



Biodiversity in Bamboo Forests: a policy perspective for long term sustainability



Lou Yiping & Giles Henley

INBAR

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International Network for Bamboo and Rattan (INBAR)

P. O. Box 100102-86, Beijing 100102, P. R. China

Tel: 00 86 10 64706161; Fax: 00 86 10 64702166 ; Email: info@inbar.int

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A case study on the implications of China's forestry policies for biodiversity in bamboo forests

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Foreword

Much attention has been given to the rise of the bamboo sector in China, which now occupies an important place in Chinese forestry. The sector has burgeoned under the objectives of rapidly alleviating poverty among farmers and feeding China's growing hunger for timber. This has been achieved through the application of scientific management to maximise output volume by clearing out competition and applying modern agricultural techniques. It is now recognized however that the loss of biodiversity that has been observed in bamboo forests has negative effects on the future productivity of these forest: rapid gains now come at the expense of future losses. If not addressed, this loss of productivity represents a potential obstacle to the success of the sector, which is an important source of income generation for thousands of bamboo farmers.

INBAR's Bamboo Biodiversity Project, a unique initiative to address this issue on both governance and forestry practice levels, has sought to determine changes in practices necessary to ensure that the bamboo forests maintain their biodiversity and health and are economically sustainable in the long term. The major findings from both management practices trials and policy analyses which are summarised in this publication, provide guidance on the changes that are needed, and how these can be brought about.

These findings come at an opportune time as the world celebrates the International Year of Biodiversity, and sets new targets to halt biodiversity loss by 2020, much of which occurs in forests. Bamboo forests for timber production are projected to increase both in area and as a percentage of forest output. By maintaining levels of biodiversity in bamboo forests to ensure their long-term health, they will be able to continue to provide timber and non-timber services into the future. Promoting biodiverse bamboo forests is therefore of central importance to both bamboo forest ecosystems and the wider forestry sector.

In China, where the issue is most relevant, INBAR has submitted a set of recommendations to the Forestry Authorities on what policy adjustments are needed. Although developed specifically for China, these suggestions are also relevant for other countries developing their bamboo sectors.

Dr Coosje Hoogendoorn
Director General
International Network for Bamboo and Rattan (INBAR)

Executive Summary

Bamboo forests are unique in their ability to meet economic and social objectives of providing timber, development and raising rural incomes rapidly and over a sustained period of time. China's example has shown that by changing their management practices, farmers are able to get richer through significantly increasing supply of timber to markets without depleting this source of timber; a relatively uncommon phenomenon in the forestry sector. The sector has expanded rapidly and in China has a value of over USD 9 billion today.

However, the change in practices has come at a cost, as losses in biodiversity resulting from these practices are undermining the quality and resilience of bamboo forests. In the long-term, these are resulting in lower productivity of forests, which translate into lower profits for farmers, causing a potential threat to the sector's sustainability. This also reduces the ability of bamboo forests to provide important non-timber functions such as erosion control, water catchment regulation and carbon sequestration. It has been shown that by implementing conservation-friendly models, acceptably high yields can be maintained without reducing the long term viability of the forests.

Policy has an important role to play. The Chinese government has had a strong role in guiding the development of the bamboo sector through the implementation of policies focussed on achieving high yields and devolving decision-making on management issues to farmers. While these have been well-intentioned, they encouraged farmers to scale up production quickly in the pursuit of profits, providing both higher timber outputs and generating income for themselves. However, important gaps in the policy framework and absence of measures which protect ecosystem health have meant that these policies are also indirect drivers of the biodiversity loss. The long term sustainability of bamboo forests as productive sources of timber, food, livelihoods and key ecosystem services requires an examination, and adjustments made to the present policies.

In a three-year project funded by the EU China Biodiversity Programme, INBAR made several key findings.

On the technical side, preliminary findings have shown that there are viable management techniques which can continue to provide economic yields in the short-run without compromising ecosystem biodiversity, and subsequently lead to long-term sustainability. Trialled conservation-based management models provide guidance for preventing degradation of bamboo forests in China, and rehabilitating those which have turned into monocultures.

On the policy side, ten recommendations related to key pieces of national forestry legislation were submitted to the Chinese Forestry authorities for their consideration when planning further development of the bamboo sector. Although these are specific to the Chinese context, they contain important lessons for policy formulation for countries that aim to develop their own bamboo sectors using China's experience as a model.

This project that led to this paper came from support and funding from the European Union through the EU-China Biodiversity Programme. The project was implemented by INBAR through a partnership with the Research Institute of Subtropical Forestry under the Chinese Academy of Forestry, and the Provincial Forestry Departments of Hunan, Yunnan and Sichuan provinces. The authors acknowledge the important contributions provided to this paper's contents and production including, but not limited to, Dr. Xu Jiliang, Associate Professor, Beijing Forestry University, Dr. He Youjun, Associate professor, Chinese Academy of Forestry and Ms Li Yanxia, INBAR Project Officer. We express our thanks to Dr Coosje Hoogendoorn, Tim Cronin and Violeta Gonzalez of INBAR with help in editing and producing this paper.



Introduction

Introduction

The growing importance of bamboo globally

Bamboo is increasingly recognized as a natural resource with a remarkably high potential to contribute to human development. Its properties of fast growth, renewability, strength and the high number of applications derived from it provide mankind with a wide range of goods and services. The potential of bamboo is deeply rooted in knowledge and tradition in Asia, South America and Africa, where it has held an integral part in people's lives as far back in history as records go, and it has over a thousand documented uses from building materials to food. The number of known uses is constantly expanding today, as advances in industrial techniques allow processing of bamboo into new shapes and forms.

As a resource which is predominantly used by the rural poor, bamboo has a large potential to boost rural incomes when the markets for it develop. This has been best observed in China's Zhejiang province, where bamboo processing and manufacturing has become a major industry. INBAR's work across three continents has repeatedly shown the international applicability of leveraging bamboo for rural income generation.

Bamboo also provides valuable environmental services, which are increasingly recognised. Its fast growth is an indication of its high capacity for carbon storage and points to a potentially important role in climate change mitigation. Bamboo forests are excellent at controlling soil erosion in water catchment areas, and planting bamboo has been used successfully to rehabilitate degraded land to productive use. Bamboo forests are important for biodiversity, from providing food and shelter to large animals (e.g. Giant Pandas and Mountain Gorillas) and birds, to the level of the less studied soil organisms, insects, and other plants and shrubs that together make up the bamboo forest ecosystems. Its cultural value and central position in many of Asia's rural beautiful landscapes demonstrates its high amenity value.

Bamboo in China

China has over 40% of the world's bamboo area and over 500 species. With a long history of use and cultural value, China today has by far the largest bamboo sector globally. It has been responsible for most of the innovation in bamboo processing, which has been matched by the expansion and productivity increases of its bamboo forests. Since the 1950's, the area of land devoted to moso bamboo, *Phyllostachys pubescens* (the most important species) has more than doubled, from 1.5 million hectares in 1957 to 5 million hectares in 2007 through natural expansion and plantation. This expansion represents one of the fastest growing areas of forestry in China, and has largely been led by the state, which has made the major decisions and policies related to the forestry industry through central planning of the economy.

The gains from the rising bamboo sector are impressive. Economically, the high returns from the development of the sector have mainly accrued to rural areas. The sector has responded well to development planning: 'bamboo counties' which have diversified into developing different bamboo industries (furniture, flooring, shoots, charcoal and so on) have led to viable rural industries which have had important multiplier effects in raising farmers and rural labourer's incomes. Profits in the sector have been reinvested into research and development of both bamboo forestry and industrial techniques which have allowed the sector to churn out new products and alternatives for many wood-based products.

Establishing policies for the bamboo sector

The Chinese government has encouraged the bamboo sector by implementing policies to enlarge land coverage and intensification, set targets for production, fund scientific research on economically-important species of bamboo, and establish “bamboo” towns and counties in provinces with rich bamboo resources. The objectives of these policies have been to promote bamboo both as a source of timber and fibre, and a source of rural income growth and development.

Because bamboo is mainly used in China to provide timber, it is regarded and classified as a tree. As such it falls under the supervision of the State Forestry Administration (the ministry in charge of forestry and activities on forest land in China). The China forestry sector in general is highly constrained, due to low volumes of domestic resources resulting from a high population growth paired with high levels of deforestation during the 20th century. In order to balance development goals without depleting forest reserves, rules have been established to govern the sector.

Policies formulated for the bamboo sector reflect these national constraints, and are strongly affected by the logging bans on other species, restrictions on harvesting and other policies made in attempt to limit deforestation. The general outcome of this has been pressure on bamboo resources to provide both high levels of timber output to make up for shortfalls from other forest resources, as well as profits for farmers when they are restricted from harvesting other forest and tree species. Bamboo forests are comparatively free of restrictions, and are thus used primarily as production forests.

The ecology of the bamboo forest

The predominant type of bamboo forest found in China is the monopedial forest, of which “Moso” bamboo is the most important species. Unlike trees, individual bamboo culms (poles) are connected underneath the ground by a network of rhizomes, from which the culms shoot. In their natural states, these bamboo systems are intermixed with tree, shrub and herbaceous layers of vegetation. They are habitats for numerous species of insects at the soil and tree layer, spiders, butterflies, birds and other higher life forms. The mix of plant species is important for maintaining high levels of nutrients in the soil, and a high degree of resilience of the ecosystem to weather events and disease and insect infestation.

Whilst undoubtedly successful in generating rural incomes for farmers and taking pressure off scarce forestry resources, the intensification of economic activity in bamboo forests has had negative effects on the biodiversity in these forests in south and south-western China. Intensive farming practices, encouraged by policies and forestry extension services have led to the reduction in species and ecosystem diversity in bamboo forests. Although the intensive management practices have led to higher yields of bamboo in the short-run, in the long-run these forest ecosystems are experiencing a reduction in resilience to external threats including pests and disease and weather events, and a reduced capacity to provide important ecosystem services including erosion control and nutrient cycling. And importantly, they are also leading to lower productivity of bamboo forests in the long run.

Loss of productivity is particularly serious, as it potentially undermines both the objective of growth of timber output from the bamboo sector, as well as returns to farmers who make investments in their forestry activities. As such, it presents a major challenge to the long-term

viability of the sector. These changes have been recognized by some within the forestry sector, but the policies and rationale which have led to these negative effects still persist.

INBAR's Bamboo Biodiversity Project

INBAR's Bamboo Biodiversity project, funded by the EU- China Biodiversity Programme, has sought to better understand and address the decline in biodiversity and its potential adverse effects on the sustainability of the sector. Policies in the areas of forestry, and bamboo specifically, were observed to be key factors driving the transformation of the forests, and an analysis of the major pieces of legislation at the central level was undertaken to determine where the problems lay. Recommendations to remove these problems were made, and presented to the national government.

The ECBP- INBAR Bamboo Biodiversity Project

INBAR began the ECBP Bamboo Biodiversity Project in 2007 in order to raise attention to the issues of biodiversity loss in bamboo forests, investigate further the potentially negative biodiversity effects of the changes in management practices, develop new models based upon conservation management, and analyse policy problems and develop policy-based solutions to the trend towards monocultures.

The project worked for three years in sites in Hunan, Sichuan and Yunnan provinces in south and south western China, which are major producers of bamboo. Each location showed different aspects of biodiversity loss and challenges due to differences in farming practices, local economies and different environments.

- Yanling Township in Hunan Province was chosen as it has much bamboo still in mixed forests, providing a good opportunity to study biodiversity in a mixed setting, as well as examine the prevention of biodiversity loss. The site was next to a nature reserve, and also a site of a long-term forestry project.
- Changning Township in Sichuan Province provided a case of a site where intensive practices had already led to significant biodiversity loss, and forests had already been converted to monocultures. The presence of an important adjacent protected area, the Shunan Bamboo Sea Nature Reserve, has resulted in greater pressure on forests outside the boundaries of the park in order to compensate for logging bans within the Nature Reserve.
- Dagan Township in Yunnan Province is located in an area where an endangered species of bamboo, Qiong bamboo, has been depleted through overharvesting and is classified as Endangered on the Red List of Rare and Endangered Plants in China. The project sought to better understand the reasons leading to the overharvesting, and strengthen institutional measures to prevent further depletion, and eventual recovery¹.

¹ Protection of endangered bamboo species will be described in an additional INBAR publication

The main outcomes of the project were:

1. Forestry sector employees at all levels and local communities in Sichuan, Hunan, and Yunnan have been able to enhance and conserve bamboo forest biodiversity by adopting, implementing, and integrating the strategies and practices tested in this project.
2. Guidelines and manuals on biodiversity conservation for natural bamboo forests have been developed. The guidelines have been disseminated to other areas in China with significant natural bamboo forest resources.
3. Policies to encourage local governmental agencies to prioritize biodiversity conservation for bamboo forests have been developed and recommended to the governmental agencies from the local levels to the national governmental level.

This report examines in depth the situation China is facing through the loss of biodiversity in commercial bamboo forests in China. **Chapter 1** provides an overview of the forestry sector in general, and the important position that bamboo has therein. **Chapter 2** examines the changes that have occurred in the management practices used by farmers, how these have affected biodiversity, and what the resulting negative effects of the goods and services that the bamboo forests has been. **Chapter 3** provides a review of the major pieces of legislation concerning forestry, and a summary of the major policy problems and the recommendations that were proposed under the project. **Chapter 4** summarises these into global lessons for countries with productive bamboo forests.

Biodiversity and Bamboo

'Biodiversity' commonly includes diversity within species (genetic diversity), between species (species diversity), and between ecosystems (ecosystem diversity)².

Genetic diversity refers to variation between individuals of the same species.

Species diversity is the variety of species in a given region or area.

Ecosystem diversity refers to the variety of different ecosystems that occur within a larger landscape.

This report deals with diversity at the **species level**, i.e. the number of species within a productive bamboo system. Specifically, it is concerned with the species diversity within a *Phyllostachys pubescens* (Moso) bamboo forest, which can be regarded as an ecosystem.



Chapter 1: China's modern experience in the forestry and bamboo sector

1. China's modern experience in the forestry and bamboo sector

China's bamboo industry is part of the country's wider forestry sector, which has experienced large changes over the last few decades in both land coverage and volume of output. It is now designed to provide continued expansion of timber supply, rural development, and environmental protection. Bamboo forests are mainly used to meet the first two objectives, and their potential to contribute to environmental sustainability has not received much attention until now.

An overview of the forest sector

Since the founding of new China in 1949, limited national forestry reserves have been a critical concern in China's forest sector. Although recent increases in forested land mean that China has the 5th largest forestry area in the world, its high population means that resources per capita are significantly lower than the world average³. A drive to make up for the low national coverage of natural forests has seen China develop into the global leader in area of plantation forests, with over 62 million hectares of planted forests out of a total of 195 million hectares of forests⁴. This accounts for approximately 31% of China's forested area, and 53% of the world total⁵. The shortage of natural forest reserves has meant that China has become a major importer of wood resources for its large wood-processing industry.

In the years between 2004 and 2009 there have been rapid gains for the forest sector. The net increase in forest area has been 20 million ha, which has pushed national forest cover up from 18% to 20% of land area. Due to an increase in area and improvement in the quality of plantation forests, there has been a shift of logging activities from natural forests into the plantation sector, which now accounts for 39% of total logging. This is part of a continued trend over the past 30 years which has seen the overall expansion of China's forests.

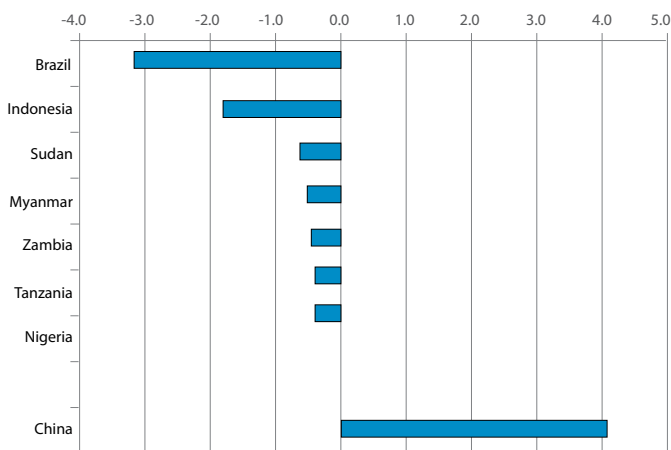


Figure 1 : Countries with the largest changes in forests (2000-2005)⁶

³ China has 0.1 hectares of forest/ capita, compared to a world average of 2.6 hectares/ capita

⁴ 7th National Forest Inventory

⁵ 'Development in China's Forestry Sector', Xinhua News Agency, March 20, 2009

http://www.china.org.cn/environment/report_review/2009-03/20/content_17473108.htm

⁶ FAO Global Forest Resources Assessment 2005

In terms of value, the forestry sector was worth RMB 1.75 trillion (USD 257 billion) in 2009, and has been growing 20% each year since 2000. It is targeted to continue to grow by 12% per year to RMB 2.26 trillion (USD 332 billion) by 2012.

As well as producing timber for consumption and energy, the important environmental functions of forests have been recognized and reforestation is widely used to national projects to reverse the negative effects of environmental degradation. Ongoing environmental degradation caused by deforestation and land conversion has resulted in soil erosion, desertification, and major flooding, all of which have come at high economic costs. By planting forests in areas where environmental problems occur, forestry has become an important tool to tackle these while simultaneously producing a range of forest products. The Chinese Academy of Forestry has enumerated the environmental services provided by China's forest ecosystems with the following results:

Service	Volume/ Value
Gross carbon storage	7.8 billion tonnes
Volume of water conserved in forests annually	495 billion cubic metres
Volume of soil fixed annually	7 billion tonnes
Improving Soil Fertility	364 million tonnes
Absorption of pollutants	32 million tonnes
Total Benefits	10 trillion RMB

Table 1: Value of China's forests environmental services⁷

The demands placed upon forestry led to the formal establishment in 1998 of a class system of forestry delineated by purpose, and goals and targets are set for each of these classes. Two first class levels of public benefit and commercial forest outline the main purpose, and these are subdivided into five classes defined as: Protective forests, Special purpose forest, Timber forests, Fuel forests and Economic forests.

China's Forestry Classification System			
First class	Second Class	Third Class	Forest Function
Public benefit/welfare forest	Protective forest	Soil and water conservation forest	Reducing flow of ground and rainfall, prevent soil and fertility loss.
		Water body conservation forest	Protecting river and drinking water resource, adjust river water flowing
		Infrastructure protecting forest	Protect infrastructure such as roads, dykes and dams
		Windbreak and sand fixation forest	Reduce wind speed; restrain deserts
		Farmland and pasture protecting forest	Improving the natural environment of farmland and pasture, protecting the productive condition of agriculture and pasture
		Fireproofing forest	Prevent and restrain forest fire
	Special purpose forest	Natural preservation forest	Protecting typical ecological system, local climate communities, rare plants, animals and forests with special value
		Seed resource forest	Protecting seed resource and hereditary gene, good seed and cultivating new variety
		Cultural and memorial forest	Protecting nature, human cultural heritage, history, and human memory
		Tourism forest	Preserving natural scenic and entertainment area
		Environment protection forest	Purify air, prevent pollution, reducing dust and noise
		National defence forest	Protecting the national border and protecting military installations
National defence forest	Protecting the national border and protecting military installations		

⁷ Source: <http://www.gxforestry.net/show.asp?id=3210>

Commercial forest	Timber forest	General timber forest	Producing timber in different sizes and types for industry
		Industrial fiber forest	Producing fiber for paper production and the wood-based panel industry
	Fuel forest	Firewood forest	Producing fuel for heat and life
	Economic forest	Fruit forest	Producing dried and fresh fruits
		Oil crops forest	Producing oil materials for industry
		Chemical materials forest	Producing forest chemicals, such as turpentine, rubber, and white wax
		Medicinal forest	Producing Chinese medicine
	Flavor seasoning forest	Producing seasoning	

Table 2: China's classification of forests by purpose⁸

The rise of the bamboo sector

Partly as a result of challenges faced by the broader forestry sector, the Chinese bamboo sector has experienced a steady rise in China over the last 50 years, and shows little indication of slowing. As seen from the bar charts below, bamboo has become increasingly important in terms of both the forested area, and market share within the forest industry. Moso bamboo now covers roughly 5 million hectares.

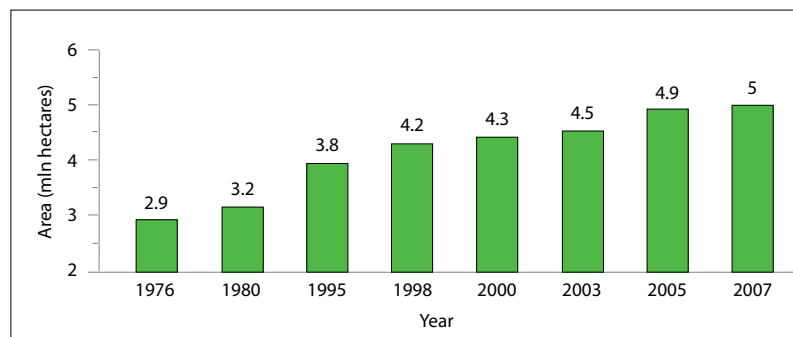


Figure 2: Increase in area of moso forests in China (FAO China Forestry Statistics)

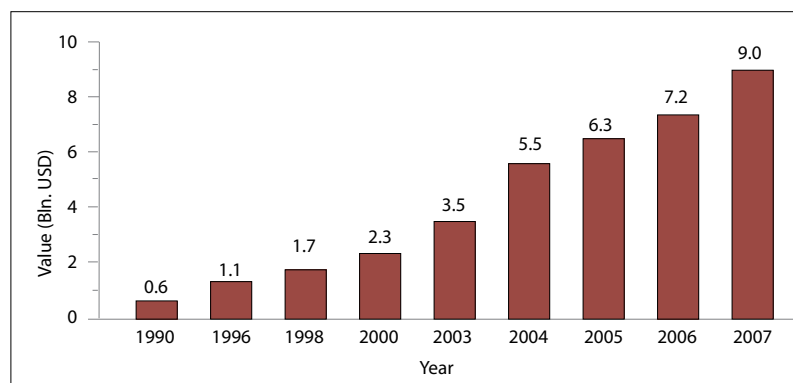


Figure 3: Rise in the value of China's bamboo industry (FAO China Forestry Statistics)

⁸ Bamboo forests mainly fall into the three shaded categories: Natural Preservation Forests, General Timber Forests and Industrial Fibre Forests, although they also provide soil and water conservation functions. This is not reflected in their classification.

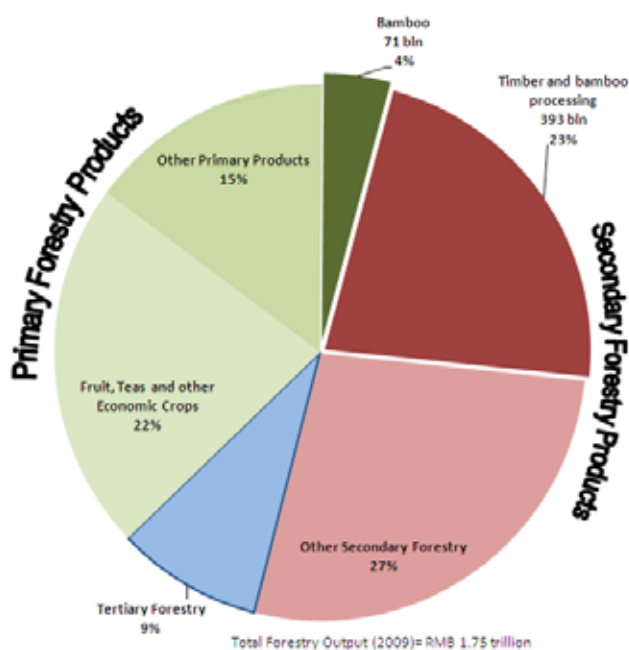
Market share and value of China's forestry output in 2009 (RMB)⁹

Figure 4: Breakdown in value of China's forestry industry

In 2009, the value of bamboo in the primary forestry sector accounted for RMB 71 billion (USD 10.5 billion), or 4% of total forestry value alone. In addition, bamboo processing accounts for a sizeable proportion of the processing industry in the secondary sector.

Of all forest industries, the wood and bamboo pulp and paper industry, wood and bamboo furniture industry grew the fastest in 2009 at annual rate of 41% and 40% respectively.

As well as the fast growth of the bamboo sector, one of its highly significant characteristics is the high level control by farmers to manage, use and derive profits. The classification of most bamboo forests as Commercial Forests means that they are subject to the least restrictions on use. 93.2% of bamboo forests are on collective forestland (as opposed to state-owned forest land), which means that farmers are relatively free to make decisions regarding land management, and therefore are a prime target for intervention. (Liu Dachang 2001).

Chapter Summary

Central planning of China's forestry sector has sought to balance objectives of increased timber supply, economic development and environmental protection. The area of commercial bamboo forests mainly to provide timber, and economic returns to farmers, who have higher levels of ownership over bamboo resources than other types of forest. Neither the environmental functions nor the environmental sustainability of bamboo forests has received much attention.

⁹ China 2009 Forestry Statistics, in http://madera.fordaq.com/fordaq/news/logs_softwood_plywood_23811.html



Chapter 2: Management changes in bamboo forests and their biodiversity impacts



2. Management changes in bamboo forests and biodiversity impacts

The increased use of bamboo forests to fulfil timber provision and rural development objectives has led to the greater intensification of farming practices, which in some areas have resulted in conversion of mixed forests to monocultures. Whilst these have provided short term high yields, they are failing to maintain long term productivity due to reductions in stand quality and resilience. The loss of biodiversity in bamboo forests is a potential threat to the long-term sustainability of the bamboo sector, and conservation-friendly models are proposed.

Management changes

As the bamboo sector has grown over the last few decades, management practices in bamboo forests have changed. Traditionally, mixed forests containing both bamboo and other plant species have been sources of bamboo timber and fibre for centuries, but extraction generally occurred at a low intensity, and natural generation of the bamboo in the forests provided ample supply.

With the rapid development of the bamboo sector, further research into science and technology of bamboo cultivation, accompanied by field trials and the development of prescriptive management techniques, has led to the introduction of more scientific management of these forests with the main aim of raising annual yields.

The principal means of increasing yields is to increase the density of bamboo culms per unit of land, effectively creating monocultures. Monocultures have a very high density of bamboo culms per hectare (2000 culms/ ha compared with 750 culms/ ha for a typical mixed forest), and many fewer other plant species (Zhang et al 2000). This means there are many more culms for harvest per year.

This is achieved primarily through active clearance of other vegetative species, including trees, shrubs and undergrowth. The aim of this is to provide greater space, nutrients and water for the bamboo. This is commonly done by performing two brush cuttings per year to clear the forest floor of saplings, seedlings, shrubs and herbage. In addition, top soil tillage is performed every one to two years and chemical fertilisers and pesticides are applied in varying quantities. Through the application of these techniques, annual yields of bamboo have been raised from 3.5 tonnes per hectare to 7-10 tonnes per hectare. Under optimized conditions, this can even reach up to 35 tonnes per hectare (Fu et al, 2000).

These management techniques have been approved and promoted by the relevant forestry bodies, and have been included into a standard on bamboo management. This has led to their greater adoption at a regional scale and it is estimated that over 4.2 out of 7.2 million hectares of natural mixed bamboo and broad-leaved or coniferous evergreen forests are at risk of conversion to monoculture forests (Jiang, 2007).

Biodiversity and ecosystem impacts

While raising production in the short-term, these management practices negatively affect species diversity and compromise the long-term stand quality, resilience, and productivity of monoculture bamboo forests.

A number of studies have demonstrated the loss of biodiversity associated with management techniques that promote monocultures. Studies by He and Lou in Fujian and Zhejiang saw significant declines in plant diversity in bamboo forests (He and Lou 1999). Grass and shrub diversity declined from 58 species to 31 species over an 11-year period following the introduction of new management techniques, leading to monoculture. A later study documented declines in soil fungi and bacteria diversity by 45% and 90%, respectively (Pan, 2000).

Monoculture forests in Hunan and Sichuan were found to have lower avian diversity. In Hunan, 15 species of bird were observed compared to 35 species in nearby mixed forests. In Sichuan, 12 species were observed compared to 34 species in nearby mixed forests (INBAR 2010).

Decline of biodiversity in bamboo forests is thought to negatively affect both site quality and resilience of stands to disease, pests, and adverse weather events. For example, although the bamboo rhizome system is a powerful soil binder, other vegetation found in bamboo forests plays an important role in protecting soil from erosion. Removal of species often results in increased wind and water erosion resulting in nutrient depletion. Vegetation, along with many bacteria, fungi, and insect species, act to maintain soil quality by nutrient cycling. A study by Zheng and Hong (1998) found bamboo stands intermixed with broadleaved trees exhibited higher amounts of desirable soil nutrients and soil qualities, including: soil porosity, aeration, and bulk density, compared to monoculture.

Larger vegetation and trees physically interact with bamboo to increase the resilience to adverse weather conditions, such as wind, hail, or snow. Low biodiversity project sites demonstrated a decrease in resilience to weather events, especially the snow disaster which hit central and southern China in 2008. Although all forests were damaged by the heavy snowfall, those forests where only bamboo grew showed a higher incidence of damage, and as a consequence, greater economic loss. The presence of other trees with greater weight tolerance and different plant architecture provided more protection to the whole ecosystem against the snow, whereas the bamboo monocultures were found to be much more damaged by the snowfall.

Loss of biodiversity is also likely to increase susceptibility to pest attack. Insect and larger fauna, such as birds, limit pest populations by predation, while plant species often provide vital habitat for these predators. A study by Zhang et al found monoculture bamboo forests have shown increased susceptibility to mite infestation compared to mixed forests (Zhang et al, 2000).

Reduced resilience together with lowered site quality ultimately negatively affects long-term productivity of bamboo forests. He and Lou found a 25% decline in productivity in their 11-year study of monoculture forests in Fujian and Zhejiang. Similarly, bamboo produced in mixed broad-leaved forests was higher in terms of quality (culm diameter and weight) and biomass than bamboo produced in monoculture (Huang et al., 1993).

Effects on	Description	Reference
Biodiversity	Monoculture forests in Hunan and Sichuan showed lower bird diversity in comparison to nearby mixed forest. In Hunan, 15 species of bird were observed compared to 35 species in nearby mixed forests. In Sichuan, 12 species were observed compared to 34 species in nearby mixed forests.	INBAR Project Bird Diversity Report, 2010
	Decline in the number of fungi and bacteria species in monoculture forests in Zhejiang and Fujian, by 45% and 90% respectively over an 11-year period.	Pan, 2000
	Decline in grass and shrub species diversity in monoculture forests from 58 to 31 species over an 11-year period.	He & Lou, 1999
Stand quality and resilience	Monoculture forests displayed higher incidence of damage compared to mixed forests following winter snow storms. Monoculture forests experience 12-35% more damage due to lower weight tolerance and higher wind speeds.	Jiang, 2003
	Monoculture forests showed increased susceptibility to mite infestation compared to mixed forests.	Zhang et al., 2000
	Mixed bamboo stands exhibited higher amounts of desirable soil nutrients and soil qualities compared to monoculture stands, including: soil porosity, aeration, and bulk density.	Zheng et al., 1998
Productivity	Monoculture forests in Zhejiang and Fujian Provinces showed a 25% decline in productivity over an 11-year period.	He & Lou, 1999
	Bamboo produced in mixed broad-leaved forests was higher in terms of quality (culm diameter and weight) and biomass than bamboo produced in monoculture.	Huang et al., 1993

Table 3: Effects of management changes on bamboo forest characteristics

These results clearly demonstrate the negative effects of the reduction of biodiversity on the stand quality and productivity of the economic bamboo forests.

Minimising management impact

In order to reduce the long term productivity decline induced by biodiversity loss, INBAR's project tested eight management models to identify differences in effects of management practices on biodiversity indicators. These indicators include the number of other plants, insects, birds, and soil organisms which were found in the forest, which together provide a picture of how healthy the ecosystem is. The tests compared management models that were popular with farmers, as well as new ones that provided acceptable bamboo yields but emphasise conservation of biodiversity.

The practices compared were:

Hunan (Baseline= Mixed forest cultivation)

1. Clear out mixed tree species: All other tree species were cleared completely from the forest floor
2. Keep mixed tree species: Other tree species are retained
3. Understory clearance: All trees, shrubs and herbs cleared from forest floor
4. Conservation-based clearance: Selected species of other shrubs and herbs are retained

Sichuan (Baseline= Monoculture cultivation)

5. Apply chemical fertilizer to soil: Chemical fertilizer is added directly to soil
6. Organic fertilizer: Organic fertilizer is applied to the soil
7. Fertilizer in stems: Chemical fertilizer is applied directly into bamboo stems
8. Soil tillage: The soil in the forest is overturned completely

The results from the tests are summarised in the table below.

Province	Practice	Plants	Insects	Birds	Soil Organisms
Hunan (Baseline= Mixed forest)	1. Clear out mixed tree species	--	-	-	-
	2. Keep mixed tree species	+	+	+	+
	3. Understory clearance	-	-	-	-
	4. Conservation-based clearance	++	+	=	+
Sichuan (Baseline= Monoculture)	5. Chemical fertiliser	-	=	=	-
	6. Organic fertiliser	+	=	=	+
	7. Fertiliser in stems	+	=	=	+
	8. Soil tillage	-			-

Table 4: Effects of management practices on biodiversity indicators¹⁰

Key: (+): observable positive effect
 (-): observable negative effect
 (+/- -): statistically significant effect
 (=): no observable effect
 (|): effect is unclear

The results from the trials indicate:

- (i.) A beneficial effect from retaining mixed tree species in bamboo forests for all biodiversity indicators (Practice 1 versus 2);
- (ii.) Benefits to all biodiversity indicators from conservation-based clearance compared to existing practices (Practice 3 versus 4);
- (iii.) Benefits from the application of organic fertiliser and fertiliser in stems to plants and soil organisms (Practice 5 versus 6,7);

The general results of the trials show that the retention of tree species, selective clearance of plants and conservative fertilising techniques provide positive effects on ecosystem health. These practices can be adopted without compromising bamboo productivity, and therefore serve as the basis for recommended practices for sustainable bamboo cultivation.

Chapter Summary

There have been major changes in bamboo management over the last few decades, as bamboo forests are being more intensively managed with culms grown at a higher density. This is being actively encouraged through policies aimed at improving yields, but these ignore the effects of loss of biodiversity on forest quality and resilience. This is now leading to degradation of forests and reductions in productivity which threaten returns to forests and the long term sustainability of the sector, if continued.

Comparisons of management models by INBAR have demonstrated the viability of conservation models, which support reasonable economic benefits in the short term and the long term through maintenance of biodiversity in the bamboo forests.

¹⁰ N.B. Comparison between indicators (i.e. between birds and insects) is not possible.



Chapter 3: Policy



3. Policy

Although the short-term gains from converting bamboo forests into monocultures were perceived as high, there are likely to be long term negative effects from reduced biodiversity which are not considered. Although the immediate reasons for intensive management is economic profit-maximising by farmers, government policies determine the institutional settings, and can help to ensure that both long term sustainability and ecosystem services are given priority. This chapter provides an overview of the current legislation relevant to forestry and biodiversity and background. The policy analysis undertaken by INBAR is presented, along with the ten recommendations which were made to make policy better serve the long-term sustainability of the bamboo sector.

Forestry and biodiversity policy in China

Forestry policy

Forestry policy in China has undergone numerous, significant changes since the founding of the People's Republic of China in 1949. There have been frequent shifts in both economic and political priorities, which have led to changes in land tenure regimes, including rights of ownership, usage and rights to profits. As described in the previous section, this has sought to balance the objectives of wood production, environmental protection and rural development.

The Forestry Law, enacted in 1998, is the main piece of legislation laying out the laws and regulations in the sector in recent years. This mainly relates to the organisation of the forestry sector in general, and deals with the priority issues of forest land reform and environmental protection for flooding and desertification. Biodiversity is currently not given much weight within national forestry policy, and no specific mention of biodiversity is made in the Forest Law. There are a number of provisions which relate to it within other pieces of legislation, which are briefly described below.

Biodiversity in forestry policy

The laws and regulations which relate to biodiversity in forests exist on three different levels.

1.) Domestic legislation:

At the national level, the Constitution of the People's Republic of China and the Criminal Law of the People's Republic of China both contain clauses specifying the important role of the State in the protection of natural resources and in biodiversity conservation, and provision of criminal charges and punishment for violating the Forest Law.

At the administrative and departmental level, regulations issued by the State Council (the highest legislative body) are put in place for the implementation of the constitution and national laws. These include '*Detailed rules for the implementation of the Forest Law*', the '*Plant Quarantine regulation and its detailed rules concerning agriculture*', '*Plant Quarantine regulation and its detailed rules concerning forestry*', '*Measures for the protection of agricultural wild plants and the Forestry Plants Quarantine and its labelling*'.

At the local level are the laws and regulations made by local government (the Peoples' Congress and Standing Committees) of the province or autonomous region. These are made based upon

the specific situation and local needs within the provinces. For instance Zhejiang province has its own Nature Reserve Regulation, Yunnan has the 'Yunnan Rare Trees Protection Regulation', and Guangdong has the 'Implement Measures for forest management' which cover rules for implementation of forestry regulation in the province.

2.) Other related provisions

China's **Nature Protection Program (1987)** is the first document providing guidance on the protection of natural resources and natural environment from a macro perspective. This document clearly articulates the Chinese government's positive attitude and position on the protection of natural resources and the natural environment.

The China Biodiversity Conservation Action Plan (1994) puts forward seven goals including 26 action plans. According to the importance, urgency and feasibility of implementation, 18 priority projects are also included. Among these plans and projects, many are potentially concerned with the bamboo forest biodiversity conservation.

The **National Biological Species Resources Protection and Utilization Plan Outline (2007)** advances the strengthening of the in situ conservation of ornamental plants' in their native area, and reinforces efforts to protect bamboo bioresources and the biodiversity in their natural habitats. The Plan indicates that establishing natural reserves is considered the most effective method for protecting both the bamboo ecosystems and biodiversity at the species level.

3.) International laws and agreements

As well as the domestic legislation, China has signed up to several international conventions governing environmental law and responsibility. These include The Convention on Biological Diversity, The Convention on International Trade in Endangered Species of Wild Fauna and Flora , The Convention Concerning the Protection of the World Cultural and Natural Heritage, The Ramsar Convention on Wetlands, and the United Nations Framework Convention on Climate Change. These are all related directly or indirectly to the protection of biodiversity.

Forestry certification in China

The use of forestry certification as a mechanism to incentivise farmers to conserve biodiversity and protect ecosystem health is gaining ground in China. Currently international and national certification organisations are trialling certification mechanisms for bamboo forests, and the use of these mechanisms is expected to become more common in the future. As there is relatively low consumer awareness of biodiversity issues in China, it is expected that the government bodies will continue to play an important role in driving the demand for certification, in addition to international markets.

Policy recommendations for improving conservation and sustainable use of bamboo forest biodiversity

An analysis of the current policy framework in China was carried out and ten policy recommendations were formulated in five general categories, which are aimed at all three levels of government. Some of the recommendations concern the thorough implementation of existing legislation or the speeding up of processes which have already been approved; others advocate changes in the systems in place, or introducing new mechanisms. The ten recommendations are summarized below, and subsequently explained in more detail.

5 Categories of Recommendation	10 Specific Recommendations
1. Clarify roles of government agencies and improve inter-agency coordination of biodiversity issues	1.1 Clarify the protection management system and mechanisms at all levels of administration
2. Re-examine bamboo's position in existing forestry legislation and the classification system	2.1 Review the inclusion of bamboo and bamboo forests in forestry policies, and re-categorize where necessary
	2.2 Promote multi-functional bamboo forest management
3. Formulate policies specifically for bamboo management	3.1 Set up a bamboo resource cultivation and management policy
	3.2 Improve technology support and research on bamboo forest biodiversity
	3.3 Improve the investment system for bamboo forest biodiversity conservation
4. Further clarify and strengthen property and usage rights	4.1 Strengthen the management of property rights over the bamboo forests, and clarify rules for requisition of forest land by the State
5. Further integrate local communities and general public into bamboo forest biodiversity protection initiatives	5.1 Establish a community participation mechanism on bamboo forest biodiversity protection
	5.2 Improve the compensation mechanism for forests (and bamboo forest) ecological benefits
	5.3 Reinforce the publicity and education on the conservation of biodiversity in bamboo forests

Table 5: Recommendations for changes in legislation and policies in China

1. Clarify roles of government agencies and improve inter-agency coordination of biodiversity-related issues

Present Situation: Currently departmental responsibilities for protecting biodiversity in bamboo forests are unclear. For the implementation of biodiversity conservation, China exercises a system of comprehensive and integrated management by various departments. According to the State Council's '3 Fixed Scheme' the State Environmental Protection Agency (SEPA) under the State Council is responsible for leading the work on biodiversity conservation. However, according to the relevant regulations and laws (such as the Forest Law) the State Forestry Administration is responsible for the administration of bamboo forests and bamboo.

Due to the lack of clarification of roles, this overlap in responsibility is prone to the creation of conflicts between the departments, over-management, and the waste of administrative resources. A clearer definition of departmental responsibility and control over specific issues is required.

RECOMMENDATION 1.1: Clarify the protection management system and mechanisms at all levels of administration

1.) At the national level, highlight the leading role played by the State Forestry Administration in matters of biodiversity protection in forests. Steps that should be considered include:

- i.) Reform the coordination system between the principal environmental protection administrations under the State Council;
- ii.) Establish a high level cooperation mechanism and progressively improve cooperation between departments involved in biodiversity protection management;
- iii.) Include bamboo forest protection measures into departmental development plans.

2.) At the local government level, establish a management agency to strengthen the cooperation between departments. 'Biodiversity protection committees' should be setup at provincial and county level to guide and coordinate the local biodiversity protection.

3.) Setup and implement law enforcement of biodiversity protection. A united enforcement mechanism made up of administrative organs for industry and commerce at various levels, public security and forestry administrative authorities should be established and a punishment policy for the illegal logging of bamboo and trade should be implemented.

2. Re-examine bamboo's position in existing forestry legislation and the classification system

Present Situation: The definition of bamboo and bamboo forests within legislation is not clear. Bamboo is not best served by its classification in forestry legislation and in the function based classification system used to delineate forests. 'The Forest Law', and its associated regulations and guidelines all define bamboo forest as a 'conventional forest', and bamboo plants as 'trees'.

This definition blurs essential differences between the bamboo forest and a conventional tree forest. There are fundamental differences between bamboos and trees at the biological and ecological level, especially given that bamboo's growth rate exceeds that of trees. In addition, bamboo must be harvested after a certain time; otherwise its productivity and utilization function is significantly lower. The lumping of bamboo together with trees results in the formulation of policies which are at odds with the bamboo sector and ecology.

RECOMMENDATION 2.1: Review the inclusion of bamboo and bamboo forests in forestry policies, and re-categorize where necessary

The biological characteristics of bamboo need to be taken into account for appropriate classification. Once the classification is completed, and the position of bamboo is clarified, appropriate protection and management measures should be identified and implemented.

Present Situation: The delineation of bamboo forests into categories based upon forestry utilisation purpose is overly rigid. The existing system which classifies forests by their different

functions places bamboo mainly in the category of commercial forests, which both defines its major role as producing timber, but also places restrictions on harvesting activities, which are sometimes inappropriate. This classification also means that there is little incentive to enhance the multiple other functions that bamboo forests can provide, such as watershed protection and soil stabilisation.

RECOMMENDATION 2.2: Promote multi-functional bamboo forest management

For bamboo forests which have already been defined as 'commercial', under the condition of controlling the allowable annual cut determination, loosen burdensome felling restrictions and allow forest managers or farmers to prepare the harvest limit. Whilst recognising the principal function is wood production, the promotion of other functions should also be encouraged. This should include afforestation and the introduction of a greater number of tree species into pure bamboo plantations, to create a biodiverse landscape and allow bamboo forests to provide 'protective forest' functions (See Table 2).

3. Formulate policies specifically for bamboo management

Present Situation: The risk of continued conversion to monocultures throughout bamboo forests in Southern and South-Western China calls for clear technical guidance for the management of bamboo forests. This should reflect the realities of the resource constraints, as well as local conditions. In addition, there is a lack of a technology support system to provide technical input into policy formulation, due largely to the absence of a strategy for biodiversity conservation, low coordination on research on bamboo forest biodiversity, and lack of promotion of research findings.

Finally, there is a lack of investment to fund bamboo forest biodiversity conservation initiatives by the government or by third parties. To date, the only significant investments which have been made in conservation of bamboo forest biodiversity have been those in preserving and extending the habitats of Giant Pandas. The small funding that exists comes from local government allocations, capital grants or subsidies from the State Forestry Administration, local funding from tourism and international projects, and is insufficient and unpredictable for budget planning purposes.

RECOMMENDATION 3.1: Set up a bamboo resource cultivation and management policy

1.) Set up a technical policy for the sustainable management of bamboo forest which increases biodiversity conservation. This should aim to further develop and encourage the adoption of more environmentally-friendly methods of cultivation instead of the currently promoted methods. At the same time, encourage the replacement of extensive management methods (where these are still used) to increase the productivity of those forests with low productivity. Checks are needed to ensure that any degradation of bamboo forests due to over-intensive management is prevented.

2.) Map out the operational measures and plans for the sustainable, biodiversity-friendly management of bamboo forest. A 'Guidance on Bamboo Sustainable Management' should be formulated at the national level.

The formulation of local standards should be encouraged, taking into account geographic location, ecological conditions, economic development and the types of bamboo resources. The local government at all levels and the local industry should prepare a plan for sustainable management, balancing the relationship between protection and utilization.

RECOMMENDATION 3.2: Improve technology support and research on bamboo forest biodiversity

- 1.) Establish strategic objectives on the research of bamboo forest biodiversity in line with China's "Bamboo Industry Science and Technology 15 Development Guidelines", which provide comprehensive guidance for the sector's development.
- 2.) Strengthen coordination between management agencies and research institutions to avoid repetition. Integrate priority research areas between the State Forestry Administration, Chinese Academy of Science and the Ministry of Education to formulate propositions on the scientific research to the State Commission of Natural Science Foundation and the National Development and Reform Commission amongst others. Coordinate lobbying efforts on scientific issues that need to be solved urgently for inclusion into national research initiatives.
- 3.) Speed up the dissemination and further demonstration of the research results of the bamboo forest biodiversity conservation project. Knowledge dissemination, technology promotion and demonstration need to be carried out to provide scientific guidance for the protection and development of bamboo forest biodiversity.
- 4.) Place more emphasis on research and development of biodiversity protection technology, sustainable utilization technology, management technology, exploration of traditional technology and perfecting the supporting policies.

RECOMMENDATION 3.3: Improve the investment system for bamboo forest biodiversity conservation

- 1.) Seek further assistance from the state to increase investment into the protection of bamboo forest biodiversity.
- 2.) Put into practice a favourable credit policy and insurance system to facilitate payments for biodiversity protection to implementing agencies or famers.
- 3.) Systematically apply for grants and loan projects from international donors.
- 4.) Establish a protection fund feedback mechanism as quickly as possible. This system should ensure that part of the economic profits from local bamboo sector and forestry revenues will be used for the bamboo forest biodiversity protection.

4. Further clarify and strengthen property and usage rights

Present Situation: There remains uncertainty in some areas regarding the property rights of forest land. These include unclear ownership, the length of leases on land, the stability of current land tenure arrangements and the rights to use the land for different purposes. Previously, uncertainty over property rights and changes of ownership and usage rules led to over-exploitation of land in the short-term due to lack of guarantees that land would not later be requisitioned, or fear that certain activities would be banned. Although a process to clarify these issues is in place, its implementation should be accelerated.

RECOMMENDATION 4.1: Strengthen the management of property rights of bamboo forests and clarify rules on requisition of forest land by the State

The current reform of the forestry property rights system should be harnessed as an opportunity to further clarify the distinctions between property rights of forestland, and the ownership over the products derived from these forests. A clear distinction should be made between the right to use, and the right to manage (i.e. making decisions regarding current and future land use). In addition, the system used to transfer or sell property rights should be standardized.

Regarding requisition of forest land:

- 1.) Ensure that all requisition and occupation activities of forestland by the State are strictly managed and carried out in an open way.
- 2.) Strictly implement the 'balanced equilibrium system' and the 'dynamic equilibrium system for forestland requisitioning and occupation' to ensure that forest land requisitions follows the legal pathway and best practices established.

5. Further integrate local communities and general public bamboo forest biodiversity protection initiatives

Present Situation: A considerable challenge remains in raising awareness of biodiversity and changing the practices of bamboo farmers. Although compensation mechanisms exist, they are inadequate. Public knowledge and participation in biodiversity conservation is low.

The ecological compensation system (Payments for Ecosystem Services)

China has already put into place a forestry ecological compensation system, the details of which are explained in Article 8 of the Forest Law.

However, compared with the bamboo forest's current economic returns, the present compensation standard is relatively low. In addition, the definition of compensation beneficiaries and scope are still incomplete. Currently, only the nature reserves at the sources of rivers and State level nature reserves are eligible for ecological compensation.

Community policy and public participation in bamboo forest biodiversity conservation

According to the Forest Law and the Wild Plants' Protection Ordinance, great importance should be attached to public participation and community development. However, problems still exist in this area.

The public awareness of environmental protection is weak, and participation is low both in scope and scale. The majority of society in China does not appreciate the importance of protecting biodiversity. This is particularly true in rural areas with low education levels, where participation in initiatives is usually mandatory and passive.

RECOMMENDATION 5.1: Establish a community participation mechanism on bamboo forest biodiversity protection

- 1.) Invite the community to participate in the protection, decision-making, implementation, supervision, adjustment and profit sharing, and coordinate the relationship between the community and the government.

2.) Improve the safeguard policy. Through laws and regulations, the state should stipulate a protection plan for the bamboo forest biodiversity protection, nature reserve establishment and the public participation in the decision-making on development plans for bioresources. At the same time, establish a community participation mechanism, improve various regulations, and build up a monitoring management team by the villagers.

RECOMMENDATION 5.2: Further improve the compensation mechanism for forests (and bamboo forest) ecological benefits

A suitable Payment for Environmental Services scheme should be established to compensate farmers for short term losses through valuation of the ecological benefits provided.

- 1.) Actively conduct scientific research and assess the value of ecological services.
- 2.) On the basis of scientific assessment of the bamboo forest, weigh the standard compensation amount for differing conditions, and establish a clear policy and scale on payments.
- 3.) Build social consensus to effectively solve the compensation problems and promote the sustainable development of the bamboo forest biodiversity.

RECOMMENDATION 5.3: Intensify the publicity and education on the conservation of biodiversity in bamboo forests

- 1.) Further enrich publicity and education on biodiversity in general through various channels.
- 2.) Enrich the format of publicity on the imperative of conserving biodiversity for economic and environmental reasons. Provide publicity and public education to the public and to the government administrative departments.
- 3.) Enhance training of teachers and educators in schools, technical institutes and other training facilities on biodiversity and its importance.

Chapter Summary

There are a number of areas of central forestry policy which have led to the biodiversity loss in bamboo forests which threatens the sustainability of the sector. Changes in the following areas are needed to ensure the long term economic viability of the sector.

- Unclear responsibilities for biodiversity within government departments, and on bamboo's position within forestry-wide policy lead to a lack of consideration for biodiversity issues in bamboo forests.
- A central policy on bamboo cultivation, with details on technical support and funding is recommended.
- Further clarity over property rights is required to ensure that farmers make decisions with long-term horizon.
- Further integration of communities into biodiversity conservation governance through education and compensation mechanisms, and more education on biodiversity for the public is needed.



Chapter 4: Global lessons



4. Global lessons

The clear link established between biodiversity and long term health and productivity of bamboo forests in China is likely to hold true with other cultivated bamboo species in different locations. The policy framework which governs how bamboo forests are used plays an primary role in defining how these forests are both seen and managed.

China's bamboo sector is unique in terms of its scale and level of organization. It presents a leading model for many countries to follow given the global constraints on forests and timber, and the ongoing need to develop rural industries and alleviate poverty. However, as this paper has shown, biodiversity is critical to keeping these forests healthy, so they can continue to perform the multiple objectives of timber provision, rural poverty alleviation and providing environmental services. Policy in the forestry sector is critical in ensuring the healthy development of the bamboo sector, and should reflect forest biodiversity as a key objective.

The policy lessons for China are also applicable in the international context, despite differences in local situations.

- **Re-examine bamboo's position in existing forestry legislation and the classification system**
Bamboo is treated differently by different countries given their local conditions-sometimes as a tree and sometimes as an agricultural crop. This is not a problem where the ecological and sectoral characteristics are carefully considered. However, where this is missing there is a risk that inappropriate policies are made which hinder the sector's sustainable development. Clear classification of bamboo should be made in accordance with bamboo's ecological characteristics, and this classification should be recognized in relevant policies and legislation. In addition, recognition of the multiple functions of bamboo is important and the ascribing of a single 'purpose' for bamboo forests should be avoided.
- **Formulate policies specifically for bamboo management**
Clear guidelines on bamboo management should be provided in order to ensure the healthiness of bamboo forests and resources. In countries with significant bamboo sectors and agencies working specifically on bamboo can play an important role in formulating these. Opportunities for knowledge transfer on biodiversity-friendly bamboo management models from China should be used where relevant.
- **Further clarify and strengthen property and usage rights**
As with other natural resources, farmers are more likely to invest in their bamboo forests and plan over long periods if they are confident in the security of their tenure and rights to use, manage and transfer resources. Rights regarding use of common resources should make explicit reference to bamboo resources, and provide guidance on management. These should include rights to use as well as responsibilities with regards to biodiversity in bamboo ecosystems.
- **Further integrate local communities and the general public into biodiversity protection in bamboo forests**
More education on the long-term negative effects of biodiversity loss on forest functions and profits for bamboo farming communities is needed. Where restrictions are needed to be placed on management methods, compensation should be provided at an adequate level. and profits for bamboo farming communities is needed. Where restrictions are needed to be placed on management methods, compensation should be provided at an adequate level.

References

Chapter 1

Development in China's Forestry Sector', Xinhua News Agency, March 20, 2009
http://www.china.org.cn/environment/report_review/2009-03/20/content_17473108.htm
(Accessed 5/9/2010)

7th National Forestry Inventory in USDA Foreign Agricultural Service
http://gain.fas.usda.gov/Recent%20GAIN%20Publications/China's%20Forestry%20Resource%20Inventory_Beijing_China%20-%20Peoples%20Republic%20of_2009-12-15.pdf
(Accessed 5/9/2010)

FAO China Forestry Statistics
<http://www.fao.org/docrep/x2613e/x2613e2h.htm> (Accessed 4/9/2010)

Liu D.C., 2001 Tenure and Management of Non-State Forests in China since 1950: A Historical Review, *Environmental History*, Vol. 6, No. 2, Special Issue: Forest History in pp. 239-263

Chapter 2

Zhang, Y.X. et al., 2000 Causes of mite pest outbreaks in bamboo forests in Fujian, China: analysis of mite damage in monoculture versus polyculture stands. *Systematic and Applied Acarology Special Publications*

Jiang, Z.H., 2007. *Bamboo and Rattan in the World*. Beijing, China Forest Publishing House

Fu, M.Y., Xiao J.H., Lou, Y.P., 2000. *Cultivation and Utilization on Bamboos*. Beijing. China Forest Publishing House
(He and Lou 1999)

Pan Y. 2000 The effects of different management practices on bamboo forest soil and ecology change. MSc. Research Institute of Subtropical Forestry, Chinese Academy of Forestry

Zheng Y.S., and Hong W., 1998. *Management of Phyllostachys pubescens stand*. Xiamen. Xiamen University Publishing House

Huang Y.C. and Zeng X.W., 1993. Management and its benefit of *Phyllostachys pubescens* mixed stand. *Journal of Bamboo Research*. 12, in pp.16-23



Bamboo forests are unique in their ability to meet economic and social objectives of providing timber, development and raising rural incomes rapidly and over a sustained period of time. China's example has shown that by changing their management practices, farmers are able to get richer through significantly increasing the supply of timber to markets without depleting the source of this timber - a relatively uncommon phenomenon in the forestry sector. However, recent changes in practices are altering bamboo forest structure and biodiversity with negative effects. INBAR's Bamboo Biodiversity Project examined current practices and policies to determine causes, as well as interventions to halt the loss in biodiversity and subsequent degradation of forests. This report presents the project's general findings, and suggests what changes are needed to ensure healthy development of China's bamboo forests, as a key component to its forestry sector.

