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Forest Management Policies and Resource Balance in China

An Assessment of the Current Situation

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Using the latest forest inventory, this article provides a detailed analysis of China's changing forest sector by focusing on new forest trends, forest policy changes, and challenges to achieving a sustainable forest management. The authors analyze the dynamics of forest resources and provide an impact assessment of forest policies on China's forestry development during the past decades. Moreover, the analysis of the forest market highlights substantial disequilibria marked by a limited domestic supply potential and a growing demand for forest products satisfied by increasing imports. Internal and external solutions are explored, and their implications for China and supplying countries are assessed.

Keywords: *forest management; forest resources; economic development; China*

1. Introduction

Despite a forest cover of 175 million ha and a standing timber stock of 12.5 billion m³ that place the country respectively at the fifth and the seventh world ranks, China can still be considered forest deficient. Its resources account for only 4% of world forests and less than 3% of world timber stock (Food and Agriculture Organization [FAO], 2003). Although China's forest coverage has recently increased up to 18.2%, it remains at half of the world average, and China's forested area per capita of 0.13 ha is far below the world average of 0.65. Timber stock comparisons highlight similar gaps because the standing stock volume amounts to less than 10 m³ per capita, whereas the world average stands at approximately 66.

Authors' Note: Part of the research was conducted when Sylvie Démurger was visiting the Hong Kong Institute of Economics and Business Strategy at the University of Hong Kong, whose hospitality is greatly acknowledged.

The forest deficit that characterizes China is the outcome of a long history of deforestation, which particularly intensified after the founding of the People's Republic in 1949. Both the quantity and the quality of forest resources in China sharply decreased during the collectivization period (1958 to 1982), notably during the Great Leap Forward and the Cultural Revolution.¹ The deforestation trend was even further exacerbated at the beginning of the 1980s, after economic transition from a planned system to a market economy started. In particular, insecure ownership rights over trees granted to rural households have led to massive forest clearings by the contracting farmers.

At the same time, China's sustained economic growth during the reform period has led to a surge in demand for forest products, although per capita consumption of wood products remains low by international standards.² The construction boom including house building in both cities and rural areas and the rising demand for educational and cultural activities have been important factors driving the sharp increase in demand and in quality requirements for wood materials, furniture, paper, and paperboard. According to unofficial estimates, the national timber consumption (excluding fuelwood) rose from 145 million m³ in 1993 to 283 million m³ in 2003,³ with the paper sector being the largest wood consumer (32% of the total), followed by construction and housing (22%), rural energy consumption (21%), and furniture (11%) (Xiong, 2004; Zhu, 2004).⁴ With further increases in income, most of these uses are expected to rise in the future.⁵

Facing the ecological consequences of forest overexploitation and the growing pressure from the demand side, the Chinese government has radically reoriented its forest policy during the past 20 years by moving from a timber production strategy to a strategy of resource and ecosystem conservation and restoration. These efforts are believed to have successfully contributed to an increase in both China's forest area and timber stock by the beginning of the 1990s (Table 1). Most recently, the national forest policy further shifted toward conservation at the end of the 1990s with the launching of Six National Key Forest Programs, which aim at restoring, conserving, expanding, and commercially developing China's forests, especially in ecologically sensitive areas such as the Yangtze and Yellow River areas in the western regions.

Although forest resources in China are expanding in both coverage and volume, constraints imposed by the new forest policy coupled with a continued growing demand for wood and structural domestic resource shortages have resulted in huge disequilibria in China's forest market. In recent years, the large gap between demand for and supply of wood has been mainly filled in by increasing imports,⁶ especially after tariffs on log imports were eliminated in 1999. China is now a major player in the international trade of many forest products such as logs, sawn wood, and wood pulp for imports and furniture for exports. China's total value of forest product imports ranks second just after the United States, and China ranks first in terms of industrial log imports (FAO, 2004). Moreover, the surge of Chinese imports is reported as causing severe ecological degradation and threatening the livelihood of

Table 1
Change in China's Regional Distribution of Forest Resources

	Second Inventory: 1977–1981		Third Inventory: 1984–1988		Fourth Inventory: 1989–1993		Fifth Inventory: 1994–1998		Sixth Inventory: 1999–2003	
		%		%		%		%		%
National										
Forested area	115.3	100.0	124.7	100.0	133.7	100.0	158.9	100.0	171.1	100.0
Timber stock	9,028	100.0	9,141.1	100.0	10,136.8	100.0	11,266.5	100.0	12,455.8	100.0
Forest cover (%)	12.0		13.0		13.9		16.6		18.2	
Northeast										
Forested area	35.1	31.0	35.7	29.0	36.6	28.0	39.4	25.0	41.3	24.5
Timber stock	2,941.4	33.4	2,892.4	32.0	3,002.7	30.0	3,178.9	29.0	3,293.0	27.2
Forest cover (%)	19.5		19.8		20.3		21.9		22.9	
Southwest										
Forested area	22.3	19.7	26.5	22.0	28.1	21.0	33.5	21.0	37.6	22.3
Timber stock	3,546.4	40.3	3,770.1	42.0	4,464.4	45.0	4,806.0	44.0	5,245.2	43.4
Forest cover (%)	10.3		12.2		12.9		15.4		17.3	
South										
Forested area	39.2	34.6	41.1	33.0	46.6	35.0	59.0	38.0	63.3	37.5
Timber stock	1,475.8	16.8	1,337.5	15.0	1,457.7	15.0	1,794.2	16.0	2,305.5	19.1
Forest cover (%)	25.3		26.5		30.1		38.0		40.8	
Three-north										
Forested area	16.6	14.7	19.4	16.0	20.4	15.0	25.0	16.0	26.7	15.8
Timber stock	837.6	9.5	914.3	10.0	985.1	10.0	1,129.3	10.0	1,254.0	10.4
Forest cover (%)	4.1		4.8		5.1		6.2		6.6	

Source: State Forestry Administration, sixth forest inventory.

Note: units = millions of hectares (area); millions m³ (stock). Forest regions include the following provinces: northeast = Heilongjiang, Jilin, and Inner Mongolia; Southwest = Sichuan (Chongqing included), Yunnan, and Tibet; South = Anhui, Zhejiang, Fujian, Jiangxi, Hubei, Hunan, Hubei, Guangdong, Guangxi, Hainan, and Guizhou; three-north = Liaoning, Hebei, Beijing, Tianjin, Shandong, Jiangsu, Shanghai, Shanxi, Henan, Shaanxi, Ningxia, Gansu, Qinghai, and Xinjiang. The first forest inventory was conducted from 1973 to 1976. At that time, the total forest area was 121.9 million ha with a stock volume of 9,532.3 million m³, and the forest cover was 12.7%.

local people in supplying countries, especially in the Asia-Pacific region, where China is the dominant trade partner of many countries for forest products. Under these perspectives, any change in China's timber supply and demand might have important environmental, economic, and social implications not only in China but also in the rest of the world.

The objective of this article is to provide a detailed analysis of China's changing forest sector along various dimensions covering forest resources and their recent evolution, changes in forest management patterns and in forest policy, and the evolution of timber supply and its consequences on international forest markets. To this end, we use the latest official forest inventory statistics released in 2005 for the period of 1999 to 2003.⁷ To our knowledge, this article is the first to use these statistics, and a comparison with previous inventories provides an important update on changing forest policies in China over the reform period. This article also contributes to the literature by confronting the very important issue of the impacts on neighboring countries and other timber-producing regions of China's recent shift toward conservation.

The article is organized as follows. Section 2 introduces changes in forest management patterns and national forest policies. Section 3 analyses changes in China's forest resources during the past two decades in terms of both quantity and quality. Section 4 discusses current and future challenges on the domestic market as well as on the international market for forest products.

2. Changes in Forest Management Patterns: From Exploitation to Protection

As briefly stated above, forest policies in China have undergone deep changes during the past 30 years. In this section, we review several major aspects of these policies before discussing their likely impact in the next section. Property rights, ownership, and tenure are intricate issues in China and deserve preliminary clarification. A specificity of the Chinese system is that the tenure of trees or forest resources can be different from land ownership. Land in China is either state owned or collectively owned. Hence, the law states that forest resources belong to the state unless it stipulates they belong to collectives, with township governments and village committees being the legal representatives. In state-owned forests, both land and trees thus belong to the state, and state-owned forestland is managed by state-owned forest enterprises. In collective forests, the ownership of land and the ownership of trees may be separated: Although land belongs to collectives, the trees can be owned not only by these collectives but also by households or jointly by different private or public entities. Forests where trees are owned by households or by other private entities have recently been classified under a "private forests" category, although land remains collectively owned. As a consequence, "private forests" constitute an increasingly important subcategory of "collective forests", as discussed in Section 2.2.

In terms of policy changes, two main issues are worth emphasizing. First, management policies and forest tenure have changed markedly in both state-owned and collective forests, however with contrasted achievements. On one hand, the state forest sector remains largely dominated by inefficient resources exploitation; on the other hand, the collective sector has turned to a privatized management, with greater autonomy granted to households. Second, recent national large-scale forest programs have marked a paradigm shift from forest resource exploitation to protection.

2.1. Slow Changes in the State Forestry Sector

With the nationalization of natural forests in the early 1950s, two major institutions have been established to take on the management of state forests: state forest industry bureaus and state forest farms. Their main objectives were to supply cheap logs to support the national industrial development with little concern about forest protection and resource overexploitation.⁸ All the economic activities of these state-owned forest enterprises (bureaus and farms) were regulated through a planning system. The central forestry authorities were establishing an annual harvesting plan, and timber production tasks were then assigned to each state forestry bureau and farm.

Until the early 1980s, the state forestry sector suffered from problems similar to other state-owned industrial sectors in China. Low timber prices, weak linkages between production and staff income, outdated equipment, and low investments in resource regeneration contributed to the overall inefficiency of this sector and to huge waste and overexploitation of forest resources (FAO, 1979; Richardson, 1990). To tackle problems of mono production, low productivity, overstaffing, and lack of incentives, the government instituted a number of measures from the beginning of the 1980s, including timber price increases,⁹ the implementation of a so-called “multiple-exploitation” policy in 1984 to promote diversification and integration in the sector,¹⁰ and the introduction of a responsibility system providing greater autonomy in enterprise’s management,¹¹ with income being more closely related to enterprise’s performance. Moreover, in the 1990s, public auctions of barren forestlands or juvenile stands of timber, leases under contract, and transformations into shareholding enterprises were introduced to improve the overall efficiency of the state forest sector.

Despite these efforts, the forestry sector still operates to a large extent under the planning system with production quotas and suffers from an inefficient management that induces forest resources depletion.¹² Moreover, the “multiple-exploitation” scheme plays only a limited role in income diversification because timber products still represent more than two thirds of the total income of the state forest enterprise (State Forestry Administration [SFA], 2004a). In addition, the contract responsibility system gives managers strong incentives to produce more timber, even illegally by exceeding harvest quota, to maximize their revenues during the contract period. As a consequence, this reform has led to an unsustainable exploitation of state-owned forests and rapid resource depletion. Richardson (1990) pointed out that at the end

of the 1980s, 30 out of 136 state forestry bureaus had no more exploitable forest resources. Harkness (1998) estimated that since 1977 the stock of exploitable natural forests has been reduced by half from 1.97 trillion to 1.04 trillion m³. More recently, the implementation of the Natural Forest Protection Program (NFPP), which entails a logging ban on natural forests in 17 provinces along the Yangtze and Yellow River basins, has further worsened the situation because of dramatic reductions in timber production and employment.¹³ As a result, the financial situation of the state forestry industry has been deteriorating and the amount of nonpaid salaries and pensions has risen steadily since the mid-1990s. In 2003, the whole state forest industry was running a net deficit of 460 million yuan. The same year, unpaid salaries and pensions amounted to 1.6 billion yuan and concerned 570,000 workers.

2.2. Management Patterns in Collective Forests: From Communities to Households

Compared to state forests, tenure and management systems for collective forests have experienced deeper changes over time and across regions, the most striking being the emergence of private ownership on trees over the reform period.¹⁴ Changes in management arrangements of collective forests have resulted in an increased role played by rural households. According to Hyde, Belcher, and Xu (2003), approximately 80% of collective forests are now under individual household management.

The turning point for collective forests management occurred when the "Decision on Some Issues concerning Forest Protection and Forestry Development" was issued in 1981. This decision included three major components: (a) the stabilization of forest tenure through property certificates provided to owners, (b) the distribution of use rights to rural households on nonforested land (known as "family plots"), and (c) the introduction of a forestry Contract Responsibility System that gave households land-use rights on collective forest lands (known as "responsibility lands"). The national implementation of this policy has resulted in a variety of management patterns from collective management to household-based tenure.¹⁵ At the household level, family plots and responsibility lands are the two main forms of forest tenure. As documented by Liu (2001), tenure is more certain for family plots because private property and inheritance rights on trees planted on family plots are guaranteed.¹⁶ Regulations are different for forestland other than family plots, and decision-making and management rights on trees may not be fully guaranteed because tree planting and harvesting are still subject to the approval of local forestry bureaus.

By the end of 1984, a total area of 31.3 million ha had been distributed to 57 million households in the form of family plots (SFA, 1986a). Most plots distributed to households were barren land and degraded or fragmented forestlands, and tree planting was intended to cover individual needs for fuelwood and timber. Moreover, as in agriculture, local governments at township and village levels contracted a large portion of the existing collective forests to households in the form of responsibility

lands. Under this system set in the early 1980s, forests remained collectively owned but the management responsibilities were transferred to households to provide them stronger economic incentives to plant more trees as well as to invest in the management of existing collective forests. In particular, incomes derived from forest exploitation on existing trees were shared between the collectives and the contracting household according to a proportion stipulated in the responsibility contract. In the 1990s, several new tenure forms emerged to improve the quality of forest management and to foster afforestation. In 1992, the Barren Lands Auction policy encouraged local authorities to auction off their barren land to households for reforestation under a 30- to 100-year lease contract. Property rights for these lands are similar to family plots (Miao & West, 2004). At the same time, household-based management patterns further diversified with the emergence of various self-initiated shareholding systems, aimed at solving problems related to land fragmentation and high family exploitation costs of small forest plots.¹⁷

2.3. New Forest Policies: A Shift From Resource Exploitation to Resource Protection

Growing concerns toward environmental protection and forest conservation have led to several key policy changes since the mid-1990s, including the adoption of a new forest classification policy as well as the implementation of various national forest programs.

Since the implementation of the 1984 Forest Law, Chinese forests have been classified according to their use into the following five categories. "Shelter forests" include forests, forest trees, and groves mainly used as shelter. They consist of forests for protecting headwaters of rivers, forests for conserving water and soil, wind-break and sand-fixation forests, farm and pastureland shelter forests, embankment protective belts, and road protection belts. "Timber forests" comprise timber-producing forests and forest trees as well as bamboo forests producing bamboo products. "Economic forests" refer to trees and perennial crops that mainly produce fruits, edible oil, and ingredients of drinks, condiments, industrial materials, medicinal herbs, and so on. "Fuelwood forests" include forests mainly used to satisfy energy needs in rural areas. "Forests for special use" include all forest areas, mainly national parks and natural reserves, designated for the national defense, scientific experiments, and environment protection.

In 1995, a new forest classification framework was introduced for experimentation in more than 40 counties and then was endorsed officially by the revised Forest Law in 1998 (SFA, 1998a). Under this new policy, the five categories of forests identified by the 1984 Forest Law were reclassified into two categories: ecological forests (consisting of former shelter forests and forests for special use) and commercial forests (comprising former timber forests, economic forests, and fuelwood forests). Regulations on management, funding, and exploitation are different for

these two categories of forests. Commercial forests basically follow market rules, whereas ecological forests remain mostly funded by the government.

The rising importance of ecological concerns has been further consolidated by the implementation of several wide-scale programs newly created or restructured from existing programs to both protect forest resources and promote forestry development within the Six National Key Forest Programs approved by the State Council in 2000. The new strategy is meant to be more integrated in the sense that it is designed to promote both protection of existing threatened forest resources and production through timber forests plantations. The six programs include NFPP, the Sloping Land Conversion Program, the Desertification and Dust Storms Control Program in the vicinity of Beijing and Tianjin Municipalities, the Forest Shelterbelt Development Program in key environmentally fragile regions, the Wildlife Conservation and Nature Reserves Development Program, and the Fast-growing and High-yield Timber Plantations Program. During the 1998 to 2003 period, the six programs were financed mainly by state investments,¹⁸ which accounted for 83.5% of a total of 94.67 billion yuan (SFA, 2004a).

The government's new concerns on ecosystem restoration are particularly embodied into two of these national programs, the NFPP and the Sloping Land Conversion Program. The destruction of natural forests in the upper and middle course of the river has been considered as one of the main causes of the 1998 Yangtze River flood that caused thousands of deaths and tremendous economic losses. First implemented in pilot areas in 1998 and then extended in 2000 for a period of 11 years, the NFPP aimed at reducing the annual timber production in natural forests, which actually dropped from 64 million m³ in 1997 to 44 million m³ in 2002 (SFA, 2004b). The three main components of the program are a logging ban (or reduction) in state-owned natural forests in 17 provinces along the Yangtze and the Yellow Rivers or in sensitive areas,¹⁹ the afforestation of barren land and mountains, and the restructuring of the state-owned forestry industry.²⁰ More than one fifth of the total forested land in China (30 million ha of natural forests) is affected by the logging ban. The strict implementation of the logging ban has however been progressively relaxed from 2000 onward to limit the negative impact of the program on local populations. Hence, restrictions are maintained or even reinforced for ecological forests, whereas several logging activities have been allowed in commercial forests to take into account both wood products needs and ecological conditions. As a result, the national timber production quota was increased again up to 52 million m³ in 2004 (SFA, 2004b).

Launched in 1999 in three pilot provinces (Gansu, Shaanxi, and Sichuan) and progressively extended to 25 provinces, the Sloping Land Conversion Program aimed at reducing soil erosion by converting more than 14 million ha of cultivated land into forests and grassland, of which 4.4 million ha of land have a slope of more than 25 degrees (Z. Xu, Bennett, Tao, & Xu, 2004).²¹ Together with land conversion,

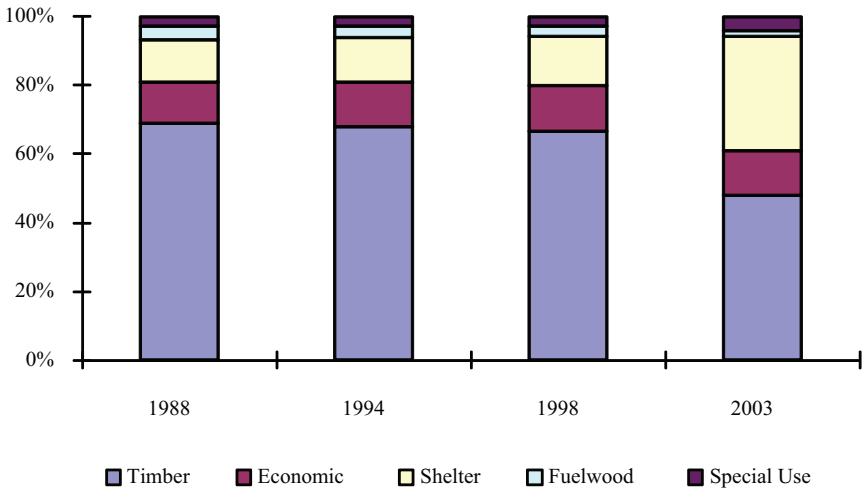
the program also entailed the objective of restructuring agricultural production and reducing poverty through a compensation scheme. This scheme grants participating households the payment of in-kind and cash subsidies for a period of 5 to 8 years. After its full-scale implementation in 2001, the conversion program became a key driving force in the afforestation increase in China. For 2003 alone, 68% of the record 9 million ha of total annual afforestation that year came from afforestation made under this program. However, although the impact of this program on households' income as well as on income inequality is generally found to have been positive, its ecological efficiency is debated on the ground of inappropriate selections of plots and species (Groom, Grosjean, Kontoleon, Swanson, & Zhang 2008; Uchida, Xu, & Rozelle, 2005; Uchida, Xu, Xu, & Rozelle, 2007; J. Xu, Yin, Li, & Liu, 2006). Moreover, the long-term sustainability of the program itself is questioned by the fact that farmers' incentives not to return their converted land to cultivation after the program payments stop are very low.

3. The "Forest Deficit": Achievements and Constraints

Since the first national forest inventory (1973 to 1976), China's forest resources have increased both in area and in standing stock volume, rising from 121.9 million ha and 9.5 billion m³ to 171.1 million ha and 12.5 billion m³, respectively, in the sixth inventory (1999 to 2003). According to the latest inventory, the annual growth of timber stock has been 496.7 million m³ during the period 1999 to 2003, whereas forest depletion is estimated to be about 365.4 million m³ per year, therefore implying a net annual increase of 131.4 million m³.

Part of these upward trends may be attributed to repeated changes in the definition of forest area during the whole period. First, the introduction of "economic forests" (including fruit trees, orchards, and other woody perennial cash crops) in Chinese forest statistics beginning in the mid-1980s has artificially boosted subsequent estimations of total forest cover. As shown in Figure 1, economic forests have accounted for 12% to 14% of the national forest area since 1988. With the implementation of the Sloping Land Conversion Program and the Fast-growing and High-yield Timber Plantations Program, one might expect that this share will eventually increase and further distort national figures as compared to international standards. Second, the canopy cover requirement to define forests has been relaxed progressively from 40% in the mid-1980s to 20% at the end of the 1990s. Third, the definition of *forest* itself has been further extended to include shrubs in the latest forest inventory. This last change itself is estimated to have contributed to an increase of 0.39 percentage points in forest cover between the fifth and sixth inventory, implying that 24% of the forest cover increase would actually come from this definition change.

Figure 1
Change in China's Forest Resources by Forest Type



Source: State Forestry Administration, various national forest inventories.

Note: Years refer to the end of the corresponding (third, fourth, fifth, and sixth) national forest inventories.

Although statistical artifacts certainly explain part of the story, they cannot alone fully account for the sustained improved situation of forest resources in China, and the above-mentioned changes in forest management and policies might also have been important driving forces as well. On one hand, the “privatization” process on trees ownership and the stabilization of forest management schemes have provided greater incentives for economic agents (including contracting households) to invest in tree planting and forest management activities. As shown by Démurger and Yang (2006), profit-seeking behaviors in the decision to plant trees have emerged throughout the reform period in China. This might have substantially contributed to the increase of collective forest resources. On the other hand, the implementation of the NFPP has effectively protected the state natural forest resource, whereas the large-scale Sloping Land Conversion Program has become the major driving force of the recent growth in forest resources. Recent estimates report that by 2007, 23.1 million ha of new plantation have been established under this program, increasing by more than 2% the forest coverage rate of the program areas (Jiang & Zhang, 2007). To further discuss the impact of these policy changes on China’s forest resources and

wood market, this section uses new forest inventory statistics to evaluate the major achievements as well as the remaining constraints.

3.1. Major Achievements

As discussed above, the major changes in China's forestry sector over the recent years can be found in the greater role given to the private sector as well as in the greater emphasis put on both afforestation and resources conservation. The contract responsibility system and new tenure forms have provided forestry households with more incentives to invest in forestry management and in tree planting. The effectiveness of these changes can be assessed through the evolution of forest resources, the changes in forest removal trends, and the relative importance of various forest categories.

Table 2 shows the distribution of forest resources by categories of ownership over trees (state owned, collectively owned, and private) in the period 1999 to 2003.²² The changing ownership structure of forest resources clearly highlights the changing role of the private sector. New tenure forms have attracted investment into forestry activities, and private participation in forestry development has risen steadily since the late 1990s. Hence, although state forests still account for the largest shares in both forested area and stock volume, China had 35.1 million ha of private forests by the end of 2003, which accounted for 20.3% of total forest area and 6.8% of total forest standing volume. Private ownership is particularly dominant in economic forests, with more than 60% of nontimber trees belonging to households and to other private owners. Moreover, the increase of private forests can be expected to strengthen in the future because private ownership was accounting for 41% of pre-forest plantations in 2003 and 80% of annual new plantations in 2003 to 2004.

A key direction to reduce pressure on natural forests and increase the overall timber supply has been to develop a domestic forest base through timber plantations. With a total 53 million ha of plantation forests, China is the world's leading country in tree plantations. As highlighted above, these activities have been undertaken by both the government and the private sector within various large-scale programs such as the Sloping Land Conversion Program and the Fast-growing and High-yield Timber Plantations Program,²³ within which 1.75 million ha had been planted by 2003 (SFA, 2004b).²⁴ As a result of these efforts, data from the latest forest inventory indicate that planted forests now account for 33% of total forest area, which represents a 6.8 million ha (or 13.4%) increase from the fifth inventory.

In terms of forest removal, one of the main characteristics of China's forest resources crisis highlighted by Yin (1998) at the end of the 1990s was the rapid depletion of natural forests. Since then, the implementation of the NFPP has contributed to changing patterns, with opposite harvesting trends between natural and planted forests on one hand and between state and collective forests on the other

Table 2
Forest Resources by Ownership Over Trees, 1999 to 2003

Category	State Forests		Collective Forests		Private Forests	
		%		%		%
Forested area	72.8	42.2	64.8	37.5	35.1	20.3
Timber stock volume	8,414.8	69.6	2,863.5	23.7	819.3	6.8
Closed forest area	68.8	48.2	54.3	38.0	19.7	13.8
Economic forest	1.1	5.1	7.1	33.1	13.2	61.8
Bamboo	0.3	6.6	2.5	51.4	2.0	42.0
Natural forest	61.3	52.9	41.5	35.9	12.9	11.2
Planted forest	8.9	16.7	22.4	42.0	22.0	41.3
Preforest plantation	0.8	17.4	2.0	41.5	2.0	41.1

Source: State Forestry Administration, sixth forest inventory.

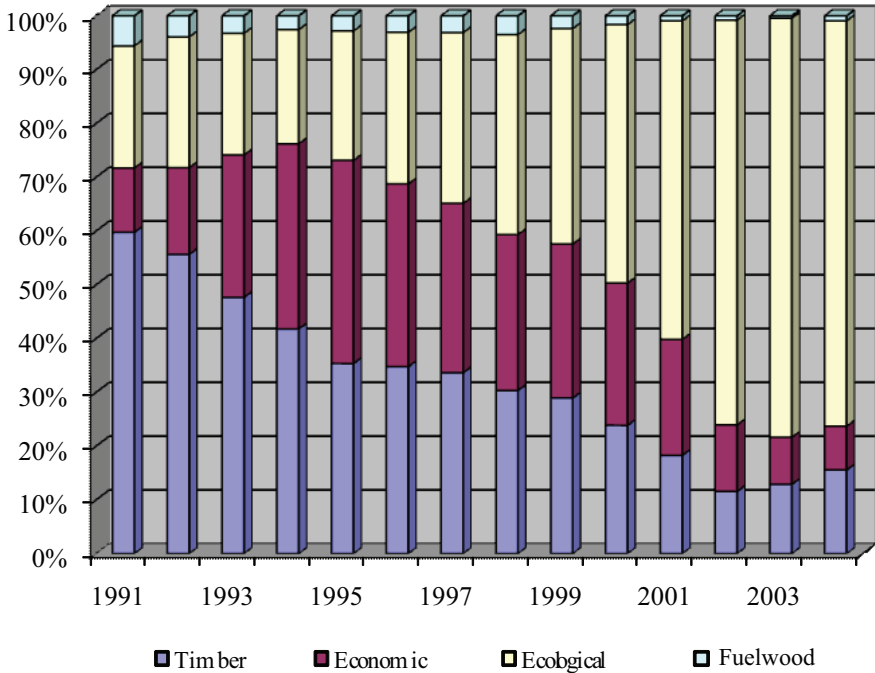
Note: units = millions of hectares (area); millions m³ (stock).

hand. Indeed, to satisfy its growing timber demand, China has promoted timber supply from planted forests and from non-NFPP areas. Therefore, during the 1999 to 2003 period, the annual harvest from natural forests was reduced by 24 million m³ whereas the annual harvest from planted forests increased by 19 million m³ as compared to the 1994 to 1998 period. During the same period, the timber harvest in NFPP areas decreased by 36.6 million m³ per year on average, mostly compensated for by an annual increase of 31.2 million m³ harvested in non-NFPP areas. Similarly, the annual average forest removal from state forests was reduced by 21.6 million m³ as compared to the 1994 to 1998 period. At the same time, the annual removal from southern collective forests (excluding southeastern state forests) increased by 10 million m³ to reach 157.5 million m³.²⁵

Last, in terms of forest use, almost half of existing forests are timber forests, one third are shelter forests, and the remaining are economic forests, fuelwood forests, and forests for special use. Figure 1 shows a significant rise of ecological forests at the expense of timber forests and fuelwood forests.²⁶ The structural change is particularly obvious from the fifth (1994 to 1998) to the sixth (1999 to 2003) inventory, during which the share of ecological forests increased from 17% to 38% of total forest area. This sharp increase can certainly be attributed to the new orientation of China's policy from forestry production to resource conservation and ecological safety reinforcement. And although the observed change may be more a matter of administrative reclassification of forests than real forest recovery, the trend may be further reinforced in the future because ecological forests have also accounted for more than 75% of the total annual afforestation since 2002.

Figure 2 highlights substantial changes in the afforestation structure over the recent years. At the beginning of the 1990s, timber forests were predominant, with a share of

Figure 2
Distribution of Afforestation by Forest Type (1991 to 2004)



Source: China Forestry Statistical Yearbook, various editions.

Note: The figure shows the proportion of each forest type in the total annual planted forests. Ecological forests include shelter forests and forests for special use.

60% of total plantings, followed by ecological forests (23%) and economic forests (12%). However, during the 1990s, timber forests gradually lost importance in favor of economic forests and, most important, ecological forests.²⁷ Since the late 1990s, the share of ecological forests in afforestation has risen sharply from 32% in 1997 to 75% in 2004, at the expense of both timber forests and economic forests. Hence, with the timber forest share in annual afforestation continuously falling from 34% in 1997 to 16% in 2004, the dramatic changes in afforestation structure since 1998 can be expected to further constrain wood supply perspectives in the future.

3.2. A Still Limited Wood Supply

Despite non-negligible achievements, China's domestic wood supply capacity remains limited. The shortage of total available forest resources, the still inappropriate

Table 3
Timber Production Quota, 1978 to 2004

Year	Production	Year	Production
1978	51,623	1996	67,103
1980	53,593	1997	63,948
1985	63,234	1998	59,662
1990	55,710	1999	52,368
1991	58,073	2000	47,240
1992	61,736	2001	45,520
1993	63,922	2002	44,360
1994	66,151	2003	47,589
1995	67,670	2004	51,973

Source: China Forestry Statistical Yearbook, various editions.

Note: unit = 1,000 m³. The table reports the production quota officially set by the government. As discussed in the text, the actual timber harvests were substantially higher than quotas during the whole period.

age structure, and the low productivity of Chinese forests all indicate that China's forest resources crisis may still be acute.

As discussed above, adjustments on forest types made under the new forestry policy have reduced the area of designated timber forests. Hence, because of increased restrictions, timber forest resources decreased by 19.5 million ha and 1.3 billion m³ between the fifth and sixth inventories. Available forests for timber production now amount to only 8.9 million ha, with a total stock volume of 1.28 billion m³, which represents 6.2% of the total closed forest area and 10.6% of total forest stock, respectively.²⁸

To satisfy the growing timber demand over the reform period, domestic supply has increased rapidly at the expense of the country's forest resources. China's timber production consists in three components: (a) planned production according to the state harvest quota, (b) nonreported above-quota production, and (c) noncommercialized production for self-consumption in rural areas. Since the introduction of the harvest quota system in 1985, above-quota production has been prevalent throughout the country, but official Chinese statistics on timber production report only the planned production (Table 3) and thus systematically underevaluate the true production level. According to estimates from the state Forestry Administration, even during the period of the sixth forest inventory (1998 to 2003), which coincided with the implementation of the NFPP, the average above-quota harvest was 75.54 million m³ per year, compared to an average quota production of 47.42 million m³.²⁹

The high level of above-quota production coupled with illegal logging significantly reduces the effectiveness of forest protection programs. Despite the reduction in production quotas and the shift in harvest from natural forests to planted forests since 1998, natural forests continue to be depleted. During the period of the sixth

Table 4
Forest Resource Depletion by Age Group and by Origin, 1999 to 2003

Age Group	Total		Natural Forests		Planted Forests	
	Volume	% of Each Age Group in the Total	Volume	% of Each Age Group in the Total	Volume	% of Each Age Group in the Total
Total	372.4	100.0	287.7	100.0	84.7	100.0
Young	62.6	16.8	46.6	16.2	16.0	18.9
Middle aged	147.3	39.6	108.6	37.8	38.7	45.6
Near mature	62.9	16.9	44.7	15.6	18.2	21.4
Mature	60.8	16.3	51.0	17.7	9.9	11.6
Overmature	38.8	10.4	36.8	12.8	2.0	2.4

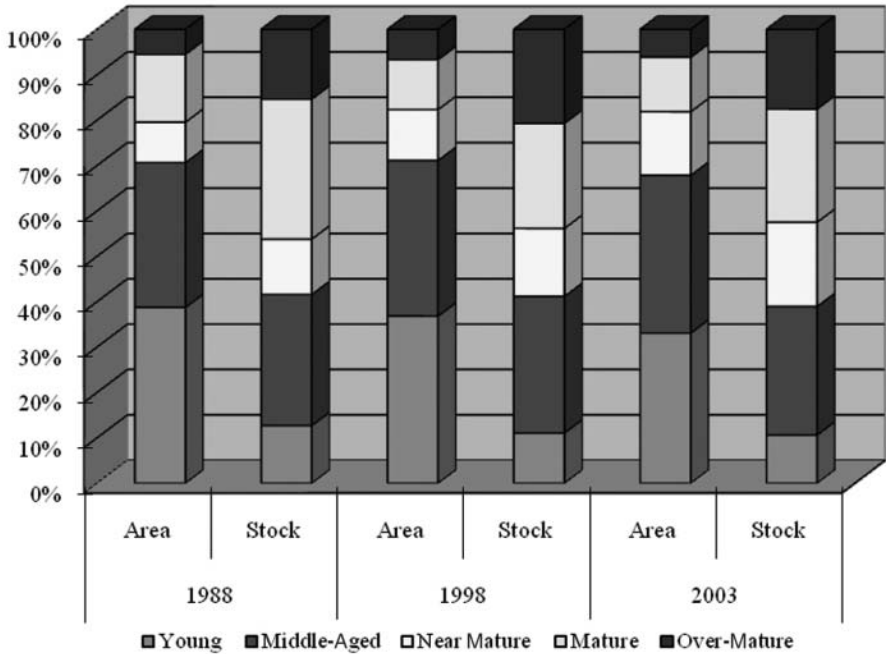
Source: State Forestry Administration, sixth forest inventory.

Note: unit = millions m³.

forest inventory, the annual removal from natural closed forests was 266.1 million m³, which still accounted for 72.8% of total forest removal. Moreover, China is prematurely harvesting its young and middle-aged forests, mainly because almost 70% of available timber forests are located in six provinces at the core of the NFPP (Heilongjiang, Jilin, Inner Mongolia, Sichuan, Shaanxi, and Tibet). Table 4 shows that 56.4% of total forest depletion comes from young and middle-aged forests, in contrast to 26.7% from mature and overmature forests, reflecting both the scarcity and the limited accessibility of mature forests. The depletion of middle-aged forests is particularly important, accounting for 37.8% of total natural forest depletion and 45.6% of total planted forest depletion.

Two additional indicators of the still acute forest crisis in China are the unfavorable age structure and the low productivity of Chinese forests. Hence, the sixth forest inventory confirms the predominance of young and middle-aged forests (68% of forest area) on one hand and the scarcity or low accessibility of mature and overmature forests on the other hand. In dynamic terms, the comparison of various national forest inventories shows interesting changes in the forest age structure since the mid-1980s (Figure 3). On one hand, both the area and the stock of young forests have decreased in relative importance in favor of middle-aged and near-mature forests since the mid-1990s, which entails a potential increase in available forest resources in a near future. On the other hand, the share of mature and overmature forests has also been declining since the end of the 1980s, which exacerbates current resource shortages. In particular, between the last two forest inventories, mature and overmature timber forests have decreased by 3 million ha with a net drop of 73 million m³ in timber stock. Finally, the low productivity of Chinese forests is reflected in the low level of the average stock volume per ha (84.73 m³ per ha). Although this level

Figure 3
China's Forest Resources by Age Group



Source: State Forestry Administration, various national forest inventories.

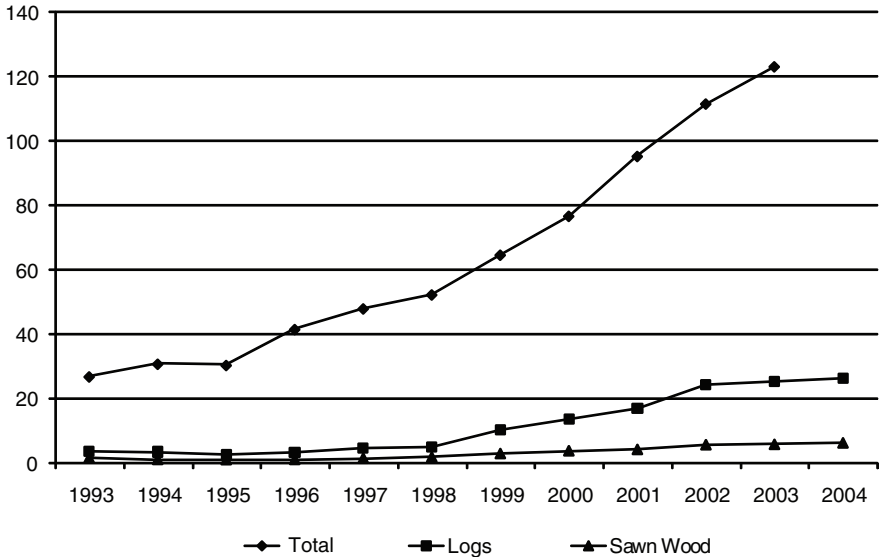
Note: Stock refers to the standing volume of the forests; year refers to the end of the corresponding (third, fifth, and sixth) national forest inventory.

has continuously increased over time (from 75 m³ per ha in the fourth forest inventory), it remains far below the world average of 99.85 m³ per ha. The productivity of both planted forests and collective forests is even lower, with 47 and 44 m³ per ha, respectively.

4. The Import Response to a Limited Supply

China's growing demand for wood coupled with a limited supply has resulted in a dramatic surge in imports for all forest products including unprocessed logs, sawn

Figure 4
China's Import of Forest Products (1993 to 2004)



Source: Xiong (2004) for total import; China Forestry Statistical Yearbook (2004) for log and sawn wood imports.

Note: Unit = millions m³. Total import includes boards, paper, paper pulp, and waste paper converted into m³ of round wood.

wood, wood chips, fiberboard, particleboard, veneer, paper, and paper pulp.³⁰ Figure 4 shows that since the implementation of the NFPP, imports of logs and sawn wood have increased massively.³¹ Recent trends also highlight a shift from high value-added imports (e.g., plywood, veneer, fiberboard, and paper) to unprocessed forest products such as logs, sawn wood, and wood pulp. Higher value-added imports made up almost half of China's timber product imports in 1997, but by 2003 logs and sawn wood constituted 78% of total timber product import value (Sun, Katsigris, & White, 2004). This trend reflects China's strategy to develop its competitive labor-intensive wood processing industry with imported raw materials to export higher value-added forest products such as furniture, paper products, and plywood.³²

China imports forest products from a number of forest-rich countries, including Russia, Malaysia, Indonesia, New Zealand, Thailand, the United States, Gabon, Papua New Guinea, Germany, Myanmar, Cambodia, and Laos. Table 5 lists China's

Table 5
China's Main Supplying Countries by Forest Products in 2003

Product	Top Countries in Order of Descending Volume
Logs	Russia (softwood), Malaysia (hardwood), New Zealand, Papua New Guinea (hardwood), Gabon
Lumber	Indonesia (hardwood), United States, Thailand, Russia (softwood), Malaysia (hardwood)
Panel segments	Indonesia (plywood), Malaysia (plywood), Malaysia (veneer), Cambodia (veneer)
Wood pulp	Canada, Indonesia, Russia, Brazil, United States
Paper	Taiwan, South Korea, United States, Indonesia, Japan

Source: Sun, Katsigris, and White (2004).

main trading partners by forest products and shows the dominant role of Asia-Pacific countries in Chinese imports. Given the large volume of its imports, China has also become the dominant forest trade partner for many Asia-Pacific supplying countries. By 2002, China accounted for more than 40% of the total log exports in Russia, Malaysia, and Indonesia. This share was even higher in some small countries of the region such as Papua New Guinea (64%), Myanmar (69%), and Thailand (81%) (Katsigris et al., 2004).

Since 1997, Russia, Malaysia, and Indonesia have been the three leading suppliers, contributing to more than 50% of China's total timber products import every year between 1997 and 2003.³³ Russia is by far China's top timber product supplier both in volume and in value, with an import volume to China of about 15.3 million m³ (round wood equivalent) in 2003, representing 12% of China's total imports (SFA, 2004a). In addition, a large number of Chinese firms have crossed the border to set up wood harvest or processing mills, essentially using Chinese labor in Russia's far eastern region.

In the Asia Pacific region where forest products exports are dominated by the Chinese market, the sharp increase in China's demand for forest products, logs in particular, has had deep negative effects on local ecological systems and on the livelihood of local communities and population. Indeed, massive deforestation and biodiversity loss can be observed in many supplying countries because of unsustainable practices and illegal loggings. According to Katsigris et al. (2004), the natural forests of Papua New Guinea and Myanmar will be completely exhausted within 10 to 15 years if current logging rates are maintained. Furthermore, deforestation and illegal loggings induced by the surge in China's wood demand have caused numerous economic and social problems, including government corruption and tax revenue loss in Russia and in Papua New Guinea as well as a reduced access to resources by

forest-dependent people and inequality in the distribution of logging trade benefits in Thailand, Laos, Cambodia, and Myanmar (Barney, 2005; Katsigris et al., 2004).

Decreasing forest resources and increasing local social resistance within supplying countries might create serious problems to Chinese imports of forest products in the future. Analyzing the future supply conditions in the Asia-Pacific supplying countries, Katsigris et al. (2004) concluded that the supply possibilities will decrease in a majority of these countries within the next 10 to 15 years. Only Russia presents a high potential of log supply for China with its vast forest area (about 280 million ha) in the far eastern region. Import perspectives are even less encouraging because the aggressive strategy to develop domestic wood processing industries in countries such as Indonesia and Russia may further reduce log availability for export to China.

5. Strategies for Sustainable Forest Management

Since the beginning of the reform period in the early 1980s, China's forest resources have increased in both area and stock volume. This encouraging trend comes of both afforestation activities and increasing efforts made by the government to protect forests with the implementation of large-scale national programs focusing on natural forest protection and plantation development. However, despite its positive impact on China's forest resources, the recent shift of forest policies from resource exploitation to protection has also contributed to a further reduction of domestic timber supply potential, already tightly constrained by historical overharvesting and by the low productivity and inappropriate age structure of existing forests. Simultaneously, the rapid increase in demand for wood driven by industrial needs in the construction, paper, and furniture sectors as well as by fuelwood consumption in rural areas has undoubtedly put heavy pressure on domestic timber supply. As a result, the continuing excess demand for wood is being more and more satisfied by imports as illustrated by the dramatic increase in China's import of forest products in recent years, and this evolution imposes severe pressures on the utilization of forest resources in countries surrounding China as well as in other parts of the world.

Although the demand for fuelwood may eventually decrease as rural households' income increases (Chen, Heerink, & van den Berg, 2006; Démurger & Fournier, 2006), the demand for wood products can be reasonably expected to increase further at a sustained rate as the country develops because the demand for specific products such as paper or furniture is income elastic. Given the conjectured growing demand for timber, the estimated gap between consumption and domestically produced forest products in China, currently above 100 million m³ (in round wood equivalent), may reasonably be expected to increase further in the future.

The analysis provided in this article highlights two major competing challenges that China has to face: protecting on one hand its natural forests for environmental consideration while satisfying on the other hand its expanding demand for wood products. To achieve these objectives, more effort is needed to promote a sound management of existing resources as well as to increase supply. In this respect, the key roles of both rural households and the private sector must be recognized and promoted together with public actions. Some policy implications can be derived as follows.

The achievement of long-term ecological objectives is critical to China's sustainable development. Therefore, the government's efforts to protect forest resources through national programs certainly need to be reinforced. However, two of the main drawbacks of these centrally designed programs are that they do not always fit local natural, economic, and social conditions and that their local implementation may differ substantially from one place to the other (Démurger, Fournier, & Shen, 2005). There is room to improve the design and the implementation of these programs to account for regional differences in the rural population needs or incomes. For example, in regions where forest resources provide the main source of energy for rural households, restricting fuelwood collection may hurt most deeply poorer households. As a consequence, the effectiveness of forest protection policies usually depends on the commitment of local authorities at the village or the township level to provide financial support to villagers. Moreover, differences in property rights over forests also contribute to differences in incentives for rural households to protect the resource. Where forests rights are allocated to households, constraints are usually harder and local management better.

Promoting innovative management forms such as shareholding systems and forest privatization would also encourage plantation activities by attracting investments in these activities. The prerequisite for a sound management is to stabilize forest policies and to secure ownership rights on planted trees. Although efforts have been made toward securing property rights to farmers, evidence shows that tenure insecurity remains a major problem in rural China (J. Xu, Katsigris, & White, 2002). In this context, farmers are reluctant to invest in long-term forest-related activities, which might still prove more risky and less efficient than other nonagricultural activities in a process of income sources diversification and insurance against agricultural risks (Démurger & Yang, 2006).

Beside strengthening rural households' incentives to invest in tree planting, greater efforts are also needed to promote and ensure the continuing development of fast-growing and high-yielding plantations made by the private sector. In particular, downstream industries such as paper and pulp could be encouraged to develop their own resource bases by establishing fast-growing and high-yielding plantations. Although it is mainly a private and market-oriented business, governments and research organizations can still play an important role by promoting high-quality species with high commercial value on one hand and providing financial and fiscal advantages such as low-interest loans and tax delays on the other hand.

Last, China also needs to secure its imports of forest products by developing stable long-term relationships with supplying countries, Russia in particular. This requires China's commitment to promote sustainable harvest patterns and increase investments in plantation activities in these countries. In this respect, effectively enforced cooperation schemes with neighboring countries could help reduce illegal logging and timber smuggling.

Notes

1. Ignoring local natural conditions, these policies have led to large-scale deforestation, especially on low-yielding sloping land. From 1949 to 1979, the total harvest volume of timber exceeded one billion m^3 (Wang, van Kooten, & Wilson, 2004). During the Great Leap Forward (1958 to 1960), thousands of hectares of forests were logged to fuel backyard steel smelters, and from the end of the 1960s onward a strong emphasis on agricultural self-sufficiency led to the increase in cultivated land to the detriment of other land uses (Harkness, 1998; Shapiro, 2001).

2. China's current per capita timber consumption is only 0.12 m^3 , less than one fifth of the world average (0.68 m^3 ; Zhou, 2001).

3. There are no official data on timber consumption and estimations vary by sources. For 2003, the Food and Agriculture Organization (2004) estimated China's total timber consumption at 247 million m^3 .

4. Aggregate timber demand is even higher when fuelwood consumption is included. Bull and Nilsson (2004) highlighted substantial data discrepancies on fuelwood consumption, which varies in a wide range from 3 million m^3 to 252 million m^3 according to sources. In 2003, domestic statistics indicated a total fuelwood consumption of 97 million m^3 , whereas the Food and Agriculture Organization estimated total fuelwood removal at about 191 million m^3 (Bull & Nilsson, 2004).

5. It may be especially the case for the construction sector with China's interior decoration market being expected to grow at an annual rate of 20% in coming years (Sun, Wang, & Gu, 2004). China's demand for paper is also expected to continue to grow rapidly, especially for newsprint paper, printing and writing paper, containerboard, and high-quality boxboard. He and Barr (2004) forecast an increase in the demand for wood pulp from 9 million tons in 2003 to 15 million tons in 2010.

6. As an example, the demand for wood pulp is mostly satisfied by imports, which filled in 62% of the nation's wood pulp demand in 2003 and 72% of the demand increase between 1990 and 2003.

7. Six nationwide forest resource inventories have been carried out by the Chinese forestry administration since 1949. Each inventory is carried out over a period of 5 years, during which data are collected in every province by local forestry bureaus.

8. Detailed accounts of state-owned forest management before the reform period can be found in Richardson (1990), Harkness (1998) or Yin (1998).

9. In 1979, state procurement prices of timber were increased by 30% on average, and in 1990, the State Council raised the prices for timber, sawn wood, and veneer produced by state forest farms in the northeast and in Inner Mongolia by 48.0%, 27.6%, and 53.0%, respectively (State Forestry Administration [SFA], 1990a).

10. This policy consisted of promoting other economic activities than timber production in state forestry bureaus and farms to create new income sources and job opportunities for redundant workers (Richardson, 1990). Sideline activities included horticulture nurseries or production of nontimber forestry products such as mushrooms and medicinal plants.

11. A contract responsibility system was introduced in the mid-1980s in most state-owned industries to increase the efficiency of the state-owned sector by giving more management freedom and economic incentives to managers and workers. Although forests, land, and equipments remained state owned, the managers of state forest bureaus and farms were given responsibility over production results, job creations, and income distribution.

12. In 1985, an annual harvest quota system was introduced to regulate timber production. In theory, the quota could not be exceeded. However, harvesting above quota was a common practice (Harkness, 1998; Richardson, 1990). Since 1990 quotas have been positively linked to each region's annual afforestation or reforestation area.

13. The various components of this national program are detailed in Section 2.3 below.

14. A detailed and well-documented review of changes in tenure and management of nonstate forests is provided by Liu (2001).

15. Nondistributed collective forests are placed under the management of collective forest farms (Zhang et al., 1999), with township and village forest farms and joint-forest farms being the dominant management forms for community forestry.

16. Property rights on planted trees introduced under the "who plants, who owns" principle in the early 1980s have been officially recognized within the revised Forest Law of China in 1998. Those "private forests" were previously referred to as "collective forests" because land ownership remains collective.

17. The shareholding system can take various forms, including farmer-farmer collaboration, company-community partnership, and cooperation with outside individuals and communities (Liu, 2001).

18. The only exception is the market-oriented program of fast-growing and high-yield plantations, mostly financed by farmers, forest farms, and foreign capital. The state invested only a marginal portion, 6.6% of the total investment for the period 1998 to 2003 (SFA, 2004c).

19. The logging ban is implemented in provinces of the middle and upper reaches of the Yangtze (Tibet, Yunnan, Sichuan, Chongqing, Guizhou, Hubei) and along the Yellow River (Qinghai, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Henan). The logging reduction in state-owned forests also concerns northeastern provinces (Jilin and Heilongjiang) as well as Hainan and Xinjiang.

20. This third component is mainly of a "social" nature and aims at facilitating the reemployment of redundant workers from state-owned forest enterprises as well as pension payments. By 2003, more than 80% of the 740,000 workers made redundant by the program had been reemployed in forestry or other economic sectors (SFA, 2004c).

21. The conversion program also includes tree planting on barren land and mountains.

22. Previous forest inventories provided a classification only according to the ownership of forest land (state or collective forests).

23. Most plantations are ecological forests, which account for 79% of the total afforested area (SFA, 2004b).

24. This program has been especially designed to promote the development of industrial tree plantations. Its objective is to increase the domestic commercial wood supply by subsidizing the plantation of 13.3 million ha of trees over the period 2001 to 2015 (Barr & Cossalter, 2004).

25. The southern region includes 10 provinces dominated by collective forests: Anhui, Zhejiang, Fujian, Jiangxi, Hunan, Hubei, Guangdong, Guangxi, Hainan, and Guizhou.

26. Ecological forests include shelter forests and forests for special use.

27. This evolution can be explained on one hand by the relative short production cycle of economic forests compared with timber forests and on the other hand by policy uncertainty, property rights insecurity, heavy taxes, and harvest and transport restrictions associated with timber forests (Liu, 2001; Miao & West, 2004).

28. Because of accessibility issues, another 2.4 million ha and 470.9 million m³ of near-mature, mature, and overmature forests are not available for wood supply. On the other hand, available resources increase to 18.9 million ha with a stock volume of 2.2 billion m³ when including forests at near-mature age.

29. China's actual timber production in 2003 has been estimated at 160 million m³, 3 times the quota production (Zhu, 2004). Depending on the conversion factor used to convert timber production into log removal from forests (Chinamarket Consulting Company, 2004; Xiong, 2004), forest removal for timber production in 2003 ranged from 246 to 278 million m³, slightly higher than the estimation proposed in the sixth forest inventory (238.9 million m³). With an additional official estimates of 97 million m³ for fuelwood, the total forest removal for 2003 ranged between 343 and 375 million m³, which is also consistent with the 365 million m³ of annual forest depletion estimated by the sixth forest inventory.

30. The import growth also resulted from preferential trade policies for forest products. By 1999, import permit requirements for wood products have been abolished, and any company legally registered for international trade is allowed to import wood products (Sun, Wang, & Gu, 2004). Meanwhile, import tariff rates for forest products have been substantially reduced, down to zero for log import. In August 2004, China also reduced by 50% the value-added tax on logs imported through border trade, especially for logs from Russia (Katsigris et al., 2004).

31. The most significant increase comes from pulp and paper that currently account for about 60% of China's forest product imports by round wood equivalent volume (Sun, Katsigris, & White, 2004).

32. Chinese exports of forest products account for almost 10% of China's total wood consumption.

33. In 2003, China's combined timber product imports from the three countries totaled approximately 23.6 million m³ (round wood equivalent), valued at US\$2.2 billion.

References

- Barney, K. (2005). Customs, concessionaries and conflicts: Tracking Cambodia's forest commodity chains and export links with China. *Forest Trends*. Retrieved December 9, 2008, from http://www.forest-trends.org/documents/publications/Cambodia%20Report_final_8-22-05.pdf
- Barr, C., & Cossalter, C. (2004). China's development of a plantation-based wood pulp industry: Government policies, financial incentives, and investment trends. *International Forestry Review*, 6(3-4), 267-281.
- Bull, G. Q., & Nilsson, S. (2004). An assessment of China's Forest Resources. *International Forestry Review*, 6(3-4), 210-220.
- Chen, L., Heerink, N., & van den Berg, M. (2006). Energy consumption in rural China: A household model for three villages in Jiangxi Province. *Ecological Economics*, 58(2), 407-420.
- Chinamarket Consulting Company. (2004, May). *China Wood Market Report*. Beijing, China: Author.
- Démurger, S., & Fournier, M. (2006). *Rural poverty and fuelwood consumption: Evidence from Labagoumen Township (China)*. Lyon, France: University of Lyon. Unpublished manuscript.
- Démurger, S., Fournier, M., & Shen, G. (2005). Forest protection policies: National guidelines and their local implication in northern Sichuan. *China Perspectives*, 59, 1-12.
- Démurger, S., & Yang, W. (2006). Economic changes and afforestation incentives in rural China. *Environment and Development Economics*, 11(5), 629-649.
- Food and Agriculture Organization. (1979). *China: Integrated wood processing industries*. Rome: Author.
- Food and Agriculture Organization. (2003). *The state of the world's forests 2003*. Rome: Author.
- Food and Agriculture Organization. (2004). *FAOSTAT data, 2004*. Rome: Author.
- Groom, B., Grosjean, P., Kontoleon, A., Swanson, T., & Zhang, S. (2008). *Relaxing rural constraints: A "win-win" policy for poverty and environment in China?* (Environmental economy and policy research discussion paper 30.2008). Cambridge, UK: University of Cambridge.
- Harkness, J. (1998). Recent trends in forestry and conservation of biodiversity in China. *China Quarterly*, 156, 911-934.
- He, D., & Barr, C. (2004). China's pulp and paper sector: An analysis of supply-demand and medium term projections. *International Forestry Review*, 6(3-4), 254-266.
- Hyde, W. F., Belcher, B., & Xu, J. (2003). *China's forests: Global lessons from market reforms*. Washington, DC: Resources for the Future Press.
- Jiang, G., & Zhang, Y. (2007, September 13). New policies of SLCP will benefit millions of peasants with significant economic and ecological benefits. *People's Daily*, p. 2.
- Katsigris, E., Bull, G. Q., White, A., Barr, C., Barnez, K., Bun, Y., et al. (2004). The china forest products trade: Overview of Asia-Pacific supplying countries, impacts and implications. *International Forestry Review*, 6(3-4), 237-253.

- Liu, D. (2001). Tenure and management of non-state forests in China since 1950: A historical review. *Environmental History*, 6(2), 239-263.
- Miao, G., & West, R. A. (2004). Chinese collective forestlands: Contributions and constraints. *International Forestry Review*, 6(3-4), 282-298.
- Richardson, S. D. (1990). *Forests and forestry in China*. Washington, DC: Island Press.
- Shapiro, J. (2001). *Mao's war against nature: Politics and the environment in revolutionary China*. Cambridge, UK: Cambridge University Press.
- State Forestry Administration. (1986a-2004a). *China forestry yearbook*. Beijing: China Forestry Publishing House.
- State Forestry Administration. (1987b-2004b). *China forestry statistical yearbook*. Beijing: China Forestry Publishing House.
- State Forestry Administration. (2004c). *China forestry development report*. Beijing: China Forestry Publishing House.
- Sun, X., Katsigris, E., & White, A. (2004). Meeting China's demand for forest products: An overview of import trends, ports of entry, and supplying countries, with emphasis on the Asia-Pacific region. *International Forestry Review*, 6(3-4), 227-236.
- Sun, X., Wang, L., & Gu, Z. (2004). A brief overview of China's timber market system. *International Forestry Review*, 6(3-4), 221-226.
- Uchida, E., Xu, J., & Rozelle, S. (2005). Grain for green: Cost-effectiveness and sustainability of China's Conservation Set-Aside Program. *Land Economics*, 81(2), 247-264.
- Uchida, E., Xu, J., Xu, Z., & Rozelle, S. (2007). Are the poor benefiting from China's land conservation program? *Environment and Development Economics*, 12, 593-620.
- Wang, S., van Kooten, G. C., & Wilson, B. (2004). Mosaic of reform: Forest policy in post-1978 China. *Forest Policy and Economics*, 6(1), 71-83.
- Xiong, M. (2004). *A study on the relationship between wood industry and sustainable forestry development in China*. Unpublished master's thesis, Chinese Academy of Forestry, Beijing.
- Xu, J., Katsigris, E., & White, T. A. (2002). *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and policy recommendations*. Beijing: China Council for International Cooperation on Environment and Development, Task Force on Forests and Grasslands.
- Xu, J., Yin, R., Li, Z., & Liu, C. (2006). China's ecological rehabilitation: Unprecedented efforts, dramatic impacts, and requisite policies. *Ecological Economics*, 57, 595-607.
- Xu, Z., Bennett, M. T., Tao, R., & Xu, J. (2004). China's Sloping Land Conversion Program four years on: Current situation, pending issues. *International Forestry Review*, 6(3-4), 317-326.
- Yin, R. (1998). Forestry and the environment in China: The current situation and strategic choices. *World Development*, 26(12), 2153-2167.
- Zhang, Y., Dai, G., Huang, H., Kong, F., Tian, Z., Wang, X., et al. (1999). The forest sector in China: Towards a market economy. In M. Palo & J. Uusivuori (Eds.), *World forests, society and environment* (pp. 379-382). Dordrecht, Netherlands: Kluwer.
- Zhou, S. (2001, June). *Quanqiu shengtai weiji yu zhongguo linye kuayueshi fazhan* [Global ecological crisis and rapid development of Chinese forestry]. *China Forestry*, pp. 1-3.
- Zhu, G. (2004). Zhongguo mucai ji linchanpin jinchukou taishi ji zouxiang [Evolutions and trends of China's timber and forest products imports]. *Zhongguo Mucai Gongye Kechixu Fazhan Gaoceng Luntan Lunwenji*, 11-36.

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