International Forestry Review Vol. 6(3-4), December 2004

The International Forestry Review

ISSN 1465 5489

PUBLISHED BY THE
COMMONWEALTH FORESTRY ASSOCIATION
www.cfa-international.org

FOREST TRENDS

Australian Government
Australian Centre for International Agricultural Research

SPECIAL ISSUE EDITED BY JINTAO XU, G. Q. BULL, S. NILSSON, A. WHITE AND A. J. POTTINGER

The International Forestry Review

Cover photo: *Xiang Shan/Fragrant Mountain, Beijing (Anders West)*

Contents

EDITORIAL

Understanding the Chinese forest market and its global implications ii
JINTAO XU and A. WHITE

PAPERS

An assessment of China's forest resources 210
G. Q. BULL and S. NILSSON

A brief overview of China's timber market system 221
XIUFANG SUN, LIQUN WANG and ZHENBIN GU

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 227
XIUFANG SUN, E. KATSIGRIS and A. WHITE

The China forest products trade: overview of Asia-Pacific supplying countries, impacts and implications 237
E. KATSIGRIS, G. Q. BULL, A. WHITE, C. BARR, K. BARNEY, Y. BUN, F. KAHRL, T. KING, A. LANKIN, A. LEBEDEV, P. SHEARMEN, A. SHEINGAUZ, YUFANG SU and H. WEYERHAEUSER

China's pulp and paper sector: an analysis of supply-demand trends and medium projections 254
D. HE and C. BARR

China's development of a plantation-based industry: government policies, financial incentives, and investment trends 267
C. BARR and C. COSSALTER

Chinese collective forestlands: contributions and constraints 282
GUANGPING MIAO and R. A. WEST

China's forest sector markets: policy issues and recommendations 299
S. NILSSON, G. Q. BULL, A. WHITE and JINTAO XU

Looking through the bamboo curtain: an analysis of the changing role of forest and farm income in rural livelihoods in China 306
M. RUIZ PÉREZ, B. BELCHER, MAOYI FU and XIAOSHENG YANG

China's sloping land conversion program four years on: current situation and pending issues 317
ZHIGANG XU, M. T. BENNETT, RAN TAO and JINTAO XU

Appraisal of tree planting options to control desertification: experiences from the Three-North Shelterbelt programme 327
QIANG MA

Forestry revenue policy in China: what has happened and why 335
JINLONG LIU, SHOUGONG ZHANG, JINZHONG YE and YIHUAN WANG

The relationship between forest research and forest management in China: an analysis of four leading Chinese forestry journals 341
M. RUIZ PÉREZ, MAOYI FU, JINZHONG XIE, XIAOSHENG YANG and B. BELCHER

TRANSLATION OF SUMMARIES

French 346
Spanish 349

EDITORIAL

Understanding the Chinese forest market and its global implications

JINTAO XU[●] and A. WHITE[■]

[●] *Deputy Director, Center for Chinese Agricultural Policy (CCAP), 5th Floor, Institute of Geographical Sciences and Natural Resources Research, Datun Road, Anwai, Beijing 100101, China*

[■] *Senior Director, Policy and Market Analysis, Forest Trends, 1050 Potomac Street NW, Washington, DC 20007, USA*

Email: jxu@igsnrr.ac.cn and awhite@forest-trends.org

China's forest market is one of the largest in the world in terms of production, consumption, and imports of wood products. Its large forest estate and massive population has meant that it has also for some time been a leading nation in terms of the number of processing plants, number of people employed in the forestry sector, the scope of its non-timber forest markets, and the overall level of contributions of forest enterprises and markets to local livelihoods. However, despite this importance the exact nature of China's forest market has long been a mystery to the outside world, as well as to most Chinese. Until recently there has been limited interest, or capacity, to seek a more detailed picture but this has changed in the last few years with China's booming forest imports and rapidly expanding domestic market.

China has suddenly become the wood workshop of the world, capturing almost one-third of the total global trade in furniture. Fully one-half of all timber imports (logs, sawnwood and panels) are now processed and exported as finished products and the marked increase in manufacturing and domestic consumption in a nation with very limited per capita forest resources has fueled the rise in imports. Furthermore, the combination of this booming domestic demand and growing export-oriented processing industry is affecting the industry globally causing some enterprises to collapse, while creating opportunities for others. An outcome of all this activity is that industry and government leaders around the world are reassessing their competitive positions in light of the new Chinese market.

While China's increased forest product demand and exports have affected supplying countries worldwide, impacts are particularly marked in the Asia Pacific Region. Some 70% of all of ChinaÍs timber imports come from Asia Pacific countries and China has become the leading market for most of them. In many cases, increasing trade flows are associated with unsustainable harvesting, corruption, illegal logging, and the abuse of indigenous and other forest community rights. But while China's surging demand has aggravated and accelerated degradation of natural forests in some situations, it is also leading to the establishment of new plantations both in China in many supplying countries. Indeed, China's growing demand also creates the possibility that millions of low-income forest producers within China and in producer countries globally can participate, and perhaps benefit in this new market. Trees and forests are the primary asset of millions of the worldÍs poorest people and when governments act to enable them to use these assets forestry can be an important instrument of rural development. This potential, for the Chinese market to assist in the alleviation of poverty both domestically and in some supplying countries, is encouraging government and development officials to inquire about the range of impacts and implications of the Chinese forest market.

But this growing global interest in the Chinese market from industry, governments and development organizations has not yet been met with rigorous and publicly accessible analyses of the macro-level trends and issues. The primary source of market information to date has been proprietary analyses, the cost of which has precluded their use to all but the largest international investors and trade associations. And even these reports have been of mixed quality due to the weakness of the official data and the lack of independent peer review. Governments, researchers, non-governmental organizations and international development institutions have lacked the information necessary to understand and assess the implications of the Chinese forest market.

This Special Issue of the *International Forestry Review* has been produced in order to begin to address this problem. Since early 2003 Forest Trends, the Center for International Forestry Research (CIFOR) and the Center for Chinese Agricultural Policy (CCAP), supported by the United Kingdom Department for International Development (DfID), has worked with partners in China and across the region to begin to build a knowledge base of the Chinese forest market and the export trade of China's Asia Pacific supplying countries. The purposes of this initiative have been to: (1) better understand strategic market issues and trends in China and in the key supplying countries in the Asia-Pacific region; (2) strengthen capacity and networks of market analysts and advocates in China and the region; and (3) begin to communicate this information to policy and market leaders in China and the region, helping them take action to ensure that this growing demand contributes to, rather than diminishes, sustainable forestry and forestry's contribution to rural development.

The Special Issue begins with **An assessment of China's forest resources** by G. BULL and S. NILSSON. After assessing the inventory, supply and demand statistics they forecast continued difficulties in reaching domestic supply targets and continued increases in imports - at least for the next several decades. They also conclude that data weaknesses and discrepancies must be addressed before a more specific, and accurate, set of targets and policies can be created. XIUFANG SUN, LIQUN WANG, and ZHENBIN GU provide **A brief overview of China's timber market system** and describe the dramatic changes since the early 1980s when the government began to privatize state-owned enterprises and open markets. The markets for imports and exports are considered in the next two papers. XIUFANG SUN, E. KATSIGRIS and A. WHITE describe **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** while E. KATSIGRIS and her collaborators from China and the Asia Pacific region turn to the issue of how this trade is affecting the forests, industry and rural peoples of the major supplying countries in the region in their paper, **The China forest products trade: impacts and implications for Asia Pacific supplying countries**. They identify a range of steps to diminish the negative impacts of the trade and move toward business and trade models that contribute more to sustainable management and improved livelihoods. The next two papers focus on the plantation sector and were prepared by colleagues from CIFOR; C. BARR, C. COSSALTER and D. HE. The first, **China's pulp and paper sector: supply-demand trends and medium term projections**, describes supply and demand trends for the pulp and paper sector and forecasts future demand. The authors conclude that demand will continue to increase in line with growth of GDP - raising the question of where the pulp and fibre will come from to meet this demand. The authors address this question in the second paper, **China's development of a plantation-based wood pulp industry: government policies, financial incentives, and investment trends**, where they assess the plantation sector in China, focusing on the Southern region. This body of work identifies that there are significant costs and environmental constraints to achieving China's plantation and supply targets despite the high level of direct and indirect subsidies. GUANGPING MIAO and R. A. WEST, in their paper **Chinese collective forestlands: contributions and constraints**, report that these areas account for some 60% of all forests and are playing an increasing role not only in supplying timber but in collaborating with industry to establish fast-growing plantations. After providing an overview of the current status of this sub-sector they assess the impacts of major policies on collective forests and their owners and identify policy reform measures that could improve the contribution of collective forests to domestic supply, conservation and local livelihoods. S. NILSSON and colleagues complete this set of papers on markets with **China's forest sector markets: policy issues and recommendations** which presents a summary assessment of key policy issues and recommendations. They report that the Chinese government has taken many admirable and substantial steps to modernize its forestry sector in recent years. Additional steps to address the property and policy weaknesses will continue to yield important returns in terms of increased domestic supply and rural development.

The volume next turns to a set of papers describing and assessing key issues in the broader forestry sector. RUIZ PÉREZ and colleagues fill a critical gap in understanding the Chinese forestry sector by describing the important and growing role of bamboo and bamboo enterprises in rural China in their paper **Looking through the bamboo curtain: an analysis of the changing role of forest and farm income in rural livelihoods in China**. ZHIGANG XU and colleagues present the results of new research assessing the implementation and impacts of the Sloping Land Conversion Program, one of the world's largest public payment schemes for ecosystem restoration, in **China's Sloping Land Conversion Program four years on: current situation, pending issues**. They conclude that this program merits substantial strengthening to achieve its goals and present recommendations to improve its efficiency and effectiveness. QIANG MA's paper **Appraisal of tree planting options to control desertification: experiences from the Three-North Shelterbelt Programme** presents a cost-benefit analysis of the Three North Shelterbelt Programme and identifies similar weaknesses in implementation and targeting. In addition, it and presents recommendations for the consideration of policy makers. JINLONG LIU and colleagues review China's forest revenue policy, in **Forestry revenue policy in China: what has happened and why** describing how it has evolved over time, how it remains a significant disincentive to investment in many parts of China, and how the government is beginning to take important steps to reform the system. RUIZ PÉREZ and co-authors provide a fitting ending to this volume with a review of forestry research in China in **The relationship between forest research and forest management in China. An analysis of four leading Chinese forestry journals**. They find substantial collaboration between government and researchers on technical issues, particularly at the provincial level. They also find that policy research is ‚almost non-existent' - an important finding that merits the attention of the Chinese government and the international research community alike. Clearly, more progress on the design and implementation of policies will require policy research, and given the growing role of China's forest sector, both China and the world would benefit from a stronger capacity for rigorous and independent forest policy research.

Putting together such a wide ranging set of papers has required the inputs of many colleagues and we would like to acknowledge them and the many institutions that have contributed their time and talent to this collaborative initiative. Thanks go to: Forest Economics and Development Research Center of the State Forestry Administration, China; Chinese Academy of Forestry; Beijing Forestry University, Center for Biodiversity and Indigenous Knowledge (CBIK), Kunming, China; Economic Research Institute, Khabarovsk, Russia; Bureau for Regional Campaigns (BROC), Vladivostok, Russia; World Wide Fund for Nature (WWF) China and Russia; Foundation for People and Community Development, (FPCD), Papua New Guinea; World Agroforestry Center (ICRAF), Kunming, China; School of Natural and Physical Sciences, University of Papua New Guinea; Faculty of Forestry, University of British Columbia; and the Forestry Program at the International Institute for Applied Systems Analysis (IIASA). We would also like to extend our great gratitude to Alan Pottinger, Editor of the *International Forestry Review*, for encouraging this work and facilitating its dissemination. Our hope is that the information contained in this Special Issue proves useful and that many more individuals and institutions will join the effort to generate and freely disseminate new information and analyses on the Chinese forest market. Finally, the Editors would like to thank both Forest Trends and the Government of Australia (through the Australian Centre for International Agricultural Research) for their generous financial support of this publication.

PAPERS

An assessment of China's forest resources

G. Q. BULL[•] and S. NILSSON[■]

[•] *Forest Resource Management, University of British Columbia, Vancouver, Canada*

[■] *Deputy Director and Forestry Program Leader, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria*

Email: gary.bull@ubc.ca

SUMMARY

China's forest resources have been and continue to be threatened. The analysis of the various reported statistics, while often conflicting, does indicate significant challenges ahead for the forest to supply the material for industrial, non-industrial, fuelwood and conservation objectives. Given forecasted constraints on domestic fibre supply for at least two decades there could be a significant increase demand for logs and forest products from China's trading partners. Overall this paper indicates the challenge in reaching more specific conclusions since there are serious data discrepancies in all major statistical areas. These discrepancies must be addressed before a clear set of land and sustainable development policies can be created.

Keywords: statistics, supply, demand, consumption, production

INTRODUCTION

China's forest resources have and will continue to face significant pressure with the combination of population growth, economic reform and gross domestic product (GDP) growth. Together, these policy and market drivers are leading to an increasing amount of forest products consumption. To gain a better appreciation of the issues it is useful to explore several critical dimensions to better understand the linkages between current and future forest resources and product demand. First, it is fundamentally important to understand the current state of China's forest resource and their contribution to a stable domestic wood supply. Second, it is critical to appreciate the current and projected demands for industrial forest products. Forest products ranked as the first of all commodity imports in 1998 (Kunshan *et al.* 1999) and the imports have risen dramatically since then (Sun 2004). Third, there are pressure on forest land to produce fuelwood, many non-timber forest products, watershed protection, and biodiversity conservation. For example, there remains a significant demand on forest to provide fuelwood in almost every region of China and there are indications that this demand is increasing (Leiwen and O'Neill 2003). Fourth, and finally, there are significant supplies of non-wood fibre materials and agricultural trees that can be used to substitutes for forest resources.

The combination of an uncertain domestic fibre supply for industrial, non-industrial and fuelwood uses combined with a growing demand for many forest products lead senior Chinese analysts to conclude that:

„...one of the present major problems facing forestry in China is that the total amount of forest resources is in-sufficient, resources available for harvesting are almost exhausted, the [forest] structure is unbalanced and the capability for supplying forest products is ra-ther low (Kunshan et al. 1997).

Can the rather gloomy claim[1] made in this statement be substantiated? To address this question we analyze the existing conflicting data on forest resources in the basic statistical categories: forest area, forest growth, forest volume and age, and forest removals (including the Annual Allowable Cut - AAC). We then place these data in the larger context of Chinese forest consumption, production and other fibre sources on the state of the forest resources and its ability to provide fibrous material for both industrial, non-industrial and fuelwood uses.

[1] It was reported that in a forest field assessment nearly 18 % of the forest areas surveyed was being overcut, another 13 % was subject to illegal cutting and over 500,000 ha a year was being deforested (Zhang 2003). Further, many of the slowing growing forest plantations have serious deformity, are of low volume and many are not economically accessible (Jaakko Pöyry 2001). Finally, while there are some fast growing high yielding plantations in China they are not enough. These findings are in sharp contrast to other reports ehich state that forest volume is increasing, forest plantation establishment has been very successful and self-sufficiency well on the way (Zhang 2002; Xu 2002; Government of China 1997).

FOREST AREA

Table 1 summarizes the statistics from various sources to indicate the range of estimates found for the timber forest. The timber forest, which are really the ‚domestic industrial wood supply forest‘ in China includes both the slow growing and fast growing plantations areas in the statistics. The first complication is attempting to compute the area of forested land as the statistics indicate there is a range.

To calculate the wood supply balance for mainland China a critical statistic is defining not the forest area but the area available for wood supply. Only one study was found which attempted to define this area, Bull *et al.* 1998. China did not report this statistic in the Food and Agriculture Organization (FAO) Forest Resource Assessment 2000 and no government reports were found with a comparable statistic. It seems that the 65.1 million ha reported is likely in the upper range of the estimate of area available for wood supply and if Kunshan *et al.* (1997) are correct in their analysis that area will probably be reduced due to an increase in the protected area by 2010. Further analysis is required to improve the assessment.

TABLE 1 *Timber forest (wood supply forest) in China*

Forested land	Timber forest	Legally protected	Economically inaccessible	Area available for wood supply	Proportion natural	Proportion planned	Base year	Sources
			000 ha					
153632	99395	21835			75244	24151	1988	National Forest Inventory 1998
159000	99400				75200	24100	2001	Jaakko Pöyry 2001
	99400	13004	21288	**65160**			1995	Bull, Mabee and Scharpenberg 1998
163000							2000	FRA 2000
133000							1995	FAO 1995
128000	84928						1997	Kunshan *et al.* 1997
		9000					2000	Kunshan *et al.* 1997
		19000					2010	Kunshan *et al.* 1997
115280	80696						1983	Zhang-Hualing 1998

In Bull *et al*'s (1998) estimates, the legally protected area of 13 million hectares (ha) applies only to the timber forest not to all forested land which other sources seem to be using in providing a statistic on protected forest land. Kunshan *et al.* (1997) forecasted that the protected area would increase from 9 million ha to 19 million ha by 2010.

In Table 2, and as mentioned earlier, the slow growing and fast growing plantation forest can be considered as part of the timber forest (Jaakko Pöyry 2001). A more careful analysis of the statistics is warranted since these plantation areas are frequently and

TABLE 2 *Plantation forest in China*

Gross planted	Industrial plantation	Non-industrial plantation	Slow growing plantations	Fast growing plantation	Fast growing plantation establishment rate - plan	Base year(s)	Sources
			000 ha				
45100						2000	FRA 2000
47000			16300	5100		2001	Jaakko Pöyry 2001
					3830	1980-1987	Kunshan *et al.* 1997
				8324		2000	Xu 2002
				6330	2500	1988-1992	Kunshan *et al.* 1997
34500						1994	Kunshan *et al.* 1997
					500	1998 onward	Kunshan *et al.* 1997
	17519	3854				1995	Brown 2000
				20000		2010	Xu 2002

optimistically described as the future major source of industrial wood supply in China. While this may be a reasonable assumption given the lack of natural forest available for wood supply (discussed later) Table 2 indicates there is a wide range of statistics on the precise area available and the nature, purpose and condition of the forest plantations.

The gross planted area reported for all forested land is around 47 million ha. After a thorough assessment the proportion that is fast growing and high in yield is estimated to be only 5 million ha (Jaakko Pöyry 2001). The plantation area statistic is important in wood supply forecasting since previous estimates of industrial wood supply suggested 17.5 million ha (Brown 2000). If the 16.3 million ha of slow growing plantation is a source of industrial wood supply then Brown's estimate is reasonable. However, as mentioned, there are serious concerns with the viability of the slow growing plantations given the extensive deformity, slow growth, presence of non-commercial species, internal transportation difficulties and prohibitive wood costs (Kunshan *et al.* 1997; Jaakko Pöyry 2001; Roberts 2004). Clearly the assumptions with respect to these slow growing plantations need further analysis.

TABLE 3 *Fast growing and slow growing plantations growth rates in China*

	Major species	Fast growth estimates m^3/ha/year	Location	Slow growth estimates m^3/ha/year	Source
Actual	Unknown	3 - 3.5	Hainan Province and Zhanjang Region		Xu 2002
Official	Eucalyptus	18		9	Jaakko Pöyry 2001
Official	Poplar	15		7	Jaakko Pöyry 2001
Official	Masson pine	8		3	Jaakko Pöyry 2001
Official	Chinese fir	10		4	Jaakko Pöyry 2001
Forecast	All species	8 - 10			Jaakko Pöyry 2001

TABLE 4 *Predicated forest growth for all of China*

Forest type	Total growth (000 000 m^3/year)	Source
All forested land	419.1	Kunshan *et al.* 1997 Vergara 1997
Timber forest	219.9	Kunshan *et al.* 1997

Table 2 also shows that the intent of the ‚official' plan was to have vast areas of fast growing plantations. The plan had two major periods 1980-1987 and 1988-1992 and together should have produced 31 million ha by 1992. The plan after 1998 was to slow the area established to 500 thousand ha per year. Again there seems to be a serious discrepancy between the plantation establishment plan and what has actually happened in China. The discrepancies between the planned area and the actual area also need further investigation. Further, there have been noted problems in China's plantations productivity and yield as noted below:

Accounts by Li and Chen (1992) and Ding and Chen (1995) report a drop in productivity between first and second rotation of about 10 per cent and between second and third rotation up to a further 40 per cent. Ying and Ying (1997) quote higher figures for yield decline... Personal observation suggests that the widespread practices of whole tree harvesting, total removal of all organic matter from a site, and intensive soil cultivation that favors bamboo and grass invasion all contribute substantially to the problem (Evans 2002).

FOREST GROWTH

Since the timber forest is the area where a high proportion of industrial wood would come from, it is essential to have an estimate of forest growth in order to assess the sustainability of supply for producing forest products. Since virtually all of China's forest that is economically viable has now been disturbed, which means the growing stock volume will be drawn down, the focus for calculating sustainable supply will have to be on the growth of the timber forests. For the plantation forests, Table 3 indicates a significant difference between the actual reported growth rates (3-3.5 m^3/ha/year) and the predicted growth rates (8-18 m^3/ha/year). Currently, the major species planted are Masson and exotic pines (*Pinus* spp.), China fir (*Cunninghamia lanceolata*) and Poplar (*Populus* spp.) with currently more focus on Eucalyptus (*Eucalyptus* spp.). For a national growth average Bull *et al.* (1998) reported 2.5 m^3/ha/yr. This is confirmed by Kunshan *et al.* (1997) (Table 4). Dividing the timber forest growth estimate of 219 million m^3 by the estimated 85 million ha of timber forest produces the same result. However, this growth statistic is extremely vague and it is not known if it is a gross annual increment, a mean annual increment, a periodic annual increment or a net annual increment. Whatever the case, it is probably the upper limit of growth with no deduction for various natural and manufacturing losses. Further investigation is warranted given the difference between the official estimates compared with the actual estimates and the significantly greater growth per unit area estimates on all forested land in contrast to the timber forest.

It should also be noted that the growth of the forest on all forested land has virtually no relationship to the needs of the forest products industry to find available supply of raw material. Furthermore, the growth on the timber forest is almost exclusively in forests which are classified as ‚nearly mature‘ or younger. This is discussed later in the paper.

TABLE 5 *Total forest volume estimates for China*

Volume (000 000 000 m^3)	Sources
Forested land	
13,0	CCAP and Butterworth 2003
12.6	Government of China 1997
11.2	China National Forest Inventory 1998
10.6 - 11.8	Zhang 2000
10.2	FAO 2001 as cited in Zhu and Taylor 2003
Timber forest	
6.6	Xu, Taylor and Amacher 2003
6.7	Kunshan *et al.* 1997
7.2	China National Forest Inventory 1998
Forest volume available for wood supply	
3.9	Kunshan *et al.* 1997
4.5	Bull *et al.* 1998
3.5	Zhang 1988
2.2	Shi and Xu 2000 (economic wood supply in timber forest)
2.3	Kunshan *et al.* 1999 • volume of nearly mature - 0,9 billion m^3 • volume of mature forest - 1.4 billion m^3 • volume of overmature forest - 1.4 billion m^3 but assume it is not available for wood supply within the timber forest - assume remote and difficult to access or protected
2.9	National Forest Inventory 1994 (prior to logging ban and not accomodating overcutting or illegal logging) • volume accessible - 1.36 billion m^3 • volume to be accessible - 1.63 billion m^3 • volume inaccessible - 0.71 billion m^3

In a forest study of over 28 provinces in China a gloomy picture emerges. Growth rates are being reduced due to short term unsustainable (excessive) logging or under-reforestation of the industrial or natural forest (Xu *et al.* 2003). Both poor logging and poor silvicultural practices have been driven by perverse economic incentives to the forest enterprise managers. They predicted in 1997 that 90 out of 135 state owned enterprises would exhaust the harvestable forest and that most of the 85 state forest enterprises in northeast China would cease to produce timber due to resource depletion (Rozelle *et al.* 1997 as quoted in Xu *et al.* 2003). There is a reported a slight increase in total standing volume (0.46 %) between 1981 and 1997 but this is largely because the volume growing in plantations are included (Xu *et al.* 2003).

FOREST VOLUME AND AGE

Table 5 indicates that there is a very significant difference between the total growing stock for all forested land of 10-13 billion m^3 (Zhang 2000; CCAP and Butterworth 2003; Kunshan *et al.* 1997), the estimate of the commercial growing stock on the timber forest of 6.6 billion m^3, the estimate of the volume on the area available for wood supply of 4.5 billion m^3 (Bull *et al.* 1998) and finally, the netted down volume of 2.2 billion m^3 (Shi and Xu 2000). This significant reduction in standing volume when combined with overcutting and illegal logging statistics (discussed later) should be considered as part of the reduction from 4.5 billion m^3 to 2.2 billion m^3, or if a reduction should be applied to the 2.2 billion m^3. This requires further analysis.

TABLE 6 *Average growing stock in China*

Timber forest		
Non-plantation areas (m^3/ha)	Plantation areas (m^3/ha)	Source
87		Shi and Xu 2000
78	35	Zhang 2003
96		Kunshan *et al.* 1997 Vergara 1997

Kunshan *et al.* (1997) state that most of the over mature forests (1.3 billion m^3) are in the remote and steep mountains areas which are difficult, if not impossible, to access. Therefore the most optimistic scenario is to assume that all of the mature forest (1.4 billion m^3) and the nearly mature forests (0.9 billion m^3) are available for wood supply. This estimate of growing stock of around 2.2 billion m^3 is confirmed in an independent report on the economics of timber supply (Shi and Xu 2000).

TABLE 7 *Age classes of the natural (timber) forests*

Age class	% in class 1994	% in class 1998
Young to middle age forest	74	70
Nearly mature forest	10	11
Mature forest	10	11
Over mature forest	6	7

Sources: Forestry Yearbook of China 1994 as quoted in Kunshan *et al.* 1997; National Forest Inventory 1998.

Another alarming statistics is the reported annual reduction in growing stock volume of 253 million m^3 with an annual loss of 271,000 ha in forest area (Kunshan *et al.* 1997). These statistics contrast with other official government reports (e. g., China's National Forest Inventory 1998) which indicate a positive change in volume and area. Again, this discrepancy needs further investigation.

In Table 6 the average growing stock of the forest is relatively low which indicates that the forests are either relatively young or very low in productivity. In many countries the forest is considered non-commercial if the average growing stock volume is below 100 m^3/ha (Bull *et al.* 1998).

Table 7 presents the most optimistic view on the maturity level of the forest. What the 1994 and 1998 estimates do not account for is the overcutting and the illegal logging of at least the last decade. As mentioned earlier the remaining over mature forest is probably not available for wood supply (Kunshan *et al.* 1997). The mature timber forests are either unevenly distributed with the majority of stands also being in the remote and steep mountainous areas with difficult access or are along the upper reaches of large river systems and therefore are critical to watershed protection (Kunshan *et al.* 1997). From combining the evidence in Table 6 and Table 7 we can see that at a maximum only the nearly mature forest is available for wood supply and that the average volume per hectare is higher but it is still only 110-112 m^3/ha (Kunshan *et al.* 1997, China National Forest Inventory 1998).

TABLE 8 *Summary of annual allowable cut, over cutting and illegal harvesting*

Year	Legally available logged volume from the timber forest (National Forest Protection Program 48 million ha)	Over cutting or illegal logging	AAC (slow growing plantations olny)	AAC (both slow and fast growing plantations)	AAC (including fuelwood, non-industrial and industrial)
	Timber forest (000 000 m^3/yr)				Forested land (000 000 m^3/yr)
Column (1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
1950	20				
1990-1996	63	91-123	52-84	175	
1997	32	87			
1998	29	87			
1999	23	87	53		
2000	14	77	53	130	
2000+	<14		53	100	
2001			42		
2002	12	116	43		223
2003			46		223
2004					223
Sources:	Zhang *et al.* 2000	Xu, Taylor and Amacher 2003; CCAP and Butterworth 2003; Feng 2004; Kunshan *et al.* 1999:83	Jaakko Pöyry 2001; Chinamarket Consulting Company 2004	Kunshan *et al.* 1997; Jaakko Pöyry 2001	CCAP and Butterworth 2003

TABLE 9 *Domestic roundwood removal estimates*

Year	Total annual roudwood removal	Industrial roudwood removal	Non-industrial roundwood	Miscellaneous	Fuelwood - domestic statistics	Reported industrial roundwood production (FAO)	Fuelwood production (FAO)	Total reported roundwood production (FAO)
	Column [2] = [3]+[4]+[5]+[6]	*[3]*	*[4]*	*[5]*	*[6]*	*[7]*	*[8]*	*Column [9] = [7]+[8]*
1988	327					98	181	279
1990-1994	297-298	116-132	64-62	20-18	97-86	90-99	188-204	280-303
1995		105				101	204	305
2001		81				94	191	285
2002	330					93	191	284
2003	354	~ 116 (illegal) + ~ 46	~75	~ 20	~97	93	191	284

Sources: Xu, Taylor and Amacher 2003; Jaakko Pöyry 2001; FAOSTAT 2004; Kunshan *et al.* 1997; Zhu and Taylor 2003; Chinamarket Consulting Company 2004.

A more pessimistic scenario is more realistic. Between the first census (1950) and the fourth census (1993) there has been a dramatic loss of 46.62 % of the mature forest. This loss has been accelerated in the last two decades and found in all regions of the country with the lowest rate of loss in the southwest (39 %) to the highest in the east (75 %). To confirm these losses a number of surveys by the National Forestry Bureau were undertaken. They found that in the upper reaches of the Yangtze River there had been a decline in forest cover from 1950 to 1998 from 30-40 % to 10 % while in Sichuan the decline from 1957 to 1993 was from 22 % to 3.3 % (Shi and Xu 2000). Further, Shi and Xu (2000) speculate that in the second largest region of China, the northeast, all mature forest will soon disappear at the current harvest rate. This loss in the mature forest available for wood supply means that the region will have to find alternative sources of roundwood supply. These findings contradict the predictions of other analysts who have assumed that the natural or industrial forest would supply around 77 % of the larger sawlogs and plylogs (or 27 million m^3/year), while plantations would supply 77 % of the smaller logs for panel and pulp production (Jaakko Pöyry 2001:108). Further analysis is required to determine which scenario is more realistic for domestic fibre supply.

FOREST REMOVALS

Table 8 summarizes the AACs estimates and some of the official projection of harvest levels. In column 2, Zhang *et al.* (2000), although not specifically detailed in their analysis, describe the allowable harvest level on the timber forest only. Due to the logging ban the harvest volume beyond the year 2000 was expected to continue dropping. Column 3, however, shows that there has been a long period of over cutting in the timber forest and in 2003, the ‚illegal logging‘ volume was 116 million m^3 (Xu *et al.* 2003). This both brings into question the value of the logging ban and recognizes that most, if not all of the illegal logging must be occurring in the small percentage area of the nearly mature or mature forest, or, they are already harvesting the best of the slow growing plantation wood to meet demand. Jaakko Pöyry (2001) estimates the volume of harvest that could be sustained from the current slowing growing plantations is around 50 million m^3/yr and the fast growing plantation around 50 million m^3/yr. For example, in 2003, 72 % of the allowable harvest or 46 million m^3 was from ‚man-made‘ forest resources, up from 62 % in 2002 (Chinamarket Consulting Study 2004). Again the forecast on the slow growing plantation is the most optimistic view given the serious question on their commercial viability. Since it is reasonable to assume that the current fast growing plantation can grow up to 10m^3/yr the forecasted volume on the current 5 million ha plantation (i. e., 50 million m^3/yr) seems reasonable until further evidence can be collected.

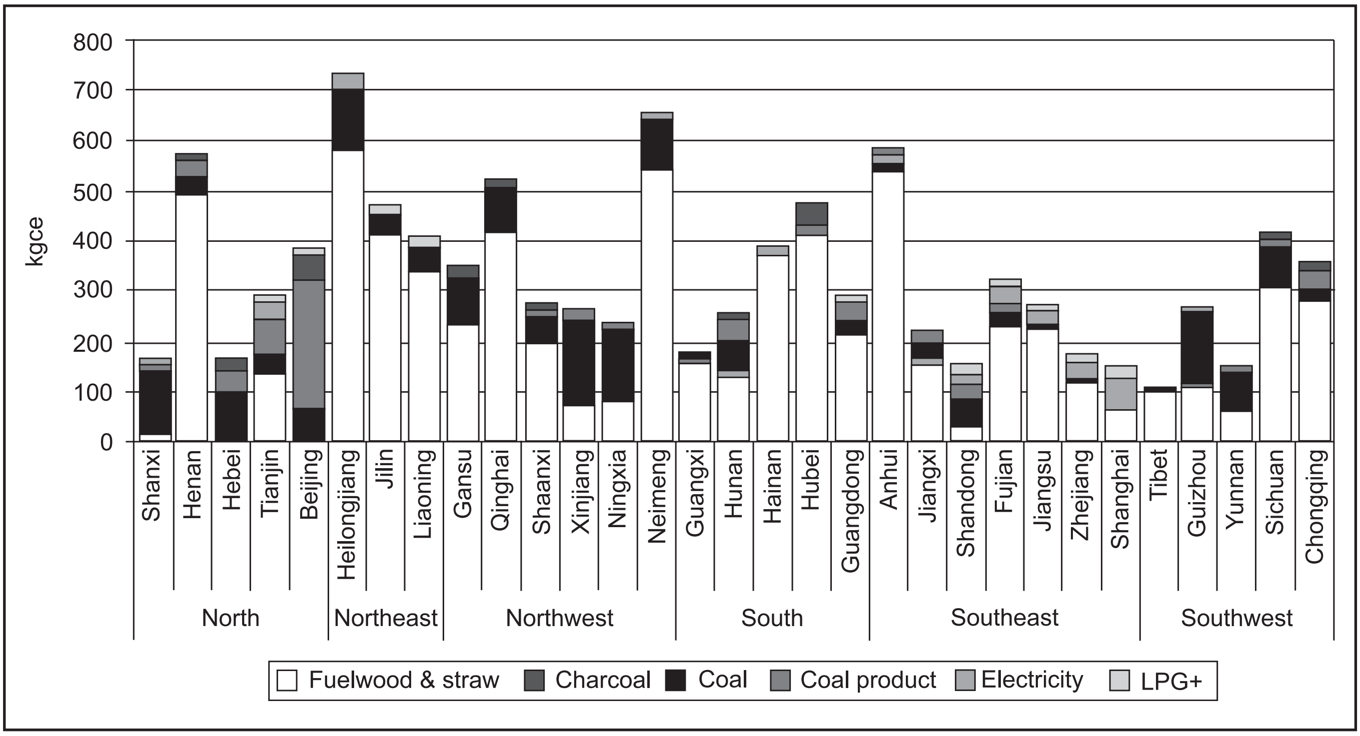
In column 4 the current AAC on the timber forest is probably calculated on the 17 million ha of plantation forest which, as mentioned are growing at approximately 3m^3/ha/yr. Again this seems to confirm that there is no mature or overmature natural forest included. Column 5 summarizes both the historic and the future AAC for all timber forest including both slow growing and fast growing plantations. Column 6 covers the entire area, referred to in official statistics as forest land, and it is likely that the AAC includes fuelwood.[2]

TABLE 10 *Annual consumption od fuelwood from all forest sources*

Volume (000 000 m^3 RWE)	Comments	Base year	Source
191		2002	FAOSTAT 2004
191		2000	FAOSTAT 2004
204		1995	Vergara 1997
221		1997	Kunshun *et al.* 1997:15
225	Primary sources unknown	unknown	Kunshun *et al.* 1997; Zhang 1988
252	Includes forest production sites, roadside shrubs, four-sided forests and protection forests	2001	Jaakko Pöyry 2001
3	The total was 3.47 million m^3. Unclear.	2003	State Forest Administration as quoted in Chinamarket Consulting Company 2004
6	SFA forest reference unknown		Kunshun *et al.* 1997:44
86	Unclear of the forest base but might be timber forest (see next table)	1994	Kunshun *et al.* 1997:45
107		1988	Kunshun *et al.* 1997:45

[2] Adding the 223 million m^3 to the 116 million m^3 of illegal harvest for the year 2003 produces an estimated total domestic timber removal of 339 million m^3 (see next section for comparison).

FIGURE 1 *Per capita energy use of rural households by province.*



REMOVAL STATISTICS

Industrial, non-industrial and fuelwood

Table 9 is an attempt to better understand the total timber harvest removals. It is clear that the there is a lack of consistency, particularly between the domestic reports and what is reported through FAO. In theory, it should be possible to add the industrial, non-industrial, fuelwood and miscellaneous removals to provide a total annual removal. However, in 2003 there are at least three major discrepancies: (1) columns 2 and 9, should be equal but there is 70 million m^3 difference which cannot be explained by any single causal factor; (2) columns 6 and 8, fuelwood, exhibit a 100 million m^3 difference; and (3) column 3, indicates illegal harvesting of 116 million m^3.

The annual roundwood removal includes industrial roundwood, non-industrial roundwood and fuel wood plus other miscellaneous uses (e. g., wood for mushroom cultivation). The FAOSTAT (2004) production statistics are different from other sources but they are

TABLE 11 *Industrial consumption, production and forest products trade in China, 2003, 2002 and 2000*

	Year	Consumption	Production	Imports	Exports	Source
Industrial	2003	172	93	106	27	
Local industrial		75	75			Sun 2004; FAOSTAT 2004
Total		247	168	106	27	
Total comparison	2003	283		123		CTDA as quoted in Chinamarket Consulting Company 2004
Total	2002	185	93	84	8	CCAP and Butterworth 2003; FAOSTAT 2004
Local industrial		75				
Total		260				
Total comparison		*268				CCAP and Butterworth 2003
Industrial	2000	163	96	60	7	Jaakko Pöyry 2001 for imports; FAOSTAT 2004
Local		75				
Total		238				

the reported Chinese official statistics. One could speculate that the production numbers have been reduced from the removals to allow for losses in the forest volume removed into the production process. Chinamarket Consulting Company (2004) indicates that the conversion factor of 57.5 % is appropriate to convert from reported log consumption to log removal from the forest. For example, in 2003 the log consumption was estimated to be 92 million m^3 which would require approximately 160 million m^3 of timber removals. The discrepancy is worth further investigation.

In 2003, the difference between 247 million m^3 and 283 million m^3 is at least partially explained by the difference in import statistics. In 2002, the difference between 260 million m^3 and 268 million m^3 could be due to a change in the estimate of the local industrial consumption. We found no additional data to update the amount consumed and further investigation is required on the local industrial consumption.

In summary, the underlying reasons for the discrepancies between the industrial production statistics presented in Table 11 and the industrial removal statistics presented in Table 10 could be: (1) the removal statistics are gross removals and do not account for losses, there could be at least 25 % to 45 % in losses; (2) there are many small producers who are not part of the statistical system and therefore the production statistics are less than what they should be due to lack of data; (3) the illegally harvested wood is likely not included in production or removal statistics; and (4) the fuelwood removal statistics are inconsistent.

TABLE 12 *Miscellaneous sources of fibre in China for ‚woody' industrial and non-industrial fibre*

Fuelwood forest	Special forest	Economic forest	Protection forest	Four sided trees	Source
000 000 ha					
4.3	3.4	16.1	16.1 (4.2 planted)		Kunshan *et al.* 1997
4.5	4.0	20.2	21.4	~2 - 2.5	Jaakko Pöyry 2001
Estimated fuelwood production					
20 million m^3/yr fuelwood	Not producing timber or fuel	Not producing timber or fuel	Producing some fuelwood	20 million m^3/yr fuelwood and poles	Jaakko Pöyry 2001

Table 10 represents a summary of the range of statistics on fuelwood consumption. It is unclear why there are two basic categories of estimates, those which are likely from the FAO and those generated by National Forestry Statistics within China. The FAO derived statistics are in the upper portion of the table and the lower portion are the Chinese government statistics.

The reported statistics, 3 and 6 million m^3, are clearly not reasonable but neither report cited offers an explanation for such a low number. The uncertainty in the statistics is troubling since there is still a very heavy dependence of forests for fuelwood. In 1999, more than 72 % of rural households in China still relied on biomass (fuelwood or agricultural waste) for energy use (Leiwen and O'Neill 2003).

Figure 1 summarizes the per capita energy uses which varies depending on the availability of other cheap energy, the weather patterns and the geography of the area. It was also found that the transition from biomass to modern commercial sources is still at an early stage, and that incomes may have to rise substantially in order for absolute biomass use to fall (Leiwen and O'Neill 2003). In other words the fuelwood usages pressures in rural China will continue into the foreseeable future.

CONSUMPTION, PRODUCTION AND TRADE

Table 11 summarizes for 2002 and 2003 the total industrial consumption in China. The total consumption reported for 2002 is 268 million m^3 (CCAP and Butterworth 2003) and using FAOSTAT data it is possible to produce a very similar statistics 269 million m^3.

Table 12 summarizes some key additional forests which are not forests for industrial uses (i. e., timber forest and fast and slow growing plantations). Fuelwood forests are communal forests grown for firewood and charcoal and over 86 % is considered to be a natural forest (Jaakko Pöyry 2001). Special use forests are for national defence, railway reserves, environmental protection, scientific purposes, scenic and cultural places and nature reserves; most are considered natural forests. Protection forests are for soil and water conservation, sand-dune and desert protection, mangrove forest, farm belts, nature reserves and National Parks. The estimated growing stock in the protection forest is between 1.8 and 2.2 billion m^3 and some fuelwood harvesting is occurring in these forests (Kunshan *et al.* 1997; China National Forest Inventory 1998). Economic forests produce non-wood forest products which are vital to farmers and are also important for soil and water protection. The major tree crops are oilseed, dry fruit, resins, spice and medicines.

Finally four sided trees, which are not considered as forest land, consist of two major *Paulownia* species. They could, in theory, produce 3-4 million m^3 of wood fibre per year. Poplar, which is used in an agroforestry setting, is estimated to produce another 20 million m³ per year for both industrial and non-industrial uses but the volumes are not included in the official statistics (Jaakko Pöyry 2001).

Table 13 provides a summary of non-wood fibre availability for industrial production processes. These fib-res, many of which are agriculture residues were approximately 429 million tonnes in total in 1994, and with 35-55 % recovery rate, generate 150-236 million tonnes per year of which a significant portion is used for other purposes, especially for energy production in the rural areas of China (Leiwen and O'Neill 2003).

TABLE 13 *Industrial non-wood fibre resources in China*

	Moso bamboo	Bamboo pulp production output - 12 % of material usage	Straw - rice and wheat - residues for pulp output - 40 % usage	Bagasse pulp production output 30 % usage	Reed pulp production 30 % of usage	Other pulp production kenaf, cotton 30 % of usage	Total consumed non-wood pulp	Source
	000 000 ha			000 000 tonnes				
1994	2.7	0.35	8.5	0.35	1.9	1.5	12.6	Zhu *et al.* 1998
1998	2.9							Bull 2004
				000 000 m³/yr roundwood equivalents				
1994 summary	**5.8**	**0.9**	**22.1**	**0.9**	**4.9**	**3.9**	**32.7**	
Base year				000 000 tonnes				
2000		3.6	9.1	2.5				Zhu 1998
2000		2.0			2.6			Bull 2004
2001							*16.8	Jaakko Pöyry 2001
Forecast								
2010		4.5	20.0	3.8	4.3		4.3	Zhu 1998
2004		5.0						Bull 2004
2010		16.0						Bull 2004

The pulp industry is restructuring in China. There has been a significant shift away from using non-wood fibre in pulp production as indicated by the closure of over 9000 small pulp mills using non-wood fibre (Zhu *et al.* 1998). However, there is still a significant use of non-wood fibres in new manufacturing technologies (Jaakko Pöyry 2001).

Table 13 also indicates that the bamboo production potential is already significant and growing with a potential before the planned expansion of area to produce at least 5.8 million m³ per year of fibre for various forest products. The bamboo use in pulp is fairly modest compared to other uses and when combined with straw, bagasse and reed, plus other agricultural residues met approximately 50 % of the domestic pulp requirements (Zhu *et al.* 1998).

FORECASTS

Table 14 is a summary of some possible future fibre availability forecasts. In all cases, the demand (as indicated by consumption estimates) will outstrip supply for industrial products. One study predicted a gap in commercial timber supply of 75 million m³ annually (Zhu 2001). Another study predicted that the commercial timber supply would be around 100 million m³ annually from the timber forest and plantations (Jaakko Pöyry 2001). In both these studies the non-industrial forests were not included and it is not clear what proportion of the fibre was used for different purposes.

Perhaps the most serious problem facing China is that these scenarios ignore the short-term problems which seem to be facing the country. Since various statistics and studies presented in this paper indicate a lack of mature and older wood, poor management and a host of other challenges there could well be a shortage of fibre in all forest listed in Table 14 for up to two decades. Further, the industrial removal data for 2002-2003 is in the range of 230 to 250 million m³ and so the scenarios reflect the optimistic view that somewhere fibre will be found to supply the age class gaps discussed in the paper.

There are suggestions that there will be a decline in the output of non-wood or agricultural waste for pulp (Zhu *et al.* 1998) but most agree there will be an increase in bamboo production (Bull 2004).

While the growth statistics suggest production of 220 million m³ from timber forest this assumes appropriate silvicultural practice, an end to deforestation and no loss of land to permanent land conversion. Finally, since the fuelwood statistics are so confusing, no attempt was made in this paper to integrate a forecast of these statistics.

CONCLUSION

The analysis of the various reported statistics, while often conflicting, highlights significant challenges ahead for the Chinese forest resources to supply the material for industrial, non-industrial, fuelwood and conservation objectives.

TABLE 14 *Long run future fibre availability scenarios*

Fibre source	**Scenario #1 (current management)**	**Scenario #2 (optimistic)**	**Scenario #2 (very optimistic)**
		000 000 m^3	
Timber forest	12	33	63
Plantations (slow growing)	20	51	85
Plantations (fast growing)	40	41	51
Non-industrial	63	63	80
Miscellaneous	12	12	12
Total roundwood fibre	**147**	**200**	**291**
Non-wood (agricultural)	20	32	32
Non-wood (bamboo)	9	6	9
Total non-wood	**29**	**38**	**41**

In general, the statistics indicate that the natural forest appears to have changed dramatically in the last two decades. It appears that most of the remaining natural forest is very young. There has been, and continues to be, significant illegal logging and overcutting activities which is further depleting the meager commercial growing stock. And, the use of forest for fuelwood shows no signs of declining.

The plantation forests of China do not yet provide a significant level of the fibre supply required. The slower growing plantation forest seem to be a disappointment since the growth rates are slow, there are plenty of deformities in the stems, and declines in yield with subsequent rotations are evident. Their contribution to future domestic supply needs requires further analysis. The faster growing plantation are also surrounded by a host of complex policy issues which could well constrain their development and expansion. These include labor productivity, property rights, competing uses for the land, environmental limitations, costs of land and other fixed costs.

The future of the use of non-wood fibre material remains open to debate. While there have been a significant number of non-wood fibre mills shut down in order to protect water, non-wood fibre may still prove to be important in the future.

The demand for forest products is growing rapidly in virtually all product categories. Given forecasted constraints on domestic supply for at least two decades there could be a significant increase in demand for logs and forest products from China's trading partners.

The forecasts indicate significant challenges ahead for the forest sector in China even when considering the most optimistic scenarios. Overall this paper highlights the need to provide more specific conclusions since there are serious data discrepancies in all major statistical areas. These discrepancies must be addressed before a clear set of land and sustainable development policies can be created.

REFERENCES

AMERICAN FOREST AND PAPER ASSOCIATION, 2004. China's fibre resources and forest industry development, American Forest and Paper Association: 101.

BROWN, C., 2000. The global outlook for future wood supply from forest plantations. Global Forest Products Outlook Study, Working Paper No. 3, Forest Products and Paper Division, Food and Agriculture Organization, Rome, Italy.

BULL, G.Q., 2004. An assessment of China's bamboo flooring industry, unpublished consulting report: 20.

BULL, G. Q., W. MABEE, and R. SCHARPENBERG, 1998. Global Fibre Supply Model. Food and Agriculture Organization, Rome Italy.

CHINAMARKET CONSULTING COMPANY, 2004. China wood market report. May 2004.

CHINA'S NATIONAL FOREST INVENTORY [5th], 1998. Beijing, China

CHINESE CENTER FOR AGRICULTURRAL POLICY RESEARCH and J. BUTTERWORTH, 2003. China solid wood products annual. United States Foreign Agricultural Service GAIN Report CH 3118. United States Foreign Agricultural Service: 45.

ROBERTS, D., 2004. China and the global paper and forest products industry: a focus on fibre. CLSA Investors Forum 2004, 14-17 September 2004, Hong Kong.

DURST, P. and C. BROWN, 2002. Sustainability of productivity in successive rotations. International conference on timber plantation development, Manila, Philippines, Food and Agriculture Organization, Rome, Italy.

EVANS, J., 2002. Sustainability of productivity in successive rotations. International conference on timber plantation development. 7-9 November 2002, Manila, Philippines, Food and Agriculture Organization, Rome, Italy.

FANG, Y., and G. CHEN, 2004. Approaches to the environmental management of disasters in mountainous areas of China. *International Journal of Sustainable Development and World Ecology* **11**: 169-180.

FAOSTAT data, 2004. Available at: http:/apps.fao.org /faostat/collections?version=ext&hasbulk=0&subset=forestry

FENG, G., 2004. A review and analysis of China's forest inventory and forecasting models. State Forest Administration Economic and Development Research Center, CIFOR (unpublished).

FU B., G. LIU, X. WANG, and Z. OUYANG, 2004. Ecological issues and risk assessment in China. *International Journal of Sustainable Development and World Ecology* **11**:143-149.

GOVERNMENT OF CHINA, 1997. National report on sustainable development. Website. Available at www.acca21.org.cn/nrport.html. Accessed October 23, 2004.

JAAKKO PÖYRY, 2001. China: Fibre Resources Report. Shanghai, China.

KUNSHAN, S., L. FENMENG, M. YOUNGQING, S. FENG and Z. ZUOFENG, 1999. China's forest product consumption and its demand for the market of international tropical forest products by 2010. Institute of Scientific and Technological Information, Chinese Academy of Forestry. International Tropical Timber Organization. Project report PD 25/96 Rev. 2(M).

KUNSHAN, S., Z. LI, F. LIN, and R. ZHENG, 1997. China's country report on forestry. Ministry of Forestry, Beijing, and Food and Agriculture Organization, Rome. Asia Pacific Forestry Sector Outlook Study APFSOS/WP/14: 118.

LEIWEN, J., AND B. O'NEILL, 2003. The Energy Transition in Rural China. International Institute for Applied Systems Analysis, Laxenburg, Austria. Interim Report IR-03-070.

ROBERTS, D., 2004. China and the global paper and forest products industry: a focus on fibre. Investors Forum 2004, Hong Kong.

SHI, P., J. XU, 2000. Deforestation in China. WP-00-E16. Chinese Center for Agricultural Policy Research, Beijing, China

SUN X. E. KATSIGRIS AND A. WHITE, 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

VERGARA, N., 1997. Wood materials from non-forest areas, Food and Agriculture Organization, Rome, Italy. Asia Pacific Forestry Sector Outlook Study, Working Paper 19: 62.

XU C., 2002. Timber plantations in China. International conference on timber plantation development. 7-9 November 2002, Manila, Philippines, Food and Agriculture Organization, Rome, Italy.

XU J., R. TAO, and G.S. AMACHER, 2003. An empirical analysis of China's state owned forests. Working paper 03 -E20.

ZHANG-HUALING, 1988. China resources, stocking, percentage of forest cover, forest surveys. *Journal of Natural Resources* **3**(3):201-214.

ZHANG K., 2000. Issues relating to the reform of forest management in China. In: ENTERS, T., P. B. DURST and M. VICTOR (eds.). Decentralization and devolution of forest management in Asia and the Pacific, RECOFTC Report N. 18, Bangkok, Thailand, Food and Agriculture Organization, Rome, Italy.

ZHANG, P., G. SHAO, G. ZHAO, D. LEMASTER, G. PARKER, J. DUNNING and Q. LI, 2000. China's forest policy for the 21st century. *Science* **288**: 2135-2336.

ZHANG TINGTING, 2003. China's forest resources face four challenges. Website. Available at www. china.org.cn/english/2003/Oct/78153.htm. Accessed 23 October 2003.

ZHAO, G., G. SHAO, P. ZHANG and G. BAI, 2000. China's new forest policy: response. *Science* **289**: 2049-2050.

ZHU CHUNGQUAN, 2001. International impacts of Chinese forest policy. In: An international conference on sustainable forestry development in China. 11-12 May 2001. Huangshan, China.

ZHU CHUNQUAN, and R. TAYLOR, 2003. China's wood market, trade and the environment, Worldwide Fund for Nature.

ZHU, Z., J. CHUNQUIAN, Z. MAOGONG, and W. HUAFU, 1998. Status, trends and prospects for non-wood and recycled fibre in China. Chinese Academy of Forestry, International Farm Forestry Training Centre, and Food and Agriculture Organization, Rome, Italy. Asia-Pacific Forestry Sector Outlook Study, APFSOS/WP/35.

A brief overview of China's timber market system

XIUFANG SUN●, LIQUN WANG■, and ZHENBIN GU♦

● Market Analyst, Forest Trends, Beijing, China
■ Professor, School of Economics and Management, Beijing Forestry University, Beijing, China
♦ Graduate student, School of Economics and Management, Beijing Forestry University, Beijing, China

Email: xsun@forest-trends.org

SUMMARY

China's timber market system has undertaken reforms as China adopts market liberalisation. Timber production and distribution were monopolised by the government prior to the 1980s but a gradual transition from state allocation to market liberalisation occurred during the late 1980s and early 1990s. Currently timber producers are allowed to market their timber directly to different buyers, although timber harvest and transport remain under state supervision.

Both China's primary wood processing industry and wood consuming sectors have experienced rapid growth. Meanwhile, China's imports of forest products has been growing, driven by the combined forces of a strong demand for timber products by domestic industries (including construction, furniture and panel) together with limited domestic productive forest resources. The government's efforts in establishment of commercial timber resources by fast growing plantations aim to reduce the imports. However, the gap between domestic supply and demand will continue to be filled by imports in the near future.

Keywords: China, timber market system, timber producers, timber distributors, wood processing industry

INTRODUCTION

Since the late 1980s, China has increasingly played a major role in world forestry, both as a producer and consumer market. The booming Chinese economy has led to an ever-increasing demand for high quality value-added wood products. As a result China has become one of the leading wood consuming countries in the world. Consumption of industrial roundwood (logs), sawnwood, wood-based panels, pulp, paper and paper boards in 2001 ranked third, fifth, second, fourth, and second in the world respectively. At the same time, Chinese forest industry has experienced fast growth to meet the increasing demand of wood products home and abroad. For example, China's plywood production recently exceeded U. S. production making China the largest plywood producing country in the world. China has also emerged as one of the most important players in the world pulp and paper market as it contributed more than 50% of the world production growth in paper and board in last decade. It has become the second largest paper and paperboard producer in the world (He and Barr 2004).

Rapidly increasing demand for wood products in China combined with limited domestic timber resources has contributed to increases in imports of wood products. Today, China has become a major net importer of timber and ranked first in the world for log imports.

This paper attempts to give an overview of China's timber market, its unique distribution system, and to describe major players in this system.

CHINA'S TIMBER MARKET/DISTRIBUTION SYSTEM

Timber production and distribution in China has gone through three distinct periods: (i) state allocation; (ii) the co-existence of state allocation with market liberalisation; and (iii) liberalisation under state supervision. The production and distribution of northern timber was subjected fully to state allocation prior to 1985. Between 1985 and 1998, a large proportion was subjected to planned allocation while a small amount was liberalised. After 1998 the production and distribution of northern timber was fully liberalised (Zhu and Taylor 2004). Nevertheless, timber harvest and transport remain under state supervision with logging and transport permits issued by the government after 1998. A similar pattern governed southern timber production and distribution. Prior to 1980 timber in the south was subject to state planned allocation. Between 1980 and 1985 a small proportion was liberalised and state planned allocation was abolished in 1985 allowing for full liberalisation (Zhu and Taylor 2004). However, the government resumed its monopoly in timber procurement in 1987. By 1998, when China implemented the Natural Forest Protection Program, full liberalisation of domestic timber trade began[1].

Figure 1 demonstrates the general framework of China's timber distribution system. Different timber producers use different channels to distribute their products. Wood processing firms receive raw materials directly from timber producers, timber markets, or timber companies, and market their products to end-users. End-users in the timber market system are individual industries, which utilize timber to manufacture final wood products, such as furniture. Wood processing firms are treated as a part of the distribution channel that connects timber producers and end-users.

Timber markets (once called ‚wood trading centres') are now newly established as wholesalers. These new players have emerged as products of the market-oriented economic reform. Currently there are hundreds of timber markets of different size in both major timber producing regions (e. g. Heilongjiang Province) and timber consuming regions (e. g. Shanghai, Guangzhou, and its neighbouring provinces). Timber prices in these markets are fully determined by markets, and trading volumes have been increasing over years.

State-owned timber companies used to be the major distributors of timber under the planned economy. They existed mainly in southern provinces and focused on wood procurement within and outside the provinces on behalf of the government. The quantity traded through them has dropped as the market economy has been adopted. Individual traders are newly emerged timber distributors under market economy. They are playing an increasingly important role in distributing timber in both state-owned and collective owned forest regions.

TIMBER PRODUCERS

China's timber resources are distributed in three major areas: the northeast, including Heilongjiang Province, Jilin Province and Inner Mongolia Autonomous Region; the southwest, including Sichuan Province and Yunnan Province; and the South, including ten provinces, namely Guangdong, Guangxi, Hunan, Hubei, Fujian, Jiangxi, Guizhou, Zhejiang, Anhui, and Hainan. State-owned forests are mainly in northeast and southwest, while forests in southern ten provinces are mostly collective owned forests. Figure 2 illustrates China's timber production during 1992-2002. Due to its limited forest resources, China has kept its timber production under state control. Several measures, such as annual allowable removal quotas, harvest permits, and shipping permits have been used.

As illustrated in Figure 2, timber production dropped after 1998, when China implemented its Natural Forest Protection Program (NFPP) or logging ban. Timber harvests from state-owned forests where natural forests exist have dropped greatly, while the share of timber production from collective owned plantation forests has increased.

FIGURE 1 *General framework of China's timber market system*

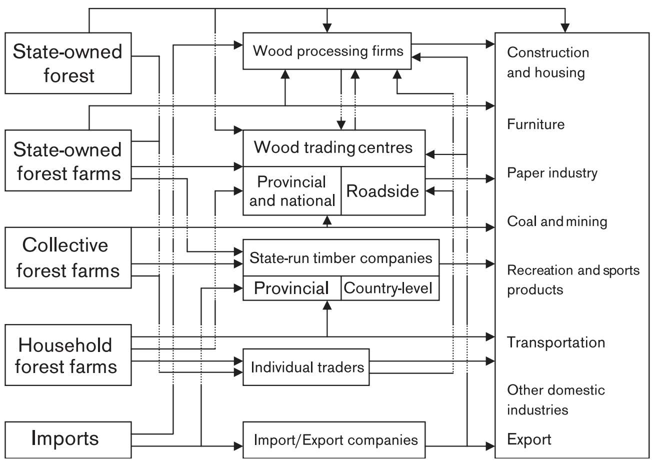


Table 1 summarises the status of different timber producers. There are two types of timber producers in state-owned forest regions; state-owned forest enterprises and state-owned forest farms. As illustrated in Table 1, there are 135 state-owned forest enterprises, mainly located in northeast and southwest China, where natural forests are the major resources. State-owned forest enterprises have rights to market their timber directly. Timber production of these enterprises dropped greatly after implementation of the logging ban in 1998. According to the SFA statistics, timber production from these enterprises was 14.56 million cubic metres in 2002 (SFA 2002), compared to over 30 million cubic metres before 1997.

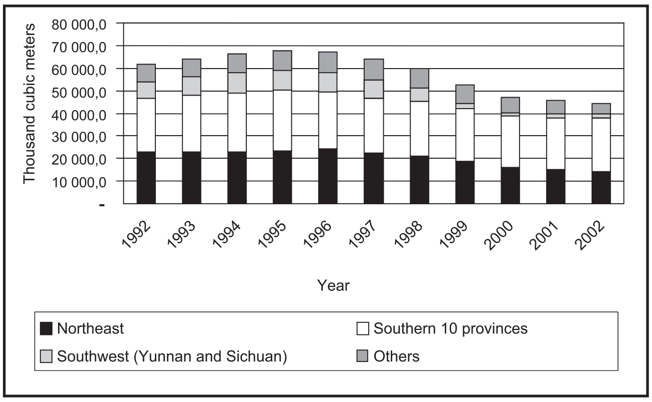
There are over 4000 state-owned forest farms nationwide and typically located in northwest China. Their total timber production in 2002 reached 8.48 million cubic metres (SFA 2002). There are multiple ways for state-owned forest farms to market their timber products, either selling directly to the end users, or to timber markets.

[1] There is no documentation from SFA showing this full liberalisation and when it started. The information was collected by the authors through interviews of officials in the SFA and industry people. The starting dates for full liberalisation vary in different provinces. For example, in Fujian Province, Yongan county started a pilot of forest tenure reform in 1999, when non-state timber buyers/traders were allowed to buy timber directly from farmers. This indicated that a full liberalisation of timber procurement in Fujian Province did not begin until 2000.

Timber producers in collective forest regions consist of two major types: collective forest farms and household forest farms. Collective forest farms are mainly located in collective forest regions which are concentrated in southern provinces such as Fujian and Guangdong province. Under the planned economy, timber products of collective forest farms were procured at county or province level by state run timber companies at government set prices. Since the market-oriented economy was adopted fewer timber products have gone through this procedure.

Household forest farms are also mainly located in collective forest regions in southern China and the plain regions of northern China. As these regions are rich in plantations, timber production has increased rapidly. This is consistent with the government's policy on protecting natural forests by shifting timber production from state-owned natural forests to collective-owned plantation forests. In 2002, timber production by household forest farms totalled around 19 million cubic metres (SFA 2002).

FIGURE 2 *China's timber production 1992 - 2002*



TIMBER DISTRIBUTORS

As state-run timber companies are playing less important roles as the market economy is adopted in China, timber markets at regional, provincial or city level have become the major timber distributors. According to a recent survey, there are 995 timber markets in China, including 344 wholesale and 651 retail markets. More than 70% of these markets opened during 1990s. However, less than 10% (82) of these markets are well established.

Timber markets tend to be differentiated along regional lines, driven by differences in local resources and economies. Traditionally, timber markets in eastern and southern coastal (consuming) regions are more involved in imported timber products than those in the north and west. However, following the logging ban in 1998, a sudden surge of imports of Russian timber turned northeast China into a major timber import centre. As a result, large-scale timber markets were constructed in Suifenhe and Manzhouli, the two largest entry gateways for Russian timber. However, these markets are very narrowly focused on importing, processing and distributing Russian logs (FAS 2001).

WOOD PROCESSING INDUSTRY

The wood processing industry referred here is the primary conversion industry, including sawnwood and wood chips, plywood, fibreboard, particleboard, and other wood based panel sectors.

China's wood processing sectors vary enormously in sophistication. Pit sawyers operate along-side computer controlled sawmills; family operated plywood mills using dried veneers coexist with modern particleboard and medium density or high density fibreboard (HDF) plants.

Sawnwood industry

Traditionally, sawmills were located in forest rich regions and most of the large sawmills were state-owned. Statistics show that most sawmills are located in the northeast state-owned forest region and southern collective forest regions. Data on 2002 showed total sawnwood production from these regions accounted for over 90% of national total (CAF 2004a). However, after implementation of logging ban in 1998, almost all state-owned sawmills were closed due to lack of resources. Many large sawmills are now operating far below their capacity. Meanwhile, numerous small family-owned sawmills or small sawnwood processing facilities have emerged, scattered within or in the neighbourhood of timber market places. According to Chinese Academy of Forestry (CAF), there are 10 350 sawmills in China, of which only 350 are considered to be large with annual capacity of 30 000 cubic metres or more. (CAF 2004a).

Due to the limited domestic timber supply, sawnwood production in China has remained relatively low during the past ten years. Because of this, sawnwood for structural uses in construction has been strictly limited. Official data showed that sawnwood production was 8.52 million cubic metres in 2002 and 11.27 million cubic metres in 2003. However, as most of sawmills are privately owned and small in scale, it is believed that official production was underestimated. CAF estimated the real production of sawnwood was as high as 53 million cubic metres in 2002 (CAF 2004a).

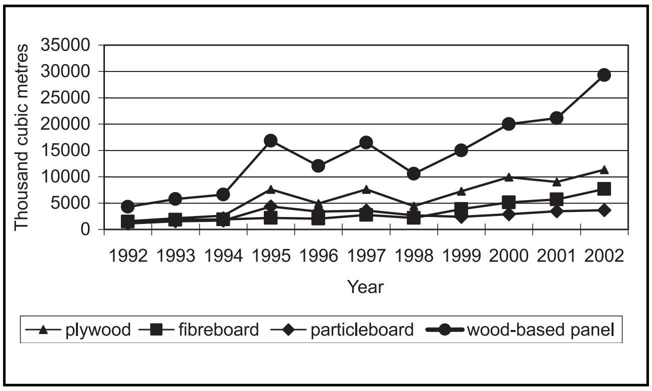
Wood-based panel industry

Since 1980s, the Chinese government has encouraged investment in the wood-based panel industry. As a result, China's wood-based panel production has been increasing rapidly. Nonofficial sources indicated that there are more than 6 000 wood-based panel plants in

China, of which plywood mills account for over 80%. The fibreboard sector experienced the second highest growth, particularly in MDF. Industry sources reveal that by June 2003 there were 370 MDF plants in China with total annual capacity of 14 million cubic metres (CAF 2004b).

By 2002, wood-based panel production in China totalled 29.3 million cubic metres, making China the second largest wood-based panel producing country in the world (CAF 2004b). Newly released 2003 data show a sudden surge in wood-based panel production, which reached 45.53 million cubic metres, a 55 percent increase over 2002. The major wood-based panel products in China are plywood, particleboard and fibreboard, as shown in Figure 3. In 2003, the production of plywood, fibreboard and particleboard consisted of 21.02 million cubic metres 11.28 million cubic metres and 5.47 million cubic metres respectively, all increased by 85 percent, 48 percent and 18 percent respectively from 2002[2].

FIGURE 3 *China's wood-based panels production*



In 2003, China's plywood production exceeded U. S. production to become the largest plywood producing country in the world. The fast development of China's plywood industry coincides with the fast development of China's fast-growing forests, especially the poplar base, which provides adequate raw material to meet the expanding international market.

Wood-based panel production is concentrated in four provinces, Hebei, Shandong, Jiangsu, and Zhejiang. Production of wood-based panels from these four provinces totalled 31.18 million cubic metres, accounting for 68% of national total (SFA 2004).

Non-state enterprises are playing a more important role in China's wood panel industry. For example, there are four plywood manufacturing bases in China, namely Pizhou in Jiangsu Province, Jiashan in Zhejiang Province, Linyi in Shandong Province, and Zhengding in Hebei Province. All plywood mills in these plywood manufacturing bases are private owned and experienced fast growth in the past several years. Most of these mills are small and family operations. As one of the four plywood manufacturing bases in China, Pizhou hosts 2,913 plywood mills. The plywood output in Pizhou totalled at 3 million cubic metres in 2003, accounted for 15 percent of China's total plywood output and export plywood 750,000 cubic metres, accounted for 40 percent of China's total plywood export. The biggest competitive advantage of these mills is their low price of their product by using locally available fast-growing poplar timber.

[2] Besides plywood, fibreboard, and particleboard, other wood-based panel products include blockboard and veneer.

IMPORTS

Timber imports play an increasingly important role in China's timber supply. Prior to the adoption of ‚opening to the outside' in late 1970s, the Chinese government employed very strict mechanisms for approving imported commodities. Import licences were required when importing forest products. Under this mechanism, only a few state authorized trading companies were allowed to deal with the international forest products trade. During the 1980s regulation of the import trade was loosened gradually. By 1999, import permit requirements for wood products were abolished and the number of companies with importing authorisation was increased significantly. Currently any company that has legally registered for international trade is allowed to import wood products.

Nearly half of China's total commercial timber has been supplied by imports in recent years (SFA 2003). Table 2 shows the volumes of wood products China's imported in 2003. Although China imports more pulp and paper products, imports of logs have experienced a rapid growth during the past several years. On the other hand, a substantial share of the wood grown or imported into China is exported in the form of processed timber, paper and finished or semi-finished manufactured products, as showed in Table 2. Currently exports account for nearly 10 percent of China's total wood consumption. Growing investment in China's furniture industry and the rapid development of its paper and plywood industries have boosted exports of furniture, paper products, and plywood. Furniture exports have increased considerably over the past years. The proportion of export furniture and paper and plywood has in 2003 reached 32% 25%, and 19% respectively of total exports of wood products.

END USERS

Continued rapid economic development, coupled with current low per-capita consumption of wood products, contributes to China's large potential in demand for wood products. Studies show that construction and housing, furniture, and paper-making are the top three timber consuming industries (see Table 3).

Construction and housing sector

Although the Chinese government encourages use of non-wood materials in construction, the large demand for wood in housing construction makes this the largest wood consumer among all industries. In 2002, the construction sector consumed 88 million cubic metres of timber[3]. As the government looks to continue to build affordable apartments to improve Chinese living conditions, wood consumption in the sector will continue to grow.

High economic growth has meant a surge in capital construction for housing, luxury hotels and office spaces. One important application of wood used in housing is interior decoration. Higher standards of living and growth of a wealthy class of consumers, particularly in large cities like Beijing, Shanghai, and Guangzhou, translates into increasing demand for high quality wood for home and office decoration and furnishing. According to China's Building Decoration Association, in the coming years, China's interior decoration market will grow at a rate of 20% annually.

Furniture sector

With twenty years of rapid development following the reforms and ‚opening to the outside', China's furniture industry has achieved considerable scale and vigour. SFA statistics showed that 14 million cubic metres of timber were consumed by the furniture industry in 2002 (SFA 2003). Because of strong demand for furniture, timber consumption will continue to grow in the coming years.

The total output value of the furniture industry in 2003 reached US $24.7 billion, up 22 percent compared to 2002, maintaining a steadily increasing momentum in the decades. At present the number of furniture manufacturing enterprises in Mainland China is over 50 000 with 5 million employees.

Among the furniture manufacturing enterprises, non-state-owned enterprises take a predominant place with foreign funded enterprises and civil-run enterprises occupying major roles. Furniture manufacturers from Taiwan, Hong Kong, Singapore, and other Southeast Asian countries moved their facilities to China to take advantage of low business costs. Most furniture manufacturing enterprises are small-scale, with distinctive regional characteristics. They are mainly distributed in south China, east China, north China and northeast of China. Concentration is very high in Guangdong province in southern China where there are more than 6000 enterprises, accounting for 12% of the total. It is home to 30% (by value) of the country's overall furniture production and its exports accounted for 50.5% of the nation's total furniture export value (Xu, Cao, and Hansen 2003), followed by Zhejiang, Fujian and Jiangsu provinces.

TABLE 1 *Description of timber producers*

Timber products (numbers)	Major locations	Timber resources an major species	Timber production (2002)
State-owned forest enterprises (135)	Northeast	3.18 billion m³ (31.52 %) Coniferous: larch, Korean pine, fir Deciduous: oak, birch, poplar	14.56 million m³
	Southwest	2.73 billion m³ (27.07 %) Coniferous: Chinese fir, Yunnan pine Deciduous: oak, birch	
State-owned forest farms (about 4342)	Nationalwide, typically northwest	0.76 billion m³ (7.55 %)	8.48 million m³
Collective forest farms	Southern 10 provinces	1.8 billion m³ (17.79 %)**	2.39 million m³
Household forest farms	South and north plain regions	0.37 billion m³ (3.65 %)**	18.92 million m³

** No data on timber resources by different farm types. These figures represent growing stocks by region, i. e. 1.8 billion m³ refers to timber resource in southern 10 provinces, and 0.37 billion m³ are resources in north plain provinces.

Source of data: China Forestry Statistical Yearbook 2002m China's Forest Resources Inventory (1994 - 1998).

Pulp and paper industry

There are roughly 3 500 paper mills in China, producing about 37.8 million tonnes of paper and paperboard in 2002 (China Technical Association of Paper Industry 2003). Almost all the paper mills source their pulp from their own, integrated pulp mills. Most paper mills are located in the east and south of China. For decades, the Chinese paper industry has relied

[3] In urban areas, wood used in construction sector is used mainly for non-structural applications, including interior decoration and furnishing. In the countryside, wood used by farmers to build their own houses is for both structural and non-structural applications.

heavily on imports to meet the growing domestic and re-export demand. Historically, the industry was characterized as ‚small-scale' with ‚low processing technology, insufficient wood fibre' and a ‚minimum capacity for producing high-grade paper' (Zhu and Taylor 2004). Non-wood fibre has been the major raw material and has caused severe pollution problems. Currently, wood pulp accounts for over 20 % of total pulp consumed by Chinese paper mills. However, demand for high-grade paper which needs more wood fibre (e. g. coated white paperboard, kraft lineboard) has been growing. As a result, imports of wood pulp continue to grow while at the same time large paper mills begin to secure their own raw material bases by establishing large-scale plantations.

TABLE 2 *China's imports and exports of timber products*

	2003 imports (RWE m^3)	**2003 exports (RWE m^3)**
Forest products	106,923,273	26,777,717
Timber products of which:	40,379,153	11,457,848
Logs	25,455,970	9,397
Lumber	7,874,210	721,084
Plywood	1,994,455	5,105,000
Veneer	558,487	266,668
Particleboard	935,999	101,226
Fibreboard	2,509,554	114,227
Wood chips	503,536	2,046,506
Wood furniture	52,635	8,545,555
Pulp of which:	47,927,090	73,202
Wood pulp	23,414,740	14,952
Paper and paperboard	18,556,521	6,699,791

Source of data: China's Customs 2003. RWE = Roundwood Equivalent Volume

TABLE 3 *Structure of timber consumption by end-users*

Industries	**Timber consumption 2002 (million m^3) (%)**
Total timber consumption by domestic industries	123.76 (100 %)
Construction and housing	88.38 (71.4 %)
Furniture	14.02 (11.3 %)
Paper industry	9.63 (7.8 %)
Coal and mining	7.35 (5.9 %)
Vehicles, ships and boats manufacturing	2.69 (2.2 %)
Others	1.69 (1.4 %)

Source: SFA 2003. China forestry development report 2003.

CONCLUSION

Although the government controls domestic timber production by such means as logging quotas and harvesting permits, China's timber market has enjoyed gradual changes as a result of market liberation. Entry into the WTO has pushed China to open its wholesale market to foreign distributors. Competition in China's timber distribution will no doubt become more severe than before.

The strong demand for timber products in China will continue in the coming years, driven by the rapidly developing construction, furniture and panel sector. More wood fibre will be consumed by the paper making industry, driven by the increasing demand for high-quality paper and paper products. The gap between domestic supply and demand will grow and imported timber products will continue to be needed to meet the gap.

REFERENCES

CHINA TECHNICAL ASSOCIATION OF PAPER INDUSTRY 2003. Almanac of China paper industry. 742 pp. (In Chinese)

CHINESE ACADEMY OF FORESTRY (CAF) 2004a. Overview of China's sawnwood sector. Forest Trends/CIFOR working paper.

CHINESE ACADEMY OF FORESTRY (CAF) 2004b. Overview of China's wood based panel sector. Forest Trends/CIFOR working paper.

FOREIGN AGRICULTURAL SERVICE (FAS). 2001. Timber markets in China. USDA/FAS online GAIN Report #CH1071.

HE, D. and BARR, C. 2004. Recent trends and projections on China's paper and board demand, supply and trade, CIFOR and Forest Trends (working paper).

STATE FORESTRY ADMINISTRATION (SFA) 2002. China Forestry Statistical Yearbook 2002. China Forestry Publishing House, Beijing, China. 749 pp. (In Chinese)

STATE FORESTRY ADMINISTRATION (SFA) 2004. China forestry development 2004. China Forestry Publishing House, Beijing, China. 117 pp. (In Chinese)

STATE FORESTRY ADMINISTRATION (SFA) 2003. China forestry development 2003. China Forestry Publishing House, Beijing, China. 124 pp. (In Chinese)

XU, M., CAO, X. and HANSEN, E. 2003. China's wood furniture industry. *Asian Timber*, September/October **2003**:35-39.

ZHU, C. and TAYLOR, R. 2004. China's wood market, trade, and environment. WWF forest for Life Programme, TRAFFIC Rufford Foundation and World Bank/WWF Alliance (forthcoming).

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

XIUFANG SUN●, E. KATSIGRIS■ and A. WHITE■

● *Market Analyst, Forest Trends, 1050 Potomac Street NW, Washington, DC 20007, US*
■ *Senior Director, Policy and Market Analysis, Forest Trends*

Email: xsun@forest-trends.org, jkatsigris@forest-trends.org, and awhite@forest-trends.org

SUMMARY

This study analyzes trends in China's forest product imports between 1997 and 2003 by both product segment and ports of entry. The same information is provided for each of the main Asia-Pacific countries supplying China. A high growth was experienced in China's forest product imports between 1997 and 2003 in both timber products and pulp and paper. Logs, lumber, and pulp are the most rapidly growing import segments as China moves towards handling more of the processing of forest products itself. Forest-rich countries in the Asia-Pacific region are playing an increasingly important role in supplying China's expanding demand.

Ocean ports in the Shanghai-Jiangsu and South China regions have maintained their leading role in the forest product trade. These have been joined more recently, and in some cases surpassed, by inland ports in Northeast China, which have been catapulted to leading roles by the booming border trade with Russia.

Keywords: China, forest product imports, Asia-Pacific, timber products, pulp and paper

INTRODUCTION

China's flourishing economy, coupled with policy constraints limiting domestic forest production, has resulted in a massive increase in forest product imports over the last several years. In a decade, China has moved from a ranking of seventh to second among all nations in total value of forest product imports and is also now the leading importing country worldwide of industrial round wood.[1]

This growing import demand is having major impacts on forests and forest peoples in producer countries and is stimulating increases in illegal logging and deforestation. The link between illegal logging and trade, in particular, is a recognized problem that has been addressed in a number of recent studies. These have used evidence from both discrepancies in trade statistics and on-the-ground investigations[2]. Expectations for China's continued strong economic growth suggest that the trends will continue, if not accelerate, in coming years. Full diagnosis of the impacts, as well as projections of import trends and identification of opportunities for low-income producers to possibly benefit from this trade, require a much clearer picture of the flows of forest product imports into China than has been available to date.

This paper provides a brief overview of forest product import trends, by both product segment and port of entry, in addition to providing the same information for each of the main Asia-Pacific producer countries supplying China. Trends are identified primarily through use of official Chinese customs data[3]. The paper is based on a more detailed analysis published by Forest Trends and CIFOR and builds on recent work by WWF and others[4]. The paper first describes the overall import trends and then describes trends by product segment. It next addresses trends in ports of entry and identifies major supplier countries. The roles of eight leading Asia-Pacific producer countries currently involved in the China trade; Cambodia, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, Russia, and Thailand, are then examined. These countries are home to some several million indigenous and other forest people as well as high concentrations of globally significant biodiversity (13 of 25 global biodi-

[1] In 1990, China was ranked seventh among nations in forest product import value. By 2000, it was ranked second, with only the US importing a greater total value of forest products. Source of data: ‚FAOSTAT Agricultural Data', Food and Agriculture Organization of the United Nations (FAO), 2004: Accessed via http://faostat.fao.org/ on March 12, 2004.

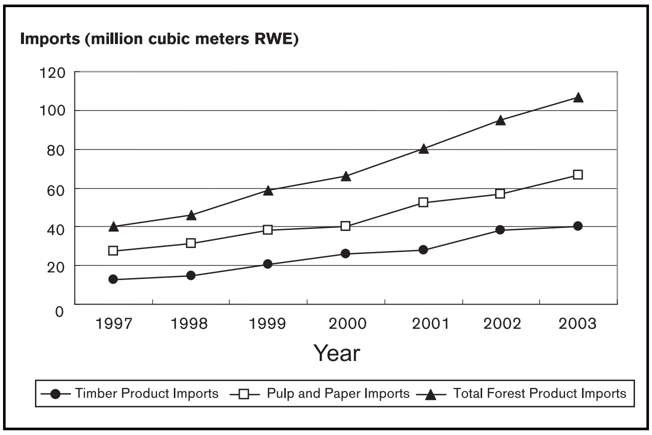
[2] The ITTO has recently commissioned a number of trade discrepancy studies, which provide details on the gap between import statistics of destination countries (e. g. China) and export statistics of supplier countries (e. g. Indonesia). Gaps are thought to be a result of product that is illegally harvested in and/or smuggled out of the producer country. An important study that covers illegal logging more generally is FAO's ‚Law Compliance in the Forestry Sector: An Overview' by Arnoldo Contreras-Hermosilla (2001). Other good sources include reports and briefings produced by the Environmental Investigation Agency's Forests for the World Programme (http://salvonet.com/eia/campaigns2_reports.shtml) and www.globaltimber.org.uk.

versity hotspots are located in the region (World Bank 2000, Operations Evaluation Department 2000)).

TRENDS IN OVERALL GROWTH
AND ITS COMPOSITION

China's forest product imports more than doubled in round wood equivalent (RWE) volume between 1997 and 2003, rising from 40.2 million to 106.7 m^3 (Figure 1)[5]. Overall imports in the sector increased by 102 % during the same period, rising from US$ 6.4 billion to US$ 12.9 billion.

FIGURE 1 *China's forest product imports 1997-2003*



Timber product imports more than tripled in volume and more than doubled in value between 1997 and 2003, reflecting China's marked expansion of its timber processing industry. This industrial expansion has been driven not only by growing domestic demand for end products, but also by international demand for exports of China's low-cost finished wood products such as furniture.

Pulp and paper are responsible for an even larger volume of forest product import growth over the period studied than are timber products. Pulp and paper products currently account for about 60 % of China's forest product imports by RWE volume. Their strong growth reflects not only a rise in the quantity of paper demanded, but also in quality criteria. That is, as the quality requirements of both China's domestic paper market and her export-oriented sectors rise (e. g. high quality paperboard for packaging), the nation is moving away from a predominantly straw-based pulp and paper industry towards greater use of (often imported) wood-based fibers (He *et al.* 2004).

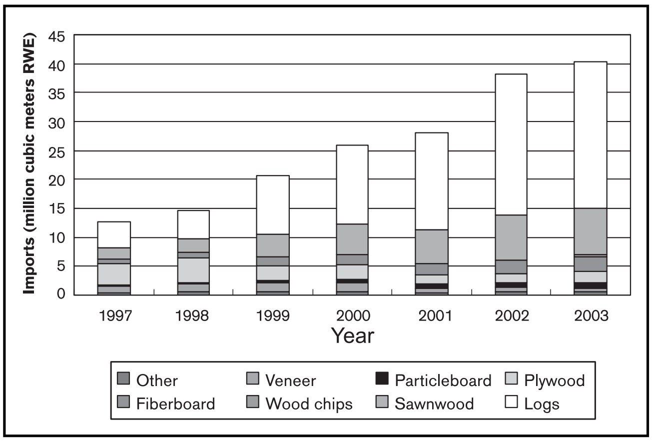
The main drivers of these general trends in forest product imports are China's strong economic growth, her low per capita endowment of wood, and policy constraints to domestic production from natural and plantation forests. To a lesser extent, recent reductions in forest product tariffs may play a role in increased imports including, possibly, a shift from illegal to legal product as smuggling becomes less attractive.

TRENDS BY SEGMENT

Timber products

Timber product imports were analyzed according to the following segments; logs (unprocessed), lumber (sawn wood), wood chips, fiberboard, plywood, particleboard, veneer, and a general ‚other' designation for more minor products (Figure 2).

FIGURE 2 *China's timber product imports by product type 1997-2003*



Logs, and to a lesser extent lumber, account for the largest portion of the strong timber product import growth occurring between 1997 and 2003. As a result, logs and lumber now make up the bulk of China's timber product imports, with over 25 million m^3 of logs and 7.9 million m^3 RWE of sawn wood imported in 2003.

Trends in timber product data reveal the Chinese economy's increasing capture of the value added of

[3] The data reflect direct imports to Mainland China only, while Hong Kong and Taiwan are treatad as supplying regions rather than destinations.

[4] Xiufang Sun *et al.*, ‚China's forest product import trends, 1997-2002: Analysis of customs data with emphasis on Asia Pacific supplier countries', Forest Trends and CIFOR, 2004; and WWF Forests for Life Programme, TRAFFIC Rufford Foundation and World Bank/WWF Alliance, ‚China's Wood Market, Trade and Environment' (eds. Zhu Chunquan and Rodney Taylor, 2004).

[5] In brief: In order to compare and aggregate volumes of timber products and pulp and paper, various types of forest products are converted to round wood equivalent volumes (RWE). Aside from logs, a conversion factor is used to convert a product's physical volume in units (m^3) to its RWE volume in cubic meters (m^3 RWE). For example, one m^3 of lumber = 1.43 m^3 RWE of lumber, while 1 m^3 of logs = 1 m^3 RWE of logs. For the sake of clarity, the text will designate which volumes are m^3 RWE (except in the case of logs). Otherwise, units of m^3 without RWE designation, when used for a single type of product, should be interpretedy as physical cubic meters. Conversion factors to calculate RWE are sourced mainly from FAO, with special pulp conversion factors provided by the China Paper Association.

natural resources, as imports enter China in a less processed state. While higher value-added imports (plywood, veneer, fiberboard, etc.) made up almost half of China's timber product imports by value in 1997, by 2003 logs and sawn wood constituted 78 % of total import value. A comparison of plywood to sawnwood imports further illustrates this trend. In 1997, plywood imports were 3.73 million m^3 RWE and sawnwood imports were 1.89 million m^3 RWE. By 2003, volume of plywood imports had dropped to 1.99 million m^3 RWE, reflecting the growth of China's own plywood capacity, while sawnwood import volume had grown to 7.87 million m^3 RWE.

In the log category, softwood logs have dominated growth and now make up 60 % of log import volume, as compared to only 21 % in 1997. In fact, from 1997 to 2003, softwood log imports grew 15 times from a base of merely 930,000 m^3 to 15.0 million m^3. Starting from a much larger base of 3.5 million m^3 in 1997, hardwood log imports in comparison grew by only two times, but were also quite substantial by 2003, reaching 10.4 million m^3.

Within the hardwood log category, tropical hardwood log imports were responsible for over 80 % of growth. While temperate hardwood log imports grew steadily between 1997 and 2003, more than doubling in volume, tropical hardwood logs made up the majority of hardwood logs throughout, constituting over 75 % of volume for each of the years studied.[6]

The bulk of lumber imports are made up of hardwood (75 % of lumber imports by volume in 2003). Softwood lumber imports, however, showed growth rates similar to those of their hardwood counterparts. Hardwood lumber imports grew from 1.0 million m^3 in 1997 to 4.1 million m^3 in 2003, with the strongest rises in tropical hardwood lumber, which made up the majority of hardwood lumber imports for each of the years studied. Temperate hardwood lumber, however, played a somewhat more substantial role than its counterpart in the log category, accounting for about a third of hardwood lumber growth by volume over the period, and actually exceeded temperate hardwood log imports in RWE volume in 2003. Softwood lumber imports rose from a base of 300 000 m^3 in 1997 to 1.4 million m^3 in 2003, with growth attributed to a sharp rise in Russian lumber imports.

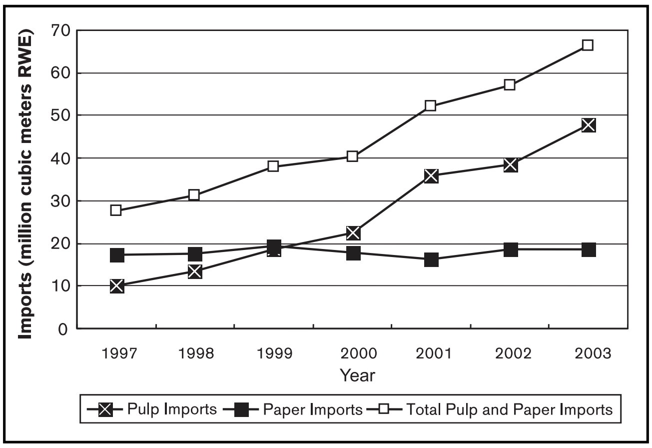
[6] Chinese customs designates three categories for both hardwood logs and hardwood lumber: (1) tropical, (2) temperate, and (3) mixed. The ‚mixed hardwood' categories, however, consist of all hardwoods (either tropical or temperate) for which China custom does not have specific species designations. The analysis on which this paper is based divides each of hardwood logs and hardwood lumber into two categories only: (1) tropical and (2) temperate. The ‚mixed hardwood' categories used by China customs are disaggregated by country and, following ITTO's definition of tropical timber, all hardwood product from tropical countries is treated as tropical, while that from other countries is classified as temperate.

Pulp and paper

As with timber products, trends in pulp and paper imports between 1997 and 2003 show the Chinese economy's increasing capture of value added (Figure 3). Sharp increases in pulp imports constitute the bulk of growth in the pulp and paper category and have moved the segment from one in which paper has historically dominated imports to one in which pulp imports far exceed those of paper.

In 1997, China imported 70 % more paper by RWE volume (17.3 million m^3) than pulp (10.2 million m^3). Pulp imports tripled in value between 1997 and 2003, with RWE volume jumping by 3.7 times. As a result, by 2003 China imported 47.9 million m^3 RWE of pulp as compared to 18.6 million m^3 RWE of paper. The trends correspond with expansion of China's woodfiber-based domestic paper manufacturing capacity.

FIGURE 3 *Comparison of China's pulp and paper imports 1997-2003*



TRENDS IN TOP PORTS OF ENTRY OF CHINA'S FOREST PRODUCT IMPORTS

As part of efforts to develop a richer and more informative picture of the growing trade flows of forest products into China, import data were analyzed by major port of entry. The map provided in Annex 1 depicts the location of the main ports covered. It should be noted that a ‚port' as referred to in this study indicates one of the 42 ports of entry operated by China's General Customs Bureau. Import data for each of these ports of entry actually represents aggregate imports for all ports and gateways in the geographic area under that port of entry's supervision. ‚Nanjing', for example, covers all ports in Jiangsu Province. In contrast, there are seven ports of entry in Guangdong Province, each covering a number of entry points. This section first presents port of entry trends for forest products overall and by product and then touches upon port trends by producer country and associated product.

General port of entry trends

Leading ports of entry for China's forest products tend to be either ocean ports in areas of China's greatest economic growth and manufacturing capability or inland ports serving border trade with producer countries. In general, there are three major geographic clusters that include the leading ports of entry for most types of forest products. These geographic clusters are:

1) The Guangzhou-Shenzhen corridor, located in South China's Guangdong Province and including the ports of Guangzhou, Huangpu (also covering areas near the city of Guangzhou), and Shenzhen (located on the border with Hong Kong);
2) The Shanghai-Jiangsu region, including the ports of Shanghai and Nanjing in eastern China; and
3) The far Northeast border area, including Harbin (the provincial capital of Heilongjiang Province and also the port of entry aggregating customs data for the whole province) and Manzhouli (a border town and railhead in the northeastern part of the Inner Mongolia Autonomous Region).

The first two of these clusters, representing major ocean port areas, have consistently played an important role in forest product imports over the period studied (1997-2003). They share the common import drivers of strong economic growth, much of China's most prosperous populace, and phenomenal concentrations of manufacturing capacity (e.g. furniture) serving both the domestic and export markets.

The third cluster, consisting of the ‚overland‘ ports of Harbin and Manzhouli, has come to prominence more recently reflecting the critical role of these ports in he sharply growing imports from the Russian Far East. This cluster is located in a much less prosperous region of China than the first two clusters.

Among the ports of entry not included in these three clusters, Qingdao (an ocean port in North China's Shandong Province and the port of entry aggregating customs data for the province as a whole) is probably the most important to note, given that it is a top player in pulp imports. Qingdao's role in the pulp trade is not surprising, as Shandong Province is known as a major center of China's papermaking industry. Kunming Port (covering all gateways in Southwest China's Yunnan Province) is also of note, given its central role in the expanding border trade with Myanmar.

Port of entry trends by product

Table 1 summarizes the major findings on ports of entry for specific categories of forest product. For timber products generally, it can be seen that the leading five ports by volume include a mix of ocean ports serving coastal China's economic powerhouses (Nanjing and Shanghai in the Shanghai-Jiangsu area and Shenzhen in Guangdong Province) and, now at the top of the list, newer entrants from Northeast border areas (Harbin and Manzhouli, which replaced South China's Guangzhou and Huangpu in the top five in timber import value in 2001 and 2002, respectively). In contrast, pulp and paper show much less of a role for Northeast border ports, with ocean ports instead clearly dominating this trade.

Log imports

The log category shows an even stronger influence of increasing overland border trade than timber products in general. The inland border ports of Harbin, Manzhouli, and Hohhot, alongside seaports Nanjing and Qingdao, were all in the top five for log imports in 2002. Interestingly, with the rise in Russian border trade, Nanjing was recently overtaken in its role as highest volume port of entry for logs by both Harbin and Manzhouli.

The softwood log trade is dominated by inland border trade. The top three softwood log ports of entry by volume are all inland border ports (Manzhouli, Harbin, and Hohhot) exhibiting strong growth trends from border trade with Russia. Softwood log imports through Manzhouli, for example, increased by a factor of 13 between 1997 and 2002.

Tropical hardwood logs enter China mainly through ocean ports, while over half of temperate hardwood logs enter through overland trade. Nanjing was the leading port in volume of tropical hardwood log imports throughout the period studied, accounting for 53 % of imports in 2002. Temperate hardwood log imports similarly indicate a single leading port, with Harbin handling the greatest volume for each year studied and accounting for 47 % of imports in 2002. Interestingly, for both tropical and temperate hardwood logs, Shanghai's role as port of entry has dropped, while that of Qingdao has grown.

Sawnwood imports

Overall, the sawnwood category does not show the same dominance of overland border trade with Russia found in the log category. This trend correlates with the greater role of hardwoods in the composition of lumber imports. In general, sawnwood imports tend to be most focused on ports serving China's major economic powerhouse regions. For sawnwood overall, for example, the top two ports are Shenzhen and Shanghai, each located in one of China's fasting growing regions. Thousands of export-oriented wood product manufacturers are based in these regions, including furniture and wood flooring mills, which consume large quantities of imported lumber.

For hardwood lumber, tropical and temperate product share the same three leading ports (Shanghai,

TABLE 1 *Chinese ports of entry - top ports and port trends by forest product category*

Product	**Top ports in 2002**	**Notes on port trends**
Timber products	1. Manzhouli 2. Harbin 3. Shenzhen 4. Nanjing 5. Shanghai	Reflecting growth in Russian timber trade, rising share for Harbin and Manzhouli which replaced Guangzhou and Huangpu in top five in timber product import value in 2001 and 2002, respectively.
Logs	1. Harbin 2. Manzhouli 3. Nanjing 4. Hohhot 5. Qingdao	Nanjing had been largest port of entry for logs before 2000, but was overtaken by Harbin and Manzhouli due to growing trade with Russia.
Softwood logs	1. Manzhouli 2. Harbin 3. Hohhot	Strong growth trends for border trade with Russia; e. g. softwood log imports through Manzhouli increased 13 times from 1997 to 2002.
Tropical hardwood logs	1. Nanjing 2. Qingdao 3. Guangzhou 4. Kunming 5. Shenzhen	Nanjing top port throughout period (1997 - 2002), handled 53 % of volume in 2002. Shanghai's role dropped over the period, while Quingdao's and Kunming's rose.
Temperate hardwood logs	1. Harbin 2. Qingdao 3. Shanghai	Harbin top port for all years (1997 - 2002), handled 47 % of volume in 2002. Shanghai's role dropped over the period, while Quingdao's rose.
Sawnwood	1. Shenzhen 2. Shanghai 3. Huangpu 4. Guangzhou 5. Manzhouli	Dramatic growth in both Shenzhen and Shanghai, located in China's fastest growing regions and home to thousands of export-oriented wood product manufacturers (e. g. furniture and wood flooring mills) requiring large quantities of lumber.
Softwood lumber	1. Manzhouli 2. Shenzhen	Manzhouli and Shenzhen replaced Hohot as top ports, each accounting for about 1/4 of total in 2002.
Tropical hardwood lumber	1. Shanghai 2. Shenzhen 3. Huangpu	Strongest growth in Shanghai, which led with 34 % of volume in 2002. Overland trade limited: Harbin joined top five in 2001; handled only 8 % in 2002.
Temperate hardwood lumber	1. Shenzhen 2. Huangpu 3. Shanghai	Shenzhen top port since 1998; handled 42 % of volume in 2002.
Plywood	1. Shenzhen 2. Shanghai 3. Guangzhou 4. Huangpu	Plywood imports overall declining, as China's production capacity increases; remaining imports dominated by coastal ports; Russia border trade ports not represented in top five.
Veneer	1. Guangzhou 2. Jiangmen 3. Shanghai 4. Shenzhen 5. Huangpu	After 2000, Shanghai and Huangpu imports dropped significantly and Jiangmen and Guangzhou imports grew; overall, veneer imports in decline.
Wood chips	1. Qingdao	China is net exporter of wood chips; 2002 surge in imports mainly into Qingdao from Australia.
Pulp and paper		
Pulp	1. Nanjing 2. Shanghai 3. Qingdao 4. Manzhouli 5. Huangpu	Combined imports of top five ports accounted for 75 % of total. Shanghai was top port between 1997 and 2000; Nanjing surpassed Shanghai in 2001; in general, coastal ports dominate.
Paper and paperboard	1. Shenzhen 2. Huangpu 3. Shanghai	Few changes over the six year period. In 2002, Shenzhen imported 41 % and Huangpu 23 %.

Note: Leading ports are listed in order of decreasing import volume.

Shenzhen, and Huangpu) for most of the period studied. For tropical hardwood lumber, Shanghai showed the largest growth and was the leading port of entry in 2002, with 34 % of volume. For temperate hardwood lumber, Shenzhen has been the leading port since 1998 and accounted for 42 % of volume in 2002. It is interesting to note that overland trade does not play the same role in temperate hardwood lumber imports as it does in temperate hardwood log imports, with Harbin handling only 8 % of the trade by volume in 2002.

Finally, for softwood lumber, Manzhouli and Shenzhen have overtaken Hohhot as the top entry ports, with each accounting for about one quarter of softwood lumber imports by volume.

Imports of panel products

While small and declining imports make analysis of ports of entry for board products less important in understanding overall trade flows, the paths of these products still merit some attention. Of particular interest is the complete absence of inland ports bordering Russia in the top five ports of entry for both plywood and veneer. Instead, the trade for these products is fully dominated by ports in the Guangdong (South China) and Shanghai regions.

Pulp and paper

Like panel products, the pulp and paper trade also shows dominance of ocean ports near major manufacturing centers. For pulp, the top five ports of entry, responsible for 75 % of imports, were Nanjing, Shanghai, Qingdao, Manzhouli, and Huangpu, with Nanjing surpassing Shanghai's ongoing position as the top port for pulp imports in 2002. It is interesting to note that only one of the two main ports serving the Russia overland trade made the top five pulp ports and was ranked only fourth. This reflects the lesser (though not insignificant) role of Russian pulp, compared to Russian logs, in the border trade.

Paper and paperboard imports show few changes in major ports of entry over the six years studied. In fact, the South China ports of Shenzhen and Huangpu (the latter covering the area in and around east Guangzhou) have dominated this trade throughout the period, with Shenzhen importing 41 % and Huangpu 23 % of total volume in 2002.

Port of entry trends by producer country and associated product

Table 2 displays key port of entry results by producer country and associated product. It illustrates the leading role of border ports across product areas for Russia (Harbin and Manzhouli Ports) and Myanmar (Kunming Port). It further shows a mix of the two ocean port clusters (Shanghai-Jiangsu and Guangdong) for imports of other major suppliers, such as Indonesia, Malaysia, and Thailand.

A few additional country-specific results are of note here. First, Nanjing, China's leading importer of tro-

TABLE 2 *Main ports of entry by Asia-Pacific producer country and product: 2002*

	Softwood logs	Hardwood logs	Softwood lumber	Hardwood lumber	Plywood	Veneer	Pulp	Paper
Russia	Harbin Manzhouli	Harbin	Manzhouli Hohhot	Harbin			Manzhouli	Manzhouli Shenzhen
Indonesia		Nanjing Shenzhen		Shanghai Shenzhen	Shenzhen Shanghai Guangzhou		Nanjing Qingdao	Shenzhen Huangpu Shanghai
Malaysia		Nanjing Guangzhou Shenzhen		Shenzhen Huangpu Shanghai	Huangpu Shenzhen Shanghai	Guangzhou Shanghai		
Thailand				Guangzhou Huangpu Shenzhen			Nanjing Gongbei	Shenzhen
PNG		Nanjing				Shanghai		
Myanmar		Kunming		Kunming				
Cambodia				Nanjing Huangpu Jiangmen	Shanghai Qingdao	Jiangmen Shenzhen		
Laos		Kunming Huangpu Shenzhen		Kunming				

Note: For each country-product pair, the table lists the top one to three ports for 2002, beginning with the top port and stopping after either 70 percent of the volume is accounted for or the third port is listed, whichever comes first. For each country, only the main forest product import categories are cove-red. While results are based on 2002 data, 2003 data shows a continuation of main trends, with only slight changes in orde-ring of top ports in some cases.

pical hardwood logs, handled 86 % of PNG log imports in 2002. Second, while border trade through Harbin and Manzhouli dominates Russian imports, ocean shipping to Dalian and Nanjing is beginning to play a role in this trade. Similarly, in the case of Myanmar, a small portion of product is being shipped to Shanghai and other ocean ports. In the pulp trade with Asia-Pacific producers, Nanjing and Qingdao (based in Shandong, a center of China's paper industry) handle the majority of Indonesian pulp, while border port Manzhouli handles the majority of Russian pulp.

TRENDS IN IMPORTS FROM MAJOR SUPPLYING COUNTRIES

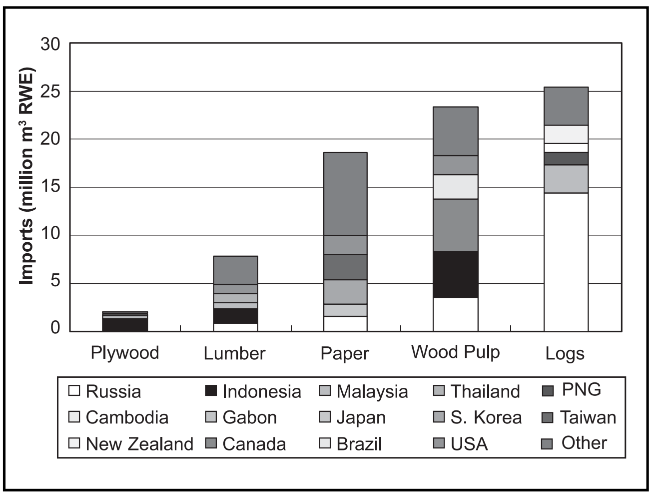
Trends in China's major supplying countries are discussed below by product. The role of top players by volume in key product areas is depicted in Figure 4. In general, the China timber product trade is dominated by Asia-Pacific countries, whereas in the case of pulp and paper, countries both within and outside of the region play significant roles.

Trends in timber product suppliers

Russia, Malaysia, and Indonesia have been the three leading suppliers by volume of timber products to China since 1997. Total imports of timber products from these three countries accounted for over 50 % of China's total each year between 1997 and 2003. In 2003, China's combined timber product imports from the three totaled approximately 23.6 million m^3 RWE valued at US$ 2.2 billion.

The rise in Russian imports over the years studied has been sharp and Russia is now the top timber product supplier by volume to China. In 1997, Russian timber product imports were 970 000 m^3 RWE and valued at US$ 93 million. By 2003, import volume had risen to 15.3 million m^3 RWE, with a value of US$ 1.055 billion.

FIGURE 4 *Leading supplying countries and regions by product (2003)*



New Zealand, Thailand, the US, Gabon, Papua New Guinea, Germany, and Myanmar may be considered a second tier of leading timber product suppliers. Together they exported over 9.7 million m^3 RWE or US$ 1.3 billion worth of timber products to China in 2003.

Log imports

Russia and Malaysia are the two leading suppliers of logs. By 2003, with average annual growth rates of 79 % from 1997, Russian product dominated log imports, far surpassing in scale imports from any other country. It should be noted that the analysis presented is by volume. A value analysis, giving heavier weighting to hardwoods due to their higher price, would diminish, but not eliminate, Russia's lead in the China log trade. Reviewing log trends over time, a shift in the top log suppliers between 1997 and 2003 is evident. Gabon, Russia, Malaysia, North Korea, and Cameroon, in order of descending volume, were the top suppliers in 1997, while in 2003, the top players in order of descending volume were Russia, Malaysia, New Zealand, Papua New Guinea, and Gabon.

Lumber and panel imports

Notable lumber suppliers in 2003 include Indonesia, USA, Thailand, Russia, and Malaysia. While Indonesia has ranked in the top five since 1997 its lumber exports to China have grown rapidly, rising from 19 % of total volume in 1997 to 26 % of a much larger base in 2002, but dropped to 20 % in 2003. The USA is China's second largest supplier of lumber, accounting for 12 % of imports in 2003, while Malaysia has dropped from top supplier in 1997 to the fifth position in the list. Growth in Russian lumber imports (from a very low base) has also been substantial, moving Russia to fourth position. The Russian government's efforts and policies aimed at encouraging the development of its own wood processing industry may have contributed to this growth (FAS 2003).

In the panel segment, Malaysian imports appear to have suffered the most from reductions in China's plywood and veneer imports, though Indonesian plywood imports have also dropped. Throughout the period studied, Indonesia was China's top plywood supplier, with Malaysia following in second place. Malaysia dominated veneer imports over the seven-year period. Veneer imports from Cambodia, the number two supplier, have, like those from Malaysia, dropped in recent years.

Trends in pulp and paper suppliers

Suppliers from outside of the Asia-Pacific region play a significant role in China's pulp and paper trade. In 2003, for example, Canada was China's top wood pulp supplier, Brazil and the USA ranked four and five, respectively, for wood pulp; and the US was China's number three paper supplier[7]. Also of note is Chile, which made the top five for wood pulp in 2002. Indonesia and Russia, from within the Asia-Pacific region, are the other two of the leading five wood pulp suppliers in 2003. The greatest absolute growth in wood pulp imports between 1997 and 2003 is found in the cases of Brazil (from where imports grew by a factor of 6.2), Indonesia (from where imports grew by a factor of 2.7), and Russia (from where imports grew by a factor of 4 times).

The key paper supplying countries or regions during these years were Taiwan (ranked first in 2003), South Korea, USA, Indonesia, Japan, and Hong Kong (replaced by Indonesia in the top five after 1997). Lack of overall growth in paper imports during the period studied is reflected in declining imports from the USA. [Some of China's top paper suppliers largely process wood fiber grown elsewhere (i. e. South Korea, Taiwan, Japan, and Hong Kong), while others produce their own wood (i. e. the USA and Indonesia)].

Trends in imports from Asia-Pacific producing countries

The Asia-Pacific countries covered in this report (Cambodia, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, Russia, and Thailand) include some of China's leading suppliers, and the Chinese trade accounts for a large portion of the forest product exports of all of these countries[8]. In total, forest product imports from Asia-Pacific countries grew at an even greater rate than Chinese forest product imports as a whole. The Asia-Pacific countries covered in this study expanded their share of total forest product imports by volume from 30 % in 1997 to 38 % in 2003.

Timber products in particular are dominated by Asia-Pacific countries, with the group of eight countries studied accounting for 70 % of imports in 2003 (up from 64 % in 1997). The share of these Asia-Pacific countries in log imports grew from 48 % to 78 % during the same period. As indicated in Figure 4, the position of leading supplier in each of the main timber product areas was held by one of the Asia-Pacific countries studied; Russia (mostly softwood) and Malaysia (mostly hardwood) held the number one and number two positions in logs, while Indonesia (mostly hardwood), was the top lumber supplier. Indonesia and Malaysia were first and second, respectively, in plywood, while Malaysia and Cambodia held the number one and number two positions, respectively, for veneer.

Finally, despite the influence of non-Asia-Pacific suppliers in pulp and paper, the role of Asia-Pacific

TABLE 3 *Summary of Asia-Pacific supplying countries studied*

Country	2003 forest product volume (million m^3 RWE)	Main products in 2003	Trends in main products over period studied
Russia	19.74	Softwood logs; also lumber, pulp	Logs dominate, strong growth in all between 1997-2002, with a small drop in log imports in 2003
Indonesia	9.67	Hardwood lumber, pulp	Lumber, pulp up/paper, plywood down
Malaysia	5.15	Hardwood logs and lumber	Relatively slow growth/plyvood, veneer down
Thailand	2.73	Hardwood lumber	Lumber up/paper down, pulp small but growing
PNG	1.39	Hardwood logs	Logs up by 6.5 times
Myanmar	1.23	Hardwood logs and lumber	Timber products (official) up three times
Cambodia	0.081	Veneer, plywood	Veneer dropping
Laos	0.023	Hardwood logs and lumber	Gradual rise of both logs and lumber

Note: For Vietnam's exports to China, of the total 2003 forest product RWE import volume of 179,913 m^3, wood charcoal made up 61 percent, while logs and lumber (mostly hardwood) made up 7 percent and 13 percent, respectively.

[7] Wood pulp as referred to here and in Figure 4 is considered a subset of the pulp category discussed earlier and included in Figure 3. Imports of the general pulp category also include wastepaper (imported to be recycled into pulp in China) and recycled pulp (paper which has already been recycled into pulp), while the term ‚wood pulp' refers only to product that has been recycled.

[8] Vietnam is not included among the Asian countries for which detailed analysis was conducted. Basic data on Vietnam's forest product exports to China, however, indicate that the country, like Cambodia and Laos, is a minor supplier (In 2003, according to official statistics, RWE volume of forest product imports to China from Vietnam was 183,655 m^3, or 0.17 % of China's total. For Cambodia, the 2003 proportion of total volume was 0.08 % and for Laos, it was 0.02 %).

countries in this category is still substantial and on the rise. The group of Asia-Pacific countries studied is particularly relevant in the case of wood pulp, with Indonesia and Russia holding the second and third places in 2003. For paper, while Asia-Pacific countries were well represented among the top five suppliers in 2003 (e.g. South Korea, Taiwan, and Japan), only fourth-ranked Indonesia among the forest-rich countries studied appeared on this list. Key findings from the analysis of the eight Asia-Pacific producer countries studied are summarized here by country and in Table 3.

For Russia, phenomenal growth in softwood logs (14 fold increase over the period studied) is the main outcome, with other import volumes dwarfed by comparison. Softwood lumber and pulp and paper (especially pulp) imports from Russia, however, are also growing.

For Indonesia, expansion of hardwood lumber (up by a factor of 4.7 over the period studied) and pulp supplied to China are the main themes. Indonesian plywood, log, and paper imports had all dropped by 2003 from peaks achieved during the intermediary years of the period studied.

Malaysia's imports exhibited much less robust growth than China's forest product imports as a whole. As expected Malaysia dropped from its position as the main timber product supplier in 1997 and, by 2003, while ranked number two, had been far surpassed by Russia in volume. Hardwood logs and lumber made up the greatest proportion of Malaysia's imports to China by 2003, with reductions in plywood and veneer volumes occurring over the period studied.

For Thailand, which ranked fourth in provision of timber products to China in 2003, lumber (predominantly hardwood) was the most significant import. Paper had accounted for over half of Thai imports in 1999, but volumes have since dropped, and pulp imports, while growing, are still less than those of paper.

Papua New Guinea's forest product imports to China are predominately hardwood logs. Expansion of this trade was substantial during the period studied, growing by five times; and, in 2003, PNG-supplied product accounted for 13.2 % of China's hardwood log imports.

Dominated by timber products, Myanmar's forest product imports to China are mainly logs (70 % of RWE volume in 2003) and lumber (28 % of RWE volume in 2003), both of which are mostly hardwood. Myanmar's official timber product imports to China grew by three times over the period studied, with log imports appearing to level off after 2000 and lumber imports continuing to grow.

Cambodia is a minor supplier of forest products to China, and imports (predominantly timber products) reduced after 2000. Veneer was the main product supplied by Cambodia, followed by plywood between 1997 and 2002. In 2003, however, plywood was the top forest product supplied to China by Cambodia, followed by lumber.

In terms of official customs data, Laos is the least significant forest product supplier to China of those studied. Pulp and paper imports from Laos were negligible during the period studied; and hardwood logs (54% of imports by RWE volume in 2003) and lumber were the main timber products imported from the small nation.

CONCLUSIONS

The foregoing summary of import trends confirms high growth rates of China's forest product imports between 1997 and 2003 in both timber products and pulp and paper. Logs, lumber, and pulp are the most rapidly growing import segments, as China moves towards handling more of the processing of forest products itself. Forest-rich countries in the Asia-Pacific region are playing an increasingly important role in supplying China's expanding demand. Finally, ocean ports in the Shanghai-Jiangsu and South China regions have maintained their leading role in the forest product trade. These have been joined more recently, and in some cases surpassed, by inland ports in Northeast China, which have taken leading roles following the booming border trade with Russia.

China's increasing dependence on forest product imports and anticipated future economic growth mean that Chinese demand is likely to continue to have dramatic social, environmental, and economic implications for forests and forest peoples, particularly in the Asia-Pacific region. These trends will continue to challenge the efforts of NGOs and some governments to address illegal logging and trade, and establish sound institutions for governing forests in supplying countries. At the same time, within China, as Liu *et al.* (in this issue) have indicated, there are major policy and institutional problems in the domestic forest sector, which hinder the nation's domestic timber supply. Without major reform, China is almost certain to continue to exert undue pressure on its neighbors' supplies. In addition to its own economic objectives, however, China has good reasons in terms of its relations with its neighboring countries to work to more effectively manage and utilize its own forest resources. Transforming China's increasing demand into positive incentives for forest stewardship across the region will require much more concerted action in both China and its neighboring supplier countries.

REFERENCES

FAS, 2003. Solid wood products annual report 2003 - China. Click http://www.fas.usda.gov/200308/145985736.pdf for a copy of the report.

HE, D., WHITE, A. and BARR, C. 2004. Recent trends in China's paper and paperboard demand, supply

and trade, CIFOR and Forest Trends, (forthcoming).
OPERATIONS EVALUATION DEPARTMENT, 2000. Biodiversity hotspots for conservation priorities, *Nature*, Vol. **403**.
SUN, X., CHENG, N., WHITE, A., WEST, A., AND KATSIGRIS, E. ‚China's Forest Product Import Trends, 1997 - 2002: Analysis of Customs Data with Emphasis on Asia Pacific Supplier Countries.' 2004. Forest Trends and CIFOR.
WORLD BANK, 2000. A review of the World Bank's 1991 forest strategy and its implementation, Vol. 1: Main Report, p. 14.
ZHU, C. and TAYLOR, R., editors. ‚China's Wood Market, Trade and the Environment.' 2004. WWF Forests for Life Programme, TRAFFIC Rufford Foundation and World Bank/WWF Alliance.

ANNEX 1 *Map of main ports of entry*

The China forest products trade: overview of Asia-Pacific supplying countries, impacts and implications

E. KATSIGRIS[●], G. Q. BULL[■], A. WHITE[♦], C. BARR[✷], K. BARNEY[⬢], Y. BUN[◈], F. KAHRL[○], T. KING[⌘], A. LANKIN[✖], A. LEBEDEV[◘], P. SHEARMAN[▲], A. SHEINGAUZ[▪], YUFANG SU[◆] and H. WEYERHAEUSER[▼]

[●] *Market and Policy Analyst, Forest Trends 1050 Potomac Street NW, Washington, DC 20007, USA*
[■] *Professor in the Faculty for Forestry, University of British Columbia, Vancouver, Canada*
[♦] *Director of Policy and Market Analysis, Forest Trends 1050 Potomac Street NW, Washington, DC 20007, USA*
[✷] *Policy Scientist, Forest and Governance, Center for International Forestry Research, P. O. Box 6596, JKPWB, Jakarta 10065, Indonesia*
[⬢] *Doctoral Candidate in the Department of Geography, York University, 4700 Keele Street, Toronto, Ontario, Canada*
[◈] *Executive Director, Foundation for People and Community Development, P. O. Box 1119, Boroko NCD, Papua New Guinea*
[○] *Visiting Researcher at the World Agroforestry Centre, Floor 3, Building A, Zhonghuandasha Yanjiadi 650034, Kunming-Yunnan, PR China*
[⌘] *Forest Information Systems, P. O. Box 3217, Boroko, NCD, Papua New Guinea*
[✖] *Far Eastern Ecoregional Project, World Wide Fund for Nature 109240 Nikoloyamskaja st., Moscow, Russia*
[◘] *Chairman of the Bureau for Regional Oriental Campaigns, Vladivostok, Russia*
[▲] *Research Associate, Remote Sensing Center, University of Papua New Guinea, P. O. Box 320, University, NCD, Papua New Guinea*
[▪] *Professor and Director, Microeconomics Division, Economic Research Institute of the Far Eastern Branch, Russian Academy of Sciences, Russia*
[◆] *Research Associate, World Agroforestry Centre, Floor 3, Building A, Zhonghuandasha Yanjiadi 650034, Kunming-Yunnan, PR China*
[▼] *Senior Scientist, World Agroforestry Centre, Floor 3, Building A, Zhonghuandasha Yanjiadi 650034, Kunming-Yunnan, PR China*

Email: jkatsigris@forest-trends.org

SUMMARY

Over 70 % of China's timber product imports are supplied by countries in the Asia Pacific region, and China is the dominant forest product market for many of these countries. Unsustainable harvesting practices, illegal logging, and negative impacts on community livelihoods plague many of these supplying countries. The countries may be divided into those still harvesting and exporting timber from natural forests on a large scale and those which have gone past their highest levels of natural forest timber harvesting and are now more aggressively pursuing plantation development and processing. Apart from Russia, China's top Asia Pacific timber suppliers could at best maintain current supply, with natural forest resources being depleted in less than 20 years. Resource limits also constrain expansion and/or long-term continuation of processed product export to China. Greater attention and action on the part of governments, market leaders, and international organizations is needed to address negative impacts, shifting supply to a sustainable, legal, and equitable basis and to determine from where China's long-term supply will come.

Keywords: China, Asia Pacific, forest product exports, livelihoods, policy issues

INTRODUCTION

China's forest product imports have grown dramatically in recent years pushing the country into a leading global role in the sector. Rapid expansion of manufacturing (often for re-export) and domestic consumption, in a nation with very limited per capita forest resources, have fueled the rise in imports[1]. While China's increased forest product demand has affected supplying countries worldwide, impacts are particularly marked in the Asia Pacific region. Forest-rich Asia Pacific countries are seeing increasing amounts of their resources heading for China. In many cases, increasing trade flows are associated with issues such as unsustainable harvesting, corruption, and lack of satisfactory livelihood opportunities for forest-dependent communities.

Identification of priority issues and possible solutions, however, requires a clear understanding of the status and trends of the forest sectors and forest product trade of these countries. In 2003 and 2004, Forest Trends and CIFOR, supported by the United Kingdom Department for International Development (DfID), worked with partners across the region to fill information gaps and build a knowledge base on the forest industry and export trade of China's Asia Pacific supplying countries. This article is a synthesis of more detailed studies by co-authors focused on the particular supplying countries which are published on the Forest Trends website, www.forest-trends.org[2].

This paper begins with a summary of the characteristics of supplying countries' forest sectors and then examines overall export trends and trade with China. The paper ends with a review of key issues associated with the China trade. The Asia Pacific supplying countries covered are, in order of decreasing volume of forest product exports to China, Russia, Indonesia, Malaysia, Thailand, Papua New Guinea (PNG), Myanmar, Vietnam, Cambodia, and Laos[3].

FOREST SECTORS OF ASIA PACIFIC SUPPLYING COUNTRIES

Common characteristics of the forest sectors of China's Asia Pacific supplying countries include uncertainties in forest area and forest sector production data, state ownership of forestlands, harvesting primarily through a concession model, and (often extensive) deforestation trends. Although, the state of forest resources, harvesting, and development of the processing and plantation sectors varies amongst the countries, they fall into two distinct groups. In the first group are countries that, while generating some concern about future supply, are producing timber on a large scale, often at peak volumes in their history, and putting relatively little emphasis on processing. These countries (e. g. Russia, Myanmar and PNG), tend to have fairly limited plantation area, having less motivation to develop alternative timber sources. They tend to have less developed processing sectors, as they can depend on high volumes of log and simple sawn wood exports for revenue. In contrast, other supplying countries (e. g. Thailand, Laos, Vietnam and Cambodia) have clearly passed peak harvesting periods in natural forests and are pursuing (or at least

TABLE 1 *Resource base in Asia Pacific supplying countries and regions: current best estimates*

Country or region	Natural forest area	Natural forest area available for wood supply	Tree plantation area	Annual industrial roudwood production	Rough estimate of years of mature natural forest remaining at current cutting rates
		000 000 ha		000 000 m³	Years
Russian Far East	280.0	96.0	0.77	12.2	> 20
Indonesia	95.0	74.2	2.00	55.0	NA
Malaysia	18.3	NA	1.75	17.9	NA
Thailand	12.0	0.0	2.80	7.8	NA
PNG	26.5	11.2	0.06	2.1	13 - 16
Myanmar	33.9	20.4	0.50	5.5	10 - 15**
Vietnam	8.1	3.1	1.71	4.2	NA
Laos	12.4	5.7	0.09	0.4	NA
Cambodia	9.2	3.9	0.09	0.1	4 - 9

** in Kachin areas supplying China

Sources and notes: Country reports prepared by authors for Forest Trends and CIFOR in 2004 (see references). Proceedings of internal Asia Pacific Partners meeting in June 2004. FAOSTAT data 2004. EC-FAO Partnership Programme 2002. FAO. Global Forest Resources Assessment 2000. World Bank 2004. Asian Development Bank 2004. World Bank 2001. MIDAS Agronomics *et al.* 2003. Gary Bull *et al.* 1998. Industrial roundwood production figures are for 2002, except for Vietnam, for which data is from 2000, and Indonesia, for which the figure given is a current (2003) authors' estimate.

[1] Hardwood imports come largerly from Southeast Asia, Latin America, Africa, and the US and are most commonly used in furniture and building interior applications. Softwoods, largerly from Russia and New Zealand, are most commonly used as construction materials and therefore are more fully destined for domestic end use.

[2] These more detailed studies include: ‚Overview of the Forest Sector in the Russian Far East: Production, Industry, and Illegal Logging,' Alexander Sheingauz 2004; ‚Status and Trends in Forest Product Exports from the Russian Far East and Eastern Siberia to China,' Alexey Lankin 2004; ‚Siberian and Russian Far East Timber Market for China,' Anatoly Lebedev 2004; ‚Navigating the Border: An Analysis of the China-Myanmar Timber Trade,' Fredrich Kahrl, Yufang Su, and Horst Weyerhaeuser 2004; ‚China's Impact on PNG's Forestry Industry,' Yati Bun, Timothy King, and Phil Shearman 2004; ‚Cambodia's Forest Sector and Supply to China,' Keith Barney 2004; ‚Thailand's Forest Sector and Supply to China,' Keith Barney 2004; and ‚Vietnam's Forest Sector and Supply to China,' Keith Barney 2004.

[3] Individual studies were conducted for Russia, Indonesia, Thailand, PNG, Myanmar, Vietnam and Cambodia; and the paper thus focuses on these countries. Data is included, however, for Malaysia and Laos as well. Ranking od countries for volume of forest product exports to China is based on official data from China Customs. If the illegal sector and transshipments were included, Cambodia, and even possibly Laos, might move ahead of Vietnam in the rankings.

exploring) increased processing and/or plantation development to enhance their forestry sectors. Indonesia, despite high industrial roundwood production, has experienced declining harvesting levels and has developed an extensive processing industry and thus trends towards this latter group as well. Finally, while Malaysia's roundwood production continues to be substantial, the nation is similarly past its natural forest harvesting peak, with its increasingly productive plantations facilitating continued high yields.

Forest resources

Table 1 summarizes the current status of the forest resource base in countries and regions supplying China, providing estimates of natural forest area, natural forest area available for wood supply, plantation area, annual industrial roundwood production, and rough estimates of years of natural forest resource remaining at current cutting rates. While a great deal of uncertainty is associated with these statistics, the table provides an indicative picture of the current status of these countries' resource bases and their potential for continuing to supply China in the future[4].

With 280 million ha of natural forest area, the forest resources of the Russian Far East (RFE) alone dwarf those of China's other Asia Pacific supplying countries (The RFE and the five provinces of Southeastern Siberia provide the bulk of Russia's timber exports to China and are thus the focus of our analysis of Russia's forest industry and trade). Indonesia, with 90-100 million ha of natural forest area, ranks second. Myanmar, PNG, and Malaysia make up a middle group in terms of natural forest area and that available for wood supply, while Thailand, Vietnam, Laos, and Cambodia make up a post-logging peak group with the most limited ability to supply wood from natural forests. With over 20 years of natural forest remaining at current cutting rates, areas of Russia supplying China are expected to have more long-term natural forest potential than any of the other supplying countries studied. Among China's other major log suppliers, for example, PNG is expected to have fully allocated its forestlands within 3 to 6 years and essentially exhausted its natural forest timber resources after another 10 years of harvesting at current rates. Similarly, industry insiders have estimated that, at current harvesting rates, the Myanmar border areas responsible for supplying timber to China have between 10 and 15 years of economically accessible resource remaining.

Plantation development or plans for such have been most marked in supplying countries or regions recognizing a decline in their industrial roundwood supply, while those not yet ‚past-peak' in natural forest production have expended less effort in this area. Apart from the case of Thailand, however, plantations represent a much smaller resource base than natural forests in each country. Indonesia (with 5.3 million ha allocated to plantations, but less than 2.0 million ha planted) and Thailand (with 4.9 million ha of plantations, of which 2.8 million ha are non-rubberwood ‚tree plantations') lead the group in tree plantation development. In Thailand, the primary source of industrial roundwood is eucalyptus (*Eucalyptus sp.*) and rubberwood (*Hevea brasiliensis*) from small-holder plantations. According to FAO statistics, Malaysia and Vietnam each have over 1.7 million ha of tree plantations. Cambodia, with only 90 000 ha of plantations at present, has ambitious plans for plantation development (Barney 2004a). Given the strong ‚prepeak' status of their natural resource bases, forest plantations have been much less of a priority for Russia, PNG, and parts of Myanmar supplying China. In the RFE, only about 0.5 % of forest area is considered plantation. Plantation area in PNG is only 61 000 ha. Finally, while Myanmar does have about 500 000 ha of plantations, over a third of which are teak (*Tectona grandis*), plantation area in the main regions supplying China is extremely limited.

Additional information on the status of forest resource bases is provided, by country, below:

Russia: While Russia's timber production peaked in the mid-1980s, the subsequent drop in production was a result of economic factors rather than resource exhaustion, so that we include Russia among the countries of our analysis that are not yet ‚past peak.' The extent of logging relative to resource base appears to be less in Russia than in other supplying countries. Official figures put harvesting in the RFE at 18.2 % of the accessible annual allowable cut (AAC), while inclusion of illegal logging estimates raises this proportion of AAC actually logged to roughly 25 % (Sheingauz 2004).

While the AAC is not exceeded overall in the RFE, substantial forest degradation is occurring. High grading (the extraction of the best timber and best species only) is a significant factor in this degradation. In addition, permits to conduct intermediate thinnings (ostensibly to restore forest maintenance functions) are commonly abused and officially sanctioned ‚thinnings' now supply a significant share of Russia's hardwood product, particularly of species for which cutting is either prohibited or limited (Sheingauz 2004).

Natural factors are also leading to forest degradation. Catastrophic forest fires, which have recently consumed an area equivalent to about four times the area harvested annually, are considered the main cause in a reduction in forest area that has been occurring over the past five years. Poor forest harvesting and slash treatment practices have exacerbated fire conditions (Sheingauz 2004).

Indonesia: Despite its very high industrial roundwood production (ranging from 47 million to 75 million m^3 per year since the mid-1990s), the vast majori-

---

[4] Uncertainties are due both to lack of data and definitional problems, such as the minimum density of resource to be included in ‚normal forest area' or the type of forestland to be defined as ‚available for wood supply'.

ty of which is channeled to the nation's massive wood processing sector, we classify Indonesia as ‚past-peak.' In recent years, logging in the nation has declined precipitously in many areas as the more accessible forests are rapidly being exhausted. It is now widely recognized that Indonesia's natural forests will not be able to sustain the country's wood processing sector at current capacity levels for much longer and that industrial plantation development will need to accelerate considerably in order to maintain current levels of wood supply. Although estimates vary, deforestation in Indonesia is generally believed to be occurring at a pace of at least 1.6 million ha annually, with a significant portion resulting from conversion to large-scale estate crops and timber plantations.

Thailand: Thailand is clearly a country past its peak in natural forest production, with rapid deforestation having occurred over the previous 20 to 30 years. However, with increasing environmental awareness and government bans on logging deforestation has now dropped off. Reflecting the weak status of its natural forests and demand of its relatively developed processing sectors, Thailand has made strong efforts to develop plantations, which (including rubber trees) now account for about a quarter of tree-covered area in the nation. Plans for expansion of planted areas remain ambitious, and there have been Chinese overtures towards investment in this sector. Yet, past initiatives in plantation development have met with low success rates, as a large portion of farmers involved in plantation programs have decided not to maintain plantings. Further, community conflict is stymieing current expansion efforts (Barney 2004b).

PNG: Production from PNG's 26.5 million ha of natural forests is currently high (over 2 million m^3 in 2002) and appears to be peaking. The bulk of the country's high volume and accessible forest has already been allocated to concessionaires and harvested. Recent satellite imagery suggests that the intensity of logging over the past seven years has been greater than in the past. Repeated harvesting of previously logged areas combined with large fires and drought in such areas may be resulting in a much larger extent of non-regeneration than previously anticipated (Bun *et al.* 2004).

Myanmar: Myanmar, with an estimated 33.9 million ha of natural forest area and an estimated 5 million m^3 of industrial roundwood production (2002), is rich in forest resources and currently a major source of timber in the region. Deforestation is severe; and production in border areas serving China is thought to be peaking (Kahrl *et al.* 2004).

Vietnam: Like Thailand, Vietnam also appears to be a formerly forest-rich country that has passed its natural forest logging peak. According to some analysts, serious deforestation trends occurring from 1980 to 1995 have since stabilized. Addressing the decline of its natural forests, Vietnam has begun to place an emphasis on plantation development, but productivity of plantations established to date has been poor and ambitious targets for further development lack specificity and actionable plans (Barney 2004c).

Cambodia: As with its neighbours Thailand and Vietnam, Cambodia appears to have passed its natural forest logging peak, albeit somewhat more recently. Some analysts indicate that little of the remaining forest in Cambodia is commercially viable. While logging continues, the rate is thought to be much slower than in the mid- and late 1990s, when illegal activity was at its height. The nation hopes to develop a substantial plantation sector; and some Chinese investors have already become active in this area (Barney 2004a).

Natural forest ownership and management

Natural forests in supplying countries are predominantly state-owned and administered, thus offering weaker community access than in the case of either private ownership or public ownership with administration by community or indigenous groups. In Russia, Indonesia, and Myanmar, for example, 99-100 % of forestlands are both publicly owned and (according to official data) administered by the Government[5]. PNG, where customary ownership rights predominate and 97 % of forestland is privately owned by communities, is the main exception to state ownership among the countries studied (White and Martin 2002). The Government in PNG, however, still exerts much greater control in determining the fate of the nation's forests than do local communities.

As is common worldwide in countries with extensive forest resources, concession granting to harvesting companies for large-scale logging is the most common mechanism through which forest access is transferred to end users in the region. Logging concessions account for the majority of forestland allocated in Russia, Indonesia (58 % of forestland), Cambodia (64 % of forestland), PNG (where the government plays a role in brokering deals between concessionaires and local communities), and regions of Myanmar serving the China market (White and Martin 2002).

Despite these trends of state control and the concession model, signs of a shift to greater community access, albeit on a limited scale, have emerged. For example, in Vietnam, while the majority of the most productive forestland is allocated to state-owned enterprises 1.43 million of the nation's over 9 million ha under forest cover was allocated to households and cooperatives in 1999; and new regulations passed in 2002 facilitate further recognition of community ow-

[5] In the case of Myanmar, the term ‚government' here is applied somewhat broadly, with insurgent groups tending to control the main forest areas supplying China.

nership. In Indonesia, a new regulatory process through which community ownership can be recognized was established in 2000. The country currently has 600 000 ha of forest area reserved for community administration. In Laos, a pilot program granting concessions to local communities rather than logging firms is being tested and has improved forest management. Finally, in Russia, indigenous people are also beginning to gain greater rights to state-owned forests (White and Martin 2002).

Commercial timber producers

Asia Pacific supplying countries have reached different levels of logging company privatization. In Russia, state-owned logging units have been essentially privatized, though the state may retain some shares; and a great number of new completely private logging firms have emerged (Sheingauz 2004). In Vietnam, state logging firms dominate, being the only harvesters allowed to commercially log during the nation's six to seven-year logging ban (Barney 2004c). In Laos, three state owned enterprises, all under the Ministry of Defence, dominate harvesting (World Bank 2001).

Foreign ownership and foreign workers are a trend associated with commercial timber producers in some Asia Pacific supplying countries. PNG and Myanmar offer the most extreme cases. In PNG, all but one of 29 concessions is operated by foreign companies, with Malaysian ownership and foreign staff predominating (Bun *et al.* 2004).[6] In Myanmar, the vast majority of China-bound timber is harvested by Chinese logging companies staffed with Chinese citizens working in areas outside of the military regime's control (Kahrl 2004). In Russia, logging is carried out mainly by Russian companies, but involvement of Chinese companies in harvesting is increasing. In Cambodia, Asia Pulp and Paper and other players in the region are making logging and plantation investments.

Finally, the scale of commercial timber producers varies from country to country. The average volume of harvesting operations in the RFE, for example, has dropped precipitously, reflecting proliferation of logging companies in the 1990s and a concurrent drop in overall production (Sheingauz 2004)[7]. In contrast, 80 % of PNG's log exports are controlled by just five companies (Bun *et al.* 2004).

Wood processing

Table 2 provides data on Asia Pacific supplying countries' wood processing sectors, including country production figures for each of sawnwood, plywood, veneer, fiberboard, wood chips and particles, wood pulp, and paper. Despite substantial uncertainties, the data overall are strong enough to facilitate identification of basic trends among countries and within each country's industrial structure.

TABLE 2 *Primary timber product and pulp and paper production in Asia Pacific supplying countries: best estimates (2002 data, unless otherwise noted)*

Country or region	Sawnwood	Plywood	Veneer	Fiberboard	Wood chips and particles	Wood pulp	Paper
	000 000 m^3 Roundwood Equivalence						
RFE	1.19	0.00	NA	NA	NA	0.02	0.09
SE Siberia	2.92	0.32	NA	NA	NA	6.07	0.79
Russia total	27.51	4.55	0.200	1.880	5.76	24.42	16.74
Indonesia	20.00	16.22	0.110	0.770	0.81	21.73	19.59
Malaysia	6.56	10.85	1.790	2.200	0.73	0.49	2.38
Thailand	0.42	0.30	0.008	0.440	3.74	3.68	6.83
PNG	0.10	0.23	0.180	NA	NA	NA	NA
Myanmar	0.54	0.05	0.003	NA	NA	NA	0.12
Vietnam	4.22	0.09	NA	0.002	3.03	0.92	1.07
Laos	0.26	0.03	NA	NA	NA	NA	NA

Sources and notes: Country reports prepared by autohors for Forest Trends and CIFOR in 2004 (see references). FAOSTAT data 2004. CIFOR 2004. Production data is for the year 2002, with the following exceptions: all Vietnam data (2000); Indonesia plywood and sawnwood data (2003), fiberboard and chips data (2000) and pulp and paper data (2001); Malaysia fiberboard and chips data (2001) and pulp and paper data (2000); Thailand veneer, fiberboard, chip, pulp and paper data (2001); PNG plywood data (2000); Myanmar veneer data (2000) and paper data (2001); Laos plywood data (2001); all Cambodia data (2001). Conversion factors used ($m^3 \rightarrow m^3$ RWE): sawnwood 1.43, plywood 2.5, veneer 2.5, chips 1.8 (metric tons $\rightarrow m^3$ RWE): mechanical wood pulp 3, chemical wood pulp 4, semi-chemical wood pulp 3.3, paper and paperboard 2.8. Note: Lacking breakdown on the type of pulp for RFE and Siberia, a weighted average conversion factor of 3.8 (m^3 RWE per metric ton), derived from the pulp type mix of Russia as a whole, was used.

Comparison of Table 2 data with roundwood production figures in Table 1 indicates that countries or regions which have not passed their natural forest harvesting peaks (e. g. RFE, Myanmar, and PNG) put relatively less emphasis on processing, while those

[6] Rimbunan Hijau, a Malaysian company, is the largest supplier of logs from PNG. It is also the top supplier of logs exported from the RFE (Bun *et al.* 2004).

[7] In the RFE's Primorsky Krai (a province), for example, the average output of typical logging enterprises in 2001 was only 22,700 m^3 (Sheingauz 2004).

past peak (e. g. Indonesia, Thailand, and Vietnam) add value to a much higher proportion of their logs. Within the group of Asia Pacific supplying countries and regions, Indonesia and Malaysia are the top producers of primary timber products (defined to include sawnwood, panels, and chips), while Indonesia and Thailand are the top producers of pulp and paper. Indonesia, which has the largest processing sector of all the countries and regions studied (including the RFE and SE Siberia, but not Russia as a whole), also has the highest production of sawnwood, plywood, and wood pulp. Malaysia is the second largest producer of sawnwood and plywood and the top producer of veneer (for which it surpasses all other producers by far) and fibreboard. Thailand and Vietnam are the top wood chip producers in the region. Indonesia, followed by SE Siberia and Thailand, is the top wood pulp producer, while Indonesia and Thailand are the top paper producers (in both cases not including Russia as a whole).

Additional information on processing in the region is given by country below:

Russian areas supplying China: The level of processing in the RFE is particularly low. Sawnwood production was less than 10 % of industrial roundwood production in 2002. No plywood was produced in the RFE that year; and pulp production was less than 5 000 tonnes. Russia, particularly as reflected in the RFE, presents a special case among the nations studied of a country that once had a relatively advanced processing sector for which production has since dropped substantially. Domestic market shrinkage and difficulties competing internationally in quality and cost have resulted in numerous mill closures and in the share of processed wood in overall forest production in the RFE dropping from 56 % in 1990 to less than 17 % in 2000. Southeastern Siberia, with its main processed products being sawnwood and pulp, has experienced more positive trends recently, including the development of new sawmills and growth in exports of pulp and wood chips (Sheingauz 2004).

Indonesia: Indonesia's massive processing sector represents a major shift from its earlier role as a major log exporter, responsible for over 40 % of the world market's tropical log exports in 1979. Processed products now play the dominant role in the nation's forest product exports. Due to resource constraints, however, all of Indonesia's major processing sectors are operating far under capacity.

The size of Indonesia's wood processing industry can be attributed in part to active government promotion of export-oriented wood processing since the early 1980s and introduction of a log export ban in 1985. Throughout the late-1990s, Indonesia supplied about 70 % of the world's tropical plywood exports, though production has dropped substantially over the past decade as large-diameter logs have become increasingly scarce. The country reportedly has 110 operating plywood mills, with a total production capacity of 11.3 million m^3 per year, but 2003 production of only 6.5 million m^3.

Since the early-1990s, Indonesia's pulp and paper production have grown very rapidly, following over US$ 15 billion of investment in the sector. Although the nation's pulp producers have made substantial investments in fast-growing plantation development, most of the country's pulp mills continue to rely heavily on ‚mixed tropical hardwoods' harvested from natural forests.

Malaysia: In addition to its top role in veneer and fiberboard and second place standing in sawnwood and plywood produced in the region, Malaysia produces substantial amounts of paper (851 000 tonnes in 2000), though wood pulp production lags (123 000 tonnes).

Thailand: Like Indonesia and Malaysia, and as a country far past its natural forest logging peak, Thailand has progressed along the forest product value-added chain. In addition to its main products of wood chips, wood pulp, and paper, Thailand also has about 2 million m^3 (3 million m^3 RWE) of particleboard capacity.

Vietnam: While Vietnam has a smaller and generally lower value-added processing sector than the countries covered above, it does have significant production of sawnwood and wood chips/particles, with wood chip production on the rise. Pulp and paper production are also significant (240 000 and 384 000 tonnes, respectively, in 2000), though previously anticipated growth is not expected to materialize in the short term. In the area of finished wood products, Vietnam has become a center of outdoor wood furniture production (competing with China), with further growth likely. As in China, much of the wood used in furniture production is not locally sourced (Foreign Agricultural Service 2003).

Other countries: The remaining countries of Cambodia, PNG, Myanmar, and Laos have very low processing capacities. Veneer and plywood are key products in Cambodia's forest product sector. Given restrictions on cutting, however, low capacities are unlikely to increase in the near future. PNG's wood processing industry is extremely small. At present, the country has just three major processing facilities, one wood chip mill, one sawmill, and one veneer mill. Aside from these, there are a number of small and medium sized sawmills. The country has no pulp and paper production, though individual households do produce balsa (Bun *et al.* 2004).

The main parts of Myanmar supplying China, Kachin State and Northern Shan State have extremely limited processing industries, reflecting the dearth of processing facilities outside of Myanmar's capital, Yangon. Myanmar's military regime has reportedly suggested that the main insurgent group controlling

Kachin State seek foreign investment in the processing sector, but potential investors, the Chinese logging companies, are deterred by the lack of political stability and basic power infrastructure. Thus, while some crude sawmilling work is done on the Myanmar side of the border, no other processed forest products are produced in the main areas supplying China (Kahrl *et al.* 2004).

Characteristics of processing enterprises

A trend of a large number of small, privately owned mills is found in several of the countries and regions studied, though it is often a smaller group of large mills that can attain the quality necessary for export. Russia, Indonesia, PNG, and Chinese-Myanmar border areas all have numerous small-scale processors. Indonesia is believed to have between 2 300 and 3 500 operating sawmills, the vast majority of which are small-scale units and/or unlicensed operations. For the RFE's province of Khabarovskiy Krai alone, official 2002 statistics indicate 104 wood processing enterprises, with annual average production per facility of only 35 000 m^3. In Russia, primary processors range from large-scale now-privatized processing factories and subsidiary mills of large commercial harvesters to primitive sawmills in RFE border areas, sometimes operating in open air (Sheingauz 2004). In PNG, sawmills are predominantly small, privately owned entities serving the domestic market, though the largest processing facilities are owned by concessionaires (Bun *et al.* 2004). Finally, Chinese border areas near Myanmar have numerous small-scale mills handling preliminary processing. In Tengchong County, for example, there are reportedly over 500 timber processing companies, only a few of which are of significant scale (Kahrl *et al.* 2004).

The trend of a smaller group of large mills serving export markets is particularly true in pulp and paper, with often just a few key players controlling a small number of large-scale export-oriented facilities in the sector. With recent industry consolidation, the Thai pulp and paper industry is quickly moving to domination by two major integrated firms; Siam and Advanced Agro (Barney 2004b)[8]. Both firms are also pursuing regional expansion[9]. Indonesia's small number of large-scale export-oriented pulp and paper mills, all concentrated geographically on the island of Sumatra, are also dominated by just a few key players. Finally, while the pulp and paper industry is less developed in Vietnam, the state-owned Vietnam Paper Corporation (Vinapimex) represents the only major industrial player. It has 20 subsidiaries, but three mills account for 50 % of production (Barney 2004c).

Most of the countries studied evidence a significant level of foreign investment in their processing sectors, with Chinese investment activity recently on the rise in several cases. As with its logging sector, PNG's processing sector, though much smaller, offers one of the most prominent cases of foreign control. While smaller mills, as mentioned, may serve the domestic market, the few large mills in the country and those that produce product for export, are foreign-controlled (Bun *et al.* 2004)[10]. Vietnam's wood chip operations, geared mainly towards export, involve investment from Japan, Korea, and Taiwan, also the top export destinations for wood chips (Barney 2004c).

Russia, Thailand, Cambodia, and Indonesia are examples of countries where large Chinese companies are investing or planning investments in the processing sectors. In addition, numerous small Chinese firms have established ventures in border areas of Russia. Reports from Primorskiy Krai indicate that Chinese processing enterprises in the province are small (enterprises investigated range from 7 to 15 employees), fully staffed fully Chinese labor, and purchase timber mainly from illegal loggers (Lebedev 2004). At the other end of the spectrum, three Chinese companies, Star Paper, Zhuhai Zhenrong, and Huacheng International, have signed a memorandum of understanding to jointly invest US$ 278 million in a wood processing project in Chitinskaya Oblast that is to eventually process 1.5 million m^3 of logs annually and produce 300 000 m^3 of timber products and 400 000 tons of pulp (Lankin 2004).

Like other plantation and pulp projects in the region, planned and in-progress Chinese-invested projects in this sector have met with community resistance. The in-progress Pheapimex-Fuchan pulp project in Cambodia, to be the nation's first major pulp mill, is a joint venture between Cambodia's largest concession holder, Pheapimex, and the China Cooperative State Farm Group. The project has resulted in local community-level protest since at least 2001, slowing plantation development (Barney 2004a). Recently, several individuals were injured in a grenade blast, as a group of 600 protesters attempted to block bulldozers that had begun clearing the forest for an acacia plantation. (Associated Press 2004). In Indone-

[8] Siam has purchased Thai Cane Paper (full purchase completed in 2004) and a controlling stake in Phoenix (in 2002). Phoenix has now been de-kisted from the Thai SET and may now be a full subsidiary of Siam.

[9] Siam has purchased a controlling share of United Pulp and Paper of the Philippines (raised to 86 % in July of 2003) and is exploring opportunities to acquire the assets of troubled Indonesian pulp and paper firms. Advanced Agro, which is owned by the Soon Hua Seng Group, has pursued plantation projects in China.

[10] PNG's main wood chip mill is owned by Japan and Niugini Timbers (JANT), a subsidiary of Hongshu Paper in Japan. Rimbunan Hijiau of Malaysia, the country's largest timber concessionaire, owns the nation's only veneer factory and its largest sawmill, as well as a number of other sawmills (Bun *et al.* 2004).

sia, the United Fiber System pulp mill project in Kalimantan, with majority investment from a Chinese company, has also stirred controversy. In Thailand, Soon Hua Seng's Advanced Agro has held high-level discussions since 1997 with a Chinese company for a proposed eucalyptus and pulp/paper venture that would reportedly produce 700 000 tonnes of pulp annually, mostly for export to China. Many are doubtful, however, that this project will be realized due to the lack of land available for concessions, the complexity and cost of establishing out-grower schemes, and the social protest likely to develop (Barney 2004b).

stination for RFE timber and, given that 80 % of RFE timber production is exported, is a major force in the RFE timber market overall (Lankin 2004). China accounts for 40 % of all Russian log exports and 12 % of the nation's industrial roundwood production (2002). The China market is rapidly coming to have a decisive influence on the small country of PNG, with Chinese exports growing from 35 % of PNG's industrial roundwood production in 2000 to 58 % in 2002 (Bun *et al.* 2004). Malaysia, second in the region only to Russia in total log exports, ships 41 % of its log exports or 12 % of its industrial roundwood production to China. Of the major log producers in the region, only Indonesia,

TABLE 3 *Role of China in Asian Pacific supplying country log markets (2002 data, unless otherwise noted)*

Country	Industrial roundwood production	Log exports	Log exports to China	Percent of log exports to China	Percent of log production to China
	000 000 m^3			%	
RFE	12.20	10.3000	NA	–	–
SE Siberia	15.10	NA	NA	–	–
Russia total	118.60	36.8000	14.8000	40	12.4
Malaysia	17.90	5.1800	2.1200	41	11.8
PNG	2.00	1.8000	1.1500	64	57.5
Myanmar	5.54	0.8800	0.6100	69	11.0
Indonesia	55.00	0.5000	0.2500	50	0.5
Vietnam	4.18	NA	0.0160	–	0.8
Laos	0.39	0.0630	0.0110	17	2.8
Thailand	7.80	0.0031	0.0025	81	7.4
Cambodia	0.12	0.0001	0	0	0

Sources and notes: Country reports prepared by autohors for Forest Trends and CIFOR in 2004 (see references). FAOSTAT data 2004. China Customs data for 2002. Data for the year 2002, except for Vietnam roundwood production (2000), Indonesia industrial roundwood production (authors' estimate: 2003), Cambodia log exports (2000), and Laos log exports (2001).

EXPORT TRENDS

Export trends of Asia Pacific supplying countries are generally congruent with the findings on forest resources and production outlined above. That is, forest rich countries, still harvesting at high levels, export and provide China, in particular, with a large amount of logs, while most countries past their natural forest logging peaks either supply China mainly with processed product or have a low level of forest product exports to China. Analysis of remaining forest resources in conjunction with export trends suggests that most Asia Pacific supplying countries will at best maintain current export levels to China for the medium term (less than 20 years), with only Russia presenting the potential of significantly increased and/or longer-term supply to China.

Log exports

Comparison of log exports to China with overall log exports and domestic production of Asia Pacific supplying countries shows that China is playing a critical role in the log export trade and in many cases overall log markets of most of the major producers (see Table 3). China, surpassing Japan in 2001, is the top export de-

congruent with its emphasis on value added products, exports just a small proportion of its very high industrial roundwood production. While about half of its official 500 000 m^3 in log exports (2002) went to China, log exports to the P. R. C. represented less than 3 % of the nation's industrial roundwood production.

For Myanmar, Cambodia, Laos, Vietnam, and Thailand, the role of the China trade in overall log production and exports is clouded by lack of accurate statistics, smuggling, and/or transshipments. Based on China Customs data, only Myanmar among these countries is a major log supplier to China. While Myanmar's military regime reports extremely low exports to China, Chinese customs statistics are generally more dependable and include exports from regions not controlled by the regime.

Processed forest product exports

As indicated by Sun *et al.* (in this issue), China is shifting towards importing unprocessed forest products as it moves forward in developing its own manufacturing capacity. The trend of lower value-added imports is particularly apparent in comparison to the low levels of plywood imports to high levels of log and sawnwood imports, and in comparison to stagnant paper imports compared to growing pulp imports.

Analysis of China's imports from a regional supply perspective (namely, assessing the proportion of key Asia Pacific producers' processed forest product exports purchased by China) indicates that exports to China play a dominant role in several product segments. China is particularly dominant in absorbing the sawnwood and pulp exported in the region, again confirming its emphasis on lower value-added imports. China also plays a very significant role, however, in the proportion of top regional producers' veneer and paper exports that it purchases. China's role in purchasing plywood from the region's top plywood exporters is much weaker. Table 4 offers a comparison, by supplying country and processed product, of exports to China, total exports, and total production. While figures for total exports and production are rough estimates in some cases, the data offers insight on trends in the region. These trends are also summarized, by product segment, below.

Sawnwood: Top sawnwood exporters in the region include Russia (9.0 million m^3 exported in 2002), Malaysia (2.6 million m^3), Indonesia (2.0 million m^3), and Thailand (1.6 million m^3). The data indicates that China plays a particularly significant role in the case of Indonesia (importing 70 % of Indonesian sawnwood exports or 22 % of total sawnwood production) and substantial roles in the cases of Thailand and Malaysia.

TABLE 4 *Processed product exports to China and comparison to overall exports and overall production of Asia Pacific supplying countries (2002 data, unless otherwise noted)*

Country	**Sawnwood**	**Plywood**	**Veneer**	**Pulp**	**Paper**
	000 000 m^3 Roundwood Equivalence				
Russia					
Exports to China	0.790	0.005	0.002	3.60	0.820
Total exports	12.900	2.900	0.048	7.20	6.600
Total production	28.100	4.600	0.200	24.40	16.700
Indonesia					
Exports to China	2.000	1.100	0.030	4.50	1.800
Total exports	72.900	13.800	NA	9.00	6.900
Total production	20.000	16.220	0.110	21.70	19.600
Malaysia					
Exports to China	0.700	0.250	0.370	0.00	0.130
Total exports	3.600	9.000	1.500	0.00	0.420
Total production	6.600	10.900	1.800	0.49	2.400
Thailand					
Exports to China	0.850	0.007	0.005	0.36	0.700
Total exports	2.200	0.095	0.005	0.76	2.200
Total production	NA	0.300	0.008	3.70	6.800
PNG					
Exports to China	0.003	0.000	0.021	0.00	0.000
Total exports	0.041	0.008	0.090	0.00	0.000
Total production	0.100	0.023	0.180	NA	NA
Myanmar					
Exports to China	0.330	0.000	0.001	0.00	0.000
Total exports	0.390	0.200	NA	0.00	0.000
Total production	0.550	0.480	1.800	NA	0.116
Vietnam					
Exports to China	0.015	0.000	0.008	0.00	< 0.001
Total exports	0.022	0.017	0.019	0.00	0.005
Total production	4.200	0.093	NA	0.92	1.100
Cambodia					
Exports to China	0.008	0.024	0.097	0.00	< 0.001
Total exports	NA	0.035	NA	0.00	NA
Total production	NA	0.035	NA	NA	NA
Laos					
Exports to China	0.008	0.000	0.000	0.00	0.000
Total exports	0.190	0.011	0.002	0.00	0.000
Total production	0.260	0.033	NA	NA	NA

Sources and notes: See sources and notes to Table 2 for references, conversion factors used, and notes on production data. Additional reference: China Customs Data 2002. Additional exceptions to use of 2002 data are: use of 2001 data for Cambodia and Laos sawnwood, plywood, and veneer exports, for Thailand and PNG plywood exports, and for Malaysia paper exports; use of 2000 data for Vietnam plywood and Thailand veneer exports.

Plywood: The top exporters of plywood in the region are Indonesia (5.5 million m^3 exported in 2002) and Malaysia (3.6 million m^3). Although both of these nations export a much higher proportion of the plywood they produce than of the sawnwood they produce, China purchases a lower proportion of these countries' plywood production than of their sawnwood, reflecting China's demand for less processed products. According to the data, China imported only 8 % of Indonesia's plywood exports (6 % of production) and 3 % of Malaysia's (2 % of production).

Veneer: Malaysia is by far the top exporter of veneer in the region (601000 m^3 exported in 2002). China imported 25 % of Malaysia's veneer exports in 2002, or 22 % of its total veneer production.

Pulp: Top exporters of pulp in the region are Indonesia (2.2 million tonnes exported in 2002), Russia (1.8 million tonnes), and Thailand (191 000 tonnes). China is clearly dominant in importing pulp exported from within the region. Based on available data, China imported 50 % of Indonesia's pulp exports (21 % of total production), 50 % of Russia's (15 % of production), and 48 % of Thailand's (10 % of production) in 2002.

Paper: The top exporters of paper in the region are Indonesia (2.5 million tonnes exported in 2002), Russia (2.3 million tonnes), and Thailand (787 000 tonnes). China's role in importing paper exported in the region is substantial, though not as dominant as for pulp, again showing China's relatively higher demand for less processed products. In 2002, China imported 27 % of Indonesia's paper exports 13 % of Russia's, and 32 % of Thailand's.

Potential for future export of logs and processed product to China

While projections of China's future forest product consumption will require a better understanding of demand drivers and implications of the nation's low per capita demand, analysis of Asia Pacific country forest resource bases and recent export trends offers an insight into the potential for these countries to supply China with log exports over the next two decades. Apart from Malaysia, countries past their natural forest logging peaks, such as Vietnam, Laos, Cambodia, and Thailand do not export large volumes of logs to China and are unlikely to have the resources to do so in the upcoming two decades. Despite its large natural forest area and sizable timber harvest, Indonesia, which exported 116 000 m^3 of logs to China in 2003, is also past its logging peak and, focusing on its own domestic processing industry, is not likely to substantially increase its raw log exports to China over the next few decades.

Instead, those countries from the region currently supplying China with the most substantial amount of logs (Russia, Malaysia, PNG, and Myanmar) should continue to be its main regional log suppliers in the next ten years. Given rough estimates on time to resource exhaustion at current cutting rates (13 to 16 years for PNG 10 to 15 years for Myanmar in areas bordering China, and over 20 years for Russia), however, it appears that only Russia will be a promising source of logs for China 20 years from the present. Projections 30 years into the future are much more difficult to make. Russia's ability to continue to supply China at current rates or the potential of other countries in the region to have either recovered their natural forest base or substantially expanded plantation area are not clear. In the shorter term (over the next few years), China's main Asia Pacific log suppliers will at best maintain current export levels to China, with only Russia presenting the potential of significantly increased supply.

Future potential for processed forest products exports to China from the region's supplying countries is closely linked to the log supply and forest resource trends discussed above. Given that China is already consuming a large proportion of the processed products exported from within the region, the question becomes whether supplying countries might expand their processing capacities. Given limits in log resources, most countries past their natural forest logging peaks would face substantial difficulties in expanding processing capacity unless they were able to secure logs from other sources. Indonesia's processing sector, for example, already has a shortage of raw materials, though continued expansion of its pulp and paper industry is expected in coming years. Large-scale plantation development presents a possible means of offsetting declines in natural forest production in such countries, though plantation efforts in both Indonesia and Thailand (the two supplying countries in the region with the greatest plantation activity to date) have met with limited success. Indeed, China is expected to soon follow Japan's lead in investing in large-scale plantation development in the region.

China's major log suppliers from the region at present (Russia, Malaysia, PNG, and Myanmar) could potentially expand processing capacity, keeping more raw logs in country for value-added production. Indeed, this is a policy option that has been raised in Russia, PNG, and Myanmar. Adoption of this strategy, however, would reduce logs available for China in most cases. While the location of processing would shift the total amount of processed product available to China might not change. Again, it is probably only Russia, given its strong natural forest resource base, which could increase export of processed product to China, while maintaining current levels of log exports to China over the next couple of decades.

TABLE 5 *Unsustainable practices, illegal logging, and other policy issues, with examples*

Lack of attention to conservation in main forest plans or codes

PNG: National Forest Plan

Unsustainable logging practices

PNG:
- Annual logged area and intensity of logging rising: logging in unsuitable areas
- 40-year cutting cycle not respected/average concession lifetime of 11 years
- Second time harvesting as little as 10 years after initial logging event

Myanmar:
- Ecological impacts of logging may spread to Chinese side of border (e. g. pests, disease, etc.)
- Annual allowable cut based on full area of country, but applied to area under central control

Legal and illegal players often the same

Cambodia: Concessionaires main players in both legal and illegal logging
PNG: Concessionaires main players in both legal and (with local cohorts) illegal logging
Russia:
- Long-term harvesting companies also involved in illegal logging
- Customs inspectors may ‚legalize‘ illegal product
- Forest Guard staff enhance low salaries through ‚intermediate cutting‘; many accept bribes to turn a ‚blind eye‘ to illegal logging

Myanmar: Individuals working for forest protection units often carry out commercial illegal logging

Loss of revenue from illegal logging

Russia: Huge losses in tax revenues

Measures adopted to combat illegal and/or unsustainable logging

Indonesia:
- Bilateral cooperation, including memorandum of understanding with China
- Log export ban (also used to promote domestic processing industry)

Russia:
- Fixed checkpoints and patrolling brigade with decent salaries
- Barcode system under development (all trees to be harvested would bear plastic barcode label)
- Control of export sites and reduction in their number (has been effective)

Cambodia:
- Donor conditionality to promote forest sector reform
- Logging moratorium (2002)

Thailand: 1989 natural forest logging ban (has stabilized deforestation of previous 20 to 30 years)
Vietnam: Partial logging ban and export quotas

The push for processing

Russia: Push to expand processed product exports to China not successful
- China import policies (import tariffs, previous VAT) favor log imports over processed product
- Chinese labor cheaper than Russian labor

Indonesia: Aggressive policies to develop processing industry have led to overcapacity

Customs issues

Myanmar: Low customs compliance due to regime’s lack of control over areas serving China
Russia:
- Lack of coordination between Russia and China customs (re: statistics, forbidden species, etc.)
- Customs violations increasing on Russia side of China-Russia border
- Corruption among customs inspectors allows large flow of illegal product

Rampant corruption

PNG: Evidence of corruption at highest levels of government; foreign concessionaires said to support political parties and individual politicians
Cambodia: Patronage of concession system said to lead to highest levels of government

Non-compliance of concessionaires and issues of concession management

PNG: Concessionaires do not meet social obligations (e. g. leave promised roads unfinisteh, etc.)
Cambodia: Concessionaires have failed to meet sustainability criteria and pay royalties due
Russia: Chinese harvesting companies do not meet requirements to process wood/hire Russians
Myanmar: Short (5 year) logging contracts with Chinese companies promote poor management

KEY ISSUES

The forest products industry and export trade in the Asia Pacific Region have enormous impacts on supplying countries, raising a host of policy issues. Serious ecological impacts across the region are linked with on-going unsustainable logging practices and, often, illegal logging, which also has negative economic impacts (Table 5). At the same time, other key policy issues merit attention (Table 5), and negative livelihood impacts (Table 6) occur in practically every supplying country, as people lose access to resources and as benefits accrue to some groups and not to others.

TABLE 6 *Key livelihood issues, with examples*

Insecure land tenure
Thailand:
- Thai farmers lack full deed to land/vast areas of occupied land designated as forest reserve
- Loss of farmland plantation development
- Upland minorities denied land rights/lack citizenship
Laos:
- Villager access to swidden farmland lost and upland groups impoverished through Land and Forest Allocation Program
Cambodia:
- Conflict due to denied access and reduction in resources caused by logging (e. g. villager-plantation company conflicts)
Inequitable distribution of benefits within country
PNG:
- People own land (traditional tenure), but government does not support development of forest resources by local people
- Non-logging development alternatives not included in National Forest Plan
- Illiterate people cheated by local elites
- Benefits for local communities as negotiated with concessionaires not realized
Myanmar (areas serving China):
- Much of benefit used military spending of insurgent groups
- Elites benefit, while communities lack electricity, roads, and other basic infrastructure
- Roads built by logging companies are fragmented/do not meet needs of communities
Transfer of livelihood benefits outside od country
Russia:
- Low benefits to Russian side in China log trade/most value-add in China
PNG:
- Predominantly foreign concessionaires/mostly foreign staff
Myanmar (areas serving China):
- Logging companies Chinese/staffed by Chinese only

Unsustainable practices

In those producer countries still harvesting large volumes of logs, continuation of current export levels to China is a concern from an ecological standpoint, due to unsustainable logging practices. Unfortunately, forest codes and plans, such as PNG's National Forest Plan, often do not contain conservation clauses. Further, rules that exist are often not well implemented. For example, the required 40-year cutting cycle in PNG is generally not respected; and average concession life from 1993 - 2000 was only eleven years, indicating cutting rates far in excess of sustainable harvesting. The annual logged area and intensity of logging have been rising in PNG, with satellite imagery indicating that some areas are being harvested for the second time, as little as ten years after initial logging and with much more destructive ecological impacts. Given that most of PNG's logs are exported (with China as the top destination), then, current export trends imply a direct threat to the sustainability of the nation's forests and the critical sector of the economy that they support (Bun *et al.* 2004).

Unsustainable practices in parts of Myanmar serving China also suggest a direct link between ecological impacts and trade in forest products with China. Given that most of the logging in Myanmar serving China has been concentrated within a (sometimes now fully clearcut) 50 to 150 km radius from the border, ecological effects of over-logging in Myanmar are expected to spill over into China's Yunnan Province through shared ecosystems. Concerned about impacts in areas such as wildlife, pest, and disease management, Yunnan's Science and Technology Bureau began to assess ecological and socioeconomic change along the border in 2003. The short duration (1 to 5 years) of contracts awarded to Chinese logging companies leads to forest degradation, as hills are logged quickly before concessions change hands. Finally, given Myanmar's complex political situation, forestry departments do not have the authority needed to monitor and regulate most of the logging serving China and also end up applying an annual allowable cut based on the country's full area to only that fraction under the military regime's control (Kahrl *et al.* 2004).

Countries past their logging peaks have adopted some policies to counter high levels of unsustainable harvesting, though problems remain, with Indonesia and, probably, Cambodia, continuing to face ongoing deforestation problems. Logging in Thailand, however, has declined to such an extent that deforestation is thought to have stabilized. The Cambodian Government put a moratorium on logging in January 2002, because of concessionaires' continued failure to meet forest sustainability criteria. While conditions put on donor loans to Cambodia have likely been the primary force in the nation's forest sector reform, the effectiveness of reforms has been questioned (Barney 2004a). Critics point to the failure of donor conditionalities to address corruption and the flawed concession system and call for its dismantling and overhaul. Logging and log export bans have also been instituted in Thailand, Vietnam, and Indonesia, though export bans may also aim at promoting domestic processing industries, as in the case of Indonesia.

Illegal logging

Illegal logging is extensive in most Asia Pacific supplying countries and thought by many to be linked with ecological deterioration. ‚Legal' logging, however, may also create negative impacts and, in the case of Russia, it is not obvious that illegal practices are more damaging than legal ones. Illegal logging of commercial scale in supplying countries often involves parties linked with legal commercial logging. In Russia, for example, long-term harvesting companies are involved in illegal logging, and customs inspectors may also be involved in the ‚legalization' of illegal product (Sheingauz 2004). In Vietnam, illegal logging is often carried out by individuals who work for forest protection units (Barney 2004c).

In the RFE and Southeastern Siberia, illegal logging is particularly severe. Alexander Sheingauz (2004) has estimated that 38 % of all logging in the RFE is illegal. One driving force in illegality is the potential for Forest Guard staff to enhance their low salaries through intermediate cuttings (which, as a result, may not always have a legitimate silvicultural basis) and bribes from illegal loggers. While illegal logging in Russia is probably linked most closely to domestic social and economic ills, Sheingauz (2004) indicates that areas with stronger exports have a higher level of illegal logging. He further notes that smuggling of illegal product is probably most common in the case of China, given that the land border facilitates export of contraband by truck, rather than ship.

Sheingauz (2004) also suggests that the substantial magnitude of illegal logging does not necessarily imply over-harvesting of the RFE as a whole or of any of its provinces, given that legal logging falls so short of the annual allowable cut. In some areas, however, the cut volume is closer to the full annual allowable cut. At the site level, illegal logging generally has the same consequences as legal logging, but may have some additional impacts. Most significantly, fully illegal loggers create damage through disregard of silvicultural requirements (i. e. selective cutting or reforestation), while large and medium size (legal) logging firms in Russia tend to comply.

Reflecting concern for the sustainability of the industry and the huge losses in tax revenues, governments at both the federal and provincial levels in Russia have taken a number of measures to prevent illegal logging. Some provinces have set up fixed checkpoints as well as patrolling brigades provided with decent salaries. At the federal level, the Ministry of Natural Resources is developing a barcode system, whereby every tree destined for harvesting would have a plastic label with barcode (Sheingauz 2004).

The link between illegal logging and environmental damage is more obvious in other supplying countries, given their more limited resource bases. In PNG, the main players in legal logging, the concessionaires, are also responsible for the bulk of illegal logging. While all the necessary laws and policies to prevent illegal logging are in place, there is a lack of political will and enforcement capacity. Government officials may in fact support these activities (see discussion of corruption below), and local cohorts are usually involved as well (Bun *et al.* 2004). In Cambodia, as in PNG, the illegal (as well as the legal) sector is thought to be controlled by the concessionaires. In the mid to late 1990s, extensive illegal exports from Cambodia to Thailand, Laos, and Vietnam were documented by Global Witness, though the current status of such activities is less clear (Barney 2004a).

Indonesia has developed bilateral cooperation with a number of countries to combat illegal logging. In particular, the nation has signed a memorandum of understanding with China that is targeted at reducing the trade in illegal forest product. Analysts report, however, that these agreements have yet to make an impact.

Livelihood implications

The livelihood implications of the forest industries and China trade for the people in Asia Pacific supplying countries are immense and critically linked to the sustainability of the forest industry in the region. Insecure land tenure, inequitable distribution of benefits within each country, and the transfer of livelihood benefits outside of the supplying country are key livelihood-related trends occurring across the region (Table 6) and demanding the attention of policy makers. While positive livelihood impacts also occur, beneficiaries are generally not the neediest or those that are losing traditional access to resources. Livelihood impacts, of course, are not due solely to the role of the China market, particularly for countries whose export levels to China are low. Thus, while the China trade may in many cases present an entry point for addressing livelihood issues, national-level initiatives in supplying countries will clearly be needed as well. In addition, action in countries to which China ships finished forest products may also be relevant.

Insecure land tenure, in the face of industry expansion, has led to displacement, loss of farming land, conflict, and loss of access to resources by forest-dependent peoples. Such property issues impede the sound development of the industry, and their resolution is a prerequisite to sustainability. Insecure tenure and its negative impact on the industry and local peoples is a particularly evident in Thailand, where only a small proportion of farmers hold full deed to their land. Vast areas of the nation are designated as forest reserve (44.7 % of total land area), though much is neither forested nor unoccupied. Loss of farmland through plantation development has resulted in scandals and successful resistance to further plantation development. Finally, Thailand's forest policy has resulted in hard line treatment of upland minorities practicing swidden agriculture in protected areas. Many of these minorities lack Thai citizenship and are denied land rights (Barney 2004b).

In Laos, implementation of the Land and Forest Allocation Program (LFAP), promoted in combination with a policy aimed at ‚stabilizing' shifting cultivation, has been identified as a primary source of new poverty creation and food insecurity in the countryside (Lao Government State Planning Commission 2001). Under the program, national territory is demarcated into village land and state production forestry or biodiversity conservation land, and village territories are also internally zoned into forest and agricultural land use areas. While the overall goals of the program are commendable in terms of promoting village tenure security, the end effect has been to unduly squeeze villagers' access to crucial swidden farmland and to create severe hardships and impoverishment for upland groups, particularly ethnic minorities.

In Cambodia, issues of access to resources and tenure security are particularly acute, as forests represent crucial sources of livelihoods for most of the nation's rural communities. Case studies have indicated that forest degradation in Cambodia has impacted livelihoods, forcing villagers to meet their forest product needs from areas farther away (McKenny and Tola 2002). Conflicts between villages and plantation companies are becoming more and more common. Prime Minister Hun Sen has even indicated that land issues could spark a ‚peasant revolution', and in October 2004 called for a review of land concessions (Associated Press 2004). The potential for such unrest is rising as Asia Pulp and Paper and other major players in the region make investments in logging and plantations in Cambodia.

Inequity in the distribution of benefits of the logging trade is common in the region. Often, poor communities most closely tied and dependent upon forestlands lose out, as local elites and/or industrial concerns absorb most of the benefits. For example, while land in PNG belongs to local people through traditional tenure and local communities must consent to any major development of their resources, these often illiterate people are frequently cheated by local elites, who benefit disproportionately from bringing logging companies into the area. In addition, negotiated benefits from concessionaire harvesting are generally not realized; and local people are often left with unfinished buildings, roads, and bridges. Finally, the government does not support local landowners in the development of their own forest resources. PNG's National Forest Plan does not address non-logging forest development alternatives, and local peoples were not consulted before the plan designated their land for logging (Bun *et al.* 2004).

In Myanmar, the benefits of timber exports accrue to only a small segment of the population and are often used for military spending. Concessionary logging combined with the drug trade has created an elite class among insurgent groups controlling border areas, while many parts of Kachin State still lack electricity, roads, and other basic infrastructure components. Roads built by Chinese logging companies, despite claims to the contrary, do not generally support the transport needs of local people as such roads are scattered and fragmentary (Kahrl *et al.* 2004).

In many cases, the direct benefits of the forest product trade are seen either to be leaving the producer country or to be accruing to foreigners in residence, impeding the potential for developing a sustainable forest industry that bolsters local livelihoods. In Myanmar, few local people are involved in the China log trade. All logging for this trade is carried out by Chinese companies, which are generally staffed exclusively by Chinese employees (Kahrl *et al.* 2004). In PNG, predominantly foreign-owned concessionaires often employ mostly foreign staff. Researchers in PNG have found, for example, that 90 % of the insured workforce at Rimbunan Hijau, the nation's largest logging company, are Malaysian, Indonesian, Chinese, or Filipino (Bun *et al.* 2004). In the case of Russia, disproportionate livelihood opportunities associated with the log trade are thought to be accruing to the Chinese side of the border, particularly because of the emphasis on raw log imports and processing by low-cost labor in China. Chinese companies are also becoming active in the forest product trade on the Russian side of the border. Some reports indicate that such companies process logs minimally in Russia to avoid the requirement of a harvesting permit to export logs, do not pay any taxes, and employ only Chinese staff (Lebedev 2004).

Other policy issues

Other forestry-related policy issues in supplying countries meriting attention include a push for increased processing in a number of countries, customs issues, non-compliance of concessionaires, and rampant corruption problems. Some desirable forest-related policies have been identified in supplying countries, but implementation is often a problem. Finally, lack of funding for government-supported organizations associated with management of the sector and natural forest protection is another important policy issue.

Efforts in countries such as Russia and Indonesia to promote greater processing of logs to increase the value-added of exports have met with varying levels of success. Russia's push to expand lumber and other processed exports to China has not borne significant results. China's import policies are thought to encourage the import of raw logs from Russia. China institutes a full import duty and value-added tax (VAT) on lumber, but has no import duty and, up until August 2004, had a 50 % VAT reduction on logs imported through border trade. In addition, given inexpensive labor in China, Russian sawn wood production costs are at least twice those in China. The raising of Russian duties on log exports to promote processing is still under discussion, though it is feared such a measure might merely increase illegal activity (Lankin 2004). Indonesia, in contrast, has met its processing ambitions through aggressive policies, but perhaps has taken these too far and is now suffering from excess processing capacity, thought to have resulted from excessive Government licensing (without periodic confirmation of raw material availability) and hidden subsidies.

Customs issues in the regional forest trade are substantial and represent a possible leverage point for addressing trade in illegal products. Gaps between forest product imports reported by China and exports reported by supplying countries are high, particularly for Indonesia and Myanmar. Myanmar's Government requires that all teak logs and all processed hardwood product bound for export pass through the capital, Yangon, but, in practice, only a small proportion of the substantial amount of hardwood lumber bound for China takes this indirect route (Kahrl *et al.* 2004).

Lankin (2004) has indicated that there is still no contact between Russian customs and Chinese customs for harmonizing national customs statistics and coordinating on species forbidden for export. Customs violations on the Russian side have gone up with increasing exports to China. Despite Russia's complex system of checking, stamping, etc., corruption among inspectors allows large amounts of illegal products to pass into China. Lankin notes that, of the counter-measures Russia has implemented, control of export sites and reduction of their number have been the most effective.

Noncompliance of concessionaires or leasing parties with regulations or agreements is common in the region. As mentioned, concessionaires in PNG often do not fulfill agreed social obligations, leaving unfinished buildings, roads, and bridges across the country (Bun *et al.* 2004). In Cambodia, a halt in transport of concession logs for which royalties have not been paid is being adopted to increase compliance (Barney 2004a). In Russia, Chinese companies involved in harvesting are said to have failed to meet provincial requirements of investment in processing and hiring of Russian employees. Several instances of Chinese companies violating concession agreements have been noted in Myanmar, as well, with examples including broken agreements by Chinese companies to provide electricity and various other services to rural communities (Global Witness 2004).

Illegal logging and other forest sector problems are often linked to government corruption. In PNG, there is strong evidence that corruption exists at the highest levels of Government and throughout the bureaucracy in association with the foreign-owned logging industry. The industry is thought to be a major source of funds for political parties and individual politicians, and national-level permits or licenses for logging concessions are said to be issued outside of the established legal process to the company that is willing to pay the right price (Bun *et al.* 2004). In Cambodia, according to Global Witness, the concession system is also linked to a high degree of corruption, with patronage leading directly to the highest levels of state (Barney 2004a).

CONCLUSION

The China forest product trade is clearly having a dramatic impact on the forests, economies, and peoples of supplying countries in the Asia Pacific Region. With strong and growing demand in China and a lack of adequate domestic supply, it is likely that the trends identified in this paper will continue for some time. Indeed, while further work is needed on demand drivers and the implications of low per capita wood consumption in China, growth in Chinese demand is expected in the short to medium-term, despite the inability of Asia Pacific supplying countries, aside from Russia, to expand overall supply of logs and processed products sustainably. As such, China may be faced with the need of developing a strategy to secure greater access to Russian resources. Given the possibility that even Russian supply may not meet its needs in the longer term, China's strategy may need to encompass other potential sources. Options might include stronger development of collective forests at home, with attention to the supply of not only softwood, but also hardwood species, and more innovative and flexible application of conservation policies in these areas. Another alternative is encouraging private investment in sustainable natural forest management and plantation development in supplying countries in the region. In the shorter term, however, China will likely continue to make use of forest products from current suppliers as much as possible, and thus may wish to formulate policies to minimize negative ecological and livelihood impacts in these countries. At the same time, given that China's timber product exports (most in the form of furniture and other finished wood products) are 50 % by RWE volume of the logs and other timber product it imports, final destination countries benefiting from China's low-cost manufacturing may have a role to play[11]. Supplying countries may also wish to develop policies minimizing negative impacts. Initiatives might emphasize, for example, the gravitation of small-scale producers toward niche markets where they can find comparative advantage, rather than direct competition with China's highly efficient and well-financed supply and manufacturing chains.

The negative impacts associated with this trade merit the focused attention and dedicated energy of governments, industry, researchers, and conservation groups around the region. The combined efforts of all of these stakeholders, through both international cooperation on shared problems and domestic initiatives, will be needed to address the underlying policy and institutional problems generating the negative impacts. Forward-thinking and proactive solutions should utilize the China trade to create incentives for investment in and the protection of forests, both in China and in supplying countries, by taking advantage of new and growing markets, new partnerships to supply capital, new technologies to lower cost of sustainable production, and better organization and empowerment of local producers. Such solutions should further enable forestry to make stronger contributions to the economic development of the region's poor people both within and outside China.

ACKNOWLEDGEMENT

The authors would like to thank Sten Nilsson of IIASA for extremely useful comments on an early draft of this paper.

REFERENCES

ASIAN DEVELOPMENT BANK. 2004. Laos Northern Regional Development Strategy. Volume 2, Part II: Forestry Strategy and Action Plan.

ASSOCIATED PRESS. 2004. UN Official Calls for Investigation of Grenade Attack on Logging Protesters. November 14 2004.

BARNEY, K. 2004a. Cambodia's Forest Sector and Supply to China: Asia Pacific Partners Working Paper No. 6. Forest Trends, Washington, D. C., U.S.A.

BARNEY, K. 2004b. Thailand's Forest Sector and Supply to China: Asia Pacific Partners Working Paper No. 7. Forest Trends, Washington, D. C., U.S.A.

[11] In 2003, China's forest product exports by RWE volume were 25 % of its forest product imports. Timber product (i. e. including logs and solid wood products, but excluding pulp and paper) exports that year, however, at 20.0 million m^3 RWE were about half of timber product imports (40.3 million m^3 RWE).

BARNEY, K. 2004c. Vietnam's Forest Sector and Supply to China: Asia Pacific Partners Working Paper No. 8. Forest Trends, Washington, D. C., U.S.A.

BULL, G., MABEE, W. and SHARPENBERG, R. 1998. FAO Global Fiber Supply Model. FAO, Rome, Italy.

BUN, Y., KING, T. and SHEARMAN, P. 2004. China's Impact on PNG's Forestry Industry: Asia Pacific Partners Working Paper No. 5. Forest Trends, Washington, D. C., U.S.A.

CENTER FOR INTERNATIONAL FORESTRY RESEARCH (CIFOR). 2004 (draft). Generating Economic Growth, Rural Livelihoods, and Environmental Benefits for Indonesia's Forests: A Survey of Issues and Policy Options. Prepared for the World Bank.

CHINA CUSTOMS IMPORT DATA. 2002 and 2003. Government of China.

EC-FAO PARTNERSHIP PROGRAM. 2002. An Overview of Forest Product Statistics in South and Southeast Asia. FAO, Bangkok, Thailand.

FAO 2000. Global Forest Resources Assessment 2000. FAO, Rome, Italy.

FAOSTAT Data. 2004. FAO, Rome, Italy.

US DEPARTMENT OF AGRICULTURE. 2003. Vietnam Solid Wood Products Annual. Foreign Agricultural Service, USDA. http://www.fas.usda.gov/gainfiles/200311/146085211.pdf.

GLOBAL WITNESS. 2003. A Conflict of Interests: The Uncertain Future of Burma's Forests. Global Witness. http://www.globalwitness.org/reports/show.php/en.00059.html

GLOBAL WITNESS. 1999. Made in Vietnam, Cut in Cambodia. Global Witness. http://www.globalwitness.org/reports/show.php/en.00024.html

KAHRL, F. SU, Y. and WEYERHAEUSER, H. 2004. Navigating the Border: An Analysis of the China-Myanmar Timber Trade: Asia Pacific Partners Working Paper No. 1. Forest Trends, Washington, D. C., U.S.A.

LANKIN, A. 2004. Status and Trends in Forest Product Exports from the Russian Far East and Eastern Siberia to China: Asia Pacific Partners Working Paper No. 3. Forest Trends, Washington, D. C., U.S.A.

LAO GOVERNMENT STATE PLANNING COMMITTEE AND NATIONAL STATISTICS CENTER AND ASIAN DEVELOPMENT BANK. 2001. Participatory Poverty Assessment: Lao P.D.R. Asian Development Bank, Vientiane, Lao P.D.R.

LEBEDEV, A. 2004. Siberian and Russian Far East Timber Market for China. Asia Pacific Partners Working Paper No. 4. Forest Trends, Washington, D. C., U.S.A.

McKENNY, B. and TOLA, P. 2002. Natural Resources and Rural Livelihoods in Cambodia: A Baseline Assessment. Cambodia Development Resource Institute Working Paper # 23. Phnom Penh.

MIDAS AGRONOMICS CO. LTD., CHAMPA LO CONSULTING CO. LTD., SCANDIACONSULT NATURA

AB, and CIRAD FORET. 2003. Tree Plantation for Livelihood Improvement Project: Final Report. ADB PPTA No. 3794-LAO. Asian Development Bank.

SCHERR, S., WHITE, A., and KAIMOWITZ, D. 2004. A New Agenda for Forest Conservation and Poverty Reduction: Making Markets Work for Low Income Producers. Forest Trends, Washington, D. C., U.S.A.

SHEINGAUZ, A. 2004. Overview of the Forest Sector in the Russian Far East: Production, Industry, and Illegal Logging: Asia Pacific Partners Working Paper No. 2. Forest Trends, Washington, D.C., U.S.A.

VANDERGEEST, P. 2003. Land to Some Tillers: Development-Induced Displacement in Laos. In: *International Social Science Journal* **LV**(1):47-56.

WHITE, A. and MARTIN, A. 2002. Who Owns the World's Forests ? Forest Trends, Washington, D. C., U.S.A.

WORLD BANK. 2004. East Asia Regional Forest Strategy. Washington, D. C.

WORLD BANK, SWEDISH INTERNATIONAL DEVELOPMENT AGENCY, AND MINISTRY OF FOREIGN AFFAIRS, GOVERNMENT OF FINLAND. 2001. Lao PDR Production Forestry Policy: Status and Issues for Dialogue.

China's pulp and paper sector: an analysis of supply-demand and medium term projections[1]

D. HE● and C. BARR■

● *President of China Economic Consulting, Inc. and a Ph.D. Candidate in Economics at North Carolina State University, based in Raleigh, North Carolina, USA*
■ *Senior Policy Scientist with CIFOR's Forests and Governance Program, Bogor, Indonesia*

Email: d_he@chinaeconomicconsulting.com and c.barr@cgiar.org

SUMMARY

This study summarizes recent trends in China's paper and paperboard sector and projects supply and demand for each of the major grades through 2010. Baseline projections suggest that China's aggregate demand will grow from 48.0 million tonnes in 2003 to 68.5 million tonnes per year in 2010. With domestic production projected to reach 62.4 million tonnes per year, China is expected to dominate global capacity expansion for most major grades. China's annual demand for fibre furnish across all grades is projected to rise from 40.2 million tonnes in 2003 to reach 59.6 million tonnes by 2010. Of this, approximately 58 % will come from recovered paper, 25 % from wood-based pulp, and 17 % from nonwood pulp. This rapid growth has far-reaching implications for forest sustainability and rural livelihoods both within China and throughout the Asia-Pacific region. It will place new strains on China's domestic wood supply and may exacerbate forest conversion and illegal logging in key supplier countries, in addition to providing both threats and potential income opportunities for smallholder tree growers.

Keywords: China, paper and paperboard, pulp, wood fibre, supply-demand trends

INTRODUCTION

China's unprecedented economic growth over the last 15 years has led to a sharp increase in demand for paper and paperboard products. During this period, the country's aggregate consumption of paper and paperboard has grown by 9.6 nearly 10 % per year, rising from 14.6 million tonnes in 1990 to 48.0 million tonnes in 2003. To meet this demand, domestic production of paper and paperboard has grown at a similar pace, expanding from 13.7 million tonnes in 1990 to 43.0 million tonnes in 2003. Accounting for over 50 % of the world's overall growth in paper and paperboard production since 1990, China is now the second largest producer globally, surpassed only by the United States.

There is a general consensus among industry analysts that China's demand for paper and paperboard, as well as domestic production, will continue to expand at a very rapid pace for at least the medium term. However, forecasts of China's consumption for 2010 have varied widely in recent years, ranging from the FAO's projection of 48 million tonnes (Zhang *et al.* 1997a) to projections of 60 million tonnes or more by leading commercial analysts (Jaakko Pöyry 2000, URS Forestry 2002)[2]. Recent market studies also project in recent years have projected that by 2010, China will consume approximately 60 million tonnes of paper and board products annually, and that most of this will be supplied by domestic producers[3]. These projections raise a number of fundamental questions regarding the raw material supply for China's paper and board industry - most notably, ‚How much fibre will be needed to support China's growing demand over the years ahead ?' ‚What types of fibre will the coun-try's paper and board industry consume ?' and

[1] This article has been adapted from Dequan He and Christopher Barr (forthcoming) ‚China's pulp, paper and paperboard sector: an analysis of supply and demand trends and projections to 2010', to be published by the Center for International Forestry Research (CIFOR) and Forest Trends.

[2] It should be noted that even within the FAO literature, estimates of China's future paper and paperboard consumption have varied widely. For instance, the *FAO Provisional Outlook for Global Forest Products Consumption, Production and Trade to 2010* (Zhang *et al.* 1997b) projected that China's total demand would reach between 59.5 million tonnes and 65.6 million tonnes by 2010, depending on the country's general economic growth and other variables. However, this estimate was revised downward quite substantially in the FAO's *Trends and Outlook for Forest Products Consumption, Production and Trade in the Asia-Pacific Region* (Zhang *et al.* 1997a), which used a different set of assumptions to project that China's total demand would reach 48.1 million tonnes in 2010.

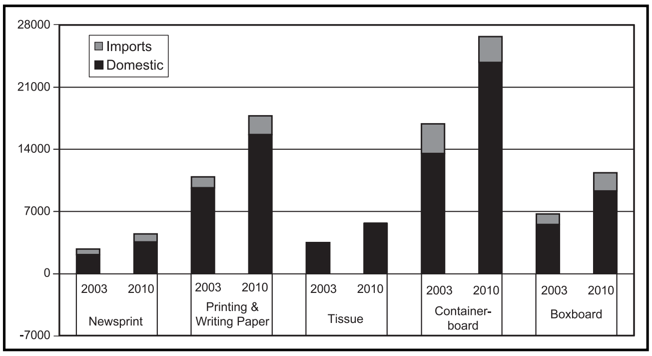
[3] See, for instance, Jaakko Pöyry's 2001 multi-client study entitled *China Forest Industries: Opportunities and Challenges - Pulp and Paper*; and URS Forestry's 2002 multi-client study entitled *The Chinese Pulp and Paper Industry; Present Position - Future Prospects*. A discussion of how these studies' forecasts compare to the projections offered in the present study is provided in He and Barr (forthcoming).

‚Where will the fibre come from ?'

The issue of where China's paper and board industry will get its fibre furnish and in what volumes has direct implications for rural livelihoods, sustainable forest management, and economic development not only within China, but also in Asia-Pacific supplier countries. Given the enormous scale involved, China's growing demand for wood fibre and wood-based pulp, in particular, provides significant income-generating opportunities for rural communities and for forest enterprises throughout the region. At the same time, China's expanding demand also poses potential threats to the livelihoods of forest-dependent people to the extent they may lose access to forests being cleared for pulp fibre or are displaced from lands being converted to pulpwood plantations.

This study represents an initial effort towards determining how much and what types of fibre China's paper and paperboard industry will consume over the medium term. We do so, first, by using an econometric model to project demand, supply, and trade for each of the major grades of paper and board through 2010. Based on these projections, we then use a similar model to estimate demand and supply for each of the major grades of fibre furnish - namely nonwood pulp, recovered paper, and wood-based pulp. It is our hope that this analysis will assist the region's policymakers and planners to anticipate the implications of China's expanding pulp and paper sector for forests and rural livelihoods throughout the Asia-Pacific region.

FIGURE 1 *China's domestic demand and imports for paper and paperboard by grade, 2003-2010 ('000 tonnes)*



Source: Authors' projections based on models developed by China Economic Consulting, Inc.

Our baseline projections suggest that China's aggregate demand for paper and board products is likely to exceed previous estimates and reach 68.5 million tonnes per year in 2010. Similarly, we project that domestic production across all grades is likely to grow by 45 % over 2003 levels to reach 62.4 million tonnes per year in 2010. The most significant volume increases by grade will be seen in containerboard and printing and writing paper (Figure 1). With this considerable growth, we estimate that China's annual consumption of fibre will grow from 40 million tonnes in 2003 to reach nearly 60 million tonnes by 2010. Of this, approximately 58 % will come from recovered paper, 25 % from wood-based pulp, and 17 % from nonwood pulp, made largely from bamboo and agricultural residues.

METHODOLOGY

In this study, we use a proprietary econometric model developed by China Economic Consulting, Inc. to project paper and paperboard demand, supply, and trade over the medium term. This model employs a weighted average index based on real consumer spending, investment, and net trade, together with projected GDP growth, to forecast demand for the major grades of paper and paperboard through 2010. To forecast supply for the various grades, we quantify currently existing capacity and combine this with confirmed capacity expansions at the mill level to estimate future installed capacity. We then multiply the expected installed capacity for each grade by an assumed operating level to project the volume of product that will be supplied by mills located in China. The assumed operating level for any particular grade depends, in part, on when new capacity expansions come online. The net trade is assumed to be the difference between demand and supply.

We use a derived demand approach to model China's demand for nonwood pulp, recovered paper, and paper-grade wood pulp. Based on the projected production levels for each grade of paper and paperboard, we estimate the volumes of the various grades of fibre furnish that are likely to be consumed as inputs through 2010. We forecast production of paper-grade wood pulp by estimating installed capacity and assumed operating levels. For nonwood pulp, our projections of domestic production are based on an assumed annual decrease of 2.5 %, corresponding to the pace at which we expect small and old paper machines are taken off-line. For recovered paper, our projections are based on an assumed 9.0 % annual increase due in part to the government's efforts to boost collection of recycled paper. Again, net trade is assumed to be the difference between demand and supply.

We use these approaches to make lower-bound, upper-bound, and baseline projections for the various grades of paper and board products and of fibre types through 2005 and 2010. For paper and paperboard, our baseline projection is based on the assumption that China's GDP will grow at an average rate of 7.5 % during 2003-2010. Our lower-bound projections assume that GDP growth will decline to 5.5 % for this period, while our upper-bound projections assume that GDP growth will remain at its recent historical levels of 9.5 %. Except where otherwise stated, historical data on pulp and paper demand and production in China have been obtained from the *Almanac of Chi-*

na Paper Industry, published by the China Light Industry Association, and from the China Paper Association.

CHINA'S PAPER AND PAPERBOARD GROWTH, 1990-2003

Paper and paperboard demand in China has expanded rapidly over the last two decades, with an average annual growth rate of 9.6 %, or 2.6 million tonnes per year, between 1990 and 2003 (Table 1). During this period, China accounted for nearly one-third of the world's overall growth in paper and board consumption; and the country currently consumes almost 14 % of global paper supply (Kuusisto 2004, Spencer 2004). Across the different grades, containerboard experienced the most significant volume increase, with demand growing by 12.8 million tonnes during 1990-2003. Printing and writing paper ranked second, with consumption growing by 7.0 million tonnes. Demand for boxboard rose by 5.6 million tonnes, while demand for tissue paper and newsprint grew by 2.6 million and 1.9 million tonnes, respectively.

TABLE 1 *Growth in China's demand and supply of paper and paperboard by grade, 1990-2003 ('000 tonnes)*

	1990	2003	Annual growth	Change in volume
Demand	**14,634**	**48,056**	**9.6 %**	**33,422**
Newsprint	526	2,410	12.4 %	1,884
Printing & Writing	3,313	10,311	9.1 %	6,998
Tissue/Household	647	3,276	13.3 %	2,629
Containerboard	3,193	15,974	13.2 %	12,781
Boxboard	1,118	6,698	14.8 %	5,580
Other paper and board	5,837	9,387	3.7 %	3,550
Net imports	**915**	**5,056**	**14.1 %**	**4,141**
Newsprint	17	340	25.9 %	323
Printing & Writing	43	711	24.1 %	668
Tissue/Household	-32	-194	14.9 %	-162
Containerboard	566	2,474	12.0 %	1,908
Boxboard	244	1,198	13.0 %	954
Other paper and board	77	527	15.9 %	450
Production	**13,719**	**43,000**	**9.2 %**	**29,281**
Newsprint	509	2,070	11.4 %	1,561
Printing & Writing	3,270	9,600	8.6 %	6,330
Tissue/Household	679	3,470	13.4 %	2,791
Containerboard	2,627	13,500	13.4 %	10,873
Boxboard	874	5,500	15.2 %	4,626
Other paper and board	5,760	8,860	3.4 %	3,100

Source: Authors' estimates based on data reported by China Economic Consulting Inc. and China Paper Almanac (2003).

One of the key drivers to the strong increase in China's demand for paper and board has been the sustained high level of GDP growth, together with consumer spending and exports. Between 1990 and 2003, China's real GDP grew at 9.7 % per year, while real consumer spending and merchandise exports increased by 8.8 % and 11.2 % per year, respectively (World Bank 2003). Growing demand for graphic paper has been driven by rising personal incomes, increase in advertising expenditures, and rapid growth in commercial printing. Rising demand for paper packaging, likewise, has been supported by strong growth in merchandise exports and changing distribution systems and packaging methods. Other factors, including China's relatively low consumption base, improvement in living standards and the shift in composition of the industry have also contributed to the strong performance in paper and board demand.

On the supply side, China's paper and board sector has expanded significantly to meet strong demand growth in 1990-2003. As Table 1 shows, China's annual paper and board production rose by 29.3 million tonnes during this period, with an average annual growth rate of 9.2 %, or 2.3 million tonnes. Net imports have filled the gap between demand and supply, growing by approximately 320 000 tonnes per year. The significant increase in production reflects China's solid growth in installed capacity, following the substantial capital investments made in the sector during the 1990s and early 2000s (Jaakko Pöyry 2000; URS Forestry 2002). This expansion came in response to strong demand growth, high levels of imports and lack of high-quality paper and paperboard in China. Since 2000, government pump priming to promote economic growth, loosened monetary policy and the development of China's domestic capital market have also contributed to the rise in paper and board capacity.

The following sections describe recent trends in China's demand, supply, and trade for the major grades of paper and board products, as well as forecasts for each grade through 2010. Appendix A provides a list of major paper and paperboard capacity expansions carried out during 2003, and ongoing and planned expansion projects announced for 2004-2006.

NEWSPRINT

Newsprint is mainly used for the publication of newspapers. Demand for this grade is closely correlated to the performance of gross domestic product. High GDP growth means rising personal incomes, which in turn, make newspapers more affordable. Other factors, such as advertising expenditures, literacy rates, pagination of newspapers and the development of electronic media, also affect demand for newsprint.

In the 1980s, China's demand for newsprint was relatively low as the printing media sector was highly controlled by the government. Newsprint consumption started rising in the early 1990s, however, as the government gradually loosened restrictions on the number of newspapers in circulation and on the advertising space available. Demand for newsprint increased from 526 000 tonnes in 1990 to 2.4 million tonnes in 2003, with an average annual growth rate of 12 %.

Other factors, such as rising consumer purchasing power due to strong GDP growth, rapid increase in advertising expenditures, and high literacy rates also contributed to the sharp growth in newsprint consumption.

On the supply side, only nine state-owned newsprint mills generated most of the newsprint consumed in China until very recently. These mills were protected by the government through controls on domestic newsprint prices and restrictions on foreign investment. In the mid-1990s, the government lifted these restrictions, leading to a considerable surge in newsprint imports during 1997-1998. This persuaded most domestic producers that they would either need to modernize their operations, or face the prospect of collapsing in a competitive market. With government support, many state-owned newsprint producers have taken steps to upgrade their machines or to expand capacity in recent years. In 2003 alone, five more newsprint machines (two of them are swing machines producing both light weight coated paper and newsprint), totaling 820 000 tonnes capacity came online (Table A 1).

In terms of market outlook, our baseline projection shows that Chinese newsprint demand will increase by about 7.2 % per year through 2010, translating to annual growth of 220 000 tonnes (Table 2). Newsprint production is forecast to grow by approximately 7.5 % per year, representing an increase of 200 000 tonnes during the same period. As a result, China will continue to import small amounts of newsprint to meet its demand. Even if our lower bound forecast plays out, China will still need to import about 24 000 tonnes of newsprint per year through 2010.

PRINTING AND WRITING PAPER

Printing and writing papers are mainly used for publication of magazines, catalogues and books (textbooks, notebooks and exercise-books). Demand growth for this grade is highly correlated to overall economic activities, especially the performance of advertising, commercial printing and educational printing and writing. China's consumption of printing and writing paper grew by 9.1 %, or 540 000 tonnes per year in 1990-2003, exceeding 10 million tonnes for the first time in 2002. Several factors have contributed to strong demand growth for this grade, including increasing levels of economic activity, a relatively low per capita consumption base, and a relatively high rate of literacy and educational demand.

Printing and writing papers can be further broken down into coated and uncoated papers. As shown in Figure 2, average annual growth in demand for coated paper was about 21 % in 1990-2003, while average annual growth for uncoated paper was 7 % during the same period. This divergence largely stems from how these two grades are utilized in the end-use market. In China, a large portion of uncoated paper is used to produce textbooks, exercise books and notebooks. Prices for these products have been highly regulated by the government, so that these books would be rela-

TABLE 2 *Projected growth in China's demand and supply for paper and paperboard, 2005-2010 ('000 tonnes)*

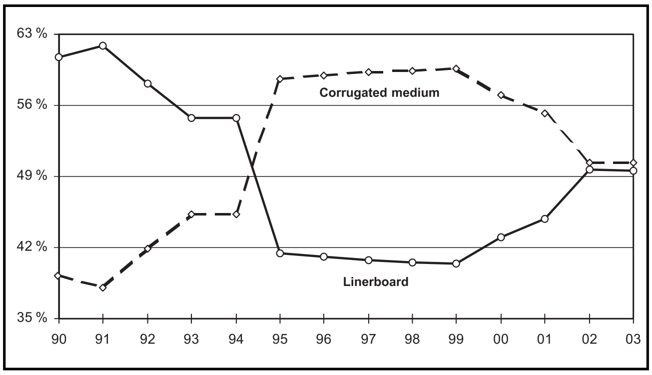
	2003	2005			2010		
		Lower bound	Baseline	Upper bound	Lower bound	Baseline	Upper bound
Demand	**48,056**	**51,094**	**52,922**	**54,185**	**61,593**	**68,528**	**75,129**
Newsprint	2,410	2,598	2,688	2,781	3,447	3,928	4,461
Printing & Writing	10,311	11,941	12,353	12,784	15,062	17,161	19,490
Tissue	3,276	3,717	3,845	3,979	4,957	5,647	6,414
Containerboard	15,974	17,907	18,598	18,802	24,227	25,920	27,311
Boxboard	6,698	7,233	7,474	7,595	9,470	10,825	11,721
Other	9,387	76,990	7,965	8,243	4,430	5,047	5,732
Net imports	**5,056**	**4,640**	**4,807**	**4,911**	**5,429**	**6,058**	**6,731**
Newsprint	340	256	265	274	443	505	674
Printing & Writing	711	1,326	1,372	1,419	1,367	1,557	1,769
Tissue	-194	-97	-100	-103	-30	-34	-38
Containerboard	2,474	1,851	1,922	1,943	1,913	2,047	2,156
Boxboard	1,198	917	948	963	1,341	1,533	1,660
Other	527	387	400	414	395	450	511
Production	**43,000**	**46,454**	**48,115**	**49,274**	**56,164**	**62,470**	**68,398**
Newsprint	2,070	2,342	2,423	2,507	3,004	3,423	3,787
Printing & Writing	9,600	10,615	10,981	11,365	13,695	15,603	17,722
Tissue	3,470	3,813	3,945	4,083	4,987	5,681	6,453
Containerboard	13,500	16,056	16,676	16,859	22,315	23,874	25,154
Boxboard	5,500	6,315	6,526	6,632	8,129	9,292	10,061
Other	8,860	7,312	7,565	7,829	4,035	4,597	5,221

Source: Authors' projections based on models developed by China Economic Consulting, Inc.

tively affordable, especially for people with lower income in rural areas. As a result, profit margins have been relatively low for publishers of textbooks and producers of exercise and notebooks.

In contrast, most coated paper is used for commercial publishing of books, magazines, catalogues, brochures and calendars. The commercial printing market has not been heavily regulated by the government. In addition, the relocation of export-oriented printing operations from Hong Kong to neighboring Guangdong Province in recent years has given a boost to the printing sector. Finally, consumers have become increasingly quality conscious, resulting in publishers substituting high quality coated paper for uncoated grades.

FIGURE 2 *Share of linerboard and corrugated medium as portion of total containerboard demand, 1990-2003 (percentage)*



Source: Authors' projections based on models developed by China Economic Consulting, Inc.

Will this trend continue ? Several factors suggest that it will. First, demand for coated papers will continue to enjoy rapid growth in export-oriented printing operations in China. With China's entry into the World Trade Organization (WTO), commercial printing operations will also benefit from strong growth in merchandise exports and foreign direct investment in telecommunications, banking and investment management. Finally, high quality coated paper will continue to be substituted for uncoated grades due to rising quality demands for consumers. We project that growth for coated grade will average 11 % (470 000 tonnes) per year during 2003-2010, while growth for uncoated grade will average 6 % (510 000 tonnes) per year during the same period.

On the supply side, production of printing and writing paper grew from 3.3 million tonnes in 1990 to 9.6 million tonnes in 2003. This was largely due to a series of major capacity expansions in late-1990s, several of which were made by leading international producers such as Asia Pulp & Paper (APP), Asia Pacific Resources International Ltd (APRIL), and Daewoo Paper. Further expansion of China's production of printing and writing paper is expected, with at least 1.7 million tonnes of new capacity scheduled to come online between 2004 and 2006 (Table A 2).

In spite of the fact that domestic production will not fully meet China's continuing growth in demand for printing and writing paper over the medium term, it is likely that a significant number of small producers will be pushed out of the market during the next several years. In the past, these small mills have survived through a combination of tariff protection, ties to local governments, and production of low-quality, but cheaper products that satisfy their customers' needs. However, the competitiveness of lower-quality products is rapidly disappearing with China's entry into the WTO and growing consumer demand for higher quality paper.

Our baseline forecast shows that China's net imports for this grade will increase from 710 000 tonnes in 2003 to 1.6 million tonnes in 2010, with a 12.4 % average annual growth rate. Even our lower bound projection indicates that net imports for printing and writing paper in China will grow by 10 % per year, or 100 000 tonnes, while our upper bound projection shows that net import growth will average 14 % per year, or 160 000 tonnes.

TISSUE AND HOUSEHOLD PAPERS

China's demand for tissue and other household paper grades grew by an average of 13 % per year during 1990-2003, rising from 647 000 tonnes to 3.3 million tonnes (Table 1). Strong economic growth in concert with rising personal incomes, low per-capita consumption levels and rising health concerns, have contributed to the double-digit growth for this grade in recent years.

China's market for tissue products has been increasing year by year, but large regional disparities are clearly seen due to the different levels of disposable income and cultural practices. For example, China's more affluent coastal regions have the highest demand for household tissue products. Inland cities support the next highest level of demand, followed by rural areas. Some disparities are also seen in demand for different levels of quality for the same product type. More affluent segments of the population consume higher quality products, while other sectors of the population utilize those of middle and lower quality.

Over the last 15 years, China's domestic producers have supplied all of the country's increased demand for tissue and household papers, following significant investments in this grade. In fact, trade data show that tissue is the only grade where China is a net exporter. Before 1997, China's gross exports for tissue were in the range of 25 000 - 55 000 tonnes per year, and they mainly went to Hong Kong. However, China exported approximately 120 000 tonnes of tissue in 2001. Gross exports continued to rise to 160 000 tonnes in 2002 and reached 230 000 tonnes in 2003.

Looking forward, our baseline projection shows that demand growth for tissue and household papers will average 8.0 % per year, or 340 000 tonnes annually through 2010 - or about 5 percentage-points lower than the 13 %-per-year achieved since 1990. This healthy growth will translate into another 2.4 million tonnes of demand by 2010 (Table 2). Production is projected to grow by 7.3 % per year during the same period, translating into an aggregate increase of 2.2 million tonnes of tissue paper. As the gap between demand and supply narrows, net exports of tissue are fo-recast to decline from 195 000 tonnes in 2003 to 34 000 tonnes in 2010.

One of the main risks for this projection is GDP growth in China, especially growth in consumer spending. Higher GDP growth would mean higher disposable income and, therefore, higher demand for tissue paper. Our upper bound projection calls for demand for this grade to grow at 10% per year to reach 6.4 million tonnes in 2010, while the lower bound projection indicates that demand for this grade will grow at around 6 % per year, reaching 5.0 million tonnes by 2010.

CONTAINERBOARD

Containerboard, including linerboard and corrugated medium, is mainly used to make fibre boxes to pack a variety of durable and nondurable goods. Demand for this grade is highly correlated with the performance of economic activities, such as industrial production and consumer spending. China's successful reforms have led to rapid economic growth, especially in the segments of merchandise exports and consumer spending, which in turn, have resulted in strong demand growth for containerboard.

In the decade following 1978, when China started making its transition to a market economy, domestic demand for containerboard more than doubled, rising from less than 1.0 million tonnes to 2.3 million tonnes by 1988. Since then, demand for containerboard has continued to experience very rapid growth, reaching 16.0 million tonnes in 2003. Chinese consumers are now buying processed food, beverages, clothing, footwear and durables that were unavailable during the pre-reform decades, and most of these are packed in fibre-based boxes. In addition, the open economy of the reform era has been driven, in part, by high levels of merchandise exports, such as footwear and toys. The exporting sectors are demanding quality packaging with added strength and better printability required to achieve competitiveness in the foreign markets.

Continued growth in containerboard continues to appear likely over the medium and long term, primarily due to the favorable outlook for China's merchandise exports and consumer spending. Our baseline projection shows that demand growth for containerboard will average 7.2 %, or 1.4 million tonnes per year from 2003 to 2010 (Table 2). This growth rate is about 6 percentage points lower than the 13 %-per-year achieved in the previous decade. The growth in containerboard demand will add about 10.0 million tonnes to the grade's total consumption by 2010, pushing it up to 25.9 million tonnes.

We attribute this significant increase to: 1) healthy growth in industrial production for durable and nondurable goods; 2) rising exports of merchandise goods resulting from China's WTO membership, which in turn, demand more packaging materials; 3) changing distribution systems and packaging methods; and 4) the increasing popularity of large-scale retail outlets in China relative to traditional open markets. Demand growth for containerboard could be even stronger if fibre boxes do not meet significant competition from alternative packaging materials (particularly plastics) in some end uses.

TABLE 3 *Growth in China's demand and supply nonwood pulp, recovered paper and wood pulp 1990-2003 ('000 tonnes)*

	1990	2003	Annual growth	Change in volume
Demand	**12,823**	**40,166**	**9.2 %**	**27,343**
Nonwood pulp	6,799	11,741	4.3 %	4,942
Recovered paper	4,172	19,199	12.5 %	15,027
Paper grade wood pulp	1,851	9,226	13.2 %	7,375
BHKP	235	2,919	21.4 %	2,684
BSKP	510	2,822	14.1 %	2,312
UKP	486	1,589	9.5 %	1,103
MEC	451	1,696	10.7 %	1,224
Other	169	200	1.3 %	32
Net imports	**739**	**15,149**	**26.2 %**	**14,410**
Nonwood pulp	3	41	21.0 %	38
Recovered paper	422	9,381	26.9 %	8,959
Paper grade wood pulp	314	5,726	25.0 %	5,413
BHKP	25	2,309	41.6 %	2,284
BSKP	210	1,962	18.7 %	1,752
UKP	36	659	25.1 %	623
MEC	6	723	43.9 %	716
Other	36	73	5.6 %	37
Production	**12,084**	**25,036**	**5.8 %**	**12,952**
Nonwood pulp	6,796	11,700	4.3 %	4,904
Recovered paper*	3,750	9,818	7.7 %	6,068
Paper grade wood pulp	1,538	3,518	6.6 %	1,980
BHKP	210	610	8.5 %	400
BSKP	300	860	8.4 %	560
UKP	450	930	5.7 %	480
MEC	445	973	6.2 %	528
Other	133	145	0.7 %	12

* Production of recovered paper means collection.

Source: Authors' estimates based on data reported by China Economic Consulting Inc. and Almanac of China Paper Industry (2003).

There are two major subgrades for containerboard: linerboard and corrugated medium. Linerboard includes kraftliner (made of unbleached kraft pulp) and testliner (made of waste paper). Recently, kraft-top testliner, which contains at least 25 % unbleached kraft pulp, has gained in popularity as the strength and burst are similar to kraftliner and the cost normally is lower. Corrugated medium includes semi-chemical mechanical medium and recycled medium. The former is made from semi-chemical mechanical pulp, while the latter is made of recycled paper.

Historically, the share of demand for linerboard was relatively high due to the lower quality of corrugated medium produced in China. For example, the share of demand for linerboard was about 60 % in 1990-1994, while the share for medium was about 40 % during the same period (Figure 2). However, there has been a major shift in the share of these two grades in recent years, primarily due to: 1) improvement in the quality of both domestically produced liner and medium; and 2) an increase in larger and faster corrugators, which require more higher-quality medium sheets.

Going forward, however, the increase in China's domestic capacity which has occurred over the last three years - and which is likely to continue through at least 2005 - can be expected to dampen the prospects for containerboard imports (Table A 2). Our baseline forecast projects domestic containerboard supply to climb from 13.5 million tonnes in 2003 to 23.9 million tonnes in 2010. We project that imports for corrugated medium will decline from 1.3 million tonnes in 2003 to about 620 000 tonnes in 2010, while imports for linerboard will increase only slightly from 1.1 million tonnes in 2003 to 1.5 million tonnes in 2010. Thus, on aggregate China will need to import about 2.1 million tonnes of containerboard annually to meet its demand growth.

TABLE 4 *Projected growth in China's demand and supply for nonwood pulp, recovered paper and wood pulp, 2005-2010 ('000 tonnes)*

	2003	2005			2010		
		Lower bound	Baseline	Upper bound	Lower bound	Baseline	Upper bound
Demand	**40,166**	**43,480**	**44,853**	**46,245**	**53,085**	**59,632**	**65,235**
Nonwood pulp	11,741	11,056	11,441	11,591	8,250	9,881	10,246
Recovered paper	19,199	22,244	22,869	23,715	31,437	34,646	38,304
Paper grade wood pulp	9,226	10,180	10,543	10,939	13,398	15,105	16,685
BHKP	2,919	3,333	3,523	3,662	5,136	6,134	6,973
BSKP	2,822	3,172	3,231	3,352	3,952	4,301	4,627
UKP	1,589	1,754	1,799	1,849	2,069	2,229	2,404
MEC	1,696	1,796	1,836	1,896	2,191	2,331	2,541
Other	200	125	155	180	50	110	140
Net imports	**15,149**	**17,431**	**17,897**	**18,603**	**22,737**	**25,193**	**27,944**
Nonwood pulp	41	56	61	71	20	36	51
Recovered paper	9,381	11,079	11,387	11,912	15,306	16,869	18,740
Paper grade wood pulp	5,726	6,296	6,449	6,620	7,411	8,288	9,153
BHKP	2,309	2,448	2,513	2,527	2,491	2,949	3,363
BSKP	1,962	2,247	2,286	2,387	2,832	3,111	3,347
UKP	659	749	774	804	901	991	1,096
MEC	723	818	818	848	1,178	1,178	1,283
Other	73	34	59	54	9	59	64
Production	**25,036**	**26,054**	**26,970**	**27,646**	**30,352**	**34,453**	**37,295**
Nonwood pulp	11,700	11,000	11,380	11,520	8,230	9,845	10,195
Recovered paper	9,818	11,166	11,482	11,803	16,131	17,777	19,564
Paper grade wood pulp	3,518	3,888	4,108	4,323	5,991	6,831	7,536
BHKP	610	885	1,010	1,135	2,645	3,185	3,610
BSKP	860	925	945	965	1,120	1,190	1,280
UKP	930	1,005	1,025	1,045	1,168	1,238	1,308
MEC	973	978	1,018	1,048	1,013	1,153	1,258
Other	145	95	110	130	45	65	80

Source: Authors' projections based on models developed by China Economic Consulting, Inc.

Over the last two decades, China has imported significant volumes of linerboard and corrugated medium to meet the country's growing demand for packaging materials. For example, China's total imports of linerboard and medium were about 630 000 tonnes in 1990, of which linerboard imports accounted for 550 000 tonnes and corrugated medium imports about 80 000 tonnes. Imports of both linerboard and medium have risen significantly since then. In 2003, imports of linerboard reached 1.1 million tonnes, while imports of corrugated medium were about 1.3 million tonnes.

BOXBOARD

Boxboard is mainly used to make carton boxes, which are widely utilized for packaging of lighter weight products, such as footwear, food, wine, cigarettes, and a wide range of consumer luxury goods. Similar to containerboard, demand for this grade is also closely correlated to industrial production and consumer spending. Since 1978, China's policy of economic liberalization has led to strong growth in merchandise exports, which has partially contributed to impressive performance of industrial production. In addition, the successful economic reforms have unleashed strong consumer demand. Consumers in China are now buying beverages, clothing, footwear and cosmetics, which were unavailable during pre-reform years. Most of these are wrapped and packaged, which in turn, has boosted demand for carton boxes and, therefore, boxboard.

Demand for boxboard was less than 500 000 tonnes in 1978, when China started implementing its economic reforms and open door policy. By 1988, demand for this grade had more than doubled to 1.0 million tonnes. Since then, demand for boxboard has continued to show rapid growth, reaching 6.2 million tonnes in 2003, with an average annual growth rate of 14 %.

Historically, imports supplied a large portion of the boxboard consumed by China. Customs statistics show that on average imports accounted for 41 % of total demand during 1990-2000. However, this share fell to 22 % in 2001-2003, primarily due to the rapid increase in domestic production in recent years. Domestic boxboard production grew from approximately 1.0 million tonnes in 1991 to 5.5 million tonnes in 2003. The two largest machines for this grade are located at the Ningbo Zhonghua Paper mill, owned by APP. These two machines came online in 1996-1997, with a combined total capacity at 600 000 tonnes.

We expect that future demand growth in this grade will remain strong through 2010, primarily due to projections of significant growth in merchandise exports, rising personal incomes and increasing production for processed food. Our baseline projection shows that boxboard demand will increase from 6.7 million tonnes in 2003 to 10.8 million tonnes in 2010, with an average annual growth rate of 7.1 % (Table 2). We anticipate that aggregate boxboard supply will increase by 70 % during the same period to reach 9.3 million tonnes in 2010. Much of this increase can be attributed to the fact that eight machines, with a total capacity of 2.4 million tonnes per year, are scheduled to come online during 2003-2004 (see Tables A 1 and A 2). Although most of China's demand for boxboard will be met by domestic production, net imports for boxboard are also projected to grow by 28 % to reach 1.5 million tonnes per year in 2010.

CHINA'S PROJECTED GROWTH IN GLOBAL CONTEXT

On aggregate, our baseline forecast estimates that China's paper and paperboard demand will grow by an average of 2.9 million tonnes annually through the remainder of this decade to reach 68.5 million tonnes in 2010 (Table 2). Significantly, it is expected that China will account for over 30 % of the world's overall growth in consumption of paper and board products during this period (Asprem *et al.* 2004). Across all grades, China's demand will increase most significantly for containerboard and for printing and writing paper - the latter of which relies, more than any other grade, on the use of virgin wood fibre.

In spite of this very substantial increase, China rapidly growing demand is not likely to place significant strains on global supplies of most grades of paper and paperboard products. Rather, over the medium term, China is expected to supply the vast majority of the paper and paperboard it consumes through domestic production (see Figure 2). Our baseline forecast estimates that domestic production will grow by 2.8 million tonnes per year to reach a total of 62.4 million tonnes in 2010 - at which point domestic producers are projected to supply roughly 90 % of China's aggregate demand. Again, the largest increases in new capacity will be in containerboard and printing and writing paper, which will expand by 10.3 million tonnes and 6.0 million tonnes, respectively.

China's continued dominance of global growth in these grades is demonstrated by the fact that China accounts for 55 % of world capacity expansions for containerboard and 65 % of expansions for uncoated printing and writing paper that have been confirmed for 2004-2007 (Roberts 2004). In addition, China accounts for 100 % of confirmed global capacity expansions for newsprint; 83 % for boxboard; 52 % for uncoated printing and writing paper; and 10% for tissue and household paper during 2004-2007 (Roberts 2004).

It should be noted that a number of potential risks to our baseline projection can be found on both the upside and downside. As China's economy is still in the early stages of development, it has the potential to continue to grow at a very fast rate as the country seeks to catch up with the world's highly industrialized economies. As a result, our upper bound forecast assumes that China's GDP will grow at 9.5 % per year in the next seven years, similar to the growth rates experienced over the last 14 years. However, consumer spending and merchandise exports are likely to contribute more to GDP growth. If this scenario plays out, growth in paper and board demand will average 6.6 % per year, or 3.9 million tonnes annually. Net imports will also grow faster (at 4.2 %, or 240 000 tonnes annually) as domestic producers will be unlikely to keep up with the pace of demand growth.

Our lower bound forecast assumes that China's GDP will grow at 5.5 % per year, or much more slowly than most analysts currently predict. This could occur, for instance, if the Chinese government fails in its current efforts to reform the country's banking system or is unable to manage a soft landing to the economic overheating that is now occurring. In the event such a scenario were to play out, we estimate that growth in paper and board demand will average 3.6 % per year, or 1.9 million tonnes annually. Net imports will grow at only 1.0 %, or 53 000 tonnes annually. Given the current uncertainties in the Chinese economy, we feel that it is critical for policymakers and planners to take both the downside and upside risks into account when making decisions based on projections for the pulp and paper sector.

FIBRE DEMAND - RECENT TRENDS AND PROJECTIONS TO 2010

What will China's rapidly growing demand for paper and paperboard mean in terms of fibre consumption? Available data suggest that China's aggregate consumption of fibre furnish across major grades, namely nonwood pulp, recovered paper, and wood-based pulp, increased from 12.8 million tonnes in 1990 to 40.2 million tonnes in 2003 (Table 3). Using a derived demand model based on forecasted production levels for the various grades of paper and paperboard, we project that China's annual demand for recovered paper and pulp fibre will reach 59.6 million tonnes by 2010 under our baseline scenario (Table 4). Fibre demand could be as high as 65.2 million tonnes depending on the sector's overall growth.

In contrast to the relatively neutral effect that China is expected to have on world paper and paperboard markets, this sharp growth in fibre demand will undoubtedly mean that China plays an increasingly significant role in the regional and global fibre trade. Indeed, Chinese companies - often with government support - have already taken steps to secure large volumes of recovered paper, wood pulp, and wood chips in world markets in order to supply domestic paper production (Wright 2004). In this regard, China is moving aggressively to achieve self-sufficiency in most grades of paper and paperboard, in addition to promoting wood pulp production, while relying heavily on imports to meet these industries' raw materials needs. The following sections describe China's projected supply and demand for the various grades of fibre furnish through 2010.

NONWOOD PULP

In 1990, nonwood pulp - principally made from bamboo, bagasse, reeds, wheat straw and other agricultural residues - accounted for over one-half of the 12.8 million tonnes of fibre consumed by domestic paper producers. Since then, however, the government has taken steps to close several thousand small-scale nonwood pulp mills because they have been a major source of water pollution, which poses problems for agricultural intensification (Roberts 2004)[4]. At the same time, the government is now seeking to promote the development of domestic wood pulp production to meet the needs of China's increasingly modern paper and board industries.

Data that are available on China's nonwood pulp industry can be described as sketchy at best. However, best estimates suggest that in spite of the government's recent effort to close mills, consumption of nonwood fibres grew by nearly 5 million tonnes on aggregate during 1990-2003. This expansion has, nevertheless, lagged well behind the sector's overall growth, and nonwood fibres accounted for less than one-third of the fibre furnish utilized by Chinese paper producers in 2003.

According to our baseline projections, China's demand for nonwood fibres will experience a moderate decrease in aggregate terms and a sharp decline in proportional terms over the next several years. Consumption of nonwood pulp will likely drop from 11.7 million tonnes in 2003 to approximately 9.9 million tonnes in 2010. By 2010, nonwood fibres are projected to account for less than 17 % of the industry's total fibre furnish. To a significant degree, the accuracy of these projections will depend on how actively and effectively the government continues to pursue its current policy of closing small-scale nonwood pulp mills, and on whether future technological innovations provide cost-effective ways of reducing the amount of pollution created by such mills.[5]

RECOVERED PAPER

Of the overall growth in China's fibre demand during the last 15 years, approximately 55 % has been supplied by recovered paper. In 1990, China's paper and board producers consumed 4.2 million tonnes of recovered paper, which then accounted for nearly one-third of the industry's total fibre demand. By 2003, the industry utilized some 19.2 million tonnes of recovered paper to account for 47 % of China's total fibre consumption. Roughly one-half of this came from imports, while the remainder was sourced domestically.

Over the medium term, our baseline forecast indicates that China's demand for recovered paper will grow from 19.2 million tonnes in 2003 to 34.6 million tonnes in 2010, at which point recovered paper will supply 58 % of the industry's total fibre furnish. During this period, recovered paper will account for no less than three-quarters of the new growth in China's overall fibre demand. Indeed, with the exception of printing and writing paper, most of the new paper and paperboard capacity that will come online in China over the next several years will rely heavily on recovered paper. The rationale for this is two-fold: on the one hand, recycled paper is cheaper than virgin wood fibre; and on the other hand, the investment

[4] Reliable data on how many nonwood pulp mills have been closed do not exist in the public domain. One widely-cited source estimates that over 4,000 small-scale nonwood pulp mills were closed during 1996-97; however, this figure has never been independently confirmed (Jaakko Pöyry 2000). Anecdotal reports have also indicated that at least a portion of the mills that have been ‚closed' have subsequently continued to operate informally.

[5] Some analysts anticipate that China will soon adopt new technologies which allow nonwood pulp to be processed efficiently and in environmentally sound way to produce high quality fibre. Ilkka Kuusisto of Jaakko Pöyry Consulting, for instance, projects that in spite of recent declines, the widespread use of such technologies will mean that China's nonwood pulp production increases over the medium-term, reaching 14 million tonnes in 2015 (Kuusisto 2004).

costs associated a paper or paperboard mill that utilizes recovered paper are considerably lower than those that involve pulp production (Roberts 2004).

Through at least 2010, we anticipate that China will continue to source approximately one-half of its recovered paper needs from external sources. The projected growth of China's recovered paper imports from 9.3 million tonnes in 2003 to 16.8 million tonnes will undoubtedly have a profound impact on the global market. In 2003, world exports of recycled paper - mainly from the United States, and to a lesser extent, Western Europe and Japan - totaled 16.5 million tonnes, and China imported 57 % of this (Roberts 2004). Many analysts believe that recovery rates in the US, Western Europe, and Japan are already near their peak, and any increases in paper recovery will largely be absorbed by internal demand within those markets (Roberts 2004, Kuusisto 2004). China's own domestic collection of recycled paper can be expected to increase by approximately 8 million tonnes through 2010; however, this will account for roughly 50 % of the projected growth in demand for this grade.

This suggests that China's substantial and rapidly expanding demand for recovered paper will almost certainly cause the world market to tighten, leading to sharp price increases for recycled paper and supply difficulties in many regions. Depending on how far prices rise, this could undermine the competitiveness of paper producers utilizing recovered paper compared to those using wood-based pulp (Roberts 2004).

WOOD-BASED PULP

With China producing an increasing volume of higher grade paper and board products, demand for wood-based pulp has been the fastest-growing segment of the industry's overall fibre furnish, averaging 13 % per annum since 1990. Consumption of wood pulp, however, still lags well behind recovered paper in terms of volume. In 1990, China's paper and board producers consumed only 1.8 million tonnes of mechanical and chemical wood pulp, which then accounted for less than 15 % of the industry's fibre furnish. By 2003, demand for wood pulp had reached 9.2 million tonnes to account for over 22 % of total fibre consumption. Bleached hardwood kraft pulp (BHKP) and bleached softwood kraft pulp (BSKP) each account for approximately 30 % of the various grades of wood pulp currently consumed by Chinese paper producers.

We project that China's demand for various grades of wood pulp will continue to increase at a rapid pace through 2010 – although in aggregate terms, the volumes of wood pulp consumed will continue to be far exceeded by recovered paper. According to our baseline forecast, China's annual demand for wood pulp will grow by nearly 65 % through the end of the decade, rising from 9.2 million tonnes in 2003 to 15.1 million tonnes in 2010. At that point, various grades of wood-based pulp will account for approximately one-quarter of the total fibre furnish utilized by China's paper and board producers.

BHKP will likely be the fastest-growing segment of wood pulp demand, effectively doubling from 2003 levels to reach 6.1 million tonnes in 2010. To a significant degree, this stems from the rapid growth of printing and writing paper production in China, which utilizes a relatively high proportion of virgin wood fibre compared to other grades. We anticipate that by 2010, pulp producers located in China will supply just over 50 % of the country's demand for BHKP, while the remainder will need to be imported. Demand for BSKP is projected to increase from 2.8 million tonnes in 2003 to 4.3 million tonnes in 2010. At that point, over 70 % of China's demand for BSKP is likely to be supplied by imports.

These projections suggest that China will continue to play a dominant role in world pulp markets over at least the medium term, and probably well beyond. According to data published by Hawkins Wright, China accounted for 55 % of the global increase in demand for market pulp during 1997-2003 (Wright 2004). Through 2008, Hawkins Wright projects that world demand for market pulp will grow from 44.8 million to 51.0 million tonnes per year and that China will account for just under 50 % of this demand. At the same time, global pulp capacity is expected to expand at an even faster pace, growing from 47.9 million tonnes in 2003 to 56.4 million tonnes in 2008. This imbalance is likely to put substantial downward pressure on world pulp prices, which in turn may sharply undermine the competitiveness of domestic pulp production within China, where pulp production costs are already high compared to countries such as Indonesia and Brazil.

IMPLICATIONS FOR SUSTAINABILITY AND LIVELIHOODS

The rapid growth of China's pulp and paper sector has far-reaching implications for forest sustainability and rural livelihoods. Given the enormous scale of China's projected demand, it is inevitable that the impacts of this growth, both positive and negative, will be felt not only within China but throughout the Asia-Pacific region, and perhaps beyond. For policymakers, civil society groups, and donor agencies that are concerned with such impacts, it will be important to take the following issues into account.

First, our projections estimate that by 2010, China's domestic supply of wood pulp will increase by 3-4 million tonnes over current levels, and domestic supply of paper and paperboard will increase by roughly 20-25 million tonnes. This implies that approximately 5-8 new pulp production lines, each with an annual capacity of 500 000 - 600 000 tonnes, and perhaps as many as 40-50 new paper and paperboard production lines will need to begin operating by the end of the decade. Some of this growth can undoubtedly be achieved by expanding the capacity of existing processing facilities; however, much of the new capacity will require the construction of greenfield mills. Such projects require access to large volumes of water, substantial amounts of power, extensive infrastructure - and for integrated pulp production - a sizeable land base. Does China have a sufficient number of sites available for expansion of the pulp and paper industry on the scale that is projected ? If these mills are not built in China, where else might the new capacity be brought online ?

Second, the projected increase in China's demand for wood-based pulp from approximately 9 million tonnes in 2003 to 15 million tonnes by 2010 will mean substantial growth in the country's annual consumption of wood fibre. If it is assumed that on average, across all grades, 4.3 m^3 of roundwood (overbark) are needed to produce 1.0 air-dried tonne of pulp, then the volume of wood consumed annually by China in the form of wood pulp - whether produced domestically or externally - will rise from just under 40 million m^3/yr in 2003 to 65 million m^3/yr in 2010. The fact that roughly one-half of the wood pulp consumed by China over the medium term is expected to be produced domestically suggests that this will place considerable new pressures on the country's internal wood supply. The extent of such pressures will largely depend on how much new pulp capacity actually comes online domestically and whether the country's ambitious plantation development plans are successful. However, as Cossalter (2004) has noted, the development of fast-growing plantations in southern China continues to face numerous challenges - including land scarcity and limited genetic diversity - which may sharply constrain their productivity and yields for quite some time.

Third, it seems inevitable that China will obtain a substantial portion of its wood pulp and wood fibre from external sources, particularly from forested countries in the Asia-Pacific region. Most analysts expect that China will source the bulk of its softwood fibre imports from the Russian Far East and New Zealand, while much of its hardwood fibre will come from Brazil and Indonesia (Wright 2004, URS Forestry 2002). Given the weak forest governance that exists in some of these countries, it is likely that China's growing demand will exacerbate current pressures on natural forests and provide added incentives for illegal logging. Already, China imports close to 1.0 million tonnes of BHKP from Indonesia annually, with much of this being made from ‚mixed tropical hardwoods' harvested from natural forests (Barr 2001). Moreover, there are growing signs that some China-based pulp producers are seeking to obtain wood fibre from countries in the Mekong region, where forest law enforcement is also notoriously weak (Lang 2002). Recent reports of Chinese producers making investments in Laos and Cambodia, for instance, certainly raise questions about whether increased volumes of illegally harvested wood fibre will soon be flowing from those countries (Greenpeace 2004).

Fourth, China's growing demand for pulpwood fibre is likely to pose both threats and new opportunities for rural communities throughout the region. On the one hand, the conversion of natural forests for pulpwood plantations has often involved the displacement of local peoples. In Indonesia, for instance, the government has allocated several million hectares of forestland to plantation companies since the late-1980s with little regard for the tenure rights or livelihoods of communities living in those areas (Harwell 2003; Barr 2001). On the other hand, the large volume of fibre that China is expected to consume will undoubtedly create opportunities for income generation that did not previously exist. It is possible that smallholder farmers and community groups would be able to earn substantial amounts of cash income by growing pulpwood fibre, either for the open market or through out-grower schemes linked to particular pulp mills (Wenming *et al.* 2002). Past experience with such schemes, however, suggests that they often carry high levels of risk for participants (Nawir 2003, Mayer and Vermeulen 2002). To work on any significant scale, the households and communities involved would need to have secure land tenure, as well as improved access to credit and markets.

Finally, China's efforts to downsize the country's nonwood pulp industry and to promote the expansion of wood-based kraft pulp production is likely to have unintended negative consequences for employment in some parts of the country. Historically, nonwood pulp has been produced by thousands of small- and medium-scale mills that utilize agricultural residues and other types of nonwood fibres. These mills are widely distributed across China, and they employ large numbers of people, in addition to providing an important source of income for farmers who supply them with agricultural residues. Our projections that annual production of nonwood pulp will decline by 1.5-3.5 million tonnes by 2010 suggests that as many as 700 mills with a capacity of 5 000 tonnes/yr - or an even larger number of smaller mills - could be closed (in addition to the large number that have already reportedly been closed in recent years). While the government's campaign to close small-scale nonwood pulp mills is largely aimed at reducing pollution of watersheds, these efforts could put several tens of thousands of people out of work and remove a significant source of income for large numbers of farmers. In aggregate terms, these job losses may be offset by the large investments now being made in kraft pulp production facilities that utilize wood fibre. However, it is important to recognize that large- and mega-scale kraft pulp mills are highly-capital intensive, and those planned for China will be heavily concentrated in the country's relatively affluent coastal regions.

ACKNOWLEDGEMENTS

This study was funded by the United Kingdom's Department for International Development (DfID) and the European Commission's Asia Pro Eco Programme. The authors gratefully acknowledge the support of each of these institutions. In addition, the authors wish to thank the following individuals for comments on earlier drafts of this paper: Andy White, Gary Bull, Sten Nilsson, Kent Wheiler, Eugenia Katsigris, David Kaimowitz, and three anonymous reviewers.

APPENDIX A: CHINA'S MAJOR PAPER AND PAPERBOARD CAPACITY EXPANSION PROJECTS

TABLE A 1 *Major paper and paperboard capacity expansions in China, 2003 ('000 tonnes)*

Company	Ownership	Location	Capacity	Grade	Startup
Guitang Group	Private	Guitang, Guangxi	15	Tissue	Q1:2003
Jilin Paper	SOE	Jilin	90	Newsprint	Q1:2003
Wangda Group	Private	Changshu, Jiangsu	180	Containerboard	Q1:2003
Wan Li Da	Private	Zengcheng, Guangdong	150	Recycled Medium	Q1:2003
Yinhe Paper	Private	Shandong	100	Recycled Medium	Q1:2003
Jindaxing Paper	Private	Guangxi	70	Newsprint	Q2:2003
Jinzhou Paper	Private	Dongguan, Guangdong	250	Recycled Medium	Q2:2003
Wangda Group	Private	Xinhui, Guangdong	170	Containerboard	Q2:2003
Bohui Paper	Private	Huatai, Shandong	300	Boxboard	Q3:2003
Guitang Group	Private	Guitang, Guangxi	15	Tissue	Q3:2003
Huatai Paper	Private	Dongying, Shandong	280	LWC/newsprint	Q3:2003
Ji Teng	SOE	Hebei	100	Containerboard	Q3:2003
Long Chen Longda	JV	Wuxi, Jiangsu	200	Containerboard	Q3:2003
Taishan Paper	Private	Laiwu, Shandong	140	LWC	Q3:2003
Dongguan Nine Dragons	WFOE	Dongguan, Guangdong	450	Boxboard	Q4:2003
Guangxi Lipu Paper	Private	Guangxi	50	Linerboard	Q4:2003
Lee & Man	WFOE	Changshu, Jiangsu	250	Linerboard	Q4:2003
Mindu	Private	Fujian	100	Boxboard	Q4:2003
Nine Dragons Paper	WFOE	Yaicang, Jiangsu	450	Kraft-top liner	Q4:2003
Sun Group	Private	Yanzhou, Shandong	200	Boxboard	Q4:2003
Yalujiang Paper	SOE	Dandong, Liaoning	180	Newsprint	Q4:2003
Yueyang Paper	SOE	Yueyang, Hunan	180	LWC/newsprint	Q4:2003

Note: Private = Chinese privately-owned company; SOE = state-owned enterprise; JV = joint venture; WFOE = wholly foreign-owned enterprise.
Source: Almanac of China Paper Industry (1999, 2002 and 2003) and China Economic Consulting, Inc.

TABLE A 2 *Major paper and paperboard capacity expansions in China, 2004-2006 ('000 tonnes)*

Company	Ownership	Location	Capacity	Grade	Startup
Jianhui Paper	Private	Donguan, Guangdong	300	Boxboard	Q2:2004
Chaohu Jinhe Paper	Private	Chaohu, Anhui	150	Boxboard	Q3:2004
Lee & Man	WFOE	Changshu, Jiangsu	250	Recycled medium	Q3:2004
Cheng Loong	WFOE	Pudong, Shanghai	300	Containerboard	Q4:2004
Foshan Huaxin Packages	JV	Foshan, Guangdong	150	Boxboard	Q4:2004
Jiangxi Chenming Paper	Private	Jiangxi	400	LWC/newsprint	Q4:2004
Ningbo Zhonghua Paper	JV	Ningbo, Zhejiang	700	Boxboard	Q4:2004
Sun Paper	Private	Yanzhou, Shandong	160	Uncoated woodfree	Q4:2004
RGM International	WFOE	Xinhui, Guangdong	450	Uncoated woodfree	Q4:2004
Gold East Paper (APP)	WFOE	Dagang, Jiangsu	700	Coated woodfree	Q1:2005
Chenming Paper	Private	Shouguang, Shandong	400	Boxboard	Q1:2005
Lee & Man	WFOE	Changshu, Jiangsu	350	Linerboard	Q1:2005
Beiya Industrial	JV	Leshan, Sichuan	50	Uncoated woodfree	Q2:2005
Nippon Paper Industries	JV	Chengde, Hubei	75	Newsprint	Q3:2005
PanAsia Paper	WFOE	Zhaoxian, Hebei	330	Newsprint	Q3:2005
UPM-Kymmene	WFOE	Changshu, Jiangsu	450	Uncoated woodfree	Q3:2005
Ningxia Meili	Private	Zhongwei, Ningxia	300	Boxboard	Q1:2006
Oji Paper	WFOE	Natong, Jiangsu	600	Coated woodfree	Q4:2006

Note: Private = Chinese privately-owned company; SOE = state-owned enterprise; JV = joint venture; WFOE = wholly foreign-owned enterprise.
Source: Almanac of China Paper Industry (1999, 2002 and 2003) and China Economic Consulting, Inc.

REFERENCES

ALMANAC OF CHINA PAPER INDUSTRY, 1999, 2002 and 2003. Published by China Light Industry.

ASPREM, M., LOPES, R., SHAW, J. 2004. The paper and packaging sector. Unpublished presentation prepared by the Global Securities Research and Economics Group at Merrill Lynch, Pierce, Fenner, and Smith Incorporated, dated April 21.

BARR, C. 2001. Profits on paper: the political-economy of fibre and finance in Indonesia's pulp and paper industries. In Barr, C. Banking on sustainability: structural adjustment and forestry reform in post-Suharto Indonesia. Center for International Forestry Research (CIFOR) and WWF Macroeconomic Program Office, Washington, D. C.

COSSALTER, C. 2004. Does China have a comparative advantage for growing pulpwood ? Presentation prepared for the International forum on investment and finance in China's forestry sector, Beijing, September 22-23.

GREENPEACE. 2004. Investigate report on APP's forest destruction in Yunnan. Hong Kong, 34 pp., dated November.

HARWELL, E. 2003. Without remedy: human rights abuses and Indonesia's pulp and paper industry. Human Rights Watch, Washington, D. C.

JAAKKO PÖYRY 2000. China forest industries: opportunities and challenges - pulp and paper. 1st edition, Jaakko Pöyry Consulting, Helsinki, 186 pp.

KUUSISTO, I. 2004. Trends and developments in the Chinese pulp and paper industry. Presentation prepared for the International forum on investment and finance in China's forestry sector, Beijing, September 22-23.

LANG, C. 2002. The pulp invasion: the international pulp and paper industry in the Mekong region. World Rainforest Movement (http://www.wrm.org.uy/countries/Asia/mekong.html).

MAYER, J. and VERMEULEN, S. 2002. Company-community forestry partnerships: from raw deals to mutual gains ? International Institute for Environment and Development, London, 176 pp.

NAWIR, A., SANTOSO, L., and MUDHOFAR, I. 2003. Towards mutually-beneficial company-community partnerships in timber plantations: lessons learned from Indonesia. CIFOR working paper no. 26. Center for International Forestry Research, Bogor, Indonesia, 77 pp.

ROBERTS, D. 2004. China and the global paper and forest products industry: a focus on fibre. Presentation prepared for the Mega-trends workshop, Center for International Forestry Research (CIFOR), Bogor, Indonesia, November 29-30.

SHI. K., LI. Z., LIN. F., ZHENG. RUI. 1997. Asia- Pacific forestry sector outlook study: China's country report on forestry. FAO, Rome.

SPENCER. C. 2004. A European investor's view of the Asian paper & steel industry. Unpublished presentation prepared by Morgan Stanley, London, dated June 8.

URS FORESTRY. 2002. The Chinese pulp and paper industry: present position - future prospects. 1st edition, URS Australia Pty Ltd., Hobart, Australia, 212 pp.

WORLD BANK. 2003. China: promoting growth with equity. World Bank country economic memorandum. Report No. 24169-CHA.

WENMING, L., LANDELL-MILLS, N., JINLONG, L., XU, J., and CAN, L. 2002. Getting the private sector to Work for the public good: Instruments for sustainable private sector forestry in China. International Institute for Environment and Development, London, 168 pp.

WRIGHT, R. 2004. Defining the China market for pulp, paper, and board. Presentation prepared for the International forum on investment and finance in China's forestry sector, Beijing, September 22-23.

ZHANG, D., BUONGIORNO, J. and ZHU, S. 1997a. Trends and outlook for forest products consumption, production and trade in the Asia-Pacific region. Working paper no. APFSOS/WP/12, Forestry Policy and Planning Division, United Nations Food and Agricultural Organization. Rome

ZHANG, D., BUONGIORNO, J. and RYTKÖNEN, A. 1997b. FAO provisional outlook for global forest products consumption, production and trade to 2010. United Nations Food and Agricultural Organization. Rome.

China's development of a plantation-based wood pulp industry: government policies, financial incentives, and investment trends[1]

C. BARR● and C. COSSALTER■

● *Senior Policy Scientist, Forests and Governance Programme, CIFOR, Jalan CIFOR, Situ Gede, Sindangbarang, Bogor Barat 16680, Indonesia*

■ *Senior Plantation Scientist, Forests and Environmental Services Programme, Jalan CIFOR, Situ Gede, Sindangbarang, Bogor Barat 16680, Indonesia*

Email: c.barr@cgiar.org and c.cossalter@cgiar.org

SUMMARY

The Chinese government is aggressively promoting development of a domestic wood pulp industry, integrated with a plantation-based fiber supply and downstream paper production. It is doing so by providing discounted loans from state banks, fiscal incentives, and capital subsidies for establishment of at least 5.8 million hectares of fast-growing pulpwood plantations. This article examines the development of bleached hardwood kraft pulp (BHKP) mills in South China, including the Asia Pulp & Paper (APP) Jinhai mill in Hainan Province and the proposed Fuxing pulp mill project in Guangdong Province. Both mills face fiber shortfalls over the medium term, and significant new investments in plantation development will be needed to provide a sustainable fiber supply at the mills? projected capacity levels. However, there are few sites in southern coastal China where fiber can be grown at internationally competitive costs. In most instances, the cost of Chinese plantation pulpwood will be considerably higher than in countries like Indonesia and Brazil, raising important questions about the economic competitiveness of Chinese pulp producers even within their home market.

Keywords: China; wood pulp, plantations, Asia Pulp & Paper, Fuxing

INTRODUCTION

During the last 15 years, China has emerged as a leading player in the global pulp and paper sector. China has accounted for more than 50% of the world's overall growth in paper and paperboard production since 1990, when the country produced an aggregate of 13.7 million tonnes across all grades. With 43.0 million tonnes of paper and board production in 2003, China is now the world's second largest producer, surpassed only by the United States. The country's aggregate paper and board production is expected to reach 68.5 million tonnes per year by 2010, as domestic producers modernize their operations and as international producers seek to capture a share of China's growing market (He and Barr, in this issue).

Historically, China's domestic pulp industry has been structured around large numbers of small-scale mills relying heavily on nonwood fibers, including bamboo, bagasse, wheat straw and other agricultural residues. Much of the new paper and board capacity now coming online, however, relies on recovered paper obtained from both domestic sources and imports (Spencer 2004). Demand for wood-based pulp has also grown substantially in recent years, particularly as China's production of printing and writing paper and other high-grade papers has expanded. A recent forecast projects that by 2010, China's paper and board industry will consume some 60 million tonnes of fiber annually across all types and grades - that is, recovered paper, nonwood pulp, and wood-based pulp (He and Barr, in this issue). Demand for various grades of wood-based pulp is expected to reach 15.1 million tonnes per year by 2010 – up from 9.2 million tonnes in 2003 – at which point wood pulp will account for approximately 25 % of total fiber consumed by Chinese producers. Bleached hardwood kraft pulp (BHKP) and bleached softwood kraft pulp (BSKP) are expected to account for roughly two-thirds of this demand, while unbleached kraft pulp (UKP) and mechanical and semi-mechanical wood pulp account for the remainder.[2]

To meet this growing demand, the Chinese govern-

[1] The research on which this article is based was funded by the United Kingdom's Department for International Development (DfID) and the European Commission's Asia Pro Eco Programme. The authors gratefully acknowledge the support of each these institutions. The authors also wish to thank Dr. Lu Wenming and Dr. Zhang Huaiquing at the Chinese Academy of Forestry for theit collaboration in this study, and to acknowledge the valuable assistance provided by the Hainan Provincial Forestry Bureau; the Guangxi Provincial Forestry Bureau; the Guangdong Provincial Forestry Bureau; and the Forestry Bureau of Zhanjiang Prefecture. In addition, the authors are grateful to two anonymous reviewers for providing many helpful comments on an earlier draft of this study. The authors are, of course, for any errors of fact or analysis.

[2] Specific projections of demand for the various grades of wood pulp in 2010 are as follows: BHKP – 6.1 million tonnes; BSKP – 4.3 million tonnes; UKP – 2.2 million tonnes; and mechanical/semi-mechanical wood pulp – 2.3 million tonnes (see He and Barr, in this issue).

ment has aggressively promoted the development of a domestic wood pulp industry. It has done so by setting ambitious capacity expansion targets for projects that integrate wood pulp and high-grade paper production and by allocating several million hectares for the establishment of fast-growing pulpwood plantations. To support these projects, the government has streamlined the sector's investment approval process and provided a variety of financial incentives and capital subsidies. These include several billion dollars worth of loan interest subsidies, discounted credit, and extended repayment periods for loans from state-owned banks.

In spite of the government's substantial support, the development of a competitive wood pulp industry in China faces a number of fundamental challenges. First, the cost of growing wood fiber in China is considerably higher than it is in countries like Indonesia and Brasil. As such, many analysts question whether Chinese wood pulp producers will be competitive even within their home market, particularly when they can often import market pulp at a lower cost than producing it themselves (cf Wright 2004; Kuusisto 2004). Second, there are signs that government subsidies are encouraging pulp producers in some parts of China to develop large-scale mills before fully securing a sustainable wood supply. The areas planted and the productivity levels achieved thus far are likely to fall well short of what will be needed to meet the projected demand for wood fiber, at least over the medium term and perhaps beyond (Cossalter 2004a; 2004b). Third, many of the risks and social impacts associated with fast-growing plantation development in China have not been fully evaluated.

In this article, we examine the policies and financial incentives that are now being used by the Chinese government to promote the development of a domestic wood pulp industry and integrated plantation resource base. We then assess the development of bleached hardwood kraft pulp (BHKP) mills in South China, where the largest investments in new pulp capacity and fast-growing plantations are now being made. The wood supply strategies of the Asia Pulp & Paper (APP) Hainan Jinhai mill project in Hainan Province and the proposed Fuxing pulp mill project in Guangdong Province are discussed in detail.

GOVERNMENT PROMOTION OF DOMESTIC WOOD PULP PRODUCTION[3]

As part of its broader effort to expand and modernize the country's pulp and paper sector, the Chinese government has actively promoted the development of a domestic wood-based pulp industry to achieve two complementary policy objectives. On the one hand, the government has sought to reduce China's growing reliance on various grades of imported wood pulp (SFA 2002b). Policymakers recognize the substantial volumes of wood pulp that China will need to consume to produce the increasing volumes of paper and paperboard that are projected over the medium-term. To restrict the outflow of hard currency and to limit the industry's reliance on highly cyclical international markets, they have made the development of integrated wood pulp and paper production within China a cornerstone of the sector's industrial strategy.

On the other hand, the government has sought to close large numbers of heavily polluting nonwood pulp mills. Mechanical pulp mills using agricultural residues have been a major source of water pollution in many parts of China, and the government has reportedly closed over 4,000 small-scale nonwood pulp mills since 1999 (Jaakko Pöyry 2001). Within this context, Chinese policymakers view the expansion of chemical wood-based pulp production as a means of replacing the lost capacity with a cleaner and more efficient pulping process. By promoting the development of large-scale wood pulp mills, government planners also view this transition as being necessary to achieve the economies of scale needed to support an internationally competitive paper industry in China.

The government has used a variety of policy measures to promote the development of a domestic wood pulp industry. China's Tenth Five-Year Development Plan, covering the period 2001-2005, called for paper capacity to increase by 14 million air-dried tonnes per year (Adt/yr) by 2010 and prioritized the expansion of projects that integrated fast-growing pulpwood plantations, wood pulp production, and high-grade paper production (SFA 2002b). Specifically, it set a short-term target for domestic wood pulp capacity to triple in size from its 2000 level by reaching 2.2 million Adt/yr by 2005. To implement these targets, the National Development and Planning Commission (NDRC) in 2001 issued a list of 42 priority pulp and paper projects which will involve approximately US$ 24 billion in investment from both domestic and foreign sources by 2010 (AF&PA 2004). The NDRC has scheduled 13 of these projects which involve the integration of high-grade paper production with fast-growing plantations – including three large-scale chemical pulp mills – for fast-track investment approval and government financial incentives.

As in other key sectors, the government has offered significant financial incentives and capital subsidies to support priority pulp and paper projects. Discounted loans from the China Development Bank, one of four government policy banks, and the Agricultural Bank of China, a state-owned commercial bank,

[3] The goverment's policies to promote a wood-based pulp industry are described in some detail in an excellent report published in March 2004 by the American Forest and Paper Association (AF&PA) entitled „China's Fiber Resources and Forestry Industry Development," Much of the information presented in this and the following section has been adapted from this report.

have been an important source of financing for many producers (AF&PA 2004). For priority projects, these institutions have provided loans with interest rates up to 10 % lower than the standard loan interest rates set by the Central Bank. These loans often come with an extended repayment period, in some cases as long as 10-15 years.

Loan interest subsidies are another important form of incentive used by the government to achieve its policy targets in the pulp and paper sector.[4] Indeed, the government has allocated loan interest subsidies totaling US$ 2.13 billion (RMB 17.6 billion) to support the NDRC's 13 high-priority pulp-paper and plantation projects (AF&PA 2004). Under this scheme, borrowers investing in priority projects are allowed to forego interest payments on loans from state-owned banks for a period of 2-3 years.[5] Typically, the Ministry of Finance will reimburse the banks involved with funds from the central budget or raised from treasury bonds. In some cases, these incentives not only allow borrowers to avoid interest payments but also to secure larger loans than they might otherwise obtain.[6]

In addition to promoting domestic investment in wood pulp production, the Chinese government has sought to encourage foreign investment as well (SFA 2002b). In March 2002, the NDRC included the following in the government's list of industry segments where foreign investment through joint ventures is encouraged:

- Wood base development for pulp and paper processing;
- Chemical pulp with annual capacity over 300,000 Adt/yr;
- Mechanical pulp (CTMP, BCTMP, APMP)[7] with annual capacity over 100,000 Adt/yr;
- High-grade paper and paperboard (except newsprint).

Significantly, the NDRC also devolved to provincial governments substantial authority over the investment approval process for forestry and pulp-paper projects (AF&PA 2004). Previously, the central government had played a lead role in approving new investments in the sector, and this frequently led to long delays before projects could begin. By devolving authority in this area, the NDRC has sought to reduce bureaucratic hurdles for investors and to facilitate fast-track approval for projects that integrate fast-growing plantations with pulp and paper production. According to a recent study by the American Forest and Paper Association, the State Council has also allowed provincial governments to „offer preferential conditions above and beyond those stipulated in national policies (i. e. the authority to set tax rates, tax holidays, and fee waivers offered to investors), in the hopes that they can attract more foreign investment" (AF&PA 2004).

CAPITAL SUBSIDIES FOR PLANTATION DEVELOPMENT

To ensure that China's pulp producers have adequate supplies of wood fiber, the government has also promoted the development of industrial tree plantations. With the adoption of China's Tenth Five Year Development Plan, the State Forest Administration (SFA) prioritized the establishment of a fast-growing, high-yielding (FGHY) plantation base by including this as one of six core initiatives in the National Forest Protection Program (SFA 2002b). The central aim of the FGHY plantation initiative is to expand the country's commercial wood supply to support domestic forest industries, especially new capacity for wood pulp production.

According to the SFA's strategic plan for the forestry sector, the government has budgeted RMB 71.8 billion – or US$ 8.6 billion – to finance the development of 13.3 million ha of FGHY plantations during the period 2001-2015 (SFA 2002a). Some 5.8 million ha, or approximately 45 % of the targeted area, is intended to be used for fast-growing plantations for pulpwood.

The fast-growing plantation program covers four priority geographic regions: China's south coastal region; the lower and middle reaches of the Yangtze River; the lower and middle reaches of the Yellow River; and Northeast China/Inner Mongolia. In aggregate terms, the largest area allocated for pulpwood plantation development is in Northeast China/Inner Mongolia, where 2.4 million ha of plantations are planned to produce pulpwood fiber (see Table 1). However, in the South Coastal and Yellow River regions, the areas planned for pulpwood are substantially larger relative to the total area allocated for FGHY plantations than they are in the other two regions.

The government has structured the FGHY program around 99 priority projects, which are eligible to receive subsidized financing to encourage fast-growing plantation development (SFA 2002a). Thirty-

[4] During 1998-2002, for instance, the Chinese government provided loan interest subsidies totaling US$ 1.67 billion for technological improvements and capacity expansions at 21 state-owned paper mills.

[5] AF&PA (2004) notes that „the standard subside term is 2 years... [However] for enterprises found on the list of China's top 520 enterprises, the subsidy term is 3 years." In at least one case – Shandong Chenming Co., Ltd – the borrower received a loan interest subsidy for 5 years.

[6] According to AF&PA (2004), „If a paper mill needs US$ 10 million for technology renovations, the Ministry of Finance would provide a 2-year loan interest subsidy totaling 1.2 million to start the project. In fact, with this government subsidy, the company can usually receive a bank loan for up to 10 times the subsidy amount (US$ 12 million)."

[7] CTMP refers to chemi-thermomechanical pulp; BCTMP is bleached chemi-thermomechanical pulp; and APMP is alkaline peroxide mechanical pulp.

TABLE 1 *FGHY plantation area targets by region, 2001-2015*

Region	Provinces	Total FGHY (ha)	FGHY for pulpwoof (ha)	Pulpwood as % of total
South coastal	Guangdong, Guangxi, Hainan, Fujian	1.9 m	1.4 m	74 %
Lower-middle Yangtze River	Zhejiang, Jiangxi, Hubei, Hunan	3.0 m	1.3 m	43 %
Lower-middle Yellow River	Hebei, Henan, Shandong	1.0 m	0.8 m	80 %
Northeast China/ Inner Mongolia	Inner Mongolia, Liaoning, Heilongjiang, Jilin	7.2 m	2.4 m	33 %

Source: State Forest Administration

nine of these projects involve the development of pulpwood plantations. Under the government's plan, development of these plantations will be subsidized through loan interest subsidies, discounted loans from state banks, and extended repayment periods.

Specifically, financing for priority fast-growing plantation projects will come from four sources:

- State-owned banks will provide 70 % of the overall financing for the FGHY program – or approximately US$ 6.1 billion – in the form of discounted loans to state forest farms, private sector plantation companies, and farmers' cooperatives. The China Development Bank and the Agricultural Bank of China, in particular, will provide loans with reduced interest rates and an extended 10-15 year repayment period.
- The Ministry of Finance will allocate 20 % of the FGHY program's total financing – or approximately US$ 1.7 billion – through loan interest subsidies.
- Local governments are responsible for providing 3 % of the program's financing.
- Plantation companies receiving the discounted government finance are responsible for contributing 7 % of their project's financing from their own funds or from commercial sources (SFA 2002a; AF&PA 2004).

LIMITS ON CHINA'S COMPETITIVENESS

In spite of the heavy capital subsidies being allocated, China faces significant constraints which are likely to limit the competitiveness of a domestic wood pulp industry. In particular, many analysts caution that it is important to remain sober-minded about the government's capacity to develop a high-quality fast-growing plantation resource base on the scale planned under the FGHY program (URS Forestry 2003; Jaakko Pöyry 2001). Past experience has shown that large-scale plantation development initiatives in China have frequently been very effective at getting large areas of trees planted on an annual basis. However, it is not uncommon for a significant portion of these areas to have low levels of productivity due to infertile soils, inadequate site management, poor stocking and/or the use of inferior genetic materials (Jaakko Pöyry 2001). It remains to be seen whether the planting targets for the FGHY program over the next several years will be met; moreover, there is little guarantee that the sites planted will achieve high levels of productivity on a sustained basis.

In many parts of the China, delivered wood costs are also substantially higher than those found in more efficient pulp-producing countries. As discussed in detail below, delivered wood costs in South China currently range between US$ 20-25 per tonne for eucalyptus from state forest farms and US$ 30-40 per tonne for eucalyptus grown on collectively owned land that is either managed by farmers' cooperatives or leased from local communities by plantation companies (Cossalter 2004a; 2004b). By contrast, pulp producers in Indonesia are reported to pay US$ 12-25 per tonne for „mixed tropical hardwoods" harvested from the natural forest and for plantation-grown *Acatia mangium*. In Brazil, where highly efficient eucalyptus plantations have been developed near the major mill sites, some producers report delivered wood costs as low as US$ 5-15 per tonne.[8] The relatively higher wood costs in China can generally be attributed to the substantial cost involved in leasing land; high transport costs resulting from poor infrastructure and the dispersed nature of small-holder plantation sites; and the need, in many areas, for heavy fertilizer inputs to compensate for poor soil conditions (Cossalter 2004a).

Given this disparity in wood costs, many analysts question whether China-based pulp producers can, in fact, compete with low-cost producers in Indonesia and Brazil – in spite of the considerable distance required to ship pulp from those countries to China (Asprem *et al.* 2004; Wright 2004). Moreover, some analysts anticipate that the world will face a growing oversupply of market pulp over at least the medium-term, which would place further downward pressure on global pulp prices. Hawkins Wright, for instance, projects that global production capacity for market pulp will increase from 47.9 million Adt/yr in 2003 to 56.4 million Adt/yr in 2008 (Wright 2004). This ex-

[8] The figures for fiber costs in Indonesia were reported by pulp and plantation companies in Riau, Jambi and South Sumatra during company visits by the authors in February and March 2003. Those for Brazil were reported by pulp and plantation companies in Bahia, São Paulo, and Paraná states during March 2004.

pansion is expected to outpace growth in global demand for market pulp, which is projected to rise from 44.8 million Adt/yr to 51.0 million Adt/yr during the same period.

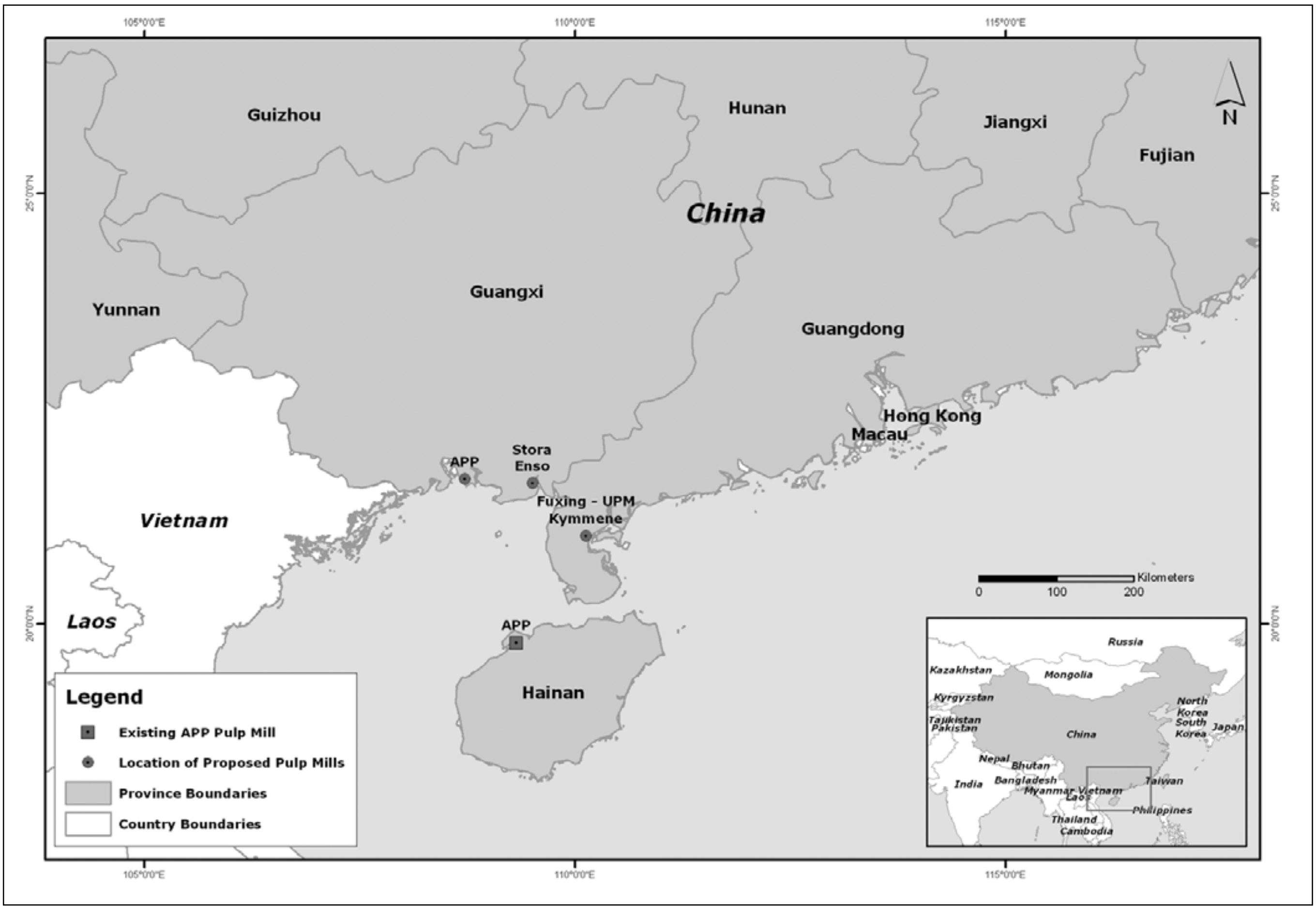
As China consumes nearly 50 % of the world's market pulp, global oversupply could mean that China-based pulp producers become increasingly reliant on either direct or indirect government subsidies to remain competitive within their home markets (Barr and Cossalter 2004). However, with China's entry into the World Trade Organization, the government will find it increasingly difficult to provide such subsidies and can no longer protect domestic producers with import tariffs as it has in the past (Roberts 2004).

PULP AND PLANTATION DEVELOPMENT IN SOUTH CHINA

The provinces of Guangdong, Hainan, and Guangxi, located along the country's southern coast, currently represent the most active region for the development of kraft pulp production in China. During the last three years, four of the world's largest pulp producers – including Indonesia-based Asia Pulp & Paper (APP) and RGM International and Finland-based Stora Enso and UPM-Kymmene – have announced that they are either actively considering and/or initiating the development of large-scale hardwood pulp mills in the region (Figure 1). Reports of what these companies are considering, and the status of their plans, have varied widely and have changed over time. As Table 2 shows, however, these producers have either conducted feasibility studies or initiated development for five pulp mills with a combined capacity of 5.6 million Adt/year over the medium to long term.

Few analysts expect that all five of these mills will be developed or that the region's installed wood pulp production capacity will approach 5.6 million Adt/year in the near future. Indeed as of January 2005, only one of the projects under consideration – APP's Hainan Jinhai mill, which began test trials in November 2004 – had even initiated construction, much less started production. On the contrary, in late-2004 UPM-Kymmene announced that it had withdrawn from the planned Fuxing pulp mill project in western Guangdong Province (which will be discussed in greater detail below). While the project may ultimately go forward with another investor, the withdrawal of UPM-Kymmene will undoubtedly mean that the Fuxing mill is delayed significantly, if it is built at all. Stora Enso has also indicated that it is now in the process of restructuring the industrial concept for the

FIGURE 1 *Development of hardwood-mills in the region*



BHKP mill it had planned for Guangxi Province. APP has, likewise, indicated that it is planning to develop a bleached hot-grind mechanical pulp mill with a capacity of 300,000 Adt/yr as a first stage for its project in Guangxi's Qinzhou Prefecture.

Each of the planned mills has structured its wood supply strategies around the development of fast-growing eucalyptus plantations. The main species being used are *Eucalyptus urophylla*, *E. tereticornis* *(12ABL Congo)* and a number of eucalyptus hybrids including: *Eucalyptus grandis x E. urophylla*; *E urophylla x E. grandis*; *E. urophylla x E. tereticornis*, which are well-suited for the growing conditions found in much of Hainan, Guangdong, and Guangxi. Large areas of eucalyptus have, in fact, been planted in the three provinces over the past decade, and clonal forestry has now become widely used. Based on provincial forest inventory figures, it is estimated that by the end of 2002, the three provinces had approximately 750,000 ha of standing eucalyptus plantations (Cossalter 2004a). However, at least a portion of these have been planted for environmental purposes and are not likely to be available for commercial use. In recent years, the region's plantations have expanded at approximately 65,000 ha annually. Growth rates and productivity levels in South China are highly variable,

TABLE 2 *Wood-based pulp mills (capacity > 500.000 Adt/year) planned for South China, as of December 2004*

Project name	**Province**	**Planned/proposed capacity (Adt/yr)**	**Status (December 2004)**
APP Hainan Jinhai	Hainan	2,400,000	Pulp line 1 with 1.1 million Adt/yr installed - test trials held in November 2004
APP Qinzhou	Guangxi	1,200,000	Approval pending for first phase of 300,000 Adt/yr
Stora Enso-Hepu	Guangxi	600,000	Approval pending - however, Stora Enso is considering a new industrial concept while studying feasibility of plantation resource base
Fuxing	Guangdong	700,000	Status uncertain - UPM Kymene withdrew from project in November 2004
RGM-Xinhui	Guangdong	700,000	Proposed - not yet approved
Total		**5,600,000**	

TABLE 3 *Effective wood demand and approximate net plantation area needed according to potential pulp capacity levels*

		Net plantation area needed		
Pulp capacity (Adt/yr)	**Wood demand (m^3/yr)**	**MAI = 12 m^3/ha/yr**	**MAI = 15 m^3/ha/yr**	**MAI = 18 m^3/ha/yr**
1,000,000	4,150,000	432,000	346,000	288,000
1,500,000	6,225,000	648,000	519,000	432,000
2,000,000	8,300,000	864,000	692,000	576,000
2,500,000	10,375,000	1,080,000	865,000	720,000
3000,000	12,450,000	1,296,000	1,038,000	864,000
3,500,000	14,525,000	1,512,000	1,210,000	1,008,000
4,000,000	16,600,000	1,728,000	1,383,000	1,152,000
4,500,000	18,675,000	1,944,000	1,556,000	1,296,000
5,000,000	20,750,000	2,160,000	1,729,000	1,440,000
5,500,000	22,825,000	2,376,000	1,902,000	1,584,000
6,000,000	24,900,000	2,592,000	2,075,000	1,728,000

Note: Wood demand is based ont he assumption that 4.15 m^3 of roundwood (solid wood under bark) is needed to produce 1.0 Adt of pulp. Approximate net plantation area is based on the assumption that plantations are managed on a 5 year rotation; and 20 % of harvested volume is non-commercial.

In spite of the uncertainties involved, the ambitious plans and large-scale investments already being made in hardwood pulp production in South China raise a number of critical questions about the region's fiber resource base. Most significantly, perhaps, how much pulpwood fiber can the region's plantations supply on a sustainable basis ? And how much land will be required to do so ? If it is assumed that 4.15 cubic meters (m^3) of pulpwood (solid wood under bark) are needed to produce 1.0 Adt of pulp, it can be estimated that some 4.15 million m^3 of pulpwood will be needed annually to support every 1.0 million tonnes of pulp capacity that is brought online. Table 3 shows the projected wood demand of the region's pulp producers at various levels of installed capacity, and the approximate land area that would be needed to supply the volumes of wood if these were to be obtained from local plantations.

with mean annual increments (MAI's) generally ranging between 10 and 20 m^3/ha/yr depending on site conditions and plantation management practices (Cossalter 2004a).

to the mill at the prevailing market price.

A third model is structured as a production-sharing arrangement between the pulp company and the local community or land-owner. The pulp company assumes full responsibility for financing the plantation development on community land, and the community is responsible for managing the site. At the end of the rotation, the wood harvested is divided between the company and the community according to an agreed ratio. Often the company provides a guarantee that it will purchase the community's portion of the wood at a pre-determined price.

TABLE 4 *APP's annual planting of pulpwood plantations in Guangdong, Guangxi, and Hainan Provinces, 1995-2003 (hectares)*

Year	Guangdong		Guangxi	Year	Hainan
	Qingyuan	Shaoguan			
1995-1996	1,771	6,069	2,495	1996	0
1996-1997	7,380	7,012	7,623	1997	6,680
1997-1998	884	1,607	3,230	1998	0
1998-1999	996	894	1,516	1999	9,346
1999-2000	468	0	8,811	2000	30,733
2000-2001	0	0		2001	0
2001-2002	0	0	est. 16,000	2002	0
2002-2003	0	0		2003	16,768
Total	**11,499**	**15,582**	est. **39,675**	**Total**	**63,527**

Source: APP, January 2003 and June 2004, for figures on Guangdond and Guangxi; Hainan Province Forestry Bureau, May 2004, for figures on Hainan.

Over the last few years, pulpwood plantations in South China have produced approximately 2.0 million m^3/yr of small-diameter logs which have been exported in the form of wood chips, principally to Japan, South Korea, and Taiwan. Smaller volumes have been used by a handful of plywood and medium-density fiberboard (MDF) mills, as well as a few medium-scale pulp and paper mills located in southern China, and in one case, in Shandong Province.

At present, the sponsors of each of the planned pulp mills are competing with one another to secure an adequate land base for their respective plantation development initiatives. Due to the population density in South China, much of the suitable land is already held by local communities and individual farmers. Pulp companies are therefore seeking to gain access to plantation land by establishing partnerships with these groups, often with the assistance of provincial and municipal governments, and they are using a number of different models to do so (Cossalter 2004a; Lu Wenming *et al.* 2002). Under one such model, companies are leasing land from local communities – for periods that sometimes range up to 30 years – and then establishing and managing the plantations themselves. The company typically assumes full responsibility for financing the project and makes annual payments to the community, but manages the site directly.

A second model is structured around a joint financing arrangement between the pulp company and a private investor although again, the plantations are developed on land that is leased from communities. Un-der this model, the pulp company and the private investor generally share the cost of plantation development, and the latter assumes responsibility for mana-ging the site, harvesting the wood, and delivering it to the mill site. Typically, the pulp company receives a predefined portion of the harvest, while the private investor retains the right to sell the remainder

Under a fourth model, pulp companies are seeking to secure wood procurement contracts with the region's state-owned tree farms, which have fairly substantial existing plantation areas. The following sections examine the fiber supply strategies of two major pulp mill projects that have been planned for the region: APP's Hainan Jinhai pulp mill and the Fuxing pulp mill project. These projects are each included on the list of 13 high-priority pulp and paper projects prepared by the National Development and Reform Commission. Much of the information presented below was obtained during company visits and field studies in Hainan and Guangdong conducted during February, March, and September 2003 and May, June, and August 2004.

APP'S HAINAN JINHAI PULP MILL PROJECT

Hainan Jinhai Pulp & Paper Co. Ltd is a subsidiary company of APP China and the sole shareholder of the group's Hainan pulp mill. This new mill is located at Yang Pu on the west coast of Hainan Province approximately 110 km from Haikou, the provincial capital. The mill site covers an area of 400 ha within the recently created Yang Pu Free Trade and Economic Development Zone, and has its own port facilities. Construction of the mill was completed in October 2004 and test trials began in late-November.

According to company announcements, APP's Hainan Jinhai mill has initiated production with an installed capacity of 1.1 million Adt/yr for bleached hardwood kraft pulp. The company plans to expand capacity to1.2 million Adt/yr by mid-2005 after debottlenecking. This is the first step of a larger project which will reportedly include the addition of a second pulp production line of the same capacity and of two paper lines of 1.6 million tonnes each. According to company plans, the Yang Pu project will have a total installed capacity of 2.4 million Adt/yr of BHKP and 3.6 million tonnes of paper once it is completed. The mill's fiber supply strategy has largely been structured around the development of eucalyptus plantations in the South China region. As Table 4 shows, APP has invested in fast-growing plantations in Guangdong, Guangxi and Hainan provinces since 1995. In making these investments, APP has sought to initiate a resource base in the neighborhood of sites that it had pre-selected for several potential pulp and fiber board industries. Several of those proposals have failed to obtain final agreement, and it now appears that the group will direct the wood from these sites to the Hainan mill, at least until other potential production facilities come online. By the end of 2003, APP had established approximately 130 000 ha of plantations, mostly composed of eucalyptus, in the three provinces.

APP's Guangdong plantations

In Guangdong Province, APP has planted an area of about 27 000 ha in Qingyuan and Shaoguan prefectures, located respectively at 120 km and 300 km northwest and north of Guangzhou. They were largely established during 1995-1998 as part of an overall plan to build a total plantation resource of 330 000 ha in Qingyuan and 400 000 ha in Shaoguan. The original purpose of these plantations was to supply two proposed pulp and medium density fiberboard mills. In both cases, the Bei Jiang River was expected to provide the water supply to the mills and to drain their effluents. In 1997, however, the provincial administration withdrew its initial agreement allowing APP to proceed with the construction of the two mills. The provincial administration's key concern was the high risk of water pollution of the Bei Jiang River, one of the main supplies of drinking water of the city of Guangzhou.

At this point, it is not altogether clear how APP will use the wood from the Guangdong plantation sites. The Qingyuan and Shaoguan plantations are far too remote to become an economic source of wood for the Hainan mill on a long-term basis. Road conditions north of Guangzhou are rather poor and access to the Guangzhou harbor is already extremely congested. However the possibility that the wood from these sites could be delivered to the Hainan mill, at least during the mill's start-up phase, should not be excluded.

APP's Guangxi plantations

Through the end of 2003, APP had planted approximately 40 000 ha in Guangxi Province. For South China as a whole, Guangxi is where eucalyptus plantations are expanding most rapidly, with approximately 40 000 ha of new plantations being established annually in recent years. The provincial government's target is to establish approximately 670 000 ha of fast-growing, high-yielding plantations linked to processing industries, particularly to pulp mills. The most significant plantation development has occurred in the coastal region, where APP and Stora Enso are developing plantations in 38 counties. To support their proposed mill projects, the two companies have planned an aggregate plantation area of 950 000 ha. A number of other companies – including Oji Pulp & Paper, Jahan Forest Products (Sino Forest Group), Feng Lin, Gao Feng Group, and Guangxi Plantation Development Company – are also developing new plantations in the southern and south-central parts of the province.

The coastal region of Qinzhou, where most of the APP plantations in Guangxi are being established, is separated from the site of the Hainan mill by the Gulf of Tonkin. Topography in this region consists of gently undulating hills. In most cases, the new eucalyptus plantations have expanded on areas classified as ‚wasteland' or have replaced sugar cane fields with low productivity. Soils are shallow and, as in western Guangdong, most sites have nutrient deficiencies. All of APP's plantations in this area have been established with eucalypt clones. According to APP officials, the company expects the MAI for these sites to be approximately 15 m^3/ha/year. Until now, the entire expansion of APP's plantations has been on land where communities and individual farmers hold user rights, the so-called ‚collectively-owned' land and ‚farm land allocated to households'. In perhaps 90 % of all cases, APP has planted these lands on the basis of land lease contracts signed with the recognized users.

APP's Hainan plantations

In 1997, APP and the Hainan Forestry Bureau, created a joint venture through their respective subsidiaries, Hainan Jinhai Pulp & Paper Co. and the Hainan Province Forestry General Corporation. This joint venture, named Hainan Jinhua Forestry Corporation Ltd, was established with the objective of building a plantation base of 3.5 million *mu* – equivalent to 233 000 ha (15 *mu* = 1 ha) – for the Yang Pu mill. Within the joint venture, the specific task assigned to the Hainan Province Forestry General Corporation has been to make land available, while APP's Hainan Jinhai Co. has been responsible for financing and managing the plantation development. According to APP's projections, the partnership's future plantations are expected to cover approximately 180,000 ha of ‚collectively-owned' land and ‚farm land allocated to households', while the remaining 53,000 ha would be provided by the provincial network of state-owned agriculture farms and state-owned forest farms.[9]

Between 1997 and 2003, the Hainan Jinhua Forestry Corporation planted a total area of 63,530 ha (Table 5). Over 80 % of this expansion has taken place on ‚collectively-owned' land and ‚farm land allocated to households' in 18 counties. Eucalyptus is the primary genus used, although areas that are not suitable for eucalyptus were planted with acacia, casuarina and pines. Planting peaked in 2000 with over 30,000 ha established during that year, before being suspended in 2001 and 2002 due to the APP group's financial difficulties.

TABLE 5 *APP's annual plantation establishment in Hainan Province, 1997-2003 (hectares)*

Plantation model	1997	1998	1999	2000	2001	2002	2003	Total
State owned farms	2,370	0	1,255	6,462	0	0	0	10,087
Collective land	4,310	0	8,091	24,271	0	0	16,768	53,440
Total	**6,680**	**0**	**9,346**	**30,733**	**0**	**0**	**16,768**	**63,527**

Source: Hainan Province Forestry Bureau, May 2004.

In developing its plantation resource base, APP is implementing several models through which farmer cooperatives and individual households grow wood fiber on their own land. Land leasing has become the most common practice throughout the province, as this is the partnership model that contains the least uncertainty and the lowest risks for the leaser. Contracts are signed for a minimum period of 12 years, but in some cases can last for 30 years.

To some extent, APP's efforts have been hindered by the fact that there has been little spontaneous engagement of local communities and individual farmers towards short-rotation plantations in Hainan. One reason for this is that until recently, there has been very limited local demand for small-diameter logs or wood chips. In addition, two companies under the authority of the provincial government share a monopoly on wood chip exports. Consequently, prices offered to Hainan producers are often 20-25 % lower than prices paid to producers in western Guangdong, where buyers purchase fiber in a competitive market.

In addition to leasing land from local communities, APP has also sought to secure wood from Hainan's existing plantations of eucalyptus, acacia and casuarina, which produce approximately 600,000 m^3 of wood on a yearly basis. These include areas planted through government-funded projects and, since 1993, plantations established by private forestry companies.[10] Two local MDF mills use approximately one-third of this production, while the rest is processed into wood chips and shipped to Japan, South Korea and Taiwan. It is estimated that about one-half of the annual production potential of the Hainan plantations grown for fiber (i. e. 300 000 m^3/yr) could be re-routed, through contractual agreements, to the Yang Pu mill. This represents approximately 7.5 % of the total wood volume required by the mill during its first year of operation.

Fiber balance

APP will need a total area of approximately 360,000 ha of plantations to sustain its Hainan pulp mill at a capacity of 1.2 million Adt/yr (Cossalter 2004a; 2004b). This would provide some 72,000 ha that could be harvested annually, assuming that sites were managed on a five year rotation. This should be adequate for generating the 5.0 million m^3 of wood needed to fully supply the mill at current growth rates.

We estimate that the 130,000 ha of APP plantations already in place in the three provinces would be able to deliver approximately 7.3 million m^3 of pulpwood during the first five years of operation of the Hainan mill (i. e. 2005-2009). If, during this period, the total pulp output is 6.0 million Adt, the mill would require approximately 25 million m^3 of wood. It is likely that at least 17 million m^3 of this – or more than two-thirds of the total volume of fiber consumed by the mill – will have to be sourced from external suppliers. The Hainan mill's fiber shortfall will be considerably greater if APP chooses to raise capacity further by installing a second pulp production line or moves ahead with plans to build a second pulp mill in Guangxi province.

Part of this shortfall could, in principle, be met by South China's inter-provincial trade.[11] Until this year, the region's three provinces have exported the equivalent of 2.3 million m^3 of wood annually in the form of wood chips. Only a very small share of this market is bound by long-term contracts, and it is possible that a significant portion of the fiber exported could be

[9] According to data provided by APP, the company expects that: (i) 15 % (approximately 35,000 ha) of the entire Hainan plantation program will be located on volcanic red soils characterized by high clay content and relatively good fertility; (ii) 50 % (approximately 116,500 ha) on the granites soils of the foothills in the central region, which are of variable fertility; and (iii) the remaining 35 % (approximately 81,550 ha) on the sedimentary infertile sands.

[10] The history of fast-growing plantation development in Hainan is relatively recent and all the areas planted until 1993 were through government-funded projects. After 1993 several industries started to invest in tree plantation. A joint venture between a private enterprise named Korean Wood Chips Company and the Hainan Province Forestry General Corporation (a subsidiary of the Provincial Forestry Bureau) was created to plant casuarina trees. The Wuzhishan Group started planting Caribbean pine for resin production. Also two MDF plants started building up their own eucalyptus resource base.

[11] See Cossalter 2004a and 2004b for a more detailed analysis of the potential effects that APP's fiber demand could have on South China's wood chip trade.

redirected to APP's Hainan mill or other pulp production facilities that may come online. However, APP's access to this wood will depend on its willingness to offer prices that are competitive with those offered by Japanese, Taiwanese, and South Korean importers. It is also conceivable that APP will seek to ship in wood from Yunnan Province, where it has forestry operations, and/or from other countries in the region where it has timber and plantation concessions, such as Indonesia or Cambodia.

THE PROPOSED FUXING PULP MILL PROJECT

The proposed Fuxing pulp mill project had, until very recently, been designed as a joint venture involving China's Ministry of Planning (which held 45 % of total shares), Finnish multinational UPM Kymmene (45 % of total shares) and Guangdong's provincial government (10 % of total shares). The proposed mill was to be located on the Leizhou Peninsula in the western portion of Guangdong Province, about 30 km south of the city of Zhanjiang. The project had been designed to produce bleached hardwood kraft pulp from plantation-grown wood, particularly eucalyptus. According to project plans, the mill would have an initial production capacity of 700,000 Adt/yr of BHKP, which corresponds to an annual wood demand of 2.9 million m^3.

TABLE 6 *Areas of eucalyptus and acatia plantation in the four prefectures of western Guangdong Province (hectares)*

Prefecture	Age class					Total
	Young	Intermediate	Nearly mature	Mature	Overmature	
Zhanjiang	38,615	29,782	18,592	11,330	40,870	139,189
Maoming	4,467	7,121	8,829	7,602	1,871	29,890
Yangjiang	2,199	3,350	2,434	1,449	8,328	17,760
Jiangmen	9,079	6,009	3,792	4,322	5,405	28,607
Total	**54,360**	**46,262**	**33,647**	**24,703**	**56,474**	**215,446**

Source: Forestry Department of Guangdong Province, November 2004.

Land and wood costs

In the north-west part of Hainan, leasing land that is not suitable for agriculture costs approximately RMB 30-55 per *mu* on an annual basis (equivalent to approximately US$ 55-100 per ha per year) depending on the location, topography and soil fertility. Land lease prices on the province's east coast are no less than RMB 70 per *mu* per year (US$ 130 per ha per year) since soils are more fertile and there is more demand for agricultural land. In August 2004, APP officially announced its new land lease policy for Hainan. A yearly payment at 30 % above the current market price would replace the company's earlier practice by which the totality of the lease was paid up-front for the entire contract duration. In addition, a special premium of RMB 70 per *mu* (US$ 130 per ha) will be paid each year during the first five years of lease for land that could be used for agriculture.

A simulation based on current practices indicates that costs for plantation establishment and maintenance are higher at most Hainan sites as compared to those found in western Guangdong (as discussed below). One reason for this is that tree growing in Hainan requires greater expenditures for fertilizer. This is especially true for the north-west part of the province, which is close to the mill. Provincial forest farms using their own land can produce pulpwood with stumpage costs of US$ 10-15 per m^3 and costs at mill gate ranging between US$ 20-25 per tonne for a transport distance of 100-150 km. However, the land availability of these government farms is extremely limited. If land has to be leased at costs ranging between RMB 30-55 per *mu* per year (US$ 55-100 per ha per year), stumpage costs come close to US$ 20 per m^3 and the range of production costs (compounded at 6 % interest rate) at mill gate is between US$ 30-40 per tonne for a transport distance of 100-150 km.

Initial plans were to launch the mill's production in 2006. However, the project encountered delays due to the government's lengthy approval process and efforts by the project sponsors to obtain guarantees that sufficient volumes of fiber would be available at an economically viable cost on a sustainable basis. In November 2004, UPM Kymmene announced that it had decided to withdraw from the project altogether. In its public statement concerning this decision, UPM implied that its withdrawal was based on concerns about the availability and cost of wood fiber in the region surrounding the proposed mill.[12]

As of January 2005, the future of the Fuxing pulp project remains unclear. It is possible that China's national government and/or the Guangdong provincial government will seek to proceed with the project if it can find an investor willing to replace UPM Kymmene. To have a realistic chance of doing so, however, the government will need to ensure that a sufficient resource base of fast-growing plantations would be available to the pulp mill if it were built. The following sections review the fiber supply strategy that had been formulated for the planned mill when UPM was

[12] In a statement posted on the company's website on November 17, 2004, UPM offered only the following explanation: „According to a letter of intent signed in 2003, the task of the joint venture company was to investigate and make preparations for wood supplies for a possible future pulp mill. The decision to withdraw was made after studies of the local conditions and the availability and cost of wood for a modern large-scale mill.“

still involved, and outline many of the issues that would need to be addressed for the project to go forward.

Fibre supply and plantation development plans

According to the project's original plans, the plantation base for the proposed Fuxing pulp mill would be located in the four most western prefectures of Guangdong, namely: Zhanjiang, Maoming, Yangjiang and Jiangmen. Approximately 220,000 ha of eucalyptus plantations currently exist in these four prefectures, although at least a portion of these have been developed for ecological purposes and will not be available for commercial use (Table 6).[13]

These plantations have a total annual production capacity of roughly 1.8-1.9 million m^3. They currently supply approximately 350,000 m^3 of wood fiber to two local MDF mills and a fiber board mill. Their annual output also consists of 500,000 bone dry tonnes (Bdt) of wood chips which are exported, and an additional 150,000-200,000 Bdt of chips sent to the Rizhao pulp mill in Shandong Province, north of Shanghai.[14] A smaller portion of the production goes to local plywood mills. It is estimated that about one-half of the eucalyptus harvested from these existing plantations could, in principle, be redirected – through contractual agreements – to the Fuxing mill in Zhanjiang, if it were built. This assumes, however, that future wood prices would not be lower than those offered by Japanese and South Korean importers.

According to the initial project plan for the Fuxing pulp mill, substantial investments would be needed to develop new areas of eucalyptus plantations above and beyond those that currently exist in western Guangdong. The mill's fiber supply strategy was to be based upon the development of 200,000 ha of plantations under three different models: ‚self managed', ‚contracted', and ‚membership' plantations.

‚Self-managed' plantations – These plantations were to be established and managed by a company affiliated with Fuxing-UPM Kymmene, and would have formed the mill's core raw material area. The company planned to develop 50,000 ha of ‚self-managed' plantations on land that would be leased within Zhanjiang and Maoming prefectures. The average distance to the proposed mill from these sites is 85 km. These plantations also were to have been used as a demonstration area for extension purposes, a base where outside tree growers could learn how to improve the cultural practices and plantation yields on their own land.

‚Contracted' plantations – Fuxing-UPM Kymmene had planned to enter into long-term procurement contracts with the ‚owners' of 60,000 ha of existing plantations. This was to include a number of existing forestry and agricultural farms located in several counties (municipalities) of the four prefectures of western Guangdong. Most of these farms are state-owned forest farms and are managed either by prefecture or county forestry or agriculture bureaus. According to the proposed plan, the current farm owners would continue to manage the plantations under contracts to the mill. These contracts were to include a protection clause that would set a minimum price for the purchase of pulpwood. The company also planned to stipulate that the Fuxing mill would purchase its wood at the local market price whenever the market price was higher than the agreed contractual price. The average distance of the ‚contracted' plantations to the mill would be approximately 135 km.

‚Membership' plantations – According to the initial project plan, Fuxing-UPM Kymmene intended to work with the four prefectures of western Guangdong, county governments and forest bureaus to develop 90,000 ha of pulpwood plantations through an outgrower program involving farmer and village land. Under this scheme, members of the outgrower program and the pulp company would sign a contract through which the latter would provide loans and technical assistance in exchange for a share of the future wood harvest. The contract would also give the pulp company a priority right to purchase any additional wood production, above the specified share, from the partner tree growers. It was expected that the ‚membership' plantations would be located at an average distance of 130 km to the mill.

Most of the project's ‚self-managed' and ‚contracted' plantations were to be managed on a five-year rotation period and would use clones of *Eucalyptus urophylla* and E. 12ABL (a variety of *E. tereticornis* bred in the People's Republic of Congo) as planting material. The minimum stand size would be 100 mu (between 6.5 and 7.0 ha). On most sites, the mean annual increment of the existing eucalyptus plantations of western Guangdong ranges between 10 and 20 m^3/ha/year, depending on site quality and management

[13] There are a number of ecological and geographical features that have favored plantation development in western Guangdong. The region's humid tropical climate is well-suited to tree growth and particularly to some of the fastes growing eucalypts. The annual mean temperature is 23.5 °C. Absolute recorded maximum and minimum temperatures were respectively 38.8 °C and -3.0 °C. The annual mean precipitation is 1,800 mm. Topography in the coastal area where eucalyptus plantation are grown consists of plains and gently undulating tablelands easily accessible to vehicles and heavy machinery used for forest work. In addition, a dense network of well maintained national and secondary roads is already in place in the region. Zhanjiang is also connected to the central and eastern part of Guangdong province as well as to the neighboring province Guangxi by rail. Finally, the four prefectures cities have their own sea port.

[14] 1.0 BDt of wood chips is equivalent to approximately 2.1 m^3 of debarked wood (sub).

practices. The sponsors of the Fuxing mill project expected that their future plantation base would have an average increment of 18.5 m^3/ha/year to be able to deliver an average of 14 m^3/ha/year of commercial wood.[15]

Fibre balance

According to the project's original plan developed in 2002, the sponsors of the proposed Fuxing pulp mill foresaw modest fiber shortfalls during the first few years of the mill's operation, which was initially scheduled for 2006. To gain insights into UPM's recent decision to withdraw from the project, we have reassessed those projections based on what we believe would have been the most optimistic scenario for the project had it gone forward (Cossalter 2004b). This reassessment is based on the assumptions that the mill would begin operating by 2008 and that the associated plantation development plan, as described above, would be fully implemented but delayed by one year.

According to these calculations, the mill could be expected to produce an aggregate of 1.015 million tonnes of pulp during its first two years of operation (i. e. 2008-2009). This would require approximately 4.2 million m^3 of pulpwood (solid wood under bark). The mill would likely have been able to secure some 3.7 million m^3 of wood from plantations associated with the project during that two-year period, while approximately 500,000 m^3 would need to be obtained from outside sources.

Similarly, during the ensuing five years of operation (i. e. 2010-2014), the mill could be expected to produce some 3.46 million tonnes of pulp, requiring an aggregate of approximately 14.4 million m^3 of pulpwood. During this period, plantations associated with the project would likely be able to generate 13.0 million m^3, leaving a shortfall of some 1.4 million m^3. Assuming that they produced a commercial MAI of 14 m^3/ha/year on an industrial scale, it is reasonable to expect that after 2014 the 200,000 ha of fast-growing plantations that were to be developed would be able to supply the Fuxing mill's entire fiber demand – at an installed capacity of 700,000 Adt/yr – on a sustainable basis.

It is quite conceivable that the relatively modest fiber shortfalls that the Fuxing mill would face in its first few years of operation could be filled through external purchases from plantation companies within China and/or through wood chip imports. Of perhaps far greater concern to the project sponsors is the fact that competition for land in western Guangdong would make it very difficult to develop a plantation resource base for a second pulp production line, if they chose to expand the mill. If, for instance, the project sponsors were to raise the mill's capacity to 1.4 million Adt/yr, they would need to develop a plantation base of approximately 400,000 ha. Moreover, as the following sections explain, plantation development in western Guangdong also faces greater risks and higher costs than are commonly recognized.

Significant risk factors

The main uncertainty regarding the development of the proposed fiber resource base lies in the extent to which farmers would agree to participate in the ‚membership' plantation scheme. Western Guangdong has a rural population of 10.5 million people, of which 4.1 million reside in Zhanjiang prefecture. Per capita area of arable land and forestland are respectively 1.08 *mu* (720 m^2) and 1 *mu* (670 m^2) is approximately, and farmers rely heavily on their land for their daily subsistence and income. Consequently, a farmer's decision to plant eucalyptus on his/her limited land area would mainly depend on the comparative benefits associated with growing eucalyptus wood rather than fruit trees or sugar cane.

Recent years have seen the proliferation of wood chip plants in western Guangdong in response to strong demand and high prices offered on the export market. Local chip producers are buying eucalyptus wood at attractive prices – up to US$ 36.5 per tonne at mill gate in September 2003 and up to US$ 40 in August 2004 for wood without bark and with diameter ranging between 3 and 8 centimeters (cm). This has led to a sharp increase in private investment in eucalyptus plantations on community and farmer lands in recent years. Much of this investment has been made by local entrepreneurs developing plantations on so-called ‚wastelands' leased from communities. Also, there have been cases of farmers converting their sugar cane fields into eucalyptus plantation.

Within this context, managers of local plantations and wood chip plants fear that the government could impose a limit on wood chips exports in order to force the re-routing of most of the current production to the Fuxing mill, if it were built. Their concern is that a limit on exports would result in lower prices for the wood chips used domestically, and this, in turn, would create disincentives for tree growers. Less favorable market conditions would lead many tree growers to re-evaluate the levels of risk and uncertainty they are willing to accept.

Eucalyptus plantations in western Guangdong also face significant risks and constraints associated with the region's biophysical conditions. A large proportion of the region's soils have granites or sedimenta-

[15] The project sponsors reportedly expected that altogether, the plantations located in the prefectures Zhanjiang and Maoming should be able to supply approximately 80 % of the mill's needs on a sustainable basis at an installed capacity of 700.000 Adt/yr. Their average distance to the mill would be approximately 90 km. Plantations in Yangjiang and Jiangmen would be located further away, at distances up to 350 km.

ry infertile sands as parent material, and therefore, they often have low fertility and poor water-retaining capacity. It is estimated that 90 % of the area of existing plantations has nutrient deficiency problems. Over the last 15 years, the widespread adoption of fertilizers and micronutrient regimes, coupled with the generalization of clonal forestry, has resulted in plantation yields more or less doubling. At present, purchase of fertilizers may account for 35-40 % of the total plantation establishment and management costs. Further progress is expected when new clones which are more efficient in the use of scarce water and nutrient soil resources become available. However, we estimate that the overall poor soil characteristics will remain the most important constraint to further improvement of plantation growth in the region.

Typhoons represent another risk factor in western Guangdong which has been largely underestimated. Typically, they come from the east between July and September. Meteorological statistics show that between 1979 and 2001, there were 45 typhoons in the region: six had winds exceeding force 12 on the Beaufort scale; 29 had winds between force 8 to 11; 10 had winds below force 8. There is a risk of at least one typhoon above force 8 every year causing breakage among young trees and exposing wounded trees to disease infection. There is also a risk of an entire age-class being knocked down every 7-8 years by a force 11-12 typhoon. Eucalypts are particularly exposed between ages 2 and 3.

Another significant risk factor is the general lack of genetic diversity in the region's plantation base. Since the late-1980s, substantial investments have been made to develop tree breeding and clonal forestry in western Guangdong. This has involved the testing of a large number of eucalyptus species and provenances, the establishment of seed orchards, the synthesis of new breeds through controlled pollination and the testing of clones. In spite of this important research effort, the number of eucalyptus clones which are available for mass distribution is still extremely limited. Approximately 90 % of the plantations established in recent years are composed of three clones: U6, W5 and Leizhou N° 1.

The fact that the very dynamic eucalyptus plantation expansion in western Guangdong is not supported by a continuous flow of new clones selected and tested for their genetic superiority and resistance to pest and diseases is a matter of concern. In other words, the new clonal eucalyptus plantations of western Guangdong lack the minimum threshold of diversity that would place the risks of pest and disease attacks at a reasonable or acceptable level. Plantation managers are concerned by the recent outbreak and rapid propagation of a new disease - not yet clearly identified - on the clone U6 of *E. urophylla*. It is likely that such phenomena will become more common in the future with an expanding plantation resource made of monoclonal stands, if nothing is done to guarantee a sufficient yearly turnover of new clones.

Land and fibre costs[16]

A simulation based on current practices and operation costs indicates that the stumpage costs of plantations established under the ‚self-managed' model would be on the order of US$ 22 per m^3 (+/- 10 %). The cost at mill gate of ‚self-managed' wood would amount to US$ 35 per tonne (+/- 10 %) for an average transport distance of 85 km between the plantation sites and the mill. The other parameters used for this simulation included:

- A land lease cost of RMB 80 per mu and per year (equivalent to US$ 148 /ha /year) payable on a yearly basis;
- Production of 70 m^3/ha of commercial wood at the end of the 5-year rotation;
- General overhead costs of the ‚self-managed' plantation estimated to be 8 % of its direct production costs;
- A 6 % rate of interest for calculating the compounded production costs.

Most of these parameters were also used for simulating the costs of wood to be produced under the ‚contracted' plantation model, the only exceptions being the cost of overhead (raised to 12 %) and the average transport distance (raised to 135 km). We have also assumed the absence of a land lease fee for the ‚contracted' model, due to the fact that the farms involved in this type of arrangement – state-owned farms, in most cases – will generally use their own land. Stumpage costs in this case would be on the order of US$ 10 per m^3 (+/- 15 %). Average costs, not including the farm's profit, for wood delivered at the Zhanjiang mill gate would amount to approximately US$ 24 per tonne (+/- 10 %).

The same simulation approach was used to estimate the wood production costs of the ‚membership' model. These calculations found stumpage and compounded costs to be US$ 12 per m^3 (+/- 10 %) and US$ 30 per tonne (+/- 10 %), respectively. The parameters used in this simulation included:

- A growth period of four years and the harvest of 64 m^3/ha of commercial wood at the end of each rotation;
- An average transport distance of 130 km between the plantation sites and the mill;
- A 6 % rate of interest for calculating the compounded production costs;
- Overhead costs of tree growers amounting to 3.5 % of their direct production/operational costs.

CONCLUSION

The Government of China is actively promoting the development of a domestic wood pulp industry by providing significant capital subsidies and investment

[16] The figures presented in this section are examined in greater detail in Cossalter 2004a and 2004b.

incentives to a handful of priority projects. Most immediately, the government is supporting 13 high priority pulp and paper projects – including three kraft pulp mills – by allocating several billion dollars in discounted loans from state-owned banks, loan interest subsidies from the Ministry of Finance, and an accelerated investment approval process. The government has also set a target to subsidize the development of up to 5.8 million ha of fast-growing pulpwood plantations in order to provide the new mills with a sustainable supply of fiber. It remains unclear what portion of this has been achieved thus far.

In this article, we have traced the wood supply strategies of two of the government's priority pulp mill projects: APP's Hainan Jinhai mill and the planned Fuxing mill project. Based on existing plantation establishment, we anticipate that both mills are likely to face fiber shortfalls over the medium term, and in APP' s case, these shortfalls will be quite substantial. Significant new investments in plantation development will be needed to provide an adequate fiber supply at the mills' projected capacity levels. This will need to involve not only expansion of annual planting programs, but also measures to increase productivity levels and to mitigate risks at plantation sites. In particular, it will be essential to expand the genetic diversity in the region's plantation resource base to strengthen protection against pests and diseases.

The need to raise productivity and to expand plantation development is particularly urgent in the case of the APP Hainan Jinhai mill, which began BHKP production trials in November 2004. To the extent that existing plantation resources are insufficient to meet the currently installed capacity, the mill will be forced to ship in wood from other parts of China or from external sources – which could include, for instance, forested parts of the Mekong region or Indonesia (Barr 2004). Given APP's experience in Indonesia – and more recently, in China's Yunnan Province – it is conceivable that fiber shortfalls at the Hainan mill could place new pressures on natural forests in supplier countries (Greenpeace 2004; Lang 2002; Barr 2001).

Estimates of the delivered wood costs for the APP Hainan Jinhai mill and the proposed Fuxing mill suggest that the cost of wood produced by state-owned forest farms will often be in the range of US$ 20-25 per tonne. By contrast, the cost of wood grown on land that has been leased by the companies or on collective land managed through outgrower schemes will often range between US$ 30 and US$ 40 per tonne, depending in part on the distance the wood needs to be transported. These costs are significantly higher than the delivered wood costs reported by producers in Indonesia and in Brasil. This, in turn, raises fundamental questions about the competitiveness of wood-based pulp production in China, particularly when substantially cheaper pulp is readily available on the global market.

The wood supply strategies of both mill projects examined in this study highlight the importance of providing secure benefits for local communities. In both cases, the pulp producers will depend heavily on collectively owned land to secure their respective plantation bases – whether these areas are leased by the companies or developed through outgrower schemes with rural households and/or farmer cooperatives (Cossalter 2004a). In either case, it will be important for the companies involved and local governments to ensure that participating farmers have secure land tenure, clear incentives for growing pulpwood, and fair payment for the wood they produce (Lu Wenming *et al.* 2002). Given the large volumes of wood that will potentially be consumed by the pulp mills currently planned for South China, the development of fast-growing plantations through company-community partnerships could hold considerable promise as a strategy for raising farmers' incomes. However, experiences from other countries suggests that plantation outgrower schemes can also pose significant risks (Nawir et al. 2003; Mayer and Vermeulen 2002). Further analysis will therefore be needed to assess the strengths and weaknesses of various models for such partnerships and to evaluate the likely socio-economic impacts of pulp and plantation projects on surrounding communities.

More generally, there is a critical need for improved government planning and regulation with respect to large-scale kraft pulp mill projects. In particular, it will be essential for government planning agencies at the national and provincial levels to ensure that a fully legal and sustainable supply of wood fiber is secured before new pulp processing capacity is installed (Barr 2004). This will require close coordination between the agencies responsible for industrial licensing – i. e. the National Development and Reform Commission (NDRC) and its provincial counterpart – and the State Forest Administration and provincial forestry bureaus. Given the very large scale of modern pulp mills, which now routinely have single production lines of 700,000 tonnes or more, there is also a need for pulp producers to develop accountable plans for meeting sustainability targets on key social and environmental issues (Spek 2004). Government agencies at the national and provincial levels should monitor the companies' implementation of these plans to ensure that key targets are being met.

Finally, there is a need for stronger financial due diligence practices, particularly on the part of China's state banks, to assess both the economic risks and the social-environmental impacts of pulp capacity expansion projects (Spek 2004). Given the large amounts of capital required, kraft pulp mills are generally associated with high levels of moral hazard, as APP's financial troubles in recent years have demonstrated. In particular, there is a need for investment institutions to involve forestry experts in evaluating pulp producers' fiber supply strategies before new processing capacity is financed (Barr 2004). China's state banks would likely benefit from participating in the Equator Principles initiative, sponsored by the World Bank Group's International Finance Corporation (IFC), and other international efforts to raise investment standards for socially and environmentally sensitive projects (Spek 2004).

REFERENCES

AMERICAN FORESTS & PAPER ASSOCIATION (AF&PA). 2004. China's fiber resources and forestry industry development. [http://www.afandpa.org/].

ASPREM, M., LOPES, R., SHAW, J. 2004. The paper and packaging sector. Unpublished presentation prepared by the Global Securities Research and Economics Group at Merrill Lynch, Pierce, Fenner, and Smith Incorporated, dated April 21.

BARR, C. 2004. Risk analysis and impact assessments for pulp and plantation investments: the case of Indonesia. Presentation prepared for the International forum on investment and finance in China's forestry sector, Beijing, September 22-23. [http://www.forest-trends-ftp.org/resources/meetings.htm#Beijing_2004].

BARR, C. 2001. Profits on paper: the political-economy of fibre and finance in Indonesia's pulp and paper industries. In Barr, C. Banking on sustainability: structural adjustment and forestry reform in post-Suharto Indonesia. Center for International Forestry Research (CIFOR) and WWF Macroeconomic Program Office, Washington, D. C.

BARR, C. and COSSALTER, C. 2004. Investment in China's pulp and plantations sector. Presentation prepared for APPITA Asia conference, Canberra, April 18-19.

COSSALTER, C. 2004. Does China have a comparative advantage for growing pulpwood? Presentation prepared for the International forum on investment and finance in China's forestry sector, Beijing, September 22-23. [http://www.forest-trends-ftp.org/resources/meetings.htm#Beijing_2004].

COSSALTER, C. 2004. Pulp industry expansion and new wood fibre demand in southern China. Presentation prepared for conference on the future of forests in East Asia and China, sponsored by Forest Trends, Kuala Lumpur, October 7-8. [http://www.forest-trends-ftp.org/resources/meetings.htm#KualaLumpur_2004].

GREENPEACE. 2004. Investigate report on APP's forest destruction in Yunnan. Hong Kong, 34 pp., dated November. [http://www.greenpeace.org/china_en/reports/ex-summary?item_id=683851&archived=&campaign_id=].

HE, D. and BARR, C. (In this issue). China's pulp and paper sector: an analysis of supply-demand trends and medium term projections. *International Forestry Review*.

JAAKKO PÖYRY. 2000. China forest industries: opportunities and challenges - pulp and paper. 1st edition, Jaakko Pöyry Consulting, Helsinki, 186 pp.

KUUSISTO, I. 2004. Trends and developments in the Chinese pulp and paper industry. Presentation prepared for the International forum on investment and finance in China's forestry sector, Beijing, September 22-23. [http://www.forest-trends-ftp.org/resources/meetings.htm#Beijing_2004].

LANG, C. 2002. The pulp invasion: the international pulp and paper industry in the Mekong region. World Rainforest Movement (http://www.wrm.org.uy/countries/Asia/mekong.html).

LU WENMING, LANDELL-MILLS, N., JINLONG, L., XU, J., and CAN, L. 2002. Getting the private sector to Work for the public good: Instruments for sustainable private sector forestry in China. International Institute for Environment and Development, London, 168 pp.

MAYER, J. and VERMEULEN, S. 2002. Company-community forestry partnerships: from raw deals to mutual gains? International Institute for Environment and Development, London, 176 pp.

NAWIR, A., SANTOSO, L., and MUDHOFAR, I. 2003. Towards mutually-beneficial company-community partnerships in timber plantations: lessons learned from Indonesia. CIFOR working paper no. 26. Center for International Forestry Research, Bogor, Indonesia, 77 pp.

ROBERTS, D. 2004. China and the global paper and forest products industry: a focus on fibre. Presentation prepared for the Mega-trends workshop, Center for International Forestry Research (CIFOR), Bogor, Indonesia, November 29-30.

SPENCER. C. 2004. A European investor's view of the Asian paper & steel industry. Unpublished presentation prepared by Morgan Stanley, London, dated June 8.

SPEK, M. 2004. Pulp mill finance: an appraisal of risk management and safeguard procedures and implications for China's industry transformation. Presentation prepared for the International forum on investment and finance in China's forestry sector, Beijing, September 22-23. [http://www.forest-trends-ftp.org/resources/meetings.htm#Beijing_ 2004].

STATE FOREST ADMINISTRATION (SFA) 2002a. The fast-growing high-yielding timber forest base development program. Unpublished document.

STATE FOREST ADMINISTRATION (SFA) 2002b. The tenth five-year plan for the development of China's national forest industry. Beijing.

URS FORESTRY. 2002. The Chinese pulp and paper industry: present position – future prospects. 1st edition, URS Australia Pty Ltd., Hobart, Australia, 212 pp.

WRIGHT, R. 2004. Defining the China market for pulp, paper, and board. Presentation prepared for the International forum on investment and finance in China's forestry sector, Beijing, September 22-23. [http://www.forest-trends-ftp.org/resources/meetings.htm#Beijing_2004].

Chinese collective forestlands: contributions and constraints

GUANGPING MIAO● and R. A. WEST■

● *Deputy Director, Economy Restructuring Research Division, China National Forestry Economics and Development Research Center (FEDRC), Beijing, P. R. China*
■ *Research Associate, Forest Trenfs, Washington, D. C., USA and Associate Fellow, College of Humanities and Development (COHD), China Agricultural University (CAU), Beijing, P. R. China*

Email: mikebj312@263.net

SUMMARY

Collective forests form the majority of China's forested area and have proven to be critical in maintaining the livelihoods of hundreds of millions of rural inhabitants, supplying wood and other forest products for China's burgeoning demand, and providing critical environmental services. This paper describes the key policy and institutional dimensions of China's collective forests and how collective forest property rights are defined both in law and in practice. The national and provincial distributions of collective forests are presented. The paper assesses the impacts and implications of critical national policies, including the National Forest Protection Program (NFPP), the expansion of the public protected area system, the Forest Ecosystem Compensation Program (FECP), the system of taxes and fees, and the log-harvesting quota. It concludes with recommendations regarding policy reforms that would strengthen the collective forest sector and increase its contribution to poverty alleviation, rural development, and sustainable forest conservation.

Keywords: collective forests, community forests, China, forest policy, tenure

INTRODUCTION

Collective forests are an important part of Chinese forests, making up some 60 % of the total forest area and contributing an ever-increasing share of timber and wood fibre to industry. The forests are also vital to hundreds of millions of rural dwellers and provide environmental services to a nation under great population pressure. However, fluctuating forest policy and mandatory programs over the last sixty years have resulted in a sector characterized by tenure insecurity and inefficiency. This paper introduces China's collective forests and then goes on to describe current policy measures that influence their productivity and contribution to rural development. The paper concludes with recommendations for policy reform for consideration by Chinese policymakers.

THE EVOLUTION OF COLLECTIVE FORESTLANDS

The history of collective forestland ownership in China is rife with discontinuity, contributing to tenure and regulatory conflicts and leading to difficulties in developing policies that promote sustainable forestry. Prior to the founding of the People's Republic of China in 1949, forestlands were predominately privately owned by an elite minority, however there were communal and state forestlands. This was the case across China with the exception of Tibet[1] and the frontier regions of Yunnan and Sichuan, where substantial tracts of forest were collectively managed territories held by ethnic minorities (Liu Dachang 2001). After the revolution, the Chinese Communist Party launched what was the first of many dramatic changes in forestland ownership. The new government initiated a Land Reform Campaign in which land was redistributed equally to the rural population.

To initiate a planned, centralized economy, the government began reorganizing rural society into elementary cooperatives[2] in the mid-1950s. This first government-initiated system of collective landholding pooled forest and agricultural resources and divided returns to individuals according to the proportion of land and other resources contributed to the collective. In the elementary cooperative, land was still privately owned owing to the Land Reform Campaign (Grinspoon 2002, Liu 2001) however, landowners lost some of their rights to individually manage. Elected leaders of the elementary cooperatives made management decisions. In many cases elementary coopera-

[1] This article uses the *pînyîn* system of Romanization for standard Chinese readings of words and place names, excepting locations that have established names in the English lexicon: Hong Kong, Inner Mongolia, Macao, Tibet, Yangtze River, and Yellow River.

[2] Elementary cooperatives ale also known as ‚lower stage cooperatives' (Grinspoon 2002) and are the equivalent of present-day natural villages or hamlets. The present governmental system groups natural villages together to form an administrative village.

tives initiated tree planting on private forestlands of cooperative members and on communal land allocated to the elementary cooperative, though the latter form of land ownership was less common at this time. Following the formation of elementary cooperatives, the central government formally recognized collective ownership of forest resources alongside state and private ownership (Grinspoon 2002), arguably a move to consolidate state control over land and natural resources, given that the only elections in China are at the village level and even these elected representatives have many obligations to higher level government.

At the end of 1956, 96 % of rural households' land was merged to form advanced cooperatives[3], amalgamating both private forestlands and those in elementary cooperatives, thus bringing private forestland ownership to an end. An advanced cooperative included hundreds of households and decision-making was further centralized. In 1958, the government launched the Great Leap Forward and made additional changes, promulgating a policy further aggregating landholding, by combining advanced cooperatives and transferring land ownership and decision-making to the commune[4]. In elementary and administrative cooperatives there was democratic representation in the groups responsible for governing land use. However, the state appointed commune leadership and thus the Party managed and administered collective land use. At the same time as the commune initiative, the government implemented a program to drastically increase steel and iron output by establishing small furnaces nationwide. The double initiatives of (1) the amalgamation of advanced cooperatives into communes and (2) the iron and steel production program resulted in mass deforestation and famine (Liu 2001).

The early 1960s was a time of retrenchment (Grinspoon 2002) and the government reverted forestlands back to advanced and elementary cooperative[5] management. The notable difference was that land ownership remained collective whereas, after the Land Reform Campaign, private land ownership was permissible in elementary cooperatives. During the period of retrenchment, the private ownership of fruit trees, non-timber trees, and previously private plantations was initially re-instituted (Liu 2001), though this was quickly rescinded during the Four Cleanups Campaign in 1964, a campaign that also sought to eliminate the corruption that contributed to the failure of the communes and the redistribution of land following the Great Leap Forward (Grinspoon 2002). From 1966 to 1976, the tumult of the Cultural Revolution embroiled China in a decade of strife that exacerbated forest mismanagement and deepened the insecurity surrounding rights to resources.

The definition of collective forestland in China is not static. In the period leading up to the Cultural Revolution, definitions included a variety of government-initiated management and ownership systems, ranging from village-level arrangements that grouped private landholdings and were governed by elected officials to township-level arrangements including thousands of households that were governed by state appointed officials. It is clear though that the meaning of collective forestland in China is different than elsewhere. Internationally, collective forests often refer to a voluntary or social grouping having rights much like those held by private forest owners, whereas in China, collective forests are often much more, if not wholly, government controlled. Fluctuating policies continued after the Cultural Revolution and the term collective forest remained complex.

THE BEGINNINGS OF CONTEMPORARY COLLECTIVE FORESTLANDS

Soon after the death of Mao Zedong[6] in 1976 another round of sweeping reforms occurred. Grinspoon (2002) and Liu (2001) record the most substantial changes, often translated into English as the Three Fixes, as follows: (1) Issuance of certificates to confirm forest resource tenure in hopes of stabilizing the sector, (2) distribution of non-forested land to rural households as family plots[7], and (3) introduction of the Contract Responsibility System (CRS)[8].

The forestlands upon which family plots are allocated remain collectively owned. As discussed, collective ownership assumes a variety of forms however, importantly, households have use and management rights over the land[9] and resources. It was not until 1998 that the revised Forest Law[10] granted transfer rights of the resources to households as well.

The CRS came about following the successes of the Household Responsibility System (HRS) in the agricultural sector. The CRS was introduced to the forest sector in the early 1980s, quickly growing to include

[3] Advanced cooperatives are also known as ‚higher stage cooperatives' and are the equivalent of present-day administrative villages (Grinspoon 2002).

[4] Communes are the equivalent of the contemporary township (Grinspoon 2002).

[5] At this time, advanced and elementary cooperatives became respectively known as production brigades and production teams (Grinspoon 2002, Liu Dachang 2002).

[6] Mao Zedong, founder of the People's Republic of China and its leader up until his death, is the *pînyîn* Romanization of his name. It is also commonly spelled Mao Tsetong or Mao Tsetung in non-Chinese literature.

[7] The Chinese word for this type of land is *zîliúshân*. Liu Dachang (2002) translates this term as family plots, while Grinspoon (2002) refers to it as freehold mountains.

[8] The Chinese word for the land set aside in the Contract Responsibility system is *zérènshân*. Liu Dachang (2002) translates this term as responsibility hills, while Grinspoon (2002) translates it as responsibility mountains.

30 million hectares and 57 million households (Liu and Edmunds 2003). This system contracts mostly non-timber forests and fuelwood forests to households, but the natural or administrative village collective often retains some control of cutting and product sales and the households have an array of schemes for sharing the benefits with the collective (Liu Dachang 2001). There are three primary forms of household responsibility management for forestlands. The first sees family plots managed in conjunction with responsibility hills. The second is the merger of individually contracted responsibility hills into a larger unit. Benefits are divided amongst the contributing households. Membership in this arrangement is not necessarily voluntary. The third and most common form is simply household management of the contracted responsibility hill (Liu Dachang 2001).

A further development was the advent of the Four Wastelands Auction Policy in 1992, whereby individuals are permitted to contract and lease degraded lands[11]. The rights accorded to these lands are similar to those of the family plots: The contractor possesses use rights for the land and the resources developed on the land (Grinspoon 2002, Liu Dachang 2001). According to Hyde *et al.* (2003), individual households now administer approximately 80 % of collective forests.

In addition to the aforementioned tenure arrangements, there is another category of land that is not allocated, leased, or contracted to individual households. These areas remain the property of either natural or administrative villages and are managed by that village government. This sort of shareholding system equally divides returns from the forest to villagers (Liu Dachang 2001). Liu and Edmunds (2003) report that this form of management was still present in each of the fifteen villages in which they conducted their research in Guizhou, Hunan, and Yunnan.

Other shareholding schemes exist too. Landholders pool their resources, either upon their own initiative or upon the behest of the government, and divide returns based upon the initial input. Such arrangements are often to supply wood and fibre to state and private companies (Liu Dachang 2001). Households that voluntarily form cooperative arrangements often retain more of the rights to their resources than obligatory schemes in which management decisions are not made by individual households. These schemes can be reminiscent of the pre-Cultural Revolution era as households may be forced to join a cooperative, violating the rights accorded them by law. A shareholding scheme may include all or part of a collective forest. If a collective forest has been parcelled out to individual households, then it is more likely that the collective forest would not be included in any one arrangement in its entirety, though this is not an absolute.

The preceding text highlights some of the more common types of collective forest arrangements. There is no catchall collective forestry ownership and management model. Grinspoon's (2002) research in Sichuan and Rozelle and Li's (1998) work highlight the diversity that exists between provinces, townships within in a county, villages within a township, and even between same-village institutions. The whole gamut exists, ranging from instances of county and village governmental ownership to household partnerships to shareholding arrangements. In each circumstance, rights, tenure security, decision-making, responsibilities, and distribution of benefits vary. Moreover, collective forests must often comply with national policies, regardless of ownership, without consultation, and with little opportunity for recourse. Therefore ultimately, collective forests are controlled by the central government, but the degree of involvement varies. In sum, there are so many variations of collective forests in China that the term itself no longer describes one set of attributes, although policies are frequently formulated and targeted to this category of land. Inevitably with unified policies targeted to such diverse realities, there are many problems, abuses, and unexpected outcomes, which might be avoided if policy were tailored to the ways in which land uses are actually decided and implemented on the ground.

COLLECTIVE FORESTS AND THE LAW

The Constitution of the People's Republic of China addresses the ownership of land and resources and makes the distinction between state and collective land[12]. The Forest Law of the People's Republic of China addresses forest resources specifically and differentiates between state and collective resources, stating that ‚forest resources shall belong to the state, unless the law stipulates they belong to the collective

[9] Since the land is designated forestland, rural households are not permitted to use it for other purposes, such as the cultivation of food crops, excepting fruit trees (Liu Dachang 2002).

[10] The available English version mistranslates the title as the Forestry Law of the People's Republic of China. We will refer to it, more accurately, as the Forest Law of the People's Republic of China throughout this paper.

[11] Degraded land is often translated to ‚wastelands' in English literature.

[12] Article 9 declares that ‚mineral resources, waters, forests, mountains, grassland, unreclaimed land, beaches and other natural resources are owned by the state, that is, by [all] people, with the exception of the forests, mountains, grassland, unreclaimed land and beaches that are owned by collectives in accordance with the law'. Article 10 states, ‚Land in the rural and suburban areas is owned by collectives except for those portions which belong to the state in accordance with the law, house sites and private plots of cropland and hilly land are also owned by collective (Peolpe's Congress 1999)'.

(People's Congress 1998)'. However, neither law defines the term ,collective', thus the ambiguity surrounding its definition is the root of many ownership and policy conflicts. In addition to these two broad property types, the Forest Law defines five classes of forests: Protection forests, timber forests, economic forests, fuelwood forests, and forests for special uses (People's Congress 1998).

(1) *Protection forests* aid in water storage, prevent soil erosion, act as wind blocks, inhibit desert and sand encroachment, stabilize river banks, shelter farmland and grassland, and line roadways.

(2) *Timber forests* function primarily to provide timber. Bamboo groves are included in this category of forest.

(3) *Economic forests* include orchards and other trees that produce foodstuff, medicinal products and industrial raw materials.

(4) *Fuelwood forests* are designated production areas for fuelwood.

(5) *Forests for special uses* include forest areas for national defence, experimental research, seed trees for propagation, and environmental protection[13], and forests of historical interest and aesthetic value[14].

RIGHTS IN PRACTICE

Collective forest property rights are intrinsically associated with ownership and indeed this is implied on numerous occasions in the preceding text about collective forestland regimes. Moreover, rights to forests are not always so simple and thus are accorded the following separate description. Zhang and Kant (2004) differentiate between physical asset rights and economic rights. Physical asset rights include use, management, and transfer rights. Theoretically, de-collectivized forestlands, like family plots, responsibility hills, and contracted land from wasteland auctions have such rights, though in practice there are many scenarios in which these rights are limited. For example, in some cases, forestlands are only permitted for certain uses or the species to be planted are determined by the government. Furthermore, there are numerous policies and initiatives, like the logging ban, creation of national parks, and forestlands for environmental services, that unilaterally restrict an owner's management options despite laws that guarantee due process and property rights protection. In addition, there are times when coercion is employed to force those with rights to forestland resources to join schemes involuntarily.

Transfer rights were affirmed in law in the Forest Law of 1998 and the Rural Contracting Law of 2002 and give forest resource owners the right to lease or contract the resources, though certain restrictions apply (Zhang and Kant 2004). For example, protection forests and forests for special uses are excluded from the list of forests for which transfer is permissible. Other obstructions to unimpeded use, management, and transfer rights include requirements for harvesting trees and transportation of logs, as well as, the prohibition of converting forestland to any other type of land use (Zhang and Kant 2004). Xu and Ribot (2004) document instances in which villages are issued forest harvest permits without forests. There are of course villages with forests, but without harvest permits, thus fuelling a black market in forest harvest permits.

Zhang and Kant (2004) describe economic rights as the right to benefit from forest resources. Use rights are often confused with economic rights. In China, for example, even if use rights are unrestrained, owners with the rights to forestland resources are frequently limited to selling their timber to state-owned timber companies and thus, the potential revenue diminished by limited market freedom. Taxes, fees, and charges are other factors that limit economic rights, but not necessarily use rights.

Government restrictions on property rights are not exclusive to China. In most nations, forestland owners do not have absolute freedom to act as they choose. For example, there are regulations that limit forest activities to protect among other things wildlife and waterways, the government can expropriate land, zoning demarcates areas for various uses, and there are taxes. However, China differs from many other nations in that often compensation for foregone activities due to governmental intervention is less than other market opportunities and recourse to contest government actions does not exist or is cumbersome. International experience exemplifies the ability of public and private forestlands to sustainably provide forest products without an impingement on rights (Taskforce on Forest and Grasslands 2002).

PRESENT SCOPE OF COLLECTIVE FORESTS

The terms forestland and forest are distinct in China. Forestland encompasses (1) forested land, (2) prospective forest areas, or (3) designated forestland yet to achieve the minimum requirements of a forest (Zhang *et al.* 1999). Currently, the minimum requirement for classification as forest area is 20 % canopy coverage[15]. The national statistics for the amount of land in each forest category is determined by extrapolating data from aerial photos and nationwide ground plot surveys[16]. Moreover, it must be mentioned that in many instances zoning generalizes across regions. For example, the Regulations for the Implementation

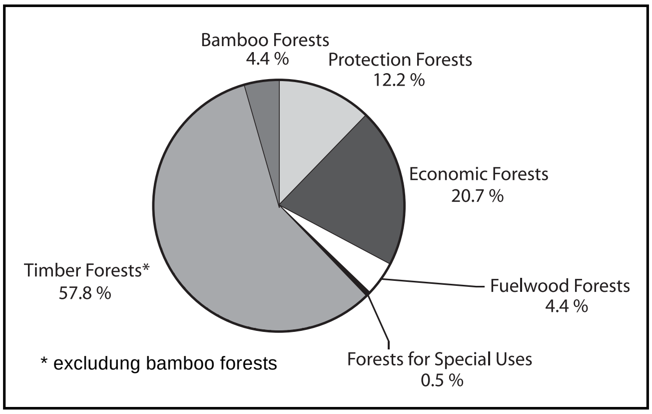
[13] Forests for special uses that are meant for environmental protection differ from the first category (protection forests) in that they are primarily for combating pollution.

[14] Note that state and collective forests for public benefit and forests compensated for ecosystem services can be included in either the protection forest or forests for special uses categories. As well, according to the National Park and Forest Tourism Management Division of the State Forestry Administration, national parks can be categorized in any of the five groupings.

of the Forest Law of the People's Republic of China, promulgated in January 2000, decrees that cultivation on sloping land with a gradient of 25 % or greater will cease and be planted with grass or trees (People's Congress 2000). Though the land may be classified as forestland, in practice some areas may not have been converted from their original farm use.

Across China[17] there are 257.0 million hectares of forestland and 153.6 million hectares of forest area, collective forests preponderantly account for almost 60 % or 89.7 million hectares of the total forest area. According to official statistics, over 60 % (55.8 million hectares) of collective forest area is comprised of timber forests, inclusive of bamboo forests and plantations[18]. Notably, there are an additional 10.9 million hectares of collective protection forests and 18.6 million hectares of collective economic forests. Conversely, there are relatively few collective forests classified as ‚forests for special uses', accounting for just over 400 000 hectares and less than 0.5 % of total collective forested area. Figure 1 shows the percentages of each collective forest category. 92.1 % of all economic forests (18.6 million of a total 20.2 million hectares) and 93.2 % of bamboo forests (3.9 million of a total 4.2 million hectares) are on collective forestland (State Forestry Administration 2000).

FIGURE 1 *Collective forests by category (%)*



Source: State Forestry Administration 2000

According to available data, China's forest area and volume is increasing (Hyde *et al.* 2003). The area and volume of timber forests, inclusive of bamboo forests and plantations, and economic forests experienced substantial growth in the last period between the two most recent forestland surveys. In each of the aforementioned forest categories, collective forests outperformed state-owned forests. However, as reported by Albers *et al.* (1998) monoculture forests and exotic tree species are replacing natural forests. These new forests supply valuable resources like wood and timber, but environmental consequences, like loss of biodiversity, are yet to be quantified.

According to the State Forestry Administration (SFA) (2003), 7.8 million hectares of forest plantations were established in 2002 and 81.3 % of them were on collective land. In total, 73.6 % of the nation's plantations are located on collectively owned land (SFA 2000). In 18 provinces, more than 90 % of total provincial plantation areas were composed of newly initiated plantations from 2002. Presently, there are plans to plant approximately 3 million more hectares of plantation forest by 2010 to meet the growing requirements of China's pulp and paper industries (Cossalter 2004).

Collective forests are found all across China, however, their proportions vary by province. In fact, the ten provinces[19] with the greatest area of collective forests account for 75 % or approximately 67 million hectares of the total. Collective forests predominate in southern China, earning those provinces the moniker Southern Collective Forest Region (*nánfâng jítî lín qu*)[20]. Indeed, nine of the ten aforementioned provinces are in southern China, while only Liaoning is situated in the north.

In 16 provinces, collective forests compose more than 80 % of their respective provincial total forest areas. Nine of these provinces have collective forest areas that exceed or equal 90 %[21]. Figures 2 and 3 show the proportion of forestland and forest area that are owned by collectives and the state for each province. The collective forestland and forest areas represented by striped bars are those listed in the Southern Collective Forest Region by Rozelle *et al.* (2000) and Katsi-

[15] This minimum was reduced from 30 % in 1996 to conform to international standards, at least partly explaining the oficially recorded increase in total forest area from 133.7 million to 153.6 million hectares in 1998 (Sayer and Sun 2003, Zhang *et al.* 1999). The amount of forest area in 1993 using the 20 % definition was never published and thus it is uncertain as to how much the actual forest area increased. Furthermore, the Chinese national statistics include bamboo forests, orchards, and shelterbelts, none of which occur regularly in other nations' forest data.

[16] According to the State Forestry Administration, the data used in this report are based on aerial photographs and 90,227 ground plots covering an area of over 57,000 hectares.

[17] This report does not include data from Taiwan, the Tibetan areas outside of military control, and the special administrative regions of Hong Kong and Macao.

[18] Chinese forest experts theorize tha the proportion of timber forests will decrease, as more forests are set aside for public benefit and included in government ecosystem service compensation programs. This will likely increase the proportion of protection forests. Mitigating the trend of decreasing timber forests will be the expansion of plantations.

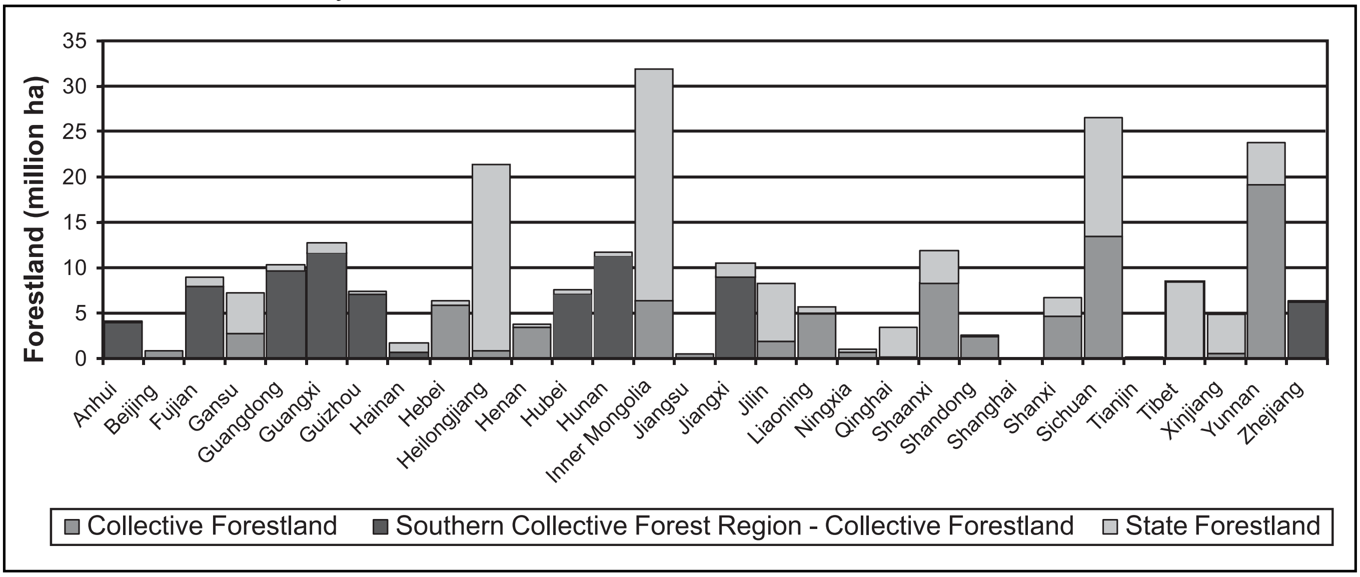
[19] In decreasing order, the ten provinces composing the majority of collective forest area are Yunnan, Hunan, Guangdong, Jiangxi, Guangxi, Sichuan, Fujian, Zhejiang, Hubei, and Liaoning.

[20] There is no one standard governing which provinces are included within the Southern Collective Forest Region. For example, Rozelle *et al.* (2000) include Fujian, Guangdong, Guangxi, Hainan, Hunan, and Jiangxi. Katsigris (2001) adds Anhui, Guizhou, Hubei, and Zhejiang to the group. Yin's (2003) list also includes these ten provinces, though he includes only part of Anhui, but goes further by adding parts of Jiangsu, Sichuan, and Yunnan.

gris (2001). This region has a population of over 480 million people, of which over 300 million, or almost 25 % of China's total population[22], live in rural parts of these ten provinces (State Statistics Bureau 2002).

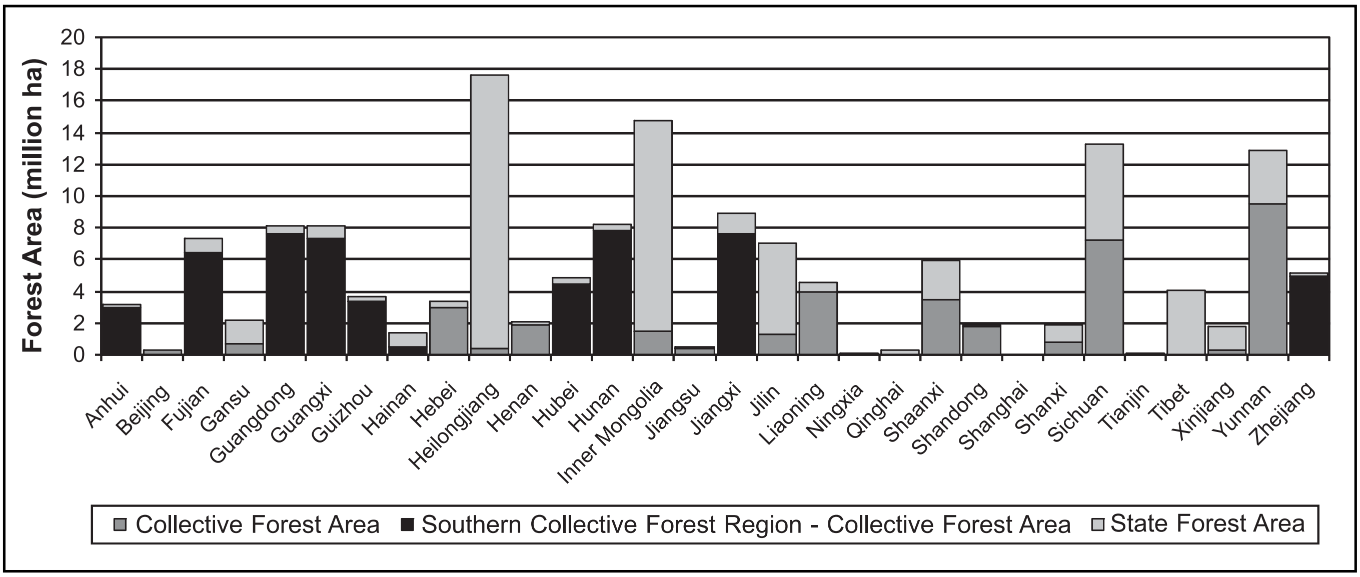
from state-owned land has declined. According to official statistics, 44.4 million m^3 of commercial timber and fuelwood was produced domestically in 2002, of which 20.5 million m^3 or 46.3 % came from collective forests (SFA 2003).

FIGURE 2 *State and collective forestland*



Source: State Forestry Administration 2000

FIGURE 3 *State and collective forest area*



Source: State Forestry Administration 2000

The growing importance of collective forests as a timber source is demonstrated in Figure 4. Since 1997, the proportion of domestic timber coming from collective forestland has steadily increased, while timber

In addition to the large percentage of timber originating from collective forests, many non-timber forest products also come from collective sources. In 2000, 67 million metric tons[23] of non-timber forest products (NTFPs) were produced, comprised mostly of fruit and amounting to 62 million tons (SFA 2003) and 7.6 billion US$[24] (Katsigris 2001). The Southern Collec-

[21] The nine provinces with collective forest areas that equal or exceed 90 % of total provincial forest area, in decreasing order, are Zhejiang, Hunan, Shandong, Guangdong, Anhui, Guizhou, Hubei, Henan, and Guangxi. The seven provinces with collective forest areas between 80 to 90 % of total provincial forest area, in decreasing order, are Beijing, Hebei, Fujian, Tianjin, Liaoning, jiangxi, and Shanghai.

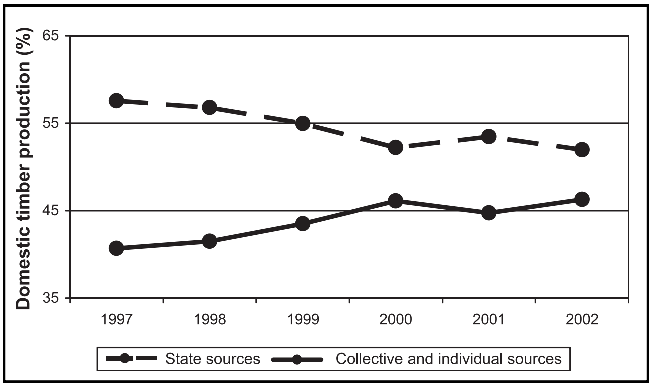
[22] According to the national census of 2000, there were 1.26 billion people in China.

[23] All subsequent tons are metric tons.

[24] All subsequent dollars will be U. S. dollars.

tive Forest Region produced the majority of the following products: Camellia oil[25] (97 %), dried bamboo shoots (93 %), resin (88 %), palm sheets (64%), and tallow[26] (61 %) (SFA 2003). Collective forests also yield great amounts of fuelwood. According to the SFA (2003), from 1997 to 2002, roughly 7 % of timber production was for fuelwood purposes.

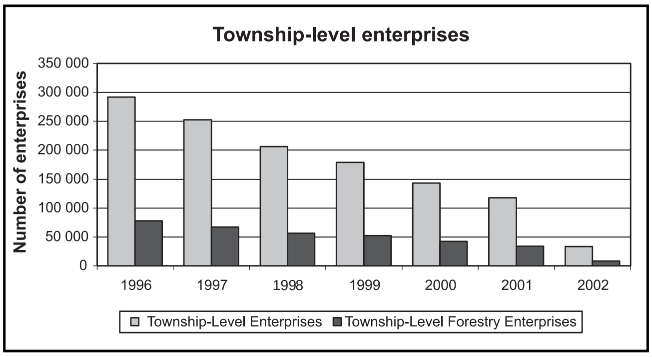
FIGURE 4 *Domestic timber production*



Source: State Forestry Administration 2000

At present, there is no national data on small-scale forest enterprises or on the contribution of collective forestry enterprises to the economy. The closest indication of the contribution of local and collective-level enterprises comes from township-level surveys of enterprises, including forestry enterprises. These statistics only include forestry enterprises with production

FIGURE 5 *Quantity of township enerprises*

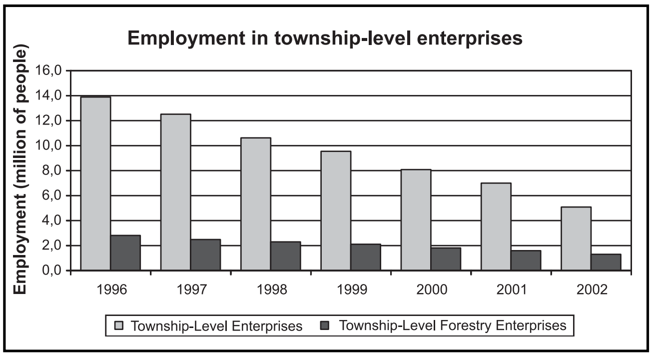


Source: China Township Enterprise Yearbook 1997-2001

value greater than or equal to 5 million CNY[27] (approximately $ 600 000). More importantly, the township-level data show the importance that the forestry sector plays at the local level. In 2002, there were 8 120 township-level forestry enterprises across China (China Township Enterprise Yearbook 1997-2001). Over 24 % of all township-level enterprises were in the forest sector, which was broadly divided into the following four categories: (1) Bamboo and timber harvesting and transportation, (2) timber, bamboo, and rattan processing, (3) furniture production, and (4) paper and paper products processing. Figure 5 illustrates the decreasing number of township-level enterprises from 1996 to 2002. This decrease is attributed in part to the increasing trend of privatizing enterprises that were previously state run.

During this period of decline, township-level forestry enterprises more or less maintained their share

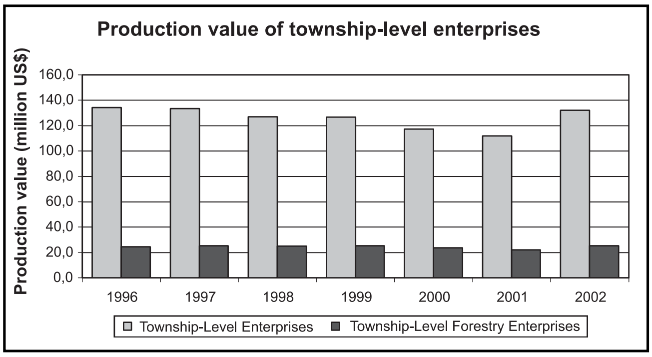
FIGURE 6 *Employment in township enterprises*



Source: China Township Enterprise Yearbook 1997-2001

within total township-level enterprises, dropping slightly from a share of 26.9 % in 1996 to 24.4 % in 2002. Employment data for township-level forestry enterprises is shown in Figure 6 and displays a similar downward trend to that for the quantity of township-level forestry enterprises. Employment in township-level forestry enterprises reduced from 2.8 million in

FIGURE 7 *Production value from township enterprises*



Source: China Township Enterprise Yearbook 1997-2001

1996 to 1.3 million in 2002. However, forestry enterprises' share of total employment in township-level enterprises rose from just under 20 % to almost 26 % over the same period.

Figure 7 exhibits the production value of the township-level enterprises. Despite the decrease in employment and quantity of township-level enterprises, the state statistics show that the production value remained relatively stable, going from $ 134.2 million in 1996 to $ 132.0 million in 2002. According to the data, the forestry segment actually increased its production output from $ 24.6 million to $ 25.4 million over the same period. Given that the number of township-level forestry enterprises decreased by almost 90 % coupled with the loss of approximately 1.5 million jobs

[25] This product comes from *Camellia* spp.

[26] This product comes from *Sapium sebiferum*.

[27] US$ 1.00 equals 8.28 CNY.

between 1996 and 2002, the growing production output is intriguing. Despite further investigation, we were unable to satisfactorily determine why the production output did not decrease along with employment and the number of enterprises. The statistics from the township-level forestry enterprises are just one component of the forestry sector and do not fully represent the contribution that forests make to rural China. In particular, the contribution of numerous collective forestry enterprises falls below the minimum production output value that the China Township Enterprise Yearbook (1997-2001) uses as a minimum in their survey of enterprises and thus is not captured in the data presented.

Collective forests contribute significantly to livelihoods and poverty alleviation in the Southern Collective Forest Region and across China, and in many places forest resources yield valuable benefits. In some regions, forest resources are the primary source of income (Zheng 2003). However, in other areas rich with forest resources, poverty prevails. Often, forest areas are in remote regions where easy access to forest resources is inhibited by distance from markets and terrain. Of the 592 counties deemed officially poverty-stricken, 496 were in mountainous regions (Chen 1996), areas afflicted by the isolation in which forest resources persevere. Li and Veeck (1999) demonstrated a correlation between plentiful forest resources and poverty.

Why such abject poverty remains amidst the abundance of valuable resources presents a challenging dilemma. For one, several programs and policies infringe upon rights to resources and impede rural inhabitants from benefiting from their surrounding resources. According to Ruiz Pérez *et al.* (2003), in their research on bamboo forests, the important contribution that bamboo forests make to local economies are ‚instructive of the potential contribution of commercial timber production to poverty alleviation and rural development. If some of the taxes and regulations that act as disincentives for traditional forest investment were reduced, then timber production and the general performance of the timber sector could follow more closely many of our observations for bamboo‘.

Rozelle *et al.* (1998) show the significance of population, land quality, wealth, and tenure as factors that influence forest cover and volume. High-quality agricultural land and wealth from industrial growth both increase forest cover and volume, offsetting the negative impact of a growing population. The authors also demonstrate the significance of tenure, showing collective forest areas to be better at increasing forest cover than state-owned forests. Similarly, Zhang *et al.* (2000) find that de-collectivization to household responsibility management upon implementation of the CRS and decreasing profitability from agricultural land both increase forest area. Conversely, Rozelle *et al.* (1998) show that forest policies to date resulted in decreasing forest cover.

Key policies affecting the collective forest sector include the logging ban component of the Natural Forest Protection Program (NFPP)[28], national parks, the Forest Ecosystem Compensation Program (FECP)[29], the system of taxes and fees, and the harvest quota. Each will be discussed in turn.

NATURAL FOREST PROTECTION PROGRAM

The pilot phase of the NFPP was implemented in 1998 and 1999, before the program was launched in its entirety in 2000. The program was developed after drought and intensive irrigation agriculture halted the flow of the mighty Yellow River for the majority of 1997 and following severe flooding on the Yangtze River the subsequent year. The program has three primary elements: (1) Complete logging bans in the upper Yangtze River[30] and mid-to-upper Yellow River[31] and diminished logging in state-owned forests, (2) reforestation and silvicultural treatments for particular forestlands, (3) provision of alternative employment and pensions of state enterprise employees. The ban was designed for specific zones of environmental significance and for state forest regions. However, in 2001, the autonomous region of Xinjiang instituted a complete logging ban in all natural forests regardless of ownership, apparently to impress the central government. Likewise, Sichuan and Yunnan introduced similar logging bans, which were subsequently condoned by the central government (Zuo 2001a).

In many places across China, the logging ban was extended to collective forests (some 26.8 million hectares according to an SFA survey of the NFPP in 2003) including a ban on the harvest of fuelwood and wood for non-commercial use, raising questions of the legality of such action, considering that the Constitution and Forest Law affirm the ownership of forestlands by collectives. Zuo (2001a) describes how in the most excessive scenarios, communities are even prohibited from accessing NTFPs and fuelwood, either by mandate or from the deactivation of infrastructure like roads and bridges. Katsigris (2001) reports drastic economic reductions across many regions of China with natural forests, notably in communities and households. In 2000 in Sichuan, for example, the output

[28] This program is also referred to as the Natural Forest Conservation Program (Waggener 2001, Yang 2001, Zhang and Kant 2004).

[29] This program is also referred to as the Forest Ecological Benefit Compensation Program (SFA 2002, Lu *et al.* 2002, Sun and Chen 2002) and translated in the Forest Law as the ‚forestry ecological efficiency compensation fund‘. Existing literature seems to use ecological, ecosystem, and environmental interchangeably. Periodically, fund or scheme is substituted for program.

[30] This includes the provinces of Chongqing, Guizhou, Hubei, Sichuan, Tibet, and Yunnan.

[31] This includes the provinces of Gansu, Henan, Inner Mongolia, Ningxia, Qinghai, Shaanxi, and Shanxi.

of timber from collective forests reduced to 6 % of past levels and resulted in a provincial loss of $120.8 million. Concurrently, employment and the number of township-level forestry enterprises were more than halved. Chen *et al.* (2001) support these claims with findings of their own that document township incomes plummeting from 1998 to 2002: In one township, annual income reduced over 75 %. The authors, along with Yang (2001), also document the decrease in taxes collected and allude to difficulties that township governments face with less revenue. In his investigation in Yunnan, Zhao (in prep.) reports that by denying communities use of their forests, the NFPP has dramatically reduced their active management, indicated by a rise in illegal forest activities, a shift from community protection patrols to policing by government forestry officials, and a declining level of effort to prevent and combat forest fires.

TABLE 1 *Collective forest area within the NFPP*

Province		**Forestland** (hectares)	**Forest area** (hectares)	**NFPP area** (hectares)
Gansu	total	7 208 700	2 174 100	2 430 500
	collective	2 806 800	664 500	708 800
Guizhou	total	7 407 100	3 673 100	4 470 700
	collective	7 013 300	3 404 100	4 154 100
Henan	total	3 786 400	2 090 100	617 700
	collective	3 457 300	1 886 900	507 300
Hubei	total	7 640 900	4 828 400	2 779 200
	collective	7 059 200	4 419 400	2 384 300
Jilin	total	8 297 400	7 069 800	3 670 000
	collective	1 842 900	1 298 500	10 000
Ningxia	total	1 004 000	146 400	719 900
	collective	683 300	67 100	436 500
Qinghai	total	3 379 500	308 800	1 927 300
	collective	102 700	26 800	83 300
Shaanxi	total	11 974 900	5 920 300	6 368 000
	collective	8 322 700	3 457 900	3 927 700
Shanxi	total	6 764 700	1 835 800	1 546 700
	collective	4 605 300	818 500	491 400
Sichuan*	total	26 579 100	13 301 500	14 641 300
	collective	13 455 800	7 220 800	7 270 600
Yunnan	total	23 807 900	12 873 200	9 237 500
	collective	19 149 000	9 519 400	6 833 300

* includes the data for Chongqing

Table 1 lists the key provinces in the NFPP, the amount of forest area covered by the program, and the portion of that area that is composed of collective forests. In Chongqing[32], Guizhou, Henan, and Hubei, more than 80 % of the NFPP area is composed of collective forests. Though Sichuan and Yunnan have proportionally less collective forest area within the NFPP, the provinces have allocated 5.8 million hectares and 6.8 million hectares of collective forests to the program.

It is generally argued that the NFPP infringes upon the rights of collective forest owners in two ways: Firstly, collective forest owners' rights to their forests, guaranteed them both in the Constitution and the Forest Law, were unilaterally denied them, as their forests were included in the NFPP without consultation during the program's design. The logging ban component of the program is compulsory and does not give owners recourse to contest. Secondly, the program does not include an instrument to compensate collective forest owners for the economic losses accrued as a result of the logging ban. Reneging on the rights of and denying the benefits accorded to collective forest owners contravene legislation, aggrandize tenure insecurity, and curtail incentives to invest in the sector.

THE EXPANSION OF PUBLIC PROTTECTED AREAS AND NATURE RESERVES

Public protected areas and nature reserves in China have historical roots dating back over two thousand years, first documented in the Qin and Han dynasties (Xu in prep.). In 1956 the central government founded the first nature reserve in modern-day China (Harkness 1998, Menzies 1994, Xu in prep.). Following the Great Leap Forward and the Cultural Revolution, the creation of nature reserves increased quickly, so that by 1999, there were 1 146 nationally protected nature reserves in China receiving funding worth $ 16.1 million in the previous year (Lu *et al.* 2002). By 2002, the number of nature reserves grew to 1575, encompassing 133 million hectares, and accounting for over 13 % of China's total land area. By 2050, the government is proposing 2500 nature reserves totalling more than 170 million hectares and roughly 18 % of the national land area (Xu in prep.).

Given the long history of human habitation in virtually all of what is now modern China, there have long been conflicts between communities and advocates of protected areas and these issues have only increased in recent years as the ambitious expansion plans have been implemented (Xu in prep.). Several concerns exist from a collective forest perspective. Firstly, communities and stakeholders have not often been consulted or their views considered during the process of establishing a nature reserve. There are numerous instances in which protected areas were delimited on maps before determining land and resource ownership. The expropriation of collective forestland, to establish protected areas, violates the rights held by legitimate owners and is often accom-

[32] Chongqing was split from Sichuan in March 1998 and its forestlands and forest areas are included in the 1998 statistics fo Sichuan. To compare the NFPP data with the provincial forestland and forest area data, the areas from Chongqing and Sichuan have been combined in the table. The areas of collective forestland and forest in Chongqing are 1,728,700 and 1,464,700 hectares respectively. The areas of collective forestland and forest in Sichuan are 12,912,600 and 5,805,900 hectares respectively.

panied by losses of rights for communities and insufficient compensatory provisions.

There are many examples of growing rural poverty and illegal activities in and around protected areas (Démurger and Fournier 2004, Harkness 1998, Xu in prep.). Xu (in prep.) documents one instance in which community members protested the expropriation of their collective forests for a nature reserve by destroying the very forests they had previously managed. Xu *et al.* (1999) describe the forest management of the Hani minority nationality in Yunnan as effectively ensuring sustained forest conservation. Harkness (1998) confirms that the government has at times wrested control of well-managed collective forestland from its owners and put it under weaker state control - thereby diminishing chances to achieve conservation goals. Though protected area managers acknowledge that economic development and agreements with locals inhabitants are prerequisites for the success of protected areas (Albers and Grinspoon 1997), the preceding examples illustrate that there are not only property and legal issues that merit greater attention and care, but that the fundamental approach of expropriating collective forestland by the government and replacing it with public ownership and administration merits rethinking. Alternative and complementary approaches that strengthen community rights and capacities to conserve their forests should be sought (Xu in prep.).

FOREST ECOSYSTEM COMPENSATION PROGRAM

Since the late 1970s, the Chinese government has initiated a number of programs aimed at restoring or protecting forests, in addition to the creation of public protected areas. The largest of these, in terms of scope and funding, have been the shelterbelt programs, all of which have been the subject of much domestic and international scrutiny. These have included the ‚Three-North', Yangtze River, Coastal, and Farmland Shelterbelt Development Programs. The projects continue to this day, though they have been united to form the Key Shelterbelt Development Program - one of China's six key forestry initiatives[33]. Extensive afforestation was the most publicized achievement of the programs. The same catastrophic environmental events that spawned the NFPP, gave rise to another program: The Sloping Land Conversion Program (SLCP)[34] (See Zhigang Xu in this issue). After some experimentation in Gansu and Sichuan in 1999, the pilot phase began in 13 provinces in 2000 and was broadened to 20 provinces by 2001. The general concept of the program was to convert cropland on steep slopes prone to erosion to forestland and grassland, compensating farmers with grain, money, and saplings (Zuo 2001b). The programs resulted in the regulations governing the implementation of the Forest Law in 2000. The regulations suggested that 30 % of forests be set aside for ecological benefit, although there was no legal obligation for provinces to adhere to this benchmark. The initial program compensated 13.3 million hectares in 11 provinces[35] with an annual budget of $ 120.7 million, or just greater than $ 9 per hectare. Seventy percent of the funding is to go to the owner or contractor that has rights to the resources, while 30 % is for administrative use (Zuo *et al.* in prep.).

In many provinces, forestry bureaus have identified regions of public benefit, jockeying for inclusion in the program. Sun and Chen (2002) report that 64 % or 8.5 million hectares of the forestland within the program is collectively owned. Of the collective forestland within the program, collective forestry farms own six %, signifying that the vast majority is under household management. There is concern that participation in the FECP, particularly in collective forest areas, is not voluntary. Indeed, Sun and Chen (2002) raise other issues pertinent to the program's long-term success. The FECP does not compensate the market value for the ecosystem services that the forestland yields to forest owners. Rather, the $ 9 per hectare is an arbitrary amount and in many circumstances does not adequately recompense for foregone activities. Qu (2002) reports that in Guangdong, there is a tremendous opportunity cost for participating, as compensation is one-tenth of the foregone revenue from other activities. Similar shortcomings are found in Anhui (Liu Yongchun 2002) and in Hunan (Zuo *et al.* in prep.). The latter authors describe that a foremost concern of participants is the balance between subsidy gains and management and use rights losses. Another puzzling absence is that of clear objectives for the FECP (Sun and Chen 2002). The FECP can manage for any of the following: Protected areas, biodiversity, non-timber forest products, tourism, hydrological functions, and carbon sequestration (Lu *et al.* 2002, Sayer and Sun 2003). Though collective forests are a valuable source of environmental service benefits, forestry bureaus have rushed to include forests while offering forest owners little option but to join a program that compensates poorly and further augments tenure insecurity and mounting mistrust between collective forest owners and governmental institutions.

[33] The other five programs are the NFPP, ste Sloping Land Conversion Program, the control of desertification, wildlife conservation and nature reserves, and the development of a forest industrial base.

[34] This program is also known as the Cropland Conversion Program (Gao 2001, GE *et al.* 2001, Li et al. 2001, Sichuan Academy of Social Sciences 2001, Zhao 2001), Tuígeng Huánlín (Grant 2001), Land Conversion Program (Liu Shuren 2002), Program for Conversion of Cropland to Forest (SFA 2002), and the Grain for Green Policy (Uchida, Xu, and Rozelle 2003).

[35] The original provinces were Anhui, Fujian, Guangxi, Hebei, Heilongjiang, Hunan, Jiangxi, Liaoning, Shandong, Xinjiang, and Zhejiang.

TABLE 2 *Areas of collective forest within the FECP*

Province	Total forest area in FECP (hectares)	Collective forest area in FECP (hectares)	Subsidy (million US$)
Anhui	800 000	618 400	7,2
Fujian	866 670	690 270	7,8
Guangxi	233 333	199 640	21,1
Hebei	126 667	97 160	11,5
Heilongjiang	166 667	9 613	15,1
Hunan	200 000	171 193	18,1
Jiangxi	126 667	72 373	11,5
Liaoning	140 000	116 487	12,7
Shandong	53 333	41 420	4,8
Xinjiang	100 000	0	9,1
Zhejiang	20 000	16 173	1,8
Total	2 833 337	2 032 729	120,7

TAXES, FEES, AND CHARGES

Taxes, fees, and charges are additional factors that limit China's poorer regions from maximizing the benefits of their surrounding forest resources. Liu and Landell-Mills (2003) succinctly summarize the situation, stating that ‚China's forest taxes are high, and its system of taxes and fees on forestlands and forest products is complex'. The system of taxes, fees, and charges is widely variable, but it often exceeds half of gross revenue. Moreover, the impacts reach further than the pocketbook, worsening social and environmental conditions.

Government agencies are not permitted to introduce taxes. However, they are able to collect taxes introduced by the central government. The taxes fail to yield sufficient funding for the agencies and local governments to operate, thus they acquire extra revenue from fees and charges, which they are able to implement[36]. Over time, fees and charges have accumulated, creating a complicated and restrictive system that characterizes the situation of today. The taxes and charges common to state and collective forestlands are as follows: (1) Special agricultural products tax, (2) value-added tax, (3) education value-added tax, (4) urban construction and maintenance tax, (5) income tax, (6) afforestation charge, (7) maintenance and upgrade charge, (8) forest protection and construction charge, and (9) forest quarantine charge (Lu *et al.* 2002, Liu and Landell-Mills 2003[37]).

In addition to these national taxes and charges, there exist four provincially mandated charges within the Southern Collective Forest Region: (1) Forest restoration charge in Fujian and Guizhou, (2) insect and disease control charge in Jiangxi, (3) fire protection charge in Jiangxi, and (4) administration charge in Jiangxi (Liu and Landell-Mills 2003). To confuse matters further, there are many unofficial charges, not to mention any of the fees. In one example from Jiangxi, unofficial charges accounted for nearly 11 % of roadside log value (Liu and Landell-Mills 2003, Liu 2003, Lu *et al.* 2002).

On numerous occasions it has been shown that forest farmers turn away from timber production due to burdensome taxes. In Guangxi, evidence showed farmers selling timber as fuelwood at $ 19.30 per ton rather than at $ 60.39 m^3, due to lower taxes and ease of transaction (Liu et al. 2003). In Hunan, an example from one county demonstrated how farmers there only received 10 % of a log's value after taxes, charges, fees, and other costs: A trifling $ 9.66 for twenty years' growth. In comparison, there were few taxes on fruit and fuelwood and the returns on those ventures greatly exceeded the timber option (Li *et al.* 2003). There was further indication that farmers increasingly involved themselves in non-timber forest product industries over timber industries (Cai *et al.* 2003).

Liu and Landell-Mills (2003) suggest that the present rate of taxes, charges, and fees encourages illegal logging. They theorize that lowering taxes, charges, and fees would mitigate the enticement to avoid their payment. Misspending the revenue collected from taxes and charges is an issue that perpetuates the ineffectiveness within collective forestry. Most of the revenue is meant for developing various aspects of the sector, though forestry agencies siphon much of it for salaries and operational costs (Yin and Xu 2002). The revenue's intended purposes remain financially neglected and problems persist.

THE LOG-HARVESTING QUOTA

In 1985, a harvest quota (often termed ‚annual allowable cut') controlling the commercial harvesting of logs, was instituted nationally for all forestland irrespective of ownership. Forest harvest quotas are commonplace in other countries around the world, however they are almost exclusively government initiatives for public forests (Bull and Schwab 2002). In China, the SFA sets the log-harvesting quota based upon the statistics from the national forest survey and the volume harvested from the previous year. The quota is divided and distributed at each level of government beginning with the SFA and resulting in the ultimate assignment of the quota across the nation at the local level. From a collective forest perspective, two categories of issues have been identified: (1) The property rights question - the inconsistency between

[36] The people's Congress at both the national and provincial levels may institute charges, thus charges vary on a provincial basis. Townships and village authorities may institute fees for a wide range of purposes, e. g. rural education, family planning, and road construction (Lu *et al.* 2002).

[37] Lu *et al.* (2002) and Liu and Landell-Mills (2003) differ in how they define charges and fees. We have listed the charges and fees according to the detinitions put forth by Lu *et al.*

[38] The authors report that in this particular area, fuelwood was quoted at $ 24.15 per cubic meter and that an instance of leasing 2000 orange trees had resluted in annual income of approximately $ 2415.

the logging quota and the Forest Law allowing collectives to use their forests, and (2) the implementation of the policy. Owners and managers of collective forests have greater difficulty gaining access to the quota than state-run corporations. In response, many collective forest owners and managers have de-emphasized timber production and shifted to cultivating cash crops, like fruit, and other forest resources, such as fuelwood. The initiation of the logging ban component of the Natural Forest Protection Program in 1988 plummeted the harvest quota from 1.6 million m^3 to 210 000 m^3 (Yang in prep.), compounding the problem of access to an already restricted supply of harvestable volume. Furthermore, Yang (in prep.) reports that there are negative socio-economic impacts in some areas as a result of being unable to access the harvest quota. As well, illegal logging activities and corruption have arisen in areas previously devoid of such practices. Though there are some cases of environmental improvement, there is speculation that these environmental achievements could have been made without diminishing management incentives and tenure security in collective forests.

CONCLUSION

Collective forests comprise the majority of all forestland in China and contribute an increasing share of wood and wood fibre to industry. In addition, collective forests yield invaluable resources and income to hundreds of millions of people across China and they are increasingly recruited into projects providing environmental services. The growing importance of collective forest areas is a trend that will continue for the foreseeable future.

In China, the meaning of collective forest has changed on numerous occasions. The collectivization of forestland began at the natural village level, but grew to include thousands of households at the township level. The changes saw many rights wrested from individuals and management put in the hands of, at first, democratically elected officials at the village level and subsequently appointed state officials in the township government. More recently, many rights to forestlands were decentralized and given to rural households in family plots, responsibility land, and land auctions. In the process the meaning of collective ownership has been confused. A collective is not a voluntary grouping of individuals or a form of common ownership in which decision-making is in the hands of those working the land. Instead, the government considers collective forests a national resource. This signals that for the time being secure rights for collective forest owners are unlikely and that collective forest owners will be subject to the will of the central government. Moreover, rural households will continue to bear the burden of responsibility for many government initiatives, yet without the rights normally associated with ownership.

Though the Chinese government has diverted substantial sums of money and implemented good-intentioned policies to the forest sector, acknowledging the sector's value, there are important legal and policy obstacles that limit the rights accorded collective forest owners and the benefits that collective forests provide. Intrusive and fluctuating forest policies leave collective owners and managers with little confidence in their rights to the land and resources. Policies like the logging ban and harvest quota diminish management incentives, encourage illegal activities, and often decrease socio-economic benefits. Moreover, a complicated system of taxes, fees, and charges further stifles the sector. The expropriation of collective forests to form nature reserves and areas for the provision of environmental services are often involuntary and accompanied by insufficient compensation. Though, the forest rights *de iure* are clear, *de facto* government and business coercion exist. Increasing forest production, improving environmental conditions, and ameliorating social and economic environs are all likely outcomes with further market reforms and policies that strengthen and secure the rights of collective forest owners and managers.

ACKNOWLEDGMENTS

We would especially like to thank Nick Menzies for his thoughtful and thorough review of this paper. We would also like acknowledge the essential contributions and support of the following people: Irene Bain, Gary Bull, Christian Cossalter, Guangcui Dai, Andy Darmawan, Tingyu Gan, Shangren Gao, Lis Grinspoon, Xueju Huang, Dina Hubudin, Ewan Lamont, Nuyun Li, Zhou Li, Zujiao Li, Yongwei Liang, A. Tyler Milley, Sten Nilsson, Alan Pottinger, Felicia M. Pullam, Gregory Veeck, Chunfeng Wang, Andy White, Paul Harris Wilt, Lini Wollenberg, Jianchu Xu, Jintao Xu, Xiuli Xu, Congming Yang, Bingqian Zhang, Kun Zhang, Lei Zhang, Jincheng Zhao, Yaqiao Zhao, Shaozhou Zhou, and Ting Zuo.

We are grateful to the Ford Foundation in Beijing for funding the project *Building Knowledge of China's Collective Forest Sector, in China and Beyond*, of which this paper is a part.

REFERENCES

ALBERS, H. J. and GRINSPOON E. 1997. A comparison of the enforcement of access restrictions between Xishuangbanna Nature Reserve (China) and Khao Yai National Park (Thailand). *Environmental Conservation* **24**(4):351-362.

ALBERS, H. J., ROZELLE, S. D. and LI GUO. 1998. China's forests under economic reform: Timber supplies, environmental protection, and rural resource access. *Contemporary Economic Policy* **16** (Jan.): 22-33.

BULL, G. AND SCHWAB, O. 2002. Regulating the harvest: Experiences and lessons from major forest countries. In *International forum on Chinese forestry policy*, ed. Xu Jintao and U. Schmitt. Proc. of China Council for International Cooperation on Environment and Development (CCICED) Task Force on Forests and Grasslands workshop, Jun. 13-14, 2002, Beijing, China. Beijing: China Forestry Pub. House. Computer CD.

CAI MANTANG, LIU DACHANG, and TURNBULL, J. W. 2003. Rehabilitation of degraded forests to improve the livelihoods of poor farmers: A synthesis of four case studies in south China. In *Rehabilitation of degraded forests to improve livelihoods of poor farmers in south China*, ed. Liu Dachang. Bogor, Indonesia: Center for International Forestry Research (CIFOR).

CHEN HAO. 1996. Analyses on population and ecological environment in poverty-stricken areas in China. *Ecological Economy* **46** (June):55-57.

CHEN LINWU, XIANG CHENGHUA, LIU XINGLIANG and MU KEHUA. 2001. *Case study on the Natural Forest Protection Program in Sichuan Province's Li County, Pingwu County, and Chuanxi Forestry Bureau*. Sichuan, China: Institute of Ecology, Sichuan Academy of Forestry.

CHINA TOWNSHIP ENTERPRISE YEARBOOK. 1997-2001. Beijing: China Statistics Publishing House.

COSSALTER, C. 2004. Does China have a comparative advantage for growing pulpwood ? The case of coastal southern China. Paper presented at International Forum on Investment and Finance in China's Forestry Sector, Sept. 22-23, 2004, Beijing, China.

DÉMURGER, S. and FOURNIER, M. 2004. The distributional impact of forest protection on rural economic welfare: Evidence from Labagoumen nature reserve (China). Hong Kong: Hong Kong Institute of Economics and Business Strategy (HIEBS), University of Hong Kong and Centre d'Etudes Français sur la Chine Contemporaine (CEFC) and Clermont-Ferrand, France: Centre National de la Recherche Scientifique (CNRS).

GE TANG, CHEN QUANGONG, LI JIN, LIANG TIANGANG and LU ZIJUN. 2001. *Case study on the conversion of farmland to grass and forest in Dingxi County, Gansu Province*. Gansu, China: Grassland Ecological Research Institute, Research Institute of Comprehensive Resource Development, and Forest Survey and Design Institute.

GRANT, A. 2001. An evaluation of China's ‚Tuigeng Huanlin' Forestry Policy: Using a village in Sichuan Province as a case study. M. S. dissertation, School of Development Studies, University of East Anglia, Norwich, UK.

GRINSPOON, E. J. 2002. Socialist wasteland auctions: Privatizing collective forest land in China's economic transition. PhD dissertation, Graduate Division, University of California, Berkeley, U. S. A.

HARKNESS, J. 1998. Recent trends in forestry and conservation of biodiversity in China. *China Quarterly* **156** (Dec.):911-934

HYDE, W. F., XU JINTAO and BELCHER, B. 2003. Introduction. In *China's forests: Global lessons from market reforms*, ed. W. F. Hyde, B. Belcher, and Xu Jintao. Washington, D.C.: Resources for the Future (RFF) and Bogor, Indonesia: Center for International Forestry Research (CIFOR).

KATSIGRIS, E. 2001. Local-level socioeconomic impacts of the NFPP. In *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and policy recommendations*, ed. Xu Jintao, E. Katsigris, and T. A. White. Beijing: China Forestry Pub. House.

LI RUI, WEN ZHONGMING, WANG FEI, WANG YUE and ZHOU MINGLIANG. 2001. *Case study on conversion of farmland to forest and grassland in Ansai County, Shaanxi Province*. China: Institute of Soil and Water Conservation at Chinese Academy of Sciences, Ministry of Water Resources, and Chinese Academy of Social Sciences.

LI TIEHUA, LIU DACHANG, XIANG WENHUA, XU GUOZHENG, and ZENG GUANGZHEN. 2003. Rehabilitation of degraded Chinese fir plantations and evergreen broadleaf forest in Huitong County, Hunan. In *Rehabilitation of degraded forests to improve livelihoods of poor farmers in south China*, ed. Liu Dachang. Bogor, Indonesia: Center for International Forestry Research (CIFOR).

LI ZHOU and VEECK, G. 1999. Forest resource use and rural poverty in China. *Forestry Economics* **4**(1)

LIU DACHANG. 2001. Tenure and management of non-state forests in China since 1950: A historical review. *Environmental history* 6 (2): 239-263. Available: http://www.lib.duke.edu/forest/Dachang.pdf

LIU DACHANG and EDMUNDS, D. 2003. Devolution as a means of expanding local forest management in south China: Lessons from the past 20 years. In *China's forests: Global lessons from market reforms*, ed. W. F. Hyde, B. Belcher, and Xu Jintao. Washington, D.C.: Resources for the Future (RFF) and Bogor, Indonesia: Center for International Forestry Research (CIFOR).

LIU DACHANG, WENG QIJIE, ZENG JIE, ZHENG HAISHUI and ZHOU ZAIZHI. 2003. Degradation and rehabilitation of evergreen broadleaf forest in Cangwu County, Guangxi. In *Rehabilitation of degraded forests to improve livelihoods of poor farmers in south China*, ed. Liu Dachang. Bogor, Indonesia: Center for International Forestry Research (CIFOR).

LIU JINLONG and LANDELL-MILLS, N. 2003. Taxes and fees in the southern collective forest region. In *China's forests: Global lessons from market reforms*, ed. W. F. Hyde, B. Belcher, and Xu Jintao. Washington, D. C.: Resources for the Future (RFF) and Bogor, Indonesia: Center for International Forestry Research (CIFOR).

LIU JINLONG. 2003. Support to private and community farm forestry in China. *Unasylva* **212**(54):57-62.

LIU SHUREN. 2002. An introduction to the Land Conversion Program. In *Workshop on payment schemes for environmental services*, ed. Xu Jintao and U. Schmitt. Proc. of China Council for International Cooperation on Environment and Development (CCICED) Task Force on Forests and Grasslands workshop, Apr. 22-23, 2002, Beijing, China. Beijing: China Forestry Pub. House. Computer CD.

LIU YONGCHUN. 2002. Implementation and experiences of the ecological compensation scheme in Anhui Province. In *Workshop on payment schemes for environmental services*, ed. Xu Jintao and U. Schmitt. Proc. of China Council for International Cooperation on Environment and Development (CCICED) Task Force on Forests and Grasslands workshop, Apr. 22-23, 2002, Beijing, China. Beijing: China Forestry Pub. House. Computer CD.

LU WENMING, LANDELL-MILLS, N., LIU JINLONG, XU JINTAO and LIU CAN. 2002. *Getting the private sector to work for the public good: Instruments for sustainable private sector forestry in China*. Instruments for sustainable private sector forestry series. London: International Institute for Environment and Development (IIED).

MENZIES, N. 1994. *Forest and land management in la-te imperial China*. London: Macmillan Press.

PEOPLE'S CONGRESS. 1998. *Forestry Law of the People's Republic of China*. Beijing. Available: http://www.novexcn.com/forrestry_1998.html

PEOPLE'S CONGRESS. 1999. *Constitution of the People's Republic of China*. Beijing. Available: http://www.novexcn.com/prc_constitution_1999.html

PEOPLE'S CONGRESS. 2000. R*egulations for the implementation of Forestry Law of the People's Republic of China*. Beijing. http://www.zhb.gov.cn/english/chanel-3/detail-3.php3?chanel3&column=1&id=54

QU JIASHU. 2002. Ecological compensation mechanisms in Guangdong Province. In *Workshop on payment schemes for environmental services*, ed. Xu Jintao and U. Schmitt. Proc. of China Council for International Cooperation on Environment and Development (CCICED) Task Force on Forests and Grasslands workshop, Apr. 22-23, 2002, Beijing, China. Beijing: China Forestry Pub. House. Computer CD.

ROZELLE, S., HUANG JIKUN and BENZIGER, V. 1998. *Forest exploitation and protection in reform China: Assessing the impact of policy, tenure, and economic growth.* Davis, Calif., U. S. A.: Dept. of Agriculture and Resource Economics, University of California, Davis. http://www.agecon.ucdavis.edu/facultypages/rozelle/pdfs/forest_china.pdf.

ROZELLE, S., HUANG JIKUN, HUSAIN, S.A. and ZAZUETA, A. 2000. *China: From afforestation to poverty alleviation and natural forest management*. Evaluation Country Case Study Series. Washington D. C.: World Bank. http://www-wds.world-bank.org/servlet/WDSContentServer/WDSP/IB/2000/08/26/000094946_00081705302466/additional/016824232_200308269004051.pdf

ROZELLE, S. and LI GUO. 1998. Village leaders and land rights formation in China. In *Annual Meetings of the American Economics Association*. Chicago, IL.

RUIZ PÉREZ, M., BELCHER, B., FU MAOYI, and YANG XIAOSHENG. 2003. Forestry, poverty, and rural development: Perspectives from the bamboo subsector. In *China's forests: Global lessons from market reforms*, ed. W. F. Hyde, B. Belcher, and Xu Jintao. Washington, D. C.: Resources for the Future (RFF) and Bogor, Indonesia: Center for International Forestry Research (CIFOR).

SAYER, J. A. and SUN CHANGJIN. 2003. Impacts of policy reforms on forest environments and biodiversity. In *China's forests: Global lessons from market reforms*, ed. W. F. Hyde, B. Belcher, and Xu Jintao. Washington, D. C.: Resources for the Future (RFF) and Bogor, Indonesia: Center for International Forestry Research (CIFOR).

SICHUAN ACADEMY OF SOCIAL SCIENCES. 2001. *Case study on conversion of farmland to forest and grassland in Tianquan County, Sichuan Province*. Sichuan, China.

STATE FORESTRY ADMINISTRATION. 2000. *National forest resources statistics 1994-1998*. Beijing.

STATE FORESTRY ADMINISTRATION. 2002. *China Forestry Development Report 2002*. Beijing.

STATE FORESTRY ADMINISTRATION. 2003. *China forestry statistics yearbook 2002*. Beijing: China Forestry Pub. House.

STATE STATISTICS BUREAU. 2002. *China statistics yearbook*. Beijing: China Statistics Pub. House.

SUN CHANGJIN and CHEN XIAOQIAN. 2002. A policy analysis of the China Forest Ecological Benefit Compensation Fund. In *Workshop on payment schemes for environmental services*, ed. Xu Jintao and U. Schmitt. Proc. of China Council for International Cooperation on Environment and Development (CCICED) Task Force on Forests and Grasslands workshop, Apr. 22-23, 2002, Beijing, China. Beijing: China Forestry Pub. House. Computer CD.

TASKFORCE ON FORESTS AND GRASSLANDS. 2002. *Annual report to CCICED*. Beijing: China Council for International Cooperation on Environment and Development.

UCHIDA, E., XU JINTAO and ROZELLE, S. 2003. ‚Grain for Green' Policy in China: Cost-effectiveness and sustainability of a conservation set-aside program. Paper presented at American Agricultural Economics Association Annual Meeting, Jul. 27-30, 2003, Montreal, Canada.

WAGGENER, T. 2001. Logging bans in Asia and the Pacific: An overview. In *Forests out of bounds: Impacts and effectiveness of logging bans in natural forests in Asia-Pacific*. FAO-RAP Publication 2001/08, ed. P. B. Durst, T. R. Waggener, T. Enters and T. L. Cheng. Bangkok: Asia-Pacific Forestry Commission FAO-RAP.

XU JIANCHU. Forthcoming. *Who drives conservation in China ? A case study in protected areas in Yunnan, southwest China*. Kunming, China: Center for Biodiversity and Indigenous Knowledge (CBIK).

XU JIANCHU, FOX, J., LU XING, PODGER, N., LEISZ, S. and AI XIHUI. 1999. Effects of swidden cultivation, population growth, and state policies on land cover in Yunnan, China. *Mountain Research and Development* **19**(2):123-132.

XU JIANCHU and RIBOT, J. 2004. Decentralisation and accountability in forest management: A case from Yunnan, southwest China. *European Journal of Development Research* **16**(1):153-173.

YANG CONGMING. Forthcoming. *The harvesting quota: Impacts on incentives for sustainable collective forest management*. Guiyang, China: Guizhou Forest Department.

YANG YUEXIAN. 2001. Impacts and effectiveness of logging bans in natural forests: People's Republic of China. In *Forests out of bounds: Impacts and effectiveness of logging bans in natural forests in Asia-Pacific*. FAO-RAP Publication 2001/08, ed. P. B. Durst, T. R. Waggener, T. Enters and T. L. Cheng. Bangkok: Asia-Pacific Forestry Commission FAO-RAP.

YIN RUNSHENG. 2003. Central characteristics of reform: Measures of the effects of improved property rights, a stable policy environment, and environmental protection. In *China's forests: Global lessons from market reforms*, ed. W. F. Hyde, B. Belcher, and Xu Jintao. Washington, D. C.: Resources for the Future (RFF) and Bogor, Indonesia: Center for International Forestry Research (CIFOR).

YIN RUNSHENG and XU JINTAO. 2002. A welfare measurement of China's rural forestry reform during the 1980s. *World Development* **30**(10):1755-1767.

ZHANG YAOQI, DAI GUANGCUI, HUNG HEYU, KONG FANWEN, TIAN ZHIWEI, WANG XUAN and ZHANG LEI. 1999. The forest sector in China: Towards a market economy. *World forests, society and environment*, ed. M. Palo and J. Uusivuori. Dordrecht, Netherlands: Kluwer Academic Pub.

ZHANG YAOQI, UUSIVUORI, J. and KUULUVAINEN, J. 2000. Impacts of economic reforms on rural forestry in China. *Forest Policy and Economics* **1** (2000):27-40.

ZHAO JUNCHEN. 2001. *Case study on conversion of farmland to forest and grassland in Heqing County, Yunnan Province*. Yunnan, China: Institute of Economics, Yunnan Academy of Social Studies.

ZHAO YAQIAO. Forthcoming. *Sustainable forestry as an alternative to the logging ban: Findings from policy experiments*. Kunming, China: Center for Community Development Studies (CDS).

ZHENG BAOHUA. 2003. *Research on the ownership of non-arable land resources in southern China*. Beijing: China Literature Publishing House.

ZUO TING. 2001a. Implementation of the NFPP. In *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and policy recommendations*, ed. Xu Jintao, E. Katsigris, and T. A. White. Beijing: China Forestry Pub. House.

ZUO TING. 2001b. Implementation of the SLCP. In *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and policy recommendations*, ed. Xu Jintao, E. Katsigris, and T. A. White. Beijing: China Forestry Pub. House.

ZUO TING, XU XIULI, and ZHANG BINGQIAN. Forthcoming. *A market-oriented innovation ? Stakeholders, process and impacts of the forest ecological compensation program (FECP) in Hunan, China*. Beijing: China Agricultural University.

ANNEX

ANNEX 1. *National forestland and forest area by province and ownership*

Province	Ownership	Forestland (ha)	Forested area (ha)						
			Total	Timber forest*	Bamboo forest	Protection forest	Fuelwood forest	Special use forest	Economic forest
National total	total	257 047 300	153 632 300	99 395 000	4 210 800	21 384 700	4 451 700	3 968 000	20 222 100
	state	105 902 000	63 886 700	47 529 800	285 600	10 464 600	455 800	3 557 600	1 593 300
	collective	151 145 300	89 745 600	51 865 200	3 925 200	10 920 100	3 995 900	410 400	18 628 800
Anhui	total	4 186 500	3 170 500	2 109 400	250 800	147 300	63 600	18 500	580 900
	state	297 500	222 000	159 200	10 500	12 700	2 300	17 400	19 900
	collective	3 889 000	2 948 500	1 950 200	240 300	134 600	61 300	1 100	561 000
Beijing	total	930 600	337 400	33 400	0	139 500	10 200	23 400	130 900
	state	59 700	37 600	3 600	0	12 200	400	16 100	5 300
	collective	870 900	299 800	29 800	0	127 300	9 800	7 300	125 600
Fujian	total	9 018 300	7 353 700	4 452 900	820 300	798 600	93 800	153 700	1 034 400
	state	1 043 700	880 200	642 500	28 800	84 100	2 400	67 200	55 200
	collective	7 974 600	6 473 500	3 810 400	791 500	714 500	91 400	86 500	979 200
Gansu	total	7 208 700	2 174 100	816 900	0	853 600	5 000	246 200	252 400
	state	4 401 900	1 509 600	696 500	0	555 700	0	240 500	16 900
	collective	2 806 800	664 500	120 400	0	297 900	5 000	5 700	235 500
Guangdong	total	10 347 000	8 150 200	6 029 700	383 800	489 400	235 100	33 600	978 600
	state	632 600	512 700	335 700	4 700	48 000	9 600	19 200	95 500
	collective	9 714 400	7 637 500	5 694 000	379 100	441 400	225 500	14 400	883 100
Guangxi	total	12 691 900	8 166 600	4 962 400	249 800	1 061 700	259 400	24 000	1 609 300
	state	1 128 900	811 900	518 800	19 200	182 600	4 800	14 400	72 100
	collective	11 563 000	7 354 700	4 443 600	230 600	879 100	254 600	9 600	1 537 200
Guizhou	total	7 407 100	3 673 100	2 193 900	54 400	361 800	345 800	118 400	598 800
	state	393 800	269 000	109 000	3 200	44 800	12 800	67 200	32 000
	collective	7 013 300	3 404 100	2 084 900	51 200	317 000	333 000	51 200	566 800
Hainan	total	1 699 600	1 349 300	233 900	21 600	522 900	0	60 000	510 900
	state	1 002 600	859 900	54 000	4 700	406 500	0	56 400	338 300
	collective	697 000	489 400	179 900	16 900	116 400	0	3 600	172 600
Hebei	total	6 312 200	3 361 300	1 167 100	0	570 900	237 900	11 200	1 374 200
	state	530 500	392 200	308 800	0	54 600	8 000	9 600	11 200
	collective	5 781 700	2 969 100	858 300	0	516 300	229 900	1 600	1 363 000
Heilongjiang	total	21 312 400	17 603 100	16 525 600	0	407 400	44 800	578 300	47 000
	state	20 457 500	17 197 000	16 283 100	0	281 500	44 800	572 100	15 500
	collective	854 900	406 100	242 500	0	125 900	0	6 200	31 500
Henan	total	3 786 400	2 090 100	1 003 900	19 400	368 000	87 100	38 700	573 000
	state	329 100	203 200	111 500	1 600	11 900	1 600	29 000	17 600
	collective	3 457 300	1 886 900	892 400	17 800	326 100	85 500	9 700	555 400
Hubei	total	7 640 900	4 828 400	3 116 500	131 200	441 600	384 000	48 000	707 100
	state	581 700	409 000	252 800	6 200	57 600	3 200	48 000	41 200
	collective	7 059 200	4 419 400	2 863 700	125 000	384 000	380 800	0	665 900
Hunan	total	11 736 600	8 239 700	5 139 800	490 000	269 000	147 300	32 000	2 161 600
	state	560 300	381 100	288 300	6 400	41 600	0	22 400	22 400
	collective	11 176 300	7 858 600	4 851 500	483 600	227 400	147 300	9 600	2 139 200
Inner Mongolia	total	31 819 500	14 748 500	12 296 300	0	595 200	291 900	719 600	845 500
	state	25 386 000	13 215 200	11 518 400	0	248 800	267 200	719 600	461 200
	collective	6 433 500	1 533 300	777 900	0	346 400	24 700	0	384 300
Jiangsu	total	592 600	462 400	137 800	23 000	61 600	9 400	8 000	222 600
	state	140 100	100 800	46 200	5 800	21 200	200	6 400	21 000
	collective	452 500	361 600	91 600	17 200	40 400	9 200	1 600	201 600
Jiangxi	total	10 453 200	8 897 800	5 902 100	627 300	352 000	608 100	44 800	1 363 500
	state	1 478 600	1 318 600	1 062 600	96 000	57 600	6 400	25 600	70 400
	collective	8 974 600	7 579 200	4 839 500	531 300	294 400	601 700	19 200	1 293 100
Jilin	total	8 297 400	7 069 800	5 772 100	0	838 100	34 200	354 800	70 600
	state	6 454 500	5 771 300	4 865 400	0	546 900	2 100	344 200	12 700
	collective	1 842 900	1 298 500	906 700	0	291 200	32 100	10 600	57 900
Liaoning	total	5 674 300	4 510 500	1 993 100	0	619 100	448 500	82 100	1 367 700
	state	670 300	584 200	388 500	0	135 800	0	37 900	22 000
	collective	5 004 000	3 926 300	1 604 600	0	483 300	448 500	44 200	1 345 700
Ningxia	total	1 004 000	146 400	23 600	0	52 800	0	25 200	44 800
	state	320 700	79 300	8 000	0	32 100	0	25 200	14 000
	collective	683 300	67 100	15 600	0	20 700	0	0	30 800
Qinghai	total	3 379 500	308 800	26 000	0	264 400	0	14 800	3 600
	state	3 276 800	282 000	12 000	0	255 600	0	14 400	0
	collective	102 700	26 800	14 000	0	8 800	0	400	3 600
Shaanxi	total	11 974 900	5 920 300	3 060 800	44 800	1 285 800	425 400	153 600	949 900
	state	3 652 200	2 462 400	1 416 800	12 700	854 000	6 400	144 000	28 500
	collective	8 322 700	3 457 900	1 644 000	32 100	431 800	419 000	9 600	921 400

ANNEX 1. *National forestland and forest area by province and ownership (continued)*

Province	**Ownership**	**Forestland (ha)**	**Forested area (ha)**						
			Total	**Timber forest***	**Bamboo forest**	**Protection forest**	**Fuelwood forest**	**Special use forest**	**Economic forest**
Shandong	total	2 638 400	1 915 200	116 800	0	494 400	11 200	3 200	1 289 600
	state	160 000	116 800	12 800	0	92 800	0	1 600	9 600
	collective	2 478 400	1 798 400	104 000	0	401 600	11 200	1 600	1 280 000
Shanhgai	total	23 300	21 800	0	2 300	3 300	0	400	15 800
	state	4 300	3 700	0	100	2 200	0	400	1 000
	collective	19 000	18 100	0	2 200	1 100	0	0	14 800
Shanxi	total	6 764 700	1 835 800	1 085 300	1 600	338 100	15 800	31 600	363 400
	state	2 159 400	1 017 300	755 200	0	210 100	15 800	26 800	9 400
	collective	4 605 300	818 500	330 100	1 600	128 000	0	4 800	354 000
Sichuan**	total	26 579 100	13 301 500	7 593 800	360 400	4 145 500	38 500	199 400	963 900
	state	13 123 300	6 080 700	3 141 400	49 700	2 664 800	0	193 500	31 300
	collective	13 455 800	7 220 800	4 452 400	310 700	1 480 700	38 500	5 900	932 600
Tianjin	total	133 000	85 800	1 200	0	38 900	0	2 800	42 900
	state	10 800	10 400	400	0	6 800	0	2 400	800
	collective	122 200	75 400	800	0	32 100	0	400	42 100
Tibet	total	8 461 600	4 081 500	2 567 600	0	1 485 100	8 800	19 000	1 000
	state	8 461 600	4 081 500	2 567 600	0	1 485 100	8 800	19 000	1 000
	collective	0	0	0	0	0	0	0	0
Xinjiang	total	4 769 100	1 783 700	220 600	0	1 346 200	2 800	150 200	63 900
	state	4 305 600	1 530 600	194 700	0	1 170 500	1 400	150 200	13 800
	collective	463 500	253 100	25 900	0	175 700	1 400	0	50 100
Yunnan	total	23 807 900	12 873 200	7 494 500	105 600	2 965 200	604 600	748 500	954 800
	state	4 658 900	3 353 800	1 645 700	33 600	834 900	57 600	652 500	129 500
	collective	19 149 000	9 519 400	5 848 800	72 000	2 130 300	547 000	96 000	825 300
Zhejiang	total	6 396 600	5 171 800	3 318 000	624 500	67 300	38 500	24 000	1 099 500
	state	219 100	192 700	130 300	2 400	21 600	0	14 400	24 000
	collective	6 177 500	4 979 100	3 187 700	622 100	45 700	38 500	9 600	1 075 500

* not including bamboo forests
** includes the province of Chongqing
Source: SFA 2000

China's forest sector markets: policy issues and recommendations

S. NILSSON● G. Q. BULL■, A. WHITE♦ and JINTAO XU▲

● *Deputy Director and Forestry Program Leader, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria*

■ *Forest Resource Management, University of British Columbia, Vancouver, Canada*

♦ *Senior Director, Policy and Market Analysis, Forest Trends, 1050 Potomac Street NW, Washington, DC 20007, USA*

▲ *Deputy Director, Center for Chinese Agricultural Policy (CCAP), 5th Floor, Institute of Geographical Sciences and Natural Resources Research, Datun Road, Anwai, Beijing 100101, China*

Email: gary.bull@ubc.ca

SUMMARY

Based on the papers contributed to this Special Issue and other studies an effort is made to identify the major policy issues facing the Chinese forest sector. The policy analysis is organized around the so-called ‚supply china' (from stump to final products' markets). The discussion of policy issues and implications centers on the identified large and growing gap in the demand/supply balance of forest products. A major problem to carry out the policy analysis is the identified lack of consistent and transparent data for the different components of the ‚supply chain'. This is a situation which must be substantially improved in order to undertake relevant policy setting for the Chinese forest sector.

Keywords: forest sector, policy analysis, data, supply chain, forest resources

INTRODUCTION

China's forest market has quickly become a dominant, if not the dominant, driver of investment and industry transition, affecting both forests and forest-dependent livelihoods globally. The future of the Chinese forest sector and its implications for the world is directly dependent on the future economic growth in China and its commitment to developing its domestic supply and manufacturing. China's gross domestic product (GDP) already accounts for 13 % of the world's output (at purchasing-power-parity), in 2004 China is probably the world's third largest exporter, it is the largest recipient of foreign direct investments, and its imports have grown by 40 % (Economist 2004). However, there are questions whether China will be able to maintain current economic growth. The fragile banks have increased lending too rapidly and helped fuel a property bubble as well as pushed the inflation above 5 %. In addition there remains a lack of transparent institutions, evidence of corruption, dramatic income inequalities, inefficient state owned enterprises and severe environmental pollution (Economist 2004).

If China's economy slows down sharply in the next couple of years, the long-term outlook on strong economic growth is bright. China's growth is not only based on a large cheap labor force but it has extensive infrastructure upgrades underway, an educated workforce, a high investment savings rate and an extremely open economy.

Thus, if the economic structural reforms continue there are good reasons to believe that strong economic growth can be maintained. Usually, economic growth slows down when incomes approach the levels of developed countries but China's GDP per capita is far below countries such as Japan and South Korea. The Economist (2004) concludes that China should be able to sustain an annual economic growth of 7-8 % for at least another decade.

In the context of growth, the analysis carried out in other papers in this Special Issue assumes that economic growth will continue to be substantial in the next decade and cause a significant gap in the Chinese forest products demand/supply balance. This gap will not only cause difficulties with the supply of forest wood products but also create conflicts with respect to Chinese non-wood forest ecosystem services and future land-uses in the country. In addition, the identified demand/supply gap will put severe pressures on the utilization of forest resources surrounding China and in other parts of the world.

The gap measured in 2002 between consumption and domestically produced forest products is 106 million m^3 expressed in roundwood equivalents (RWE) as presented by Sun *et al.* (2004) in this volume. The likely future gap at around 2010, based on the analysis in Bull and Nilsson (2004), He and Barr (2004), Sun *et* *al.* (2004), and Sun (2004) in this volume, may be in the magnitude of 150-175 million m^3 RWE.

This discussion of policy issues and implications centers on this large and growing gap in the demand/ supply balance of forest products and is organized around the so-called ‚supply chain' which begins with the so-called ‚wood balance'. The supply chain follows the wood raw material from the forest resources through the industry to the market and it takes into account the side effects that the products produced are having on other functions, services and sectors inside and outside China.

A wood balance is a method to control the consistency of data and can be described in a simplified way as aggregated equations:

domestic production of wood raw material + domestic production of other fibres used in the forest sector + import of wood raw material and other fibres – export of wood raw material and other fibres = domestic production of forest products in the industry expressed in RWE

domestic forest industrial products in RWE + imports of forest industrial products (RWE) – exports of forest industrial products (RWE) = domestic consumption of forest industrial products (RWE)

After a thorough review of the existing literature and statistics, we can conclude that we are not able to accurately close the ‚Wood Balance'. Nonetheless, we have a partial understanding of the current structure of the Chinese forest sector and on this basis we will concentrate on the issues that are in alignment with the evidence presented in the other papers in this Special Issue in order to give a consistent set of recommendations.

FOREST RESOURCES AND FIBRE SUPPLY

The analysis by Bull and Nilsson (2004) shows that the Chinese forest sector is facing a major challenge in meeting the future demands on forest resources to provide material for industrial, non-industrial and conservation uses. But the size of the challenge cannot accurately be assessed given the incomplete, non-transparent and conflicting data. For example, there is no satisfactory assessment of forest areas available for wood supply, there is conflicting information on the productivity and areas of plantations, there is no satisfactory assessment of current and future growth as well as on stocking quality, there are discrepancies in the information on growing stock in different forest categories and age classes, and there are major discrepancies in the removal statistics that indicate substantial illegal logging or over-harvesting.

A key issue for setting any policies for the future of the Chinese forest sector is to have the domestic supply options correctly identified. In order to do this the Chinese Government should consider:

- *Establishing a new and transparent forest inventory in order to make the needed supply assessments. The inventory should include areas, growing stock, growth, quality, non-wood functions and services for all forest categories.*
- *Carrying out transparent assessment of future possible supply of different services from the forest resources in order to identify the conflicting demands and possible solutions to these conflicts.*

The aggressive Chinese Government plantation program, which is closely linked to the assessments of the future forest resource base, has a target of establishing 13.4 million ha of new plantations during the period 2001-2015. The program is focusing on the development of the domestic industry, especially the pulp industry as discussed in the analysis by Barr and Cossalter (2004). In that study the authors conclude that these plantations will not be cost competitive with plantations in many other producing countries due to frequent cases of shallow and nutrient poor soils, water shortage, locations far from industrial sites, etc. Jaakko Pöyry (2001) arrived at similar conclusions.

The plantations are also bound to generate land-use conflicts and the land that the government hopes to allocate to plantations might not be available. As indicated by West *et al.* (2004) the majority of forest land in China is owned by collectives and they are increasingly asserting their property rights to choose the uses of their lands. In many regions the prime plantation land has already been planted and in many cases the land targeted by the government for plantations could be used for the production of crops with substantially higher economic returns in comparison with pulp fibres (Barr and Cossalter 2004, Jaakko Pöyry 2001). There is also the question of how many sites are available for new greenfield mills for pulp production in China due to constraints in water supply (Roberts 2004), environmental impacts, and transportation infrastructure (Jaakko Pöyry 2001, Roberts 2004). It is not at all clear that the produced wood in the planned pulpwood plantations (5.9 million ha) can be used domestically in China. It may be that China would be much better off both economically and environmentally to import the needed pulp. Therefore, the Chinese Government should consider:

- *Revisiting the planned plantation program and evaluate whether this is the most efficient economically, socially, and environmentally sound way for satisfying the future demand of pulp in China.*

The re-examination should include evaluations of the potential impacts of proposed sites for greenfield pulp mills on local water supplies and quality and the broader environment, taking into account local people's perspectives and concerns. It should also identify the most suitable locations of plantations in the vicinity of the existing identified sites for pulp production. In all cases, evaluations should begin with an assessment of the perspectives and interests of the property owners to commit their land, and possibly labor, to industrial plantations. Potential investors should also carefully evaluate the productivity, water, land-use, and environmental dimensions of the proposed plantations. At the same time, steps should be taken to include in the analysis the feasibility to increase productivity and lower production costs for each of the areas where the government aspires to encourage plantations.

The current plantation program is divided into plantations for pulpwood (5.9 million ha), logs for panels (5.0 million ha) and large timber (2.5 million ha). This division makes limited sense from an economic point of view. It also makes limited sense from a property rights and incentives point of view. It is one thing to plan for the establishment of plantations on public land. It is another to propose that private property owners adopt technologies to achieve a government target. This latter situation, which dominates potential plantation areas, requires much more careful use of financial and regulatory instruments of the government. In addition, new plantations should be designed in such a way that there is flexibility in the type of fibre produced, whether for pulp or veneer, for example. In the end, the use of the yield of plantations will be determined by the market therefore the Chinese Government should consider:

- *Revisiting the overall goals of the current plantation program and setting separate objectives and strategies for the public and collective lands, including steps to ensure that the plantations will generate flexibility in the type of product produced.*
- *Revisiting the current policy of shifting production from natural to plantation forests, and develop plans to boost the sustainable production of natural forests - particularly in regions where forestry can contribute significantly to rural incomes and broader development.*

There is also the issue of fuelwood, which will have some influence on the future availability of industrial fibres. Bull and Nilsson (2004) in this volume have identified that there are huge uncertainties with respect to the utilization of fuelwood. Based on this analysis as well as analysis by Leiwen and O'Neill (2003), it seems like the consumption is currently in the magnitude of 150 million m^3 per year but, according to some Chinese sources, the consumption could be substantially higher. Leiwen and O'Neill (2003) conclude that this demand will increase in the foreseeable future. One significant question is: What kind of forests will provide for this fuelwood consumption ? We know that some of the fuelwood is coming from four-sided forests, fuelwood forests, protection forests, etc., but we also know that an unknown quantity of the fuelwood is coming from the so-called timber forests. It is important that the Chinese Government consider:

- *Assessing the future fuelwood demand in China and determining which forest resources will supply the material required in the future and how policies should be reformed to better encourage sustainable production of fuelwood - without adversely competing with industrial fibre. The analyses will have to consider the overall energy policies in China.*

The analysis of the available and non-transparent statistics on the current harvest or removals by Bull and Nilsson (2004) in this volume leads to the conclusion that China is severely over-harvesting the existing domestic forest resources and that substantial illegal logging is taking place in China. The analysis also suggests that the logging ban introduced in 1998 and 1999 is, in reality, not being fully enforced. This finding points to the fundamental weakness of such ‚bans' in China, or in other countries, where the vast majority of rural people remain reliant on fuelwood, timber for household use, and where many communities have depended on commercial harvesting for their livelihoods and where the capacity to enforce the law is weak. Therefore, the Chinese Government should consider:

- *Removing the logging ban and reforming broader forest regulatory framework, taking into particular account how they affect the rights and incentives of collective forest owners, and then once a sound framework is in place, introducing strong measures against over-harvesting and illegal logging.*

If over-harvesting and illegal logging are not brought to a halt, and if simultaneously, steps are not taken to ensure incentives to invest and manage new forests, the long-term supply/demand balance will be even more severe and dramatic than that presented earlier in this section.

In the future, the difficult demand/supply balance situation for wood fibres in China also means that non-wood fibres will play an important role. As demonstrated by He and Barr (2004) in this volume the total demand on fibres in 2003 for the Chinese pulp sector was about 40 million tons and some 12 million tons were supplied from agricultural residues and nearly 20 million tons from recovered paper (about 50 % of the total fibres consumed). The He and Barr (2004) assessment indicates that the importance of the non-wood pulp fibres will decline over time due to quality requirements on the different paper grades in the future and due to environmental problems with the usage of non-wood fibres. But recovered paper could play an even more important role in the future and constitute some 60 % of the fibre mix in the pulp sector. This increased demand could be met by doubling (+9 million tons) the domestically recovered paper and increasing imports by 7-8 million tons. Thus, the domestically recovered paper will play an important role in the future of the Chinese forest sector. For this scenario to materialize it is important that the Chinese Government consider:

- *Establishing, together with private sector actors, efficient collection systems for recovered paper.*

From the discussion above it is also obvious that the Chinese statistical system reporting on the forest resources, other fibres and their utilization needs substantial strengthening. Therefore, the Chinese Government should consider:

- *Implementing a new, transparent, statistical system covering all relevant aspects of the forest resources, other fibres and their utilization (This is also valid for industrial production, consumption and trade, which will be discussed in succeeding sections).*

Without an efficient and transparent statistical system for the Chinese forest sector there will be significant difficulties in setting new policies for the sector and doing the much needed evaluation of any policy measures taken. Thus, this is a key issue in maintaining an efficient policy process.

INDUSTRIAL PRODUCTION

From the analysis carried out in this volume it is obvious that the Chinese Government has begun to restructure the domestic forest industry and aims to dramatically increase production and exports over time.

The He and Barr (2004) analysis presented in this volume provide us with a satisfactory understanding of the pulp and paper sector structure. This study indicates that domestic pulp production will increase by some 4 million tons of wood pulp by 2010, which means establishing 5-8 new greenfield mills. We have already raised the issue of the availability of suitable sites of this magnitude. We have also raised the need for new investment procedures and criteria, as well as the independent investigation of suitable sites for greenfield pulp mills.

There are also other concerns about the future of the Chinese wood pulp sector. Wright (2004) claims that China's wood pulp production is unlikely to be competitive with imported wood pulp until the current plantation program will start to produce substantial yields. This means that China will continue to depend on imported wood pulp for at least 20 years.

The paper and paperboard industry is also very fragmented and growing quickly. There are some 4000 mills but only about 115 mills have the capacity of exceeding 10 000 tons per year. Currently, the committed and proposed capacity additions in the paper and paperboard sector are growing faster than the growth demand, risking the development of overcapacity in the industry. This seems to be at least partly driven by very aggressive set of subsidies provided to the sector from the Chinese Government, exceeding several billion US$ between 1998 and 2002 alone (AFPA 2004). Given the structure of the industry and the cost profile for production there are questions on how competitive the domestic paper and paper production will be in comparison to imported paper products produced in integrated mills (Wright 2004).

He and Barr (2004) in this volume also predict the increase to be some 20-25 million tons in the domestic paper and paperboard production by 2010. Some of this production increase can be achieved by expanding the capacities of existing mills but it is likely that a number of greenfield mills are also required. Therefore, there is a need to instill new rigor into the investment process, requiring independent investigation of the financial costs and benefits of proposed mills taking water conditions, the costs of local fibre supply, infrastructure and market trends into account. Given the real need for greater supply of pulp and paper and the real risk of overcapacity and misuse of limited government funds, it is of importance for the Chinese Government to consider:

- *Reassessing the justification for public subsidies for industrial investments, developing new investment criteria and procedures for public banks, and more carefully analyzing the possibilities for expanding the pulp and paper sector.*

Earlier we discussed the important role of recovered paper and highlighted the need for a policy of developing efficient systems for the collection of recovered paper. There is another aspect to the domestic recovered paper in China; it is of low quality because it contains a high amount of fibre from agricultural residues. Low quality recovered paper cannot be used in quality grades of paper, which will be in greater demand in the future. In order to use the domestically collected paper in the most industrially efficient way the collection of recovered paper must be based on strict quality grading.

Pigments and chemicals can be as high as 50 % in the fibre furnish of quality papers (Jaakko Pöyry 2001). Therefore, the Chinese Government should consider:

- *Establishing a program for increased use of domestic pigments and chemicals in the Chinese paper process since China has good raw materials for production of these pigments and chemicals.*

There are other dimensions of the dependence of a high rate of recovered paper. Häggblom (2004) predicts that the global demand for recovered paper will increase by 63-65 million tons per year in 2010. Roberts (2004) concludes that only the USA can increase the export of recovered paper within a short time frame but it is limited to 5-10 million tons. Given this situation the prices for all key grades of waste paper are likely to increase substantially in real terms. Therefore, there are reasons for the Chinese Government to consider:

- *Revisiting the current strategy of a strong dependence on imported recovered paper for the Chinese paper and paperboard production.*

The accessibility of recovered paper may be difficult in the future and the prices may become too high to suit the Chinese production structure. If that is the case, a different industrial pulp and paper strategy is needed in comparison to what we see today.

We do not think at this stage that we have a clear view of the current structure of and production by the wood products industry, especially the saw milling and plywood industries. In particular, no one seems to have a clear understanding of the role of the many small mills that, as demonstrated by West *et al.* (2004), continue to play a critical role in rural employment.

The declining supply of domestic raw material is a major constraint for the development of the saw milling and plywood industries. As demonstrated by Bull and Nilsson (2004) in this volume the domestic supply of large and quality logs has declined dramatically in recent years and will continue to do so in the future. This is accelerating these industries dependence on imported logs as well as encouraging greater use of bamboo and other substitutes for lumber.

In order to develop solid policies for forest industrial development the Chinese Government should consider:

- *Carrying out an investigation of the Chinese solid wood products industry with respect to capacities, technologies, location, production, wood utilization, ownership structure, and contributions to local employment and public revenue.*

This sector is the biggest consumer of the domestic industrial forest raw material and without a clear understanding of the current structure of this industry there will be large difficulties in planning for the future.

Based on the above measures we think there is a need for the Chinese Government to:

- *Develop a united strategy/vision on the future structure of the total forest industry over time in China. The strategy must build on financial and economic analysis on China's future competitive position in the global forest sector as well as the potential for the forest industry to contribute to rural employment and development. The new structure should take into account how the current policy framework and infrastructure inhibits the flow of fibre to the industry due to transportation constraints.*

The appropriate structure should also be created with a market-driven approach and not be based on domestic financial solutions/constructions as is currently the case.

CONSUMPTION

With the analysis carried out in this volume we feel it is possible to compose a reasonable view of future pulp and paper consumption in China (He and Barr 2004). But for other industrial forest products the picture is much less clear. Given the statistics discussed in the paper of Sun (2004) the current consumption of lumber could be somewhere between 55 and 105 million m^3/year (the upper boundary does not seem possible due to the wood available). Jaakko Pöyry (2004) claims that the total consumption of lumber, plywood and boards was 44 million m^3 in 1999 and predicts it to be 56 million m^3 in 2010. Based on Sun (2004) and Sun *et al.* (2004) in this volume the consumption of plywood and boards in 2002/2003 is some 43 million m^3. Earlier we also highlighted the difficulties with the consumption figures on fuelwood. With this range of consumption statistics there are huge difficulties in setting relevant policies for the future. Therefore, the Chinese Government should consider:

- *Establishing a new system to calculate the end-use of the different forest products consumed by the Chinese society in order to get reliable consumption estimates. This analysis should account for end-use pattern changing over time with increased economic development. The latter information is important in forecasting the future consumption of forest products.*

MARKETS

The huge gap between demand and supply is driving urgent policy issues both at the international and the domestic levels.

From Katsigris *et al.*'s (2004) analysis in this volume it can be seen that many of the countries supplying China today with forest primary and secondary industrial forest products are not operating in a sustainable manner. Over-harvesting, unsustainable practices and illegal logging are prevalent, and are not only destroying local livelihoods for many people today, but diminishing the potential for forestry's contribution to sustained rural development tomorrow. The potential for continued, and even expanded, negative impacts will increase substantially with the widening gap between domestic supply and demand in the future forecasted by Bull and Nilsson (2004) in this volume. The Katsigris *et al.* (2004) report also reveals the important and increasing role of Chinese companies and investment into some supplying countries, most notably Myanmar and Russia. While China in no way can be responsible for ensuring the enforcement of policies and laws in other countries it can adopt policies at home that discourage or prohibit Chinese investment into illegal and unsustainable operations as well as prohibit imports from questionable sources. Other countries have begun to move in this direction, either by requiring proof of legal sources or outright bans against imports from particular countries. The Forest Law Enforcement and Governance forums, underway in Asia and under construction in the Eurasian region are important fora for intergovernmental dialogue and actions on these topics. For these reasons the Chinese Government should consider:

- *Prohibiting Chinese public and private investments into forest operations in countries where the illegality and unsustainable forest practice is prevalent, such as Myanmar, and develop new criteria and procedures for encouraging investment into forestry operations that are independently certified to be legal and sustainable.*
- *Establishing a moratorium on imports from countries where over-harvesting, illegal logging, and unsustainable practices and/or the abuse of indigenous and other traditional rights are prevalent, and simultaneously engage those supplying country governments in steps to put their country forest operations on sustainable footing, including measures to require the independent certification of sustainable practice and legality.*

These are critical steps for the Chinese forest sector in order to be taken as credible contributors towards advancing the sustainable management of the world's forest resources. At the same time, it is critical that the international community support China in adopting more responsible procurement and investment policies, by simultaneously adopting similar policies.

There is also another policy issue coming out of Katsigris *et al.* (2004) analysis. It is concluded that most of the countries currently supplying China with forest raw material in the Asia Pacific region will in the future ‚at best be able to maintain current export levels to China'. By analyzing the future supply conditions in these countries it can be concluded that this is probably an over-estimate and the supply possibilities will decrease in a majority of these countries within the next 10-15 years, with the exception of Russia. Katsigris *et al.* (2004) conclude that ‚only Russia is presenting the potential of significantly increased supply of logs to China'. This leads to the conclusion that the Chinese Government should consider:

- *Developing a strategy and policy on how to secure the needed increased import of forest raw material (and forest industrial products) in the future.*

Without a clear import strategy there is a high risk that China will fail to get the demanded raw material.

In this strategy, as identified by Katsigris *et al.* (2004), Russia is crucial. We have assessed the potential for increased export from Russia in the future. Our assessment is that Russia, under current conditions, can sustain a harvest of industrial wood of the magnitude of 250 million m^3 per year and the current harvest is assessed to be in the magnitude of 175 million m^3 of industrial wood. This means that the potential for increased export from Russia is in the size of 75 million m^3 of industrial wood. There will be substantial competition for this potential increased volume from other rapidly growing developing economies, particularly India. At the same time, the Katsigris *et al.* (2004) report and the Russian analyses from which this report draws clearly identifies the extensive problems of illegal and unsustainable logging in Russia. Because the Chinese market is becoming increasing dependent upon Russian supply the Chinese Government should consider:

- *Developing a strategy to both advance sustainable and legal production in Russia and secure sufficient import potential of forest raw material (and forest industrial products).*

Given the assessed difficult future demand/supply situation it is of utmost importance that the domestic market with respect to wood supply is functioning efficiently. West *et al.* (2004) in this volume have investigated the domestic forest resources and property rights. It can be concluded that the collective forests are the most important from a wood supply point of view but that there are difficulties with respect to property rights in order to have an efficient market for the wood supply (West *et al.* 2004). The physical assets rights do not correspond with the economic rights and some collective forests are limited by having obligations to deliver only to the state owned industrial companies. In order to stimulate the forest management and bring in economic incentives into the collective forest system and the markets, the Chinese Government should consider:

- *Working towards clarifying and strengthening joint property and economic rights in forest areas, including strengthening respect for collective and individual properties.*

There are also other hindrances for an efficient market with respect to the domestic wood supply. The tax, fee and charge system being in place with respect to the utilization of the forests is a major bottleneck for the establishment of an efficient market. It is not reasonable that the charge system often exceeds half of the gross revenue fro the utilization of the collective forests (West *et al.* 2004). The present system currently acts as a disincentive for investments and utilization of the forests (West *et al.* 2004). The Chinese government has begun reforming the rural tax code, but this has not yet reached into many forested areas or yet led to the reduction of forest taxes in many areas. Therefore, the Chinese Government should consider:

- *Accelerating reforms of the current charge system to become an efficient tool for investments in forestry, for efficient utilization of the forests and contribute to a sound development of the domestic markets for wood supply.*

This measure will also improve the livelihood conditions for the rural people living in forested regions as well as the ecological conditions.

Sun (2004) in this volume describes Chinese 995 formal Timber Markets to serve the industry with the supply of wood raw material. It is our view that these timber markets contribute to both efficiency and economic losses in the fibre supply chain. Therefore, we recommend the Chinese Government:

- *Deregulate the ,timber markets' and restructure the wood supply market based on pure market principles.*

The policy implications relating to the widening gap in supply/demand of forest products in China discussed in this paper do not claim to be a complete set of required policy or strategy changes. But we suggest that these are the major policy implications to be dealt with now and that the set of policies/strategies proposed are internally consistent.

REFERENCES

AFPA 2004. China's Fibre Resources and Forestry Industry Development. AFPA, Washington D. C., USA.

BARR, C. and COSSALTER, C. 2004. China's Development of a Plantation Based Wood Pulp Industry: Government Policies, Finance Incentives, and Investment Trends.

BULL, G. and NILSSON, S. 2004. An Assessment of China's Forest Resources.

ECONOMIST 2004. The Dragon and the Eagle. *The Economist* 2 October, London, UK.

HÄGGBLOM, R. 2004. Global Forest Trends. Paper presented at the World Bank Seminar ,Business Opportunities in the Forest Sector', Helsinki, 7 May, Jaakko Pöyry, Finland.

HE, D. and BARR, C. 2004. China's Pulp and Paper Sector: Supply-Demand Trends and Medium Term Projections.

KATSIGRIS, E. *et al.* 2004. The China Forest Products Trade: Asia Pacific Supplying Countries.

JAAKKO PÖYRY 2001. China Forest Industries. Opportunities and Challenges, Volumes 1–3, Multi-Client Study, Jaakko Pöyry Consulting, Singapore and Shanghai.

LEIWEN, J. and O'NEILL, B. 2003. The Energy Transition in Rural China. Interim Report IR-03-070. International Institute for Applied Systems Analysis, Laxenburg, Austria.

ROBERTS, D. 2004. China and the Global Paper and Forest Products Industry: A Focus on Fibre. CIBC, Ottawa, Canada.

SUN, X. 2004. A Brief Overview of China's Wood Market System.

SUN, X., KATSIGRIS, E. and 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.

WEST, A. *et al.* 2004. Chinese Collective Forests: How Property Rights and Policy Affect the Sector.

WRIGHT, R. 2004. Defining the China Market for Pulp, Paper and Board. Paper presented at Forest Trends seminar in Beijing, China 23 September 2004. Forest Trends, Washington, D. C., USA.

Looking through the bamboo curtain: an analysis of the changing role of forest and farm income in rural livelihoods in China

M. RUIZ PÉREZ[●] B. BELCHER[■], MAOYI FU[♦] and XIAOSHENG YANG[♦]

[●] Department of Ecology, Faculty of Sciences, Universidad Autónoma de Madrid, Spain
[■] Center for International Forestry Research, Bogor, Indonesia
[♦] Research Institute of Subtropical Forestry, Chinese Academy of Forestry, Fuyang, Zhejiang, P. R. China

Email: manuel.ruiz@uam.es

SUMMARY

Forestry and poverty analyses in China show an ambiguous relationship. While the co-occurrence of forest rich areas and poor counties has been noted by some authors, others have stressed the role played by forestry in these areas where it is frequently one of the few options available. Our study indicates that the expansion of off-farm income is the fundamental development process taking place in many areas of rural China. Forestry can offer good income generating options to farmers, but as the local economy develops forestry tends to be displaced by more attractive alternatives. There are niche specialisation opportunities even for rich farmers, normally linked to a certain degree of vertical integration, enhanced by specific features of some forestry uses like bamboo.

Keywords: rural livelihoods, poverty, forestry, bamboo, China

INTRODUCTION

In the 25 years of post-Maoist reforms, China has demonstrated one of the most spectacular development processes of the 20th century. Between 1978 and 2002 rural per capita income increased 528 %, the incidence of rural poverty declined from 30 % to 3 %, and the economy has expanded at close to 10 % annually (State Council Information Office 2001, NBSC 2003). China's growth has had a more pro-poor effect than that of the other Asian giant, India (World Bank 2002). However, this pro-poor effect has been offset to some degree by increasing income disparities (Choi 1996, World Bank 2000), and this has negatively affected the anti-poverty campaigns in China. In fact, the number of officially poor people increased by 800 000 in 2003, reversing a trend of continuous decline since 1978 (Xinhua 2004).

Within this context, we examine the role of forests and forestry in poverty alleviation and rural development. How has forestry contributed to livelihood improvement ? What is the role of forest-based activities and opportunities in farmers' choices ? Questions of this kind have been addressed, to a certain extent in other sectors (especially in agriculture and industry) and at the macro level, but the social impacts of the policy reforms as experienced in the forestry sector are relatively poorly documented.

As in most developing countries, rural populations in China have disproportionately high levels of income poverty. Average rural per capita income is 32 % of urban income, and rural living expenditure is less than 35 % of urban living expenditure (NBSC 2003). The nature of poverty is different in rural and urban settings as well. In the Chinese context, communal lands have been allocated to households in a relatively egalitarian way within each village. Poverty in rural areas has less to do with food security than with a generally lower level of social services (health, education) and higher vulnerability when compared with urban areas (Jalan and Ravallion 1999, Liu, Hsiao and Eggleston 1999). Indeed, while rural poverty is contained and decreasing, urban poverty is now expanding quickly (CPDCR 2004).

The massive deforestation that has occurred in China has no doubt resulted in severe negative impacts on people who rely on these resources. There is a correlation between high dependence on forests and poverty, and the depletion of forest resources that has been criticized by many authors (Niu and Harris 1996, Smil 1997, Harkness 1998) can aggravate poverty. This is compounded by the poor performance of most forest industries when compared with the overall industrial sector in the country (Research Group of Forestry Economics 1998). Consequently, forest workers have among the lowest standard of living in China (Binghao and Lu 1999). Forest salaries appearing at the bottom of the list of over 60 categories or sectors published in the national statistics, and with a widening gap between national average wage and forest wage in recent years[1]. An analysis of the structure of rural farm-based income indicates that of the four sectors (crops, livestock, fish and forestry) included in Chinese statistics, forestry has experienced the lowest growth between 1985 and 2002 (NBSC several years). These facts help explain the view of Kejian and Yang (1996) that past forest interventions in the country have been a ‚vicious circle of poverty - afforestation - poverty'.

At the same time, a major effort has been made to expand forest cover in these regions. Most World Bank funded forest projects have focused on poor areas, and Rozelle *et al.* (2000) conclude that they have been good for poverty alleviation. Some authors (see Hyde *et al.* 2003, Liu 2003, Liu and Yin 2004) accept that forests have a role to play in poverty reduction, but this role may have been constrained by government market controls, insecurity of tenure and other types of interventions. Forestry related opportunities will change depending on local conditions. It is quite likely that in remote areas and among minority populations, the safety net and subsistence values of forests are the most important. It is also among these populations where cash income from trade in non-timber forest products (NTFP) is relatively more important. Forestry often represents the main, or even the only, cash-income generating opportunity for many in these poor regions. Although at a national level forestry contributes only 2.3 % to farm-derived rural cash income and 1.1 % to total rural income (NBSC 2003), it is an important source of income in income-poor but forest-rich counties, where up to 70 % - 80 % of the revenue can come from forests and forest-related activities (Da 1999, Zhang 2000). A significant part of public investment for rural environment and natural resources protection go to afforestation projects, contributing to employment creation (Rozelle *et al.* 2000). This investment has increased in recent years, particularly in connection to ecological programmes and a growing interest by foreign investors in plantations (Zhang 2003). Indeed, forest-based enterprises often constitute the only industry present in poor counties, serving both as main pillars for the development of the local economy and important taxpayers (Peng 1999, Zhang and Yuan 1999).

Remoteness and isolation, together with natural handicaps, have much to do with poverty, as epitomized by the mountainous and dry regions of China. Of 592 officially listed poor counties in the mid 90s, 496 were in mountainous areas (MoF 1995). And it is frequently in these regions, less accessible and with natural constraints limiting intensive agriculture, that forests have been preserved. It is therefore common to find a pattern of isolation, poverty and relatively large forest cover, and it is difficult to disentangle the causal links.

Li and Veeck (1999), in their study of forest resource use and rural poverty in China, explore the contribution of forests to rural income in poor areas. They found a significant overlap between counties officially classified as having abundant forest resources and severe poverty counties. Using multi-county models based on county and provincial level statistics they found no relationship between forest variables and income, concluding that the availability of forestry opportunities and forest resources contribute only very slightly to per capita income. Thus, according to these authors, forestry activities in rural China are not making the direct contributions to people's livelihood that the sector could and should be making, even in forest-rich counties. Although informative and thought provoking, the work of Li and Veeck does not help us to understand the contradictory evidence and perspectives on forestry and rural poverty.

The question arises: do forest resources and forestry activities promote rural development in China or are they part of the poverty trap ? We explore this question based on an analysis of the bamboo sub-sector and of the broader set of farmers' livelihoods options in a multi-county comparison.

FARMERS OPTIONS IN THE CONTEXT OF CHINA'S FORESTRY

Forestry in China is closely linked to agriculture, with forests and plantations commonly playing a complementary or supportive role in both management and income-earning (Westoby 1987, Tapp 1996). This is reflected in the unusually broad definition of forestry applied in China; ‚forest' refers to most forms of tree or bush cover, including tea, and many fruit and nut species that would be classified as part of the agricultural statistics in most countries. These are designated as ‚forest fruits' or ‚economic forests'. It is common to have several ministries or agencies involved in the management of these economic forests, sometimes resulting in poor coordination among them, as epitomized by the case of the tea[2] (Etherington and Forster 1996). At the same time, the production value of a number of these orchards and tree-based food production systems is commonly accounted as agricultural production, thus creating an imbalance between official land-use statistics and their corresponding production value. This leads to an underestimate of the value of forestry and of growth in the forest sector (Li 1996).

This fact has more than an anecdotal importance. It affects forest investment and development plans and farmers' options for forest management, and has

[1] Forestry wages represented 55 % of national wages in 1998, but only 44 % in 2003 (NBSC, several years).

[2] Etherington and Forster (1996) report tea farmers in Yunnan saying with sarcasm: ‚One bush, three policies, and three departments in charge'.

a direct influence on understanding how forestry contributes to poverty alleviation. Forestry departments at different levels in the administration, as sole authorities or in conjunction with other departments, have the mandate to implement development plans in forest land. Designated forest land normally cannot be converted to other uses without the corresponding planning permission. Most wasteland conversion plans require that land to be converted into forest or grassland. Likewise, the Natural Forest Protection Program and similar programs elsewhere in China have as their main thrust the afforestation of arable land on steep slopes. At the same time, farmers are interested to maximize their profits within the constraints of the land use plan. Given the option, they prefer to plant fruit trees, economic forests or bamboo on land earmarked for re-/afforestation. These products have increasing demand and are far more profitable than timber, which requires long-term investments and is subject to greater market uncertainty and heavy taxation (Liu and Landell-Mills 2003)[3]. There is ample evidence from all over China to support this point. It can be seen in the conversion of slash and burn to rubber plantations in Yunnan (Cao and Zhang 1997); in fruit tree and bamboo plantations in the Integrated Mountain Development Plans (Forestry Economics Editorial Board 1998, Wang and Zhao 1999, Liu and Edmunds 2003); in the Southern Collective Forest Region (Liu and Landell-Mills 2003); in the authors' fieldwork experience in several counties; and even in poverty alleviation programs through forestry activities in the Loess Plateau, replacing many of the former shelterbelt program activities (Joint Survey Group 1999).

Economic forests also constitute one of the main land-uses being established in auctioned wastelands (Hanstad and Li 1997, Yu *et al.* 1999). Interestingly, fruit and nut trees are also often the main plantation type under the Natural Forests Protection Programme (NFPP), predominating over timber and ecological plantation forests (Zhang 2000 unpublished). This has given rise to criticism that the intended environmental benefits of the NFPP have been undermined (Zhu 2000).

Conventional (i. e., timber oriented) forests still represent the largest amount of forest land in China. They are the dominant focus of forest institutions at different administrative levels, and many farmers are engaged in their management and in the expansion of plantations, even if they are also planting economic forests (Tapp 1996, Zhang 1996). A common pattern is to have fruit trees and bamboo in more accessible areas, normally on land under individual farmer household responsibility system, contract management or acquired through wasteland auction schemes. Timber plantations remain in the more remote places, and are managed as individual plots, joint stock cooperatives or through joint agreements between farmers and forest farms (Kejian and Yang 1996, Zhang 1996).

The key point is that, under present circumstances and given the option, farmers, forest farms and forestry authorities[4] are actively engaged in the expansion of fruit and nut trees and bamboo plantations, which are considered more profitable than conventional timber plantations and tend to have a more transparent, less burdensome taxation system, but are still classified as forestry activities.

The best indication of this trend is the increase in the area and the output of economic forests, from 6.1 million ha and 7 million metric tons (mt) output in 1978 to 27.3 million ha and 68.8 million mt in 2000, ranking China as first in the world in area and output for such crops. This change has been reflected in changes in the structure of rural markets; it has promoted rural development and relieved poverty (Lei 1999). Likewise, bamboo plantations have increased from 3.2 million ha in 1978 to 4.6 million ha in 2002 (SFA several years). Thus, while conventional (i. e. timber) forests have been depleted and timber-based forest industry is increasingly relying on imports (Sun, Katsigris and White 2004), at least until massive new timber plantations start producing, economic forests and bamboo plantations and their associated industries are thriving, offering farmers good opportunities to increase their income and to rise out of poverty.

Despite the strong growth and importance of this component of the Chinese forestry sector, analyses of forestry and poverty alleviation have typically been done from the perspective of conventional (timber) forestry. This helps explain the contradictory results of Li and Veeck, who do not differentiate between types of forests in their work, as well as some of the ambiguities in the analysis of causal relations between forestry and poverty.

THE BAMBOO SUB-SECTOR

Bamboo is an important component of Chinese forestry, having both symbolic and material value[5]. There are 39 genera and close to 500 species (depending on taxonomic criteria) of which over 100 are utilised (Zhu *et al.* 1994). With 4.6 million ha of pure bamboo forests and plantations, and 3 million ha of ‚mixed and mountain natural bamboo stands' (SFA 2003), China

[3] Zhao (2000) suggests that pursuing non-timber forest products (fruit trees and bamboo) may also have to do with tenure security as farmers who planted timber trees cannot cut them now under the NFPP in Simao Prefecture, Yunnan.

[4] In fact, many forestry bureaus we have visited, beyond promoting fruit and nut tree crops, are also engaged in off-forest activities, like hotels, restaurants and other non-forestry related industries, showing a surprising level of diversification of economic activities.

[5] The words attributed to Confucius *‚Man can live without meat, but cannot live without bamboo'* epitomize this dual value.

has the largest bamboo resource base in the world. Significant amounts of woody bamboo[6] occur in 17 provinces, with 10 provinces having over 100 000 ha each. Four contiguous provinces (Fujian, Jiangxi, Zhejiang and Hunan) have more than half a million ha each, accounting together for over 60 % of total bamboo plantations in China.

The bamboo resource base has increased steadily over the past two decades, both in surface area (32 %) and in density of stands (41 %). The combined expansion of plantations and increased density of stands has resulted in an exponential increase in output of bamboo culms and shoots (590 % and 1050 % respectively) that contrasts sharply with the stagnant and recently decreasing output of timber.

There are important differences in the rate of expansion of different types of bamboo. *Moso* bamboo (*Phyllostachys heterocycla* var. *pubescens* (Mazel) Ohwi), a monopodial bamboo with high quality culms that represents over two thirds of total bamboo plantations, has expanded slower (17 %) than sympodial bamboos like *Bambusa* spp., *Dendrocalamus* spp., *Sinocalamus* spp. (with an 83 % increase) in the last two decades.

Consequently, the fastest active expansion[7] of bamboo has taken place in provinces like Sichuan where sympodial bamboos can grow. A notable exception has been Yunnan province where bamboo area has decreased 30 % during this period. This decrease, which parallels the general decrease of forest resources in the province (Guo *et al.* 2002), has been recently redressed with the above mentioned new policies. Four southwest provinces (Sichuan, Yunnan, Guangxi and Guizhou, the latter starting from a very low base) account for 73 % of total new plantations established in recent years (SFA, several years). Five main features help to explain this exceptional dynamism:

- The dual use of bamboo for culms and shoots in short rotation cycles with productivity (both for land and labour) that compares with agricultural crops makes it an economically attractive option as a forest land-use to farmers.
- The relatively small management unit required (with 10 mu, equivalent to 0.66 ha, being a typical bamboo area managed by a family in our samples) means that bamboo can easily be adapted to the household responsibility system. In our sample of counties, between 80 % and 99 % of total bamboo area is managed by households.
- Both bamboo culms and shoots are traded in open markets, being one of the first forest products in China to be exempted from State marketing board control. Market intermediaries, agreements between farmers and large bamboo processing firms and even incipient futures markets can be found in different regions.
- The variable scale and diversity of processing units and the possibility of a degree of pre-processing by farmers makes local processing a viable option. Bamboo epitomizes the rural value-adding industrialization approach which has been promoted in many parts of China, while its diversity of uses allows for a certain degree of county-level spatial specialisation.
- An expanding national, regional and international demand for bamboo as a substitute for wood and for some superior goods like bamboo shoots and bamboo flooring has attracted national and foreign investment[8] helping to develop new technologies.

In combination these features give an economic attractiveness and a flexibility that have made bamboo a useful resource for adapting to and taking advantage of the opportunities offered by key policy reforms related to land tenure, commercialization, industrialization and exports.

SOURCES OF INCOME AND LIVELIHOOD STRATEGIES

Cross-sectional studies of bamboo farmers' income in Anji county (Zhejiang) showed that although rich farmers obtained the highest absolute income from bamboo, it was the middle income group of farmers who gained the most in relative terms (Ruiz Pérez *et al.* 1999). The authors' interpretation was that in a county like Anji, with a mature bamboo sector, this resource represented a normal opportunity for middle income farmers. Poor farmers were too poor to maximize the opportunity, whereas rich farmers had superior economic options available. These findings were questioned by Kant and Chiu (2000). Based in their survey of one village in Linan county (Zhejiang), they argued that the poorest farmers had benefited most from bamboo and that the income differences (measured by Gini coefficients) had been reduced. There are important methodological differences between the two studies. Notably, Ruiz Pérez *et al.* used quintiles to define five equal-sized income groups,

[6] There are a large variety of thin-stemmed and herbaceous bamboo species that are economically less important.

[7] We differentiate between ‚active expansion‘ of bamboo, which is deliberately promoted by farmers, and ‚passive expansion‘, which is due in part to the aggressive growth of bamboo rhizomes that can colonise neighbouring lands. The second is very common in monopodial bamboos, helping to explain the early use and current predominance of *moso* bamboo in Chinese plantations that also benefit from a less dramatic effect of synchronous flowering on *Phyllostachys* species (McClure 1993). However, as bamboo expands in tropical regions and new demands appear, other species are being incorporated, thus reducing the rate of expansion of *moso* bamboo.

[8] Foreign investment was more important in the early stages of the reform, mostly during the 1980s.

and the sample was spread randomly in 8 villages in Anji. Kant and Chiu used three income classes based on official income definitions, resulting on very unequal number of farmers per class; moreover, since they only worked in one village they could not measure inter-village differences, which was the main source of differentiation in Anji study.

We decided to replicate the study and to expand it to different development contexts and levels of importance of bamboo, and to include details of all sources of income. We maintained Anji as a benchmark expanding the work to Pingjiang county (Hunan) and to Muchuan county (Sichuan) along an East-West gradient within sub-tropical China. The three counties have similar percentage of forest cover, but differ in the type of forests, capacity of established forest industry, infrastructure development, access to markets and general level of development.

Anji is a relatively prosperous county (2001 per capita income 15 860 RMB), well connected to large external markets and big cities like Hangzhou (the capital of Zhejiang province) and Shanghai. About 58 % of the county is covered by forests, of which 57 % is bamboo. Most forest areas are located at the periphery of the county, while a large central plain is occupied by agriculture. Anji is a ‚mature‘ county from a bamboo point of view, being close to a ceiling with regards bamboo plantations. With a long production tradition and well-developed and diversified processing industry, bamboo has offered farmers good income opportunities, but the expansion of the industry has to rely increasingly on bamboo from other counties.

Pingjiang is an officially poor county (2001 per capita income 3 120 RMB) located in Hunan province within the Centre region, 600 km west from the coast. Around 51 % of the county is covered by forests, but only 7 % of the forest is bamboo. Most bamboo areas are located in the higher elevation zone in the southeast of the county, in less accessible areas, far from the main roads. Bamboo-based industry was limited to a large bamboo fan factory and few small workshops. The collapse of the factory in the early 1990s meant stagnation for bamboo until very recently. Most bamboo culm production was sold for processing in other counties.

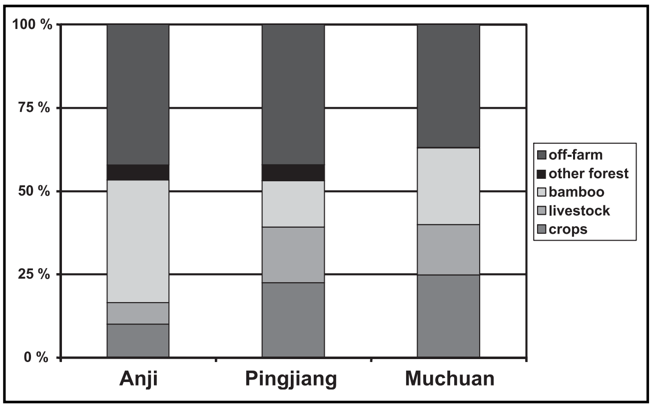
Muchuan county is located in Sichuan province in the southwest region. It is also a low income county that has just recently emerged from the list of poor coun-ňties (2001 per capita income 4 140 RMB). Located at the border of Yunnan province, the fastest expanding bamboo province in recent years, this county showed the highest bamboo expansion rate among our study areas. About 56 % of the county is covered by forests, of which 38 % is bamboo. Mountains divide the county into two large watersheds in the south-east and the north-west. As in the other counties, bamboo areas tend to be concentrated in these high elevation places. Most of the bamboo area is in the southern part of the county, which has better transport infrastructure and more bamboo processing factories (mainly bamboo paper for traditional and modern uses). A concentration of new bamboo plots is observed around two of the three large industrial bamboo-paper factories in the extreme south of the county.

In each county we selected three townships with bamboo resources and three villages within each township. Twenty farmers were randomly selected from each village. We used a questionnaire to collect data on land tenure status, income from different farm and off-farm activities and general family structure. Information from farmers' recall and written records was requested to assess changes in these variables over time, a task facilitated by the record-keeping tradition of many Chinese farmers. We obtained a total of 177 valid questionnaires in Anji, 159 in Pingjiang and 158 in Muchuan. For each county three equally distributed income classes were used to characterise low, middle and high income farmers to facilitate comparison between different counties.

Sources of income for different income categories

The structure of income for the five income categories used (crops, livestock, bamboo, other forests, off-farm) appears in Figure 1. The different components of farm-based income vary between counties, but off-farm income is relatively consistent (from 37 % in Muchuan to 43 % in Anji). As expected from county level statistics, Anji farmers get the highest share of income from forestry, followed by Muchuan and Pingjiang.

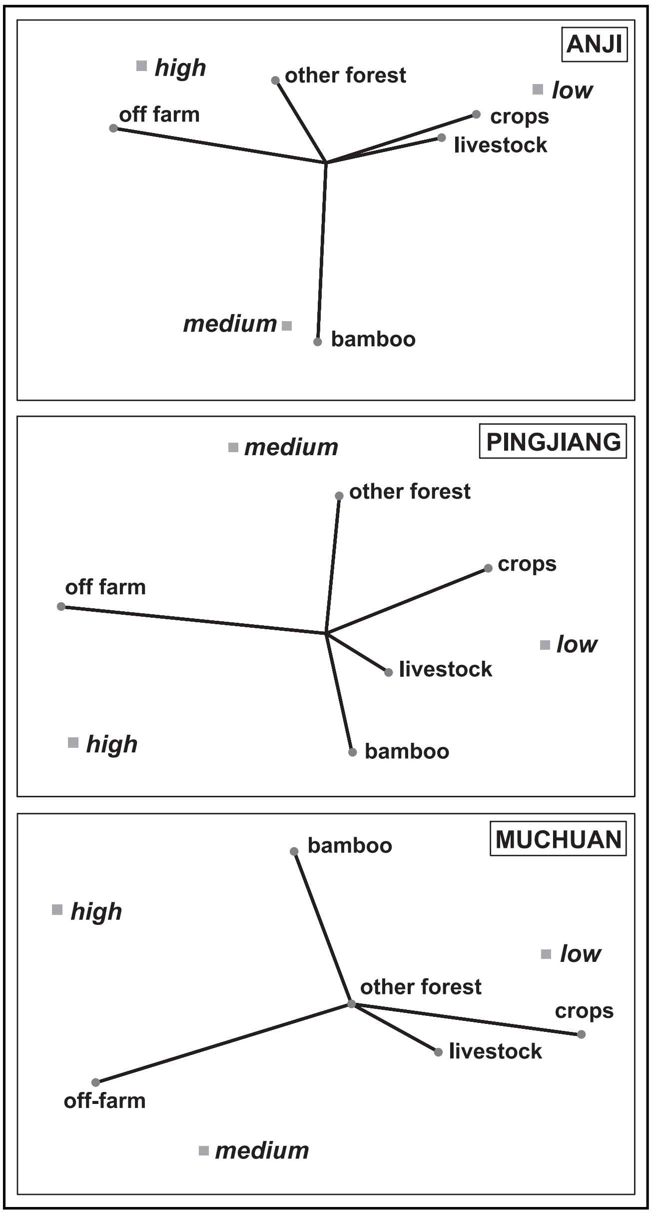
FIGURE 1 *Structure of farmers' income in 2000.*



Average income for each of the three income categories (low, middle and high) was calculated for each county. Principal Components Analysis was conducted on these data, indicating the predominant sources of income by category (Figure 2).

In all three counties, high- and middle-income farmers tend to be associated with off-farm income. Low-income farmers are associated with crops and livestock, two activities that tend to play a complementary role representing the classical farm-based income in the region. These results are consistent with findings in other regions that underscore the importance of off-farm income in rural livelihoods (Lanjouw and Feder 2001, Haggblade, Hazell and Reardon 2002), an opportunity that is maximized by better-off farmers in our cases.

FIGURE 2 *Principal Components Analysis biplots showing relative importance of main income sources among three income classes in 2000.*



The role of bamboo changes between counties. It is associated with middle-income farmers in Anji, with high-income farmers in Muchuan, and falls between high- and low-income farmers in Pingjiang. Income from other forest activities (mainly tea and fruits, but also timber and other products) is rather small in our samples, but tends to be opposed to income from bamboo, indicating a somewhat mutually exclusive forest-related option; farmers can choose to allocate their forestry land and labour to one or another option, but seldom combine both together, signalling a certain degree of forest-based specialisation.

Forest-based income distribution

Figure 3 represents the contribution of forest-based incomes for each county and income category of farmers. Given the dominance of bamboo in forestry activities in the villages selected, a similar distribution occurs for bamboo-based income. The importance of forestry for farmers at different levels of income varies between counties. The results in Anji, based on new data from a different sample, confirm earlier findings of Ruiz Pérez *et al.* (1999). In this county, where bamboo- and other forest-based income opportunities have reached a plateau, with very moderate recent expansion, forestry behaves as a normal income opportunity in which middle-income farmers are involved in a more prominent way. However, in Pingjiang, where forestry has been stagnant, offering few development opportunities, low-income farmers are relatively more dependent on this source of income. The trend is reversed in Muchuan, a county where bamboo and general forestry activities have been expanding rapidly for over a decade. Here, high-income farmers make the most of the opportunity. Kruskal-Wallis tests[9] show these differences are statistically significant for the last two counties (Table 1).

TABLE 1 *Kruskal-Wallis test for relative contribution of bamboo and forestry to farmers' income in 2000 by low, middle and high income categories.*

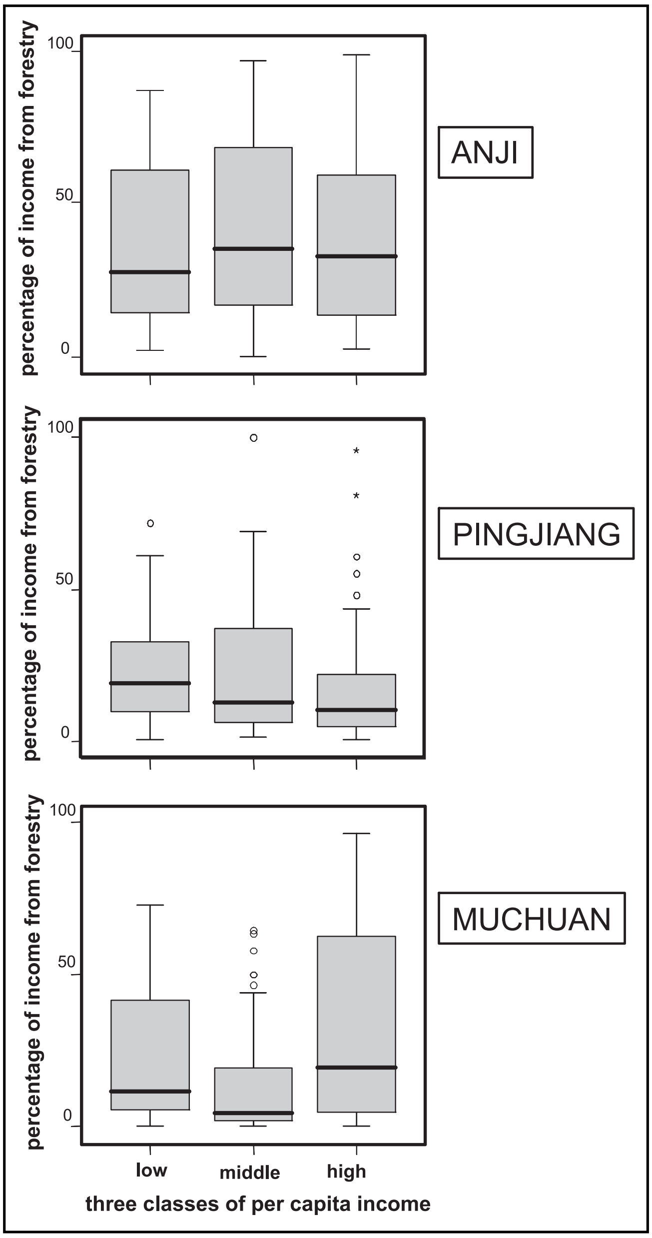
County	Bamboo		Forestry	
	K-W	sign.	K-W	sign.
Anji	1.656	0.437	1.177	0.555
Pingjiang	10.226	0.006	5.046	0.080
Muchuan	10.898	0.004	10.869	0.004

The results support the proposition that bamboo, and forestry activities in general, play a differentiated role in farmers' livelihood strategies according to the development context and opportunities offered by these activities. Under fast-expanding forestry conditions and with limited alternative economic opportunities, the richest farmers will benefit proportionally more from forestry resources. With stagnant forestry conditions, rich farmers will look elsewhere for the few opportunities available, and it is the poor farmers who will benefit proportionally more from forest resources. With a healthy and mature forestry sector and a wide range of opportunities, middle-income farmers are the ones who benefit proportionally most from forestry resources, falling between those who

[9] We have used this non-parametric test because some of the data do not follow a normal distribution.

‚need not' (rich farmers with access to better options) and those who ‚cannot' (poor farmers, too poor to maximize the opportunity). Figure 4 represents an idealised model of this proposition.

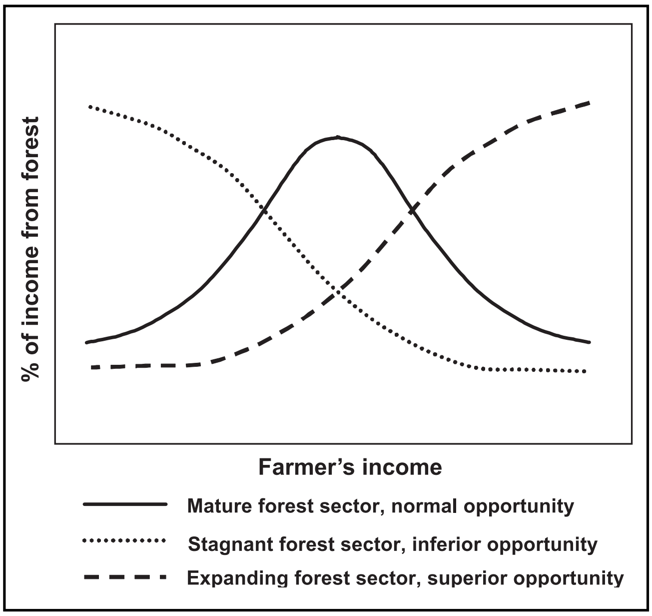
FIGURE 3 *Boxplot showing the contribution of forest income for each category of income in 2000.*



Changes in income

Income data for each of the main categories were registered for the years 1985, 1990, 1995 and 2000. A comparison of income sources in 1985 - at the beginning of the reform period - and in 2000, the year of reference for our study, is shown in Table 2. The relative contribution of crops remained fairly stable within counties, providing the base of farming income. Livestock and forestry based incomes tended to decrease in relative importance. Off-farm income showed a dramatic increase of between 2.0 (Anji) and 2.8 times (Muchuan), making up an average of 40 % for the three counties in 2000. These results parallel general changes in the structure of rural income in China, as reported by yearly statistics. Primary, farm-based income for the whole country represented 81.1 % of rural net income in 1985, but only 50.2 % in 2002 (NBSC, several years). The reverse trend is observed for off-farm income that currently represents half the total net income in rural areas.

FIGURE 4 *Idealised model of contribution of forest sector to farmers' income for different forest development contexts.*



In order to assess rates of change, we grouped farmers in each county in three equal-sized categories of relative income change between 1985 and 2000. We used ternary plots (Figure 5) to represent changes in the main sources of income - agriculture (including crops and livestock), forestry (bamboo and other sources) and off-farm - for the three categories of income change (farmers that experienced low, middle and high income change respectively). The direction of the arrows indicates a pattern consistent with the above-mentioned findings. The relative contribution of off-farm income increases in all categories and the increase is consistently higher the higher the category of change in income, with the differences being statistically significant in the three counties (Table 3). Agriculture (crops and livestock) income decreased, more markedly in Muchuan and Pingjiang and less in Anji. The decrease was again consistently higher the higher the change in income category, being statistically significant for the three counties. Forestry-based income showed a more varied response, with a general decreasing trend, although the differences were not statistically significant. In Anji, with its mature bamboo sector, the higher the increase in income, the higher was the reduction in forestry income. In Pingjiang, with a stagnant bamboo sector, low and high income change farmers showed a higher decrease in forestry-based income. In Muchuan, a county with a strong expansion of bamboo, the higher the increase in income the lower was the decrease in income from forestry (in fact, farmers that experienced the highest change in income maintained a similar relative contribution of forestry to total income). Muchuan is also the county with the lowest average decrease in forest-based income. The differences are statistically significant in Anji (Table 3).

TABLE 2 *Change in the average structure of income for each county between 1985 and 2000.*

	Anji		Pingjiang		Muchuan	
	1985	2000	1985	2000	1985	2000
Crops	9.7 %	10.2 %	27.2 %	22.8 %	19.9 %	24.9 %
Livestock	14.9 %	6.7 %	28.0 %	16.8 %	38.7 %	15.0 %
Bamboo	49.3 %	37.4 %	16.7 %	14.1 %	27.7 %	23.1 %
Other forest	4.5 %	4.5 %	8.8 %	4.6 %	0.2 %	0.1 %
Off-farm	21.3 %	43.0 %	19.3 %	42.7 %	13.0 %	36.9 %

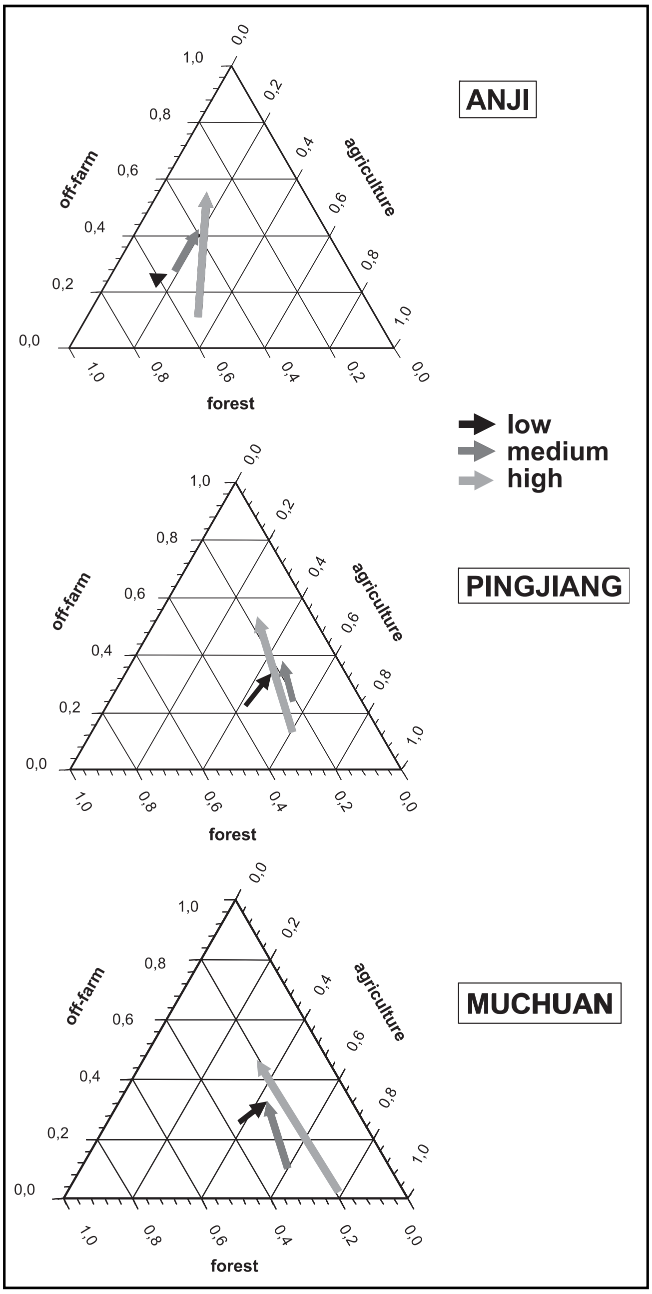
TABLE 3 *Kruskal-Wallis test for change in relative contribution of agriculture (crops and livestock), forestry and off-farm to farmers' income between 1985 and 2000 by low, middle and high change in income categories.*

County	Change in agriculture		Change in forestry		Change in off-farm	
	K-W	sign.	K-W	sign.	K-W	sign.
Anji	38.299	0.000	30.366	0.000	49.987	0.000
Pingjiang	22.273	0.000	2.577	0.276	28.239	0.000
Muchuan	36.696	0.000	1.541	0.463	32.038	0.000

Bamboo industry wages

The extension of this analysis to bamboo industry opportunities complements the above findings. Ruiz Pérez *et al.* (2003) compared bamboo-industry wages in three counties with differentiated per-capita income and development levels. In a county with low per-capita income and low levels of industrial development, the average bamboo industry wage was close to the average provincial wage. As the county increased the per-capita income and level of industrialisation, average bamboo industry wage decreased in comparison with average provincial wage (Figure 6). The interpretation is that as the county develops and the market offers better job opportunities, bamboo industries have to compete, being outperformed by more modern and dynamic industries. This view is reinforced by data on the employment of women in bamboo industries in those counties that show the reverse trend (i. e., lower percentage of women employed in bamboo industries in counties with relatively higher bamboo industry wages compared with average provincial wages), consistent with gender studies in China indicating that women are overrepresented in less attractive sectors (Riley 1995, Hare 1999, Dong *et al.* 2004).

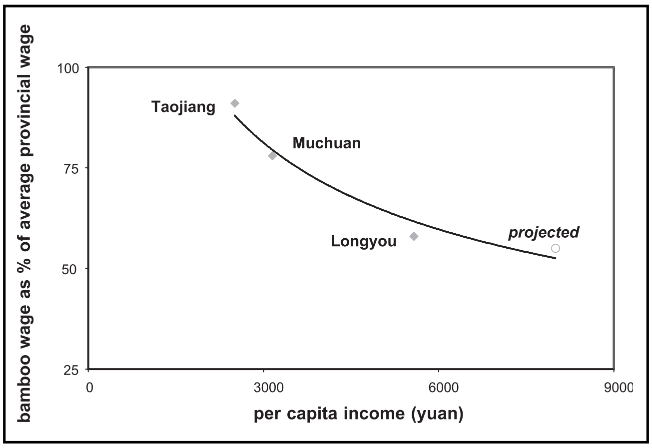
FIGURE 5 *Ternary plots of relative change in main income source (agriculture, forestry and off-farm) for three classes of income change (low, medium and high) between 1985 and 2000.*



Farmers' niche differentiation and specialisation through forestry

Before concluding, we would like to stress the stochastic nature of our results that ought to be interpreted as general and probabilistic trends rather than deterministic relations. In this sense, an important question is whether forestry provides opportunities for some farmers to improve their conditions. Our data indicate that off-farm income is the main pathway up the income ladder, and that forestry and agriculture have been losing ground (faster in higher income farmers and in those whose income increased most in the period from 1985 to 2000). However, our data also show that there is a small group of farmers in the high income category in the three counties that get a substantial, even dominant, part of their income through forestry.

FIGURE 6 *Relationship between per-capita income and relative ratio of bamboo industry wage to average provincial wage (modified from Ruiz Pérez et al. 2003).*



A general feature of this small group of better-off farmers with high forest-based income is a sort of ‚vertical integration' at the household level, where the farmer has managed to control a large amount of forest land and at the same time has some forestry-related (trade or processing) businesses. Thus, the three largest forest land holders in Anji and Muchuan and the second and third largest in Pingjiang are in the high income class. Interestingly, this situation does not apply to agricultural land, where differences between farmers tend to be less pronounced. Indeed, the coefficient of variation (standard deviation/mean) for agricultural land is noticeably smaller than the coefficient of variation for forest land for the three counties and in all income categories (Table 4), indicating a more egalitarian division of agricultural land compared to forest land.

TABLE 4 *Coefficient of variation (standard deviation/ mean) for agricultural and forest land in the three counties.*

County	Agricultural land	Forest land
Anji	0.71	0.95
Pingjiang	0.55	1.62
Muchuan	0.59	1.59

This indicates a potential niche for specialisation and high income generation through forestry that can be realized by a small group of dynamic farmers. This seems to be exacerbated by the conditions under which land was distributed in China and the opportunities for extended access to forest land and wasteland to be converted to forestry. This raises the intriguing question of the role of forestry in farmers' wealth accumulation and the creation of a rich class that controls land with a strong forest link in the specific context of China.

CONCLUSIONS

What is the role of forestry in livelihood change in China ? An important conclusion of our work is that this link has to be understood in the general context of overall rural development processes. Off-farm income opportunities are dominant: the better the off-farm options available, the more farmers go off farm for employment, and especially those in the higher income groups. However, the symmetric statement linking reduction of farm-based activities and development does not necessarily follow, even if the expansion of off-farm implies reduction of farm-based activities.

A way to formulate this is to ask whether less forestry would lead to more development ? The answer to this question will depend on the context and level of development, or the starting point from which we depart. When few alternatives are available, an expanding forestry sector is an attractive way for farmers to increase their income and for a county to develop in aggregate. However, after a certain level of development is achieved, more dynamic sectors take over as the spearhead of county's modernisation and development. At the same time, a stagnant forestry sector, even in a poor county, will not be a favoured option for middle- and high-income farmers to follow.

Independent of this general trend, forestry can offer a niche specialisation where, even with a relatively stagnant forestry sector, a smaller group of farmers can derive important benefits. In our cases this seems to be associated with a certain degree of vertical integration, where rich farmers combine relatively large forest holdings with some degree of processing and/ or trading. We lack sufficient information to extrapolate this to the rest of China, although patterns of land tenure and rural industrialisation seem to support it in the most densely populated provinces. This vertical integration is easier for certain forestry uses like bamboo, whose expansion and apparent success is facilitated by inherent advantages in raw material production and processing, including a fast rate of growth, regularity of production, diversity of uses, and diverse and wide ranging scale of processing technologies. Bamboo also has the added advantage that it is a useful wood substitute in a country with insufficient wood production capacity and policy and market constraints still affecting wood production. That is why bamboo has a bright future in Chinese forestry.

A final consideration from our research is that forestry may not only offer a pathway (under certain conditions) for farmers to emerge from poverty. In the Chinese context, with highly egalitarian agricultural land distribution, forestry may also be an avenue for land and wealth accumulation.

ACKNOWLEDGEMENT

We thank the Forest Bureaus of Anji, Pingjiang and Muchuan for their technical and logistic support. We also thank the European Union, the Science and Technology Office of Zhejiang and the Spanish Cooperation Agency AECI for funding of this research.

REFERENCES

BINGHAO, C. and LU, J. 1999. China's major forest regions: Natural forest protection and sustainable development. *Forestry Economics* [China] **5**(2):8-16.

CAO, G. and ZHANG, L. 1997. Preliminary study on rubber plantation as the local alternative to shifting cultivation in Yunnan Province, China. Unpublished report.

CPDCR (China Population and Development Country Report). 2004. Cited by Xinhuanet, 7 September 2004. Rural poverty down, urban poverty up.

CHOI, H. 1996. Inequality of income growth in China. *Asian Economics* **25**(4):80-91.

DA, F. 1999. Natural forest protection in Sichuan Province. *Forestry Economics* [China] **5**(2):37-43.

DONG, X. Y., MacPHAIL, F., BOWLES, P. and HO, S. P. S. 2004. Gender segmentation at work in China's privatized rural industry: Some evidence from Shandong and Jiangsu. *World Development* **32**(6):979-998.

ETHERINGTON, D. and FORSTER, K. 1996. ‚All the tea in China': The reformation and transformation of the tea industry. In: GARNAUT, R., SHUTIAN, G., and GUONAN, M. (eds). *The third revolution in the Chinese countryside*. pp 265-276. Cambridge University Press, Cambridge, UK.

FORESTRY ECONOMY EDITORIAL BOARD. 1998. New Actions in National Comprehensive Mountainous Development. A collection of experiences of experimental practices in various counties. *Forestry Economics* [China] **3**(1):67-74.

GUO, H., PADOCH, C., COFFEY, K., CHEN, A. and FU, Y. 2002. Economic development, land use and biodiversity change in the tropical mountains of Xishuangbanna, Yunnan, Southwest China. *Environmental Science and Policy* **5**:471-479.

HAGGBLADE, S., HAZELL, P., and REARDON, T. 2002. Strategies for stimulating poverty-alleviating growth in the rural nonfarm economy in developing countries. EPTD Discuassion Paper #92. World Bank, Washington, D. C.

HANSTAD, T. and LI, P. 1997. Land reform in the People's Republic of China: Auctioning rights to wasteland. *Loyola of Los Angeles International & Comparative Law Journal* **19**:545-583.

HARE, D. 1999. Women's economic status in rural China: Household contributions to male-female disparities in the wage-labor market. *World Development* **27**(6):1011-1029.

HARKNESS, J. 1998. Recent trends in forestry and conservation of biodiversity in China. *The China Quarterly* **156**:911-934.

HYDE, W. F., BELCHER, B., and XU, J. 2003. Introduction. In: HYDE, W.F., BELCHER, B., and XU, J. (eds). *China's forests. Global lessons from market reforms*. pp.1-21. Resources for the Future Press, Washington, D. C.

JALAN, J. and RAVALLION, M. 1999. Are the poor less well insured ? Evidence on vulnerability to income risk in rural China. *Journal of Development Economics* **58**:61-81.

JOINT SURVEY GROUP. 1999. Sustainable Forestry Development and Achievements in Loess Plateau. *Forestry Economics* [China] **4**(1):10-20.

KEJIAN, O. and YANG, S. 1996. Survey of the joint-stock management reform of Chunlei forest farm, Jinping county of Guizhou Province. *Forestry Economics* [China] **1**(1):55-59.

KANT, S. and CHIU, M. (2000). Bamboo sector reforms and the local economy of Linan County, Zhejiang Province, People's Republic of China. *Forest Policy and Economics* **1**(3/4):238-299.

LANJOUW, P. and FEDER, G. 2001. Rural non-farm activities and rural development: From experience towards strategy. Rural Development Strategy Background Paper #4. World Bank, Washington, D. C.

LEI, J. 1999. Reform and development of forestry in China guided by the Deng Xiaoping theory. *Forestry Economics* [China] **5**(2):17-26.

LI, Z. and VEECK, G.. 1999. Forest resource use and rural poverty in China. *Forestry Economics* [China] **4**(1), 80-92.

LI, Z. 1996. China Forestry: The way out. *Forestry Economics* [China] **1**(1):23-31.

LIU, C. and YIN, R. S. 2004. Poverty dynamics revealed in production performance and forestry in improving livelihoods: the case of West Anhui, China. *Forest Policy and Economics* **6**(3/4):391-401.

LIU, D. (ed.) 2003. Rehabilitation of degraded forests to improve livelihoods of poor farmers in south China. Center for International Forestry Research. Bogor, Indonesia.

LIU, D. and EDMUNDS, D. 2003. Devolution as a means of expanding local forest management in South China: Lessons from the past 20 years. In: HYDE, W. F., BELCHER, B., and XU, J. (eds). *China's forests. Global lessons from market reforms*. pp.27-44. Resources for the Future Press, Washington, D. C.

LIU, J. and LANDELL-MILLS, N. 2003. Taxes and fees in the Southern Collective Region. In: HYDE, W. F., BELCHER, B., and XU, J. (eds). *China's forests. Global lessons from market reforms*. pp.45-58. Resources for the Future Press, Washington, D. C.

LIU, Y., HSIAO, W. C. and EGGLESTON, K. 1999. Equity in health and health care: The Chinese experience. *Social Science and Medicine* **49**:1349-1356.

McCLURE, F. A. 1993. The Bamboos, a Fresh Perspective. Harvard University Press, Cambridge, MA.

MoF (China Ministry of Forestry). 1995. China Forestry Action Plan. Chapter VII. Comprehensive forestry development and poverty alleviation in mountainous areas, China Forestry Action Plan.

NIU, W. Y. and HARRIS, W. M. 1996. China: the forecast of its environmental situation in the 21st century. *Journal of Environmental Management* **47**: 101-114.

NBSC (National Bureau of Statistics of China). 2003. China Statistical Yearbook 2003. China Statistics Press, Beijing.

PENG, Z. 1999. Adjusting the forest benefit structure to push forestry sustainable development. *Forestry Economics* [China] **5**(2): 51-59.

RESEARCH GROUP OF FORESTRY ECONOMICS. 1998. An analysis of the development speed and economic benefit of Chinese forestry industry enterprise. *Forestry Economics* [China] **3**(1): 10-21.

RILEY, N. E. 1995. Chinese women's lives: rhetoric and reality. *Asia Pacific Issues* **25**:1-8.

ROZELLE, S., HUANG, J., HUSAIN, S. A., and ZAZUETA, A. 2000. From afforestation to poverty alleviation and natural forest management: An evaluation of China's forest development and World Bank assistance. World Bank, Washington, D. C.

RUIZ PEREZ, M., ZHONG, M., BELCHER, B., XIE, C., FU, M., and XIE, J. 1999. The role of bamboo plantations in rural development: the case of Anji County, Zhejiang, China. *World Development* **27**(1): 101-104.

RUIZ PEREZ, M., BELCHER, B., FU, M., and YANG, X. 2003. Forestry, poverty and rural development: Perspectives from the bamboo sub-sector In: HYDE, W. F., BELCHER, B., and XU, J. (eds). *China's forests. Global lessons from market reforms*. pp.151-176. Resources for the Future Press, Washington, D. C.

SMIL, V. 1997. China shoulders the cost of the environmental change. *Environment* **39**(6): 6-37.

STATE COUNCIL INFORMATION OFFICE. 2001. White Paper on Rural China's Poverty Reduction. State Council Information Office, Beijing.

SFA (State Forest Administration) (several years). Chinese Forestry Yearbook [in Chinese]. China Forestry Publishing House, Beijing.

SUN, X., KATSIGRIS, E, and WHITE, A. 2004. Meeting China's growing demand: An overview of import trends, ports of entry, and supplying countries, with emphasis on the Asia-Pacific Region. Forest Trends-CCAP-CIFOR.

TAPP, N. 1996. Social aspects of China fir plantations in China. *Commonwealth Forestry Review* **75**(4): 302-308.

WANG, C. and ZHAO, X. 1999. Components and measures for integrated mountain development in China. *Forestry Economics* [China] **4**(1): 21-29.

WESTOBY, J. 1987. Making green the Motherland: Forestry in China. In WESTOBY, J. (ed). *The purpose of forests. Follies of development*. pp. 270-287. B. Blackwell, Oxford

WORLD BANK. 2000. World Development Report, 2000-2001.World Bank, Washington, D. C.

WORLD BANK. 2002. India and China: Which country has experienced more pro-poor growth and why ? PREM Learning Week, World Bank, Washington, D. C.

XINHUA. 2004. 800 000 more Chinese live in poverty in 2003. *Xinhua News*, 20 July 2004.

YU, G., YU, L., HUANG, C. and CHEN, G. 1999. Survey and exploitation on forestland transfer in integrated mountainous development. *Forestry Economics* [China] **4**(1): 30-34.

ZHANG, D. and YUAN, R. 1999. Problems and countermeasures for the development of rosin derivative products for naval stores industry in China. *Forestry Economics* [China] **4**(1): 61-66.

ZHANG, D. 2003. Policy reform and investment in forestry. In: HYDE, W.F., BELCHER, B., and XU, J. (eds). *China's forests. Global lessons from market reforms*. pp.85-108. Resources for the Future Press, Washington, D. C.

ZHANG, L. 1996. Full scale promotion of degraded land tenure for acceleration of plantation and poverty relief. *Forestry Economics* [China] **1**(1): 60-63.

ZHANG, Z. 2000. Natural Forest Protection Program. First meeting of the China Council for International Cooperation on Environment and Development. Forests-Grasslands Task Force. Unpublished notes from presentations and discussions on July 18 and 19, 2000.

ZHAO, Y. 2000. Impacts of the logging ban on the community in Simao Prefecture, Yunnan Province. First meeting of the China Council for International Cooperation on Environment and Development. Forests-Grasslands Task Force. Unpublished notes from presentations and discussions on July 18 and 19, 2000.

ZHU, C. 2000. Case study on returning steep cultivated land to forests: Policy and its impacts. First meeting of the China Council for International Cooperation on Environment and Development. Forests-Grasslands Task Force. Unpublished notes from presentations and discussions on July 18 and 19, 2000.

ZHU, S., MA, N. and FU, M. 1994. A Compendium of Chinese Bamboo. China Forestry Publishing House, Beijing.

China's Sloping Land Conversion Programme four years on: current situation, pending issues

ZHIGANG XU● M. T. BENNETT■, RAN TAO♦ and JINTAO XU▲

● *Research Fellow, Center for Chinese Agricultural Policy (CCAP), Institute of Geographical Sciences and Natural Resource Research, Chinese Academy of Sciences, Datun Road, Anwai, Beijing, 100101 China*

■ *Visiting Scholar, CCAP*

♦ *Shaw Research Fellow, Institute for Chinese Studies, the University of Oxford, and Research Fellow, CCAP*

▲ *Deputy Director, Center for Chinese Agricultural Policy (CCAP)*

Email: mbennett.ccap@igsnrr.ac.cn

SUMMARY

With a budget of RMB 337 billion (over US$ 40 billion), the Sloping Land Conversion Program (SLCP) is one of China's most ambitious environmental initiatives, and is one of the world's largest land-conservation programs. Pending successful completion, it will have significant implications for China's forests and remaining natural ecosystems, representing an almost 10 % increase in current national forest area. However, we provide evidence that it is in danger of failing to reach its goals due to flaws in design and implementation. Four years into the program, this paper uses a 2003 data set of 358 households to examine SLCP implementation and to suggest improvements. Of central concern has been overly quick expansion over the past few years, which has served to exacerbate problems already revealed, but not adequately addressed, during the pilot phase of the program.

Keywords: sloping land conversion, program sustainability, targeting, rural household income.

INTRODUCTION

With a budget of RMB 337 billion (over US$ 40 billion), the Sloping Land Conversion Program (SLCP) is one of China's most ambitious environmental initiatives, and is one of the world's largest land-conservation programs (WWF 2003). Initiated in 1999, it is now being implemented in more than 2000 counties across 25 provinces and municipalities in China, and currently has enrolled some 15 million farmers. It has the stated environmental goals of reducing water and soil erosion and increasing China's forest cover and area by retiring steeply sloping and marginal lands from agricultural production. In particular, under SLCP the State Forestry Administration plans to convert around 14.67 million hectares of fragile cropland to forests by program completion in 2010, 4.4 million of which will be land with slopes of 25 degrees or above (SFA 2002). As such, pending successful completion, it will have significant implications for China's forests and remaining natural ecosystems, representing an almost 10 % increase in current national forest area (Hyde *et al.* 2003).

Since it started, almost 7.2 million ha of land have been converted under the program, indicating that already half of its goals have been met in the first four years alone (Xu *et al.* 2004). However, this apparent success must be viewed with caution, since it is the result of extremely rapid expansion over the past two years. Such expansion has revealed weaknesses in program design and implementation that threaten the program's long-term goals, and bring into question the veracity of its claimed accomplishments to date. Various authors have pointed to problems in implementation observed during the pilot phase that raise concerns about program design and cost effectiveness. These include problematic targeting of plots, low survival rate of planted trees, problems in the delivery of compensation to participants, and issues related to rent-seeking opportunities for local governments that exist under the program's current design (Zuo 2002, Xu and Cao 2002).

To examine whether such issues have indeed continued into the full-scale implementation phase of SLCP, we use a 2003 data set of 358 rural households from villages participating in SLCP to take a look at program implementation and outcomes four years into its execution. Specifically, this paper looks at two key measures of program design and implementation: targeting effectiveness, and what impact it has had to date on participating household income. Limitations in the data and brevity of the time period covered preclude measurement of the environmental benefits of the program to date. However, given that farmers participating in SLCP are generally of the poorest in China, if the livelihoods of participants are not sufficiently improved as a result of program participation, they will have the incentive to return to farming marginal lands once subsidies are curtailed. Thus, shorter-term impact on participant income is an important gauge of the long-term sustainability of the program's environmental goals.

The remainder of the paper is organized as follows: we begin with a brief introduction to SLCP, discussing its creation, goals, and general implementation to date; the following three sections then explore cost and targeting effectiveness, farmer compensation and program administration, and short-term program impact on participant income, respectively. In the section on cost and targeting effectiveness, we present evidence that though generally in line with program goals, targeting is still problematic. In the section on farmer compensation we provide evidence that problems in targeting, program compensation standards and program administration have resulted in numerous cases wherein participants have not been fully compensated for the foregone net revenue of their plots set aside under SLCP. We then present evidence in the section on program impacts that SLCP has had, on average, negligible impact on participant income in our sample, suggesting that its goals of poverty alleviation are not being realized. We conclude by emphasizing that insufficient consideration was put into program design and budgeting at the outset, that the pilot phase was not adequately utilized to identify and correct flaws in design and implementation, and that speed of expansion needs to be considerably reduced and monitoring and evaluation improved so that the environmental benefits and enhanced rural livelihoods promised by the program can be realized.

The Sloping Land Conversion Program

In the summer of 1998, devastating floods swept through the middle reaches of the Yangtze River causing great loss of life and large-scale economic and environmental damage. More significantly, these floods washed away any illusions held by Chinese authorities that the high rates of deforestation occurring in the upper reaches of the Yangtze from timber harvesting and land conversion could continue to be ignored. Experts generally agree that such deforestation, and consequent increase in rates of soil erosion, has significantly damaged watershed services and thus exacerbated, if not precipitated, the 1998 floods (World Bank 2001, WWF 2003). In general, an estimated 2 billion tons of silt is released into the Yangtze and the middle and upper reaches of the Yellow River annually. Around 1.3 billion tons of this is estimated to result from sloping cropland, and data suggests that west China, with 70 % of the estimated 6.07 million ha of agricultural land with slopes greater than 25 degrees, contributes the majority of this (Xu *et al.* 2002). As such, the 1998 floods spurred the central government to initiate the Sloping Land Conversion Program in 1999, with particular emphasis on west China.

Also known as *Grain for Green*, SLCP stipulates that farmers who convert degraded and highly sloping cropland back to either ‚ecological forests' (defined by the State Forestry Administration as timber-producing forests), ‚economic forests' (orchards, or plantations of trees with medical value) or grassland will be compensated with (1) an annual in-kind subsidy of grain, (2) a cash subsidy, and (3) free saplings, provided to the farmer at the beginning of the planting period. To account for differences in regional average yields, the grain subsidy is set at 2250 kg/ha (36 bu/acre) in the Yangtze River Basin, and 1500 kg/ha (24 bu/acre) in the Yellow River Basin. The cash subsidy is RMB 300/ha of eligible land (US$ 36/ha or US$ 15/acre) per year. Both grain and cash subsidies are for 8 years if ecological forests are planted and for 5 years or 2 years if economic forests or grasses are planted, respectively (Xu *et al.* 2004).

Apart from its sheer size, the SLCP differs from most other water and soil conservation programs in China for a couple of reasons. First of all, the central government stated that the program aims not only to conserve soil and water in China's ecologically fragile areas, but also to restructure the rural economy so that participating farmers can gradually shift into more environmentally and economically sustainable activities such as livestock breeding and off-farm work (SFA 2002). As such, it is interesting for its integration of environmental goals with those of agricultural restructuring and poverty reduction. Secondly, the program directly engages millions of rural households as core agents of project implementation, being essentially a public payment scheme for environmental services. Fifteen million farmers have participated in the program in the first four years alone, and leaders have estimated that upon completion SLCP will affect 40-60 million rural households (Uchida *et al.* 2004, Xu *et al.* 2004).

Under the program, the State Forestry Administration plans to convert around 14.67 million hectares of fragile cropland to forest by 2010, 4.4 million of which is estimated to be on land with slopes of 25 degrees or above (SFA 2002, WWF 2003). Pending successful long-term implementation, it could therefore have significant implications for China's forests and remaining natural ecosystems, since it would increase national forest area by almost 10 % of its current level (Hyde *et al.* 2003). Table 1 details converted land area and grain subsidies under the program by year, and gives an idea of the immensity of SLCP. The pilot phase of the program began in 1999 with initial implementation in the three western provinces of Sichuan, Shaanxi and Gansu, all of which are located at the middle and upper reaches of the Yellow River Basin and upper reaches of the Yangtze River Basin. In March 2000, the pilot was then officially extended to 174 counties in Yunnan, Guizhou, Sichuan, Hubei, Shanxi, Henan, Shaanxi, Gansu, Ningxia, Qinghai and Xinjiang, as well as Chongqing municipality. In June 2000, another 14 counties in Hunan, Hebei, Jilin and Heilongjiang were added, and in 2001 the program was expanded to include a total of 20 provinces, 400 counties and 27 000 villages. By the end of 2001, a total of 1.2 million hectares of cropland had been converted under SLCP, as well as an additional 0.47 million hectares of barren land (Xu *et al.* 2004, Uchida *et al.* 2004).

According to internal government reports, upon full implementation in 2002 SLCP was extended to a total of 1897 counties across 25 provinces, and by the end of 2003 the program had encompassed more than 2000 counties in 25 provinces. By the end of 2003, 7.1 million hectares of cropland had been converted, and 4.92 million hectares of barren land had been afforested (Xu *et al.* 2004). Figure 1 below presents a graphical illustration of converted land area under SLCP by year. During the pilot phase an average of 408 000 hectares of cropland was converted per year. Upon full-scale implantation beginning in 2002, however, this jumped to 2.9 million hectares per year, a more than sixfold increase. The number of enrolled counties also jumped significantly, by 374 % between the end of 2001 and the end of 2002.

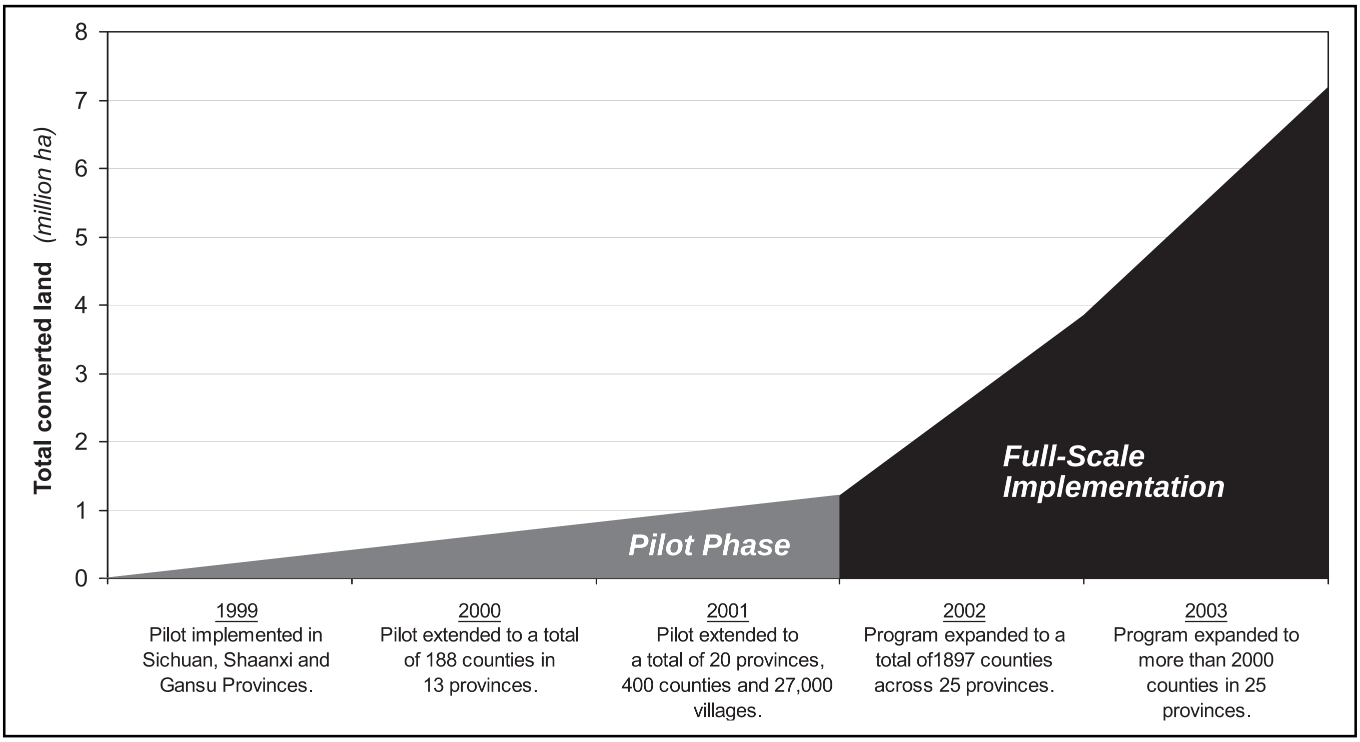
Though the speed of program expansion and land conversion suggests that SLCP has been extremely successful, having already reached half of its goals within the first 4 years of implementation, such numbers have in reality served to highlight concerns - already voiced during the pilot phase - that problems in design and implementation are adversely affecting program effectiveness and sustainability. A key worry is that the program places undue burden and cost on local governments, which in turn could be causing problems in program administration such as low survival rates of planted trees, insufficient delivery of compensation to farmers, lack of respect for the principals of volunteerism, and difficulties in targeting and monitoring (Zuo 2002, Xu and Cao 2002). These need to be brought to the attention of policy makers, since they point to potentially critical flaws in program design and implementation that will adversely affect the program's ability to reach its goals efficiently and sustainably. As such, we provide evidence in

TABLE 1 *Total converted area and grain subsidy under SLCP, 1999-2003*

Year	Converted area (1,000 ha)		Annual grain subsidy delivered	
	Current year	Cumulative total	Quantity (million tons)	Expenditure (billion RMB)
1999	381.30	381.30	0.70	0.98
2000	404.70	786.00	1.44	2.01
2001	420.00	1,206.00	2.21	3.09
2002	2,646.70	3,852.70	7.05	9.87
2003	3,338.00	7,190.70	13.16	18.42
Total	**7,190.70**		**24.55**	**34.37**

Source: Stale Land Administration

FIGURE 1 *SLCP converted land area by year*



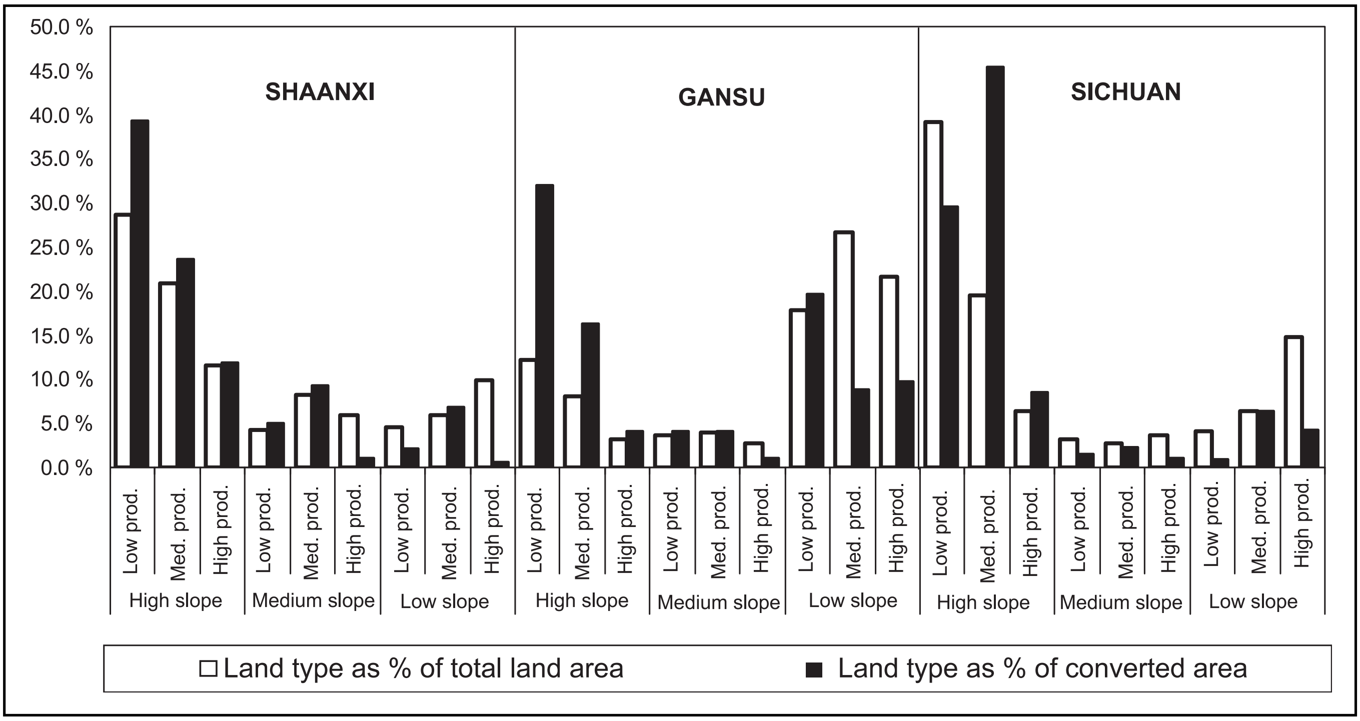
the following sections that targeting effectiveness has indeed been less than optimal, and that this, combined with an overly simplified compensation scheme, has made a significant number of participants potentially worse off under SLCP.

Cost and Targeting Effectiveness

Since the program's stated goals are to prevent soil erosion and restore forests and grasslands, its designers have made steepness of slope one of the main criteria for the selection of plots for conversion. At the same time, as pointed out in Uchida *et al.* (2004), plot production history should also be considered so that these goals can be achieved at minimum cost in terms of foregone agricultural output and in accordance with the program's other aims of reducing poverty and efficiently restructuring agriculture production. We thus examine targeting in our sample in terms of land slope and productivity.

We use a large household survey collected in 2003 by the Center for Chinese Agricultural Policy, Chinese Academy of Sciences, in Gansu, Shaanxi and Sichuan provinces. The data set is of 358 households (2067 plots) selected via stratified random sampling of 2 counties in each province, 3 townships in each county, 2 villages in each township and 10 households in each village. Since this data is from the three western provinces where SLCP was first initiated on a pilot basis in 1999, it allows for a look at program implementation over a comparatively long time period. Furthermore, the data include both participants and nonparticipants, and so allow for examination of overall targeting of plots in the selected areas, rather than only of those of participating households as has been done in other studies (e. g. Uchida *et al.* 2004, Xu and Cao 2002). Figure 2 presents the composition of total land area versus composition of converted land area by region and land type. Land is categorized as ‚Low', ‚Medium' or ‚High' productivity based on 1999 (i. e. pre-SLCP) net revenue per hectare[1]. Although this is not an absolute measure of land productivity, since it does not account for labor inputs and household characteristics, for the purposes of this examination it is reasonable (as a rough proxy for the opportunity cost to farmers of retiring particular land areas) for evaluating SLCP targeting. ‚High', ‚Medium' and ‚Low Slope' land is defined as land that has a slope greater than 25 degrees, between 15 and 25 degrees, and less than 15 degrees, respectively. From Figure 2 it can be seen that although, in general, plots with higher slopes and lower productivity appear to be predominantly targeted, significant variation exists. Fully 63 %, 48 % and 75 % of the converted plots in Shaanxi, Gansu and Sichuan, respectively, have slopes greater than 25 degrees and are of medium to low productivity. At the same time, however, in Gansu almost 19 % of converted area is low-slope and high-to-medium-productivity, with 38 % being on low-slope area in general. Furthermore, almost 10 % of converted land in Shaanxi, and 11 % in

FIGURE 2 *Land type shares of total area and converted area*



Source: 2003 Survey Data

[1] To account for regional differences in land productivity, regional samples were sorted into thirds based on their within-sample 1999 net-revenue.

Sichuan, are also on land with a slope less than 15 degrees. This reveals problems in implementation, since in general low-slope land should not be selected into the program, especially if it is relatively productive.

Another indication of good targeting is that the share of the total area of lower-productivity higher-slope land that has been converted is greater, and preferably much greater, than that of higher-productivity lower-slope land. As can be seen in Table 2, this appears to be the case, but with important exceptions. For Shaanxi, almost 82 % of total high-slope low-productivity land area has been converted, compared to less than 4 % of the high-productivity low-slope land. However, in Sichuan, only 20 % of the high-slope low-productivity land has been converted, whereas around 34 % of low-slope medium-to-high-productivity land has been enrolled. In Gansu, only 56 % of high-slope low-productivity land has been converted, while almost 10 % of low-slope high-productivity land has been converted.

TABLE 2 *Percentage of land area type converted under SLCP, 2002*

	% of land area type converted under SLCP		
	Shaanxi (*n*=575)	Gansu (*n*=765)	Sichuan (*n*=727)
All plots	**59.4 %**	**21.4 %**	**26.5 %**
Slope > 25°	**73.0 %**	**47.7 %**	**34.0 %**
Low productivity	81.8 %	56.0 %	20.0 %
Medium productivity	67.2 %	43.3 %	61.8 %
High productivity	61.5 %	27.6 %	35.1 %
Slope 15° - 25°	**49.8 %**	**19.3 %**	**13.6 %**
Low productivity	70.8 %	24.3 %	12.7 %
Medium productivity	67.1 %	21.8 %	22.0 %
High productivity	11.0 %	8.8 %	8.0 %
Slope < 15°	**28.0 %**	**12.4 %**	**12.1 %**
Low productivity	27.2 %	23.6 %	5.6 %
Medium productivity	68.5 %	7.1 %	26.2 %
High productivity	3.8 %	9.6 %	7.7 %

Note: Productivity is measured as 1999 (pre-program) net revenue/ha, and was divided into types by sorting the regional samples into thirds.
Source: 2003 Survey Data

In general, these results suggest that at minimum far too much productive, low-sloping cropland is being retired, particularly since in all samples high-sloping, low-to-medium productivity land area remains in use. Further supporting these conclusions, Uchida *et al.* (2004) find in their 2000 survey of 144 participating households that almost 17 % of low-sloping cropland in the sample was converted under SLCP, while 32 % of high-sloping cropland was not.

SLCP Compensation Standards and Administration

Another key measure of successful design and implementation is whether or not participating households have been made better off, or at least no worse off, as a result of participation. This is in line with SLCP's other goals of poverty alleviation and improved restructuring of agricultural production (SFA 2002). At minimum, the combination of subsidy standards and targeting should be such that compensation to participating households should at least equal average pre-program net revenue from the plots they have retired under the program[2]. Unfortunately, evidence from our 2003 survey, and from Uchida *et al.* (2002), suggest that compensation standards do not adequately account for regional and inter-household production variability, which combined with poor targeting has resulted in shortfalls in compensation to participant households in a number of cases. Uchida *et al.* (2004), for example, find in that around 24 % and 77 % of their sample households in Ningxia and Guizhou provinces, respectively, received payments less than pre-program net revenue from the plots. Though they estimate that for the whole sample compensation exceeds pre-program net revenue by a total of RMB 46 885, this hides a net shortfall in compensation for the sample in Guizhou of RMB 4 609. Furthermore, these numbers actually underestimate total shortfall in compensation, since the above-market price of RMB 1.4 /kg paid by the government to the state grain sector to purchase program grain is used to monetize the grain portion of total subsidies.

In our sample, we also find significant shortfall in compensation. Table 3 below compares 1999 (pre-program) net revenue per hectare of converted plots with monetized SLCP compensation. In contrast to Uchida *et al.* (2002), we use 1999 grain market prices to monetize the grain portion of the SLCP subsidy. We find that for more than one fourth of participants in the sample, the SLCP standard falls short of the net revenue received from the plots in 1999 before conversion, for a total shortfall within this group of RMB 47 356. Overall, the total gain to participant farmers in the sample exceeds total loss by RMB 111 393. However, the difference between opportunity costs and compensation benefits varies greatly by region (and household), highlighting the point made by Uchida, Xu and Rozelle (2004) that apart from issues related to targeting, compensation standards are insufficiently graded to account for production heterogeneity. Net average gain per household for Shaanxi, for example, is RMB 1 026, compared with RMB 95 for Sichuan, and a net loss of RMB 18 per household for Gansu. This compares with an overall average net gain of RMB 757 per household for Ningxia and an overall net loss of RMB 61 per household for Guizhou in Uchida *et al.*'s sample.

[2] For the purposes of this analysis, we shall ignore considerations of risk, which would suggest that insofar as participating farmers are risk averse, all else equal, they would be willing to receive an annual fixed subsidy that is less than the expected net revenue from plots they retire from production under SLCP.

TABLE 3 *Participating farmers' average opportunity cost versus real compensation standards*

		Net losing households	Net gaining households	All participating households
Shaanxi *(n=103)*	Number of households	7	96	103
	Opportunity cost RMB*	322	12	34
	Converted land area (ha)	5.13	68.13	73.27
	Compensation - opportunity cost RMB	-14778	120478	105700
	Average net gain as % of compensation	-120 %	74 %	60 %
Gansu *(n=85)*	Number of households	40	45	85
	Opportunity cost RMB*	239	65	135
	Converted land area (ha)	8.07	11.93	20
	Compensation - opportunity cost RMB	-13139	11614	-1525
	Average net gain as % of compensation	-68 %	41 %	-3 %
Sichuan *(n=76)*	Number of households	22	54	76
	Opportunity cost RMB*	364	70	164
	Converted land area (ha)	7.27	15.47	22.73
	Compensation - opportunity cost RMB	-19439	26657	7218
	Average net gain as % of compensation	-85 %	55 %	10 %

* Defined as 1999 (pre-program) net revenue from the converted plots.
Source: 2003 Survey Data

Unfortunately, these problems are overshadowed by evidence that actual delivery of program compensation to farmers often falls short of total compensation stipulated by SLCP. Zuo (2002), for example, gives anecdotal evidence that in a number of instances full compensation does not reach participating farmers for various reasons. In some cases, a portion is deducted by village government either to pay laborers to plant trees on the farmer's converted land, or to pay back-taxes owed by the farmer. Our fieldwork both for this survey and another in Hunan Province has also revealed serious diversion of funds slated for farmer compensation. In other cases, shortfalls are the result of plots that have been converted but have not yet been fully certified under SLCP. Xu and Cao (2002) find that in a group of 1 026 households, fully 49.5 % had received only partial compensation, 8.5 % had received only grain and 17.6 % had received no compensation at the time of the survey.

Table 4 below details a comparison of the SLCP compensation standards with the average of actual compensation received by the participating households in the 2003 survey. We find that in all six survey areas, average actual grain and cash compensation delivered at the time of the survey fall short of stipulated compensation standards. The average shortfall in cash compensation for the whole sample is RMB 195/ha, more than half of the SLCP standard, and ranges from fully RMB 270/ha in Linxia County, to RMB 45/ha in Jingnin County, both in Gansu Province. The average shortfall in grain compensation is 953 kg/ha for the sample overall, and ranges from a maximum of 1 267.5 kg/ha in Yanchuan County, Shaanxi Province, to a minimum of 225 kg/ha in Chaotian, Sichuan Province. In addition to such shortfalls, numerous farmers in the 2003 survey also reported that subsidy grain delivered was old and of poorer quality.

These shortfalls are symptomatic of both poor program budgeting, and larger issues involving China's system of rural finance. Regarding budgeting, program coordination, inspection and compensation delivery for millions of plots is burdensome and costly for local governments. Yet it has only been since 2002 that the central government has allocated any administrative fees to provincial governments for SLCP implementation. These, however, have been insufficient, and are often in large part diverted by higher levels before reaching the townships. This is partially a result of the fast expansion of the program, which has created even greater administrative needs, and thus shortfalls in required administrative funds, and which has in turn led to problems in implementation and subsidy delivery. In a township in a key project county in Shaanxi Province, for example, half of the participating plots were not inspected and compensated on time. In another township of the same county, many participating plots had yet to be inspected even three years after they had entered SLCP; though the county government recruited 30 additional staff to deal with these problems, manpower has still been far short of that required to inspect some 67 thousand hectares of converted land.

Diversion of funds has come as little surprise to those familiar with the complex institutional dynamics of rural China. In fact, rather than grant localities the power to set the compensation level, the central government settled on a simplified, two-tier compensation scheme in part to prevent local governments from exploiting their informational advantage by exaggerating estimates of the forgone incomes of converted land so as to inflate their subsidies[3]. Nonethe-

[3] This type of behavior is a continuing and significant issue in China's local public finance and governance system. It is due, in part, to significant shortfalls in local government finances, especially in less developed regions, due to significant lack of tax compliance and the decentralization of rural public finances (Wong 2000).

TABLE 4 *Average grain and cash compensation standards and actual delivery in surveyed areas, 2002*

Province	County	Grain compensation					Cash compensation	
		Wheat	Paddy	Corn	Actual delivery	SLCP standard	Actual delivery	SLCP standard
		kg/ha					*RMB/ha*	
Shaanxi	Yanchuan	120	0	112.5	232.5	1500	60	300
	Liquan	607.5	0	607.5	1215	1500	90	300
Gansu	Jingnin	622.5	0	187.5	810	1500	255	300
	Linxia	255	0	67.5	322.5	1500	30	300
Sichuan	Chaotian	592.5	1027.5	397.5	2025	2250	45	300
	Lixian	847.5	1072.5	0	1927.5	2250	195	300
Average		**390**	**217.5**	**210**	**810**	**1763**	**105**	**300**

Source: 2003 Survey Data

less, local governments have found other ways to milk the system by focusing their efforts on increasing their land conversion quotas, either through direct negotiation, or by first overreaching their land conversion quotas and then bargaining for more subsidies. Such behavior can be traced to the beginning of SLCP in 1999, when the three pilot provinces of Sichuan, Shaanxi and Gansu overshot their quotas by more than 100 % within 3-4 months. This continued through 2000, when 312 counties initiated land conversions on their own initiative, despite the fact that the central government's plan was to implement the pilot program in only 174 counties. To date, the State Forestry Administration continues to receive numerous requests from local governments asking for higher land conversion quotas.

Perhaps of greatest concern regarding these institutional issues is that they have also resulted in a lack of respect for the principles of volunteerism embodied in the program. The authors found an extreme example of this during survey work in a mountainous and rainy county of Hunan Province in the Yangtze River Basin, wherein the township government, after organizing local farmers to retire 30 % of their arable land, were trying to pressure them to retire a further 30 %. This, furthermore, was done with little consideration of the fact that township per capita arable land was already only 0.05 hectares, barely enough for subsistence. In the 2003 survey used for this paper, both participants and non-participants were asked questions regarding the degree of autonomy they had in deciding whether or not to participate. The responses to these questions are presented in Table 5 below. Only 15 % of participants and 28 % of non-participants said that they had a degree of autonomy in participation, with the greatest degree of auto-nomy in Shaanxi, where 24 % of participants and 40 % of non-participants indicated that they had autonomy to choose. In Gansu and Sichuan, only 8 % and 10 %, respectively, of participants, and 29 % and 22 %, respectively, of non-participants said they had autonomy to participate. And despite the goals of optimal restructuring of agricultural production, participants generally felt they had little autonomy in deciding which plots to retire or types of trees to plant. Gansu appears to be the worse example of this, where only 15 % of participants said they could choose which areas to retire, and less than 13 % said they could choose with plots to retire.

SLCP Impact on Participant Income and Sustainability

Though examination of these larger institutional issues is beyond the scope of this paper, they do bring into question the overall effectiveness and sustainability of SLCP. In line with this, we can at minimum look

TABLE 5 *Farmer autonomy in SLCP participation (n=348)*

Group	**Measure of autonomy**	**% that said „yes"**			
		All	Shaanxi	Gansu	Sichuan
Participants *(n=264)*	Were you consulted before program implementation ?	**15.1 %**	24.3 %	8.1 %	10.1 %
	Did you have autonomy in choosing the types of trees to plant ?	**36.0 %**	46.7 %	34.9 %	22.8 %
	Did you have autonomy in choosing which areas to retire ?	**34.9 %**	52.3 %	15.1 %	32.9 %
	Did you have autonomy in choosing which plots to retire ?	**30.5 %**	40.2 %	12.8 %	36.7 %
Non-participants *(n=84)*	Could you choose whether or not to participate in the program ?	**27.8 %**	40.0 %	29.4 %	22.0 %

Source: 2003 Survey Data

at sustainability in the short-run through program impact on participant income. Our panel data set allows for a unique look at this issue, since it contains 1999 and 2002 data for both participants and non-participants. Table 6 below presents sample averages and standard deviations of the different components of 1999 and 2002 household per capita net income for SLCP participants and non-participants, by region[4]. To begin with, these numbers suggest that SLCP has indeed induced a restructuring of agricultural production, whereby participants have shifted relatively more of their inputs out of cropping and into livestock. In Shaanxi, for example, growth rates for cropping income were 35 % for non-participants compared with only 12 % for participants (including received subsidies). In Gansu, these were about -26 % and -32 %, respectively, and in Sichuan cropping income declined by 30 % for both groups. Conversely, growth rates for livestock income were higher for participants than they were for non-participants. In Shaanxi, average household per capita livestock income for participants increased by more than tenfold, compared to only 175 % for non-participants. In Gansu, participants' livestock income grew by 1744 %, compared with only 586 % for non-participants, and in Sichuan these numbers are 845 % and 514 %, respectively.

Regarding average total net income, growth rates and differences in growth rates between participants and non-participants vary significantly by region. In Shaanxi Province, growth rates of participant and non-participant income (counting subsidies received) look to be about the same at between 41 % and 42 %. Conversely, average income of participants in Gansu grew by only 2.3 %, compared to 12 % for non-participants. In Sichuan, SLCP participant income actually grew faster than that of non-participants, both without and counting subsidies received. As a more rigorous look at SLCP impact on income, we use a simple first-difference model to explain the level change in household per-capita total income between 1999 and 2002. The model controls for household and regional-specific fixed effects, as well as for household endowments of labor, land and capital. Furthermore, the lack of autonomy by many of the households in the sample, ironically, enables us to control for self-selection bias. All else equal, we find that SLCP participation has had no significant impact on participant income, both for the whole sample as well as for the sub-sample of households that said they had little choice in whether or not to participate.

At first glance, this could suggest that the environmental goals of the program are being achieved at minimal cost, since on average farmers are being made

TABLE 6 *Per capita net income of households participating and not participating in SLCP, 1999 and 2002*

Region	**Total income*** Income component	Non-participating households		Participating households	
		1999	2002	1999	2002
		Mean *(standard deviation)*			
Shaanxi	**Total Without subsidy**	**940 *(777)***	**1335 *(930)***	**986 *(1077)***	**1325 *(1874)***
	Total With subsidy received	–	–	–	**1394 *(1877)***
	Cropping without subsidy	465 *(521)*	626 *(429)*	420 *(672)*	401 *(622)*
	Cropping with subsidy receiced	–	–	–	470 *(628)*
	Livestock	6 *(23)*	17 *(63)*	18 *(78)*	208 *(916)*
	Off-farm	388 *(623)*	590 *(947)*	401 *(554)*	525 *(680)*
	Other	82 *(233)*	101 *(234)*	147 *(686)*	191 *(826)*
Gansu	**Total Without subsidy**	**1803 *(1681)***	**2021 *(1741)***	**1287 *(980)***	**1287 *(942)***
	Total With subsidy received	–	–	–	**1317 *(942)***
	Cropping without subsidy	484 *(350)*	360 *(246)*	589 *(523)*	370 *(320)*
	Cropping with subsidy receiced	–	–	–	399 *(345)*
	Livestock	17 *(53)*	119 *(220)*	6 *(30)*	113 *(222)*
	Off-farm	1192 *(1570)*	1346 *(1624)*	633 *(679)*	681 *(647)*
	Other	110 *(515)*	196 *(541)*	59 *(204)*	124 *(393)*
Sichuan	**Total Without subsidy**	**1419 *(1425)***	**1654 *(1271)***	**1635 *(1195)***	**1961 *(1524)***
	Total With subsidy received	–	–	–	**2067 *(1514)***
	Cropping without subsidy	721 *(938)*	506 *(633)*	829 *(931)*	472 *(590)*
	Cropping with subsidy receiced	–	–	–	577 *(583)*
	Livestock	33 *(42)*	202 *(200)*	49 *(75)*	459 *(1187)*
	Off-farm	543 *(953)*	714 *(987)*	674 *(897)*	869 *(971)*
	Other	122 *(295)*	232 *(476)*	83 *(251)*	161 *(375)*

* All units are in 1999 RMB
Source: 2003 Survey Data

[4] Useable data could be obtained for 348 out of the 360 households surveyed in the 2003. Households were selected out of this sample due to various concerns regarding idiosyncratic sources of income.

no worse off from the program, and could be made better off were compensation delivery to be improved. However, as has been shown earlier regarding targeting and compensation standards, these results hide a significant degree of variation in the distribution of both owed and received benefits, so that some farmers are being made worse off while others are benefiting. Furthermore, evidence in the literature of problematic implementation regarding the environmental components of the program, such as low survival rates of planted trees, suggests that the environmental benefits obtained are less than optimal (Zuo 2002, Xu and Cao 2002). At minimum, these results run counter the claims made in the Chinese official press that SLCP has been very successful in achieving its goals of poverty reduction (e. g. *The People's Daily*, Dec. 26, 2002). More alarming is the possibility that the program is indeed reducing poverty for some, but at the cost of greater poverty for others, since evidence suggests that the net result of SLCP has been to redistribute income within the group of poor rural households being targeted. Insofar as they are representative of SLCP implementation overall, these results suggest that the program is in serious danger of failing to achieve its stated long-term goals.

CONCLUSIONS

Overall, the Sloping Land Conversion Program is a welcome initiative to combat the serious problems affecting rural China of deforestation, soil and water erosion in ecologically fragile areas, poverty and the environmental sustainability of agriculture. The program is fundamentally correct in focusing on the connection between rural poverty and environmental degradation. In the absence of the means to shift to more productive and sustainable activities, many poor rural households have no choice but to expand farming onto marginal lands, thereby maintaining a vicious cycle wherein poverty and rural environmental degradation serve to mutually sustain and exacerbate each other. However, the results of our examination of targeting and program cost effectiveness suggest that if SLCP is to truly help break this cycle, central authorities need to seriously reexamine its design and implementation.

Current evidence should give cause for worry, since it indicates that SLCP is in danger of failing to achieve its long-term goals, and in fact could be worsening the situation of some participant households. Of foremost concern is the speed of expansion. Though the pilot phase indeed achieved modest success, the sheer size of the Program means that expansion needs to be accompanied by thorough monitoring and evaluation. Zuo (2002) points out that insufficient use was made of the pilot phase for identifying and rectifying problems in the program. Current evidence suggests that expansion has primarily served to reveal and exacerbate extant flaws in design. Central authorities need to clarify the targeting criteria of SLCP, and to improve budgeting to reduce the administrative burden on local governments, thereby reducing incentives to divert compensation funds. Rent-seeking incentives can also be reduced through a comprehensive and careful determination of the criteria used to choose which areas to retire, as well as of the land conversion quotas for localities. In absence of clear rules and careful monitoring and evaluation, the current top-down structure of SLCP ensures that these institutional issues will persist.

Finally, authorities need to ensure that the principals of volunteerism are followed. Individual farmers and local governments are best situated to be able to identify their own needs and constraints within the general goals of SLCP, and so design should allow for greater individual and local initiative and innovation in deciding how best these goals can be achieved. Furthermore, greater creativity in program design could help to improve outcomes. For example, market instruments such as auctions could improve program cost effectiveness by better harmonizing compensation with farmer opportunity costs. However, for such innovations to arise and take hold, authorities need to slow down implementation, and carefully reexamine overall program design and administration. Achieving SLCP's long-term goals requires a long-term perspective.

REFERENCES

XU, J., KATSGRIS, E. and WHITE, T. (eds) 2002. *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and Policy Implications*. CCICED-WCFGTF (China Council for International Cooperation on Environment and Development, Western China Forests and Grassland Task Force). China Forestry Publishing House: Beijing.

HYDE, W., BELCHER, B. and XU, J. (eds) 2003. *China's Forests: Global Lessons from Market Reforms. Resources for the Future*: Washington, D. C.

THE PEOPLE'S DAILY 2002. Wo guo tuigenhuanlin gongcheng jinzhan shunli chuxian chengxiao. [Sloping Land Conversion Program Achieves Early Success], December 26.

SFA (State Forestry Administration) 2002. Master Plan for the Sloping Land Conversion Program.

UCHIDA, E., XU, J. and ROZELLE, S. 2004. Grain for green: cost-effectiveness and sustainability of China's conservation set-aside program. Land Economics, forthcoming.

WONG, C. 2000. Central-local relations revisited: The 1994 tax sharing reform and public expenditure management in China. *China Perspectives* **31**: 52-63.

WORLD BANK 2001. China: Air, Land and Water, Environmental Priorities for a New Millennium. World Bank, Washington, D. C. 174 pp.

WWF (WORLD WIDE FUND for Nature) 2003. Report suggests China's ‚Grain-to-Green' plan is fundamental to managing water and soil erosion. http://www.wwfchina.org/english/loca.php?loca=159.

XU, J. and CAO, Y. 2002. Chapter 4. In: Jintao Xu, Eugenia Katsigris and Thomas A. White (eds). *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and Policy Implications*. CCICED-WCFGTF. Beijing Forestry Publishing House: Beijing.

XU, Z., XU, J., DENG, X., HUANG, J., UCHIDA, E. and ROZELLE, S.. 2004. Grain for Green and Grain: The impact of China's conservation reserve program on grain prices and food security. Report submitted to the World Bank.

ZUO, T. 2002. Part II. The Sloping Land Conversion Program (SLCP). Chapter 3. Implementation of the SLCP. In: Jintao Xu, Eugenia Katsigris and Thomas A. White (eds). *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and Policy Implications*. CCICED-WCFGTF. China Forestry Publishing House: Beijing.

Appraisal of tree planting options to control desertification: experiences from Three-North Shelterbelt Programme[1]

QIANG MA

Food and Agriculture Organisation of the United Nations, Vialle delle Terme di Caracalla, 00100 Rome, Italy

Email: qiang.ma@fao.org

SUMMARY

A range of afforestation models have been developed to combat desertification in China. These models stress the integration of tree planting with other land-uses to reduce risks and produce multiple benefits. This paper describes how cost-benefit analysis can be used to select and choose between these models, taking into account the different time periods between planting and harvesting of trees and other crops. It also describes how the costs of desertification can be included in the cost-benefit analysis. The results show that most of the agroforestry and productive plantation models are financially viable, but that the revegetation models are not financially viable. However, the revegetation models could be economically justified, depending on the rate of increase in desert area. If the rate of increase is high enough to justify revegetation, the financial results of the analysis can be used to indicate the incentive that would be required to make these models financially attractive.

Keywords: cost-benefit analysis, afforestation, agroforestry, desertification, revegetation.

INTRODUCTION

Desertification is a significant problem in China, affecting many parts of the northeast, north and northwest of the country. Currently, it is estimated that about 262 million ha of land are affected by desertification, equal to about 27 % of the total land area of China (or 79 % of the total area of arid, semi-arid and dry sub-humid land). Furthermore, it is estimated that the area affected by desertification is expanding at a rate of 246 000 ha per year (CCICCD 2000).

TABLE 1 *Main factors leading to desertification in China*

Causal factor leading to desertification	Area affected (in million ha)
Wind erosion	161
Water erosion	20
Freeze-thaw	36
Salinisation	23
Other	21
Total	**262**

Source: CCICCD (2000).

Desertification in China arises as a result of a number of different factors, such as erosion, freeze thaw and salinisation (see Table 1). Erosion is one of the most important factors and results in an estimated loss of about five billion tons of topsoil each year. Salinisation is another important factor that in some areas is caused by the inefficient use of water for agriculture. For example, there are around 99 million ha of saline land throughout China and it is believed that poor or inadequate irrigation practices are responsible for this problem in many of these areas.

The destruction of arable land is probably the main cost of desertification. In addition to this, other major problems associated with desertification include sandstorms (leading to negative health effects), environmental degradation, loss of indigenous vegetation and reductions in the availability of water. With respect to the latter, permanent watercourses have become seasonal and underground water tables have dropped in many of the areas affected by desertification. As an indication of the scale of the problem, it is estimated that 400 million people live in the rural areas that are most affected by desertification in China.

AFFORESTATION IN THE THREE-NORTH SHELTERBELT PROGRAMME

To tackle this immense problem of environmental degradation and loss of natural resources, the Government of China started to implement the Three-North Shelterbelt Programme in 1978. This programme is the largest afforestation programme in the World and aims to establish 35 million ha of forests between 1978 and 2050. The programme includes most of northeast, north and northwest China, covering an area of 410 million ha (or around 42 % of China's total land area).

[1] This paper is based on a study for the FAO Project: Afforestation, forest research, planning and development in the Three North Region (GCP/CPR/009/BEL). The views expressed here are those of the author and do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The main objective of the programme is to protect agricultural and pastoral land, as well as human settlements, from the wind and water erosion associated with desertification. The activities used to achieve this objective include the establishment of shelterbelts, the introduction of improved land management practices and various investment projects to support desert and sand dune stabilisation and reclamation.

Afforestation in the Korqin Sandy Lands

As a contribution to this programme, FAO assisted the Government of China with the development and implementation of improved afforestation techniques in the Korqin Sandy Lands from 1991 to 2002 (FAO 1998 and 2002). The main activities covered by this project included the following:

- land-use and site classification, including the development of 16 afforestation models that are suited to the local conditions in the areas most affected by desertification;
- research into poplar clones and other tree species that are adapted to the project area and which were then used in the afforestation models;
- improved nursery techniques, including the production of unrooted cuttings (which can be used with mechanized planting techniques in poplar plantations) and mechanized undercutting of one-year-old seedlings for pine plantations;
- improved afforestation techniques, such as planting with mechanized auger planters and medium depth planters in poplar plantations; and
- the development and testing of revegetation techniques, such as fencing and broadcast sowing of shrubs.

One of the final activities of this project was the production of an economic appraisal of the various options for afforestation in the Korqin Sandy Lands. The aim of this appraisal was to show which options are economically viable and which may require financial support (and, if so, whether that support could be justified).

Land-use and site classification

Land-use maps show the current location of different land-uses and they are an important tool for planning future activities such as afforestation. They are also very useful for identifying priority areas for intervention, based on the current severity of degradation in different areas. The project developed a land-use classification system adapted to the Korqin Sandy Lands and, from satellite images, produced a land-use map at a scale of 1:200 000. The map covers an area of approximately 8.7 million ha, from Shuangliao County in the east to the Hongshan Reservoir in the west (300 km) and from Kulun Town in the south to Tiaonan City in the north (350 km).

Site classification systems are also very useful, as they help to identify where different tree species can be planted and the levels of growth that might be expected. Four site classes were developed for the Korqin Sandy Lands, based on the depth of the underground water-table and the presence of topsoil, as main criteria, supplemented with additional information about vegetation and the intensity of human disturbance (see Table 2). This site classification was used in the production of the afforestation models described below. In addition, a site classification map (at a scale of 1:50 000) was produced for the southern part of the Korqin Sandy Lands, based on the land-use map and observations in the field.

Description of the afforestation models

The 16 afforestation models developed by the project were designed to meet the following broad objective:

‚To contribute to sustainable rural development, by increasing production and income from appropriate land-uses that integrate forestry, agriculture and animal husbandry in a holistic and complementary fashion, within the productive capacity of the land‘.

Within this overall objective, each of the models was designed to address one or more of the following individual objectives:

- to produce environmental benefits associated with increased vegetation cover (e. g. increased biodiversity, carbon-fixing and reductions in sandstorms inside and outside the project area);
- to increase the protection of remaining relicts of original natural vegetation such as open woodlands and grasslands;
- to increase local farmers' incomes and reduce the number of farmers in remote villages living at a subsistence level;

TABLE 2 *Summary of the site classification developed for the Korqin Sandy Lands*

Site class	Name	Description
1	Pastoral zone	Grassy lowlands, with water-table less than 1 metre from the surface.
2	Agroforestry zone	Lower foot-slopes of hills, with cultivated land (without windbreaks, living fences, or soil fertility restoration measures) and water-table 1.0 - 2.5 metres from the surface.
3	Productive shelterbelt zone	Upper foot-slopes of hills, with water-table 2.5 - 4.0 metres from the surface.
4	Revegetation/protection zone	Degraded sand-sheets and dunes, with water-table more than 4 metres from the surface.

Source: FAO (2002).

- to increase employment opportunities for local people from small-scale rural production and service-providing industries;
- to increase and protect agricultural production (e. g. through establishment of shelterbelts); and
- to increase wood and fodder production from new forest plantations and shelterbelts

Past experiences with desertification control projects have shown that there are significant risks of crop failure for both agricultural and tree crops. They have also shown that the potential for production in such areas is severely limited by site factors. Consequently, the models that were developed for the project stressed the following:

- the integration of forestry, animal husbandry and agriculture (to reduce the risk of failure);
- the application of new and improved techniques; and
- the careful selection of crops, to reflect the productive capacity of the land (expressed by the site-class).

Based on the above objectives, the 16 afforestation models were grouped into three categories: four agroforestry models (AF1 to AF4); four productive plantation models (PP1 to PP4); and eight revegetation models (RV1 to RV8). These models were used for sites class 2 - 4, because it is possible to grow (more profitable) agricultural crops on land in site class 1.

In the agroforestry models, agricultural production is the main objective, with tree planting a secondary activity to protect agricultural production and produce some benefits from wood production. The costs and benefits of all crop production are included in the appraisal of these models as the crops are planted in intimate mixtures (e. g. interlocking grids, rows and blocks of trees and other crops).

In the productive plantation models, the focus is more on wood production as an objective and a secondary objective is the protection of neighbouring agricultural crops. In these models, the trees would be planted in large blocks, so only the costs and benefits of wood and fodder production are counted in the appraisal. However, these models also result in significant off-site benefits in terms of shelter for the neighbouring agricultural crops.

The revegetation models are designed for the very poorest sites, where water and nutrients are scarce and soil erosion is a significant problem (see Figure 1). In these models, the main objective is environmental protection and enhancement (including soil and sand dune stabilisation), with very little production of commercial crops. However, in most cases, some production of commercial crops (e. g. wood, fruit and fodder) will eventually occur after many years. Consequently, in the appraisal it was assumed that the value of these outputs will be equal to the continuing costs of maintenance in later years and the appraisal is based on the costs of establishing vegetation in the early years of the models and the very limited benefits during the period.

A brief description of each of the models is given in Table 3 below and a fuller explanation can be found in FAO (2002).

FIGURE 1 *Poor site with soil erosion*

TABLE 3 *Summary of the 16 afforestation models developed for Korqin Sandy Lands*

Code	Site class	Description	Objectives	Components
			AGROFORESTRY MODELS	
AF1	2	Mixed shelterbelts with alterating fodder and agriculture crops	Agricultural production, fodder production, wind protection for crops, wood production and environmental protection	Tree shelterbelts (*Populus* and *Pinus* spp.) with shrubs Hedgerows of shrubs to separate fodder and food crops (*Salix matsudana, Amorpha, Carraghana, Hippophae rhamnoides*) Fodder crops (alfalfa, *Hedysarum, Astragalus*) Food crops (maize, beans, vegetables)
AF2	2 - 3	Shelterbelts for fruit trees	Fruit production, wood production and environmental protection	Tree shelterbelts (*Populus* and *Pinus* spp.) with shrubs Fruit trees (*Prunus siberica, Prunus armeniaca*, and other fruit trees)
AF3	2 - 3	Shelterbelts for Seabuckthorn plantations	Fruit production, wood production and environmental protection	Tree shelterbelts (*Populus* spp.) Fruit bushes (*Hippophae rhamnoides*)
AF4	3	Shelterbelts for rainfed crop production	Agricultural production or fodder production, wind protection for crops, wood production and environmental protection	Tree shelterbelts (*Populus* spp.) Fodder crops (alfalfa, *Hedysarum, Astragalus*) or food crops (maize, beans, vegetables)
			PRODUCTIVE PLANTATION MODELS	
PP1	3	Productive poplar plantations	Wood production, environmental protection and fodder production	Block plantations (*Populus* spp.) with rows of shrubs
PP2	3	Productive poplar shelterbelts with rain-fed agriculture	Wood production, wind protection for crops and environmental protection	Wide shelterbelts (*Populus* spp.) to protect areas used for agriculture
PP3	3	Productive pine plantations	Wood production, environmental protection and fodder production	Block plantations (*Pinus* spp.) with rows of shrubs
PP4	3	Alternating belts of different trees species	Wood production, environmental protection and fodder production	Mixed plantations in blocks, consisting of alternating belts of different species (*Populus* and *Pinus* spp. and native tree species)
			REVEGETATION MODELS	
RV1	4	Open woodland with fruit trees	Almond production, regeneration of natural vegetation and environmental improvement	Small blocks of almond trees in natural grassland
RV2	4	Shrub woodland with fruit trees	Almond and fruit production, regeneration of natural vegetation and environmental improvement	Small blocks of almond trees and Seabuckthorn in natural grassland
RV3	4	Pine woodland with shrubs	Environmental improvement, regeneration of natural vegetation and wood production	Small block plantation (*Pinus* spp.) surrounded by shrubs
RV4	4	Poplar woodland with fruit trees and shrubs	Environmental improvement, regeneration of natural vegetation and wood and fruit production	Small block plantation (*Populus* spp. and *Prunus armeniaca*) surrounded by shrubs
RV5	4	Willow open woodland with fruit trees and shrubs	As above	Small block plantation (*Salix gordejevii* and *Prunus armeniaca*) surrounded by shrubs
RV6	4	Elm woodland with shrubs	Environmental improvement, regeneration of natural vegetation and wood production	Small block plantation (*Ulmus* spp.) surrounded by shrubs
RV7	4	Open grassland with shrubs	Environmental improvement, regeneration of natural vegetation and fodder production	Shrubs in a grid of crossed belts
RV8	4	Open grassland on sand dunes	Environmental improvement, regeneration of natural vegetation and fodder production	Planting of natural fences

Source: FAO (2002).

APPRAISAL OF THE DIFFERENT AFFORESTATION OPTIONS

The appraisal of the different afforestation models was based on standard cost-benefit techniques, as explained in Gregersen and Contreras (1992) and Gregersen *et al.* (1993). All of the models have been implemented to some extent during the project, so information about the costs of each model was obtained from records of expenditure from the project. To calculate the benefits of each model, yields were estimated from local knowledge and experience and current market prices of outputs were used in the appraisal.

All of the agroforestry and productive plantation models were assessed against a baseline of zero costs and benefits if the models were not implemented (i. e. a ‚without project' or ‚do nothing' option). Consequently, the results of the cost-benefit calculations represent the net benefits of implementing each of the models. This is the same as assuming that the land used for afforestation has an opportunity cost of zero (i.e. the land has zero value in its best alternative use). As noted above, in the case of the revegetation models, the costs of implementing these models dominated the cash flow in the financial cost-benefit calculations. However, in the ‚without project' alternative, it can be assumed that these areas of severe land degradation would expand, leading to off-site costs. Therefore, the opportunity cost of not implementing these models was also analysed as a way of examining whether it would be economically justified to invest in these afforestation options (see below).

The costs and benefits of taxes and subsidies were not included in the appraisal calculation. Thus, the results of the analysis can be used as a starting point to examine how fiscal policies could affect the economic viability of the different afforestation options. In addition, with the exception of the cost of losing productive land to desertification, the non-market costs and benefits of the different options have not been examined. In most of these options, afforestation would probably also lead to the production of some net non-market benefits and this should be considered when assessing the final results of this analysis.

The cost information used in the appraisal was quite reliable, as this was based on records of expenditure. Furthermore, costs are early on and therefore quite certain. To keep it simple, there are no alternative scenarios in sensitivity analysis of costs. However, because the yields were estimated (and past experience showed a lot of variation in yields), the benefits from each model were less certain. In addition, considering the long time period before some of the outputs of each model will be produced, there was also some uncertainty about the validity of using current market prices to value the outputs of each model. To reflect this uncertainty, the appraisal calculations were also repeated assuming a 20 % fall in benefits (to reflect the possibility of prices and/or yields lower than expected). This sensitivity analysis was used to further examine the economic viability of each agroforestry and productive plantation model with less optimistic assumptions about yields and prices and to see how this might also affect the relative performance of each option.

Calculation methodology

The standard cost-benefit technique used to assess a project (and to compare between alternative projects) is to calculate the Net Present Value or NPV of the project.

In the case of these afforestation options, a difficulty arises with using this approach because some of the afforestation models contain components that each have a different life (e. g. annual crops surrounded by poplar shelterbelts that will be cut after 15 years). Furthermore, even if the costs and benefits of annual crops were repeated year after year in the calculations until the tree crops would be harvested, each of the options would still have different project lives because the tree crops in different models would be harvested at different ages.

The NPVs of different projects are only comparable when the length of each project is roughly the same, so the solution to this problem is to calculate the ‚annual equivalents' of all costs and benefits and to compare these. Annual equivalent NPV can be though of as NPV per year (although the calculation of annual equivalents is more complicated than simply dividing NPV by n). In addition, the annual equivalent NPV for the forestry components of each model can be added to the annual profits obtained from the annual crops, to give an annual equivalent for the combination of forestry and agricultural crops mixed together.

An alternative approach is to ‚capitalise' the stream of annual equivalent NPVs to give the ‚soil expectation value' (SEV). This is the present value of each option, assuming that the crops would be planted and harvested again and again ad infinitum. Thus, this calculation also solves the problem of different project lives. The SEV can be simply calculated as the Annual Equivalent (AE) divided by the discount rate[2] (or, in the case of annual crops, the annual profit or surplus of income over costs, divided by the discount rate). Thus, the SEV can be though of as the capital value of the land, while the annual equivalent NPV can be though of as the rental value of the land.[3]

[2] A discount rate of 12 % was used in this appraisal, because this is the discount rate used by the World Bank for assessing afforestation projects in China.

[3] Note: in the case of the revegetation models, each model would be implemented once, and then it is assumed that management costs would equal the benefits from crop production after a certain time. Thus, in this case, the NPV = SEV, because there would be no future replanting of these crops. In this case, the AE can be calculated as the SEV multiplied by the discount rate.

In addition to the above, the cost-benefit ratio was also calculated for each option. Normally, the cost-benefit ratio is calculated as the sum of all discounted benefits divided by the sum of all discounted costs (and a ratio of more than one indicates a positive NPV). In this analysis, the same approach was followed, except that the annual equivalents of costs and benefits were used in the calculation (to overcome the problem described above). The cost-benefit ratio can be used to choose between different options when funds are scarce because, by dividing costs by benefits, it shows which options give the best returns to any fixed amount of expenditure.

RESULTS

The annual equivalent costs, benefits, NPV, SEV and cost-benefit ratios were calculated for each of the different afforestation options under the two assumptions about benefits (no change and a 20 % fall in benefits) and are shown in Table 4.

TABLE 4 *Results of the appraisal of the 16 afforestation models*

Code	Results with no change in benefits					Results assuming a 20 % fall in benefits		
	Annual equivalents			SEV	Cost-benefit ratio	Annual equivalent NPV	SEV	Cost-benefit ratio
	Costs	Benefits	NPV					
	AGROFORESTRY MODELS							
AF1	1227	1475	197	1648	1.15	-97	-810	0.92
AF2	1097	1900	803	6693	1.73	423	3525	1.38
AF3	2450	3172	721	6014	1.29	87	727	1.03
AF4	751	1013	261	2180	1.34	59	492	1.08
	PRODUCTIVE PLANTATION MODELS							
PP1	582	983	311	2596	1.53	132	1107	1.22
PP2	507	886	378	3150	1.74	200	1673	1.39
PP3	357	224	-133	-1100	0.62	-178	-1485	0.50
PP4	430	617	186	1555	1.43	63	526	0.14
	REVEGETATION MODELS							
RV1	453	213	-240	-2004	0.47			
RV2	649	391	-257	-2147	0.60			
RV3	329	148	-181	-1509	0.45			
RV4	353	114	-239	-1995	0.32			
RV5	443	207	-235	-1965	0.46			
RV6	335	52	-282	-2353	0.15			
RV7	280	42	-238	-1984	0.15			
RV8	224	0	-224	-1867	n. a.			

Note: All of the above figures are expressed in Yuan per ha (except the cost-benefit ratios).

Agroforestry models

In general, it can be said that all of the agroforestry models are financially viable, because the NPV and SEV are above zero and the cost-benefit ratio is greater than one. The four different models result in an annualised NPV of between 197 Yuan per hectare and 803 Yuan per hectare. In other words, the farmer or investor planting these crops would receive an average annual net benefit from planting these crops of between 197 Yuan per hectare and 803 Yuan per hectare, after taking into account the discount rate of 12 %. However, if prices and/or yields were to fall by 20 %, all of the NPVs would fall and model AF1 would no longer be financially viable (because the NPV would become negative).

The critical factor for model AF1 is the relatively high cost of this option, which is also reflected by the fact that this model has the lowest cost-benefit ratio. Considering that models AF1 and AF2 are alternative models for Site class 2, this suggests that model AF2 is the preferred option. Of the other two models, AF3 has a higher NPV than AF4 under both assumptions about benefits. However, due to the low costs of establishing AF4, the latter has a slightly higher cost-benefit ratio. This suggests that AF3 would normally be preferred, unless funds are scarce, in which case AF4 is the preferred option.

Productive plantation models

According to the results of the cost-benefit analysis, models PP1, PP2 and PP4 are financially viable, while model PP3 is not because it has a negative NPV. This result is the same under both assumptions about future benefits. The reason why model PP3 is uneconomic is because the benefits are so low. This is due to the choice of pine in model PP3, which requires a much longer time to mature (40 years, compared with a rotation of 15 years for the poplar used in the other models)[4].

Model PP2 is clearly the best option, as it has the highest NPV and cost-benefit ratio of all of the options under both assumptions about benefits. In addition, because this model is designed as large productive shelterbelts of poplar, it would also lead to signi-

[4] These rotation ages were based on the results of sample plots that have been established by the project since 1991.

ficant off-site benefits in terms of protecting neighbouring agricultural crops.[5] Model PP1 is the next most attractive option, followed by model PP4. However, it should be noted that model PP4 may also lead to some environmental benefits, as it includes planting native tree species. It may also have another benefit, which is the reduction of the risk of crop failure due to the planting of more than one species.

Revegetation models

As noted above, the main purpose of these models is revegetation rather than timber or cash crop production and the expected revenue from trees and crops is extremely low because of the very poor condition of degraded land. Thus it is assumed that these models require an investment in planting and maintenance in early years until the vegetation is established. Following this period, it is assumed that income from harvesting will cover the costs of continued maintenance. Because there is very low or no income in these models, the costs and benefits in the early years are included in the appraisal and the annual equivalent NPV and SEV of each of the models is negative.

Table 4 shows that the total annualised net cost of these models varies from 181 Yuan per hectare to 282 Yuan per hectare (equal to a total ‚capitalised' investment of 1 509 Yuan per hectare to 2 353 Yuan per hectare. Model RV3 (pine) is the least costly option, while models RV1, RV2, and RV6 (poplar, willow and fruit trees) are the most costly. The higher costs of the latter reflect the more intensive management that would be required to try to establish these crops on degraded land. Poplar, willow and fruit trees can be commercially very valuable, but they require a lot of management inputs. Thus, where the land is very degraded, it makes more sense to focus on crops that have low management inputs rather than crops that may eventually produce more valuable outputs.

Because all of the NPVs and SEVs for the revegetation models are negative, none of these models are financially viable. However, in the broader economic sense, they could produce significant benefits. For example, reduced desertification leads to reductions in the loss of neighbouring land, sand storms, and increased living standards. Most of these benefits are difficult to evaluate, but it is possible to examine loss of land. One way to examine this is to compare the cost of these models with the cost of losing neighbouring land to desertification.

[5] This model assumes that trees would only cover 57 % of an area of mixed crops and shelterbelts, whereas the other models are based on 100 % tree cover over relatively large areas. Thus, the off-site benefits of crop protection from this model would be much higher than for the other models, due to the relatively large edge-effects between the edges of the plantations and neighbouring crops.

[6] This is an assumption used here as an example. An alternative growth rate (e. g. linear growth) could be used as an assumption to test the sensitivity of the results.

Assuming that desertification spreads at a constant increase rate[6], the total value of land lost to desertification can be calculated with the following formula:

$$\sum_{n=1}^{\infty} \mathrm{AE} \times ((1+g)^n - 1$$

where AE = the annual equivalent NPV (per ha) of the land that would be lost;

g = the increase rate of desertification; and

n = the year in which the loss occurs.

As n tends to infinity, the above sum would also tend to infinity. However, the discount rate reduces the present value of future losses so, as long as g < d, a modified version of the SEV formula can be used to calculate the SEV (or ‚capitalised' value) of these future losses from desertification. The formula that should be used is given below:

$$\mathrm{SEV} = \mathrm{AE} \times \left[\frac{1}{\frac{1+d}{1+g} - 1} - \frac{1}{d} \right]$$

where SEV = the total ‚capitalised' value (per ha) of the land lost to desertification;

AE = the annual aquivalent NPV (per ha) of the land that would be lost

g = the growth rate of desertification; and

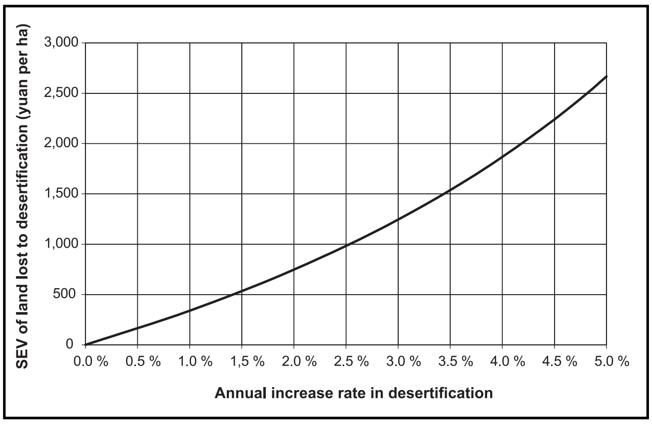
d = the discount rate.

Table 4 shows that seven of the agroforestry and productive plantation models have a positive annual equivalent NPV and the average annual equivalent NPV for these models is around 400 Yuan per hectare. Using this value for AE in the above equation and with a discount rate of 12 %, it is possible to calculate the SEV of the land lost to desertification at different assumed increase rates of desertification. The results of this calculation are shown in Figure 2.

The SEV of the revegetation models varied from 1 867 Yuan per hectare to 2 353 Yuan per hectare, so the results shown in Figure 2 would suggest that the cheaper revegetation options could be economically justified in areas where desertification is spreading at a rate of 4.0 % or more and the more expensive revegetation options could be economically justified in areas where desertification is spreading by more than 4.5 % per year[7]. Although this information still does not exactly answer the question of whether these models can be economically justified, it does convert the financial results into a required rate of increase in desertification that could be monitored in the field.

[7] This assumes that the revegetation entirely stops the spread of desertification to neighbouring land.

FIGURE 2 *The Soil Expectation Value (or ‚capitalised value') of land lost to desertification, assuming an annual equivalent NPV of that land of 400 Yuan per ha*



CONCLUSIONS

The afforestation models that have been produced for the Korqin Sandy Lands can assist policy makers and planners to introduce mechanisms to control desertification and develop productive uses for this land that meet the overall objectives of the Three-North Shelterbelt Programme. The cost benefit analysis shows which options produce the best financial returns and these results can be used as part of forestry extension activities. In particular, the results can be used to show the benefits of some of the techniques that have been developed on the project (e. g. the use of genetically improved tree species, species selection and the use of new types of equipment for tree planting and revegetation).

In the case of the revegetation models, the cost-benefit analysis indicates that none of these models is financially viable. However, they may be economically viable, depending on the rate of increase in desertification. The rate of increase in desertification should be monitored to identify those areas where the spread is rapid and use of the revegetation models could be justified.

Currently, land-based economic activities in areas subject to desertification are not subject to the payment of taxes and charges. This support is probably justified given the generally very low levels of profitability from such activities in arid areas. However, in the very worst sites (Site class 4) this tax-exemption does not provide enough of an incentive to encourage land managers and investors to implement the revegetation models. It is suggested that, in such areas, the state should consider supporting the implementation of these models through incentives such as grants or the provision of subsidised tools and materials. The level of annual support that would be required is shown by the annual equivalent NPVs of these options in Table 4 or, alternatively, lump-sum grants could be given (equal to the SEVs shown in Table 4).

Because this cost-benefit analysis is only partial and does not take into account all of the non-market costs and benefits associated with each of these options, these results should be considered as part of a broader assessment of options to meet the objectives of the programme. For example, some of the options could result in much higher non-market benefits than others. However, the results presented here should be useful to policy makers that are trying to make these difficult choices.

REFERENCES

CCICCD 2000. China national report on the implementation of United Nations Convention to Combat Desertification and national action programme to combat desertification, China National Committee for the Implementation of the United Nations Convention to Combat Desertification (CCICCD), Beijing, China, available at: http://www.unccd.int/cop/reports/asia/national/2000/china-eng.pdf.

GREGERSEN, H. M. and CONTRERAS, A. H. 1994. Economic assessment of forestry project impacts, Forestry Paper 106, Food and Agriculture Organization of the United Nations, Rome, Italy.

GREGERSEN, H. M., ARNOLD, J. E. M., LUNDGREN, A., CONTRERAS, A. H., DE MONTALEMBERT, M. R., and GOW, D. 1993. Assessing forestry project impacts: issues and strategies, Forestry Paper 114, Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO 1998. Afforestation, forestry research, planning and development in the Three North Region (Phase I): Project findings and recommendations, Terminal Report of Project GCP/CPR/009/BEL, Food and Agriculture Organization of the United Nations, Rome, Italy, available at: http://www.fao.org/docrep/field/383925.htm.

FAO 2002. Afforestation, forestry research, planning and development in the Three North Region of China, Technical Project Review Document (1991-2002), Food and Agriculture Organization of the United Nations, Rome, Italy, available at: http://www.fao.org/DOCREP/005/AC613E/AC613E00.htm.

Forestry revenue policy in China: what has happened and why

JINLONG LIU[●], SHOUGONG ZHANG[■], JINZHONG YE[♦] and YIHUAN WANG[▲]

[●] *Associate Professor in Participatory Forestry and Rural Development Sociology, Forestry Research Institute, Chinese Academy of Forestry, Wanshou Shan, Beijing 100091, China*

[■] *Professor, Chinese Academy of Forestry, Wanshou Shan, Beijing 100091, China*

[♦] *Professor in Rural Development Sociology, China's Agriculture University, No. 2 Yuanmingyuan Xi Lu, Haidian, Beijing 100094, China*

[▲] *Associate Professor in Rural Development Sociology in China's Agriculture University, No. 2 Yuanmingyuan Xi Lu, Haidian, Beijing 100094, China*

Email: liujl@forestry.ac.cn

SUMMARY

China forestry taxation and charging system has been evolving from a planned to a market oriented system which in practice is complex, overburdened, inconsistent, and affected by high avoidance and low efficiency in collection. These are disincentives for forest management, and both household welfare and the environment are worse off because of them. Before 1985 government revenue came from controlling the price of timber and the market. After the market opened up, revenues came increasingly from taxes and additional charges on farmers. In the past 7 years, funds from the state fiscal account from forestry development have increased more than 20 times, but misuse of government funds either at collection, or in transfer from central fiscal accounts has resulted from overstaffing in the government sector and poor enforcement. Since 2002, the Chinese government has taken some measures to address these problems: it has eliminated Special Agriculture Product Taxation and illegal charges; decreased the rate of officially approval charges, and promised to eliminate the Agriculture Production Tax within 5 years from 2004. China's case shows that government institutions were the major constraints on reform of forestry taxes and charges reform, and also that full solution of the problems involved will need to go well beyond the forestry sector itself.

Keywords: China, forestry taxes, levies, sustainable forest management, economic appraisal

INTRODUCTION

China has been in a transitional period since the introduction of agricultural reforms in the late 1970's, since when industrial, financial and trade reforms have followed. Average annual GNP growth rate in the past two decades has been in excess of 9 %, and China now ranks high in international trade and foreign investment, in addition to imports of energy and other raw materials. In the forest sector, fiscal policy has been, and remains one of the most important factors in forestry development for China. China's heavy dependence on forest products imports to meet its rapidly growing needs means that its internal forest management and supply issues have major implications for forests globally.

China has powerful economic, environmental and social incentives to protect and manage its forests effectively and sustainably. Its experiences in forestry, in the context of the broad transition from highly concentrated political and market control to a wider distribution of economic authority and less-administered markets, are salutary.

China has the world's fifth largest forest area and has recently ranked as the top net importer of timber or timber related products. From an environmental perspective, 38 % of the country (about 367 million hectares) is affected by soil erosion, while desertification is prevalent in 27 % of the land area and spreads annually by a quarter of a million hectares. Biodiversity is under threat, with 15-20 % of the country's fauna and flora species reportedly threatened with extinction (World Bank 1994). These figures explain why changes to China's fiscal policy on forestry development have always attempted to orientate its goals towards achieving environmental protection and forest resource protection. In the past two decades, China's fiscal policy on forest development has changed gradually but significantly, in what might be termed a ‚trial and error' process. Although it has been little documented, the lessons learned by China could be instructive for fiscal policy design in other countries, in particular, in those countries in a period of transition from highly concentrated political and market control to a wider distribution of economic authority and less-administered markets.

THE STATUS OF REVENUE COLLECTION SYSTEMS IN CHINA

Prior to the 1980s', China followed a top-down model of economic planning. Production, marketing and consumption were all part of a unified central system that included the authority to collect all government revenues and allocate all expenditures. As in other sectors, the forest tax used to be simple and low at only 10 % of production cost. Afforestation charges varied between the regions, which were 5-10 yuan m^3, and forest maintenance charges were 5 yuan m^3. The charges collected were strictly regulated for use in forestry development only. (Zhao and Gao 1999).

From the early 1980's, rural reform and decentralization has occurred. However, the central government's system of taxation and expenditure has remained unchanged, and government sectors have continuously increased staff numbers[1]. Government sector authorities have had to increase collections of revenue under various categories in an attempt to balance the budget. This in turn has led to further expansion and overstaffing of government sector organizations. Deficits occurred at all levels of government throughout the 1980s and 1990s, and they still exist today, particularly in local government (Li 2000).

The State Council first responded to this developing situation in 1984, by granting central and local government agencies authority to collect their own charges. Local governments at various levels and in different sectors established their own charge system to collect additional revenues, and some commercialized some services for additional revenues (Li 1999). Local governments, in particular at the county level, also created many small and dispersed charges levied through unofficial and informal channels. A lack of transparency and accountability in the budgetary system was the primary result of this process (Table 1, Jia Kang 1999).

TABLE 1 *Government revenue from levies and taxation in related to national income in China*

Year	Legal levies/GNP (%)	Taxation/GNP (%)
1985	2.6	22.8
1990	4.1	15.2
1993	4.1	12.3
1995	6.6	10.3
1996	8.8	10.1

Source: see Jiakang (1999)

The central government realized the negative impacts of the above policy and started to regulate the expansion of levies in 1994. Since 1996, the revenues from officially approved levies have been placed in accounts held by the finance sector in county, prefecture and provincial levels for subsequent dispersal by the appropriate agency. The forestry authorities at various levels must now apply to the finance authorities at the same level for approval to use these funds.

The current system of forest taxes and levies was created as part of the fiscal reforms of 1994 and rural fiscal reforms of 2001. The following taxes and levies are levied on forestland, forests and forest products from plantations and natural forests, whether state-owned, collectively or privately owned, unless specifically indicated otherwise.

Agriculture Products Tax (APT)

After 1994, as part of the fiscal reform, Special Agricultural Products Tax (SAPT) was created for local government. The tax is restricted to a maximum rate of 8 %, but is collected twice, from producers at the farm gate and again from buyers at the market. Provincial government could approve to 10 % of this tax as additional income. From 2002, a new round of rural tax reforms commenced. SAPT was eliminated and APT started which is restricted to a rate of 7 %, collected from producers at the farm gate. Central Government has undertaken, in 2004, to reduce this form of taxation annually, and to eliminate it completely within five years, as a stimulus to rural development.

The industrial products taxes such as Value Added Tax (VAT) and Income Tax, are also implemented for forestry products.

Forest Levies approved by the State Forestry Administration

The State Forestry Administration has approved afforestation and infrastructure maintenance levies, totaling 20-25 % of sales revenue of logs and bamboo, along with smaller charges to cover protection and quarantine costs. Local authorities at the province, prefecture and county levels share the proceeds of these charges. Considerable discretion over the activities supported with these revenues is accorded to the collection agency. Also, various forest authorities have experimented with their own modifications of the system The State Forestry Administration (SFA) modified its own policy on forest charges in 2000 allowing provincial forest authorities to reduce SFA-approved charges by a set percentage as an incentive for foreign investment[2]. The SFA has now begun consultations on merging all SFA-approved charges into one (greatly reduced) levy.

Forest Levies approved by the Provincial People's Congress

These are quite common in collective forest regions[3], but are seldom applied in other forest regions.

[1] Taking Linxiang County of Hunan province as an example, in 1997, there were 11 578 government staff among a total population of 444 900.

[2] In Guangdong, 50-70 % of the charges for afforestation and for construction charges can be returned to foreign investors after their enterprises successfully replant a harvested area.

[3] For instance, Jiangxi province has established charges for insect and disease control, fire protection and administration.

Unofficial Forest changes

Agencies below the provincial level are not authorized to impose charges other than those already approved. Nevertheless, many unauthorized charges do occur in many places in China, and these vary greatly between localities[4]. The forestry agencies are not alone in this practice; it is also present in the fiscal, commercial, industry, water conservation, and power development sectors.

Table 2 illustrates the high degree of variability in forestry taxes and charges across various localities in China.

Avoidance and Enforcement

Not surprisingly, in view of the above, avoidance and enforcement are serious problems in the forestry sector in China, especially in those areas where rates of forest taxes and charges are high; as high as 50 % for SFA approved forest charges (Chen 1995). In some cases, enterprises misreport income and expenditure[7], while in others, the effectiveness of collection of revenue is poor[8], and in other cases illegal removals are substantial[9].

TABLE 2 *Forestry taxes and charges (various localities, as % of wholesale prices)*

	South China collective forestry region				Northeast China state forestry area	Plain area	North China
	Key forestry area		Hilly agricultural area				
Location	Huaihua pref. Hunan	Xiushui county of Jiangxi	Yueyang county of Hunan	Yongxiu county of Jiangxi	Baihe State Forest Farm	Mingquan county of Henan province	Chifeng prefecture, Inner Mongolia
Tax	25.3	20.8	16.0	17.6	10.0	0	0
Legal levies	23.3	29.6	21.8	29.0	0	25.0	12.0
Unofficial approved levies	2.4	6.5	0	10.6	0	2.5	0
Total	51.0	56.9	37.8	57.2	10.0	27.5	12.0

IMPLICATIONS OF CURRENT FOREST REVENUE ARRANGEMENTS IN CHINA

Inconsistencies and disincentives in the revenue system

It is clear that, although China has uniform taxation policy for products from natural forests and plantations, actual taxation rates vary greatly. While there could be legitimate cost and demand factors involved in these differences, it appears that they are much more the product of inconsistent criteria and processes across different local authority administrations. It is also apparent that in most cases this development has resulted in very high taxes and charges on timber, relative to its market prices[5].

The higher the taxes and charges, the greater the incentive to avoid them, and local authorities have become aware of the serious disincentive created by this problem and have attempted to reduce their forest charges, but these have not succeeded to date[6].

Inefficiency of revenue collection

Even if all revenues due were being collected (and it is evident from the above that it is not) the costs of

[4] In Jiangxi, for example, more than 30 such charges are levies for the design of harvest plots, construction of infrastructure, flood prevention, hydropower development fund, biogas development and so on (Zhang 1999).

[5] This can be estimated by examining different prices such as market price, stumpage value or fixed price set by authorities. In Jiangxi province, the setting price for taxation and charge collection is 30 % higher that that of marketing price (Xie 1999).

[6] In Jiangxi, for example, while the provincial forest authority reduced the official base price for calculating the revenues that are subject to forest charges, prefecture authorities commonly set the official base price at a rate that is 10 % higher than that set by provincial authorities, and county authorities often raise that base price a further 20 %: thus offsetting the decrease in the charge rate. In Huaihua prefecture, the number of unofficial forest charges initially declined, but were then replaced by a longer and more burdensome list of charges. Xie (2000) and Liu Jinlong (2002) document cases where the timing of collection and method of calculation of taxes and charges imposed by local governments has been inappropriate, again resulting in much higher charges being extracted than is actually provided for in the applicable. In some cases tax is levied before timber is sold, or even harvested, and in other cases legitimate cost deductions incurred by the enterprise are not exempted. Often, taxes are set on the basis of value added, regardless of the level of profit (or absence thereof) in the operation.

[7] An investigation made in South China Collective Forestry Area (Liu, Natasha 2003) shows that in four out of five forest enterprises (including individual households), the official payments of tax and charges ranged from 8-41 % of gross income of timber. Most enterprises maintain two sets of finance accounts. It is probable that actual avoidance in this case is much higher than the official calculation.

[8] In Hunan and Jiangxi provinces, only 40-70 % of authorized revenue was collected.

[9] In some counties in Jiangxi province, illegal harvest excess 50 % of official approval harvest quota. Some timber processing enterprises actually consume 6-10 times of approved harvest quota: negotiations in this area frequently lead to ‚black‘ or ‚grey‘ deals and corruption.

revenue collection in the sector would be a high proportion of total revenue recovered. As noted earlier various taxation and charges are imposed on the same products, collected by different governmental authorities, creating a redundant system of collection, excessive bureaucratic employment and duplicated record-keeping. In some counties, more than half of the personnel in forestry bureau are employed in revenue collection.

A test on collection of SAPT was conducted strictly followed the regulation of SAPT at Genghuang township of Woyang county, Anhui province, which is very mountainous regions. 19 tax collectors had stayed in the villages of this township for 2 months to trace the production and trade of special agriculture products and they were able to collected total 40 000 yuan of SAPT. But the direct collecting cost, excluding salary of tax collectors, was 40 000 yuan. Thus, township authority said: ‚households in this township live in about 100 hills, and agriculture special products (including from forests) are different among householders and products vary great among trees. It is impossible to calculate the value of harvest in these hills. Therefore, we collected SAPT based on number of people in households'.

Misuse of revenue

Officially revenues collected from forestry charges are all intended to finance forest development. In fact, a large proportion of these revenues is allocated for staff salary and operational costs in the forest sectors, in particular in county level[10]. The net effect of this can in many cases be that income collected from forestry by government is transferred from the forested areas, which tend to be relatively poorer, to other, wealthier areas.

ECONOMIC APPRAISAL OF CHINA'S FORESTRY TAXES AND OTHER CHARGES

Before the Householder Responsibility System (HRS) was introduced in China, timber was listed as one of the important industry products, subject to centralized control over the amount of production, consumption and prices of products. Timber prices were based on labour cost from harvesting to the timber collection point, and were therefore much lower than the market price. The tax rate was set at 10 % of sale price and forestry charges were also set by government. Forestry charges were considered as a part cost of restoration of forest harvesting capacity or regeneration after harvesting virgin forests.

[10] In Xiushui county of Jiangxi province, 94 % of county revenue from forestry charges went to afforestation in 1992, while in 1999, only 33 % went to afforestation. Local government in forestry areas uses the income from forestry charges for public finance, even supporting urbanization and industry development (Xie Chen 2000).

After HRS was introduced in China, the timber market was gradually opened until late 1980. The price of timber increased, but the rate of taxes and charges increased faster. Based on some figures provided by Xia (2000), in Jingzhou county of Hunan province, prices for a particular grade of pine log increased relatively rapidly, but taxes increased even faster (Table 3).

TABLE 3 *Forestry taxation and levies in Jingzhou county of Hunan province*

Year	Log collection price near farm gate Yuan/m³	Share for taxes and levies Yuan/m³	Farmer share Yuan/m³	Rate of taxes and levies (%)
1978	80	15	65	19
1985	180	45	135	25
1987	360	182	178	50
1999	650	342	308	52

Below is a summary of the economic and social impacts of the fiscal situation which has evolved in the forest sector in China.

Redistribution of income

China's forestry tax policy burdens the poor disproportionately, because, as noted above forestry regions in China tend to be poorer than average. They are located in remote and fragile eco-regions, with fewer jobs, and less development opportunities. Moreover, forestry taxes and charges effectively devalue forestry resources *in situ*, exacerbating the situation of the poor in forest locations. By contrast, regions where local governments are less dependent on the revenue collected from forestry are comparatively richer. They can finance timber industry development, and can benefit from more judicious use of local tax revenues, applied to development projects. Another aspect of inequity in this area arises from the observation made earlier in this paper (see footnote 8) that, although forest charges in a given administrative area are supposed to be levied uniformly, in fact they are not. Large companies, foreign investors, major infrastructure investments such as hydropower and highway projects, are all in strong positions to negotiate resource prices with local government authorities.

Ability to pay

Current taxes and charges do not equitably consider the ability of rural foresters or forest farms to pay, either in policy design or practical implementation. Given the limitations on labor opportunities in the formal forestry sector, the imposition of royalties upon non-timber forest products imposed by State-owned farms is questionable. Rural dwellers have traditional rights to collect forest products such as mushrooms or pine seeds, fuel wood, and the revenues from this directly supplement farm incomes; supposedly a priority concern in China.

TABLE 4 *Budget allocated from central fiscal account to forest sector*

Year	Amount (billion Yuan)
1990	1.1
1995	2.0
1997	2.0
1998	3.7
1999	5.9
2000	11.3
2001	22.0
2002	34.0
2003	43.1
2004	43.8

Administration cost issues

As noted earlier, taxes and charges are collected under systems which are complex, leading to duplication, lack of accountability and transparency, and over-staffing in the revenue collection area. Taxes and charges are calculated on the sale price of timber which fluctuates year by year, even season by season. In an environment of transparency and efficient, coordinated revenue collection, such a variable pricing system might be effective, but in the cases it leads mainly to poor enforcement, corruption in collection.

Compliance costs for taxpayers who harvest small amounts of timber are higher than those for larger scale operators. Fixed and uniform costs apply to the range of requirements for applications, revenue payments, reporting, and approvals of harvest quotas and plans, regardless of the size of the operation, or its remoteness from the relevant administrative centre.

There are some innovations in revenue management which local governments could experiment further with. For example, forestry enterprises pay a fixed amount revenue for tax, the local forestry bureau assists in collecting tax (very often through a state owned timber collection company which is authorized to be the only agency to implement collections), township governments could collect a fixed amount of revenue for tax, or levy individual farmers equally based on member of householders, whether or not farmers have revenues from forests.

Lack of an efficient market for forest management services

Although local forest agencies have ‚commercialized‘ services such as grading and inspection, clients are offered no choice but to engage these services, and pay the price set for them because no private sector alternative exists. As noted earlier, while many of the charges in the sector are collected in the name of financing for reforestation or infrastructural expenses incurred by the agencies, most of the funds collected are actually diverted to supporting oversized and inefficient forest agencies.

CONCLUSIONS

Taxes and other charges on forestry in China have been much higher than for many other sectors, and this has been a major disincentive to investment in private plantation development. There is no evidence that high taxes and charges will reduce commercial harvest and hence save Chinese forests for environmental services. People in local communities, and employees in state farms depend on income from forestry and will continue to need to harvest them for subsistence income. Local governments and forestry agencies are heavily reliant on forests for operational funds. The high taxes are also a disincentive to trials on promoting market-based instruments for forestry development: for instance opening markets for trade of forest land use rights; promoting farmer associations for forest protection and management; and utilizing market-instruments for environmental services (such as the National Compensation Fund for Environmental Service; services for landscape protection (eco-tourism sector); and water protection (hydro power)). Current taxes and charges also discourage application of some techniques for degraded land rehabilitation and plantation improvement, for instance enrichment planting, and thinning for improving quality of forests, mixture plantation promotion.

The Central Government is aware of the current situation in the forests sector. It intends to reduce taxes and charges related to forest products, as part of its overall strategy to support the rural economy and reduce the income disparities between rural and urban regions of the country. As noted earlier, China initially adopted a dual system which applied different policies to urban and rural areas, including social pension and employment arrangements. A social pension system has still not been established in rural regions: at present, lands allocated to individual householders are assumed to be a substitute for farmers' social welfare. In recent years, marginal income from land has become an increasingly smaller proportion of total revenue in the rural economy. One of reasons for this is heavy taxes and charges levied on products produced by farming- including timber products, causing stagnation in household revenue in rural regions. The resulting disparity between rural and urban incomes is causing increased social problems and tensions in rural regions. In 2002, China initiated a new round of rural taxation reforms, eliminating many charges related to agricultural products. In 2004 the central government promised to eliminate agricultural taxes within 5 years as part of its policy to improve the rural economy.

As part of rural reform, sector authorities including the forest sector were instructed to eliminate charges related to rural products. The SFA, in addition to provincial authorities have joined the initiative and have taken action to eliminate forest charges. However, one of consequences of this is that not enough revenue is being collected for local authorities to operate effectively. Table 4 illustrates the budget allocated from the central account to the forest sectors. In the last eight years, there has been a large budget increase.

From 1991-2002, revenue collected nationally for the Afforestation Fund amounted to 47 billion Yuan in total; around 4 billion Yuan annually. It is roughly estimated that the charges collected by the forest sector amounts to about 12 billion Yuan annually in recent years. This is now declining slightly due to the new rural policy outlined above as well as reducing harvest amount with the policy scheme of logging ban in some natural forest regions. Forestry agencies at various levels of administration have become aware that revenue from these charges will form a declining proportion of total income for forestry development and bureau operations, and they are turning increasingly to applications for forestry development funds from higher level authorities, to meet their needs.

The history of central government financed forestry projects in China contains many examples of misallocation of government funds, resulting in shifts of funds away from plantation and forestry management, into forestry agency operations, with the concomitant problems of agency overstaffing discussed in this paper. Duplication of functions and revenue sources, and a lack of transparency and accountability in the many agencies and groups which overlap each other, have created major problems for sector management in the decentralized system, and are hampering progress toward efficient and market-oriented systems of allocating, managing and protecting forest resources and the interests of rural people who depend most upon them.

Solutions to some of the problems may be found from within the forest sector itself, but it must also be recognized that some of the social, political and cultural issues involved are more systemic and widespread than the forest sector issues. In general, reform of government institutions and systems in all parts of the world tends to lag far behind the introduction of economic reforms aimed at an effectively decentralized and market-oriented economy. The recent history of forestry in China serves to demonstrate the persistence and intransigence of this problem.

ACKNOWLEDGEMENTS

This paper is part of the research output from the FAO funded project *China's Fiscal Study Contributed to Sustainable Forestry Management* and the Ford Foundation funded project *Rural Fiscal Reform: the effect of timber tax reform on government operation*. The authors thank Mr. Adrian Whiteman, FAO policy researcher, for his insights which contributed greatly to this research.

The authors also owe a special debt of gratitude to Jim Douglas for his highly constructive suggestions for improving the manuscript and his careful editing of the draft.

REFERENCES

CHEN Y. 1995. Levy taxes on forests areas instead of on timber. Forestry Economics (in Chinese). **6**: 44-47.

GRUT, M., GRAY, J. A. and EGLI, N. 1991. Forest Pricing and Concession Policies: Managing the High Forests of West and Central Africa. World Bank Technical Paper No. 143. Africa Technical Department Series. Washington, D. C.

JIA, K. 1999. The study on the thinking of standardization of governmental income and the reform of levies to taxation. *The World of Management*, Vol. **4**:55-64; 1999.

LI, W. 1999. The Construction of Tax System during the Period of Economic Transference in China, The China's Taxation Publishing House. 224 pp.

LI, S., WANG, D. and HE, D. 2000 Reform levies to taxation, China Auditing Publish House. 147 pp.

LIU, J., LIU, JINFU, YUAN, W. 2000. Study on Forestry Taxes and Levies in South China Collective Forests Regions. Forestry Publishing House.175 pp.

LIU, J., NATASHA, L. 2003. Taxes and fees in the southern collective forest regions. In: WILLIAM F. H., etc. 2003. *China's Forests*. Centre for International Forestry Research, and Forest Trend.

SUN, C. 2002. Forest tax and fiscal policy issues in China: status and implications for reform. In: *Proceedings, International Forum on Chinese Forestry Policy*. CCICED Task Force on Forests and Grasslands, pp.17-22. China Forestry Publishing House, Beijing.

XIE, C. 1999. Investigation and study on forestry taxation and charge-based on Hunan province. *Forestry Economics*, **6**:26-35.

XIE, C. 2000. Investigation and study on forestry taxation and charge-based on Hunan province. *Forestry Economics*, **1**:21-28.

ZHANG, X. 1999. The Forestry Taxation and Levies Issue in the Collective Forestry Area of Fujian and Jiangxi province. Forestry Economics, **6**:36-45.

ZHAO, M., GAO, Y. 1999. Theory and Practice of the Forestry Fund. The Publishing House of Harbin Industry University. 193 pp.

The relationship between forest research and forest management in China: an analysis of four leading Chinese forestry journals

M. RUIZ PÉREZ[●], M. FU[■], J. XIE[■], X. YANG[■] and B. BELCHER[♦]

[●] *Department of Ecology, Faculty of Sciences, Universidad Autónoma de Madrid, Spain*
[■] *Research Institute of Subtropical Forestry, Chinese Academy of Forestry, Fuyang, Zhejiang, P. R. China*
[♦] *Center for International Forestry Research, Bogor, Indonesia*

Email: manuel.ruiz@uam.es

SUMMARY

We analyse the collaboration between forestry research institutions and forestry departments in China based on a bibliometric study of four leading Chinese forestry journals. Multiple-authored papers are frequent, and there is a significant collaboration between research and implementing agencies. This collaboration centres on applied research, being less common on fundamental research and almost non-existent on policy research. Universities, National research institutes and National and Provincial level forest departments act as the key organisers of research, with specialised domains and types of collaboration. This helps explain the success of Chinese forestry experiences in recent years.

Keywords: forestry research, collaborative research, bibliometric, China

INTRODUCTION

A consensus has emerged that the combination of land, market and forest enterprise reforms, together with the recent emphasis on forest protection, has had a positive effect on the Chinese forestry sector, having been proposed as a model for other countries (Rozelle *et al.* 2000; Hyde, Belcher and Xu 2003). While major changes in policy have been normally considered at the base of this success (Albers *et al.* 1998; Bruce *et al.* 1995; Wang *et al.* 2004), little is known about the role of forestry research in the process of developing and implementing new policy measures.

Collaborative research between national and international forestry research institutions has been proposed as a way to reinforce links between different research agencies, to build local and national research capacities, to develop networks of joint-interest parties, and to influence the general forestry agenda (CIFOR 2004). Collaborative research between in-country institutions has received less attention. In this paper, we extend the international collaborative research assumptions to collaboration between Chinese institutions conducting forestry research. We analyse the connection between research institutions and forestry departments at different levels as an enabling factor that contributes both to policy design and its successful implementation in China.

METHODOLOGY

Tens of forestry research journals are currently published in China. We base our analysis on a bibliometric study of four leading Chinese forestry journals, selected as representatives of current national forestry research from different perspectives. The criteria for selection was the journal scope, the prestige of the institution that publishes it and the recognition as important journal among Chinese and foreign forestry specialists.

- Scientia Silvae Sinicae - SSS (*Linye Kexue*), the most important forestry journal in China, was established in 1955 by the Chinese Forestry Society. It is published bimonthly. It has a general scope and tends to publish academic and applied papers.
- Forest Research - FR (*Linye Kexue Yanjiu*), a national reference journal, started in 1988. It is a bimonthly publication of the Chinese Academy of Forestry. It focuses more on applied research.
- The Journal of Beijing Forestry University - BFU (*Beijing Linye Daxue Xuebao*) started in 1979. It is published bimonthly by the Editing Department of Journals of Beijing Forestry University. It tends to focus on academic papers.
- Forestry Economics - FE (*Linye Jingji*) was created in 1979. It is published monthly by the Research Cen-

ter of Economic Development of the State Forestry Administration. It is the journal of reference for forestry socio-economic and policy research in China.

We reviewed all the papers published in the last five years (1999 to 2003), annotating authors' order of appearance and affiliations. These were grouped in eight main institutional categories, divided in two sub-groups. The first, for research institutions, inclu-ded National Research Institutes (NRI), Universities (UNIV), Provincial Research Institutes (PRI) and Other Research Institutes (ORI). The second included forestry management agencies of different sorts and at various levels: County Bureaus (B-county), City Bureaus (B-city), Provincial Departments (B-province) and National level Departments (B-national). Authors from private enterprises were included in this second group at the corresponding level (local, provincial or national) of their enterprises. A paper can have more than one affiliation given the frequency of multi-authored work published.

Based on the title, summary and keywords, papers were ascribed to one research category from applied forestry (silviculture, tree genetic improvement, and pest control), fundamental biological research (ecology, biology-physiology), social science research (socio-economics, policy) and a general category of others that included a variety of subjects (production technology, machinery, management of production units, etc.).

Two basic assumptions guide our analysis: a) co-authored papers represent collaborative research; b) research collaboration between institutions represents interactions that facilitate their mutual influence. Based on these assumptions, we analyse below the structure of research and interactions between institutions by research subject categories.

RESULTS AND DISCUSSION

A total of 2855 articles were compiled, their number having increased steadily during the past five years (table 1). Universities (38.4 %) and National Research Institutes (23.7 %) are the dominant institutions accounting for almost 2/3 of all authors' affiliations (table 2). However, there is a certain degree of specialisation by journal. Universities dominate the two more academic journal (BFU); universities are also predominant in SSS, that represents a combination of academic and applied research; National Research Institutes (notably those from the Chinese Academy of Forestry) lead in the more applied journal, FR; whereas National and Provincial (mainly Forestry) Departments tend to publish in the socio-economic and policy journal FE. This reflects a trend for in-house publishing, where university and NRI researchers tend to select the journals published by their respective institutions.

Single-author papers represent 25 % of the articles; most work is co-authored, with an average of 3 authors per paper (figure 1a). The distribution varies by journal and research subject. The three general forestry journals (FR, BFU and SSS) have similar co-author distribution. FE stands as the journal with the lowest (1.6) level of co-authored articles. Social science research has a lower level of collaborative papers than the rest. Policy research represents an extreme case, with 71 % of all papers as single-author (figure 1b).

Ecology as fundamental research and silviculture as applied research stand as the two main pillars of forestry research in the four journals selected (table 3). Socio-economic research also plays an important role, while policy research is the least frequent subject. Again there are important journal differences indicating the journal specialisation, particularly visible in the case of FE. Policy research is also the most journal-specific subject; 95 percent of all recorded policy research gets exposed and debated in FE, making this one of the key forest policy public forum debate in China.

Cooperation between different institutions is common in China's forestry research. In our sample, universities have the highest research inbreeding, with 67.3 % of their papers published exclusively by university authors. They are followed by National level agencies (notably the State Forestry Administration) with 63.5 % and National research institutes with 61.1 %. At the other extreme, city forest bureaus (47.5 %) and county forest bureaus (46.6 %), with the lowest percent of publications by members of the same institutions, tend to publish their papers in collaboration with different groups, mainly National research institutes and universities. This underscores the role of the two major research institutions as forestry research leaders, while the local forestry administration tends to have a dependent and complementary role. This interpretation is confirmed by the rate of senior authorship in publications. NRI (88.4 %) and universities (81.9 %) tend to dominate as first authors in the papers in which they participate, whereas senior authorship ratio is low in city bureaus (33.1%) and county bureaus (24.2 %).

Co-authored work is particularly important when the cooperation is established between research institutions responsible for creating the knowledge and technology base and forestry departments at different levels responsible for forest management and policy development. This collaboration is a significant feature of forestry research in China. A total of 17.2 % of the papers published in the reviewed journals are co-authored by staff from both type of institutions. Papers co-authored between research and management institutions are more frequent in applied research (pest control, tree improvement and silviculture, with approximately 25 % of papers in these subjects being co-authored, see figure 2). Fundamental research (e-

TABLE 1 *Number of articles per journal and year of publication.*

Journal	Year of publication					
	1999	2000	2001	2002	2003	Total
Forest Research	114	111	114	123	124	586
Beijing Forestry University	118	130	119	153	130	650
Scientia Silvae Sinica	146	152	141	176	210	825
Forestry Economics	75	101	173	214	231	794
Total	**453**	**494**	**547**	**666**	**695**	**2855**

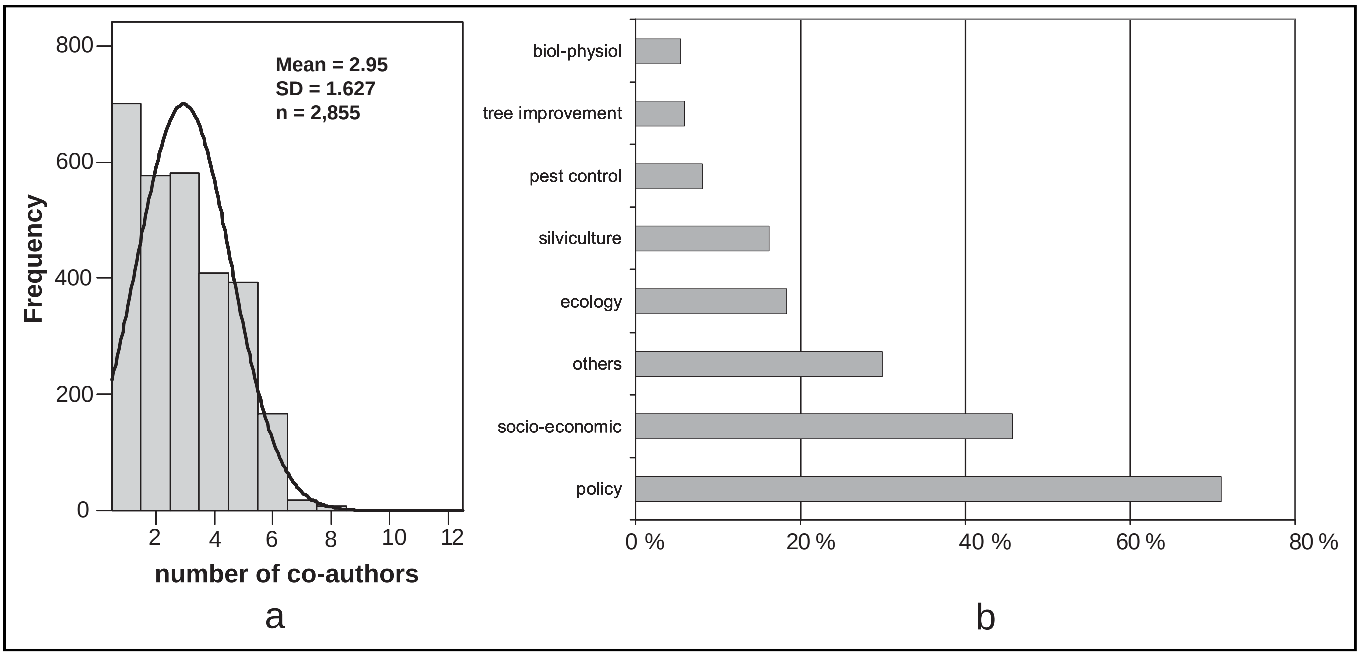
TABLE 2 *Frequency of institutions per journal*

Institution	Journal				
	FR	BFU	SSS	FE	All
NRI	425	83	316	118	942
UNIV	177	603	525	223	1528
PRI	63	24	99	27	213
ORI	50	91	27	6	174
B-county	105	35	76	69	285
B-city	47	21	35	39	142
B-province	35	8	44	105	192
B-national	59	62	72	308	501
Total	**961**	**927**	**1194**	**895**	**3977**

TABLE 3 *Frequency of research subject per journal*

Research subject	Journal				Total
	FR	BFU	SSS	FE	
policy	3	4	4	210	221
biol-physiology	58	83	99	0	240
tree improvement	93	86	89	0	268
pest control	105	39	125	2	271
socio-economic	8	21	11	288	328
silviculture	144	95	119	55	413
ecology	86	155	208	47	496
others	89	167	170	192	618

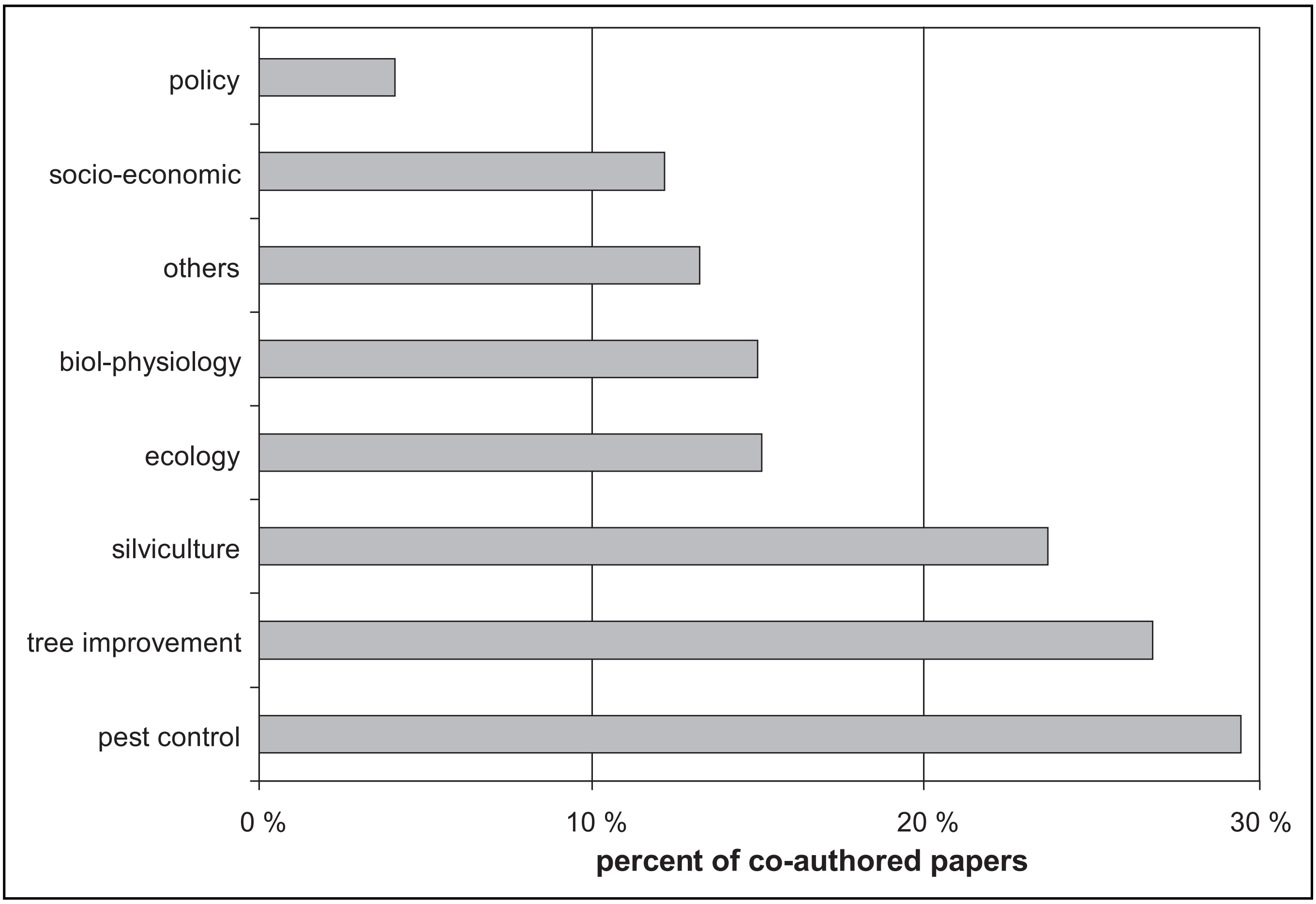
FIGURE 1 *Authors per paper (a) and percent of single author papers by subject.*



cology, biology-physiology) as well as socio-economic papers tend to have around 15 % of the articles co-authored by authors of both research and management institutions. Finally, policy research, with only 4 % of papers, is the domain where less collaboration between research and management takes place. It is also the domain where more papers are published by non-research institutions, notably National and Provincial level forest departments.

Two factors help explain this situation. First, many policy articles are policy discussion and preliminary proposal documents rather than policy research articles as such. Moreover, the policy-making process in Chinese forestry concentrates in the power-controlling agencies at National and Provincial level, where the basic forestry policy decisions take place. Thus, while collaborative work between research institutions and forestry departments is fundamental in China's forestry research and policy implementation activities, this collaboration seems to stop when dealing with the development of new policy measures and the discussion that precedes it, at least in public

FIGURE 2 *Percent of co-authored papers by subject*



forum like forestry journals. This is particularly clear in the case of Forestry Economics, the journal published by the policy think-tank institution of the State Forestry Administration.

To conclude the study, we have conducted a principal components analysis of the cross-tabulation between research subjects and research institutions. The results of the first two axes (representing 89.9 % of the total variance of the data) appear in figure 3. This allows us to propose a three groups-structure of forestry research in China as represented by the publications in the four leading Chinese forestry journals selected.

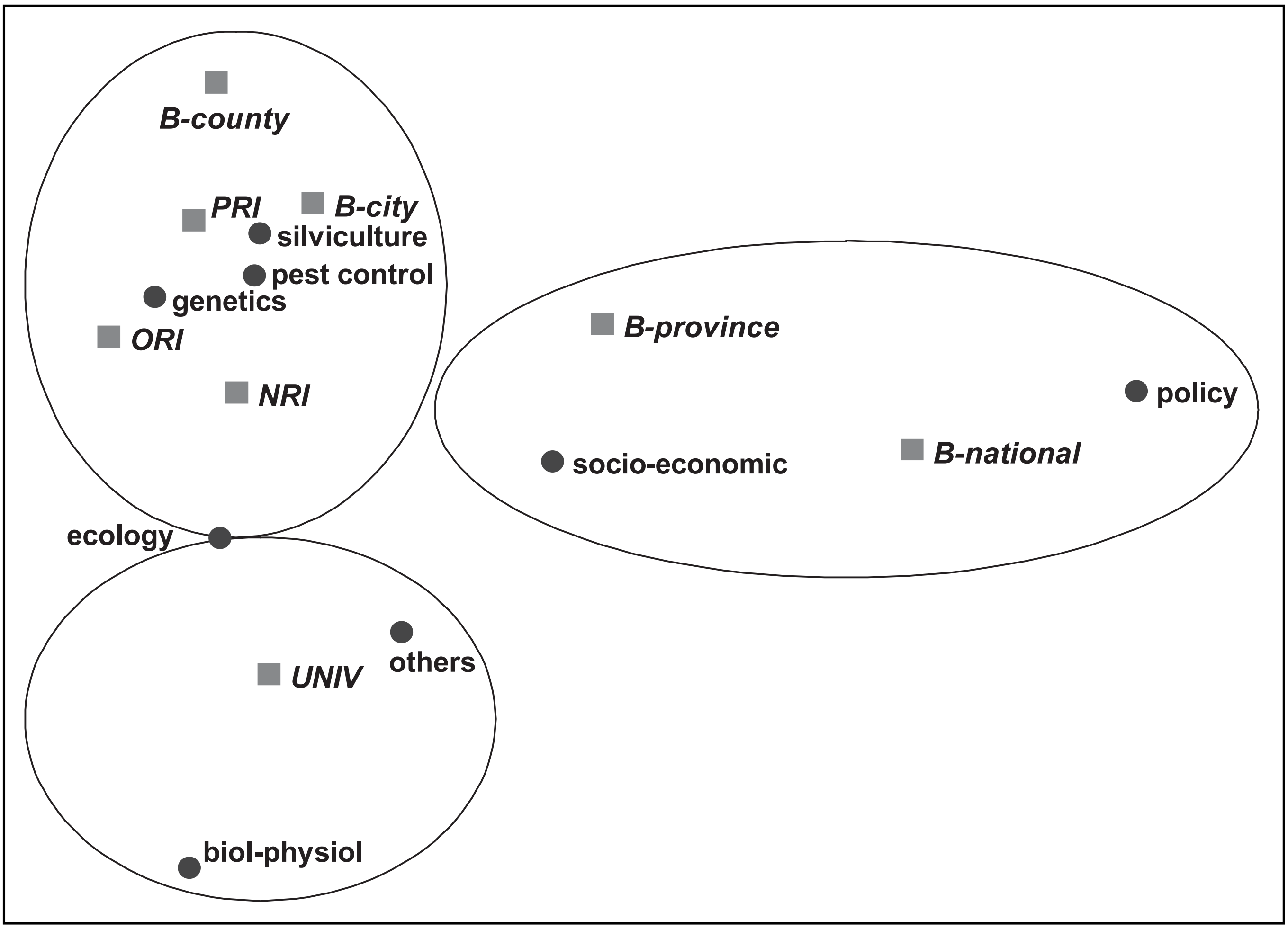
- The first, organised around university teams, deals mainly with fundamental research (ecology, biology, physiology) having also some relation with socio-economic subjects. This research tends to have a certain degree of inbreeding, although collaboration takes place also with other research institutions, mainly National research institutes.
- The second, organised around National research institutes, focuses on applied research, as well as on ecology and some socio-economic issues. This research has less inbreeding, having a functional collaboration with county, city and to a less extent provincial level forestry departments or bureaus.
- The third level corresponds to socio-economic and especially policy research, conducted by power-wielding, policy developing and implementing agencies at National and Provincial level, with little connection in what research is concerned with the rest of forestry players.

CONCLUSIONS

We have looked at Chinese forestry research through the window offered by four leading Chinese forestry journals. The degree of in-house publishing and journal specialisation introduce a certain bias in the sample and the results. At the same time, the importance of the journals selected and the institutions that publish them comprise sufficient breadth of outputs to represent adequately leading forestry research outputs in China. The inclusion of a more neutral journal like Scientia Silvae Sinicae, that also has the highest amount of papers in our sample, also helps to balance possible biases.

We identified institutional collaboration as a significant feature of this research. A special aspect of this collaboration is the joint work conducted between research and management agencies, particularly important in the case of applied research. This collaboration tends to be a functional relationship by

FIGURE 3 *Principal Components Analysis of the cross-frequency tabulation between research subject and research institutions.*



which research institutions get the expertise and empirical knowledge of the field offered by forest agencies (especially at local level) while maintaining the intellectual leadership of the research. In this sense, local forestry agencies act as efficient intermediaries between professional researchers and farmers, helping to explain the seemingly success of China's forest policies in recent times.

The collaboration recorded in these four journals, however, seems to stop at the level of social, particularly policy, research, both indicating a trend for tight control of the policy process, but also an opportunity for improved collaboration given the well established tradition in other research domains.

REFERENCES

ALBERS, H., ROZELLE, S. and GUO, L. 1998. China's forests under economic reform: timber supples, environmental protection and rural resource access. *Contemporary Economic Policy* **16**:22-33.

BRUCE, J. W., RUDRAPPA, S. and ZONGMIN, L. 1995. Experimenting with approaches to common property forestry in China. *Unasylva* **46**(180):44-49.

CIFOR. 2004. Science for Forests and People. CIFOR Annual Report 2003. CIFOR, Bogor, Indonesia.

HYDE, W. F., BELCHER, B., and XU, J. (eds). China's forests. Global lessons from market reforms. pp.1-21. Resources for the Future Press, Washington, D. C.

ROZELLE, S., HUANG, J., HUSAIN, S. A., and ZAZUETA, A. 2000. From afforestation to poverty alleviation and natural forest management: An evaluation of China's forest development and World Bank assistance. World Bank, Washington, D. C.

WANG, S., van KOOTEN, G.C. and WILSON, B. 2004. Mosaic of reform: forest policy in post-1978 China. *Forest Policy and Economics* **6**:71-83.

TRANSLATION OF SUMMARIES

FRENCH

Une évaluation des ressources forestières de la Chine

G. Q. BULL et S. NILSSON

Les ressources forestières de la Chine ont été et sont toujours menacées. L'analyse souvent contradictoire des diverses statistiques prélevées indique que des défis de taille se profilent à l'horizon si la forêt veut continuer à assurer ses objectifs industriels, non-industriels, de combustibles et de conservation. Du fait des contraintes prévues dans la production de la fibre domestique pour au moins vingt ans, on pourrait assister à une demande accrue de bois et de produits dérivés du bois chez les partenaires commerciaux de la Chine. L'ensemble de cet article rend évidente la difficulté de parvenir à des conclusions plus spécifiques du fait des différences importantes apparaissant dans les données de tous les principaux domaines statisiques. Il est nécessaire de faire face à ces décalages avant qu'un ensemble de plans d'action pour la terre et le développement de longue durée puisse être créé.

Brêve vue d'ensemble du système de marché du bois en Chine

XIUFANG SUN, LIQUN WANG et ZHENBIN GU

Le système de marché du bois en Chine a été témoin de réformes alors que la Chine est en train d'adopter une libéralisation de ses marchés. La production et la distribution du bois étaient monopolisées par le gouvernement avant les années 80. Une transition graduelle allant d'attributions de l'état à une libéralisation du marché s'est effectuée pendant la fin des années 80 et le début des années 90. A l'heure actuelle, les producteurs de bois peuvent faire commerce de leur bois directement avec leurs clients, bien que la récolte et le transport soient encore sous la supervision de l'état. Les secteurs de l'industrie de transformation du bois primaire et de consommation du bois ont tous deux connu une croissance rapide. L'importation des produits forestiers en Chine s'est accrue parrallèlement,due aux ressources domestiques limitées et poussée par la forte demande pour les produits de bois des industries domestiques, lesquelles comprennent la construction, meubles et panneaux. Visant à réduire l'import, le gouvernement effectue des efforts pour établir des ressources commerciales de bois en établissant des plantations à croissance rapide. La différence entre la production domestique et la demande devra cependant être résolue par l'import pour les années à venir.

Assurer la demande de la Chine pour les produits forestiers: une vue d'ensemble des tendances de l'import, des ports d'accès et des pays fournisseurs (avec une attention particulière portée sur les pays de l'Asie-Pacifique)

XIUFANG SUN, E. KATSIGRIS et A. WHITE

Cette étude analyse les courants de l'import des produits forestiers en Chine entre 1997 et 2003 par une segmentation des produits, ainsi que les ports d'accès et chacun des principaux pays fournisseurs de la Chine dans l'Asie-Pacifique. La Chine a connu une forte croissance des importations de produits forestiers entre1997 et 2003 pour les produits du bois, la pâte et le papier. Les bûches, le bois de construction et la pâte sont les segments d'importations à la croissance la plus rapide, alors que la Chine se dirige vers une plus grande prise en charge de la transformation des produits forestiers. Les pays de l'Asie-Pacifique riches en forêt jouent un rôle de plus en plus important dans l'approvisionnement de la demande en expansion de la Chine. Finalement, les ports océaniques dans les régions Shangai-Jiangsu et Chine du Sud ont maintenu leur rôle majeur dans le commerce des produits du bois. Ils ont été rejoints, et parfois même supplantés par des ports continentaux en Chine du Nord-Est qui ont été catapultés dans des rôles majeurs par le commerce de frontière en plein essort avec la Russie.

Le commerce des produits forestiers chinois: impact et implications pour les pays fournisseurs de l'Asie et du Pacifique

E. KATSIGRIS, G. BULL, A. WHITE, C. BARR, K. BARNEY, Y. BUN, F. KHARL, T. KING, A. LANKIN, A. LEBEDEV, P. SHEARMAN, A. SHEINGAUZ, YUFANG SU et H. WEYERHAEUSER

Plus de 70% de l'import de produits du bois de la Chine est fourni par des pays de la région Asie-Pacifique. La Chine est également le marché dominant pour beaucoup de ces pays. Ils sont affectés par leurs pratiques de récoltes qui ne pourront durer, la coupe illégale, les impacts négatifs sur les moyens d'existence des communautés de forêt indigènes ou autres, ainsi que par d'autres problèmes de politique. Les pays de l'Asie-Pacifique fournisseurs de la Chine peuvent être divisés en deux catégories: ceux qui récoltent et exportent encore le bois à grande échelle (en mettant peu d'emphase sur les plantations et la transformation), et ceux ayant dépassé l'apogée de leur récolte et qui se lancent d'une manière aggressive dans la plantation et ses projets et dans l'industrie de transformation. En mettant la Russie à part, les fournisseurs de bois de la Chine les plus importants dans l'Asie-Pacifique pourraient, dans le meilleur scénario, soutenir leur production actuelle pendant 20 ans, au prix, cependant, de la destruction de leur ressources de bois. Les limites des ressources amenuisent la croissance et/ou la continuation à long terme de l'exportation des produits transformés en Chine. Les implications de ces problèmes prennent trois directions, la première: une attention plus grande mérite d'être accordée par les dirigeants des marchés et les créateurs des lignes de conduite à l'impact négatif gigantesque de ce commerce sur les forêts naturelles et les moyens d'existence, la seconde: conduire cette production vers une base équitable, durable et légale à courte et moyenne échéance nécessite qu'une attention soit portée sur les problèmes sous-jacents de ligne de conduite et institutionnels. La troisième lance un défi à long terme au secteur forestier global: la Russie mise à part, il n'est pas du tout clair d'où l'approvisionnement de produits forestiers à long terme et/ou croissant pour la Chine va provenir. Les gouvernements de la région et les organisations internationales doivent faire face à ces trois aspects en leur accordant une plus grande attention , et en étant prêts à agir.

Le secteur du papier et de la pâte de la Chine: une analyse des courants de l'offre et de la demande et des prévisions à moyen terme

D.HE et C.BARR

Cette étude résume les courants récents dans le secteur de l'industrie chinoise du papier et du carton et prévoit l'offre et la demande pour chacun des grades majeurs jusqu'à 2010. Des prévisions de base suggèrent que la demande d'ensemble de la Chine ira de 48.0 millions de tonnes en 2003 à 68.5 millions de tonnes par an en 2010. Aves sa production domestique prévoyant d'atteindre 62.4 millions de tonnes par an, on s'attend à ce que la Chine domine la capacité globale d'expansion pour la plupart des grades majeurs. En regardant le futur, la demande annuelle de fibre de bois de la Chine à travers tous les grades est prévue d'augmenter de 40.3 millions de tonnes en 2003 à 59.6 millions de tonnes en 2010. De cela, approximativement 58 % proviendra de papier recyclé, 25% de pulpe de bois et 17% de pulpe autre que le bois. Cette croissance rapide a des implications à grandes ramifications pour la durabilité des forêts et la subsistance rurale de la Chine même et à travers la région Asie-Pacifique. Elle va placer de nouvelles contraintes sur la production domestique de bois chinoise et pourrait exacerber la conversion des forêts et la coupe illégale dans certains des pays fournisseurs, menaçant les producteurs d'arbres à petites exploitations, tout en leur offrant également des opportunités potentielles de revenus.

Le développement d'une industrie de pâte de bois basée sur des bois de plantations en Chine: lignes de conduite du gouvernement, motivations financières et courants d'investissement

C.BARR et C.COSSALTER

Le gouvernement chinois est en train de promouvoir très fortement le développement d'une industrie de pâte de bois domestique qui soit intégrée avec l'approvisionnement de fibres provenant de plantations et l'enchaînement de la production de papier. Il le fait en offrant des prêts bon-marché à travers les banques d'état, des bénéfices fiscaux et des subventions de capitaux pour l'établissement d'au moins 5.8 millioins d'hectares de plantations de bois à croissance rapide cultivé pour sa pâte. Cet article examine le développement des usines de bleached hardwood kraft pulp (BHKP) en Chine du Sud, lesquels incluent l'usine de Asia Pulp & Paper à Jinhai dans la province de Hainan, et le projet prévu de l'usine à pâte de Fuxing dans la province de Guangdong. Ces deux usines font face à pénurie de fibre substantielle à moyen terme, et des nouveaux investissements d'envergure dans le développement des plantations seront nécessaires pour fournir un approvisionnement de fibres durable aux niveaux de capacité prévus des usines. Il n'existe toutefois que quelques sites sur la zone côtière de la Chine du Sud à même de produire de la fibre à un coût qui soit compétitif. Dans la plupart des cas, le coût du bois de plantation chinois cultivé pour sa pâte sera considérablement plus élevé que celui des pays comme l'Indonésie ou le Brésil, ce qui pose des questions importantes sur la compétitivité économique des producteurs de pâte chinois, même dans leur propre marché national.

Les terres de forêt collectived de Chine: contributions et contraintes

GUANGPING MIAO et R. A. WEST

Les forêts collectives forment la majorité des régions forestières en Chine et se sont révélées être vitales pour maintenir le niveau de subsistance de centaines de millions d'habitants ruraux, fournissant le bois et d'autres produits forestiers à la demande en pleine expansion de la Chine, et fournissant aussi des services environnementaux cruciaux. Cet article décrit la ligne de conduite principale et les dimensions institutionnelles des forêts collectives de Chine et la manière dont les les droits des forêts collectives sont définis, légalement et en pratique. La distribution nationale et provinciale des forêts collectives est présentée. L'article évalue l'impact et les inplications des lignes de conduite nationales critiques qui incluent le programme national de protection des forêts (NFPP), l'expansion du système des zones publiques protégées, le programme compensatoire de l'écosystème forestier (FECP), le système des impôts et des charges, et le quota de récolte des bûches. Il s'achève avec des recommendations de réformes des lignes de conduite qui renforcerait le secteur des forêts collectives et augmenterait leur contribution au soulagement de la pauvreté, au développement rural, et a la conservation durable des forêts.

Marché de secteurs forestiers en Chine: questions posées par les pans d'action et recommandations

S. NILSSON, G. BULL, A. WHITE et JINTAO XU

Nous essayons d'identifier les questions majeures des plans d'action auxquels le secteur forestier de la Chine fait face en nous basant sur les articles qui contribuent à cette édition spéciale sur la Chine, ainsi que sur d'autres études. L'analyse des plans d'action est organisée autour de ce qu'on apelle la „chaîne de production" (du bois coupé aux produits finis du marché). La tension entre les lignes de conduite et leurs implications se concentre sur le hiatus d'importance (et grandissant) qui a été identifié dans l'équilibre entre l'offre et la demande des produits forestiers. L'un des problèmes majeurs rendant l'analyse des plans d'action difficile est le manque de données claires et cohérentes qui a été identifié pour certains des éléments de la „chaîne de production". Cette situation devra s'améliorer substantiellement pour quedes lignes de conduites établies dans le secteur forestier chinois puissent être appliquées dans le futur.

En regardant à travers le rideau de bambou: une analyse du rôle changeant des revenus fermiers et forestiers dans les moyens d'existence ruraux en Chine

M. RUIZ PÉREZ, B. BELCHER, MAOYI FU et XIOASHENG YANG

L'analyse de la pauvreté et de la sylviculture en Chine vivent une relation ambigüe. Alors que la co-existence des zones riches en forêt et des régions pauvres a été notée par certains auteurs, d'autres ont stressé le rôle joué par la sylviculture dans ces zones, où elle est fréquemment l'une des rares options disponibles. Notre étude indique que l'expansion des revenus obtenus hors de la ferme est le processus de développement fondamental s'exerçant dans plusieurs régions de la Chine rurale. La sylviculture peut offrir de bonnes options génératrices de revenus aux agriculteurs, mais, alors que l'économie locale se développe, la sylviculture a tendance a être remplacée par des alternatives plus attirantes. Des opportunités de spécialisation très ciblées se présentent, même pour les agriculteurs aisés. Elles sont normalement liées à un certain degré d' intégration verticale et renforcées par des aspects spécifiques de certains usages sylviculturels comme le bambou.

Le programme de conversion des terres inclinées en Chine quatre ans plus tard: situation actuelle, questions nécessitant une réponse

ZHIGANG XU, M. T. BENNETT, RAN TAO et JINTAO XU

Avec un budget de 337 billions de RMB (plus de 40 billions de $ américains), le programme de conversion des terres inclinées (SLCP) est l'une des initiatives environnementales chinoises les plus ambitieuses et l'un des plus importants programmes de conservation des terres au monde (WWF 2003). S'il se termine avec succès, ce programme aura des implications de taille pour les forêts de Chine et ses écosystèmes naturels encore en existence. Il se traduira par une augmentation de presque 10 % de la couverture forestière actuelle (Hyde, Belcher et Xu 2003). Nous exposons cependant le danger qu'il court de ne pas atteindre ses buts du fait d'erreurs dans sa préparation et dans sa mise en pratique. Cet article utilise, quatre ans après sa mise en action, un ensemble de données de 2003 sur 358 cas pour examiner la mise en pratique du SLCP et suggérer des améliorations. Le problème central a été l'expansion trop rapide des quelques dernières années, qui a servi à exacerber des problèmes déjà mis à jour mais non résolus adéquatement pendant la phase pilote du programme.

Evaluation des options de plantations d'arbres pour contrôler la désertification: des expériences du programme du Three-North Shelterbelt

QIANG MA

Une panoplie de modèles de reboisement a été développée pour combattre la désertification en Chine. Ces modèles mettent l'accent sur la nécessité d'intégrer la plantation d'arbres avec d'autres utilisations de la terre pour réduire les risques, et produire des bénéfices multiples. Cet article décrit la possibilité d'utiliser une analyse bénéfice-coût pour sélectionner et choisir parmi ces modèles, en prenant en compte les différences dans la période de temps s'écoulant entre la plantation et la récolte pour les arbres et d'autres cultures. Il décrit également la manière dont le coût de la désertification peut être inclus dans l'analyse bénéfice-coût. Les résultats montrent que la plupart des modèles d'agroforesterie et de plantations productives sont viables financièrement; alors que les modèles de revégétation ne le sont pas. Ces derniers pourraient cependant être justifiés économiquement selon le rythme de croissance dans la zone désertique. Si le rythme de croissance est suffisamment élevé pour justifier la revégétation, l'analyse des résultats financiers pourrait être utilisée pour indiquer quelle est la motivation nécessaire pour rendre ces modèles financièrement attractifs.

Vue d'ensemble de la politique des revenus sylviculturels en Chine: ce qui s'est passé et son pourquoi

LIU JINLONG, ZHANG SHOUGONG, YE JINZHONG et WANG YIHUAN

Les systèmes de taxation et de paiements de la sylviculture en Chine sont passés d'un système planifié à un sytème orienté vers le marché, ce qui est en pratique complexe, trop chargé, changeant, et affecté par un prélèvement peu efficace et.une évasion fiscale très répandue. Ces facteurs diminuent la motivation derrière la gestion des forêts, et l'état de l'environnement et le bien-être des exploitants ont empiré de ce fait. Les revenus du gouvernement provenaient avant 1985 de son contrôle des prix du bois et du marché. Après l'ouverture du marché, les revenus provinrent de plus en plus des impôts et des taxes additionelles appliquées aux cultivateurs. Les fonds du compte fiscal d'Etat provenant du développemment de la sylviculture ont augmenté de plus de 20 fois ces 7 dernières années, mais la mauvaise gestion des fonds gouvernementaux au niveau du prélèvement ou du transfert en provenance des comptes fiscaux centraux a résulté d'un sureffectif dans le secteur gouvernemental et d'un manque d'autorité dans l'obtention des paiements. Le gouvernement Chinois a pris davantage de mesures pour pallier à ce problème depuis 2002 en abolissant la taxe sur les produits de l'agriculture spécialisés, les charges illégales, et, en diminuant le taux des charges approuvées officiellement, tout en promettant d'éliminer la taxe sur la production agricole sur une durée de 5 ans (à partir de 2004). Le cas de la Chine montre que les institutions gouvernementales formaient les contraintes majeures affectant la réformes des taxes et des charges appliquées à la sylviculture, et qu'une solution complète aux problèmes concernant ce sujet devra aller bien au-delà du seul secteur de la sylviculture.

La relation entre la recherche forestière et la gestion forestière en chine: une analyse de quatre journaux de sylviculture chinois majeurs

M. RUIZ PÉREZ, M. FU, J. XIE, X. YANG et B. BELCHER

En nous basant sur une analyse de quatre journaux chinois majeurs de sylviculture, nous analysons la collabortion entre les institutions de recherche en sylviculture et les départements de sylviculture en Chine. Il est courant que les articles soient rédigés par plusieurs auteurs, et une collaboration importante existe entre les organismes de recherche et ceux de mise en pratique. Cette collaboration se base sur la recherche appliquée, cette dernière étant moins fréquente dans la recherche fondamentale et pratiquement nonexistante dans la recherche des lignes de conduite. Les universités, les instituts de recherche nationaux, et les départements forestiers de niveau national et provincial agissent en tant qu' organisateurs-clé de la recherche, ayant des domaines spécialisés et divers types de collaboration. Cela aide à expliquer le succès qu'ont connu les expériences chinoise en sylviculture ces dernières années.

SPANISH

Evaluación de los recursos forestales de China

G. Q. BULL y S. NILSSON

Los recursos forestales de China han sido y siguen siendo amenazados. Un análisis de la variedad de estadísticas publicadas, que a veces riñen entre sí, indica que será difícil que los bosques provean todo el material necesario para cumplir con las necesidades industriales y no industriales y de madera combustible, y con los objetivos de la conservación. Dadas las limitaciones previstas sobre la oferta nacional de fibra, podría haber un aumento significativo de la demanda de troncos y productos forestales por parte de los socios comerciales de China. En términos generales, este artículo demuestra la dificultad de sacar conclusiones más específicas, ya que hay importantes discrepancias en la información sobre todas las principales áreas estadísticas. Estas discrepancias deben ser resueltas para poder establecer políticas claras sobre el uso de la tierra y el desarrollo sostenible.

Panorama breve del sistema comercial de madera en China

XIUFANG SUN, LIQUN WANG y ZHENBIN GU

El sistema comercial de madera en China ha sido reformado como parte de la liberalización del mercado en el país. Antes de los años 80, la producción y distribución de madera fue monopolio del gobierno. Durante los últimos años de los 80 y los primeros de los 90, ocurrió una transición gradual de la distribución estatal a la liberalización del mercado. Ahora se permite a los productores vender su madera directamente a diferentes compradores, aunque la cosecha de la madera y su transporte sigan bajo la supervisión del estado. La industria primaria de procesamiento de madera y el sector del consumo de madera han experimentado un crecimiento rápido. Mientras tanto, las importaciones chinas de productos forestales han aumentado también, impulsadas por la fuerte demanda de productos de madera por parte de la industria nacional, incluyendo la construcción, los la industria de muebles y de paneles, y las limitaciones sobre los recursos nacionales. Los esfuerzos del gobierno tienen como objetivo reducir las importaciones a través del establecimiento de plantaciones de crecimiento rápido para aumentar los recursos comerciales de madera. Sin embargo, la distancia entre la oferta y la demanda nacional seguirá siendo cubierta por las importaciones en el futuro inmediato.

Demanda china de productos forestales: panorama de las tendencias de importaciones, puertos de entrada, y países proveedores, sobre todo de la región del pacífico asiático

XIUFANG SUN, E. KATSIGRIS y A. WHITE

Este estudio analiza las tendencias de las importaciones chinas de productos forestales entre 1997 y 2003 por sector de producto y por puerto de entrada, además de para cada uno de los principales países proveedores de China en la región del Pacífico asiático. Se experimentó un rápido crecimiento de las importaciones chinas de productos forestales entre 1997 y 2003, de productos de madera y también de pulpa y papel. Los sectores del mercado en mayor aumento son los troncos, maderos y pulpa, ya que China misma procesa una proporción cada vez mayor de los productos forestales. Los países ricos en recursos forestales de la región del Pacífico asiático juegan un papel cada vez más importante en el suministro de la demanda en expansión de China. Los puertos de mar de las zonas de Shanghai-Jiangsu y China meridional han mantenido su protagonismo en el comercio de productos forestales. A estos países se han sumado, y a veces han tomado la delantera, los puertos interiores del noreste de China, que han llegado a tener protagonismo por el comercio en auge de la frontera con Rusia.

Comercio de productos forestales en China: impactos e implicaciones para países productores del Pacífico asiático

E. KATSIGRIS, G. BULL, A. WHITE, C. BARR, K. BARNEY, Y. BUN, F. KHARL, T. KING, A. LANKIN, A. LEBEDEV, P. SHEARMAN, A. SHEINGAUZ, YUFANG SU y H. WEYERHAEUSER

Más de 70 por cien de las importaciones chinas de productos forestales proviene de países de la región del Pacífico asiático, para los cuales China es el mercado principal. Estos países productores están gravemente afectados por muchos problemas, entre los cuales figuran las prácticas de cosecha no sostenibles, la tala ilegal, y los impactos negativos sobre comunidades indígenas y otras comunidades que dependen de los bosques. Los países del Pacífico asiático que suministran productos forestales a China pueden dividirse en aquellos que todavía cosechan y exportan troncos en gran escala (y donde hay poco énfasis en las plantaciones y el procesamiento), y los países donde ya pasó su época principal de tala, pero que se enfocan en las plantaciones y el procesamiento. Aparte de Rusia, los principales proveedores de troncos del Pacífico asiático no podrían hacer más que mantener el suministro actual, y en menos de 20 años los recursos estarían decimados. Las limitaciones de recursos también restringen la expansión y/o continuación a largo plazo de las exportaciones a China de productos procesados. Por eso, este trabajo tiene implicaciones en tres áreas. Primero, los impactos negativos de este comercio sobre los bosques naturales y el sustento de las comunidades locales son graves y merecen una mayor atención por parte de quienes toman las decisiones políticas y comerciales a nivel regional y mundial. Segundo, el cambio de este modelo de suministro hacia un modelo más sostenible, legal y equitativo a plazo corto o medio requiere la solución de problemas subyacentes de tipo político e institucional. Y finalmente, dejando Rusia aparte, resulta difícil ver de donde puede proceder el suministro a China de productos forestales a largo plazo, sin contar la necesidad de un aumento de la oferta. Este problema constituye un serio desafío para el sector forestal mundial. Es importante que estos tres temas reciban una mayor atención, y también acción, por parte de los gobiernos regionales y las organizaciones internacionales.

El sector de pulpa y papel en China: análisis de tendencias de oferta y demanda y proyecciones a plazo medio

D. HE y C. BARR

Este estudio resume las tendencias recientes en el sector de pulpa, papel y cartón madera en China, y postula la oferta y demanda para cada tipo de producto hasta el año 2010. Las proyecciones de base sugieren que la demanda total de China aumentará de 48.0 millones de toneladas en 2003 a 68.5 millones de toneladas al año en 2010. Ya que se espera que la producción nacional llegue a 62.4 millones de toneladas al año, se proyecta que China domine la expansión de la capacidad mundial para la mayor parte de las diversas calidades de estos productos. Mirando hacia el futuro, se espera que la demanda anual china de todas las calidades de acabados de fibra suba desde 40.2 millones de toneladas en 2003 a 59.6 millones de toneladas en 2010. De esta cantidad, un 58 % aproximadamente provendrá de papel reciclado, un 25 % de pulpa basada en la madera, y un 17 % de pulpa de otros orígenes. Este crecimiento rápido tiene implicaciones de gran alcance para la sostenibilidad de los bosques y para el sustento de las comunidades rurales en China y en toda la región del Pacífico asiático. Este cambio ejercerá mucha presión sobre la oferta nacional de madera en China y puede exacerbar la conversión de bosques y la tala ilegal en los principales países proveedores, además de crear amenazas y también oportunidades potenciales de ingresos para los cultivadores de árboles a pequeña escala.

Desarrollo en China de una industria de pulpa de madera basada en plantaciones: políticas gubernamentales, incentivos financieros, y tendencias de inversión

C. BARR y C. COSSALTER

El gobierno chino está promociando fuertemente el desarrollo de una industria nacional de pulpa de madera, integrada con la producción de papel con suministro de fibra procedente de plantaciones. Esta política se lleva a cabo a través de la provisión de préstamos descontados de bancos estatales, incentives fiscales, y subvenciones de capital para lograr el establecimiento de al menos 5.8 millones de hectáreas de plantaciones de madera de pulpa de crecimiento rápido. Este artículo examina el desarrollo de aserraderos para la producción de pulpa de madera dura „kraft" tratada con blanqueadores (BHKP) en el sur de China, incluyendo el aserradero Jinhai Asia Pulp & Paper (APP) en la provincia de Hainan y el proyecto de producción de pulpa Fuxing en la de Guangdong. Ambos proyectos deben afrontar deficiencias sustanciales de fibra a plazo medio, y harán falta importantes inversiones nuevas en el desarrollo de plantaciones para asegurar un suministro sostenible de fibra para el nivel de capacidad proyectado de los aserraderos. Sin embargo, existen pocos lugares en la zona costera del sur de China donde se puede producir la fibra a un costo competitivo. En la mayor parte de los casos, el costo de la madera de pulpa de plantaciones chinas sera bastante más alto que en países como Brasil, y este hecho plantea cuestiones importantes sobre la viabilidad económica de la producción china de pulpa incluso dentro del mercado nacional.

Bosques de propiedad colectiva en China: aportes y limitaciones

GUANGPING MIAO y R. A. WEST

Los bosques de propiedad colectiva forman la mayor parte de la extensión forestal china y se ha visto que tienen una importancia fundamental para el sustento de millones de habitantes de zonas rurales, ya que estos bosques proveen madera y otros productos forestales para una demanda en auge, además de proporcionar otros servicios importantes de tipo ambiental. Este artículo describe los principales temas políticos e institucionales relacionados con los bosques de propiedad colectiva en China, y explica como se definen en la práctica los derechos colectivos de propiedad forestal, además de presentar la distribución nacional y provincial de los bosques de propiedad colectiva. El artículo evalúa los impactos y las implicaciones de las políticas nacionales principales, incluyendo el Programa Nacional de Protección Forestal (NFPP), la expansión del sistema de áreas públicas protegidas, el Programa de Indemnización para Ecosistemas Forestales (FECP), el sistema de impuestos y cuotas, y los cupos para la tala de árboles. El artículo concluye con unas recomendaciones en cuanto a reformas políticas que fortalecerían el sector forestal colectivo y aumentaría su aporte a la paliación de la pobreza, al desarrollo rural y a la conservación forestal sostenible.

Los mercados del sector forestal chino: políticas y recomendaciones

S. NILSSON, G. Q. BULL, A. WHITE y JINTAO XU

Con referencia a los artículos de este número especial de la revista y otros estudios, hay un esfuerzo para identificar las principales cuestiones políticas que debe afrontar el sector forestal chino. El análisis se centra en el suministro, desde la cosecha hasta los mercados finales de los productos. La discusión de las cuestiones políticas y sus implicaciones se enfoca en la distancia grande y creciente entre la oferta y la demanda de productos forestales. Una dificultad importante para la realización del análisis se radica en la falta de datos coherentes y transparentes sobre los componentes diferentes de la cadena de suministro. Este problema deberá ser resuelto en gran medida para que puedan crearse políticas relevantes en cuanto al sector forestal chino.

A través de la cortina de bambú: análisis de cambios en el papel de los ingresos forestales y agrícolas en las comunidades rurales de China

M. RUIZ PEREZ, B. BELCHER, MAOYI FU y XIAOSHENG YANG

Los análisis del manejo forestal y de la pobreza en China muestran una relación ambigua. Mientras que algunos autores han constatado una correlación entre las áreas ricas en recursos forestales y las zonas pobres, otros han puesto énfasis en la importancia del manejo forestal en estas áreas, donde en muchas ocasiones es de las pocas opciones disponibles. Nuestro estudio demuestra que la expansión de los ingresos no agrícolas constituye el proceso de desarrollo más importante en muchas zonas de la China rural. El manejo forestal puede ofrecer a los campesinos buenas opciones para la generación de ingresos, pero con el desarrollo de la economía local el manejo forestal suele ser reemplazado por alternativas más atractivas. Existen oportunidades para la especialización en mercados específicos incluso para agricultores ricos, y éstas suelen ser relacionadas con un cierto grado de integración vertical, con énfasis en usos forestales específicos como el del bambú.

Programa de Conversión de Tierras en Desnivel en China cuatro años después: situación actual y asuntos pendientes

ZHIGANG XU, M. T. BENNETT, RAN TAO y JINTAO XU

Con un presupuesto de RMB 337 mil millones (más de US$ 40 mil millones), el Programa de Conversión de Tierras en Desnivel (SLCP) constituye una de las iniciativas ambientales más ambiciosas de China, y es uno de los mayores programas de conservación de la tierra del mundo (WWF-Adena 2003). Al ser completado, tendrá implicaciones significativas para los bosques y ecosistemas naturales que quedan en China, ya que representan un aumento de casi 10 % en el actual área aforestada nacional (Hyde, Belcher y Xu 2003). Sin embargo, este artículo proporciona pruebas de que el programa corre el riesgo de fallar en sus objetivos, debido a deficiencias en el diseño y la implementación. Después de cuatro años del programa, el artículo utiliza una muestra de datos registrados en 2003 en 358 familias para examinar la implementación del SLCP y para sugerir mejoras posibles. La expansión excesivamente rápida de los últimos años es una fuente de preocupación, ya que ha exacerbado los problemas ya revelados, pero no solucionados, durante la fase piloto del programa.

Evaluación de opciones para la plantación de árboles en aras del control de la desertificación: experiencias del Programa *Three-North Shelterbelt*

QIANG MA

Se ha desarrollado una amplia gama de modelos de aforestación para combatir la desertificación en China. Estos modelos ponen énfasis en la integración de la plantación de árboles con otros usos de la tierra para reducir los riesgos y producir beneficios múltiples. Este artículo describe como el análisis de costos y beneficios puede ser usado para seleccionar y elegir entre estos modelos, teniendo en cuenta los diferentes períodos de tiempo entre la plantación y la cosecha de árboles y otros cultivos. También describe una forma de incluir los costos de la desertificación en el análisis de costos y beneficios. Los resultados muestran que la mayor parte de los modelos de agrosilvicultura y plantación productiva son factibles en términos económicos, pero no los modelos de revegetación. Sin embargo, éstos podrían ser justificados en términos económicos, según el ritmo de aumento del area desertizada. Si el ritmo de desertificación es suficientemente alto para justificar la revegetación, los resultados financieros del análisis podrían ser utilizados para indicar el incentivo necesario para hacer atractivos estos modelos en términos financieros.

Revisión de políticas sobre ingresos forestales en China: desarrollo y motivos

LIU JINLONG, ZHANG SHOUGONG, YE JINZHONG y WANG YIHUAN

En China, el sistema fiscal en cuanto a la silvicultura y los métodos de cobro ha evolucionado desde un sistema planificado hacia uno basado en el mercado, el cual en la práctica es complejo, sobrecargado, contradictorio y afectado por un alto índice de evasión y una baja eficiencia en la recaudación. Estos problemas no fomentan el buen manejo forestal, y perjudican el bienestar económico y el medio ambiente. Antes de 1985, los ingresos del gobierno procedían del control del precio de la madera y del mercado. Al abrirse el mercado, los ingresos empezaron a derivarse cada vez más de los impuestos y de cargos adicionales sobre los agricultures. En los últimos siete años, los fondos fiscales del estado procedentes del desarrollo forestal han aumentado más de 20 veces, pero un exceso de personal en el sector gubernamental y deficiencias en la aplicación de la ley ha causado un grave problema de malversación de fondos o durante la recaudación o en su traslado de las cuentas fiscales centrales. Desde el 2002, el gobierno chino ha tomado medidas para enfrentar estos problemas. Los Impuestos Especiales sobre la Producción Agrícola serán eliminados dentro de cinco años a partir del 2004. El caso de China demuestra que las instituciones gubernamentales han sido los principales obstáculos para la reforma de los impuestos y cargos forestales, y también que una solución completa de los problemas relacionados tendrá implicaciones muy amplias más allá del sector forestal.

La relación entre la investigación y el manejo forestal en China: análisis de cuatro principales publicaciones silviculturales

M. RUIZ PÉREZ, M. FU, J. XIE, X. YANG y B. BELCHER

En este artículo se analiza la colaboración entre las instituciones de investigación forestal y los departamentos de silvicultura en China, basándose en un estudio bibliométrico de cuatro principales publicaciones silviculturales. Son frecuentes los artículos de autores múltiples, y existe un grado significativo de colaboración entre las agencias de investigación y de implementación. Esta colaboración se centra en la investigación aplicada, ya que no es tan común en la investigación fundamental y casi inexistente en la investigación sobre políticas. Los institutos nacionales de investigación y los departamentos forestales a nivel nacional y provincial son los principales organizadores de la investigación, con dominios y tipos de colaboración especializados. Esta colaboración sirve al menos en parte para explicar el éxito de las experiencias forestales chinas en los últimos años.

GUIDELINES TO AUTHORS

Manuscripts will only be accepted for consideration if they conform to the following.

1. Manuscripts offered for publication should be submitted by email to **alan.pottinger@cfa-international.org**
2. The text, excluding tables, references and appendices, should not exceed 6,000 words.
3. Contributions must be original and not have been submitted for publication elsewhere.
4. A summary of not more than 150 words must be supplied, together with 5 proposed keywords.
5. The layout of the text and style of table and figure legends and references must conform to that of the IFR. This means:
    - Main title in Arial, Text in Times New Roman
    - The hierarchy of headings is: CAPITALS, **bold lower case**, *italics lower case*.
    - Left justification should be adopted throughout. Hyphenation should not be imposed on the text.
    - Figures and Tables should be inserted at the end of the references using the standard IFR text and style for titles.
    - All figures should be submitted separately as .eps files, of 300 dpi, and the longest side at least 15 cm in length. They should be in black and white.
    - Tables or graphs should be submitted separately as EXCEL files. They should be in black and white.
    - For text citations, papers should be referred to as (Smith 1998) and papers by the same author in the same year should be distinguished by lettering in sequence (1998a, 1998b, etc.) Where papers are by not more than three authors all names should be cited, otherwise the first name followed by '*et al*.'
    - Metric units are preferred and S.I. units should be used wherever appropriate.
    - The complete scientific name (genus, species, authority and, where appropriate, cultivar) should be cited at the first occasion of mention of an organism and written in italics (authority in normal type). If vernacular names are used, they must be accompanied by the correct scientific name at first use.
    - At the end of the paper, the list of references must be arranged in alphabetical ordering without serial numbering. The following standard forms of citation must be used:
        - author's name, all authors' initials to follow surname, journal and book titles in italics, journal volume number in bold. Second and subsequent lines should not be indented. For example

Journal paper
LÄHDE, E., LAIHO, O., NOROKORPI, Y. and SAKSA, T. 1999. Stand structure as the basis of diversity index. *Forest Ecology and Management* **115** (2/3): 213-220.

Paper or chapter in proceedings
SMITH, W.J. 2001. Selection of tree species for arid environments. *In*: BLACKBURN, J.W. (ed.) Multipurpose trees and shrubs for fuelwood and agroforestry. *CNRD Monograph* No4. 366 pp.

Book
PHILIP, M.S. 1994. *Measuring trees and forests*. 2nd edition, CAB International, Wallingford, England. 310 pp.

- Unnecessary use of capitals should be avoided. For example

HOLMGREN, J., JOYCE, S., NILSSON, M. and OLSSON. H. 2000. Estimating Stem Volume and Basal Area in Forest Compartments by Combining Satellite Image Data with Field Data. *Scandinavian Journal of Forest Research* **15:** 103–111.
Is incorrect.

HOLMGREN, J., JOYCE, S., NILSSON, M. and OLSSON. H. 2000. Estimating stem volume and basal area in forest compartments by combining satellite image data with field data. *Scandinavian Journal of Forest Research* **15:** 103–111.
Is correct.

- Websites should only be quoted in isolation where hard copies are not available.

PREPARATION FOR PUBLICATION

Contributions will be referred to at least two expert referees. Authors will be consulted if the paper is considered suitable but alterations are thought desirable. After alterations have been agreed and incorporated, the paper will be considered final.