Paradoxes and Challenges for China's Forests in the Reform Era

Alicia S.T. Robbins and Stevan Harrell

The China Quarterly / *FirstView* Article / April 2014, pp 1 - 23
DOI: 10.1017/S0305741014000344, Published online: 07 April 2014

Paradoxes and Challenges for China's Forests in the Reform Era*

Alicia S.T. Robbins† and Stevan Harrell‡

Abstract

China's relatively recent dramatic increase in forest area has been hailed domestically and globally as one of the world's few environmental success stories, but significant problems remain in China's reforestation efforts. We describe the challenges that China still faces if it is to meet its laudable – but sometimes contradictory – goals for its forest sector: improving rural livelihoods, sustaining and restoring ecosystem services, and increasing output of the forest product-dependent manufacturing and construction sectors. We do so while pointing out the unintended consequences of implementing these policy goals: overstatement of the quantity and quality of the forest recovery, domestic human and ecological costs of the reforestation, and externalization of China's continually growing demand for timber and forest products in the form of increased imports from vulnerable forests in other parts of the world.

Keywords: China; forests; land tenure reform; forest industries; environmental policies

---

In 2011, the State Forestry Administration (SFA) reported that at the end of 2009, 20 per cent of China's land area was forested, up from the estimated 5–8 per cent in 1950, and that another 4 per cent of land would be forested by 2020.[1] This increase in forest area has been hailed domestically and globally as one of the world's few environmental success stories,[2] in contrast to both deforestation in other countries and China's own dismal record on many other environmental issues. There is no doubt that more of China is now forested than in 1950 or 1990, and that the massive process of deforestation that characterized much of recent Chinese history, from the Qing period through to the Cultural

* We are grateful to Susan Whiting and John Perez-Garcia for their comments on earlier versions of this article.

† School of Environmental and Forest Sciences, University of Washington. Email: astr@uw.edu (corresponding author).

‡ Department of Anthropology and School of Environmental and Forest Sciences, University of Washington.

1 State Forestry Administration 2011.

2 Liu, Jianguo, et al. 2008.

 doi:10.1017/S0305741014000344

Revolution, has now been halted or reversed. However, significant problems remain. While not wishing to deny the indubitable progress of China's reforestation efforts, in this article we describe the challenges that China still faces if it is to meet its laudable – but sometimes contradictory – goals for its forest sector: improving rural livelihoods, sustaining and restoring ecosystem services, and increasing output of the forest product-dependent manufacturing and construction sectors. We do so while pointing out the unintended consequences of implementing these policy goals: overstatement of the quantity and quality of the forest recovery, domestic human and ecological costs of the reforestation, and externalization of China's continually growing demand for timber and forest products in the form of increased imports from vulnerable forests in Russia, Southeast Asia and Africa.

Roots of the Crisis: Forestry in the Maoist Period

When the PRC was founded, China had already experienced centuries of deforestation, particularly during the Qing and Republican eras; one estimate places forest cover at 26 per cent in 1700 and at only 9 per cent in 1937.[3] Policies in the Maoist period did little to address this lack of forests. Forestry between 1949 and 1978 was marked by rapid resource exploitation and depletion, with little concern for regeneration or active management. Between 1953 and 1958, all forestland was removed from private ownership and placed into either state-owned or collective forests.[4] Most wood production for construction, mining and transport came from state-managed forest farms, while collective forests supplied wood for fuel and construction needs for local communities.[5] Investment in regeneration was low.

During the 1950s, the government recognized that China's forests were historically depleted and inadequate, and called for the afforestation of nearly 100 million hectares (mmha) (approximately 10 per cent of China's total land area), with a focus on creating protected areas and planting fast-growing species of high economic value.[6] However, these early efforts at afforestation are now generally regarded as having been ineffectual, with high rates of mortality owing to a lack of technical expertise, poor selection of sites and species, and an inadequate definition of responsibility that led to neglect in the maintenance and protection of young forests.[7]

If the afforestation programmes of the initial years of the PRC were ineffective, the policies of the Great Leap Forward period were disastrous for forests. It is estimated that between 20 and 30 mmha were deforested between 1958 and 1962,

3 Ling 1983.
4 Richardson 1966, 237. Beginning in 1960, collective forest management, like that of agricultural lands, was devolved from the commune and brigade to the production team. Office of Rural Forest Reform, State Forestry Administration 2010.
5 Ross 1980.
6 FAO 1982, 305.
7 Ibid.

constituting the loss of about a quarter of China's forested areas.[8] Modest recovery after 1962 still left China's forested area at a historic minimum (see Table 1).

Undoing (Some of) the Damage: A Brief History of Forest Policy and Practice during the Early Reform Era

China began the reform era with a severely deforested landscape (12–13 per cent coverage, much of which was low quality), a confused system of tenure rights and obligations, and the ambition to grow all sectors of its economy. From 1978 to 1998, although some attention was given to afforestation, environmental policies changed little from those of the Maoist era. While environmental problems were recognized and environmental protection was made a goal of state policy, China's leaders repeatedly stressed that environmental policy should not impede economic expansion.[9] For the forest sector, this meant continued emphasis on maximum short-term productivity.[10]

The collective sector

Forest tenure reforms have not been as consistently successful as those in the agricultural sector, and have followed even more of a "trial and error"[11] process.[12] The first collective forest reform was the Resolution on Issues Concerning Forest Protection and Development, also known as the "three fixes reform" (*sanding gaige* 三定改革), issued in 1981.[13] This reform led to three new forms of management: family plots (*ziliushan* 自留山), often deforested areas turned over to households for replanting; responsibility hills (*zerenshan* 责任山), where families shared management responsibilities and split the income from timber sales between the collective and individual households; and collectively managed forests (*tongguanshan* 同管山), where all management decisions remained in the hands of the production team. While management and resource ownership shifted, land ownership itself was retained by the collective.

Although one important goal of the early reforms was to improve tenure security for rural households and collectives,[14] results were mixed.[15] A combination of competing interests for land usage and previous reversals in tenure policies during the Mao period had already led to a lack of confidence in resource ownership rights,[16] possibly leading some farmers to harvest trees rapidly.[17] This initial

8 He, Fanneng, et al. 2008.
9 Jahiel 1998; Ross 1998.
10 Economy 2004, 64–67.
11 Qian and Xu 1993.
12 Yin, Xu and Li 2003.
13 State Council 1981.
14 Ibid.
15 Démurger, Hou and Yang 2009.
16 Liu, Dachang 2001.
17 Harkness 1998.

Table 1: **Forested Area and Standing Biomass in China, 1949–2008***

Year	Forested area (mmha)	Share of total area (%)	Change from previous period (%)	Standing biomass (billion m^3)	Change from previous period (%)
1949	109.01	11		–	
1962	80–113	8–12	−27 to +4		
1973–1976	121.86	12	+8 to +52	8.66	
1977–1981	115.28	12	−5	9.03	+4
1984–1988	124.65	13	+8	9.14	+1
1989–1993	133.70	14	+7	10.14	+11
1994–1998	158.94	16	+19	11.27	+11
1999–2003	174.91	18	+10	12.46	+11
2004–2008	195.45	20	+12	13.72	+10

Notes:

*Data before the 1970s are unreliable and controversial. See He, Fanneng, et al. 2008; Démurger and Yang 2007; Dikötter 2010; Dai et al. 2011; He, Hong, Shiffley and Thompson 2011. Data from 1973 onwards are based on National Forest Inventories and can be assumed to be more reliable. The large increase in forest coverage between the fourth and fifth inventories (1989–93 to 1994–98) partly reflects a change in the definition of forested area from a minimum of 30% to 20% canopy cover.

period of reform witnessed widespread illegal cutting,[18] and a 10 per cent reduction in forest coverage in southern collective forests.[19] The high rates of harvest during this time also led to changes in stocking and species composition, and fragmentation of forests.[20] In response, the government quickly reversed course, suspending household tenure reforms in 1985.[21]

The state sector

Reforms in the state-owned forest bureaus began simultaneously with those in other state-owned enterprises, although it was not until 1989 that this sector was formally decentralized into separate, albeit still connected, units.[22] Silvicultural management was further decentralized by splitting up some of the large forest farms and contracting out to collectives, which sometimes further contracted out to households or groups of households.[23]

Initial reforms in the state sector led to accelerated cutting of many forests, particularly in the south-west,[24] during the 1980s and early 1990s. Local governments in poor and remote areas experiencing a local version of the "resource

18 Song et al. 1997.
19 Liu, Dachang 2001.
20 Liu, Dachang, and Edmunds 2003.
21 Xu, Jintao 2008; Song et al. 1997.
22 Zhang 2000.
23 Ibid.
24 Sichuan forest coverage has been reported to have dropped from 28% "in the 1970s" to 14% "in the 1980s," see Economy 2004; and forest coverage in the "Upper Reaches of the Yangtze" was reported to have dropped from 30–40% in the 1950s to 10% in 1998, see Stockholm Environmental Institute 2002. These figures may be exaggerated, but there is no doubt that there was extensive cutting in the south-west in the 1980s and 1990s.

curse"[25] were faced with increased needs for revenue to fund development while simultaneously losing central and provincial subsidies. As a result, they depleted their resources by selectively harvesting large-diameter trees and experienced a consequent loss of forested area,[26] a trend that continued until the south-western logging ban of 1998.

Forest protection and reforestation

Although the primary emphasis in the early reform period was on economic growth, the government also introduced new programmes aimed at the protection and restoration of forests and biodiversity. In 1978, the Three North Protective Forest Project (*sanbei baohulin gongcheng* 三北保护林工程) was launched in an attempt to use afforestation to combat desertification in the north and north-west. The 1995 Forestry Action Plan for China's Agenda 21 emphasized three objectives: 1) ensuring sustainable forestry and increasing overall forest coverage and volume; 2) modernizing forestry as an industry and raising productivity and efficiency; and 3) revamping the management system and improving education and public awareness. The development of the entire forest sector since then has largely conformed to these guidelines.

Results

The first National Forest Inventory (NFI) in 1973–1976 estimated that forest cover stood at 121.9 mmha, or nearly 13 per cent of total land area.[27] Stepped-up cutting led to a decrease of about 6 mmha by the second NFI of 1977–81, particularly in the south-west, but overall forest coverage subsequently increased steadily through the fifth NFI in the mid-1990s (see Table 1), mainly attributable to large-scale reforestation efforts and the creation of forest plantations.[28]

The State of the Forests, 1998–2011

In the summer of 1998, devastating floods struck Hubei, Hunan and Jiangxi.[29] The floods were quickly blamed on the extensive deforestation of the *upper* Changjiang 长江 (Yangtze) watershed from the 1950s to the 1990s. As a result, three crucial policies were implemented, including an almost total ban on commercial logging in the south-west and two national-scale programmes: the Natural Forest Protection Programme (*tianranlin baohu gongcheng* 天然林保护

25 Sachs and Warner 2001.
26 Albers, Rozelle and Li 1998.
27 Démurger, Hou and Yang 2009.
28 Stone 2009; Albers, Rozelle and Li 1998.
29 See Schmidt et al. 2011 for recent research casting doubt on upstream deforestation as the cause of the 1998 mid-Changjiang area floods.

工程) and the Returning Farmland to Forest Programme (*tuigeng huanlin gongcheng* 退耕还林工程).[30]

These forest-focused programmes are part of a more general trend towards concern for environmental protection and restoration adopted since 1998, which has included a spate of environmental-protection laws,[31] elevating the State Environmental Protection Agency to ministry status in 2008, the promotion of "sustainable development" as a national slogan,[32] and recent investment in alternative energy.[33] These all reflect the state's efforts to balance the goals of economic growth and environmental protection. However, China's environmental record has been decidedly mixed. The forest sector, although doing somewhat better than, for example, water resources or air quality, has also had a mixed record, demonstrating the diverse and perhaps contradictory goals now adopted for forestry: improving rural livelihoods, protecting and enhancing ecosystem services, and growing the forest-sector economy.

These diverse goals conflict with each other at some levels, but they all depend on the quantitative and qualitative recovery of forests. Realizing this, in 1998 the government made a radical change in its investment strategies in the forestry sector. As Figure 1 shows, the investment strategy of the 1950s through to the 1970s reflected the general goals of economic development and national construction, in which forest resources were used for short-term gains without much thought to long-term sustainability; investment favoured industry over silviculture[34] and afforestation by a ratio of 2:1. After the 1998 shock, expenditures shifted dramatically to afforestation and silviculture, and expenditures in this sector came to dominate industry by 9:1. Only since 2008, perhaps with the confidence that silviculture and afforestation have been put on a stable basis, has industry again risen from 3 per cent of total investment in the forest sector in 2006 to 17 per cent in 2009.

China's forest stocks, 1998–2011

The seventh NFI (2004–2008) reported a 12 per cent overall increase in forest coverage over the previous inventory (see Table 2).[35] Total forestland increased by 20 mmha to 195 mmha, and further growth increased forest cover to an estimated 21 per cent of total land area in 2010. The government's goal is to increase

30 CCP Central Committee and State Council 1998. The *tuigeng huanlin* programme has a variety of English nicknames, including Grain-for-Green and the Sloping Land Conversion Programme. We choose to use the literal translation here, since it better portrays the intent and nature of the programme.

31 Ferris and Zhang 2005.

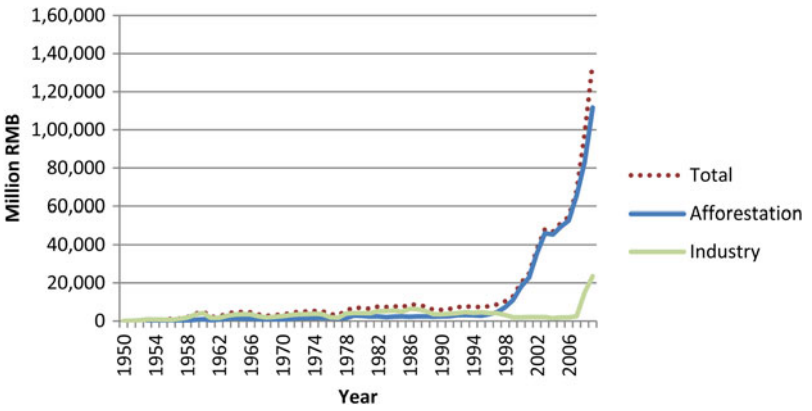
32 Cann, Cann and Gao 2005; Li, Yongxiang 2005; Tilt 2010, 192.

33 Chinafaqs.org. 2011. "China FAQs: alternative energy," 11 May, http://www.chinafaqs.org/library/chinafaqs-key-frequently-asked-questions#Renewable%20and%20Alternative. Accessed 4 February 2013.

34 Silvicultural practices vary globally, but here we mean a potential combination of planting, thinning *and* harvesting activities. Silviculture can be distinguished from purely afforestation programmes, which may include no planned thinning or harvesting activities.

35 State Forestry Administration 2010.

Figure 1: **Total Real Investment in China's Forest Sector, 1950–2009**



Source:
State Forestry Administration 2010.

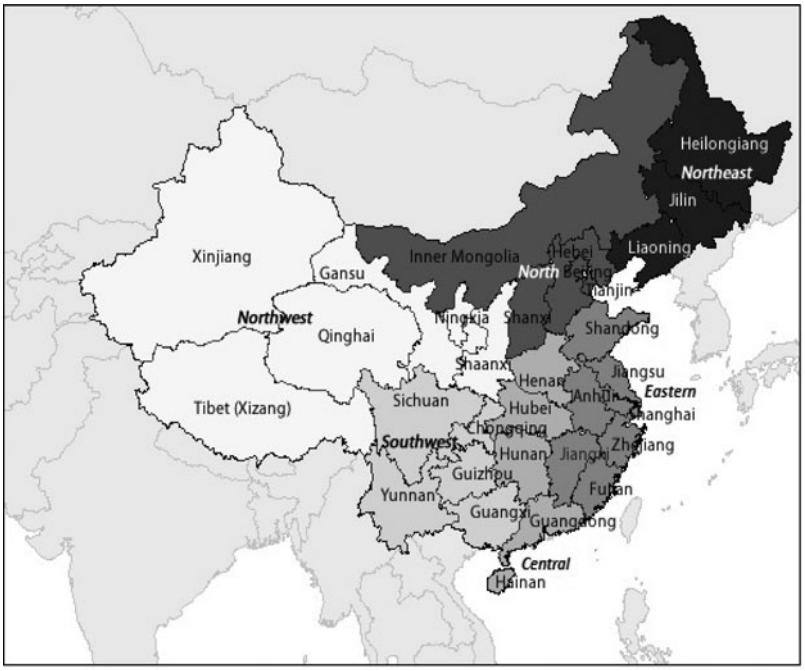
national forest cover to 26 per cent by 2025.[36] Inner Mongolia, Yunnan, Heilongjiang and Sichuan have the largest areas of forest. Much of the total increase in inventory occurred in Guangxi, Yunnan, Inner Mongolia, Sichuan and Gansu. The north-west region, which has the lowest overall coverage, experienced the greatest percentage increase, rising by 26 per cent. The central and south-west regions continue to account for half the country's forest coverage, with the north-east and the north regions accounting for another 34 per cent.[37]

Ecosystems Recovery and the Challenges of Forest Quality

Afforestation schemes have contributed significantly to the reported increase in forest cover since the 1980s, recovering an average of approximately 5 mmha per year. Particularly since 1998, government subsidies and loans from multilateral institutions have facilitated the establishment of large-scale, fast-growing plantations through two kinds of programmes: regional shelterbelts and nationwide recovery schemes. Although both have been reported as wildly successful in overall quantitative terms, the quality of the forests and the ecosystem services they provide is often questionable. There are very few close-to-mature forests remaining, and young and middle-aged forests have lower density and productivity than older forests.[38] This is, of course, an inevitable result of previous deforestation; one cannot plant mature forests, and newly-planted forests will have less biomass than those they replace.

36 Wang, G., et al. 2008.
37 Forestland is now defined as land with at least 20% canopy cover. Fruit trees and cash orchards began to be included in the mid-1980s, followed by a reduction in canopy cover requirements, and later by the inclusion of shrubs.
38 Yin 1998.

Figure 2: **Geographic Regions for Forest Statistics**



Source:
Map created by authors.

Shelter forests

Probably the best known shelterbelt is the Three North Protective Forest Project, colloquially called the Great Green Wall (*lüse wanli changcheng* 绿色万里长城), which was initiated in 1978 and has a projected completion date of 2050. Intended to combat desertification and soil loss, as well as reduce the impact of dust storms that plague north China, it covers parts of 13 provincial-level

Table 2: **Forest Area by Region and as a Percentage of Total Land**

	Forest Area (mmha)			**Percentage of Total Land**		
	1999–2003	2004–2008	% increase	Total area	1999–2003	2004–2008
North	26.35	30.67	16	151.86	17%	20%
North-east	32.51	36.15	11	79.18	41%	46%
North-west	18.12	22.79	26	304.42	6%	7%
East	28.66	30.53	7	80.86	35%	38%
Central	36.03	41.66	16	101.60	35%	41%
South-west	50.18	57.84	15	232.77	22%	25%
National	174.91	195.45	12	950.69	18%	21%

Source:
State Forestry Administration various years.

units and 551 county-level units in the north-east, north, and north-west, and is scheduled to reforest over 30 mmha, or about 3 per cent of China's total land area.[39] In addition, the Taihang Mountain Afforestation Project (*Taihangshan fulin gongcheng* 太行山复林工程) has also covered more than 20 mmha in a specific effort to reduce sandstorms. However, desertification has continued to advance in the northern regions despite the afforestation projects, leading to questions about the structure, quality and diversity of the trees planted in such programmes. Survival rates of the Great Green Wall plantations have been estimated to be as low as 15 per cent. Some scholars have raised the possibility that poorly planned afforestation efforts, including planting any trees at all in areas that have long been grassland or shrubland, have led to negative balances in soil moisture, thus potentially exacerbating the very desertification problems that such policies are intended to combat.[40] The very partial success of these programmes seems to reflect a general tendency in China to solve ecological problems through large-scale, uniform megaprojects which are often poorly adapted to local conditions.

National-scale reforestation programmes: NFPP and RFFP

The Natural Forest Protection Programme (NFPP), introduced in 1998 and implemented in 2000,[41] called for a reduction in annual timber harvests in natural forests from 32 mmm^3 to 12 mmm^3, conservation of nearly 90 mmha of forest, and afforestation and revegetation of 31 mmha.[42] Specific measures included logging bans in the upper reaches of the Changjiang and Huanghe 黄河 (Yellow River), reducing logging in state-owned forests, engaging in reforestation and improved silvicultural treatments, and subsequently providing alternative employment opportunities for state forest workers.[43] The NFPP covers 18 provinces and autonomous regions, focusing mainly on the upper Changjiang and Huanghe watersheds, as well as state-owned forests in the north-east and Hainan.

The Returning Farmland to Forest Policy (RFFP) was piloted in Sichuan, Shaanxi and Gansu in 1999, and implemented more widely the following year as part of the "open up the west" development programme. The RFFP was designed to reduce run-off and soil erosion, and increase forest coverage by converting former crop-growing areas on sloping lands into forest.[44] The RFFP has been held up as the world's largest programme of payment for ecosystem services, and claims poverty alleviation as a key component.[45] This programme provides farmers with saplings to plant, along with grain and cash subsidies to replace

39 Cao 2008.
40 Ibid.; Rozelle, Huang and Benziger 2003; Luoma 2012; Cao et al. 2011; Wang, X.M., et al. 2010.
41 State Forestry Administration n.d.
42 Cao et al. 2010.
43 Miao and West 2004.
44 State Council 2002; Xu, Jintao, et al. 2010; Bennett 2008.
45 Li, Jie, et al. 2011.

income from foregone agricultural activities. A secondary goal is to shift farmers into less intensive agricultural activities (such as livestock breeding) and off-farm employment.[46] As of 2010, the RFFP had enrolled more than 21 mmha.[47] By the end of the programme, it will have affected the landholdings of an estimated 40–60 million households across 25 provinces.[48]

Both programmes have ostensibly met their ecological targets for harvest reductions and resource protection.[49] It is unclear what the effect on the long-term timber supply will be – although up to 75 per cent of the land is slated to be planted as production forests,[50] the survival of the trees and shrubs planted has been called into question.[51] According to one estimate, only 22.9 per cent of the 268 mmha of forests planted under the NFPP and RFFP have been retained; in terms of environmental protection objectives, this implies a waste of approximately 75 per cent of the 244 billion yuan spent on major reforestation projects between 1998 and 2005. Afforested areas are often overestimated because the SFA is in charge of both reforestation *and* assessment of success.[52] Not surprisingly, access to better technical support has been suggested as a means of increasing survival rates and reducing programme costs.[53]

Challenges

China has doubtless made serious efforts to reverse the centuries-long trend of deforestation and to mitigate the ecological effects of more recent development policies. In many ways, China has turned the corner; more of the country is forested than at any time since the early Qing. However, the general tendency to implement reforestation and forest protection in a top-down manner, often without due consideration of the suitability of particular programmes and particular species in specific places, has meant that much of the noble effort at reforestation has been unsuccessful, and much of the funding for such programmes has been wasted. Even in areas where programmes have shown success, forests will not grow back immediately; the ultimate success of the reforestation effort will demand both improved methods and patience. In the meantime, as we show below, China will need to depend on foreign imports to feed much of its forest products industry, putting stress on forests in countries that may not yet have the capacity to manage their forests with even the care and expertise shown in China.

46 Xu, Zhigang, et al. 2004.
47 State Forestry Administration 2010.
48 Xu, Jintao, et al. 2010.
49 Xu, Jintao, et al. 2006.
50 Bennett 2008.
51 Trac et al. 2007; Weyerhaeuser, Wilkes and Kahrl 2005.
52 Meng 2011.
53 Bennett, Mehta and Xu 2011. For a comparative assessment of the RFFP in three sites in Sichuan, see Trac et al. 2013.

Rural Livelihoods and the Challenges of Poverty and Environmental Justice

Since 2003 in particular, there has been a concerted effort aimed at individualizing collective forests and securing tenure rights. The Comprehensive Collective Forests Reform (*jiti linquan zhidu gaige* 集体林权制度改革) brought further changes in 2008.[54] Although confirming collective ownership, this policy established individual rural households as the dominant holders of effective rights, allowing them to lease or transfer their plots to other farmers or to corporate contractors. It established the contract period as 70 years, with the right to extend.[55] It also called for a clear demarcation between public benefit forests (*gongyi lin* 公益林),[56] which are to be managed for the ecosystem services they perform, and commodity forests (*shangpin lin* 商品林), which are to be leased to private contractors and managed for revenue generation.

Few studies have yet examined the impacts of either the 2003 or 2008 reforms. The primary intent of the 2003 reforms was to increase timber harvests in provinces where de-collectivization is occurring, increase the share of forestry in household income, and increase afforestation efforts by farmers.[57] Currently, and particularly in the southern region, collective forests are largely made up of plantations and production forests, as well as fruit and cash crop orchards.[58] Effective implementation of reforms will help to enhance the productive use of these lands, particularly in the context of improving rural livelihoods. The SFA implemented the 2008 reforms following pilot projects in Jiangxi and Fujian, leading to increases in farmer incomes. In general, these programmes were most successful in areas near forest product industries that would buy their products.[59]

For most rural residents across the country, forestry does not contribute substantively to farm income. In forest-dependent communities, the story differs. National statistics do not provide data on these farmers' incomes, but a survey of forest farmers in Fujian showed that forestry contributed as much as 16 per cent to their overall income; in Jiangxi, it contributed almost 13 per cent.[60] Some studies report that up to as much as 70–80 per cent of income in forest-dependent communities can come from forest-related activities.[61] Yet, rural residents in forest-dependent communities continue to be among the country's poorest.[62] Their poverty often stems from their geographical remoteness, which affects opportunities for economic development. Liu and Yin found that

54 CCP Central Committee and State Council 2008.
55 There are unconfirmed reports that some contracts have been signed with a period of less than 70 years.
56 Also translated as "ecological reserve forests."
57 Xu, Jintao 2008.
58 Wang, Sen, van Looten and Wilson 2004.
59 Interview with State Forestry Administration, Bureau of Village Forestry Reform and Development (Guojia linyeju nongcun linye gaige fazhansi), 6 November 2009.
60 Xu, Jintao 2008.
61 Ruiz Pérez et al. 2004.
62 Miao and West 2004.

increased productivity in rural households and the contribution of forestry to livelihood improvements were offset by increases in production input costs.[63] Consequently, already impoverished areas have additional disadvantages in economic development.

Viewing rural livelihood improvement solely through the lens of increasing cash incomes ignores the many rural people who rely on a mixture of cash and subsistence farming or agroforestry.[64] In many upland forest-dependent communities, households depend on forest resources for fuel, building materials and non-timber forest products. However, peripheral people in China, particularly ethnic minorities, have long been viewed as "uncivilized," especially those practising shifting cultivation in upland areas.[65] After 1949, the resources these peripheral people depended on, and had managed through traditional ecological practices, were placed under state or collective management and treated as free goods to be extracted and exploited as the state saw fit.[66] Resource policies were further intended to both "civilize" peripheral people (which often meant re-settling them in fixed villages and encouraging them to follow Han Chinese farming practices) and direct their production efforts towards state goals.[67] To the present day, many such communities are allowed to manage their collectively held forest resources only under strict guidelines that assign township and county governments micromanagerial authority over cutting decisions.[68] Under the 2008 reforms, however, such communities have been encouraged to put their collective forest lands out to bid. In our own experience in Liangshan Yi 凉山彝 Autonomous Prefecture, Sichuan, this results in a one-time "sale" (as local people term it) to an unknown outside speculator. Households receive a lump-sum payment and are unclear about what authority the speculators assume over the forest; in the meantime, households continue to gather firewood and cut timber for construction.[69]

Effects of reforestation programmes

The major conservation programmes have been plagued by several problems related to rural livelihoods. First, the central government provided 80 per cent of the funding for the NFPP's implementation, requiring the remainder to come from already hard-pressed local governments. Although the programme is not targeted exclusively at collective forests, forest-owning collectives are required to participate, and landowners are not compensated for economic losses stemming from the reduction in available harvest.[70] As employment among

63 Liu, Can, and Yin 2004.
64 Flower 2009.
65 Sturgeon 2005, 27–29.
66 Harkness 1998.
67 Sturgeon 2005, 52–53.
68 Urgenson et al. 2010; Trac 2010, 9–13.
69 Author's field notes taken in August 2008, November 2009, August 2010 and September 2011.
70 Miao and West 2004.

forest-dependent communities has shrunk, it is estimated that rural income will have shrunk by 3–7 billion yuan, pushing many back into poverty.[71]

In some regions, the programmes may be overcompensating landowners for retiring their lands, making the programmes cost-inefficient.[72] In others, there have been large shortfalls in payment delivery and/or landowners have suffered losses amounting to half or more of their income.[73] Many rural people have seen their traditional access rights significantly restricted,[74] not just in terms of their agricultural practices, but also in non-timber forest products and firewood collection, and livestock grazing. In a few communities, eco-tourism industries have sprung up to replace forestry activities, creating a limited number of new economic opportunities.[75] However, in general, these programmes are not creating short or long-term economic opportunities and have a fixed period within which they will continue to provide payments.

Ongoing challenges

The relationship between tenure reform, rural incomes and forest ecological health is not a simple one, and the regime has not always dealt with this complexity in an ideal manner. Most obviously, implementation of reforms has not always provided secure tenure: rights have been granted, revoked and changed too often, despite the fact that success depends on tenure certainty and limited market distortions. This is perhaps the inevitable result of "crossing the river by feeling the stones," but it has led in some cases to overexploitation of timber resources in the short run, without replanting, and thus to decline in forest cover and quality.[76] Programmes that provide payments for environmental services, such as the RFFP, have been widely celebrated as successful in stabilizing incentives and thus promoting forest conservation and improving rural livelihoods; however, many of these programmes are subsidized by the central government and will not continue indefinitely. Both the NFPP and the RFFP also suffer from a top-down approach that leaves little apparent room for flexibility in local choices.[77] State directives control even the species permitted to be planted and areas required to enrol, regardless of the ecological suitability.[78] The top-down approach to the NFPP has left many landowners feeling deprived of any decision-making autonomy, and the durability of the programme's conservation effects is questionable as landowners may be inclined to start farming their lands again after the subsidies end. There is evidence that agroforestry practices, and intercropping in particular, may contribute significantly to overall agricultural productivity

71 Xu, Jintao, et al. 2003.
72 Uchida, Xu and Rozelle 2005.
73 Bennett 2008.
74 Xu, Jianchu, and Melick 2007.
75 Xu, Jintao et al. 2006.
76 Yin and Newman 1997.
77 Xu, Jintao, et al. 2006; Bennett 2008; Trac et al. 2007; Urgenson et al. 2010.
78 Uchida, Xu and Rozelle 2005; Uchida et al. 2007.

while simultaneously providing environmental services.[79] Ensuring that landowners have the right to determine and engage in mixed practices might enable win-win situations where livelihoods and the environment are improved.[80]

There is also an assumption that privatization is universally superior to communal management in promoting long-term care of forests, because it will "liberate the productive forces of the farm household."[81] The 2008 forest tenure reforms were implemented on the basis of this assumption, and indeed there is evidence that privatization, when carried out in such a way that it offers stable tenure, provides incentives for sustainable management. At the same time, examples of privatization of grassland and forest resources in other parts of China have shown that privatizing certain areas and letting others remain under collective management can promote severely unequal access to resources and consequent overuse of the collective areas.[82] As long as there are communities that depend on forest resources for subsistence, policies will need to take account of equity of access and methods of managing common-pool resources, rather than simply embracing private rights as a panacea.[83]

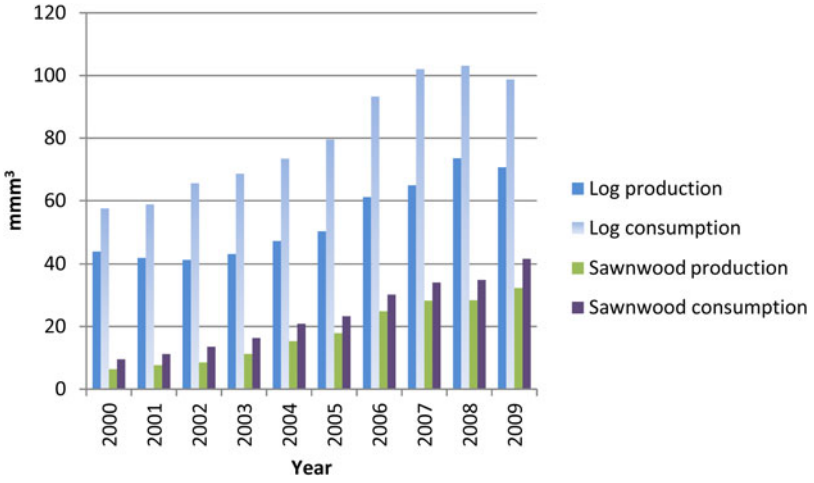
Without improved access to economic opportunities and tenure security, conservation policies could impede, not improve, rural livelihoods in forest-dependent communities. In addition, it is quite possible that without the right property institutions, even the ecological goals of these programmes will be impossible to achieve. Authorities may soon find themselves at a crossroads, having to decide between the goals of ecological sustainability and increased cash income for rural households.

Development of the Forest Products Sector and the Challenges of Sustainable Production

In addition to ecosystem services and rural livelihoods, China's forests are also managed as a source of income and raw materials for construction and manufacturing industries. Domestic production of logs is controlled by quotas set by the central government. These quotas are intended to limit harvest to volumes at or below annual incremental growth, and logs are consumed or processed domestically. While the government has a stated goal of increasing domestic production, and has in fact increased the timber quota over the last two five-year planning cycles, actual annual growth in log production in recent years has been inconsistent. From 2000 to 2009, the total harvest of logs increased from 44 mmm^3 to 71 mmm^3 (see Figure 3). However, these official statistics ignore above-quota

79 Yin and Hyde 2000
80 Hyde, Amacher and Magrath 1996.
81 CCP Central Committee 2008, section 1, paragraph 1.
82 Williams 1996; Harris 2009.
83 The experience of pulp and paper manufacturer Stora Enso, which was reportedly sold use rights transferred by Hepu county officials and intermediaries in Guangxi province who had not obtained the required consent of households (Li and Nielsen 2010), further demonstrates how households continue to be deprived of their property rights, even after privatization rights were affirmed through the 2008 law.

Figure 3: **Officially Reported Log and Sawnwood Production and Consumption, 2000–2009**



Source:
State Forestry Administration various years.

production, which may be close to double the reported production volume: the SFA estimated that above-quota log production had averaged 75.5 mmm^3 per year from 1998 to 2003.[84] Given the more than 19 per cent annual growth rate in sawnwood and panel production in China in the last decade, it seems improbable that total log consumption did not also grow apace. Our own assessment, based on China's officially reported wood product production, is that log consumption is, at minimum, 30 per cent higher than officially reported.[85]

Semi-finished and finished goods are much less likely to be underreported than are timber resources. While China's log production has recently grown somewhat, its production of semi-finished (e.g. sawnwood, panels, etc.) and finished (e.g. furniture) wood products has grown rapidly during the same period. This growth has been fuelled primarily by demand from wood product markets (including those abroad) and the domestic construction sector. The raw materials needed to feed this growing demand have increasingly been supplied by imports from other countries.

It is widely recognized that the domestic resource base is extremely constrained and will be for the foreseeable future. Natural forests, although recovering, were previously drawn down, and the 12th Five-Year Plan calls for reduced harvests from these forests. Plantations will increasingly provide the harvestable resources needed to meet quotas. The annual allowable cut, quotas, permits, high taxes and other restrictions have all been used to constrain supply. However, demand has grown dramatically in recent years, and while it is currently closely linked to

84 Démurger, Hou and Yang 2009.
85 Robbins 2011, 116–130.

the export industry, it is likely to become increasingly linked to domestic demand, particularly as China's middle class expands and housing resources become more available. Grossly underestimating the volume of wood needed to maintain – let alone increase – production will create incentives for continued misreporting of resource use and will inhibit the ability to improve product quality. An increasing reliance on imports to fuel its export-oriented wood products industry (discussed below) has meant that many of these timber products come from countries with lower costs and poorly enforced environmental standards.

International Repercussions and the Challenges of (Literally) Externalizing Costs

Although domestic production of logs has increased modestly, China is increasingly reliant on roundwood imports to meet the growth in demand for semi-finished and finished wood products. According to official Chinese statistics, total consumption of logs, by volume, grew at an average annual rate of 7.6 per cent between 2000 and 2008, before declining by 4.2 per cent in 2009. Between 2005 and 2009, the average annual reported contribution of imports to this consumption was 33 per cent. These materials fuel the production of both China's manufactured exports and goods consumed domestically. The growth in consumption has led China to become the world's largest importer of tropical logs; it accounts for nearly a third of global imports of coniferous logs, and about a tenth of non-coniferous, non-tropical logs (see Table 3).

The increased extraction of primary materials from developing and transitioning economies has led to concerns about the long-term sustainability of resources in those countries and the equity in the gains from trade.[86] Many of China's primary non-coniferous (hardwood) and coniferous (softwood) source countries have been identified as exporting suspicious logs. These countries include Russia, Malaysia, Papua New Guinea, Gabon and the Solomon Islands.[87] The largest single source for both coniferous and non-coniferous logs is Russia (see Figure 4). In 2008, Russia supplied 75 per cent of the coniferous logs and 44 per cent of the non-coniferous logs imported by China. Other primary sources of coniferous logs include New Zealand, the US and Canada. Malaysia was the largest source of tropical logs in 2008, supplying 48 per cent of China's tropical logs. There is wide concern that Malaysia serves not only as a source of logs, but also as an intermediate for logs exported illegally from Indonesia, which ranked very low in terms of its own official exports to China. According to the Food and Agricultural Organization, other primary sources included Papua New Guinea, Gabon, and to a lesser extent, Congo, Myanmar, Cameroon and Equatorial Guinea.[88]

86 Zhu, Taylor and Feng 2004

87 Lawson and MacFaul 2010.

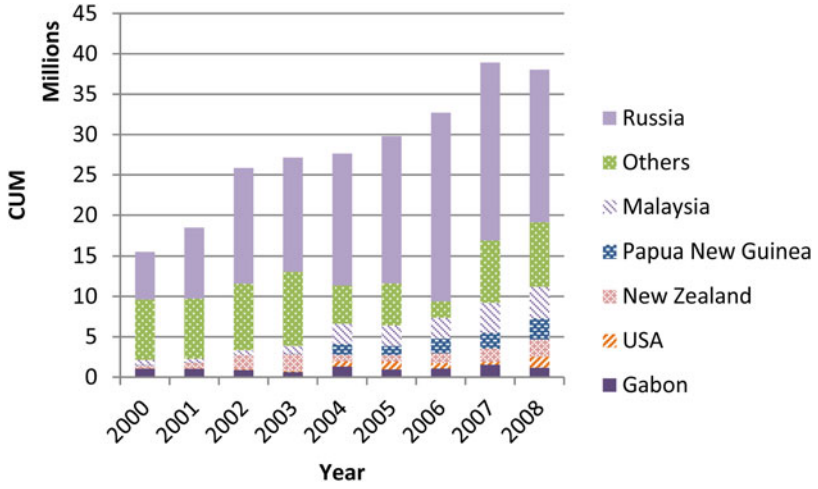
88 Estimates for China's imports of tropical roundwood from the International Tropical Trade Organization (ITTO) vary from those of the FAO. The ITTO reports Guyana, Togo and the Central African Republic as exporting greater quantities than Equatorial Guinea and Myanmar.

Table 3: **China's Global Imports of Logs as a Percentage of World Log Imports, 2003–2009 (%)**

	2003	2004	2005	2006	2007	2008	2009
C quantity	20	21	22	24	27	27	32
NC quantity	10	9	15	14	18	14	9
T quantity	57	57	55	56	57	56	78
C value	19	19	22	24	28	38	38
NC value	16	11	22	25	28	27	14
T value	53	54	47	50	51	80	88

Notes:
C = Coniferous; NC = Non-coniferous, non-tropical; T = Tropical
Source:
FAO 2011.

Figure 4: **Log Imports by Source, 2000–2008**



Source:
FAO 2011.

Although China's own domestic resource base is severely constrained by both natural factors and policy instruments, as described above, the government's forestry development plan has called for continued expansion of its forest-based industries, planning an annual 12 per cent growth in wood product production.[89] This indicates a strong commitment by the government to affirm China's role as an exporter and will likely require continued high levels of imports. There is widespread concern that, at current prices, this will result in the depletion of forest resources in those countries with less-stringent, or poorly implemented,

89 State Forestry Administration 2009.

environmental policies, and those that may be eager to develop their natural resource-based industries.[90]

China has responded to some of the criticisms by signing bilateral agreements with countries such as Myanmar and Indonesia to help prevent illegal imports, and by increasing outreach and training programmes in its trading countries. The EU's Forest Law Enforcement, Governance and Trade (FLEGT) programme and Voluntary Partnership Agreements, and the US's Lacey Act Amendment provide policy frameworks intended to stop the import of illegally harvested wood and wood products into the EU and the US. As an intermediary between material-source and product-destination countries, Chinese importers and manufacturers are learning how to navigate these rules. Non-policy mechanisms, such as product and chain-of-custody certification, are also being implemented to control the supply chain of illegal and unsustainable wood products. However, although the number of chain-of-custody certificates has grown in recent years, few enterprises actually use any certified wood in the production of their goods.[91]

Ongoing challenges

China is now the world's largest producer and exporter of forest products.[92] The government's stated goal of continuing to expand its forest products industries while conserving its own domestic resource base will mean that questions of legality and sustainability will not disappear anytime soon. If China's domestic log production continues to be assigned by quota, then it will continue to rely on imports to fuel its growth in wood product production and it will face increasingly high prices for timber imports. This would be particularly true for tropical logs, where the number of exporting countries is fairly small. There may be new opportunities for trade between China and regions from which it does not currently import significant quantities, such as Brazil, but there is a limited number of sources of tropical wood and many of these countries are actively trying to limit deforestation. China is a major driver of demand for the trade in tropical and coniferous logs. Without a significant increase in domestic production of both coniferous and non-coniferous logs, it will continue to be reliant on imports. In the coniferous sector, Russia, North America and New Zealand are likely to be the most important sources of increased imports; in the non-coniferous sector, there is greater concern about where China will draw its imports from. Even if it is able to increase non-coniferous log production, it will be unable to produce large volumes of tropical logs. Although it currently serves largely as an intermediary between resource-rich developing countries that supply its raw wood resources and income-rich consuming countries to which it exports wood

90 Zhu, Taylor and Feng 2004, 30–47.
91 Lawson and MacFaul 2010.
92 State Forestry Administration 2009.

products, China will be expected to play an increasing role in ensuring the use of well-managed and legally harvested timber materials, not just at home but abroad as well.

Conclusion

There is no doubt that China has made enormous strides in its efforts to improve rural livelihoods, protect its forest ecology and grow its forest-based industries. Yet, the results are, in many ways, mixed, and the efforts have undoubtedly had negative, and often overlooked, unintended consequences. The problems for state-controlled forests are in a sense more straightforward: they primarily involve balancing the imperatives of enterprise profitability and domestic timber demand with those of forest ecological health. The situation in collectively-owned forests, whether they are managed as commons or by individual leasing mechanisms, is more complex. Forest-dependent communities continue to be among China's poorest, and their economic development continues to lag far behind the coastal and urban regions. The state has promoted land tenure reform to try to provide income at the same time that it ensures reforestation and high-quality forests, and these two aims have not always been compatible.

When we examine recent forest history on a national scale, we see a generally bright picture – forest coverage has increased, which is a good thing. However, gains may be overstated even on a national scale unless the ongoing problems of illegal logging and poor forest quality within China are acknowledged and addressed. Moreover, on a more local scale, many of the policies directed at increasing forest coverage have dubious long-term sustainable benefits for rural households, and questionable ecological outcomes. The forest industry has expanded rapidly in the last 15 years or so, but it has become reliant on imports, often from countries with highly suspicious flows and poor environmental records of their own. The government has clearly stated its intent to expand, not limit, the forest-processing industry. If resources abroad become more expensive, there is likely to be a push to open up designated conservation areas to greater timber production domestically.

The triple goals of ecological sustainability, improved rural livelihoods and increased production are all laudable ones; it remains to be seen how well China can balance them against one another. As a major producer, consumer, importer and exporter of wood and wood products, China is now expected to participate and demonstrate leadership in industry development and efficient resource use and trade, as well as in forest resource conservation and sustainable use.

References

Albers, Heidi, Scott Rozelle and Guo Li. 1998. "China's forests under economic reform: timber supplies, environmental protection, and rural resource access." *Contemporary Economic Policy* 16(1), 22–33.

Bennett, Michael. 2008. "China's sloping land conversion program: institutional innovation or business as usual?" *Ecological Economics* 65(4), 699–711.

Bennett, Michael, Aashish Mehta and Jintao Xu. 2011. "Incomplete property rights, exposure to markets and the provision of environmental services in China." *China Economic Review* 22(4), 485–498.

Cann, Cynthia W., Michael C. Cann and Gao Shangquan. 2005. "China's road to sustainable development." In Kristen Day (ed.), *China's Environment and the Challenge of Sustainable Development*. Armonk, NY: M.E Sharpe, 3–34.

Cao, Shixiong. 2008. "Why large-scale afforestation efforts in China have failed to solve the desertification problem." *Environmental Science and Technology* 42, 1826–31.

Cao, Shixiong, Li Chen, David Shankman, Chunmei Wang, Xiongbin Wang and Hong Zhang. 2011. "Excessive reliance on afforestation in China's arid and semi-arid regions: lessons in ecological restoration." *Earth Sciences Review* 104, 240–45.

Cao, Shixiong, Xiuqing Wang, Yuezhen Song, Li Chen and Qi Feng. 2010. "Impacts of the natural forest conservation program on the livelihoods of residents in northwestern China: perceptions of residents affected by the program." *Ecological Economics* 69(7), 1454–62.

CCP (Chinese Communist Party) Central Committee and State Council. 1998. "Zhonggong zhongyang guowuyuan guanyu zaihou chongjian, zhengzhijianghu, xingxiushuili de ruogan yijian" (Opinions of the CCP Central Committee and the State Council regarding reconstruction, regulation of water sources, and construction of waterworks following the disaster), 20 October, http://cpc.people.com.cn/GB/64184/64186/66688/4494418.html. Accessed 15 January 2013.

CCP Central Committee and State Council. 2008. "Zhonggong zhongyang guowuyuan guanyu quanmian tuijin tuanti linquan zhidu gaige de yijian" (Opinions of the CCP Central Committee and the State Council regarding implementation of the reform of collective forest rights), 22 August, http://web.bhtsg.gov.cn/html/dzjg/qzfbm/lyj/gfxwj/201208221760839.html. Accessed 15 January 2013.

Dai, Limin, Yue Wang, Dongkai Su, Li Zhou, Daopu Yu, Bernard J. Lewis and Lin Qi. 2011. "Major forest types and the evolution of sustainable forestry in China." *Environmental Management* 48, 1066–78.

Démurger, Sylvie, Yuanzhao Hou and Weiyong Yang. 2009. "Forest management policies and resource balance in China: an assessment of the current situation." *Journal of Environment and Development* 18(1), 17–41.

Démurger, Sylvie, and Weiyong Yang. 2007. "Economic incentives and afforestation incentives in rural China." *Environment and Development Economics* 11, 629–649.

Dikötter, Frank. 2010. *Mao's Great Famine*. New York: Walker & Co, 174–78.

Economy, Elizabeth. 2004. *The River Runs Black: The Environmental Challenge to China's Future*. Ithaca, NY: Cornell University Press.

FAO (Food and Agricultural Organization). 1982. *Forestry in China.* FAO Forestry Paper 35. Rome: United Nations FAO.

FAO. 2011. FAOSTAT. http://faostat.fao.org/. Accessed 31 August 2011.

Ferris Jr., Richard J., and Hongjun Zhang. 2005. "Environnmental law in the People's Republic of China." In Kristen Day (ed.), *China's Environment and the Challenge of Sustainable Development*. Armonk, NY: M.E. Sharpe, 66–101.

Flower, John. 2009. "Ecological engineering on the Sichuan frontier: socialism as development policy, local practice, and contested ideology." *Social Anthropology* 17, 40–55.

Harkness, James. 1998. "Recent trends in forestry and conservation of biodiversity in China." *The China Quarterly* 156, 911–934.

Harris, Richard B. 2009. "Rangeland degradation on the Qinghai–Tibetan plateau: a review of the evidence of its magnitude and causes." *Journal of Arid Environments* 74, 1–12.

He, Fanneng, Quansheng Ge, Jianru Dai and Yujuan Rao. 2008. "Forest change of China in recent 300 years." *Journal of Geographical Sciences* 18, 59–72.

He, Hong S., Stephen R. Shiffley and Frank R. Thompson. 2011. "Overview of contemporary issues of forest research and management in China." *Environmental Management* 48, 1061–65.

Hyde, William, Gregory Amacher and William Magrath. 1996. "Deforestation, scarce forest resources, and forest land use: theory, empirical evidence, and policy implications." *World Bank Research Observer* 11(3), 223–248.

Jahiel, Abigail. 1998. "The organization of environmental protection in China." *The China Quarterly* 156, 757–787.

Lawson, Sam, and Larry MacFaul. 2010. *Illegal Logging and Related Trade: Indicators of the Global Response*. London: Chatham House.

Li, Jie, Marcus W. Feldman, Shuzhuo Li and Gretchen C. Daily. 2011. "Rural household income and inequality under the sloping land conversion program in western China." *Proceedings of the National Academy of Sciences* 108(19), 7721–26.

Li, Ping, and Robin Nielsen. 2010. *A Case Study on Large-Scale Forestland Acquisition in China*. Washington, DC: Rights and Resources Initiative.

Li, Yongxiang. 2005. "State Power and Sustainable Development in Southwest China." PhD diss., University of Washington.

Ling, Daxie. 1983. "Woguo senlin ziyuan bianqian" (Changes in our country's forest resources). *Zhongguo nongshi* 2, 26–36.

Liu, Can, and Runsheng Yin. 2004. "Poverty dynamics revealed in production performance and forestry in improving livelihoods: the case of West Anhui, China." *Forest Policy and Economics* 6, 391–401.

Liu, Dachang. 2001. "Tenure and management of non-state forests in China since 1950." *Environmental History* 6(2), 239–263.

Liu, Dachang, and David Edmunds. 2003. "The promises and limitations of devolution and local forest management in China." In David Edmunds and Eva Wollenberg (eds.), *Local Forest Management*. London: Earthscan Publications Ltd, 20–54.

Liu, Jianguo, Shuxin Li, Zhiyun Ouyang, Christine Tam and Xiaodong Chen. 2008. "Ecological and socioeconomic effects of China's policies for ecosystem services." *Proceedings of the National Academy of Sciences* 105(28), 9477–82.

Luoma, Jon R. 2012. "China's reforestation problems: big success or just an illusion?" *Yale Environment* 360, 17 January, http://e360.yale.edu/feature/chinas_reforestation_programs_big_success_or_just_an_illusion/2484/. Accessed 4 March 2014.

Meng, Si. 2011. "A skeptical take on China's forestry targets," *China Dialogue*, 29 April. http://www.chinadialogue.net/article/show/single/en/4259. Accessed 4 February 2013.

Miao, Guangping, and R.A. West. 2004. "China collective forestlands: contributions and constraints." *International Forestry Review* 6(3–4), 282–298.

Office of Rural Forest Reform, State Forestry Administration. 2010. "Woguo jiti linquan zhidu gaige fen wei jige jieduan?" (How many periods is the reform of our country's collective forest rights system divided into?), 5 July, http://lygg.forestry.gov.cn/portal/lgs/s/2596/content-401771.html. Accessed 4 February 2013.

Qian, Yingyi, and Chenggang Xu. 1993. "Why China's economic reforms differ: the M-form hierarchy and entry/expansion of the non-state sector." *Economics of Transition* 1(2), 135–170.

Richardson, Stanley. 1966. *Forestry in Communist China*. Baltimore: Johns Hopkins Press.

Robbins, Alicia. 2011. "China's Forest Sector: Essays on Efficiency, Foreign Investment and Trade and Illegal Logging." PhD diss., University of Washington.

Ross, Lester. 1980. "Forestry Policy in China." PhD diss., University of Michigan.

Ross, Lester. 1998. "China: environmental protection, domestic policy trends, patterns of participation in regimes and compliance with international norms." *The China Quarterly* 156, 809–835.

Rozelle, Scott, Jikun Huang and Vincent Benziger. 2003. "Forest exploitation and protection in reform China: assessing the impacts of policy and economic growth." In William Hyde, Brian Belcher and Jintao Xu (eds.), *China's Forests: Lessons from Market Reforms*. Washington, DC: Resources for the Future.

Ruiz Pérez, Miguel, Brian Belcher, Maoyi Fu and Xiaosheng Yang. 2004. "Looking through the bamboo curtain: an analysis of the changing role of forest and farm income in rural livelihoods in China." *International Forestry Review* 6(2–4), 306–316.

Sachs, Jeffrey, and Andrew Warner. 2001. "The curse of natural resources." *European Economic Review* 45(4–6), 827–838.

Schmidt, Amanda, David Montgomery, Katharine Huntington and Liang Chuan. 2011. "The question of communist land degradation: new evidence from local erosion and basin-wide sediment yield in southwest China and southeast Tibet." *Annals of the Association of American Geographers* 101(3), 1–20.

Song, Yajie, William Burch Jr., Gordon Geballe and Liping Geng. 1997. "New organizational strategy for managing the forests of southeast China: the shareholding integrated forestry tenure (SHIFT) system." *Forest Ecology and Management* 91(2–3), 183–194.

State Council. 1981. "Zhonggong zhongyang guowuyuan guanyu baohu senlin fazhan linye ruogan wenti de jueding" (Decisions of the Central Committee and the State Council regarding some problems of protecting forestry for forest development), 8 March, http://cpc.people.com.cn/GB/64184/64186/66701/4495425.html. Accessed 15 January 2013.

State Council. 2002. "Guowuyuan guanyu jinyibu wanshan tuigeng huanlin zhengce shishi de ruogan yijian" (Some opinions of the State Council regarding taking a step towards successfully implementing the policy of returning farmland to forest), http://www.china.com.cn/chinese/zhuanti/xbkf5/798409.htm. Accessed 3 February 2013.

State Forestry Administration. n.d. "Changjiang shangyou, Huanghe shangzhongyou diqu tianranlin ziyuan baohu gongcheng shishi fang'an" (Plan for implementing the Natural Forest Resource Protection Project in the upper Changjiang and upper and middle Huanghe areas); "Dongbei, Neimenggu deng zhongyao youlin qu tianranlin ziyuan baohu gongcheng shishi fang'an" (Plan for implementing the Natural Forest Resource Protection Project in the key areas of the northeast and Inner Mongolia), cited at http://baike.baidu.com/view/2886868.htm. Accessed 4 February 2013.

State Forestry Administration. 2009. *Linye changye zhenxing guihua 2010–2012 nian* (*China Forestry Revitalization Plan, 2010–2012*), http://www.chinaeuc.com/show.asp?id=358. Accessed 25 May 2011.

State Forestry Administration. 2010; various years. *Zhongguo linye tongji nianjian* (*China Forestry Statistical Yearbook for 2009*; and other years). Beijing: Zhongguo linya chubanshe.

State Forestry Administration. 2011. "Quanguo zaolin lühua guihua gangyao 2011–2020 nian" (Outline of national plans for reforestation, 2011–2020), http://www.forestry.gov.cn/uploadfile/main/2011-7/file/2011-7-12-8920476e3e204817a8d33e821e5fdb44.pdf. Accessed 4 February 2013.

Stockholm Environmental Institute. 2002. *China Human Development Report 2002: Making Green Development a Choice*. Oxford: Oxford University Press.

Stone, Richard. 2009. "Nursing China's ailing forests back to health." *Science* 325(5940), 556–58.

Sturgeon, Janet. 2005. *Border Landscapes: The Politics of Akha Land Use in China and Thailand*. Seattle: University of Washington Press.

Tilt, Bryan. 2010. *The Struggle for Sustainability in Rural China*. New York: Columbia University Press.

Trac, Christine. 2010. "Rural Energy Development as a Means for Forest Conservation: Modernizing the Chinese Peasant Household." MES thesis, Yale School of Forestry and Environmental Science.

Trac, Christine, Stevan Harrell, Thomas Hinckley and Amanda Henck. 2007. "Reforestation programs in southwest China: reported success, observed failure, and the reasons why." *Journal of Mountain Science* 4(4), 275–292.

Trac, Christine Jane, Amanda H. Schmidt, Stevan Harrell and Thomas M. Hinckley. 2013. "Is the Returning Farmland to Forest Program a success? Three case studies from Sichuan." *Environmental Practice* 15(3), 350–366.

Uchida, Emi, Jintao Xu and Scott Rozelle. 2005. "Grain for green: cost-effectiveness and sustainability of China's conservation set-aside program." *Land Economics* 81(2), 247–264.

Uchida, Emi, Jintao Xu, Zhigang Xu and Scott Rozelle. 2007. "Are the poor benefiting from China's land conservation program?" *Environment and Development Economics* 12(4), 593–620.

Urgenson, Lauren, R. Keala Hagmann, Amanda Henck, Stevan Harrell, Thomas Hinckley, Sara Jo Shepler, Barbara Grub and Philip Chi. 2010. "Socio-ecological resilience of a Nuosu community-linked watershed, southwest Sichuan, China." *Ecology and Society* 15(4), 2–23.

Wang, G., J. Innes, J. Lei, S.W. Wu and S. Dai. 2008. "Towards a new paradigm: the development of China's forestry in the 21st century." *International Forestry Review* 10(4), 619–631.

Wang, Sen, Cornelius van Looten and Bill Wilson. 2004. "Mosaic of reform: forest policy in post-1978 China." *Forest Policy and Economics* 6(1), 71–83.

Wang, X.M., C.X. Zhang, E. Hasi and Z.B. Dong. 2010. "Has the Three Norths Forest Shelterbelt Program solved the desertification and dust storm problems in arid and semiarid China?" *Journal of Arid Environments* 74, 13–22.

Weyerhaeuser, Horst, Andreas Wilkes and Friedrich Kahrl. 2005. "Local impacts and responses to regional forest conservation and rehabilitation programs in China's northwest Yunnan province." *Agricultural Systems* 85, 234–253.

Williams, Dee Mack. 1996. "Grassland enclosures: catalyst of land degradation in Inner Mongolia." *Human Organization* 55, 307–313.

Xu, Jianchu, and David Melick. 2007. "Rethinking the effectiveness of protected areas in southwestern China." *Conservation Biology* 21, 318–328.

Xu, Jintao. 2008. "Collective forest tenure reform in China: what has been achieved so far?" Working paper, http://policydialogue.org/files/events/XuJintao_collective_forest_tenure_reform_china.pdf. Accessed 5 March 2014.

Xu, Jintao, Ran Tao, Zhigang Xu and Michael Bennett. 2010. "Sloping land conversion: does expansion equal success?" *Land Economics* 86(2), 219–244.

Xu, Jintao, Runsheng Yin, Zhou Li and Can Liu. 2006. "China's ecological rehabilitation: unprecedented efforts, dramatic impacts, and requisite policies." *Ecological Economics* 57, 595–607.

Xu, Jintao, Yu Ying, Xie Chen, Li Changgang, Chen Baolin and Kou Lei. 2003. "Tianran lin ziyuan baohu gongcheng dui jitilin ji shequ jingji fazhan de yinxiang" (Impacts of the Natural Forest Conservation Program on collective forestry and community economic development). *Linye jingji* 6, 28–32.

Xu, Zhigang, Michael Bennett, Ran Tao and Jintao Xu. 2004. "China's sloping land conversion programme four years on: current situation and pending issues." *International Forestry Review* 6(3–4), 317–326.

Yin, Runsheng. 1998. "Forestry and the environment in China: the current situation and strategic choice." *World Development* 26(12), 2153–67.

Yin, Runsheng, and William Hyde. 2000. "The impact of agroforestry on agricultural productivity: the case of northern China." *Agroforestry Systems* 50, 179–194.

Yin, Runsheng, and David Newman. 1997. "The impact of rural reforms on China's forestry development." *Environment and Development Economics* 2(3), 289–303.

Yin, Runsheng, Jintao Xu and Zhou Li. 2003. "Building institutions for markets: experiences and lessons from China's rural forest sector." *Environment, Development and Sustainability* 5(3–4), 331–351.

Zhang, Yaoqi. 2000. "Costs of plans vs. costs of markets: reforms in China's state-owned forest management." *Development Policy Review* 18(3), 285–306.

Zhu, Chunquan, Russell Taylor and Guoqiang Feng. 2004. *China's Wood Market, Trade and the Environment*. Monmouth Junction, NJ: Science Press USA.