of difference between the understory make-up of needle pure plantations and needle broad-leaved mixed plantations in species richness suggests that planting mixed stands is not necessarily superior to planting pure stands for promoting understory diversity of woody species. While abundance of regeneration of woody species can be faster under broad-leaved pure or mixed-species plantations than in needle pure plantations, the abundance, richness and species composition depends on their plantation species or canopy cover.

Keywords: Pure plantations; Mixed plantations; Diversity; Restoration; Understory regeneration

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Understanding impacts of silvicultural treatments on key species in the managed forests of Betul district, M.P. – an ecological perspective

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Different silvicultural systems have a different potential for affecting the structure and composition of the diversity of the forest ecosystem as they tend to favour some species and affect others negatively. The forests of the Betul district are mainly under five silvicultural practices viz. Teak conversion, Selection-cum-improvement, Coppice-with-reserve, Improvement and Rehabilitation of degraded forests. The Teak conversion WC has the highest proportion of Tectona grandis (63.9%) represented in all the classes upto exploitable girth along with species like Adina cordifolia and Lagerstroemia parviflora. Tectona grandis is also represented in all size classes upto exploitable girth in Selection-cum-improvement WC, Coppice-with-reserve WC and Improvement WC, but in much lower densities. The Coppice-with-Reserve WC has fruit bearing species like Buchnania lanzan, Terminalia belerica and Terminalia chebula in the higher girth class (>91cm GBH). Timber species are represented in the girth class (31-90 cm GBH) only. In the Improvement WC timber species were found in the low to middle size classes i.e. 31-90 cm GBH category but had negligible representation of fruit bearing trees. The Rehabilitation of degraded forest WC had an overall low tree density (314/ha) and little or no regeneration.

Relevant Theme: Forest ecology, hydrology and biodiversity

Relevant Subtheme: Forest Management and Biodiversity

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Forests and Forestry of China: The state, challenges and perspectives

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1.Basic natural and socio-economic factors influencing forests and forestry of China
Climate features
Topographic conditions
Economic factors
Population
Biodiversity
Land use changes
Polices

2.Forests of China
Forest cover: 8% (1949) to 20.36% (2008)
Distribution map of forests
Forest types: The richest country on forest types in the world, including the various natural forests and plantations from cold-temperate to tropical regions.

3.Forestry of China
Classified forest management approach
Timber production
Management situation
Timber import and export data

4.Challenges
Because of big and fast growing population and rapid development of economy, the forestry of China is facing many challenges on forest management, timber supply and conservation.
Perspectives of forestry in China
The governments of China have paid many attentions to both of conservation and forestry development since 1990's, and got the great achievements.
Six National Ecological Construction Programs have made great contributions.
Strategic plan of forestry developme

The calorific value of bamboo in dependency of the culms age

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Bamboo has gained increasing attention, especially due to its fast growth and its versatile utilization. It is used by millions of people in their daily life and is a resource for timber, pulp and paper, and food industries - not only in Asia. So far the bioenergy sector has shown only marginal interest in bamboo, whose energetic properties are less intensively studied than its physical ones.

Two studies of Dietenberger (2009) and Schoenherr (2010) had been carried out within the Sino-German research project ValWood, to gain knowledge on energetic - and chemical properties of the two bamboo species Phyllostachys pubescens and Bambusa emeiensis for energy recovery.

Both species were tested on calorific value, moisture, ash and chloride content in dependency on the culms age and the sample's position along the culm. Compared to woody biomass, both species show similar calorific values and only slightly higher chloride and ash contents.

References

DIETENBERGER, R. (2009), Eigenschaftsuntersuchungen von Bambus zur energetischen Verwertung. Diploma thesis, University of Freiburg, Germany.

SCHOENHERR, S. (2010), The energetic properties of Phyllostachys pubescens and its potential use for thermochemical biomass conversion. Bachelor of Science thesis, University of Applied Sciences Eberswalde, Germany.

Sustainable Forest Management - challenges for ecosystem services

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The global situation requires more than during the past decades a sustainable use and management of land and natural resources. Actual problems like food insecurity, a growing demand for biomass for food, feed, raw material and energy, the ongoing land degradation and desertification, water scarcity, the need for an efficient use of natural resources, and last but not least climate change issues all challenge land users, scientists, planners and decision makers in a different manner and intensity. Beside the principles of the Millennium Ecosystem Assessment, also national, regional and local needs increase the pressure to both a sustainable, economically viable management as well as ecology sound management of land resources. These include a) supporting (nutrient cycling, soil formation, primary or biomass production), provisioning (food, fresh water, wood, fibre, fuel), c) regulating (climate-, flood-, disease-regulation, water purification), and cultural (aesthetic, spiritual, educational, recreational) ecosystem goods and services. Forests, obviously sometimes forgotten important components of terrestrial ecosystems, are heavily endangered, but will also contribute both as natural and as man-made forests significantly to the global challenges. The presentation gives an overview about the actual global trends and development, and shows based on the research results of the Sino-German research project ValWood, principles and values gained during the last years as contribution for a improved assessment and planning of forest resources in China.

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Adaption of silviculture to climate change

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In many parts of the world, increasing temperature and changing precipitation regimes, as well as extreme weather events like heat waves, drought and storms, put a high level of disturbance pressure on forests. In the first section major impacts on German forests are described and vulnerability of tree species and regions are identified. Furthermore, the basic silvicultural approach in Central Europe, close-to-nature silviculture, is outlined. After a revision of general adaptation strategies such as active or passive adaptation, we address diverse silvicultural options to assist forest adaptation to climate change, with an emphasis on tree species or provenance selection and regeneration / felling systems. Furthermore, we investigate the strengths and weaknesses of close-to-nature silviculture (CNS) as a means to adapt forests to climate change. For this we check to what degree CNS systems make use of management principles which are considered as effective for increasing the adaptive capacity of forests to a changing climate. Finally we propose an integrative adaptive management concept and emphasize the need for further research.

Key words: climate change, adaptation, tree species selection, close-to-nature silviculture

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Multipurpose use of forest land - assessing changes, their drivers and their impacts to society and environment

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Forest management is ideally a governance tool derived from forest related policies and aimed to address societal goals. In forestry we have occasionally seen our sector in isolation from other and adopted management approaches focused on e.g. timber production or forest conservation. It may have contributed to increased timber growth but made it difficult to address deforestation, biodiversity and poverty. A centralized perspective has dominated. We now see the emergence of policies and concepts, for example.SFM, targeting local needs and a broader scope of issues.

A crucial question is management for whom and by whom. In many developing economies (e.g. China, Vietnam) local households and communities have in recent years acquired strengthened property rights to forest and forest land. For households with capacity to invest in their own land this change could mean a jump out of poverty. For rural people without individual property rights or significant incomes, common pool resources are crucial for their subsistence, and community based management may be preferable to protect their need of multipurpose forest use. A process of increasing property rights has occurred in other countries historically. E.g. in Sweden, state forest land was allocated to private households in the 19th century. Although timber is usually important for households, the land is a resource to be used for supporting and improving their livelihood security, based on their specific situation. The State's role is providing frames for the land use that can safe-guard broader national needs and promote a sustainable use of resources.

Over the past decades new factors change the rural life in many developing countries. Such factors are e.g. globalization, new markets, infrastructure development and urbanization When local products can be sold all over the world, rural production systems (forest, agriculture land etc) can easily be overused and degraded, unless there are adequate governance systems in place.

Rural communities continuously address and adapt to the changing situation in their land management, either it is forestry, agriculture or other production, in order to cope. Policy makers need means to understand changes and their impacts for making wise decisions. Besides good governance and stable institutions, it requires robust and flexible monitoring systems integrated with the policy process and, in addition, methods that address the social, economic and ecological aspects of resource use. The monitoring may address the outcome of existing plans and strategies but realizing that people will by the end of the day base their management on their own situation. In recent years there has been a continuous development of methodologies and tools for assessing and monitoring land use changes for policy purposes both in the North and in the South, examples are National Forest Assessments (FAO and other).

For understanding socio-economic aspects and drivers e.g. "why do people do what they do?" it is often necessary to undertake case studies in restricted landscapes. Interdisciplinary approaches combining biophysical and sociological methods could then be very useful. As policies need to be agreed on local level for being effective such consultative techniques are very important.

One example where these approaches will be crucial is REDD+ with its needs to continuously monitor and evaluate changes in a broad context and in relation to negotiated agreements.

Production of valuable wood – determination of wood quality of standing trees using terrestrial laser scanners

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We present our work concerning the processing of terrestrial laser scan data of single trees. It helps to overcome weaknesses of current measurement techniques. Terrestrial laser scanners offer a point cloud of the tree and this cloud can be analyzed. We deduce stem quality information like sweep and taper which can be processed by use of the basic shape of the tree in the point cloud. We also aim to analyze bark characteristics of single trees out of terrestrial laser scan data.

To do so, 14 trees were scanned by a terrestrial laser scanner each from four viewpoints. This results in 56 point clouds describing the geometry of the vegetation of a forest part. All four scans describing the geometrical structure of one tree need to be spatially related. Then, they are reduced only to the data concerning the tree. After doing so the three dimensional shape of the tree can not only be visualized but also be analyzed. Data of the tree crown is rather hard to gather as it is often occluded by other branches of the subject tree or branches of adjoining trees. Instead, geometrical information about the stem up to the crown base like sweep or taper can be deduced. The structure of the stem by an approximation of successive cylinders also simplifies the shape of the stem and therefore the amount of data.

A current research topic of our group is the analysis of the bark structure of single trees out of terrestrial laser scan data. We compare the measurement of scars out of the point cloud with manually gathered data and deduce information about the interior quality of the tree stems. This information may provide consistent information for the wood market.

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Mechanization of harvesting processes in Eucalyptus stands

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As forest harvesting causes between 50-60 % of the total cultivation costs (XIE, 2003), the optimization of harvesting techniques is one of the most important aspects in terms of forest management. Currently harvesting is typically done in motormanual work in China.
Within the Sino-German research project ValWood, studies on the actual harvesting process for Eucalyptus stands were carried out in Gunagxi province. Time working studies were used to describe the time consumption of single working processes. Results showed a clear dependency between the required working time and the dbh of the trees, which resulted in a productivity - and cost model for the motormanual harvesting of Eucalyptus. Based on the results the optimised dbh for these harvesting techniques, could be determined, to decrease the costs of actual harvesting operations.
Furthermore, possibilities of mechanization of harvesting techniques will be discussed. Based on scenario, it seems to be attractive to mechanize single working processes (e.g. hauling) even today. However, other processes, like felling and processing, seem to be cost competitive to motormanual work for the near future.

Reference

XIE, Y. (2003), Developing a strategy for sustsainable management of eucalyptus plantations in china, in Eucalypts in Asia: Proceedings of an international conference held in Zhanjiang,
Guangdong, Peoples Republic of China, 7-11 April 2003, ACIAR Proceedings, vol. 111,
edited by J. W. Turnbull, pp. 32–38, Canberra.

Terrestrial Laser Scanners for determination of biomass

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Accurate and reliable information about forest structure and fundamental information of individual trees like tree species, diameter at breast height (dbh), and tree height provide a basis for forest management. Traditionally forest data can be obtained by use of ground-based survey techniques. Some measurements as the dbh and tree height can easily be done while accurate information of diameters still higher are more difficult to get using non-destructive methods. Regarding future developments in data acquisition better quality and new parameters for scientific questions and ecological aspects will be expected. Light detection and ranging (LIDAR) also known as laser scanning offers the possibility of a fast collection of data with a high resolution and accuracy. The main scanning techniques being airborne laser scanning (ALS) and terrestrial laser scanning (TLS).
Using different algorithms TLS data can be used to gather standard forest inventory information as well as parameters describing quality aspects of trees such as taper, branch-free bole length, sweep, number of branches, etc.. Although there are already some non- destructive tools and techniques for tree measurements available, one of the most accurate and comfortable known is ground-based LIDAR. However the accuracy of terrestrial laser scanners depends on many different components like the technique of the scanner, the software used to analyze the data, outside influences like wind, etc.
Since the dbh is the basis for the tree basal area (tba) and fundamental for lots of models, precise dbh data are essential. For this study we concentrated on the single scan modus. The theoretical procedure for automated diameter estimation used for this study as well as results for different stands are presented. Additionally the advantages and disadvantages of this technique will be brought up.

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Maintaining biodiversity through sustainable forest management: Challenges under a changing climate and environment in the Sahyadri Mountain Forests of Kerala

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Changing climate and large-scale human interference have large impacts on forests, which are reflected in the loss of biodiversity, decrease in natural resources availability and increase in the degree of natural hazards, especially in developing countries like India where poverty and rapid growth in human and livestock population lead to encroachment into forests. The issues are very serious in the State of Kerala in Peninsular India. Orography of the Sahyadri (Western Ghats) Mountain that borders the eastern side of Kerala produces heavy rainfall upto 5000mm a year, making the Ghats region a dense evergreen forest. Rainfall is becoming highly seasonal, with more occurrences of thunderstorms with large droplets, resulting in severe of floods and erosion. Because of the steep slopes, the water flows fast down, creating floods in lowlands. Long dry season and falling groundwater storage lead to the extinction of seasonal plants. Strong winds associated with thunderstorms and storms in the Indian Ocean uproot big trees. Dry soil and lightning cause forest fires. Deforestnation and introduction of plantation crops replacing the natural vegetation has affected the topography and the water holding capacity of soil and reduced summer water flow in the rivers and the storage capacity of dams. Together with this, construction of a number of dams and large-scale sand and rock quarrying in the hill region results in landslides and flash floods. Debris flow has considerably reduced the river runoff and has made some of the once perennial rivers seasonal. Construction of several dams in the Ghats cleared millions of hectares of thick forests. As a result of the changes in climate and degradation of forests, biodiversity is losing is at an alarming rate, making the Ghats an environmental hot spot. Many rare and costly medicinal plants, herbs and precious trees and several species of birds, amphibians and insects endemic to the region are under threat. Several mini hydro projects under consideration and the promotion of hill tourism may destroy more green cover, including the remaining patches of tropical evergreen forest. Shift in regional climate may affect the biodiversity significantly. Rules and regulations to protect the forests become farce because of weak administrative mechanism, corruption and vested political interference. Sustainable management of forest may help maintaining biodiversity, boost the current economic development and help alleviating poverty of the indigenous population. Worldwide recognition of Ayurveda, the Indian system of medicine and new findings on the commercial use of certain plants raises a good hope. There are large areas of restorable degraded forests and afforestable wastelands. Community forest projects with the cooperation of local population could improve livelihood conditions of the poor. In the schemes for adaptation and impact mitigation, vulnerable people are often neglected. The mega schemes such as the ‘green India mission’ could be better implemented with their cooperation. This paper assesses the impact of climate change and environmental degradation on the Sahyadri Mountain forests of Kerala. Current policies and strategies related to climate, forest and environment have been critically reviewed to suggest guidelines for the sustainable forest management.

Influences of tree species and forest management practices on above ground and below ground carbon and nutrient distribution in plantation forests at the red soil region in China

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Tree species and forest management can have significant influences on carbon and nutrient balances in forest ecosystems. These influences can be even more pronounced in artificial forest systems typical for the vulnerable red soil region in China. The objective of this study was to characterize and assess the sizes and changes in above ground and below ground nutrient pools in plantation forests of different tree species (Pinus massoniana, Cunninghamia lanceolata, Mytilaria laosensis, Erythrophleum fordii, Castanopsis hystrix) in relation with applied forest management practices (whole tree harvesting vs. selected harvest of single tree compartments). The investigated sites showed considerable differences in carbon stocks depending on the tree species and the different amount of total tree biomass. Additionally, severe limitations of plant available phosphorus (Pav) could be observed within the forest ecosystems. Considerably high amounts of nutrients were stored in tree crown compartments, such as leaves and branches, which made up between 10 % and 27 % of stand biomass. Consequently, whole tree harvesting together with clear cut strategies and removal of harvest residues can lead to severe losses of plant available nutrient fractions, and especially of Pav, enhancing further depletion of the sites, while selective harvests of stem wood without the removal of residues could help to maintain sustainable forest management systems in the investigated plantation forests.

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A Study on structures in less and entire touched forest stands of Sardasht forests

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The area of Western forests of Iran is about 5/5 million hectares of the protective, economic and social, and recreational role and where underground water supplies of high value. The main trees formed the forests are , three Oak (Quercus brantii Quercus infectoria , Quercus libani). Unfortunately, these forests have been utilized in the coppice method. Study and get more information in terms of structure can be caused better management in silviculture . In northern Zagros, especially in Western Azerbaijan province there are some sites that due to lack of access to, or of the holy sites in less than the destruction of the utilization or harvesting. By studying these places can protect so much potential productive Zagros forests. In cross–sectional, two stands were elected, one site was natural forest without or less utilization and another with utilization. Hundred percent inventory was done for gathering data. After analyzing information by using the software Mini tab, Spss, Excel ,for the conflict between means , t and k- test was used. Vertical feather by using the software svs has drawn. Results indicated that the average studied parameters to include diameter in breast height(dbh) and the height of trees and the area of dbh and the volume and the amount of regeneration in two stands in the 5% probability is meaningful. So there is significant difference between two stands.

Key words: natural and destroyed forest stands, Quercus, Western Azerbaijan Iran, the structure.

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An evaluation of forest conservation perceptions after a decade of community conservation in Afadjato-Agumatsa, Ghana

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Perceptions of communities about natural resource conservation are important intermediate outcomes of conservation interventions. This is especially important in community-based natural resource management regimes, where they need to be assessed before the ultimate outcome of conserved natural resources and biodiversity. The assessments of these perceptions are also very important for conservation management purposes. Selected communities in the Afadjato-Agumatsa area in Ghana, West Africa started community forest conservation in 1999 with technical support from a conservation organization as well as financial support from an international agency. At the beginning of the conservation action, forest conservation perceptions were assessed. In this study, we evaluated the changes in perceptions about forest conservation in three communities living in the Afadjato-Agumatsa area in Ghana, between 1999 and 2009. The method we used was a qualitative pretest posttest evaluation. We also assessed which socio-economic factors predicted peoples' perceptions about forest conservation. The results suggest that there has been an overall increase in support for forest conservation in the area expressed by the cultural, natural resource and economic benefits and values from the forests since 1999. This increase could be influenced by the cultural and economic benefits that the conservation program introduced. However, some respondents continue to hold reservations about restrictions to the exploitation of natural resources that the conservation program has imposed. This concern has to be continually managed.

Keywords: Forests Conservation, Perceptions, Communities, Evaluation, Natural Resources, Ghana

Changing and Degradation forest ecosystem diversity due to forest exploitation, challenges & solutions, Case Study, North West of Iran, Arasbaran Forest

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This study was carried out in North-Wet of Iran, Arasbaran forest to investigation of forest diversity and composition of tree species variations in protected and unprotected areas (under human impacts) and management of none-woody product of Arasbaran forest. In the region, rural people formerly made farming lands with clear cutting of forest stand that now due to decreasing land productivity especially in sloppy areas, occurred rarely. On the other hand increasing traditional domesticated with exploitation forest stand to preparing fuel, charcoal trade and harvesting non-woody products of forest such as medicinal plants and forest fruits changed forest stand in last decades. Results of 120 samples that recorded with Systematic Randomized Sampling method from forest stand in two selected plots, with and without destructions, showed replacing forest main Species with Invaders Plants in under human impacts areas. Analysis with TWINSPAN test specify that in the destruction areas of stand, invaders species such as Malva sylvestris, Crataegus meyeri, Crataegus orientalis, Prunus spinosa and Mespilus germanica is developed and forest stand diversity is changed in these areas. Main species such as Quercus macranthera, Carpinus betulus, Acer campestre, Acer monspessulanum, Evonymus latifolius, Sorbus boissieri, Sorbus graeca, Sorbus torminalis, Fraxinus sp, Lonicera spp, Viburnum lantana, Ribes orientale, Taxus baccata and etc decreased in damaging areas. To management of this stand, developing cultivation of main native species in damaged areas from pioneer species to settle main species respectively and consideration to medicinal plants production according to rich diversity of region medicinal flora is necessary.

Key Words: none-woody product, clear cutting, Invaders Plants, TWINSPAN

Production of valuable wood in China

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The usual situations of forest plantations contain lots of disadvantages concerning economical, ecological and social purposes. Oftentimes, not site-adapted, non-indigenous tree species are planted very densely in vast monocultures, which lead to economic deficits in the long run regarding planting costs, costs for thinning and harvesting and regarding economic loses for the end product timber, which is of perfectible quality. Also, these kinds of forests often don't entirely fill their ecological and social functions. Therefore, future forest management should shift from stand- based to single tree based systems.

ValWood aims to develop and implement a new and improved single tree based system, comprising economical, ecological and social advantages. Through a wide planting distance between the valuable trees, it is possible to produce trees of large diameters during a short rotation time. This saves costs for planting and thinning. Due to the lower number of trees on one hectare, pruning can be done very intensively, which guarantees a high quality of the log at the end of the rotation time. However, there is an overall management principle to follow: In the first years, when the height increment is still increasing, the forest manager should take care of the quality of his trees (artificial or natural pruning). At that time, when the height increment is decreasing, the forest manager should take care of the diameter growth of his trees (thinning).

Research has been carried out on the relationship between crown width and stem diameter. By the help of growth models, many kinds of different growth scenarios could be set up. As the models are very flexible, it is possible to adapt forest management to almost every requirement of the forest manager in a way, which respects species- specific needs and growth behaviour.

These management systems also meet a lot of ecological and social functions, which offers additional benefits. Meeting economical, ecological and social needs: systems fulfilling there requirements deserve the attribute "sustainable".

A Study on the Development of the Methodology to Value the Social and Environmental Benefits of Forests, Connected with Payment Scheme for Forest Ecosystem Services

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I. Objective

The objectives of this study are to establish valuation system for the social and environmental benefits of forests, to improve current methods for quantifying some functions of forests, to examine the applicability of other valuation approaches, and to develop valuation methods for the social and environmental benefits of forests newly to be added as valuation items.

II. Results and Discussion

1. This study estimates the value of public function of forest by choice experiment(CE). The function of maintaining health and cultural heritage is excluded due to its lack of popularity. The survey is designed to select three functions which are most preferred given that it is difficult to answer due to many choices. There are four levels including the current status. The survey is designed with combination of attribution and level made by experiments design, and conducted nationwide in 508 people. As a result of survey, formation of living environment (141,000 won), storage and purification function of water (131,000 won), suction of CO_2 (125,000 won), and ecosystem protection (11,0001 won), offer beautiful landscape (98,000 won), reduction of soil sediment (88,000 won), recreational function of forest (82,000 won), prevention of landslide (70,000 won) are in order in terms of high potential price. An annual household willing to pay amount to maintain the current status was 629,000 won. If it increased annually by 1%, it would be 850,000 won and by 2%, it would be 1,030,000 won. The benefits multiplied by the entire 16,619 household in the current status were about 10 trillion 466.78 billion won, about 14 trillion 136.86 billion if increased by 10%, and about 17 trillion 126.55 billion won if increased by 20%.

2. To evaluate the multi-functionality of forests using Contingent Valuation Method(CVM), and to verify the validity of the CVM approach for each function, the research management system for the 11 functions of public benefit targeted for evaluation has been established based on a preliminary survey on subject households in Seoul and the capital area. The final applied model was Double-bounded dichotomous choice CVM. The values of individual functions of public benefit expressed through annual willingness to pay per household were as follows: Carbon Dioxide Absorption (66,083won), Forest Purification (57,520won), Forest Healing (56,425won), Living Environment Formation (50,731won), Forest Scenery (41,966won), Cultural Heritage Maintenance (41,373won), Forest Recreation (38,776won), Biological Diversity (38,664won), Soil Erosion Prevention (38,441won), Watershed Conservation (34,484won), Landslide Prevention (24,887won), etc.

3. This report suggested two alternatives for the methodology to value the social and environmental benefits of forests based on the results of this study. One is the valuation methods, comprised of methods to value the social and environmental benefits of forests using current quantification method and replacement-cost approach. The strength is to maintain the consistency and costs less time and money than the other options. The other option is the stated preference approach like CVM and CE, which estimate the value of benefits by population of beneficiary multiplied by the estimate of willingness to pay. It costs relatively much time and money in design and survey. But it is based on economic theory and can measure willingness to pay of actual beneficiary.

Community forestry and carbon enhancement: the lessons from an early REDD+ project in Nepal

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Community forestry (CF) has become a successful participatory forest management system in global arena. Many countries have put this as priority program because it aims in conserving the forest resources and reducing the poverty of the local communities who are managing a specific forest area. Now, communities are administering at least 377 million ha of global forests which come more that 22 precent of all forests in developing countries and around 10 precent of global forests. With the changing scenarios and considerations of the role of the forests to mitigate climate change in UNFCCC negotiations, REDD+ (reducing emissions from deforestation and forest degradation plus conservation of the forest, sustainable use of the forests and enhancement of the carbon stock) mechanism is evolving up as a latest tool to encourage developing countries to save and /or improve their forests with appropriate incentives. This mechanism expects to reduce CO_2 emissions from forestry sector which is significant at present situation.

To place the REDD plus concept in practice, many pilot projects are under implementation for designing and setting up the REDD+ mechanism in many developing countries like Nepal.

As Nepal is a pioneer in community forestry with three decade long experiences, it has successfully handed over more than 25% of the national forest to local forest dependent communities for conservation, management and use of the forest resources according to national and local jurisdiction. These forests deserve huge potential to enhance forest carbon stock and bring additional incentives from the possible REDD+ frameworks to the communities. To analyses the possibility of REDD+ in these forests, a REDD+ project is under implementation in tree watershed areas of Nepal covering 10265.5 hectare of forests managing by 105 community forest user groups with 93791 local people. In this project, local communities are encouraged to change different existing practices and habits with several project interventions from the project inception in 2009. As results, this have enhanced on an average 3.13 tons of forest carbon per hectare (tC/ha) ranges from 1.4 to 5.3 tC/ha during one years of time. This shows the potential of REDD+ in community forestry with some interventions to change community practices.

Key words: REDD+, community forestry, carbon enhancement, Nepal

Effect of ecosystem restoration method to carbon storage allocation in subtropical China

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Ecosystem restoration can be realized via both artificial and natural processes. How dose the restoration method affect the ecosystem services is an important concern. Field investigation has been carried out in five forest ecosystems in Jiulianshan National Nature Reserve in sub tropical China, and the relationships between ecosystem carbon storage and restoration method were analyzed. Results indicated that ecosystem carbon stocks were similar for both artificial and natural restoration method 32 years after. But the timber volume was quite different with highest value for artificial Chinese Fir forest and lowest for natural secondary forest. This suggests that different ecological restoration method should be used when pursuing different ecosystem services.

Biomass and distribution characteristic of 28-year-old MytiLaria laosensis Plantation in Southwest of Guangxi

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The biomass and distribution characteristic of 28-year-old MytiLaria laosensis plantation in south of Guangxi were studied by the method of sampling permanent plot and allometric dimension. The results showed that the estimated biomass of the plantation ecosystem was 281.47t•hm-2, the distributing pattern was tree layer (97.89%）>litter layer (1.87%）>shrub layer (0.16%）>herb layer (0.08%）. The biomass of tree layer was 275.54t•hm-2, it's distribution pattern was stem (63.01%）＞root (21.01%）＞branch (9.64%）＞bark (4.38%）＞leaf (1.72%）＞fruit (0.25%）. The biomass distribution of different diameter classes was normal distribution approximately, biomass of the tree in the diameter class from 25cm to29 cm accounted for 48.15 percent of the total biomass of tree layer.

Key words: Southwest of Guangxi; MytiLaria laosensis plantation; biomass; distribution

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Dynamics of litter decomposition in eucalyptus plantation and water quality implications*

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Abstract: To investigate the dynamics of litter decomposition in planted forest stands and its water quality implications, litter samples (leaf, shoot, and cortices) collected from five forest stands (EU_1=1 year-old *Eucalyptus*; EU_4=4 year-old *Eucalyptus*; AM=7 year-old *Acacia mangium*; PL=13 year-old *Pinus massoniana* Lamb; and BL=mixed broadleaved softwood) were incubated under 28℃ and leached using water for 255 days. The experiment results showed that in the first 105 days, litter leachate of *Eucalyptus* plantations (EU_1 and EU_4) had significantly higher coloration, N, P contents and lower pH than that of other three planted forests (AM, PL, and BL). The cumulative amount of COD (chemical oxygen demand) released from leaf litters were 193.9 g kg^{-1} and 212.8 g kg^{-1} for forest stands EU_1 and EU_4, respectively, which were 4.2, 4.0, 4.3 and 5.3, 4.4, 4.7 times higher than that of AM, PL, and BL, respectively. The mass loss, N and P leaching rate of leaf samples from stand EU_1 were significantly higher than that of AM, PL, and BL. The mass loss rate of cortices from EU_1 was significantly higher than that of PL. No significant difference was observed for the leaching rate of shoot litters. Overall, the decomposition rate of litter followed the order of EU_1>EU_4>AM>BL≥PL. Among the four different litter samples, leaf litter were the easiest to be decomposed while shoot litter were the most difficult to be decomposed. The pH values of litter leachate of *Eucalyptus* plantations negatively correlated with leachate chroma and COD. The COD content showed significant correlation with the concentration of total N and P in leachate.

Key words: litter; leaching; water quality; eucalyptus plantation.

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Carbon sequestration and stabilization of newly sequestered carbon in an afforested soil in a valley-type savanna, southwestern China

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Great concerns about C sequestration capacity and stabilization of sequestered C in forested soils have been focused under the background of global climate change. Organic C densities in soil and in soil fractions at four sampling times (1991, 1997, 2003 and 2010) in Acacia auriculiformis plantations afforested in 1991 were investigated at a valley-type savanna, southwestern China, via combination of density fractionation and acid hydrolysis technique. The results showed that the gain of C in soil had accelerated following the afforestation of wasteland. C sequestration rates of the surface (0-15 cm) and subsurface (15-30 cm) soils averaged 37.89 and 16.84 g m-2 year-1 during the 19 years after afforestation, respectively. The percentage of organic C in heavy fraction to total SOC in the surface soil was 71.44% in 2003, which was significantly ($P<0.05$) higher than that in 2010 (67.99%). The recalcitrant C index of light fraction was significantly ($P<0.05$) higher than that of heavy fraction in 2003 irrespective of soil depth, but both decreased with aging of trees. Approximately 57-70 percent of newly sequestered C was protected by physical mechanism and 33-49 percent was transferred into biochemical recalcitrant fraction during the period of 12-19 years after the trees planted. The results reveal that afforested soils at the valley-type savanna have a great capacity for C sequestration. The biochemical stability of physically protected C is lower than the unprotected one following the afforestation of wasteland. Both the stability, however, declines with time.

Key word: soil organic carbon, carbon sequestration, carbon stabilization, afforestation, density fractionation, acid hydrolysis, valley-type savanna

Erosion and forest restoration impacts on ecosystem carbon dynamics

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To quantify the consequences of erosion and vegetation restoration on ecosystem C dynamics (a key element in understanding the terrestrial C cycle), field measurements were collected since 1959 at two experimental sites set up on highly disturbed barren land in South China. One site had received vegetation restoration (the restored site) while the other received no planting and remained barren (the barren site). The Erosion-Deposition Carbon Model (EDCM) was used to simulate the ecosystem C dynamics at both sites. The on-site observations in 2007 showed that soil organic C (SOC) storage in the top 80-cm soil layer at the barren site was 50.3 ± 3.5 Mg C ha–1, half that of the restored site. The SOC and surface soil loss by erosion at the restored site from 1959 to 2007 was 3.7 Mg C ha–1 and 2.2 cm, respectively—one-third and one-eighth that of the barren site. The on-site C sequestration in SOC and vegetation at the restored site was 0.67 and 2.5 Mg C ha–1 yr–1, respectively, from 1959 to 2007, driven largely by tree growth and high atmospheric N deposition in the study area. Simulated findings suggested that higher N deposition resulted in higher on-site SOC storage in the soil profile (with SOC in the top 20-cm layer increasing more significantly), and higher on-site ecosystem C sequestration as long as N saturation was not reached. Lacking human-induced vegetation recovery, the barren site remained as barren land from 1959 to 2007 and the on-site C decrease was 0.28 Mg C ha–1 yr–1. Our study clearly indicated that vegetation restoration and burial by soil erosion provide a large potential C sink in terrestrial ecosystems.

Temporal and spatial impact of fire on *Pinus koraiensis* Trees' growth in a Northern Temperate Forest

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Background: The effects of fire on forest ecosystems monitoring are manifold caused by species-specific responses. The study of such responses is essential for understanding forest dynamics, especially if management attempts to emulate natural disturbance regimes under condition of global climate change. Poorly understood of the effect of a ground fire on growth in long term would restrain the development of new "near-natural" forest management practices. One basic requirement for achieving this objective is a better understanding of how the tree growth is controlled by fire, on temporal and spatial scales. This paper evaluates the spatial and temporal effects of a groundfire on the radial growth of fire tolerance species Korean pine (Pinus koraiensis) trees growing in the Changbai Mountain Nature Reserve which occurred more than 90 years.

Method: Study sites located approximately at 784 m of altitude above sea level (N42°20′211″, E128°05′705″)with mean annual temperature is 3.7 ℃, and mean total annual precipitation for the region is 707 mm. In 2008, 30 fire-damaged P. koraiensis trees with visible scars on the bark and dbh's greater than 30 cm were cored in the study area. The same number of trees was cored as undamaged trees at same dbh level in the area at a distance of 100 m from the damaged area. Dendroecological methods widely applied in temperate forests for quantifying, dating historical canopy fire events and analyzing the climate-growth correlation was used in this paper. The climate variables correspond to the monthly mean, minimum and maximum temperatures and the precipitation values from August of the previous year to August of the year of growth. The competition status of each sample tree as affected by the nearest four neighboring trees was assessed using Hegyi's competition index. The study material is rather homogenous and probably unique (almost the same age class above 150a), allowing such a temporal and spatial analysis of the long-term effects of a ground fire (burn in 1866)on the growth of an important tree species in a northern temperate forest.

Results: The results showed that temperature and precipitation during the previous winter had a significant effect on the mean annual radial growth of both groups. Trees which had been damaged by an old fire were more sensitive to the negative effect of high summer temperatures and to the positive effect of high spring temperatures than the undamaged group. As expected, the radial growth rate was reduced by increasing competition from neighboring trees. In contrast to previous studies, the damaged individuals ($r=-0.586$, $p=0.013$) were affected more severely by competition than the undamaged ($r=-0.35$, $p=0.242$) during the past 5 five years.

This study confirms that the effect of a fire on tree growth may persist for a long time. This effect became evident in evaluation of the neighborhood competition which influenced dam aged trees considerably more than the undamaged ones. The changes in the climate during the past three decades, especially the higher temperatures in the growing season, showed also significantly different effects on the damaged and

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undamaged trees.

The carbon storage and content dynamics of Eucalyptus urophylla×E.grandis short rotation plantation in Guangxi Dongmeng Forest Farm

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The carbon (C) content, storage, and distribution within the components of a Eucalyptus urophylla×E.grandis ecosystem on the Guangxi Dongmen National Forest Farm were measured during different years within a short rotation period. The ecosystem components studied consisted of soil, forest litter, understory (shrubs and herbs) and the overstory. The results revealed that the average carbon content of the total forest increased with stand age, comprising 46.83%, 46.92%, 47.68%, and 48.29% of the forests at ages 1.6, 3.6, 5.6, and 7.6, respectively. The carbon content in the overstory components ranged from 42.3% to 50.2%, with the leaves > stem >branch>root >bark. When considering the ecosystem components, carbon content of the overstory (47.63%)>shrub (44.09%)>litter (43.04%)>herb (40.27%). Analysis of variance (ANOVA) indicated that there was no significant difference ($F=0.31$, $p>0.05$) between stand ages within each ecosystem component. However, significant differences were found ($F=11.17$, $p<0.01$) between ecosystem components within a given stand age, indicating that the species composition and plantation characteristics have great impact on carbon content. The total carbon storage increased with forest age, displaying 87.686, 107.078, 131.549 and 155.136tC hm–2 in 1.6, 3.6, 5.6 and 7.6 year old stands, respectively. The net annual carbon storage of the overstory was found to be 9.260, 9.460, 12.590 and 12.149 t C hm– 2 a– 1 in 1.6, 3.6, 5.6 and 7.6 year old stands, respectively, thus indicating a peak rate of storage during the rotation period. The average carbon storage of litter accounts for 18.1% of the annual net carbon storage of the overstory, which contributes more to carbon sequestration.

Key words: Eucalyptus urophylla×E.grandis, short rotation plantation, carbon content, carbon storage, annual net carbon fixed

Comparative Studies on Genetic Diversity of Davidia involucrata Baill. and Davidia involucrata var. vilmorniana (Dode) Wanger by ISSR

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Dovetree (Davidia involucrata Baill.), as the first grade protected plant in China, is one of the best well known relict species of the Tertiary. It belongs to Daviadiaceae with a single genus, and Davidia involucrate var. vilmoriniana (Dode) Wanger is a variety of dovetree. They have been famous ornamental plants for its flower just like a dove spreading the wings and having the nice moral of peace. In general, they share the similiar distrubition. In order to investigate their differences in molecular level and to discuss the genetic diversity for further research on its sceintifical application, 229 samples from six natural populations and two artificial populations were selected for analysis by using ISSR. For D. involucrata, a total of 127 bands, between 200 to 2000 base pairs, were obtained with 10 ISSR primers. 119 of the bands were polymorphic and the percentage of polymorphic bands was 93.81%. The percentage of polymorphic bands of different population was between 40.21% and 76.29% with the average of 58.64%. At the species level, the Nei's genetic diversity(Hs) is 0.3013, and Shannon's information index is 0.4566. At the population level, Nei's genetic diversity ranged from 0.1491 to 0.2690 with the average 0.2191, and Shannon's information index ranged from 0.2200 to 0.4028 with the average 0.3232. The differentiation coeffection among the populations was 0.2627 and the gene flow was 1.4. The results showed that there was high genetic diversity in D. involucrata, genetic differentiation and gene flow existed between the populations, but the main genetic differentiation was within the population. UPGMA cluster analysis based on Nei's genetic distance among populations showed there was no correlation between the cluster analysis result and the geographic distribution of dovetree. The approximate results of genetic diversity were found in its variety. 100 ISSR primers detected, no marker was found between D. involucrata and D. involucrata var. vilmoriniana. From the cluster analysis, individuals of D. involucrata and its variaty did not gather together respectively either.

Key words: Davidia involucrata Baill.; Davidia involucrate var. vilmoriniana (Dode) Wanger; genetic diversity; population; difference; ISSR

Foundations：National Natural Science Foundation of China（31060053）；Natural Science Foundation of Henan Province（62580021）；Young Foundation of Henan University of Science and Technology（13090063）

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Evaluation on Salt Tolerance of 25 Species of Poplar Cuttings in the Lab

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The growth and morphological characteristics of 25 species of poplar were investigated. The trees were cultivated in Hongland nutrient solution which was made with sodium chloride (NaCl) solutions with concentration of 1.00, 3.00, 4.00, 5.00, 6.00, and 8.00 g/L, respectively. Under such salt stress, the new branch length and biomass accumulation of trees decreased as the salt concentration increased. The root/shoot ratio of most of species showed an escalation and then reduction tendency. Under low concentration of salt (CNaCl 4.00 g/L), compared to CNaCl =1.00 g/L, the root/shoot ratio of 11 species increased. After salt treatments, with the increase of salinity concentration, the contents of chlorophyll of 8 species were decreased. Based on the analysis of growth and morphological appearance, it turned out that 6 species have high salt-tolerant, 7 species are moderately salt-tolerant, 7 species are low and 5 species fail to resist salt stress.

Key words: poplar; salt stress; hydroponic experiment; salt tolerance

Integrated Ecological and Economic Evaluation of ValWood Agroforestry in China

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The increasing demand for wood and renewable energies requires more intensive land use systems both because scarcity of land resource does not permit extension over new lands and also because the already cultivated land have not been utilized to their full potential. The ValWood agroforestry aims to develop an innovative sustainable land use that combines the production of valuable timber from long-term rotation (20-40 years) forestry with short-rotation land use through forestation and landscape restoration of formerly agricultural lands and secondary and degraded forest lands as an alternative to the traditional agroforestry system. Various ecological and economical benefits accrue as a result of the combined cultivation of long rotation trees with short rotation crops, including economic returns spread over the entire range of production periods, soil protection through continuous coverage of land, carbon storage in soils and production of high quality and long durability timber. This paper presents an integrated ecological, economic and social evaluation of the innovative ValWood agroforestry and traditional land use models through cost–benefit analysis (CBA).The difference of ecological, socioeconomic impacts and technical aspects of the sustainable land use pattern between Germany and China are also compared. The demonstration plots of ValWood agroforestry established in Pingxiang, China, are selected for empirical study. The conclusions drawn from this study promote more productive, sustainable, and poverty-reducing land management.

Key words: Agroforestry, Integrated ecological and socioeconomic evaluation, Innovative land use, ValWood

End product-based inventory valuation to support multi-use forest management

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Multi-use forest management has been emphasized in recent years to promote a balanced approach in the planning of forest management and utilization of forest resources. This approach has also reflected the requirements from the green environment and social acceptability in managing our natural resources. In the implementation, it needs a great effort in integrating research results and techniques from various disciplines including ecological, environmental, social and economic considerations, etc. One of the major challenges in implement the multi-use forest management is the decision making that is heavily relied on how to valuate the forest resources. In this presentation, a new method of inventory valuation will be described that recognizes values for a given inventory may not always be constant, but vary with utilization strategy and product market conditions. The conventional forest products, value-added new products, and some none traditional products can be measured in monetary sense; however, most ecosystem services can only be evaluated by indices. This has created difficulties in decision-making due to the lack of a "common currency". The new method can provide a flexible and is capable of comparing values in monetary with indices, so that a better decision support can be achieved.

Clump Planting: A Technological Innovation of Forestation for Valuable Trees

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Currently the development of valuable trees species meets the problems such as long rotation of cultivation, low usage of improved variety, lack of techniques of silviculture and management in timber forest of valuable trees, so many species cannot planted over large areas in mountains. In this article, we learn experience from other species which successfully used clump planting, applying techniques of the oriented cultivation for future crop tree, to develop the mixed plantation with clump planting for reforestation of valuable trees in a large mountain area. Three models of mixed plantation with clump planting are introduced in this article, including the model 1‘coniferous and broad-leaved mixed within a clump’; model 2 ‘broad-leaved in clump mixed coniferous in single’ and model 3‘mixed with clumps of two or more different broad-leaved’.

Key words: valuable trees species, future crop tree, clump planting, mixed plantation, thinning within a cluster

Individual Biomass Regression Model of Mytilaria laosensis in Southwest of Guangxi

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Based on the inventory data of a 28-years-old Mytilaria laosensis plantation and the biomass measurements of the mean sample trees, the correlation between diameter at breast height (DBH), tree height (H), D2H and different parts of an individual tree were analyzed. Five biomass models, including power function model of individual tree of Mytilaria laosensis in southwest of Guangxi province were established by regression analysis. The results showed that the relationships between stem, branch, bark, total biomass and D2H were significant while the relationships between leaf biomass and DBH and between root biomass and H were significant. In the models in which the independent variable is the DBH (D), tree height (H) and D2H respectively, total tree, trunk, and bark biomass recession models were fitted best, leaf and root biomass recession models were fitted moderately, and branch biomass recession model were fitted worst. Power function model was the best regression model for fitting biomass of the most parts of an individual tree except bark biomass.

Key words: biomass; regression models; Mytilaria laosensis; southwest of Guangxi

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Temperature sensitivity increases with soil organic carbon recalcitrance along an elevational gradient in the Wuyi Mountains, China

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No consensus exists regarding soil organic carbon (SOC) lability and the temperature sensitivity of its decomposition. This lack of clear understanding limits the accuracy in predicting the long-term impacts of climate change on soil carbon (C) storage. In this study, we determined the temperature responses of labile and recalcitrant organic carbon (LOC vs. ROC) by comparing the time required to decompose a given amount of C at different incubation temperatures along an elevational gradient in the Wuyi Mountains in southeastern China. Results showed that the temperature sensitivity increased with increasing SOC recalcitrance (Q10-labile=1.39±0.04 vs. Q10-recalcitrant=3.94±0.30). Q10-labile and Q10-recalcitrant values significantly increased with increasing soil depth. The effect of elevational vegetation change was significant for Q10-recalcitrant but not for Q10-labile, though they increased along the elevational gradient. The response of ROC pools to changes in temperature would accelerate the soil-stored C losses in the Wuyi Mountains. Kinetic theory suggested that SOC decomposition was both temperature- and quality-dependent. It is probably that increased temperature would promote more CO_2 release from recalcitrant soil organic matter (SOM) in cold regions, resulting in a greater positive feedback to global climate change than previously expected. Moreover, the response of ROC to changes in temperature will determine the magnitude of the positive feedback due to its large storage in soils.

Key words: Soil organic carbon, Labile, Recalcitrant, decomposition, Temperature sensitivity, Elevational gradient (vegetation)

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The Effect of Rodent-mediated on seeds dispersal and nature regeneration of *Phylanthue emblica* in Jinsha dry-hot valley

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This study is the first time study on the relationships of rodents and *phyllanthus emblica* seeds dispersal and its germination in Jingshajiang dry-hot valley. The result showed that: the seed of this plant dispersal distance by rodents in this test about more than twice of the contrast, reach 1118.4±45.8cm; the rodents reduces the quantity of above ground seeds to 0.3±0.1/㎡, compare to the contrast(1.1±0.3/㎡), and increases the quantity of seeds to 1.3±0.2/㎡ below ground about 1.1±0.3cm depth. In this experiment, large amount of seed were dispersed to belowground by rodents, exist in underground seeds can eliminate animal predators, avoid direct sunlight on the surface, which have good germination conditions, increases seed germination rate and seedling saving the following, investigated indicate that 915±86 hm^{-2}seedling were fond in August 2010, and 915±86 hm^{-2} survived in August 2011，the seeding has been substantially improved compare to contrast(about 625±174 hm^{-2}).

Key word: Dry-hot Valley ; Rodent; Native species; *Phylanthue emblica*

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The neighborhood effect in the older-growth temperate forest in Changbai Mountain of China.

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Species interaction was one of the core problems in ecology. Species interanction always depended on the scale. So the neighorhood effect was crucial that fine-scale spatial interactions regulate the demography of component tree species. Accumulating evidence also suggested that density dependence is wide in plant commnities. We discussed the effect of density dependence in broad-leaved Korean pine mixed forest. Based on the field twice investigation data of Changbaishan (CBS) plot (the broad-leaved Korean pine mixed forest 25 hm^2 plot). According to international big plot investigating method from the center of tropical forest science (CTFS), the stem of diameter of breast height (DBH) ≥1cm was surveyed and located in the CBS plot in 2004. We finished the second surveying in 2009. In addition, the small tree was more easily affected than the big tree. So we analyzed the neighborhood effect in 5 m including the tree growth and tree alive. The results showed there is no species show significant negative correlation between tree growth and con-species neighbor denstiy in broad-leaved Korean pine mixed forest. There is four species show significant negative correlation between tree survivor and con-species neighbor denstiy in broad-leaved Korean pine mixed forest. If one species growth or survivor show significant negative correlation with con-species neighbor density, the phenomenon usually was suggested belonging to negative density dependence. Our results suggest that negative density dependence is rare in broad-leaved Korean pine mixed forest.

Keywords: neighborhood, density dependence, broad-leaved Korean pine mixed forest, 25hm^2 big plot.

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The role of forest gap in shaping tree-ring growth and response to climate on the Tibetan Plateau

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There distributes a large area of forest in southeastern Tibetan Plateau where the average elevation is greater than 4000 m above sea level. Forest gaps of different sizes are typical characteristics of these forests. Yet the role of forest gaps in shaping forest dynamics is poorly understood so far. Particularly, it is not clear how forest gaps affect radial growth of trees and their response to climate. Here we report a dendrochronological study of the trees surrounding a forest gap in Chuangdu of southeastern Tibetan Plateau. The study site was chosen in a forest that has a gap of 106 m in maximum length and 69 meter in maximum width. A total of 62 tree-ring increment core samples (one core per tree) were collected from trees surrounding the forest gap. The position of each sampled tree in the forest was recorded and the tree-ring widths were measured, crossdated and analyzed. The results show that radial growth in trees in the outer circle of the forest gap differs from that in the inner circle. The response of tree rings to climate variation also differs for trees in the outer and inner circles. Our results indicate that space availability and weather condition interact in shaping the growth of trees surrounding forest gaps and knowledge of this interaction helps for forest management in face of future climate change.

Forest gap increases tree-ring sensitivity to climate change on the Tibetan Plateau

The role of forest gap in shaping tree-ring growth response to climate change on the Tibetan Plateau

A Successful Case of Integrated Sustainable Development of Mountainous Area—Analysis of the Economy, Ecology and Livelihoods Development in Lin'an

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Distinguished Fellow of INBAR for Life

In order to illustrate the development and changes in the hilly and mountainous areas of China after the establishment of the People's Republic of China, especially since the implementation of the Opening Policy of China in 1978, we took a comparatively successful case – Lin'an City, Zhejiang Province, and would like to introduce it's the Integrated Sustainable Development Model of Lin'an.

The Government administrative system of China
1.1 From the top level government, the different administrative levels are listed below:
State Council
Provinces (23), Autonomous Regions 5), Municipals (5), Special Administrative Regions (2) – in total 35 (including Taiwan)
Prefecture Level Cities (163), Autonomous Prefectures or Leagues (36) – in total 199
Counties (1140), County Level Cities (296), Autonomous Counties or Flags (172), Districts under Prefecture Level Cities (669) – in total 2277
Towns and Townships
Villages
1.2 Baseline information of Lin'an
Lin'an is under the administration of Hangzhou, the capital of Zhejiang Province. Zhejiang is located in the east coastal area of China, neighboring to Shanghai Municipal City, Jiangsu, Anhui, Jiangxi and Fujian Provinces. It contains 11 Prefecture Level Cities, 90 Counties and Districts.
The total population of Lin'an as up to year 2010 is 525,859.
The total area of Lin'an is 3126.8 square kilometers; the hilly and mountainous area covers 86% of the total area. Up to year 2010, the total farmland area was 17,055 hectares, total forests area was 259,713 hectares. The forest coverage was 78%.

2. Status of economy, ecology and livelihood of Lin'an in the past 32 years
2.1 Mono-culture of crops could not alleviate the poverty in Lin'an
Before the Opening-Up and Reform Policy, Lin'an was one of the Poverty Counties. The local government had been focusing on resolving the problems of "food" and "warmth" of the people, and proposed the guiding policy making "food" the principle development goal. All resources had to be used for producing more foods, which resulted in damages of large areas of forests, serious water and soil erosion, as well as land degradation. These had given Lin'an a serious lesson: mono-culture of crops could not alleviate poverty and provide enough food.
Since China implemented the Opening-Up and Reform Policy in 1980, in the past 32 years, Lin'an has experienced a transformation process from "poverty" to "well-off", from "damaging resources" to "protecting resources", from "mono-management" to "multiple management", from "cutting down trees" to

"protecting trees", even "appreciating trees", and is now has achieved a comparatively sustainable and balanced win-win situation in ecology, economy and livelihood.

All governments of Lin'an, over the past 32 years, had carefully studied the past experiences and lessons and accordingly made integrated strategic planning for local development, these would include land system reform, infrastructure construction, fiscal and tax policies supporting environment-friendly industries, as well as a strong backup of scientific researches and technical services.

2.2 Status of economy, ecology and livelihood of Lin'an

A series of data are indicating Lin'an's development in economy, ecology and livelihood over the past 32 years (please see the appendices 1). These data show that great changes happened in this hilly and mountainous county-level city. They also show the effects of the policies and measures taken by the local government in different development stages, and the accomplishment achieved through these measures.

2.2.1 The achievements in ecology construction

The forests coverage rate increased from 64.1% in 1985 to 78% in 2009; the standing per hectare increased from 5.14 million m3 in 1985 to 8.30 million m3 in 2009; the natural reserve area increased from 1898.79 ha to 7994 ha in 2009; Since 1980, the number of Shutdown polluting enterprises is 125; the ratio of qualified industrial wastewater discharge is 99.45%; the garbage treatment rate in rural areas is 87%;

On green energy development, the number of small hydropower station increased from 29 in 1980 to 99 in 2009; power capacity increased from 22,000 kw/h to 400,000 kw/h; rural household solar energy utilization rate reached 50%.

2.2.2 The achievements on economic development

The total GDP increased from 204 million RMB in 1980 to 23,503 million RMB in 2009; meanwhile, per capita GDP increased from 455RMB (297.3USD) to 44,694RMB (6543USD);

The industrial structure became more and more rational: the portion of primary, secondary, and tertiary industry changed from 49.5%/32.40%/18.10% in 1980 to 10.5%/55.7%/33.8% in 2009.

Rural industrial structure also changed dramatically, forestry products became dominating in place of traditional agricultural products. In 1980, the portions of agricultural production value took 51.5% of the gross agricultural production value, forestry production value took 23.1%; in 2008, the portions became 30.2% and 46.8% respectively. The production value of forestry products increased from 3.05 million RMB in 1980 to 4935 million RMB in 2009, among which NTFPs production value increased from 22.8% in 1990 to 89.8% in 2009 in the gross forestry production value.

The rapid development of ecotourism and farm-stay in mountainous area:

Since 1997 and 2003, eco-tourism and farm-stay respectively started to be developed in Lin'an; until now, they have become new economic growth points. The number of tourists increased from 1.71million in 2000 to 5.235 million in 2009; the tourism revenue increased from 800 million RMB to 2.85 billion RMB in 2009. Up to 2009, the number of guests in the farm-stay hotels reached 963,500; NTFPs eco-tourism and farm-stay have become one of the three pillar green industries in Lin'an mountain area.

2.2.3 The public services and farmer's livelihood was greatly improved

The per capita annual net income of rural population increased from 246 RMB (161 USD) in 1980 to 11910 RMB (1759.5 USD) in 2010; the housing area increased from 35m2 in 1980 to 71m2 in 2009. The past shade houses have turned into multi-storied houses. As early as in 1985, the enrollment in school for 9-year compulsory education in rural areas reached 100%; the popularization of medical insurance covered 92% of the rural population. Since 2005, the availability of hardened roads, public transportation facilities for each village, and TV sets for households reached 100%; the living conditions of farmers basically reached well-off level. The portion of poverty population reduced from 60% in 1980 to less than 1% in 2005.

From the above changes, we can see Lin'an mountainous area has taken an integrated and sustainable way of development.

These accomplishments got in the past 32 years gained Lin'an many rewards and honors, such as "China Bamboo Hometown", "China Hickory Hometown", "National Forests City", "National Model City of Environmental Protection", "One of the Top Hundred Countries in Comprehensive Strength", "National Excellent Tourism City" and so on.

In September, 2010, with the supports from Ministry of Science and Technology of China (MOST) and International Network of Bamboo and Rattan (INBAR), the International Symposium on Integrated Sustainable Development in Mountain Areas was held in Lin'an. Over 100 participants from 21 countries (including over 30 Chinese experts) participated in the symposium; they spoke highly of the accomplishments of Lin'an mountainous area development since the Opening-up and Reform, and evaluated the triple-win (economy, ecology and livelihood) integrated sustainable development model of Lin'an. At last, based on the agreement from all participants, "Lin'an Declaration" was published (see the appendices 2), in order to extend Lin'an experiences to other developing countries.

Main experience of integrated sustainable development in mountain areas of Lin'an

The main experience of Lin'an development can be concluded into nine aspects.

3.1 The right guiding ideology and development goals

3.1.1 The triple-win (co-win) development model

Lin'an is one of the earliest counties in China who introduced the concept of sustainable development. In early 1990s, Lin'an had already proposed the visions of "Green mountains, clear water and rich people", as well as "To develop an economic ecology and an ecological economy". In 1995, Lin'an identified specific approaches to achieve the above, thus, "While keeping the development of fine crop fields steadily, promote the greening of hilltops and mountain tops, with major efforts dedicated to developing the NTPFs at the hillsides and gentle slopes", achieving a co-win situation in ecological, economic and people's livelihoods. Changing people's ideology and concepts became the key for sustainable development.

3.1.2 Identified goals for development:

To construct "a top city in ecology and economy, a well-known cultural city, a leisure vacation resort";

To realize the goal of a "well-off society" by 2010;

To realize a more prosperous economy, a more harmonious society, a wealthier life, and accomplish modernization by 2020.

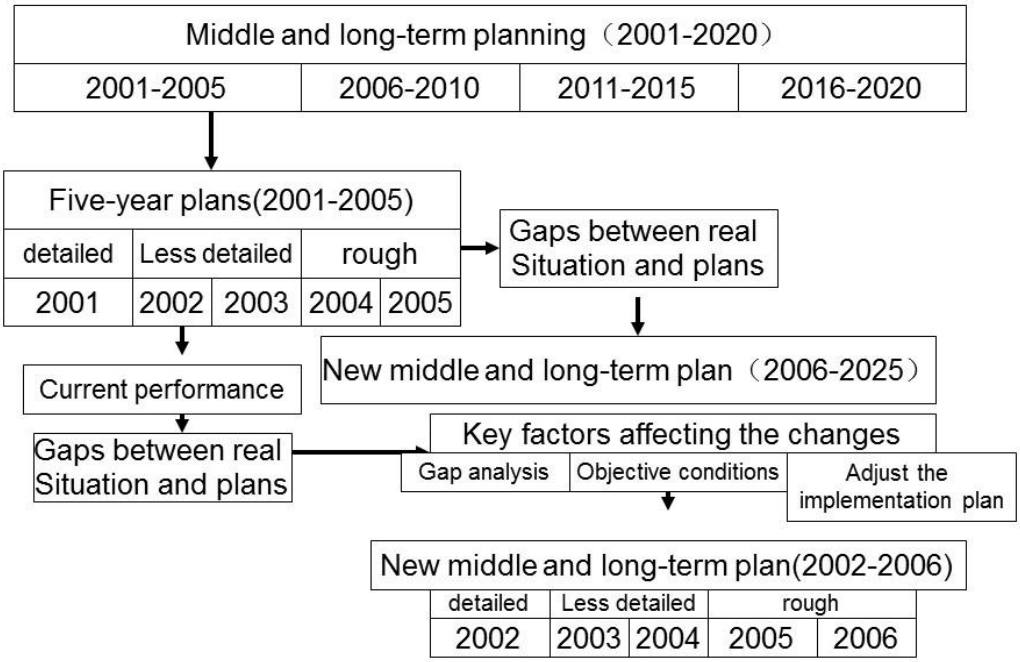
3.2 Scientific planning

3.2.1 Scheming

Beside the long-term development plan (2002 – 2020), mid-term plans such as the five-year socio-economic development programs and short-term (annual implementation) plans were also identified (see Figure 1). The approach of scroll programming was applied.

These plans were made under a multi-participation mechanism by which Government officials, scientists and representatives of common people got together to develop local strategic development plans. The plans were presented to the Local Communist Party Congress, People's Congress and Political Consultative Conference for discussion, amendments, and finally approved by the People's Congress. Once approved, the plans became official and had legal effectiveness, and should not be affected by the changing of governments.

Figure 1:



3.2.2 Strict implementation of the strategic plans

All the successive governments had been adhering to the plans strictly. Each year, the government made detailed work plan, specifying responsibilities and progress of each department. Monitoring, evaluating, rewarding and punishment system was adopted for government department at all levels.

3.3 Reform of the land policies

-An important measure encouraging initiatives of the farmers and promoting the rural sustainable development

Before the Opening and Reform Policy, China's lands were owned and managed by the State and Collective (communities). Farmers were allocated with income according to their contribution of labors. This system had largely inhibited initiatives of the individual farmers in developing the lands. After the Opening and Reform Policy, the management rights of the lands were gradually transferred to individual households. This transformation can be divided into three stages which can be called three land policy reforms.

3.3.1 First stage

The household land-user right contract system (Period: 1978-2002)

Main policies include transferring the land properties management (use) right from state to collective; contracting the user-rights of farmlands and forestlands to farmer households (usually, the contract period is 30 years), while the farmer owns the user-right and profiting right from lands, but has no right to transfer, thus, the farmer has incomplete property right.

As a result, over 70% of the lands were contracted to households, which had greatly enhanced the initiatives of farmers.

3.3.2 Second stage

The renewed land user-right contracting (Period: 2003—2009)

Main policies include extending contracting period to 50 years; transferring of the contracted lands was allowed and encouraged, scaled-management therefore was possible.

As a result, 70,000 ha forestland licenses were issued to the farmer households, which were 93% of the

total to be issued; the contracting period was extended to 50 years. Farmer's initiatives were higher.

3.3.3 Third stage

New reform of the collectively-owned forestlands (Starting time: 2009 -)

Information systems of forest land and forestland flow platform were established. In 2009, the registered mortgage loans accumulated to more than CNY 50 million, 170 million were granted; until 2010, the loans increased to 80million.

3.4 Rehabilitation and reconstruction of the ecological system

3.4.1 Natural forests protection projects

Since 1984, the natural forests protection project was firmly implemented: Chaotic logging and charcoal making were severely banned, timber harvest was limited.

3.4.2 Measures were taken for managing the forests in a sustainable way

Since the Opening and Reform Policy, the past policies prioritizing food and steel production at the costs of destroying forests were changed. Measures protecting the natural forests were taken, large areas of wasted hillsides, degraded lands and slopes on the mountains were reforested, and economic forests (NTFPs) were intensively developed. These measures had effectively increased the forest coverage, standing volumes, tree growth in unit area and the production value of the forests in Lin'an.

Since early 1990s, large scale afforestation projects were carried out on depleted, degraded and wasted lands on the hills and mountains, forest coverage was increased. Up to year 2000, all wasted and degraded lands were rehabilitated or reforested. (see Table 1)

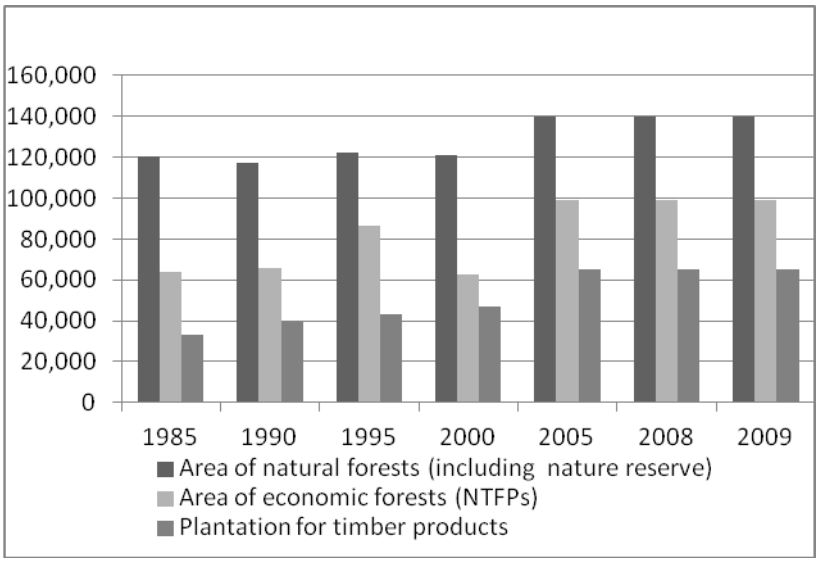
Table 1:

No	Items	Unit	1980	1985	1990	1995	2000	2005	2008	2009
1	Forestland area	Ha		186,333	185,460	192,067	219,126	240,389	254,885	259,713
2	Forest coverage	%		64.1	64.9	67	74.9	76.55	76.55	78
3	Standing volume of forests	Million m3		5.14	4.86	5.08	5.16	8.58	8.30	8.30
4	Standing volume per hectare	m3/ha		42	26.2	31.05		44.7	39.1	39.1
5	Timber logging	m3	99,400	128,600	173,600	83,000	72,650	65,043	81,879	95700

3.4.3 Enlarging ecological forests areas to make forests structure more rational

The areas of Natural Reserves and Ecological Forests for environment protection were enlarged, different types of forests – natural forests, industrial timber forests and economic forests (NTFPs) were kept at a reasonable portion (36.8%/ 24.97%/ 38.22%, Figure 2), while the ecological functions of the forests were effectively sustained. The portion of the area of natural reserves was increased from 0.61% in 1985, to 2.56% in 2008 (Figure 3).

Figure 2: Forests area (Ha)



3.4.4 Attaching great importance to environment protection and industry pollution treatment

Polluting enterprises were shut down; environment-friendly enterprises were supported and prioritized by the government. Up to date, 125 polluting enterprises were shut down. Ratio of qualified industrial wastewater discharge increased from 23% in 1990 to 99.45% in 2009.

Figure 3: Increase of the area of the natural reserves

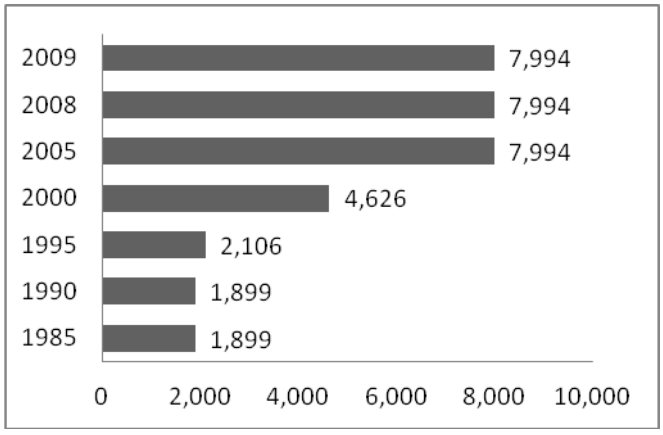
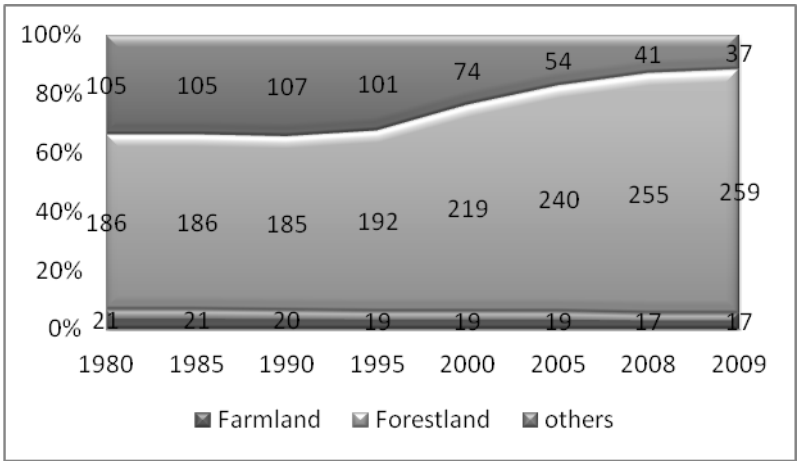


Figure 4: Forestland and farmland area (thousand ha)



3.4.5 Implementation of Forest Ecological Compensation Mechanism

Since 2008, Forest Ecological Compensation Mechanism has been applied (CNY 280/ha).

3.5 Supporting policies for rural industries

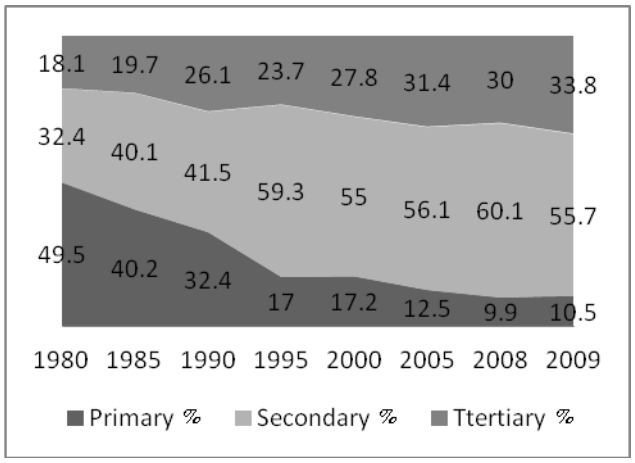
3.5.1 Organizational construction

The regulations for Zhejiang farmers' professional corporations" was issued in 2004 and officially implemented from January 1, 2005, which provided legal guarantees for the healthy development of new forest management organizations in mountain areas.

3.5.2 Promoting extension of industry chain to make the structure of primary, secondary and tertiary industries become more and more rational

Lin'an had been traditionally a typical agricultural county, with weak industries and underdeveloped tertiary industry. After the establishment of the People's Republic of China, in a 30 years' time (1949-1980), basic secondary and tertiary industries were put in place, yet were rather weak. Now the structure is more adequate, the proportions of the production values of the three industries were changed from 49.5%/32.4%/18% (1980) to 10.5%/55.7%/33.8% (2009) see Figure 5. The changes indicated that the industrial structure has become more rational, the supply chain was extended and the added value of products was increased.

Figure 5: Industrial structure



3.5.3 Infrastructure construction

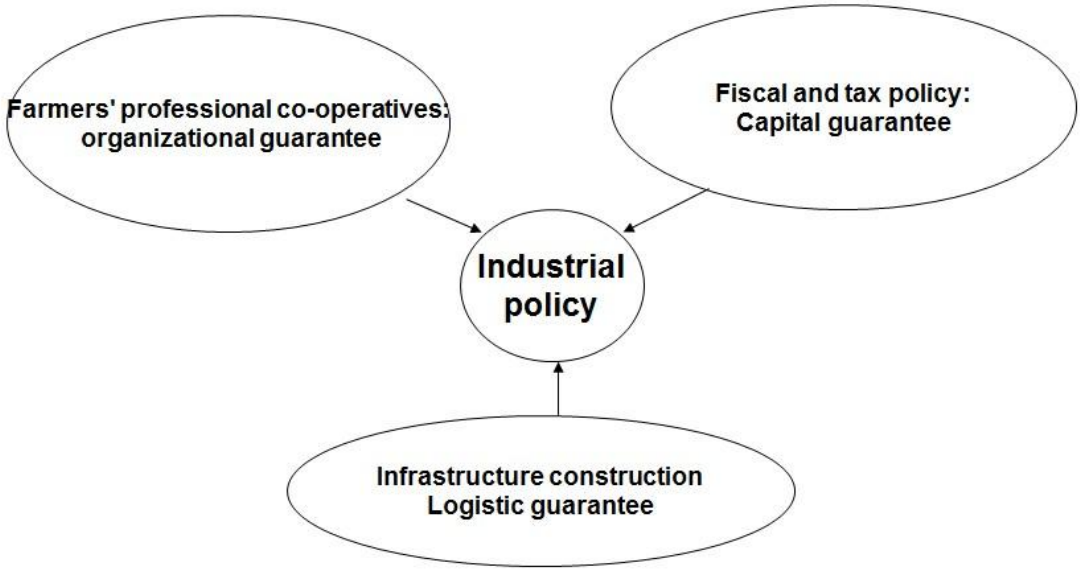
The governments of Lin'an had attached great importance to the construction of infrastructures in the rural area. Up to 2008, all villages were connected to the main roads with hardened roads, buses were available to all villages and the telecommunication and mobile phone networks had fully covered Lin'an. In 2009, the government plan for forest road construction was issued, according to the plan, 1000 km of forest roads would be built within 5 years. The New Socialism Countryside Projects have been implemented in all aspects in the rural areas since 2006, the rural public service and infrastructure facilities are improving progressively.

3.5.4 Fiscal and tax policies

In 2002, Lin'an pioneered in removing the tax on agricultural products (including agriculture, forestry, animal husbandry, aquatic product), which is 5 years earlier than the national implementation; the Agricultural Tax was stopped in 2005. Subsidies were provided to farmers who plant NTFPs, such as bamboo at the initial development stage; soft loans were provided to industries that have local features,

such as bamboo shoot and hickory processing production.

Figure 6:

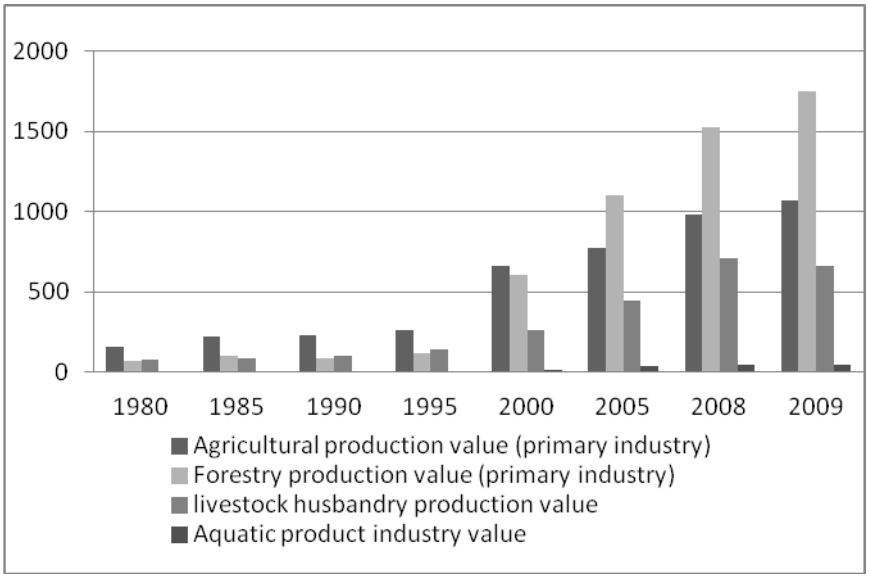


3.5.5 Increased proportion of the forest industries in the rural industries

As measures and policies were implemented to strengthen the ecological system in mountainous and hilly areas, converting farmlands to the forests, and to develop green industries such as NTFPs production, etc., the status of the forest industries had been gradually elevated amongst the rural industries.

Similar structural changes were also made in rural industries. The portions of agriculture, forestry, husbandry and aquatic were respectively 51.5%/23.1%/ 24.8%/0.6% in 1980, until 2008, the portions became 30.2%/46.8%/21.6%/1.4%. (Figure 7)

Figure 7: Distribution of gross agricultural production value (Million RMB)



3.6 Promote the development of environment-friendly industries

3.6.1 Governments took measures to promote NTFPs development and forests sustainable management

NTFPs became the dominating industry of people living in the mountainous rural areas. The NTFPs

industries are green industries whose development is not at the cost of destroying the natural ecological systems, in a certain way, the development of NTFPs had provided conditions for forest protection. Now, NTFPs' total production value takes over 90% of the total forestry production value. Since the 1990s, the NTFPs had become the most important source of rural income generation in Lin'an, the development of the NTFPs industries had also accumulated capitals for the development of the other industries. When the other industries were set up and start to develop, the proportion of NTFPs income in the total income of rural per capita population started to reduce (see table 2, and figure 8). The NTFPs production value keeps growing up, and NTFPs are bringing more income to farmers, which provides guarantee to forests protection and minimize deforestation.

Table 2: NTFPs became the dominating in the forestry

Items	Unit	1980	1985	1990	1995	2000	2005	2008	2009
Forestry production value (excluding eco-tourism)	Million RMB			510	680	1,800	3,580	5,019	5,498
NTFPs production value (including bamboo, hickory, medicinal plants, flowers, fruit, seedlings, Yang Tong, etc.)	Million RMB	3.05	32.0	116.1	641	1,069	3,350	4,832	4,935
Portion of NTFPs production value in forestry production value	%			22.8	94.3	59.4	93.2	96.3	89.8

Figure 8: Increase of NTFPs production value

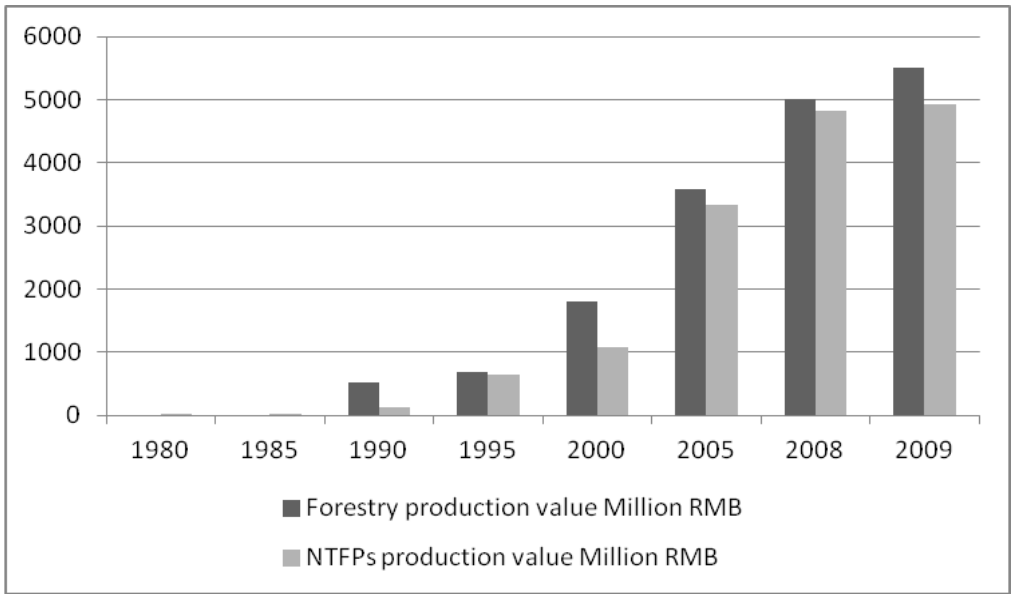
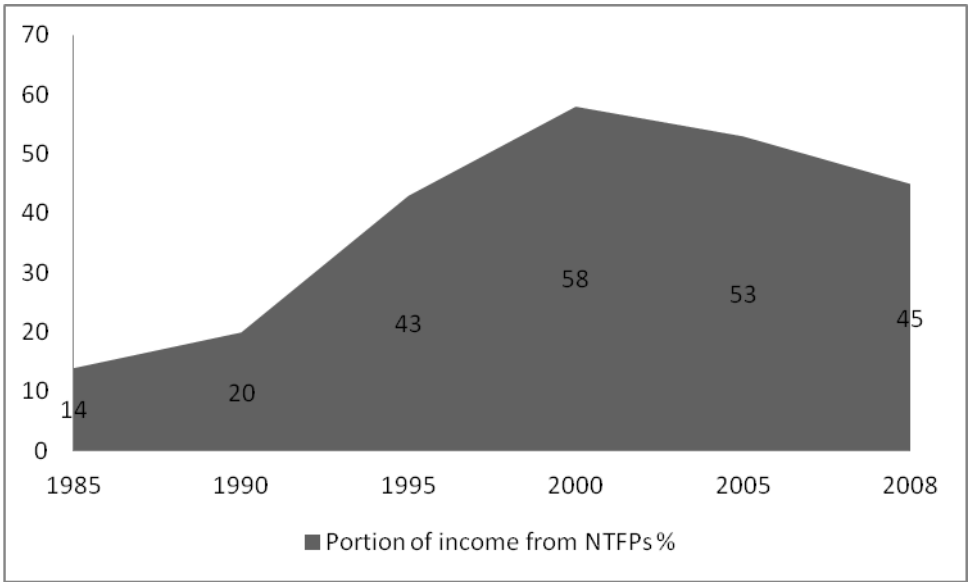


Figure 9: Portion of income from NTFPs



3.6.2 Great efforts were made in developing green energies such as small hydro-power stations, solar energy and bio-energy.

3.6.3 Eco-tourism and farm-stay have become new growth point of rural economy

Eco-tourism (started from 1997) and rural leisure tourism (farm-stay) (started from 2003) had also been developing fast, which did not only increase farmer households' incomes, but also improved the cultural awareness of the rural communities. The two industries, as the green industries, had become the new growth point of rural economy in the hilly and mountainous areas of Lin'an. Because of the two industries, enormous changes had taken place in the economy and culture of the rural areas, enhancing the urbanization process of the rural hilly and mountainous areas.

Table 3: Green energy development

No	Items	Unit	1980	1985	1990	1995	2000	2005	2008	2009
1	The number of small hydropower stations	stations	29	51	61	69	78	89	98	99
2	Power capacity	thousand kw/h	22,000	72,840	92,700	97,750	251,800	290,390	400,000	
3	Rural household solar energy utilization rate	%	Up to 2008, reached 50%							
4	Methane utilization	m3	Up to 2008, reached 245,00 m3/year							

Table 4: Fast development of the eco-tourism sector (1997-to date)

No	Items	Unit	1980	1985	1990	1995	2000	2005	2008	2009
1	Tourism revenue	Million RMB					800	1,560	2,420	2,850
2	Number of visitors	thousand tourists/times					1,710	3,301	4,559	5,235
3	Tour ticket revenue	Million RMB					23	53	83.23	105

Table 5 Farm-stay had become the new fashion of leisure consumption of the surround large cities (2003-to date)

No	Items	Unit	1985	1990	1995	2000	2005	2008	2009	2010
1	Number of households managing farm-stay hotels	household					300	500	530	
2	Number of guests in the farm-stay hotels	thousand					330	867.3	963.5	
3	Income of farm-stay tourism	Million RMB					8	40.76	48.19	
4	Employment in the farm-stay business (job opportunities)	person					350	1400	1580	1690

3.6.4 Rural industries created lots of job opportunities

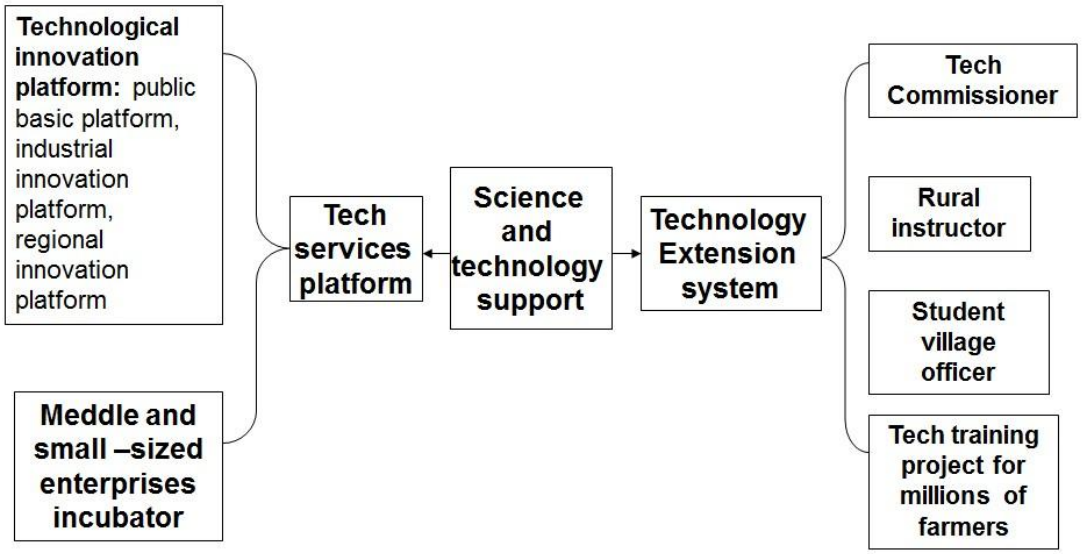
The mountainous/rural industries were expanded with extended production system and value chain. Most of the processing was carried out in the rural area, which promoted the rural industrialization and modernization. Farmers' roles are no longer limited as producers; they became workers and managers in the factories/companies; many farmers are also involved in products transportation and sale. For example: only in bamboo shoots sales, as many as 5000 households are involved. The bamboo shoot and culm processing, hickory nut harvesting and processing, as well as the eco-tourism and farm-stay required large amount of labors, Lin'an's local labors cannot meet the total demand, labors from other locations were attracted to Lin'an. Only the green sectors of Lin'an may attract more than 30,000 labors from other locations every year.

3.7 Science and technology support

3.7.1 Technical Innovation Platform

Through resource integration, a number of platforms were established for public technology services, industrial technology innovation and local practical technology innovations, a better system was established for scientific initiations where "government supports platforms, platforms serve enterprises, while enterprises volunteer in innovations".

Figure 10



3.7.2 Middle and Small-sized Enterprises Incubator

The function of the Incubator are mainly providing policy, technical, capital and other services, at the same time, provide facilitations to new enterprises in getting through the difficult initial stages of development, promote cooperation and exchanges, help scaling-up their businesses.

3.7.3 Technology extension system

Technology extension centers were set up at city and town level; technical commissioners, college graduates were sent to townships and villages to provide technical supports. The Technology Training Project for 100 Thousand Farmers was also implemented.

3.7.4 Technology Training Project

From 2001 to 2009, supports were provided for various technical training activities in rural areas, especially less developed areas, including workshops, distance learning, skills training for employment, education of workers in rural enterprises, rural youth training and official capacity building.

3.8 Multi-participation mechanism

In the long term development course, Lin'an had been persistent in the multi-participation of leaders, scientists/technicians and the public in decision making processes, demo-site establishment, capacity buildings, etc.

Various professional NGOs provided linkages and medium services amongst the stakeholders. These organizations had played important roles in providing technical services, popularizing the new technologies, providing market information, controlling product quality. In Lin'an, various associations were established, such as bamboo industry society, bamboo shoot industry society, hickory society, and flower association.

Professional corporations and associations are now developing fast in Lin'an. The corporations may guarantee the stabilized supply of raw materials, facilitate the improvement of raw material and product quality, keeping the market channels smooth, etc., these roles had helped the rural industrial sectors to achieve multiple-win situation. There are many cases of a common farmer became an owner of a big enterprise through hard works and continuous strives.

3.9 Rural urbanization and industrialization

3.9.1 The New Rural Development Project had promoted the integrated livelihood development in hilly and mountainous areas

With the consistent efforts of the local government in infrastructure construction, a comparatively complete

rural public service system was established. Each village had identified their respective middle-long-term plan for integrated sustainable development. Based on the various conditions of the villages, the plans made respective goals for ecology, economy, and livelihood and culture development for each village. These goals are now being pursued with project activities implemented in villages.

3.9.2 Establishment of education and health service systems

The local government had been persistent in implementing the policy of 9-year composed education, the education facilities were strengthened. At the same time, medical and endowment insurances were implemented for rural population. These facilities were provided under the national New Rural Construction program, they have gradually reduced the gaps between urban and rural areas, in some aspects, the present rural living conditions may had exceeded the urban conditions.

Table 6: Education and health service systems

No	Items	Unit	1980	1985	1990	1995	2000	2005	2008	2009
1	Enrollment in schools for 9-year compulsory education in rural areas	%		100	100	100	100	100	100	100
2	Popularization of medical insurance	%						88	90.4	92
3	Pension insurance rates	%						31.7	42.5	45
4	Participation rate of medical insurance in rural areas	%						90	98.5	99

3.9.3 Construction of public facilities

The rural people in the mountainous and hilly areas were provided with public facilities and services similar to those provide in urban areas.

Table 7:

No	Items	Unit	1985	1990	1995	2000	2005	2008	2009
1	Availability of hardened roads and public transportation facilities for each village	%	50	70	90	99.5	100	100	100
2	Availability of communication facilities in the hilly and mountainous areas (village, household telephone, mobile phone, and Internet)	%				60	100	100	100
3	Availability of cable TV	%					100	100	100

3.9.4 Rural living conditions in the mountainous and hilly areas gradually approach or even exceed conditions in the urban areas

Figure 11: The disposable income of urban and rural area

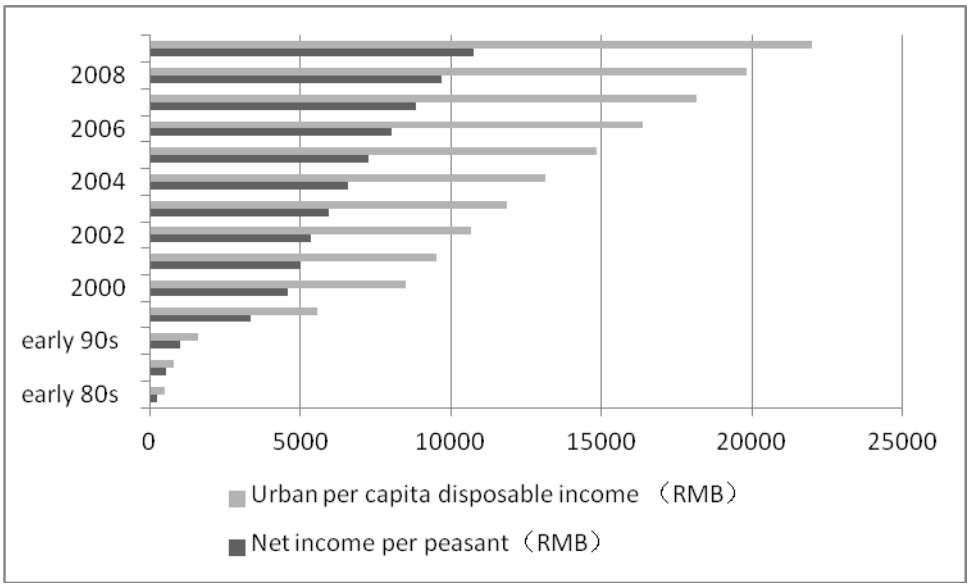


Table 8: per capita housing area

No	Items	Unit	1980	1990	1995	2000	2005	2008	2009
1	Per capita urbane housing area	m2		10	18.3	26.6	38	38	41
2	Per capita rural housing area	m2	35		45.7	51.6	65.6	70	71

Improvement of living conditions of rural population in hilly and mountainous areas

Figure 12: Per capita annual net income of rural population

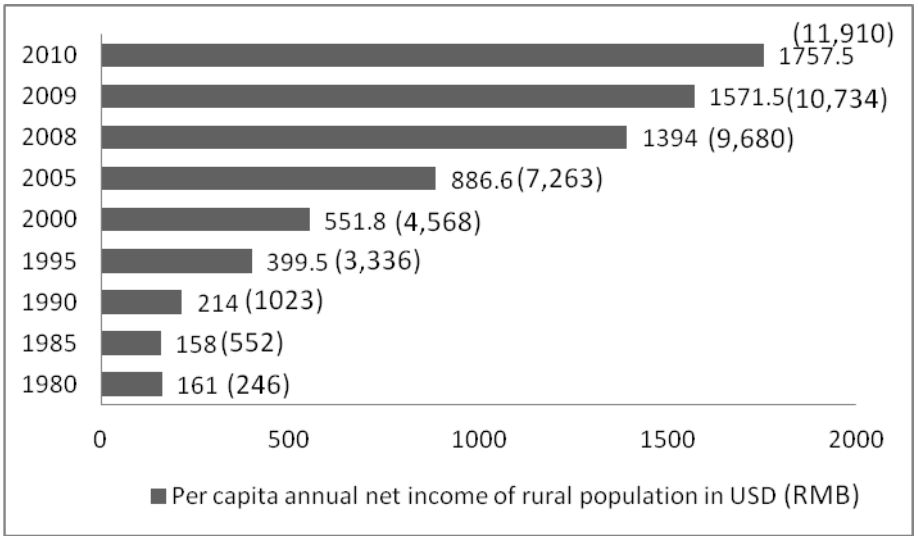


Table 9: Mountainous poverty population (Poverty alleviation targets)

No	Items	Unit	1980	1985	1990	1995	2000	2005	2008
1	Income standard of poverty population	CNY	120	331	613	2001	2751	Subsidies for low-income households	
2	Portion of poverty population	%	60	50	40	25	5		

Table 10: Popularization of electronic appliances in rural households (number of appliances per hundred households)

Items	1982	1985	1990	1995	1998	2000	2002	2005	2006	2007	2008	2009
Black and white TV	3	25	59	63	55	38						
Color TV	0	8	20	44	78	103	118	148	150	159	164	170
Washing machine	0	2	12	28	42	52	58	71	84	85	86	88
Refrigerator	0	0	16	33	52	57	58	74	78	89	90	97
Air conditioner	0	0	0	0	3	5	7	32	39	48	50	52
Computer								8	14	22	23	34
Telephone						40	73	97	97	97	97	98
Cell phone						18	42	130	146	170	184	204
Camera			4			12		13	13	11	15	15
Motorcycle			8			60		82	79	63	65	66
Automobiles								4	5	8	9	13

Challenges for further development of Lin'an mountainous area

Through 32 years continued efforts, Lin'an triple-win development model in mountainous and hilly areas has been widely accepted and implemented by local government and people; however, there is only paving ways for genuine integrated sustainable development goals. Presently, Lin'an is facing the following main challenges in further development.

4.1 The eco-system remains fragile

4.1.1 The forests' water and soil conservation capacity and production capacity is still weak

From 1950s to 1980s, it was in the context of massive construction in China, the policies of prioritizing food and steel production were implemented national wide, including in Lin'an, large areas of forests were used as fuel wood. House buildings in local communities also caused forests damage. The forests in Lin'an were seriously destroyed. Through 32 year's rehabilitation and reforestation, the hilly area in Lin'an were recovered with forests, however, until now, most of the forests are still young; their water and soil conservation capacity is weak, standing volume of each unit area are relatively low.

4.1.2 Industrial pollutions of surrounding cities threatens the ecological security of Lin'an

Lin'an is located to the west of a big city cluster of Shanghai, Hangzhou, Suzhou and others in east coastal area of China. In summer, the humid polluted airs with SO2 usually are driven to hit Lin'an and formed acid rains, which definitely influence forests growth, and acidify soil. So apart from fighting against local industrial pollution, Lin'an further development also requires environment improvement of surrounding areas.

4.2 Creating new balance between economy and ecology

4.2.1 Too much land were taken for industrial use

In the past 32 years, Lin'an's economy developed rapidly; gross GDP increased 114 times. Due to the correct guiding ideology and measures, the ecology development was able to go hand in hand with economy development. However, since 2009, Lin'an started a new wave of industrial development which raised the requirement for more land. As a result, considerable areas of forests land and farm land have been taking for industrial use, which is likely to increase risk of water and soil erosion.

4.2.2 Big challenges from urbanization

China is undergoing massive urbanization. In 1980, its urbanization rate was less than 20%; until 2010, it reached 49%. In Lin'an, the urbanization pace was slow compared with national average speed, as it managed to develop rural industries and green industries, which attracted many farmers to stay in rural areas. However, urbanization trends are overwhelming, and are exerting influences on Lin'an further development, which is bound to affect the future industrial structure and local community constructions.

4.3 Aging of rural labor force

Since Opening and Reform policy, industrialization and marketization were greatly speed up, and people's education level has been raise up; thus, more and more young people have been leaving for urban areas, or got involved in rural industries, such as products processing and sales. Those who remained in the villages are only the aged and the children; the labor force was becoming weak, labor shortage is now emerging in rural industries development.

The above challenges indicate that in different development stages, different new problems and challenges would come out. To solve the new problems, the measures and policies should be evolved accordingly, in order to create new balance among economy, ecology and livelihood to reach triple-win situation. The processing of overcoming challenges is essentially a continuous and systemic development process.

Lin'an Declaration, China
September 24th, 2010

Background

An International Symposium on Integrated Sustainable Development in Mountain Areas was held in Lin'an City, Zhejiang Province, China from 20-24th September 2010. The Symposium aimed to discuss the success and replicability of the Lin'an sustainable development model, share experiences from other parts of the world, and seek ways of fostering its broader adaptation. Over 100 delegates including development practitioners, university and government researchers, policy makers, entrepreneurs and investors, from 25 countries in Asia, Africa, Latin America, Europe and North America participated.

Declaration

Recognizing that:

Mountain areas cover 20% of the world's land area and are rich in resources, including forests and minerals, and are the source of much of the world's freshwater.

Forests in mountain areas provide essential ecosystem services, protect biodiversity and are essential for the mitigation of, and adaptation to, climate change.

Mountain areas are home to a disproportionately high percentage of poor people who depend on these resources for their lives and livelihoods. The livelihoods of the 17% of the world's population (i.e. approximately 900 million people) (Worldbank, 20102) who live in the mountains depend directly on their ability to grow, harvest, process and market crop, livestock, fish and forest produce, and their ability to adapt production and marketing as conditions change.

Mountain areas are highly fragile and susceptible to natural disasters, but their deforestation and degradation are rampant in many developing countries, resulting in increasing threats to the livelihoods of inhabitants, and to the global environment. Economic and population growth have combined to increase pressure on land, water, forest and biodiversity.

The Millennium Ecosystem Assessment and other global and regional studies have established beyond

[2] Brodnig, Gernot and Prasad, Vivek. 2010. A View from the Top: Vulnerability in Mountain Ecosystems. Social Development Notes: Social Dimensions of Climate Change. Worldbank, Washington DC. 4pp.

doubt that global sustainability is in crisis.

Models of effective sustainable development in mountain areas that balance economic, environmental and social development would enable broad adoption and adaptation for the good of the mountain peoples and environments throughout the world.

Sustainable development of mountain areas, which cover 69% of China and in which 83% of counties classified as poor are located, are one of the top concerns of the Chinese Government for improving rural societies, economies and the environment.

The participants appreciated the highly successful and innovative model of sustainable development in Lin'an due to the following achievements:

Greening of 76.6% of the area, increasing productivity and production, restoring the ecological balance and the economy, resulting in average per capita incomes of USD 6268 in 2008, an increase from USD 297 in 1985;

Assigning land-use rights for 60% of forest land to individual households for growing and managing forests and the development of Non-Timber Forest Products (NTFP) and forest industries, which has reduced poverty from 60% in 1980 to 1%in 2008;

Enabling people to derive 45% of their income from NTFPs, thus avoiding felling of trees and degradation of forests, and improving ecosystem services and conserving biodiversity;

Conserving and enabling better use of water resources, increased productivity, and improved health and sanitation;

Ensuring widespread use of renewable energy resources such as hydro-power, solar energy and biogas, thereby reducing emissions of green-house gases and their impact on climate change;

Improving the investment climate and facilitating trade through multi-stakeholders/agencies in remote areas, resulting in faster and more inclusive growth;

Providing modern infrastructure in rural areas, including housing, to arrest the out migration of rural population for wholesome development;

Introducing policy and institutional innovations, technology, health insurance, promoting environmentally friendly industries, eco-tourism, good governance, better connectivity and communication, and multi-stakeholder participation.

Such models of sustainable development are urgently required to achieve the Millennium Development Goals (MDG) and commitments made under U.N. conventions. Therefore the participants of the symposium resolve that:

The achievements and experiences of the Lin'an model be widely publicized within and outside China through a wide range of media for the benefit of countries facing similar problems.

Continuous research, innovation and extension be pursued to refine and adapt the model to meet future challenges.

Funding for research, technology transfer and training be sourced from international and national sources.

Special appreciation be accorded to Lin'an government, universities, research institutions and international organizations, demonstration households and entrepreneurs, scientists, technicians and officials for their devotion, hard work and innovation in developing and successfully implementing such a unique model.

A workable plan for realizing this be developed by stakehololders.

Date

Chair.

The effect of litter nutrient cycling to soil on Pinus massoniana Plantation in Three Gorges Reservoir Area

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The quality and quantity of litter and its decomposition rate in some extent represent the nutritional status of the soil. The effect of litter nutrient cycling including the amount and pattern of litterfall, substrate quality, nutrient return and decomposition to soil nutrient was studied in Pinus massoniana plantation in Three Gorages Reservoir Area, China. Our objective was to elucidate the contribution of litterfall, substrate quality and decomposition to soil nutrients of the studied forest ecosystem and improve recommendations for their management and conservation. Mean annual total litterfall observations was 4.71 Mg ha-1 year-1, which tended to be lowest in February and highest in November. The rank order in organs of yearly litterfall was reproductive organs＜bark＜branch＜others＜leaf. The rank order litter nutrient returned to the soil was as follows: N > Ca > K > Mg > P. Leaf decomposition rate was low with 70.24 % of litter mass remaining after 360d exposure. Canonical correspondence analysis reflected the litter nutrient cycling was significantly correlated with soil nutrient, the impact of nitrogen, phosphorus, cellulose, hemicellulose, lignin, the lignin/N ratio, C/N ratio in leaf litter substrate quality to soil nutrients were significant, nitrogen content of substrate quality and soil total nitrogen content was significantly correlated. Soil pH, bulk density and N content were significantly negatively correlated, with litter C / N ratio, lignin / N ratio was significantly positively related. Principal component analysis indicated that litterfall and substrate quality accounted for 85.66% of the variation in the soil nutrients, which explained more variability in soil nutrients than does litter decomposition. The study also indicated that soil nutrient poor accompanied relatively low litter quality, soil surface organic matter, N, P nutrient contents were the similar variation with corresponding nutrient content in substrate quality. In addition, our study suggested that Pinus massoniana plantation had advantages in short-term nutrient uptake, growth, and nutrient cycling; however, it had disadvantages in soil development and regeneration and sustainable land management.

Keywords: Three Gorges Reservoir area, Litterfall, Substrate quality, Turnover, Soil nutrient, Canonical correspondence analysis

Determining of onset of the self-thinning within the even-aged Chinese fir (Cunninghamia lanceolata (Lamb.) Hook.) stands

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The objective of this study was to determine the self-thinning onset based on quantifying relationship between the maximum average stem volume (V (dm^3)) and density (N (stems/ha)) of Chinese fir stands. The study used 5 initial density levels (2 m × 3 m, 2 m × 1.5 m, 2 m × 1 m, 1 m×1.5 m and 1 m × 1 m) and 3 replications for each level, thus a total of 15 plots. Subsets of the data were constructed and consisted of 0-67%, 2-67%, 5-67%, 10-67%, 15-67%, 20-67%, 23-67%, 25-67% and 30-67% mortality intervals. Ordinary least squares (OLS) and reduced major axis (RMA) regression techniques were used to obtain self-thinning parameters for each mortality interval subset and thus determine onset of the self-thinning based on the mortality rate. As a result, the self-thinning trajectory with a mortality interval of 2–67% sufficiently represented and onset of self-thinning is that mortality rate is above 2%. Based on onset of the self-thinning with 2% mortality rate, the dynamics of the ratio of crown length and tree height (CL/TH) and the mean stem taper were analyzed. We conclude that self-thinning may occur when the ratio of CL/TH in closed stands approaches 0.4 or the mean stem taper is below 1.0, regardless of the initial planting density. This new information will be useful for determining the optimal thinning regimes for Chinese fir stands.

Contribution of Diurnal and Nocturnal Insects to the Pollination of Jatropha curcas (Euphorbiaceae) in Southwest China

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Jatropha curcas L. is being increasingly planted worldwide but questions remain regarding its pollination biology. This study examined the contribution of diurnal and nocturnal insects to the pollination of monoecious J. curcas, through its floral biology, pollination ecology and foraging behavior of potential pollinators. Nectar production of both male and female flowers peaked in the morning, declined in the afternoon, and rapidly bottomed during the night in all of their anthesis days. The diurnal visitors to the flowers of J. curcas are bees and flies, and the nocturnal ones are moths. Flowers received significantly more visits by diurnal insects than by nocturnal ones. Through bagging flowers during night or day or both or exclusion, we compared fruit and seed production caused by diurnal and nocturnal pollinators. Both nocturnal and diurnal visitors were successful pollinators. However, flowers exposed only to nocturnal visitors produced less fruits than those exposed only to diurnal visitors. Thus, diurnal pollinators contribute more to seed production by J. curcas at the study site.

Key words: Jatropha curcas, diurnal pollination, nocturnal pollination, female reproductive success, nectar production

Optimization of stand operation at an individual tree level based on GIS within close-to-nature forest management

Wang Yiyang

Forest management has evolved from a relatively classical timber production approach to multipurpose management to reconcile various conflicting demands between timber and non-timber resources. Traditional forest management models based on stand or landscape level should be transformed to an individual tree level. This paper describes a method and process for supporting decision making at the level of individual trees following an approach based on close-to-nature siviculture. Target trees and disturbing trees algorithm and their decision methodology based on GIS were used to find an optimal solution. The method was applied to an even-aged plantation of Cunninghamia Lanceolata in Fubo forest experimental farm, Pingxiang, Guangxi Zhuang Autonomous Region southern China to improve target tree management at tree level. Decision methods and GIS technology are used to find an optimal solution of individual trees to be tended, protected and harvested. The results showed all the trees in the plot can classicized into 24 target trees, 36 disturbing trees, 2 special trees and 229 ordinary trees. The results also indicated that the managers could consider all trees simultaneously and the optimal solution founded had the highest probability of being the best by using this method. Although it could be used as a tool for decision-making processes in forest management and applied in a generalised manner, time and costs of gathering data in the field need to be considered.

Physiological responses and risk assessment of urban trees to elevated ozone under background of climate change

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Air pollution has become a serious environmental problem affecting human health, quality of urban life and sustainability of urban ecosystems, particularly in cities of developing countries. Tropospheric ozone (O3) is regarded as one of the most widespread air pollutants. Ground-level O3 concentrations have been increasing in urban areas since the industrial revolution. Current O3 concentrations in ground level of urban area are potentially high enough to adverse affect on urban plants.

Based on the results of our studies on the relationship between urban trees and global climate change in recent years, the effects of elevated O3 on eco-physiology of trees were reported， mainly in the O3-induced visible injury, the impacts of elevated O3 on the growth, photosynthesis, antioxidant system and the emission of volatile organic compounds (VOCs). We hope our work will provide a scientific reference for the further research on the impact of O3 on trees, especially on the sustainable forest management and the selection of urban tree species in respect to the increased atmosphere O3 concentration under the global climate change.

Finally, the current work carried out by us in physiological responses and risk assessment of urban plants to elevated O3 was also presented here.

Key words: climate change; elevated O3; physiological response; risk assessment; urban trees

The response of tree's radial growth to climate warming and CO_2 increasing

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The tree has complex and specific reponse to the increased temperature and enriched CO_2 under the condition of global change.Based on the stem radial growth of the regional dominative conifer species such as Pinus tabulaeformis in Liaoning province, the single and couple effects of temperature increase and CO_2 enrichment, and the response pattern of tree radial growth to the couple impact of global warming and CO_2 enrichment and its inter-control mechanism were studied by using dendrochronological method and open top chamber simulation technique. In this study, we quantitate the relationship of tree stem radial growth and the tree's potential ability of carbon storage in typical regional forest ecosystem under the background of global change, and to reveal the information of ecological process, and the contributation and the potential of regional forest ecosystem for reducation of the CO_2 enrichment and limitation for warming.

Individual growth characteristics and difference analysis of *Calocedrus macrolepis*—a endangered plant in Mojiang and Changning

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Calocedrus macrolepis is rare and endangered in China and has higher value in precious timber and ornamental plantation. The distribution of its natural forest is very scarce and undergoes many human disturbances. In present study, result from stem analysis of two growing points indicated that (1) the growth rate was slow in the tree at age 20-30, growth increment decreased in the tree at age 70-80. (2) In the initial stage, the growth rate of Mojiang was lower than Changning, but in the middle and terminal stage, this status was opposite. The gross volume increment of Mojiang was higher compared with Changning, which was consistent with growth characteristics and environmental condition of C. macrolepis. (3) According to its growth characteristics, some management measure were put forward including putting up shed in seedling stage, release cutting in sapling stage, thinning in mature age, etc. This lays a foundation for cultivation and protection of C. macrolepis in the future.

Key words: Calocedrus macrolepis; Growth dynamics; Growth increment; Divergence comparison

Effects of Continuous Eucalyptus Plantation on Activity of Polyphenol Oxidase and Contents of Phenol in Soil.

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Phenols are the important secondary metabolites in vital process in plant, being as the main allelochemicals through root excreting or plant residue decomposing into soil, which play an important role on feedback and regulation effects on environmen,. Polyphenol oxidase (POP) can decompose the phenols in soil to reduce the allelopathy among plants. In this study, Variation of the soil POP activity and phenolics contents were tested in soil layers l0-20cm and 20-40cm in non-root region and 0-20cm in root region in different continuous plantation of Eucalyptus urophylla ×E. grangdi in tropical forestry research center of Chinese academy of forestry, 2- and 5-years forests at the first rotation and 2-year forest at the second rotation, and sampled, respectively, which will enrich the researches on allelopathy and make a reference for sustainable management in Eucalyptus plantation.

The results are showed here briefly. (1) Among the various soil layers in different rotation of Eucalyptus, the trend of pH value showed higher in l0-20cm and 20- 40cm soil layers in non-root region than in 0-20cm soil layers in root region. It was visible for pH value decreasing with the years, particularly being the lowest value in 2-year forest of first rotation. (2) The POP activity in non-root region showed higher than in root region, performed the order with l0-20cm and 20- 40cm soil layers in non-root region, 0-20cm soil layer in root region, in turn, and increasing trend with the rotations of continuous cropping. (3) The total phenols and complex phenol contents showed higher in root region than in non-root region, and tended to decrease with the rotations of continuous planting. Water-soluble phenol contents showed higher in non-root region than in root region, while tended to decrease with the rotations of continuous planting. (4) The significant correlations were viewed that the soil POP activity was negatively correlated with total phenols, complex phenol, and positively with water-soluble phenol, indicating the degradation of phenolics was caused by POP. As regard for significant relationship between POP activity and polyphenol content, the lower the soil pH, the smaller POP activity. The pH value of soil had significant negative correlation with the soil POP activity, total phenol and complex phenol, but positive correlation with water-soluble phenol.

From the above analysis, the contents of total phenols and complex phenol tended to decrease with time of eucalyptus cultivation while the soil POP activity rose. The visible accumulation of phenolic compounds were not found in continuous planted eucalyptus, but degraded with soil POP activity gradually enhancing, and non-free phenol did not harm the environment. Soil water-soluble phenol increased with the growing years with only 3.39μg • g-1 to the maximum value. It could not come to conclusion that such a low amount of phenolic substances led poisoning or promoting role on the growth of individual trees in Eucalyptus plantation. The changed form of phenolic compounds, the effect and mechanism will further be studied through the biological evaluation and controlled environmental conditions.

Key words Eucalyptus; soil; Polyphenol Oxidase activity; Phenol

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Research on the Change of Frozen Soil Environment of Fired Clear Cutting Forest in Greater Higgnan Mountains

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After the forest fire the frozen soil happened a series of changes, this paper, from the choice of different fire after fire degree (severe area, mild area),different slopes,natural forest to compare a frozen soil environment factor and changes in the rate of carbon dioxide. Research reveals the forest fire in sunny slope shady slopes of air temperature is severe > mild > natural forest is single-peak curve and the highest temperature curve appear in the afternoon at 2 PM. In different degree mark place on fire, in severe and mild fire, the mountain slope surface temperature of sunny slope shady slopes soil 10cm, 20cm the temperature change of the Single-peak curve form, and its spikes of time special agreement. But, severe burning and mild fire in sunny slope shady slopes ,all showed that severe burning surface temperature and light the fire surface temperature is high. From the release of carbon dioxide rate changes on the dynamic situation, the different degree and the fire a slope sand soil respiration rate of sunny slope shady slopes is basically the same change trend, are the single-peak curve and the sun respiratory rate than the yin slope, soil respiration rate is highest when all appear at 2 PM. In Shady Slopes ,the soil respiration rate of severe fire is shady seems to be higher, mainly reflects in between 10:00-16:00, Second is controlled zone, a mild slope .In addition, the rate of carbon dioxide in mild slope soil mark place fire of shady slopes luffing minimum during the day, severe fire the soil respiration rate mark place large horns. And insunny slope respiratory rate highest, probably because of the vegetation cover against microbial and the strong respiratory in this area.

Key words: Different degree of fire; The greater higgnan mountains; Environmental factors; Carbon dioxide

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Contribution of Diurnal and Nocturnal Insects to the Pollination of Jatropha curcas (Euphorbiaceae) in Southwest China

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Jatropha curcas L. is being increasingly planted worldwide but questions remain regarding its pollination biology. This study examined the contribution of diurnal and nocturnal insects to the pollination of monoecious J. curcas, through its floral biology, pollination ecology and foraging behavior of potential pollinators. Nectar production of both male and female flowers peaked in the morning, declined in the afternoon, and rapidly bottomed during the night in all of their anthesis days. The diurnal visitors to the flowers of J. curcas are bees and flies, and the nocturnal ones are moths. Flowers received significantly more visits by diurnal insects than by nocturnal ones. Through bagging flowers during night or day or both or exclusion, we compared fruit and seed production caused by diurnal and nocturnal pollinators. Both nocturnal and diurnal visitors were successful pollinators. However, flowers exposed only to nocturnal visitors produced less fruits than those exposed only to diurnal visitors. Thus, diurnal pollinators contribute more to seed production by J. curcas at the study site.

Key words: Jatropha curcas, diurnal pollination, nocturnal pollination, female reproductive success, nectar production

Different Degree of Forest Fire Cold Temperate Zone Soil Carbon Storage Effect

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In this paper, the two study region which were burned forest in 2003, respectively were chosen in greater hinggan mountains in Inner Mongolia to research the carbon storage and its vertical distribution character under different fire degree. The results follow as: No matter heavy burned or light burned, fire has significant influence on soil carbon storage of cloudy and sunny slope in 0-20cm depth, particularly in 0-10cm depth. According to the soil carbon rate quantitative estimate different fire degree, different soil slope up carbon storage, A reminder of the northern forest environmental problems. To realize cold temperate zone soil forest fires could exacerbate the thawing permafrost, and could lead to release more CO_2, and to let people know cold temperate zone soil and permafrost further damage of the devastating consequences after.

Keyword: Permafrost; Carbon storage; Forest fires

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“Fertile Island Effects” Characteristics of Albizia kalkora Prain Shrubs in Hot-Dry Valley ——Study on Spatial Distribution of Soil Organic Carbon and Water

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Hot-dry valley is a typical and degraded ecosystem in southwest of China. Its vegetation are divided into the “Tree Savanna” and “Shrub Savanna”. Due to the massive existence of the isolated trees and shrubs, they made the originally barren but uniform soil nutrient and moisture gathered to the isolated trees and shrubs, and formed "Fertile Island Effects" in dry-hot valley. And the‘Fertile Island Effects’furtherly exacerbated heterogeneity and plaque of soil, water and other resources, it formed semi-desert and desert landscape in hot-dry valley. At present, there are not reports about the study of the formation and maintenance mechanism of the‘fertile island effect’in dry-hot valley. Albizia kalkora Prain is an universal local species with drought tolerance in hot-dry valley, it has the special status in degraded ecosystem of hot-dry valley. Through the research of Albizia kalkora shrubs spatial distribution of soil organic carbon and soil moisture, we could understand the soil resources distribution pattern and transformation process of the degraded ecosystem of hot-dry valley. The results showed that: (1) The soil organic carbon and soil moisture’spatial distribution are uneven, they are accumulated in the Albizia kalkora shrub’ roots. Thera are obvious difference between the ‘island ‘ inside and outside with the testing indexes, especially the soil surface.The indicators showed: shrub root > crown edge > open space, it illustrated the Albizia kalkora shrub with strong" fertile island effect". (2) From the perspective of spatial scale, its distributions may be partially beyond its crown coverage area, and the‘Fertile Island Effects’ has certain spatial correlation with the direction and depth of the soil; the soil testing indexes in and out of island decreased with soil depth increases; and the " effect tends to decreasing and lose with soil depth increased.

KeyWords: hot-dry valley, Albizia kalkora Prain, fertile islandeffect.

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Strategies for Multi-objective cultivation of Korean Pine Plantation

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Korean Pine (*Pinus koraiensis*) is main tree species of Korean pine and broad-leaved forest which is climax vegetation in northeast of China. For the reason of economic and ecological benefits characterized by high yield wood and seed production, high quality timber, evergreen, long life, and wide range of uses, no other tree can be matched. To make this long-rotation species play a greater benefits and output continuous ecological benefits, the researchers of Liaoning Institute of Forest Management worked more than 50 years .The key technology system of multi objective cultivation has been developed and widely applied in this region.

1 Clone seed stand

Grafting on seedlings in nursery or grafting after planting with shoots or buds from high yield seed trees make the pine flower and fruit early. The research results show that the clone seed stand grafted at Caohekou town in 1968 began to fruit after 4 years. While the seedling stand planted in same time was found the fruit until 7 years. The fruiting rate of clone seed stand by grafting is 4.5% at 9 years, 40% at 26 years, 47% at 31 years and 90% at 35 years, respectively. The seed output can be 1250kg per hectare in an abundant year. The average annual production can be kept at 500kg per hectare (average of abundant year, common year, and short year.).

2 large-diameter timber forest

The key to cultivate Korean pine large-diameter timber is density. For the existing stand, the main measure is thinning. The results showed that the effects of thinning represent diameter growth. At different age stage, diameter increment in thinning plot greatly increased than that of control. Meantime, the increment increase with thinning density. The effect of thinning before 30 years is better than that after 30 years with 20% increase of total mean increment.

The results also showed, besides tree growth, thinning enhance light intensity inside the forest. The improvement of stand condition benefit tree growth and seed production and quality. A survey on different density Korean pine thinning plot was made at 41 years in Caohekou town. The result showed density affect tree fruiting rate. Great difference of seed yield was found among different density stand. The yield of heavy thinning stand is twice that of control. Moreover, individual nut quality, seed number and empty rate are better than those of control.

In addition, as the result of increased diameter growth by thinning, the individual volume was increased, which improved timber quality and economic output. The data of 56 years thinning plot indicated that diameter in thinning plot is 32.9cm, which has matched the state felling standard. However, the diameter in control plot is only 28.7cm, which needs at least 20 years growth to 32.9cm, showing thinning can advance 20 years felling.

3 Timber and seed forest

Korean pine is known as timber and seed. This technology aims at high quality timber and high yield seed

production. Meanwhile, the ecological effects should be given attention.

Measures and basis for timber and seed forest cultivation: Fruiting has close relation to tree branching in existing stand. Based on 11 investigated stands planted at different time in Liaoning east area, 30% natural branching was found in 20 years stand, over 50% in 50 years. The average branched individual volume of 11 stands is 27.1% higher than average of stands. Correspondingly, fruits are 3.76 times higher than stands, indicating tree branching in Korean pine plantation promotes radial growth and fruiting.

Manually branching(topping) of Korean pine can promote fruiting. Topping means cutting tree top at certain height to induce multi-top which more fruits are expected. For the characters of top fruiting, topping causes to multi-top, generally 3 tops. Accordingly, individual fruit numbers is increased. A topping experiment with heavy thinning(15% less than suitable density) in 26,39 years stand and light thinning in 34 year stand were implemented. The results showed topping after heavy thinning increases fruits by 9% to 32%(from 33 to 125kg per hectare). Heavy density decreased fruits for the reason of affecting branching on top.

For the topping stands, when age is more than 40 years, intermediate felling should be implemented to keep density within 300 to 350 stocks. Topping combined pruning at the same time. Prune branch to 8m height above site. Top all branches above the third wheel of stem. The season should be winter followed the abundant year.

4. Discussion

(1) Selection of grafting materials: materials should be high yield clones from local Korean pine seed orchard, progeny forest, or choose high yield dominant trees in fruits in existing stands.

(2) Rebuilt existing young stands to clone stand: the following issues should be given attention in practice. ① To ensure the grafting survival, training to the workers is necessary before graft and the skillful worker is desirable. Sometimes, grafting is not always on the leading shoot after plantation, which directly affects growth and fruiting. ② suitable grafting age is within 3 years after plantation. ③ grafting density should accord to clone fruit standard(400 to 1200 stocks per hectare).

(3) To promote the stand fruiting early, the following key technology should be thought: ① Release bindings and prune parental stock betimes. Normally, bindings may be released after 90 days grafting. Cut the phyllogen of parental stock if cion is sure alive. ② Afterwards, annual pruning should be done at early spring before sap flow. Lateral branches should be cut except those no affection on cion growth. Generally, the action takes 3 to 4 years until all branches are cut out.

(4) Due to low density of Korean pine clone fruit stand, the enough light under young stands can be intercropped herbs and potherb such as Gentiana scabra Bunge, Radix Acanthopanacis Senticosl, Aralia Clata(mig)Seem,etc.

(5) The aims of pine cultivation should be diverse to large-diameter timber, seed and timber, clone fruit, mixture, multi-layer forest. At present, the trend of recognition seed and ignoring timber and ecological benefit sould be turned to the development of three benefits.

(6) For the plantation list in noncommercial wood, it is recommended active management should be applied and implement heavy thinning to promote vegetation recovery under crown and give its ecological effect.

(7) Pruning is an important measure to cultivate high quality pine timber. Lateral branch upgrowth, rich in oil, less self-pruning is its ecological character. Some timber self pruned shows defect. Accordingly, to improve timber quality and value as well as get more economic gains, intermediate felling should be combined with pruning on large-diameter forest and seed and timber forest cultivation.

Study on Assessment and Conservation of the Wuzhou Urban Plant Diversity in Guangxi Province

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The situation about the construction of urban green space, vascular plant biodiversity, component and characteristics of flora, types of plant resources, ancient and famous trees, rare and endanger plants and alien invasive plants was analyzed, on the survey of plant biodiversity in Wuzhou city. The assessment system of Wuzhou urban plant biodiversity was established and its current situation, environmental threaten and protection measures was assessed quantitatively. Suggestion on Conservation was put forward at 4 levels of plant biodiversity about Wuzhou city. The results were as follow:

(1) There were 803 species plants belonging to 496 gens and 151 families in Wuzhou urban built-up area, including 286 species of tree(35.6% of total species number), 173 species of shrub(21.6%), 66 species of liana(8.2%) and 277 species of herb(34.6%). There were 516 species of native plants(58.4% of total species number), 74 species of alien plants(9.7%) and 213 species of instruction and acclimatization plant(26.5%).

(2)The origin types of flora were in multiplicity and tropical apparently; The number of plant species the species belong to single gen and family were rich but not special enough, and the species belong to single gen and family were rich but little in aged plants; The flora of transition was apparent.

(3)The types of plant resources were in multiplicity but lack of integral utilization and exploiting, except Pinus massoniana. The incidence of diseases and insect pests on ancient and famous trees were higher, the protection measures for rare and endanger plants were short of effect and the awareness of ecological protection were not strong enough.

(4)The species number of garden plants was not enough abundant and much of instruction and acclimatization plant; the forms of vertical greening and types of plant configuration were little.

(5)From the four levels of landscape, ecosystems, species and genetic biodiversity, the assessment system of Wuzhou urban plant biodiversity was built by using the Analytic Hierarchy Process(AHP). Its current situation was not bad, more suggestion on conservation should be put forward to dissolve the existed problems and improve the ecological system of urban plant biodiversity.

Key Words: Wuzhou City; Urban; Plant Diversity; Assessment; Analytic Hierarchy Process; Suggestion on Conservation

Correlations of Soil Enzyme Activity and Nutrients , Microbes in Soil of Robinia pseudoacacia plantation with different degrees of degradation at Yellow River Dalta

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Abstract Aims Our objectives were to 1）explore the changing laws of soil enzymes, Nutrients,Microbes in the process of degradation for Robinia pseudoacacia plantation.2)explore the correlation between soil enzymes and nutrients as well as PH and salt.3)explore the correlation between soil enzymes and microbes.

Methods Select Robinia pseudoacacia plantation which were in different degrees of degradation; Measure the values of soil enzymes, soil nutrients, and the numbers of microbes in laboratory;Determine the correlation among the soil enzymes, soil nutrients, and microbes by correllation analysis.

Important findings With the aggravation of the degradation degrees of Robinia pseudoacacia plantation, activities of soil enzymes such as Urease, Polyphenol oxidase, Peroxidase decreased gradually. Hydrogen peroxidase had a different change; Urease had remarkable positive correlation with Polyphenol oxidase, Peroxidase. Peroxidase had positive correlation with Polyphenol oxidase while the activities between other enzymes had low correlations. variation trends of soil nutrients are similar to soil enzymes.the congtents of soil nutrients such as organic matter, total nitrogen, available nitrogen, available P decreased with the the aggravation of the degradation degrees of Robinia pseudoacacia plantation while soil PH and salts had the reverse trend compared to soil enzymes. Soil enzymes, especially Urease ,had high positive correlation with soil nutrients and negative correlation with soil PH and salts. Among microbes, the number of bacteria was highest. Fungi, actinomycetes, and bacteria had diffenrent variation trends. Urease had high positive correlation with bacteria, actinomycetes, .Bacteria had high positive correlation with enzymes except Hydrogen peroxidase.

Researches on estimation method of forest carbon sequestration Based on BP Neural Networks

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This paper introduces theory of BP neural networks and constructs forest carbon sequestration model based on BP neural networks mainly factored by the forest area, forest coverage rate, stock volume of forest, damage forest area, completed investment, plant diseases and insect pest. The BP neural networks were trained and simulated on the sixth forest resources inventory data. The results showed that: it has less error and higher accuracy and reliability that offers a new method of simulation in forest resource management.
Keywords: Forest carbon sequestration; BP Neural Networks; Forecast;

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Effect of thinning and fertilization regimes on carbon density of Quercus acutissima plantations

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Carbon density of Quercus acutissima plantation, a widely planted tree species in Jianghuai hilly lands, was studied in thinning and fertilization experiments using sample plot investigation. The thinning experiment comprised of four treatments (CK、15%-T15、30%-T30 and 50%-T50), the fertilization experiment also included four treatments (0.00、0.15、0.30 and 0.45 kg tree-1). The results show that tree carbon density in T15, T30 and T50 increased by 9.1%, 29.6% and 28.4% than CK, respectively; tree carbon density enhanced with increasing fertilization volume. Carbon density of different tree's organs in thinning and fertilization treatments was in the order of stem>root>branch>bark>leaf. Litter carbon density reduced with increasing thinning intensity, and increased with increasing fertilization volume. Soil carbon density enhanced with increasing thinning intensity and fertilization volume, it was not significant difference between thinning and unthinning treatments, and fertilization treatment was significantly higher than unfertilization treatment. Total carbon density of Q. acutissima stands was in the order of T30 >T50 >T15 > CK for thinning treatment, and it enhanced with increasing fertilization volume. Therefore, thinning and fertilization were helpful to enhance carbon storage for Q. acutissima plantation in Jianghuai hilly lands.

Key words: Q. acutissima, thinning, fertilization, carbon density

Fire Interference on Larix gmelinii of Soil Properties Pines

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In this paper, the two study region which were burned forest in 2003, respectively were chosen in greater hinggan mountains in Inner Mongolia to research the volume weight of soil, soil porosity and the carbon storage. The results follow as: After the occurrence of the forest, the fire is mild to severe fire the serious destruction of the vegetation, leading to severe after fire surface reduce soil bulk density; For the same reason, leading to severe fire surface soil porosity after a mild after fire surface soil porosity greatly reduced; Soil organic carbon content of the changing rule of the surface layer of interference by 0-40 cm soil organic carbon content is greatly reduced and the rest of the layer has not changed much.

Keyword: Permafrost; Carbon storage; Forest fires

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Concerning ecological productivity

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The ecology productive forces, it is one of the ancient magical and tremendously powerful natural reaction. Human and human social production, evolution and development, the social productive forces and natural nature twices generation and evolution development and present profusion multifarious natural phenomenon, are ecological productivity masterpiece, ecological productivity is worthy of the creator. In human haven't unravel the mysteries of ecological productivity, before the ancients consistent the ecological productivity as creator, as omnipotent god's score a lucky hit to ecological productivity do the objective description and accurate interpretation, and ecological productivity produced cannot use digital to measure biological resources, created can not use words to express the ecological value. Ecological productivity - creator, ecological productivity - god, both on human, human society, the social productive forces, evolution of nonresonant-type deciphering the driving force of development, Also on human, human society, the social productive forces and biological and ecological system, nature of the relation between accurately reveal, But for human, human society and social productivity evolutionary direction of science leads. To develop the productive forces, we must first cherish, protection and development of ecological productivity.

key words： Ecosystem, The production of biological resources, Create ecological productivity

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The influence of detrending methods on the stability of relationship between climate and Picea crassfolia radial growth

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Climate change not only affect the growth of trees but also lead the relationship changing between the growth and climate, many studies had focus on the growth-climate relationship divergence phenomena, while standardization methods of tree ring width chronologies into ring width index chronologies also effect this relationship. So to understand the influence of standardization methods on the divergence phenomena, in this study, we tested the stability of growth-climate relationship by comparing relationship between the climate and the chronologies in two paired of Picea crassfolia in different elevation by different bootstrap cubic spline detrending methods. The result showed that with the raising elevation, climate factor limited the radial growth of Picea crassfolia shift from moisture to temperature. In the altitude of 2700m, relationship between the radial growth of spruce and mean temperature of last December had undergone differentiation, standard chronology fitted by short bootstrap spline retained more precipitation signals; at an altitude of 3000m, positive correlation of radial growth with mean temperature and precipitation in September of previous year was becoming more significant; in the altitude of 3300m, positive correlation between radial growth and precipitation of current Summer in the latter period was no longer significant, while positive correlation between radial growth and temperature of current Spring and Summer was obviously changed. All the results indicated that the result of divergence phenomena was effect by the climate signals retained in the chronologies which was heavily depending on the detrending methods, that suggested it is necessary to choose the reasonable spline bootstrap length in the growth divergence phenomenon studies.

Key words: Picea crassfolia; tree ring; climate change; detrending methods; divergence phenomena

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The Study on Carbon Storage of Populus Davidiana Secondary Forest in Temperature Zone

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This paper mainly discussed temporal-spatial pattern of community biomass and carbon storage in per tree, the stand, the understory vegetation and litter layers of different age group Populus davidiana Secondary forest, based on surveying biomass of different age group Populus davidiana secondary forest, including young forest, half-mature forest, near-mature forest, mature forest and over mature forest. The results showed that the forest and all organs' biomasses of Populus davidiana secondary forest had a tendency of obvious increasing with the increase of different age group, the proportion of trunk was increasing, especially in half-mature forest. The biomass of understory vegetation and litter layer also had a tendency of obvious increasing with the increase of different age group. The order of community total carbon storage in different plantation layers was as follows: tree layer > litter layer > understory vegetation. The carbon storage in young forest, half-mature forest, near-mature forest, mature forest and over mature forest was 27.1466 t hm^2,53.5451 t hm^2,60.8898 t hm^2,77.9158 t hm^2,79.1353t hm^2, respectively. The carbon storage in tree layer was 22.2065 t hm^2, 47.2157 t hm^2, 52.0563 t hm^2, 68.4453 t hm^2, 68.7731t hm^2, respectively. The average carbon storage in litter layer and understory vegetation was 5.8144 t hm^2, 2.1727t hm^2, respectively. The carbon storage in tree layer, litter layer and understory vegetation accounted for 86.05%, 10.39%, 3.57%, respectively. The result demonstrated that the carbon storage in Populus davidiana secondary forest changed regularly with different age group, it had a huge potential for carbon sink. The carbon storage in half-mature forest grew rapidly, and lasted a long time. It is a critical stage for forest management. Natural thinning is useful for promoting trees grow, the carbon storage will not reduce with stand density dropped.

Keywords: Populus davidiana forest; Secondary forest; age group; Biomass; Carbon storage

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Donmiant species groups of montane evergreen broad-leaved forest response to ice storm damage in Damingshan mountain

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A damaging ice storm struck southern China in early 2008, affecting 19 provinces of China and nearly 17.65 million hm^2 of forests. The subtropical evergreen broad-leaved forest of Damingshan National Nature Reserve has been severely damaged in this disaster. A 3.2hm^2 plot was set up in the National Nature Reserve. The plot was divided into 80 subplots, each of 20m×20m. In 2009 and 2010, 20 dominant species that important values are largest such as the *Huodendron biaristatum*, *Acer fabric* and *Litsea suberosa* were identified. The results show: the frequency of the *Huodendron biaristatum*, *Beilschmiedia tsangii*, *Diplospora fruticosa* and *Acer fabric* showed a downward trend, while *Engelhardtia roxburghiana*, *Castanopsis fabric* and *Lindera metcalfiana* were a significant increase, respectively, Increased by 9, 7 and 5. The important value of *Sloanea chingiana*, *Betula utilis*, *Macropanax rosthornii*, *Acer fabric*, *Diospyros morrisiana*, *Alniphyllum fortunei*, *Litsea suberosa*, *Stewartia gemmata*, *Beilschmiedia tsangii*, *Eurya loquaiana* and *Huodendron biaristatum* decreased by 2.1-11.0%, while the biggest decline are *Stewartia gemmata*, *Beilschmiedia tsangii* and *Huodendron biaristatum*, respectively 11.0%, 10.2% and 7.3%. However, the important value of the *Lindera metcalfiana*, *Manglietia conifera*, *Engelhardtia roxburghiana*, *Castanopsis fabri*, *Diplospora fruticosa*, *Machilus pauhoi*, *Elaeocarpus japonicus* and *Cinnamomum jensenianum* increased by 0.6-46.5%, of which the largest on the rise are *Engelhardtia roxburghiana* and *Cinnamomum jensenianum*, respectively 46.5% and 20%. However, the changes of the frequency and importance value of community dominant canopy species will affect the community stability.

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Discussion on the changing environment to construct urban forest

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In this paper, the author firstly analyzes some problems in current urban forest construction, including the neglect of natural site resources and ecological mechanisms, the regardless of actual site and applying foreign models blindly, destruction of the original diverse habitat, eradication of the original abundant native species, paying a high cost for construction and maintenance, building incomplete ecosystems and freezing landscape image. Above problems lead to the unsustainable forest landscape and missing natural services, etc. And then proposes that urban forest planning and construction on changing environment should be on the time axis to create a dynamic urban forest landscape, focus on site personalization and local features of the urban forest landscape, and advocate the organic-symbiotic building concept. Again, the author promotes gradually improve and cultivate habitat conditions of forest through the retention and protection the original topography, hydrology, vegetation, animals, microbes, micro-climate and other environmental factors of the site, develop a reasonable, feasible, flexible urban forest planning and technical route rooted in the land, and full use of natural forces to promote construction and succession of urban forest ecosystems. Finally, the author believes that forest should integrate into urban and change together, integrate into public life and grow together, and according to local conditions, build the urban forest landscape with characteristics of low-input, zero maintenance, accessible, rough, poetic, native wild, species richness, habitat diversity and distinct seasonal.

Key words: Landscape architecture; Urban forest; Ecological planning; Local landscape; Dynamic landscape

Research on Species Diversity of Slope Greening Plant Communities of Nanyou Expressway in Guangxi

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Through quadrat investigation，Respectively investigation and research the main plant community species of Acacia confuse — Cymbopogon tortilis community（Cataloged as S1，Similarly hereinafter）,Melinis minutiflora thick growth（S2），Bauhinia blakeana — Wedelia trilobata community（S3），Litsea glutinosa + Acacia confuse — Melinis minutiflora community（S4），Tephrosia candida + Cajanus cajan — Crotalaria pallida + Melinis minutiflora community（S5），Cassia bicapsularis — Eupatorium odoratum community（S6），Acacia confuse — Eupatorium odoratum community（S7），Cajanus cajan — Melinis minutiflora community（S8）of the slope ecological recovery vegetations of Nanyou expressway (Nanning to Youyiguan expressway) in Guangxi. The results show that: ⑴Total recorded 82 species green plant by survey, which belong to 40 families and 76 genera; 39 species of woody plants and 43 species of herb plants. ⑵The size order of the community Patrick abundance index (S) is S1 (S = 48) > S7 (S = 29) > S5 (S = 23) > S6 (S = 18) > S4 (S = 16) = S8 (S = 16) > S3 (S = 12) > S2 (S = 6); And The size order of the community Margalef index (Da) is S1 (Da = 4.5487) > S7 (Da = 3.2392) > S5 (Da = 2.8008) > S6 (Da = 1.9752) > S4 (Da = 1.6298) > S8 (Da = 1.5752) > S3 (Da = 1.2230) > S2 (Da = 0.5531).⑶The size order of the community Shannon-Wiener index (H ′) size order is S5 (H ′= 1.8245) > S6 (H ′= 0.8889) > S1 (H ′= 0.7875) > S7 (H ′= 0.7527) > S8 (H ′= 0.6603) > S4 (H ′= 0.6224) > S3 (H ′= 0.2093) > S2 (H ′= 0.0229); And The size order of the community Simpon index (D) is S5 (D = 0.7965) > S6 (D = 0.4693) > S1 (D = 0.3415) > S4 (D = 0.3358) > S8 (D = 0.2831) > S7 (D = 0.2803) > S3 (D = 0.0790) > S2 (D = 0.0057).⑷The size order of the community Pielou evenness index (Jsw and Jsi) is S5 (Jsw = 0.5819, Jsi = 0.8327) > S6 (Jsw = 0.3075, Jsi = 0.4969) > S8 (Jsw = 0.2381, Jsi = 0.3020) > S4 (Jsw = 0.2245, Jsi = 0.3581) > S7 (Jsw = 0.2235, Jsi = 0.2903) > S1 (Jsw = 0.2034, Jsi = 0.3488) > S3 (Jsw = 0.0842, Jsi = 0.0862) > S2 (Jsw = 0.0128, Jsi = 0.0068).⑸ All kinds of plant communities belong to unstable community, the size order of stabilization is S1>S2>S7>S5>S6>S8>S3> S4.
Key words: slope greening; plant community; species diversity; research; Nanyou expressway

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Leaf Anatomical Structures and Their Stress Resistance of Eight *Ficus* Species

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Abstract: In order to investigate the stress resistance of eight common *Ficus* species in Southern China, the leaf anatomical structures were analyzed by using statistical method. The observation index include：the thickness of upper and lower cuticles, the thickness of upper and lower epidermis, thickness of palisade tissues, thickness of spongy tissues, thickness of leaf, stomatal density of epidermis, stomatal length. These index were evaluated by principal component analysis. The result showed that the sum of contribution value of the first two principal components was 81.384(more than 70) and could represents the majority information of all original factors. And the maximum contribution rate came from the thickness of leaf. The results of cluster analysis showed that *F. elastica* was one category and *F. virens* var. *sublanceolata* was another category, the third category was compose of the others species. By using fuzzy cluster analysis method, the stress resistance ability in anatomical structures of eight species in sequence of *F. elastica* ＞ *F. microcarpa* ＞*F. altissima* ＞*F. microcarpa* 'Golden Leaves'＞*F. benjamina* ＞*F. religiosa* ＞*F. celebensis* ＞*F. virens* var. *sublanceolata*. The conclusions accord with the results from cluster analysis and further verified the reliability.

key words: *Ficus* plant, leaf anatomical structure, stress resistance, quantitative analysis

Carbon and Nitrogen Storage and Distribution of *Cryptomeria fortune* plantations in Southeast Guangxi

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In this essay，the 31 years *Cryptomeria fortune* plantations in Liu Wan Forestry Farm located in GuangXi province are chosen, and the carbon and nitrogen content and distribution pattern of three density scale *Cryptomeria fortune* plantations in the southern subtropical are researched. The result shows: (1) The total carbon storage of low density, medium density and high density *Cryptomeria fortune* plantation systems was 355.72 t hm^{-2},417.21 t hm^{-2},378.71t hm^{-2}respectively, and nitrogen storages was 17.91 t hm^{-2}、22.13 t hm^{-2}、19.99 t hm^{-2}, as the order of the order medium density > high density > low density. (2) The carbon storage in the vegetation layer was 127.71 t hm^{-2},101.98 t hm^{-2},100.12 t hm^{-2} respectively, by the order of low density > medium density > high density, and as56.01 %, 32.35%, 35.94% of the soil carbon storage. (3) The nitrogen storage in the vegetation layer are1048.85 kg hm^{-2}, 674.26 kg hm^{-2}, 705.69 kg hm^{-2}, following the descendent order by low density, high density ,medium density, and as 6.22 %,3.14 %,3.66 % of the nitrogen storage in soil layers. In the low mountain of the southern subtropical region, the carbon and nitrogen patterns of *Cryptomeria fortune* plantation systems could be influenced by the stand density, and most of the carbon and nitrogen storage storing in soil layers.

Key words: *Cryptomeria fortunei*; density effect; carbon storage; nitrogen storage

A model to determine multifunctional forest selective cutting intensity

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Selective cutting is the center issue of multiple use forest management (MFM). To solve the problem that how to determine small levels ecological - economic use forest selective cutting intensity and other indicators this paper develop a model. The model consider the account maximize and balanced sustainable use of total forest economic &ecosystem functions. This model let the total forest benefit as objective function， forest growth and equilibrium degree as limit functions, taking into account species, site index, density and other factors. Manager can calculate the optimal intensity and frequency of selective cutting with this model. Harbin City Larix forest multi-functional management method as an example was analyzed .

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近地层 O_3 浓度升高对我国亚热带典型树种的影响

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近地层臭氧（O_3）是光化学污染物的主要成分和重要的温室气体之一，可以对植物产生氧化伤害。目前，关于 O_3 对亚洲树种的影响研究较少，尤其是以亚热带树种为试验对象的研究几近空白。本研究采用开顶式气室法，于 2008-2010 年连续三个生长季进行野外模拟试验，分别进行了我国亚热带典型树种的臭氧敏感性筛选试验与长期 O_3 浓度升高对水杉与青冈栎幼苗伤害症状、生长及生理生化机制的影响试验，旨在较全面地探讨亚热带树种对 O_3 浓度升高的响应差异，为选育较强的臭氧抗性树种提供理论基础。研究所取得的主要结果如下：

1. O_3 显著降低被调查十种亚热带典型树种叶片光合色素含量、净光合速率、电子传递效率与总抗氧化能力，并且加剧膜质过氧化程度。被调查落叶树种与常绿树种 O_3 伤害剂量分别约为 10 ppm·h 与 20 ppm·h 以上，并且被调查落叶树种比常绿树种生物量降低幅度更大。O_3 敏感性排序为：鹅掌楸、水杉、枫香> 香樟、青冈、木荷、全缘冬青> 湿地松、红叶石楠、舟山新木姜子。

2. 比叶重较大的植物叶片伤害症状出现较晚，生物量降低幅度较小。此外，单位臭氧吸收量下抗氧化能力大小也是树种间 O_3 敏感性差异的原因。

3. 长期 O_3 浓度升高显著降低水杉幼苗光合色素含量与净光合速率，抑制羧化效率与电子传递效率，并显著降低水分利用效率。当 AOT40 值累计为 10ppm·h 时，叶片出现伤害症状，并且随着暴露时间延长叶片衰老加剧、提前脱落；试验结束时 AA+120 处理下总生物量显著降低 11%，而根冠比保持不变。

4. 长期 O_3 浓度升高显著降低青冈栎幼苗当年生全展叶片光合色素含量；当 AOT40 值累积超过 20 ppm·h 时，叶片出现伤害症状；气孔与非气孔因素共同作用导致净光合速率显著降低；但连续两个生长季 O_3 浓度升高条件下，青冈栎幼苗异速生长与生物量的累积及分配无显著变化。

墨江、昌宁两地濒危植物翠柏个体生长特性及差异分析研究

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翠柏（*Calocedrus macrolepis*）为国家二级珍稀濒危保护植物，在珍贵用材和园林观赏方面具有较高价值。翠柏天然林分布稀少且遭到了严重人为干扰，呈零星分布的状态。本文通过对翠柏主要分布区墨江、昌宁翠柏植株树干解析，比较了两地翠柏的生长差异，结果如下：1）翠柏初期 20-30 年间生长缓慢，到 70-80 年，发育达到数量成熟，生长量开始下降并趋于稳定；（2）墨江点翠柏初期生长不及昌宁点，但中后期的生长却优于昌宁地区，总材积生长量墨江较高，与翠柏的生长特性和自然环境条件相符；（3）针对翠柏的生长特点，提出幼苗时搭建荫棚，幼树时期进行疏光伐，数量成熟龄时进行间伐或疏伐，促进生长等经营措施，为翠柏资源培育与保护奠定基础。

关键词：翠柏，生长动态，生长量，差异对比

长江滩地安庆和岳阳地区杨树人工林生态系统碳通量及生产力特征比较研究

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我国人工林面积广阔，人工林碳汇功能、碳循环机制研究已经成为我国应对气候变化的一个重要着眼点。本研究借助涡度相关法和动态气室法对长江滩地安庆地区 1989 年营造的杨树人工林生态系统和岳阳地区 2000 年营造的杨树人工林生态系统 2005-2007 年的碳通量和生产力特征进行了研究。研究结果表明：(1)两地区滩地杨树人工林的净生态系统碳交换量(NEE)具有明显的日变化和季节变化特征，在日尺度上,白天表现为碳汇，夜晚表现为碳源。就年尺度来讲，杨树开始展叶期(3 月末 4 月初)至落叶期(10-11 月)期间表现为碳汇，其余时间表现为碳源。安庆站 5 月为最大碳汇月，2 月为最大碳源月；岳阳站 6 月为最大碳汇月，11 月为最大碳源月。总体上，两站都为碳汇系统。影响 NEE 的环境因素主要有光合有效辐射、温度和土壤水分。岳阳站总初级生产力(GPP)和净生态系统生产力(NEP)都大于安庆站，但净生态系统生产力(NPP)小于安庆站。(2) 两地区生态系统呼吸(Reco)具有明显的季节变化，每年的最大值出现在 8 月，最小值出现在 1 月，Reco 受空气温度、土壤温度和土壤含水量共同影响，总体上看空气温度是驱动 Reco 的主要因子。岳阳站人工林生态系统呼吸大于安庆，其中岳阳站土壤呼吸和地上部分呼吸分别占总呼吸的 78.7％（其中根系呼吸占 Reco 的 37.7％，土壤异养呼吸占 Reco 的 41％）和 21.3％；而安庆站的比例分别是 88.1%（其中根系呼吸占 Reco 的 38.9％，土壤异养呼吸占 Reco 的 49.2％）和 11.9%。(3) 安庆站生态系统碳储量大于岳阳站。岳阳站植物和土壤碳储量分别占生态系统的 35.88%和 64.12%；安庆站的比例分别为 42.15%和 57.85%。此外，还采用生物量法对通量观察系统估算的生态系统固碳量进行了验证，结果表明生物量法估算值略低于涡度相关法的估算值。开展杨树人工林生态系统碳循环的研究，对杨树林生态系统合理经营管理，以及充分发挥其减缓气候变化的生态效应具有重要意义。

SDR4-Kikvidze-Ohsawa 确定喀斯特山地灌草群落优势种及群落结构特征分析

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选择贵州典型喀斯特山地草地植物群落为研究对象，采用标准样地调查法，对不同海拔、坡向的植物群落数量特征进行基础调查，采用 SDR4-Kikvidze-Ohsawa 与 IV-Kikvidze-Ohsawa 对喀斯特山地灌草群落优势种进行确定，讨论该方法与传统的人为确定法之间的差异。结果表明：1.海拔梯度上灌草植被群落中优势种数目变化特征为：SDR4-Kikvidze-Ohsawa 判定的优势种数目随海拔升高依次为：9 种，12 种，13 种，14 种，17 种；IV-Kikvidze-Ohsawa 判定的优势种数目随海拔升高依次为：10 种，11 种，10 种，13 种，13 种。两种方法的对比中，SDR4-Kikvidze-Ohsawa 判定的优势种变化更加明显，更接近群落特征。2.采用 SDR4-Kikvidze-Ohsawa 对喀斯特山地灌草群落优势种进行确定，分别为扭黄茅（Heteropogon contortus）、矛叶荩草（Arthraxon lanceolatus）、车桑子（Dodonaea viscosa）、白刺花（Sophora davidii）、硬秆子草（Capillipedium assimile）、鼠尾粟（Sporobolus fertilis）、香薷（Elsholtzia ciliata）、斑茅（Saccharum arundinaceum）、紫茎泽兰（Eupatorium adenophorum）、金丝草（Pogonatherum crinitum）香茅（Cymbopogon citratus）、莠竹（Microstegium nudum）、牡蒿（Artemisia japonica）、鬼针草（Bidens pilosa）、画眉草（Eragrostis pilosa）、苔草（Carex L.）、狗尾草（Setaria viridis）、白茅（Imperata cylindrica）、刺芒野古草（Arundinella setosa）、小白酒草（Conyza Canadensis）、野青茅（Deyeuxia arundinacea）、三脉紫菀（Aster ageratoides）。3.SDR4-Kikvidze-Ohsawa 和 IV-Kikvidze-Ohsawa 对不同海拔梯度的灌草植物群落优势种组成分析中发现，多年生和一年生草本植物种类随海拔升高呈增加趋势，而灌木植物种类在优势种组成中未出现。4.采用 IV 和 SDR4 对植物群落结构分析发现。喀斯特山地灌草植物群落结构随海拔的升高呈现出，多年生草本植物种类比例逐渐降低，一年生草本植物和灌木植物没有明显的变化规律，这说明，喀斯特山地草地植物以多年生草本为主的植物群落结构类型。5.对喀斯特山地灌草植物群落不同海拔梯度密度特征分析发现，群落密度随海拔升高呈显著增加趋势（$F=20.600$; $P\leq 0.01$）。群落中矛叶荩草（Arthraxon lanceolatus）和扭黄茅（Heteropogon contortus）种群在数量上占优势，同时矛叶荩草和扭黄茅种群密度随海拔升高呈现出增加趋势；但矛叶荩草种群密度在群落中的比例呈现出下降趋势，而扭黄茅种群密度在群落中的比例呈现出升高趋势。6.喀斯特山地草地植物群落以禾本科（Gramineae）、菊科（Compositae）、蔷薇科（Rosaceae）、唇形科（Labiatae）为主；其中禾本科植物种类比例随海拔升高呈现出下降趋势，而菊科、蔷薇科、唇形科植物种类比例呈现出升高趋势。

祁连山林线附近祁连圆柏生理指标随海拔变化

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高山林线附近环境因子变化剧烈，成为研究植物对环境适应性及其对全球气候变化响应的理想区域。本文以祁连山林线树种祁连圆柏（Sabina przewalskii）为研究对象，在生长旺季（7 月份）对祁连圆柏成年树和幼树当年生针叶不同海拔处光合色素（叶绿素和类胡萝卜素）和非结构性碳水化合物（NSC；可溶性糖和淀粉）含量变化进行研究发现，幼树光合色素（Chla、Chlb、Chl）随海拔升高总体呈升高-降低-升高的变化趋势，最高值在高海拔；成年树光合色素（Chla、Chlb、Chl）随海拔梯度升高总体呈下降趋势，但并不呈线性变化，而是在中海拔出现最低值；叶绿素 Chla/b 及 Car/Chl 比值随海拔上升总体呈升高趋势，而且类胡萝卜素（Car）含量总体呈升高趋势，其在成年树针叶中的值高于幼树，说明成年树在在抵御高海拔强光、紫外线辐射的环境因子的能力高于幼树。幼树和成年树 NSC 含量随海拔升高均呈降低再升高的趋势，最高海拔的 NSC 含量高于低海拔，且幼树的 NSC 含量在各海拔高于成年树。结果表明，祁连圆柏随海拔升高光合能力可能并没降低，而随海拔升高，温度降低，树木生长缓慢，对碳水化合物的利用减少造成在高海拔 NSC 积累，说明其在高海拔生长不受碳限制。这暗示在全球气候变化变暖背景下会促进祁连圆柏的生长，且祁连圆柏林线具有沿海拔上升的潜力。

关键词：光合色素；可溶性糖；淀粉；海拔梯度；祁连圆柏

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兼顾碳贮量和木材生产目标的森林经营规划研究

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本研究以吉林省汪清林业局金沟岭林场为对象，基于小班调查数据，以木材生产和碳增量净现值最大为规划目标，考虑采伐量不大于生长量、均衡采伐、生长模型等约束，建立了的多目标规划模型。通过LINGO软件求解，得到了50年规划期的最优经营方案，并进行了灵敏度分析。结果表明：各个森林类型在不同分期间伐强度在 1%-15%之间，择伐强度在 1%-35%之间。规划期木材总采伐量为 182.33 万 m^3，规划期末地上碳贮增量为 47.92 万吨；规划期总收益为 95434.40 万元，其中木材净现值 91895.50 万元，碳贮增量净现值 3539.30 万元。多目标经营方案可以同时满足对木材生产和碳贮增量的需求，是一个折衷的方案。与木材生产经营方案（方案 3）相比，多目标经营方案（方案 1）和碳贮增量经营方案（方案 2）在规划期内的木材净现值分别减少 2.67%、45.43%，但地上碳贮增量净现值分别增加 29.88%、50.42%。因此增加碳贮增量要以减少木材采伐量为代价。分析了低、中、高三种碳价格对多目标经营方案的影响，表明整个规划期内木材采伐量随着碳价格的增加而减少，而碳贮增量随着碳价格的增加而增加。本研究为考虑择伐方式和碳贮存的多目标经营规划研究提供了研究方法和参照。

关键词：木材生产，地上碳贮量，净现值，多目标规划

三峡库区不同退耕还林模式水土保持特征及调控因子

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水土流失已经成为中国主要的生态问题，水土流失的防控得到了政府和科学界的高度重视。水土流失的机理、影响因素和防治措施的研究是国内外颇受关注的科学问题。土地利用/覆盖变化（LUCC）与水土流失的关系已成为水土流失治理研究的关注重点之一。三峡库区 95%以上为低山丘陵地带，流失的水土直接入库对三峡工程产生了巨大影响，严重制约了该地区社会和生态环境的可持续发展。国家已经将三峡库区列为全国水土保持重点防治区，并在库区大力推广退耕还林工程，研究退耕还林工程的水土保持效益对于库区生态环境的建设具有重要意义。本文通过对库区典型退耕还林模式的水土流失的监测，分析其不同降雨条件下的水土流失特征及影响因子，探讨三峡库区不同退耕还林模式对水土保持的作用及意义，为三峡库区水土流失的治理提供科学依据。研究发现（1）退耕还林后库区的水土流失问题得到了有效控制，退耕还林后各土地利用类型的年地表径流量下降了70~95%，泥沙流失量则比农田降低了 97%以上，不同土地利用类型年地表径流量的大小顺序为农田（346.0 m^3/hm^2）>茶园（187.53 m^3/hm^2）>柑橘（117.41 m^3/hm^2）>竹林（96.89 m^3/hm^2）>板栗（54.77 m^3/hm^2）>林地（36.54 m^3/hm^2），各退耕还林模式中乔木林和竹林对水土保持的效果最为理想，可在库区大面积推广；（2）退耕还林后各土地利用类型的年地表径流量与降雨量呈较好的指数关系，随着降雨量的增加而增加。除农田和板栗林外，各土地利用类型年地表径流量与降雨强度关系不显著；（3）泥沙流失量与降雨量和降雨强度的关系均不显著，说明泥沙流失除降雨外还受到其他因素的影响，具体机理还有待进一步研究；(4)各土地利用类型地表径流的 80%以上，泥沙流失量的 95%以上都是发生在暴雨条件下，暴雨事件成为库区水土流失的主要气候影响因素；（5）凋落物层盖度是控制退耕还林各模式地表径流的主要因素，各土地利用类型的年地表径流量均随着凋落物层盖度的增加而显著降低。

关键词：三峡库区，兰陵溪小流域，退耕还林，水土流失，调控

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三峡库区兰陵溪小流域生态系统健康评价

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流域生态系统健康与社会经济、人类、 生态环境等密切相关。近年来，随着流域生态问题的日益突出，如何评价流域生态状况正成为水利科学、 环境科学和生态学领域研究的热点之一。

本文以长江上游水土保持重点防治区域、三峡库区退耕还林重点示范点——兰陵溪小流域为研究对象，以联合国经济合作开发署提出的 P-S-R(压力-状态-响应)模型为框架，基于遥感影像、DEM 和统计调查数据，运用“3S”技术，建立起来了化肥施用强度、农药施用强度、人口密度、人为干扰指数、NDVI、高质量植被重要值、景观破碎度、生态弹性指数、物质生产、土壤侵蚀度、土地垦殖指数、均年收入 12 个评价指标的基于 100 m ×100 m 网格评价单元的空间数据库，运用相对综合评价法，获得了兰陵溪小流域 2002 年和 2007 年生态系统健康的评价结果，并进一步分析了该流域生态系统健康的时空分布特点及与压力的关系。结果表明：

（1）小流域生态系统健康综合评价指数平均值从 2002 年的 0.531 提高到 2007 年的 0.781；小流域 2002 年生态系统健康综合评价指数分布范围为 0.177—0.788，呈正态分布；2007 年生态系统健康综合评价指数分布范围为 0.325—1，成偏正态分布。

（2）在空间分布方面，小流域的生态系统健康具有一定的地理地带性特点：水平方向，生态系统健康状况西南部好于东北部和中部；垂直方向，随着海拔的升高，小流域生态系统健康状况逐步好转。

（3）在时间变迁方面，从 2002 年至 2007 年，5 年间，小流域生态系统健康状况得到了显著改善。健康状况好转的网格区域占区域总面积的 94.44%，其中，显著好转的占 63.27%，明显好转的占 19.78%；健康状况恶化的网格区域占区域总面积的 2.02%,其中显著恶化的只占 0.03%；健康状况无明显变化的网格区域占区域总面积的 3.53%。

（4）从小流域压力统计结果中可以得到，压力严重超出流域承受范围的区域已经从 2002 年的 3.711%下降到 0%；超出流域承受范围的区域也由 2002 年的 6.544%下降到了 0.135%；压力几乎没有的区域则从 2002 年的 59.137 上升到了 90.609%。总体来说，小流域承受压力大为降低，区域生态环境质量得到了明显改善。在对小流域压力分析过程中，发现压力与小流域生态系统健康状况呈反比。从 2002 年和 2007 年的压力分布统计结果中得出，这两年，小流域所承受压力的区域面积在减少，但压力分布的区域主要都是在东北部、中部及东南部生态系统健康较差的地方。

关键词：兰陵溪小流域　生态系统健康评价　　遥感　　fishnet 网格

三种林型土壤呼吸及其影响因子的研究

2011 年 1 月至 12 月，采用 LI-COR-6400-09 气室连接到 LI-COR-6400 便携式 CO_2 / H_2O 分析系统测定麻栎（Quercus acutissima Carruth）、麻栎+枫香（Liquidambar formosana Hance）、麻栎+湿地松（Pinus elliottii）和三种人工林的土壤呼吸，并分析了土壤水热因子对土壤呼吸的影响。研究结果表明：三种人工林土壤呼吸的季节动态存在明显的季节性变化，都呈现不规则的曲线格局。全年土壤呼吸速率平均值分别为麻栎+枫香 3.605μ mol·m^{-2}·s^{-1}、麻栎 2.999μ mol·m^{-2}·s^{-1}、麻栎+湿地松 2.453μ mol·m^{-2}·s^{-1}，三种林分土壤呼吸的季节变化与土壤温度呈显著的指数相关，土壤温度可以分别解释土壤呼吸变化的 85.04%、79.11%和 71.27%，与土壤含水量呈直线方程关系，土壤含水量可以解释土壤呼吸变化的 66.36%、55.31%和 69.69%。麻栎+枫香、麻栎和麻栎+湿地松林分全年土壤呼吸的 Q10 值分别为 2.78、2.66 和 2.65。两种人工林群落土壤呼吸季节变化表现出受非生物因子温度和水分变化的调控，同时也受森林植被的根生物量、凋落物量的影响。

脱落酸对低温下雷公藤幼苗光合作用与叶绿素荧光的影响*

黄 宇　荣俊冬　陈礼光 郑郁善**
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以 1 年生雷公藤扦插苗为试材，研究低温胁迫下不同浓度外源 ABA(0、5、10、15、20、25 mg·L^{-1})叶面喷施处理对雷公藤叶片光合作用及叶绿素荧光参数的影响。结果表明：喷施 20 mg·L^{-1} 的 ABA 能显著提高雷公藤幼苗的抗冷性，减缓低温下雷公藤叶片净光合速率(Pn)、蒸腾速率(E)、气孔导度(Gs)、胞间 CO_2浓度(Ci)的下降幅度，提高幼苗叶片的光合能力。低温处理 6 d 后，随 ABA 浓度的上升，雷公藤叶片的初始荧光(Fo)下降，最大荧光(Fm)和 PSII 最大光化学效率(Fv/Fm)上升，PSII 实际光化学量子产量(ΦPSⅡ)、光化学猝灭系数(qP)先下降后上升，而非光化学猝灭系数(qN)呈下降－上升－下降趋势。Pn、Gs、qP、Fm 和 Fv/Fm 均在 20 mg·L^{-1}ABA 处理时达到峰值。不同浓度 ABA 的相对电子传递速率(rETR)随着光化光强度增加呈先上升后下降的趋势，当光化光强度(PAR)达到 395 μmol·m-2s^{-1}时，各处理的 rETR 达到最高值，其中 2520 mg·L^{-1}和 20 mg·L^{-1}ABA 处理分别比对照高 17.1 %和 5.2%。雷公藤叶片 ΦPSⅡ的光响应曲线均随光化光强度升高而下降，qN 的光响应曲线呈相反趋势。

关键词：雷公藤 低温 脱落酸 光合特性 叶绿素荧光

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中国标准森林经营认证实践

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森林可持续经营认证是国际上从市场和林产品贸易的角度促进森林可持续经营的一个途径。国内对森林认证的研究起步于上世纪 90 年代，经历了较长的时间。于 2007 年 9 月颁布了《中国森林认证 森林经营》、《中国森林认证　产销监管连》行业标准。2009 年 10 月中国第一家森林认证机构“中林天合(北京)森林认证中心”在北京成立。中国的森林认证从研究、引入、提出标准、建立机构，走过了复杂的过程，建立了自己的认证体系。笔者有幸参与了第一家中国标准森工企业森林经营认证的模拟认证和实际认证的全过程。本文依据中国标准森林经营认证的实践过程，就中国标准认证对森工企业的影响，标准的完善、审核评估过程、开展森林认证工作的优势和存在问题及建议等诸多问题进行了讨论。

关键词：中国标准；森林认证

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基于 MODIS NDVI 的三峡库区近 10 年植被覆盖度动态变化分析

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自国家实施“长治”工程以来，三峡库区相继开展了“长江防护林工程”、“天然林保护”、“退耕还林（草）”等生态工程，森林面积明显增长、水土流失得到有效控制，库区生态环境进一步改善。但随着三峡工程兴建，在库区移民迁建、工矿企业搬迁等基础设施建设过程中，土地利用结构及产业结构也相应发生了调整，自然植被可能受到进一步的人为扰动，一部分林业用地也被征用侵占。库区植被的破坏与保护两种现象并存。因此，快速、准确、有效地提取三峡库区植被覆盖度，有助于我们更好地认识和模拟库区陆地生态系统的动态变化特征，为库区工农业生产布局提供决策支持。本文以 MODIS-NDVI 为数据源，利用像元二分模型估算了三峡库区 2000—2009 年的年最大植被覆盖度，并基于像元尺度对库区年最大植被覆盖度的时空变化特征及其驱动力进行了分析。结果表明：（1）三峡库区植被覆盖处于较高水平，年最大植被覆盖度>60%的区域占库区总面积 92.35%；（2）近 10 年来，三峡库区年最大植被覆盖度增加的面积总体大于降低的面积，但呈显著增加或降低趋势的像元仅占总像元数的 7.16%，在各区县中石柱、江津、丰都的植被状况存在退化风险；（3）降水是库区植被覆盖度年际波动的主导因子，其中当年 5—8 月降水量与年最大植被覆盖度的相关性最高，但在空间上有所差异，其中呈显著正相关区域主要分布于库区西部低山丘陵农业种植区，降水量增加有利于该区域植被生长，而库区东北部分高海拔地区的年最大植被覆盖度与降水呈显著负相关，过大降水量反而抑制该区域的植被生长。

关键词：植被覆盖度；像元二分模型；NDVI；时空变化；三峡库区

山地森林-干旱河谷交错带生态环境特征及植被恢复对策

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采用环境梯度分析方法，沿海拔 2130-2810 米梯度采样分析看，随着海拔高度的增加，土壤性质发生着明显的规律变化，土壤类型、结构、水分、养分、团聚体分形维数均呈现由干旱河谷→交错带→山地森林带的趋好的变化，山地上部自然环境条件相对优越于下部，而表层土壤 pH 值随着海拔高度的增加而降低，尤其是限制因子水分，在旱季土壤水分差异较大，随着海拔的上升土壤水分有所增加，干旱河谷段土壤水分处于严重亏缺状态；从生物多样性看，随海拔增加旱生植物逐渐减少，水分条件好的地段，生物多样性丰富，不同地段间物种相似性较低，物种替代速率较高，与大多数交错带表现为两种生态系统中种的交错和重合不同，山地森林与旱生灌丛两种生态系统交替时表现出植物种类的突变性特征。这些因素综合，充分显示出交错带具有明显的生态过渡性、脆弱性、敏感性。在植被恢复过程中应考虑生态环境梯度变化，采用交错带“上抑下延”的策略，以恢复森林植被。

关键词：山地森林 干旱河谷　交错带　生态环境　植被恢复对策

喀斯特森林植被自然恢复过程中凋落物现存量碳库特征研究

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采用空间代替时间的方法，研究了退化喀斯特森林自然恢复过程中凋落物现存量碳库特征，结果表明：（1）退化喀斯特森林自然恢复过程群落凋落物现存量随演替上升呈减少趋势，其早期下降快，中后期下降缓慢且趋于平稳。①出现这一规律与恢复过程中生活型变化有关，早期群落优势种趋于C-选择生活史式样，通常枯枝落叶层丰富并常持续存在，草多，一年一死，凋落量大，后期树种以S-选择生活史式样的物种多，通常枯枝落叶层稀少、有时持续存在。②本研究区的灌乔群落阶段、乔木群落阶段、顶极群落阶段凋落物现存量分别为 4.62t/hm$_2$、4.32t/hm$_2$、3.83t/hm$_2$，比南亚热带鼎湖山季风常绿阔叶林恢复演替系列马尾松林（8.72t/hm$_2$）、针阔叶混交林（9.94t/hm$_2$）、季风常绿阔叶林（6.56t/hm$_2$）要低，比中亚热带北缘浙江天童山季风常绿阔叶林演替系列马尾松林（11.52t/hm$_2$）、马尾松木荷林（10.44t/hm$_2$）、木荷林（10.27t/hm$_2$）、栲树木荷林（10.37t/hm$_2$）、栲树林（10.45t/hm$_2$）的凋落物现存量要低很多，研究区与上述一南一北两常态地貌都要小，不符合随纬度增大凋落物现存量增加的规律，这反映了喀斯特非地带性因素对凋落物现存量的影响，但在演替的后期天童山马尾松木荷林到顶极栲林之间凋落物现存量变化缓慢且趋于平稳，这与本研究中后期凋落物现存量变化缓慢且趋于平稳的结论相似。③本研究区灌木群落、灌乔群落、顶极群落凋落物现存量分别为 4.79t/hm$_2$、4.62t/hm$_2$、3.83t/hm$_2$，广西环江灌丛（4.07t/hm$_2$）、藤刺灌丛（3.41t/hm$_2$、乔灌丛（4.76t/hm$_2$）、木伦自然保护区顶极群落（6.28t/hm$_2$）凋落物现存量相比，茂兰灌木群落阶段凋落物现存量要大、乔灌群落阶段约相当、顶极阶段要小，因纬度相差不大，故纬度性影响较小，但经对比样地海拔、岩石裸露率、群落盖度等相互之间相差较大，另外茂兰与广西环江、木伦两研究区群落的优势种（气候的干湿性导致，茂兰偏湿、广西偏干）也不相同，这说明喀斯特样地生境异质性对研究结果会造成相当大的差异。（2）本研究表明凋落物自然含水率从草本群落阶段到灌木群落阶段先下降，后由灌木群落阶段到顶极群落阶段缓慢增长，其中草本群落阶段凋落物自然含水率最大。（3）本研究得出不同恢复阶段群落之间凋落物现存量含碳率差异不显著，但碳密度早期与中后期差异明显，且随演替上升碳密度呈下降趋势。这说明恢复过程中决定各恢复阶段群落凋落物现存量碳库大小的关键因素是凋落物现存量的积累，其中叶量是重要因素。①各恢复阶段凋落叶所占的比例在66.6%-77.15%之间，这与俞国松研究同一区域喀斯特原生林、次生林、灌木林凋落物年凋落量凋落叶所占的比例在 64.7%-75.9%之间比较相符合。这表明茂兰喀斯特森林凋落物含碳率大小主要受叶的含碳率影响。②随恢复演替阶段上升，群落凋落物现存量碳表现出碳的源的效应，早期阶段现存凋落物碳密度高且变化大，固碳能力不稳定，但碳源效应显著，中后期阶段碳密度相对较低，但变化小，趋于一致，碳源效应不显著，固碳能力稳定，这又反映出恢

复早期碳素主要存在于凋落物碳库中，对转化为土壤有机碳的潜力大，中后期凋落物碳库储存的碳素少，可转化量小，也即随恢复演替阶段上升，生态系统碳循环在碳素以凋落物有机碳素形态向土壤有机碳素形态转化这一环节上功能变得越来越完善，且最后趋于平稳。（4）本研究建立了凋落物现存生物量碳密度(Y)与凋落物现存生物量(x)的关系方程：二者的关系按照一元线性方程变化，其统一的表达式为：Y=bo+b1x,其中 bo 与 b1 为常数。这对估测研究区各演替阶段群落凋落物碳密度具有重要的现实意义。

关键词：喀斯特森林；凋落物；退化；自然恢复；碳库特征

典型岩溶石漠化区根系生境及其类型研究

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在贵州岩溶石漠化区，根据碳酸盐岩分布、地貌类型及岩石类型分布情况，共随机调查了 152 个根系生境剖面；利用岩石类型 r，岩层产状倾角 a，根系分布范围内的岩石斑块数 n，破碎度指数 Fi，裂缝内土层深度 Ts，裂缝宽度 Cb，垂直剖面土壤有效面积 S，土壤有效面积比 Es，植物根系分布的长宽幅度 Rh、Rb，根分布面积比 Er，根比/有效比 Ers 等指标；首先根据 DCA 和 PCA 分析，选择线性模型的 RDA 排序方法，以根系分布范围内的岩石斑块数和破碎度指数作为 RDA 的解释变量，其余指标作为 RDA 的响应变量，划分根系生长空间类型；同时采用定性和定量分析相结合的方法进行快速聚类，划分植物根系生境类型；其次根据岩性-产状-空间多层性进行了生境类型命名，最后得出各类型的总体特征及各根系生境类型的特征。结果表明：1）岩溶石漠化地区植物根系生长的空间不仅在地表土壤层，更多生长在地表以下的岩石裂隙形成的地下空间中；根系生长的地下空间大小与岩性、岩石产状、裂隙大小、裂隙土层深度以及岩石斑块数有关。因此，可用岩性、产状、根系分布范围内的岩石斑块数、土层深度、裂缝宽度、垂直剖面土壤分布范围、植物根系分布的长宽幅度等指标评价岩溶石漠化区植物根系生境；2）岩溶石漠化地区植物根系利用空间具多层性，可分为表层空间、单层空间、多层空间三种类型；表层空间类型与土壤有效面积比 Es 影响较大，单层空间类型与土层深度 Ts 和裂缝宽度 Cb 关系密切，多层空间类型与土壤有效面积 S，根系分布长宽幅度 Rh、宽度 Rb，根粗 Rc，根分布面积比/土壤有效面积比 Ers 相关；3）对贵州岩溶石漠化地区 152 个剖面依据岩性、产状、裂隙特征、土壤特征、根系利用特征等划分为 18 个植物根系生境类型；分别为：I-白云岩零产状表层空间类型，II-白云岩零产状单层空间类型，III-白云岩零产状多层空间类型，IV-白云岩水平产状表层空间类型，V-白云岩水平产状单层空间类型，VI-白云岩水平产状多层空间类型，VII-白云岩倾斜产状表层空间类型，VIII-白云岩倾斜产状单层空间类型，IX-白云岩倾斜产状多层空间类型，X-白云岩直立产状单层空间类型，XI-白云岩直立产状多层空间类型，XII-灰岩零产状单层空间类型，XIII-灰岩零产状多层空间类型，XIV-灰岩水平产状单层空间类型，XV-灰岩水平产状多层空间类型，XVI-灰岩倾斜产状多层空间类型，XVII-灰岩直立产状单层空间类型，XVIII-灰岩直立产状多层空间类型；同时分别对各根系生境类型特征进行了具体描述。本研究加深了对植物根系生长的生态多层性的认识，这对于充分认识岩溶石漠化区立地条件，正确评价石漠化区退化植被恢复的生境条件，加快植被恢复技术研究，具有重要的意义。

关键词：类型；根系生境；岩溶石漠化区

兴安落叶松林生态系统碳积累特征分析

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大兴安岭是我国唯一的寒温带林区，其森林土壤又是我国陆地生态系统重要碳库，在减缓温室气体快速升高过程中具有重要作用。本项研究以兴安落叶松林生态系统为研究对象，获取兴安落叶松林生态系统有机碳储量、碳分配、土壤固碳速率等数据，得到如下结论：

（1）兴安落叶松林生态系统生物量由乔木层、灌木层、草本层和凋落物层生物量组成，总生物量为109.20±41.90t/hm$_2$，各组成部分表现为乔木层＞灌木层＞凋落物层＞草本层，其中植物活体（乔木层、灌木层、草本层）生物量为 94.07t/hm$_2$，贡献率达 85.14%，凋落物及粗死木质残体的总生物量为 15.13t/hm$_2$，占 14.86%。

（2）兴安落叶松林生态系统乔木层平均含碳率为 48.95±0.47%，灌木层平均含碳率平均为 50.48±0.44%，草本层平均含碳率为 47.37±3.56%，凋落物现存量平均含碳率为 44.60±2.81%，倒木平均含碳率为 50.50±3.49%，大枝平均含碳率为 51.13±2.28%；土壤含碳率随土壤层次的加深逐渐减少，0～10cm 的含碳率为 8.89±1.44%，10～20cm 的含碳率为 6.82±1.86%，20～30cm 的含碳率为 3.72±1.08%，30～40cm 的含碳率为 3.11±0.70%，40～60cm 的含碳率为 1.38±0.20%。

（3）兴安落叶松凋落物输入有季节变化，从 2009 年、2010 年各月份凋落物的输入没有明显的变化，变化范围在 0.0171—0.5319 t/hm$_2$，峰值均出现在每年 9 月份，谷底值均出现在每年生长旺盛的 7 月份，其成单峰曲线，顺序依次为；9 月份＞4--10 月份＞5 月份＞8 月份 6 月份＞7 月份，其中叶的产量的峰值与谷值变化与总产量相一致，同植物的生理过程相一致，且叶的产量占凋落物重量的 40%--80%。

（4）兴安落叶松森林土壤呼吸与异养呼吸和自养呼吸均呈显著性相关关系，但与异养呼吸的相关性要高于自养呼吸。兴安落叶松森林土壤呼吸及其组分呈现明显的日变化和季节变化。土壤呼吸的日变化呈单峰曲线，而自养呼吸和异养呼吸的日变化与土壤呼吸相似，但变化的趋势不明显。凋落物不同处理对土壤呼吸有一定的影响，但这种影响并不显著。但对土壤呼吸和异养呼吸与土壤温度的相关性有明显的影响。

（5）兴安落叶松林生态系统生长季凋落物量（含碳量）为 8.62t/hm$_2$，土壤呼吸生长季碳排放量 4.91 t/hm$_2$，因此兴安落叶松生态系统表现出显著的“碳汇”功能。

本项研究将为准确估算寒温带森林对区域碳平衡的贡献提供科学依据，同时也为正确评估其碳汇、碳源功能，对我国履行《京都协议书》、制定相关政策具有重要的现实意义。

关键词：兴安落叶松；生物量；含碳量；碳贮量；土壤呼吸

中国在用木质林产品碳储量

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森林采伐和木质林产品使用改变了森林生态系统和大气之间的自然碳平衡。随着社会经济的发展和人们生活水平的提高，人们对木质林产品碳储量的需求也越来越大。同时木质林产品在一些领域可以替代化石燃料、钢铁和水泥等能源密集型产品，这对于减少温室气体排放有着巨大的减排潜力，因此发达国家一直想利用木质林产品碳储量抵消国家温室气体排放。为正确合理的估算木质林产品碳储量及其变化，并提高国家温室气体清单的编制质量，国际社会广泛开展这部分温室气体碳储量变化的研究工作。

本研究主要是利用达喀尔会议上建议的储量变化法、生产法和大气流动法来估算我国在用木质林产品碳储量及其变化，并对比基于国内外参数估算的我国木质林产品的碳储量结果。研究表明：（1）我国在用木质林产品是一个碳库，且碳储量在不断增加；但三种方法估算的碳储量结果是不同的；（2）三种方法分别估算 1961-2004 年我国锯材、人造板、纸和纸板以及其他工业原木产品碳储量总体趋势也在不断增加；（3）1961-2004 年木质林产品的碳储量变化不断波动变化；（4）利用国内外不同参数估算我国在用木质林产品碳储量结果不同，这主要是由于国内外参数的不同以及一些参数的假设的差异，造成相同方法下得出的在用木质林产品碳储量也就不同。参数是碳储量估算过程中的重要因子，因此需要进一步研究计量参数对碳储量估算带来的影响。

关键词：木质林产品；碳储量；计量参数；估算方法

上海市垃圾填埋场植被特征分析

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基于上海市 8 个区 11 个典型垃圾填埋场植物群落调查数据，运用植被生态学分析方法总结上海市垃圾填埋场植被特征。结果表明：本次共调查到植物 77 科 165 属 189 种，且封场早期以自然侵入草本植物为主，木本植物主要以人工栽植为主，其他为次生演替先锋物种，如构树、朴树、桑树、苦楝等；垃圾填埋场植物区系以北温带分布比例最高，其次为泛热带分布和东亚分布，而种数较多的科依次是菊科、禾本科、蔷薇科和豆科，并含较多锦葵科、唇形科和藜科植物，且单种科比例较高，其中以上海乡土种占据决定优势，而归化种比例相对较高；本次调查垃圾填埋场群落可划分为常绿阔叶林、常绿针叶林、针阔混交林、落叶阔叶林和常绿落叶阔叶混交林 5 种类型，主要群落类型一般缺乏灌木层，自然侵入乔木植物个体径级呈不连续分布。因而应根据不同垃圾填埋场的植被现状以及周边环境，建设特色乡土植物景观和城市“森林”岛。

关键词：垃圾填埋场；区系；群落类型；优势种；科属组成

上海城市人工林动态监测研究：群落结构与种群空间格局

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运用生态系统定位监测和实验生态学的手段，在较长的时间尺度上研究城市人工林的群落结构及动态，可以准确揭示城市人工林的发展动向及其内在机制，为城市森林的经营管理提供重要依据。以国际大都市上海为研究区域，根据森林生态系统定位的技术要求和规范，于 2011 年在奉贤海湾森林公园设置面积为 1ha 的样地 1 个，调查、定位样地内所有高于 1.3m 的木本植物，分析群落的结构特征及主要种群的空间分布格局。

结果表明，海湾森林公园 1ha 样地内，共记录有 3056 棵植株，共有 10 科 13 属 13 种。其中常绿树种 5 种，共 1674 棵，平均高度 4.9m，平均胸径 7.2cm；落叶树种 7 种，共 1382 棵，平均高度 6.0m，平均胸径 7.3cm。群落内女贞的重要值最大，为 20.74，其次为喜树、椤木石楠、乌桕、香樟、栾树，分别为 15.03、11.80、11.57、8.61、8.37，构成常绿-落叶阔叶混交群落。林下自然更新的木本植物有 15 种，包括香樟、女贞、椤木石楠、乌桕、喜树、栾树、光皮梾木、苦楝，以及蚊母、胡颓子、海桐、珊瑚树、火棘、小蜡、柘树等，草本植物有 51 种。

随尺度变化，香樟、女贞、椤木石楠、喜树、乌桕、栾树等 6 个主要种群的空间分布呈不同格局。尺度在 2m 以内，6 树种空间格局均呈随机分布或均匀分布，其它尺度上多为聚集分布，其中喜树在 36m 以上尺度呈随机分布，乌桕、椤木石楠分别在 43m 和 45.5m 以上尺度又呈随机分布。从种间关系看，喜树、女贞、乌桕之间的关系密切，两两呈正关联关系。因此，树种多以集群分布为主，并有一定的随机性；而常绿、落叶树种间相伴出现，呈混交状态，符合该地区近自然植被构建的模式。

豫东平原农林复合生态系统碳动态

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近些年来，随着经济的发展和人口的增长，我国的生态环境面临着越来越严峻的形势。耕地面积的减少，森林面积、绿地面积的锐减，水灾旱灾的频繁发生，都在提醒着我们尽快采取相应措施的必要性和紧迫性，而有关方面的研究也因此而越发的重要。森林作为生态环境中至关重要的一个环节，一直是大家研究的重点，而耕地更是关乎国计民生。于是将两者结合而成的复合生态系统也成为研究的重点。笔者跟随导师所作的研究就是关于豫东平原农林复合生态系统碳动态。众所周知大气中二氧化碳含量的升高是温室效应的最大原因，而本研究就是计划对农林复合生态系统的碳动态做一个持续一年的调查以研究清楚作为农林复合生态系统，在一年中的不同阶段，是碳源还是碳汇，并计算出具体的数据，这样对碳源、汇的变化有一个更清晰直观的认识，便于更精确的计算生态系统的碳源碳汇。

长江滩地主要草本植物对土壤 CH_4 和 CO_2 通量的影响

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岳阳市君山区长江滩地广阔，以种植杨树人工林和芦苇为主要土地利用方式。益母草是杨树人工林内优势草本植物。本研究运用静态箱法观测益母草和芦苇对 CH_4 和 CO_2 通量的影响。结果表明两种植物在光照条件下对 CH_4 吸收速率有显著提高，无光照条件下对 CH_4 吸收速率均无显著提高，但均改变了 CH_4 吸收的变化规律；两植物在有光照和无光照条件下对 CO_2 排放速率都有显著提高。留有益母草和芦苇样地在有光照条件下，甲烷平均吸收速率分别是对应裸地的 3.0 和 6.0 倍；留有益母草和芦苇样地有光照条件下，CO_2 平均吸收速率分别是对应裸地的 2.6 和 4.7 倍，在无光照条件下是对应裸地的 2.2 和 4.2 倍。原因可解释为维管植物的对流传输一方面加强了对根围氧气的供给，使根围 CH_4 和有机质氧化加速，另一方面加快了根围 CO_2 向土壤外排放；光照能加强对流传输和增强光合作用；芦苇具有比益母草更发达的通气组织。

关键词：温室气体，芦苇，益母草，对流传输

武汉市近自然改造马尾松人工林自然度评价

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人工林近自然改造是森林近自然经营的重要内容。自然度是描述森林健康状况、确定森林景观保护价值和制定人工林经营计划的重要指标，但其评价方法尚不成熟。本研究选取群落组成、群落结构、群落演替、外部干扰四方面的 10 个指标，构建了基于林分尺度的近自然改造人工林自然度评价的指标体系与评价方法，并对武汉市 8 个试验区的马尾松人工林近自然改造林分进行了自然度评价。结果表明，武汉市马尾松人工林近自然改造林分的自然度值由对照林分的 0.271 提高到了 0.545，自然度等级由Ⅱ级提高到了Ⅲ级。马尾松人工林近自然改造措施提高了林分的植物种类丰富度，有效地促进了顶极种、次顶极种的更新与群落演替。评价指标的选取针对复层、异龄、混交群落结构的林分改造目标，具有综合性与可操作性。所构建的林分尺度自然度评价体系是衡量林分近自然改造效果的有效方法。

关键词：自然度；近自然森林；近自然改造；马尾松人工林；评价方法

许昌城市森林生态系统定位研究站建设及发展方向

许昌林业科学研究所 辛国奇

河南省典型生态系统研究网络（HNFERN）中长期建设规划（2009－2020），是河南省林业生态省建设重要组成部分，根据不同区域森林生态类型，建设覆盖全省的森林生态系统定位监测研究站点，目的是为林业生态省建设和社会经济可持续发展提供科技支撑。河南省典型森林生态系统研究网络管理中心（简称“生态网络管理中心”） 全面负责网络的建设和管理工作，生态网络管理中心设在河南省林业科学研究院。目前该网络在全省范围建有七个不同森林生态类型定位研究站，许昌城市森林生态系统定位研究站是其中唯一的城市森林生态类型研究站，主要任务是对城市森林类型生态系统进行研究。

一、功能定位

许昌城市森林生态系统定位研究站功能定位在三个方面：一是积累长期的观测数据资料。二是建设完善的城市森林生态系统研究平台。三是根据观测数据资料进行分析研究，探索城市森林生态系统动态变化及演变规律，对其功能进行综合评价。

二、研究对象与任务

（一）研究对象

城市森林生态系统是城市生态系统的一个亚系统，城市森林生态研究是以城市森林生态系统为研究对象。城市森林是城市构建体系中的重要生物组成部分，它是由城市区及其周边地区范围内，以木本植物为主的所有绿色植被组成，对改善城市生态环境、保护生物多样性、提高人们的健康和文化生活质量起着极为重要作用。首先，城市森林是以木本植物为主的植被体系。其次，植被生长环境为城市区及其周边地区。第三，它不是以生产木材为主要目的，而是以改善城市生态环境为主要目的，兼顾景观、休憩、文化等多功能特性，促进人们健康、提高居民文化生活质量。第四，受人类活动的直接影响比较大。因此许昌城市森林生态系统的地理范围，初步包括以森林梯度综合观测塔为中心，辐射半径 15－20㎞ 的城市区域及周边。

（三）研究任务

依据城市森林生态系统长期观测数据资料，对城市森林生态系统的层次结构、植物种类特性、树种选择配置、构建方法、区域分布、动态演变、生态功能等方面进行研究。为城市森林规划、设计、营造、保护、管理和评价提供科学依据，实现城市森林生态效益最大化，满足都市居民健康和文化生活质量不断提高的需要。

三、近期研究项目规划

（略）

四、设想

城市森林生态系统定位观测研究是一个新兴领域，目前在我国没有可借鉴的成熟经验。许昌城市森林生态系统定位研究站于 2009 年 9 月开始立项规划，2010 年 7 月开始实施建设，2011 年 5 月完成基本建设任务，经过 6 月份试运行，7 月正式运行，开始观测和相关研究工作。城市森林的许多生态现象是一个综合复杂的动态变化过程，这个过程要持续十年到 100 年甚至更长时间，科学实验需要一个长期的研究计划和设计。在这些时间内持续对城市森林生态对城市的影响观测是必要的，要克服许多障碍，使零散的研究实现交叉综合。认真详细的记录实验数据和观测值，做到长期妥善保管，保持研究工作的长期延续性，很好地发挥研究平台和纽带作用，为科学机构持续可用提供完备的基础性数据资料。通过确定长期发展目标，加强教育、交流、协作、评估等工作，最终目标达到：（1）获得城市环境对城市森林生态系统影响的反应，以及对城市森林生态环境过去、现在和将来在时空演变机理的认识。（2）利用这些知识推测城市森林生态、演化及人类社会活动对其影响，为应对未来城市环境变化、促进城市健康发展提供科技支持，为政府决策提供依据。（3）提高站点能力，通过协作实现交叉站互联合作；引领综合和交叉站研究，实现基本站数据、实验和模型共享的长期发展网络，（4）在现有基础设施、人才资本基础上，形成完善的观测网点，实现研究成果应用最大化。

参考文献：

1. 于秀波,杨萍等. 中国生态研究网络年报（2010） 中国科学院地理科学与资源研究所
2. 祝宁,柴一新. 论城市森林生态研究框架 《中国城市林业》2003(3)
2. 彭振华. 论中国森林生态网络体系城镇点的建设 《世界林业研究》2002(1)
3. Strategic and Implementation Plan, Research and Education (LTER) (2011) *www.lternet.edu*
4. Linking Urban Design and Ecology，Baltimore Ecosystem Study: BES *www.beslter.org*
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人工林群落植物更新限制研究

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人工林经营过程中，出现生物多样性减少、土壤退化、面源污染、生产力下降等诸多生态环境问题，其中，最为核心的就是生物多样性减少问题。本文通过群落学调查、间伐实验及固定幼苗样方监测实验，对马尾松纯林、红锥纯林、马尾松红锥混交林三种不同人工林群落林下植物更新进行了近 2 年的研究。结果显示：三种人工林林下植物更新的种类和数量都很少，表现出较低的生物多样性；间伐处理和去除凋落物促进了林下植物的更新，但更新幼苗的种类和数量有限，且幼苗死亡率较高。综合分析我们认为，植物的传播限制及人工林群落中生境限制共同导致了人工林群落中较低的生物多样性。

关键词：人工林，群落，植物，更新，限制

尖峰岭热带山地雨林碳交换的动态特征和影响因素研究

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热带雨林仅占全球陆地面积的 7-10％,植被面积的 13％(Melillo, *et al.*, 1993; Malhi & Grace, 2000; Lewis, 2000)，但由于通过光合和呼吸作用吸收和释放了大量的碳，因此，热带森林在全球碳循环中起着非常重要的作用。对于热带森林到底是碳源、碳汇抑或是中性的问题，目前仍然存在争论（Melillo, *et al.*, 1993; Malhi & Grace，2000; Lewis, 2000)。由于净初级生产力的下降(Kira & Shidei 1967)，热带雨林，特别是老龄林（Old-growth）通常认为其对于碳的固定与释放是基本平衡的（Waring & Schlesinger, 1985)。为了揭示尖峰岭热带山地雨林老龄林其碳源汇的大小和驱动因子，本研究利用尖峰岭近 20 年固定样地调查数据，同时结合涡度协方差技术，综合开展热带山地雨林固碳能力及其影响的研究，结果显示：

基于 1983 年开始近 25 年固定样地清查数据计算的中国海南岛尖峰岭热带山地雨林的生物量结果表明：雨林生物量随林木径级的增加而增大， DBH>10 cm 的个体占生物量总和的 90%以上，尤其是数量不到 1%的大径级个体（DBH≥45 cm)，其生物量所占比例更是高达 32%，充分反映了在热带森林中大径级个体对生物量和碳密度的贡献占据绝对的主导作用。生物量密度在 397.05 ± 57.92 和 502.35 ± 96.32 $Mg\ ha^{-1}$ 范围间变动，平均为 453.13 ± 80.06 $Mg\ ha^{-1}$；林木碳密度在 201.43 ± 29.38 和 254.85 ± 48.86 $Mg\ C\ ha^{-1}$ 范围间变动，平均为 230.84 ± 40.61 $Mg\ C\ ha^{-1}$。基于样地调查估算的山地雨林地上部分碳汇大小 P9201 样地平均为 2.38 ± 0.49 Mg C $ha^{-1}yr^{-1}$，P8302 样地为 -0.95 ± 0.63 Mg C $ha^{-1}yr^{-1}$。

基于 2006 年到 2009 年近四年涡度协方差通量监测结果显示，尖峰岭热带山地雨林碳交换昼夜节奏明显，日碳交换通量变异较大，在-9.20 ~ 5.20 g C m^{-2} day^{-1} 范围间变动（在涡度协方差技术中，通常用负值代表碳吸收，正值代表碳释放)，碳交换通量季节及年间变异较大，雨季碳交换能力明显强于旱季；以涡度协方差测定的碳交换通量和 CO_2/H_2O 廓线估测的林内 CO_2 存储通量估算的 2006-2009 年尖峰岭热带山地雨林生态系统净碳交换（NEE）分别为-1.89 ± 0.43、-2.96±0.40、-2.42±0.42、-2.15±0.41 Mg C • ha^{-1} • yr^{-1}，平均为-2.36±0.42 Mg C • ha^{-1} • yr^{-1}，表明尖峰岭热带山地雨林为净的碳汇；总生态系统生产力（gross ecosystem productivity, GEP，由涡度协方差计算的日-NEE 和估算的生态系统呼吸 R_e 之和计算得出）分别为 19.19 ± 2.23、19.19 ± 2.46、21.38 ± 2.27、19.04 ± 2.23 Mg C • ha^{-1} • yr^{-1}，平均为 19.70 ± 2.30 Mg C • ha^{-1} • yr^{-1}。

本研究表明，不管是涡度协方差监测还是样地资源清查，结果都显示尖峰岭未受扰动的热带山地雨林为净的碳汇，说明热带森林仍然存在巨大的碳汇潜力；尖峰岭热带山地雨林碳交换与降雨（尤其是暴雨降雨次数）和干旱状况呈明显的二次曲线变化趋势，降雨和干旱月份次数是尖峰岭热带山地雨林碳交换能力的两个关键影响因子，但碳交换能力同时受台风等极端干扰事件的影响。

毛竹林长期生产力保持机制及维持技术

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林业可持续发展是未来林业发展的必然方向，毛竹（*Phyllostachys edulis*）是中国特有的竹种，具有生长快、产量高、面积大、生态效益好的特点，经过多年的经营，毛竹林产力普遍发生衰退的现象，如何保持毛竹林的长期生产力已成为一个亟待解决的科学问题。2007 -2010 年，对我国主要毛竹产区福建永安市、福建顺昌县、江西安福县、浙江安吉县、四川长宁县不同类型、不同经营时间的毛竹林的生长情况进行了调查，对毛竹林的退化情况、退化机理和保持技术进行了研究。主要研究结论如下：

1、毛竹林生产力随着经营时间的增长呈退化趋势。毛竹林随着经营时间的增长，平均胸径和树高呈下降的趋势。劈草、垦复和施肥等常规经营措施在短期内可以提高毛竹林地平均胸径和树高，胸径在经营 10 年后达到最大值为 10.95 ㎝，树高在 13 年达到最大值为 15.01 m，胸径和树高极显著高于未经营林分的 8.44 ㎝和 12.72 m；但是随着经营时间的增长，毛竹林的平均胸径和树高呈下降的趋势，经过 30 年的经营，毛竹林平均胸径（10.12 ㎝）的下降幅度达到极显著水平，而树高（14.18 m）未达到显著水平，说明胸径对于经营时间的敏感度高于树高。

2、毛竹林生物循环特性是毛竹林长期经营生产力下降的内在原因之一。森林凋落物是森林生态系统的重要组成部分，是森林生态系统物质循环的重要环节，是森林生态系统自肥的重要机制之一。毛竹林分年凋落量很小，仅为 1.73 $t\ hm^{-2}\ a^{-1}$，明显低于丛生竹小叶龙竹和麻竹的年凋落量，与年凋落物量较小的杉木林比，毛竹林凋落物仅为杉木林的 49.43%。通过对福建永安经营措施相同的毛竹纯林，竹阔混交林（混交比 8：2）和竹针混交林（混交比 8：2）的养分循环特征研究表明，三种林分年吸收量分别为 421.37±42.09 $kg\ hm^{-2}$、690.88±65.09 $kg\ hm^{-2}$ 和 376.22 ±15.95 $kg\ hm^{-2}$；年归还量分别为 26.70±2.79 $kg\ hm^{-2}$、58.47±12.04 $kg\ hm^{-2}$ 和 64.84±3.73 $kg\ hm^{-2}$；年存留量分别为 406.64±40.55 $kg\ hm^{-2}$、670.81±60.95 $kg\ hm^{-2}$ 和 357.21±14.85 $kg\ hm^{-2}$，毛竹林具有较大的年吸收量和较小的年归还量。

3、毛竹林生产作业特点和不合理的经营措施加速了养分的流失和土壤质量退化。毛竹林是人为干扰最为严重的森林类型之一，劈草、垦复、施肥等常规经营措施在短期内能够提高毛竹林生产力，但随着经营时间的增长，毛竹林生产力呈下降趋势。同时，长期劈草和施肥造成了土壤综合质量的下降，不同劈草毛竹林地土壤性质综合评价得分为 0.6390、劈草 10 年为 0.3558、劈草 30 年为 0.4320；

不施肥土壤综合性质得分为 0.5693、施肥 5 年为 04286、施肥 10 年为 0.3744。垦复可以提高土壤综合质量，但有较大的水土流失风险。不垦复毛竹林地土壤性质综合评价得分为 0.3548、垦复 3 年为 0.4117、垦复 10 年为 0.4635、垦复 30 年为 0.5815。毛竹林每年通过采竹和挖笋，将大量的营养物质带出竹林。通过对福建永安不同管护类型毛竹林的研究表明，垦复+施肥+灌溉毛竹林每年采伐和挖笋的生物量占林分总生物量的 27.87%，垦复+施肥的林分占 24.54%，劈草的林分占 24.51%；带出林分的 5 种养分（N、P、K、Ca、Mg）总量分别为 307.65 kg hm^{-2}、215.49 kg hm^{-2} 和 222.90 kg hm^{-2}。毛竹林频繁的人为经营活动和每年的采竹挖笋作业加速了毛竹林系统养分失衡和土壤质量退化。

4、以营养管理为核心的经营措施是毛竹林长期生产力保持的关键，应以科学定位竹林经营目标为核心，开展竹林结构合理调整，进行林地生态管理，兼顾毛竹林经济效益和生态效益。

（1）科学定位竹林经营目标。根据立地条件，因地制宜，科学定位竹林经营目标。在林地坡度较大（＞25°），水土流失严重的毛竹林分以维持其完整系统结构为经营目标，充分发挥其生态效益的基础上兼顾经济效益；坡度较小（＜25°），水肥充足的毛竹林采用免垦少垦、生态施肥、混交经营等技术，实现经济和生态效益双赢。

（2）合理调整竹林结构。根据经营目标，合理调整竹林立竹度和年龄结构。立地条件好的竹林密度以 2700～3000 株 • hm^{-2}，年龄结构 1-4 度以 3∶3∶3∶1 为宜；立地条件差的毛竹林分密度以 1750～2200 株 • hm^{-2} 为宜，适当留养大龄毛竹。在此基础上推广营造混交林，尤其是竹阔混交林。竹阔混交林植物区系分布较毛竹纯林分布广泛，物种多样性显著高于毛竹林纯林。

（3）优化组合常规经营措施。不同经营手段进行组合、轮替以及同一措施的间隔应用，兼顾毛竹林的生态效益和经济效益。劈草经营提高了毛竹林养分贮存量、年吸收量和存留量，降低毛竹林的养分归还能力；施肥降低林分养分利用系数，提高养分的循环速率，降低养分周转时间；灌水提高毛竹林的养分归还量，降低了养分循环系数，缩短了养分的周转时间。推广劈草、垦复、施肥、灌水等经营手段进行组合、轮替以及同一措施的间隔应用；化学肥料与有机肥料交替使用；短时间全垦改为多年轮垦、带垦。

（4）促进养分归还。人工促进养分归还，增强林地自肥能力。① 竹蔸开破技术。利用钢棍或锄击穿竹腔、电动钻头击穿（或者开山板斧力劈）竹蔸，同时进行竹蔸施肥，促成雨水从竹蔸内进入根鞭系统，加速腐烂，解除竹蔸长期占据空间资源与养分不能快速回归问题。②人工促进竹林植被恢复技术。适度砍山除杂，留养阔叶乔木，乡土树种优先留养。③采伐剩余物管理技术。把枝、叶、根留在林分中增加毛竹林养分归还量，枝、叶、蔸占林分总生物量的 23.87%。

关键词：毛竹林；长期生产力；退化机理；生态经营技术；