Forest Transition to Sustainable Forestry Management and Rehabilitation in China

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ABSTRACT

Forest transition in China was the result of a combination of political, social, economic and cultural factors; and forest transition in China was stable, and forest quantity and quality in China would continue to improve. Our study laid a fundamental foundation to understand the dynamics of human-environment systems in China and also provided potentially beneficial policy recommendations to enhance capability of sustainable forest management.

The forest transition did occur in China. More than half of China's territory used to cover by forests 5000 years ago. By 1850, 44% of China's forests had been cleared, leaving China with around 17% of forest cover, and forest cover continued to decline to 12.5% in 1949 when People's Republic of China (PRC) was found (Houghton 2002, He *et al.* 2007, Fan and Dong 2001). However, in the last three decades, forest cover began to increase rapidly in China, to 20.36% at 2008 according to official data released by the State Forestry Administration.

As China has one fifth of world population and 5% of global forests, the recent rapid economic development, moderate development stage, a better understanding of forest transition in China has great significance to China and to the world as well. Great expansion of forests in the last two decades in China has contributed to global carbon sequestration, biodiversity conservation and in improving local and national environment. In particular, contemporary China has to restructure economy and reform social, political system to safeguard environment, harmonize the nature and social economic system in China as well as address the challenge of limits of natural resources, and pursue new paradigm of development – so called ecological civilization. Comprehensive analysis of China's forest resources, forest legislative framework, drivers to deforestation and forest degradation, afforestation and forest rehabilitation, had provided theoretical interpretation of forest transition in China from the perspectives of economic, institutional and cultural parameters, and a better understanding of the dynamic of human-environment systems.

Population pressure is considered to be the direct cause of forest degradation. The greater the population pressure was, the more demand for foods, resulting in deforestation and other activities leading to a decrease in the forest cover. China's population increased from 540 million in 1949 to 1.34 billion in 2010. After 1949, especially in the 1980s, the pressure of population on forest resources was gradually reduced. The indexes of population pressure on forests such as grain yield, population size and firewood consumption were decreased rapidly in 1980s with the decrease of cultivated land area. Because of this, it significantly reduced rural poverty and the dependence on the forest for peasants, and promoted the recovery of forest resources.

The increasing income of the farmers significantly reduced firewood consumption. For a long time, the main fuel used in rural areas was straw, firewood and other biomass energy. In 1980s, the proportion of firewood consumption decreased gradually, with an annual decreasing rate of 1%, from 39.8% in 1979 to 28.6% in 1991. The changing of the rural energy consumption structure reduced people's dependence on the forest.

Over 30 years, China has carried out the economic reform towards the market. Forest authority has made a great effort to provide favor environmental condition, including collective forest tenure reform, state forest farm reform for private sector to participate in afforestation, and forest management, and for provide incentive of various stakeholders including oversea investors, civil society, and urban citizenship to participating in forest investment and forest management. However, the growth of forest, the direct intervention of the government, the strengthening of forest and the control of forest land using played very important roles in promoting the forest transition.

Since the mid 1980s, the Chinese Government had strengthened the control measures and established a set of completed forest resources management system, from harvesting, transportation, processing to law enforcement and market management. It was the cornerstone of the government to promote all forestry reforms, to prevent the risk of forest management and to contain the down trend of forest resources.

China mainly exports labour-intensive products and import land-intensive products. Since 1980, the number of imported timber has increased sharply. China has become one of the biggest timber

producing, trading and consuming countries in the world, and is the world's wood products processing base and trading centre. The large amount of imported timber had eased the pressure of timber production and met the shortfall of domestic timber consumption. This had great help to the development of economy, the protection of forest resources and the transition of forest. In addition, globalization influences Chinese social development and resources management in a more extensive and profound way. The large-scale labour migration reduced the number of peasants in inland provinces, which reduced the living dependence on forest for the farmers. The emigrated labour force transferred money to their inland family, reducing the farmers' livelihood pressures on forest resources, deforestation and the forest land utilization concentration degree. The increasing job opportunities and the demand for labour force in eastern areas improved the labour wages, which, to a certain extent, reduced the farmers' activity in engaging in forestry production. These factors played a positive role on the protection and restoration of forest resources in China.

China's traditional forestry knowledge is very rich and varied. China is abundant in all kinds of forest species resources, including tall trees, shrubs, herbs as well as animals. There are many different forest management practices, such as daughter fir planted in minority areas of southern China and pollard system; abundant forest management knowledge, like local rules and regulations valid for the whole village; colorful forest cultures, which can be embodied in the *Feng Shui* forest, sacred trees, forest elements in national festivals and cultures. Some researchers studied the traditional forest utilization technology, management system and forest culture, and showed the characteristics of local, integral and comprehensive as well as its dynamic changing process and unique way of inheritance for traditional forestry knowledge in China, especially in minority areas. The traditional ideology, including integration of human and haven, and considering managing mountains as a central of country management, do influence China's politics and strategic planning. China's rich traditional knowledge and culture do have a special meaning in forest transition.

On the basis of the above analysis, we carry out an empirical test of China's forest transition by using the panel data of 30 provinces and municipalities in China since 1984 and taking the theory of *Environmental Kuznets Curve* as evidence. The main results are as followings: (1) The coefficient of government's silvicultural investments is positive, pointing out that silviculture investments promote the growth of China's forest. It proves that the Chinese Government is an important force to promote forest growth; (2)The impact of per capita food production on forest coverage is negative, significantly at 1% level. The competitive mechanisms of farmland and woodland may play a role, indicating that China has entered the stage of converting farmland to woodland in economic development; (3)The impact of the proportion of rural population on forest coverage is positive, significantly at 1% level, showing that the bigger rural population is, the faster forest grows; (4) The effect of forest coverage on forest growth between 1977 and 1981 was positive, significantly at 1% level, indicating that natural geographic environment and resource endowments had a significant impact on forest growth.

The turning point appeared in forest transition between 1985 and 1998 in China, when the forest coverage rate reached around 13%, and then the forest area began to grow continuously and favorably. Forest change and economic growth among the Chinese provinces do not follow the *Environmental Kuznets U Curve*, but an S-type curve. Forest transformation of Chinese provinces happened at the same time, not successively with the high or low level of GDP per capita. Forest transition in China is the result of a combination of political, social, economic and cultural factors, and it cannot be simply explained by *economic development pathway*, *forest scarcity pathway* or *governmental dominant*.

Looking to the future, China's economy will continue to grow; the pressure of population and land will continue to decline due to urbanization and demographic transition; food growth will be primarily dependent on the increase of agricultural productivity; and it is estimated that more and more marginal agricultural land will be converted to forestland. Ecological civilization construction has made forestry more important in the developmental strategy of Chinese Government, and it is estimated that governmental investment in forestry will continue to expand. The intensification of the trend of global trade liberalization will continue to create a supportive and stable international environment for timber's imports and exports in China. In summary, the main driving forces of China's forest transition, such as economic growth, urbanization, non-agricultural employment, grain yield, governmental investment, globalization, and forest culture, will not weaken in the future, but continue to improve. Forest transition in China is sustainable and positive.

China is among the countries with forest transition. The turning point appeared in forest transition between 1985 and 1998 in China, when the forest coverage rate reached around 13%, and then the forest area began to grow continuously and favorably. Dynamical mechanism of forest growth or reduction is different in different periods. China's forest area has grown in the take-off stage of industrialization, rather than after the industrialization. Forest transition in China is the result of a combination of political, social, economic and cultural factors. Forest transition in China is stable, and forest quantity and quality in China will continue to improve.

China witnessed a huge increase in forest area in the last three decades and the forest transition in China contributes to global carbon sequestration, biodiversity conservation and in improving local and regional environment. Although great achievements have been made in forest generation and conservation in China, China is still a country short of forest resources as a whole and with poor quality of forests. Forest coverage in China is only 66% of that of world's average level. Forest area per capita is 0.145 ha in China, less than a quarter of that of the world's average. Amount of growing stock of arbor forests per hectare is 85.88 cu m in China, only reaching 78% of world average level. Ecological problem is still one of the most prominent problems that restrict sustainable development in China. Ecological products are the scarcest products, and the disparity is most obvious in ecological conditions between China and developed countries.

It is recommended that:

- Urbanization should advance steadily to ensure that farmers are the largest beneficiaries;
- Continuing the implementation of afforestation, and to strengthen the governance and restoration of ecologically fragile areas;
- Strengthening the domestic timber supply, and making full use of the timber market in the world;
- Specifying the division of government and market in order to prompt market to play a greater role in forestry;
- Promoting decentralization of forest management and stakeholder participation.

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UNITS

1 ha = 15 mu
USD1 = CNY6.3

ACRONYMS

APAFRI	Asia Pacific Association of Forestry Research Institutions
APFNet	Asia-Pacific Network for Sustainable Forest Management and Rehabilitation
FAO	Food and Agricultural Organization of United Nations
FSC	Forest Stewardship Council
KY	Kyoto University
NTFPs	Non-timber forest products
RUC	Renmin University of China
SFA	State Forestry Administration of China
SNU	Seoul National University

CHAPTER 1 BACKGROUND

Table 1.1. Brief Profile of China

Some Important data on China			
Location	East Asia		
Climates	Tropical monsoon, Sub-tropical Monsoon, Temperate, Alpine		
Rainfall	20 to 3,000 mm (Mean 680 mm)		
Temperatures	-50 to 40^{o}C		
Major land types	Mountains 33% Plateaus 26% Basins 19% Plains 12% Hills 10%		
Major land use(2005)		Mil ha	%
Agricultural Land		657	68.4
1.Forest land		235.1	24.5
2.Pasture land		262.1	27.3
3.Arable land		122.1	12.7
4.Garden plot		11.5	1.2
5.Other Agricultural land		25.5	2.7
Construction Land		31.9	3.3
1.Residential area and mining land		26	2.7
2.Land for transport		2.3	0.2
3.Land for water conservancy		3.6	0.4
Unused Land		271.1	28.2
Total Land Area		960	100
Population			
		Million (2010)	%
Urban population		669.8	49.95
Rural population		671.1	50.05
Total population		1340.9	100
Natural Growth Rate of Population	0.479 %		
Ratio of agricultural land to agricultural population:	0.12 ha per capita		

Sources: 1. Outline of China Land Use Overall Plan 2006–2020
2. China Statistical Yearbook (2011)

1.1 Brief profile about China

The People's Republic of China covers about 9.6 mil sq km and is the third largest country in the world, next only to Russia and Canada. China is also the world's most populous country, with 1.34 billion people at the end of 2010, about 19% of global population (China Statistical Yearbook 2011). Given its tremendous size, presenting a simple picture of China is extremely difficult. Nevertheless, in what follows an attempt is made to draw out key features of China's environment, economy and governance structure associated with land use aiming to provide a backdrop for the remainder of the report.

1.1.1 Geography and climate

China covers an area 5 500 km from north to south, and 5 200 km from west to east. China extends over a wide array of climatic zones including tropical, subtropical, warm-temperate, temperate and cool-temperate zones. In the north, mean annual temperatures may be as low as -5^{o} C, while in the south temperatures rise to 25^{o} C. Annual precipitation is equally varied, ranging from 2 000 mm in the southeast to 0–200 mm in the northwest. Geographically, China is also characterized by contrasts. Elevation declines while precipitation increases from west to east, and climate changes from plateau mountain climate to temperate continental, tropical, subtropical and temperate monsoon. In the west, high plateau and mountains dominate, covering 26% and 33%, respectively, of China's total area. As

we move east, mountains give way to basin areas and plains. Snow melting in the high plateau and mountains in the west provide the headwaters for many of the country's largest rivers.

1.1.2 Flora and fauna

Given its geographical and climatic diversity, it is not surprising that China is also one of the most biologically diverse countries in the world. China ranks third in the world with about 32 800 higher plants. 25000 of them are angiosperm that belongs to 2946 genera of 291families, and 240 are gymnosperm that belongs to 34 genera of 10 families. There are about 8 000 tree species in China, among which 2,000 are conifers (26 genera) and 6,000 are broad-leaves (260 genera). Some of the world's most precious and rare tree species are found in China, e.g. the Dawn Redwood (Metasequoia), Gingko (Gingkobiloba), Chinese tuliptree (*Liriodendron chinenese*), and Chinese cypress (Cupressusduclouxiana). About 1000 of these tree species are important commercial tree species, 300 of which are reproducing tree species. China has the world's 13.7% of vertebrate species, with a total number of 6 445, among which about 1400 species are birds, 450 are mammals, 300 are reptiles, 270 are amphibians and 2 500 are fishes[1].Endemic species abound and include well-known animals such as the giant panda (Ailuropodamelanoleuca), golden monkey (Cercopithecuskandti), South China tiger (Pantheratigrisamoyensis), brown-eared pheasant (Crossoptilonmantchuricum), white-flag dolphin (Lipotesvexillifer), Chinese alligator (*Alligator sinensis*) and red-crowned crane (Grusjaponensis).

There are 2 599 reserves that have been established by 2010. The reserves cover a total area of 149 mil ha or 14.9% of land area of China, which has increased 125.8% and 69.1% respectively comparing to 1999 (see Figure 1.1). Up to now, the increases of both number and area of reserves have been stable.

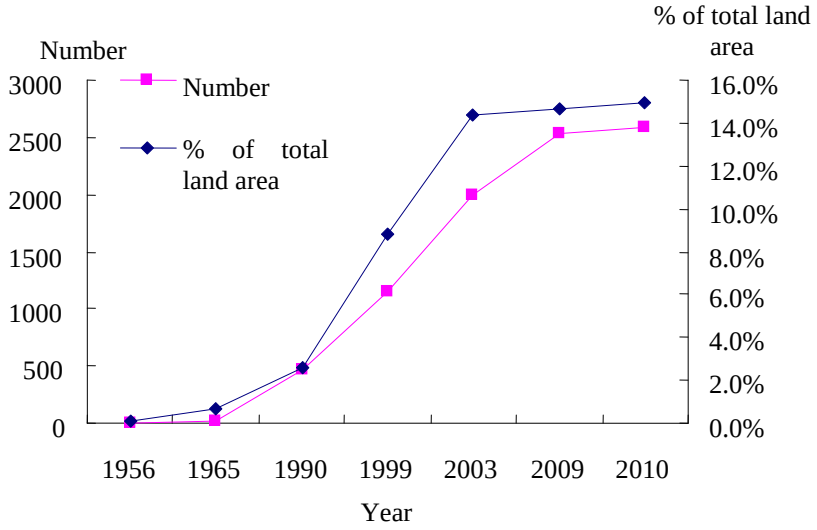


Figure 1.1. Growing trend of reserves in China

Besides, there are also about 50 000 of small natural reserves have been established by 2010 with a total area of 15 000 ha, including forest, wet land, wild animals and plants and their habitat breeding ground, ancient and rare trees, cultural heritages, natural landscapes.

1.1.3 Governance

China implemented a local administration system, i.e. dividing administrative district and establishing local governance institutions for convenience of administrative management. Four levels of local government including province, city, county and town were set up under central government. Local governments at all levels were responsible and reporting to their upper level government. All levels of local governments were state administrative organs under the unified leadership of the State Council, and were subordinate to it. The general local government system included local People's Congress, government, the local People's Court, and the local People's Procuratorate. The administrators of all

1. Source: China Biological Diversity Protection Action Plan 2011. State Environmental Protection Administration. Beijing.

local level governments were elected by the People's Congress at the corresponding level. Local governments at all levels were responsible to and under supervision of the People's Congress at the corresponding level.

Local governments above the county level supervised all kinds of undertakings such as economy, education, science, culture, health, urban and rural construction, and public security at their respective administration regions. The local governments above county level would also issue executive orders, and be in charge of appointing and dismissing, training, evaluating, awarding and punishing government staff. Local governments at the town level would execute resolutions of the People's Congress at the same level and upper level administrative organ, and supervise administrative work in their corresponding jurisdiction.

1.1.4 Economy

Over the past thirty years, China has achieved average annual growth in GDP of around 10% (see the following two figures). In 2010, Per Capita GDP in China was CNY29 992 (USD4 686), Per Capita Retail Sales of Consumer Goods was CNY11 736 (USD1 834), and proportion of total value of imports and exports to GDP was 50.3% (China's National Bureau of Statistics). Today, China ranks among the top manufactured goods exporters, and its outputs of some major agricultural products (e.g. grain, cotton, meat) placed first in the world.

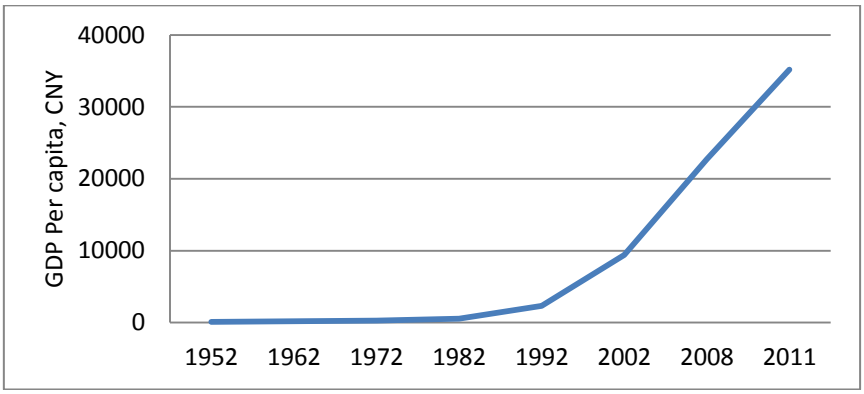


Figure 1.2. Change of China's per capita GDP after PRC was founded.
Source: China Statistical Yearbook (2012)

Due to rapid economic progress, China has made tremendous progress on poverty alleviation. From 1978 to 1996, the country has lifted some 300 million people out of poverty, representing the most successful poverty reduction campaign in history (Ziegler 1997). In the meantime, the national rural poverty line was lift up, from CNY200 (USD69) in 1985 to CNY625 (USD75) in 2000, and to CNY2 300 in 2011(USD356) an annual per capita (The Rural Poverty Monitoring Report of China 2013). The rural poverty population decreased 58 million from 2000 to 2009, leaving 36 million in all. This achievement is perhaps the most visible benefit of the government's "socialist market experiment" launched in the late 1970s. According to this new model, efficiency is promoted through the expansion of markets in the allocation of resources and a greater role for the private sector. In 2010, private enterprises are estimated to account for 60% of GDP, and above 75 % of the social employment (Wang 2011).

Urbanization in China developed rapidly following the growth of economy. The urban population grew from only 11% in 1949 to 36% in 2000 and to over 50% in 2011 (NBS 2012). Urbanization and economy development improved economic structure of China. The proportion of industrial and service sector rose rapidly while the proportion of primary industry in GDP declined from 28.2% in 1978 to 10% in 2011(NBS 2012). The main source of energy in rural regions has been changing from fuel wood to electricity and liquefied gas and so on, reducing energy demand pressure on forest resources.

1.1.5 Rural population and Rural-Urban immigration

China has a dual system: the rural citizenship and the urban citizenship, identified by the Hukou (residential certificate) System. In 1987 around 75% of the population lives in rural areas, and most of them were engaged in private agriculture. Official data has shown that the urbanization rate has reached to around 50% by 2011 (China Statistical Yearbook 2011). The rural population in 2010 was 670 million, and about 159

million rural people registered as rural population were active in cities, doing all kinds of jobs, from as labourers in state-owned enterprises to street vendors, but without enjoying social security as the urban citizens do (Ministry of Human Resources and Social Security of China 2011).

Rural population growth is relatively low, as compared to urban population growth, also indicating a big rural-urban migration. Drawing on the push-pull theory, there are mainly two reasons why the rural-urban migration happens: first, the push force, which means that low income, less opportunity and poor education push people out of rural area; second, the pull force, which indicates that high income, good education and comfortable living conditions in urban area all together pull people to the city. According to statistics, interprovincial migration between 1990 and 1995 was 10.66 million. Ten years later, interprovincial migration increased to 38.04 million between 2000 and 2005. The number further soared to 55.23 million between 2005 and 2010 (Chan 2012). Development of labour intensive industrial and service sector in southeast coastal cities has absorbed plenty of labour from inland rural China. Lower population density in inland rural area thus ease pressure on dependence and exploitation on forest resources, leading to forest regeneration and better local ecological environment.

1.1.6 Globalization

Open-door to outside world became China's basic national policy since 1980s. Value of international trade including trade of forestry products rose rapidly, especially after China joined the WTO in 2001(Figures 1.3 and 1.4). Boost of the international trade greatly drove the economic growth, and China became the "world factory". Cities open to foreign economic activities were firstly concentrated in eastern coastal area as a result of policy support and geographic locations, and then spread from coastal to inland area after 1990. Although an all-around open pattern has been formed, eastern coastal region is still the centre of China's opening up. Exports of goods in 9 eastern coastal provinces took up 86.4% of total exports in 31 mainland China provinces (NBS 2012). The imbalance in the development of globalization has triggered massive migration of people from inland to eastern coastal areas, as individuals were attracted by non-farm jobs created through exports in the east.

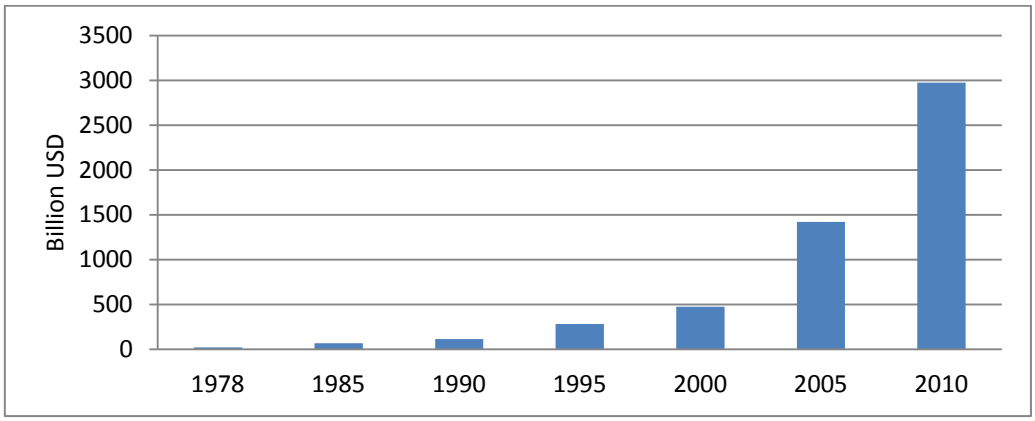


Figure 1.3. Total volume of foreign trade

Source: China Statistical Yearbook (2012)

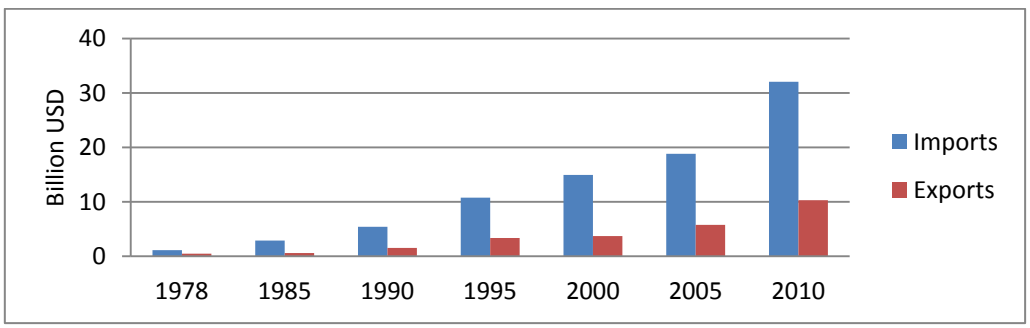


Figure 1.4. Volume of imports and exports of forest products

Source: FAO

1.1.7 Major environmental concerns

In China's context, environmental issues commonly refers to the issues related to environmental pollution, and ecological issues commonly refers to those related to natural resource management, such as forest, water, and pasture. The former was under administration of the Ministry of Environmental Protection, and the latter was involved by various ministries including agriculture, ocean, water sectors, but mainly by the State Forestry Administration. China has started to carry out administrative system reform, for better governance and coordination for comprehensive issues such as environments and development, but yet clear picture what will it be.

Along with the rapid economic growth, China faces challenges from pollution of water, atmosphere and soil unprecedentedly. Population growth, traditional agriculture pattern and increased industrial and household emission in recent 30 years are all causes of environmental problems with details as followings:

(1) *Water pollutions*. The national surface water was mildly polluted as a whole in 2012. In the ten biggest watersheds, percentage of good, fair and poor water conditions were 68.9%, 20.9% and 10.2% respectively. The major pollution indicators were chemical oxygen demand (COD), five-day biological oxygen demand (BODs), and potassium permanganate index. Quality of groundwater was even worse than surface water (Figure 1.5). Main pollution indicators were iron, manganese, fluoride, total dissolved solids and so on. Over proof of heavy metal was also found in some monitoring points. This may suggest that industrial pollution was the primary pollution source.

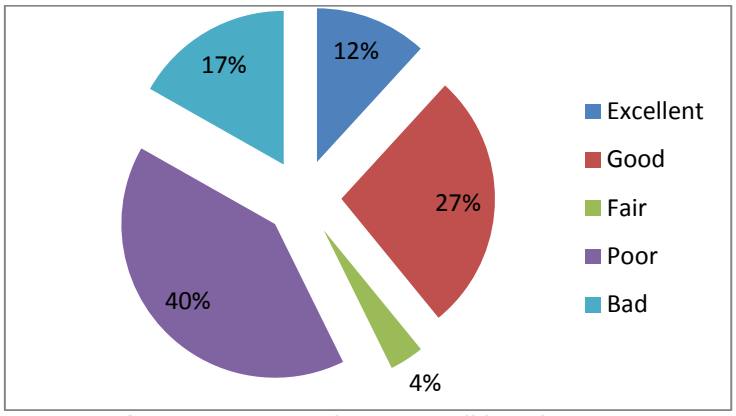


Figure 1.5. Groundwater conditions in 2012
Source: Environmental Bulletin of China (2012)

(2) *Air pollution*. Total emission of sulphur dioxide (SO_2) was 21.8 mil tons in 2012, of which 19.1 mil tons were from industrial source. Total emission of oxy-nitride was 23.4 mil tons, of which 16.6 mil tons were from industrial source. In cities at prefecture level and above, annual concentration of particulate matter (PM) was between 0.021 and 0.262 milligram per cubic meter. Concentration exceeded the environmental standard in 57.2% of cities. Acid rain occurred in 215 cities, accounting for 46.1% of total 466 cities that were monitored. There were 133 cities where frequency of acid rain was above 25%, and frequency of acid rain was above 75% in 56 cities. Area of acid rain regions was accounting for 12.2% of national land area (Ministry of Environmental Protection 2012).

(3) *Soil erosion and geological disasters*. Soil erosion area was 294.91 mil ha, accounting for 31.12% of total census region in 2012. Soil erosion region is in western China where the area was ecologically vulnerable and over exploited. A total of 14 322 of various kinds of geological disasters occurred in 2012, leading to a direct economic loss of CNY5.3 billion and killing more than 380 people.

(4) *Water disasters*. China has an extremely imbalanced water spatial distribution because of various monsoon climates and geographic conditions from west to east and from north to south. The north of Yangtze river drainage basin area have 64% of land area of China but only 19% of water resource, which means the north always has severe drought. In 2012 for instance, 11.2 mil ha of farmland and 123.7million people were affected by floods; with 673 death, 159 missing,

0.59 million houses collapsed and direct economic loss of CNY267.5 billion. In addition, 9.3 mil ha of farmland and 16.4 million people and 8.5 million big livestock were affected by drought, which caused a direct economic loss of CNY53.3 billion (Ministry of Environmental Protection 2012).

(5) *Rural environmental concerns*. With the development of industrialization and urbanization, industrial pollution, domestic pollution and livestock pollution were the main environmental issues in rural area. Monitoring result of rural environmental quality on 798 villages suggested that air condition was good generally, but drinking groundwater and surface water were contaminated to different degree. Pollution indicators for drinking surface water source were ammonia nitrogen, total phosphorus, and five-day biological oxygen demand. Pollution indicators for drinking groundwater source were total coliform bacteria group, ammonia nitrogen, and fluoride. This reflected the overuse of chemical fertilizer (Ministry of Environmental Protection 2012).

Aiming to solve these environmental problems, the Chinese Government has made environmental protection a basic national policy, and has adopted a range of measures to accelerate the construction of a resource-conserving and environmentally friendly society. Important measures include rural ecological and biodiversity protection and reasonable natural resource exploitation and utilization which are closely related to forestry development, and also include optimizing industry structures, implementing major ecological development and environmental renovation projects and so on (SFA 2009).

Apart from direct participation of citizens in the making and implementation of environmental policies, citizens now also have enough freedom to organize themselves, express their environmental concerns and set new public agendas for environmental reform in contemporary China (Tang and Zhang 2008). At present, over 10 000 local, provincial and national environmental NGOs exist in China (Mol 2009). Strong sense of citizen participation was reflected in terms of rights protection, construction project decision-making, environmental quality evaluation and government accountability.

1.1.8 Minority issues

China is a multinational country and has 56 nationalities in total and all the nationalities are indigenous people. According to Data Release Bulletin of the Sixth National Population Census conducted in 2010, the Han nationality has the population of 1.2259 billion, accounting for 91.51% of the total; the rest, the other 55 minority has 0.11379 billion, 8.49% of the total.

Chinese Government has issued series of laws and regulations for forbidding all kinds of discrimination and oppression. Over thousands of years' China's ethnic groups have lived together over vast areas through intermarriage, immigration, trade and cultural fusion, while some live in individual concentrated communities in small areas.

Most minorities have their own culture. A total of 433 items comprising 35.5% of those which have been included in the State-level intangible cultural heritage were from 55 identified minorities. Out of the 36 items included in "Human Beings Verbal and Intangible Cultural Heritage Representative Work" selected by UNESCO, 14 were from the minorities.

Chinese minorities mostly live in economically backward regions, especially in the mountainous regions, where virgin forests are mainly located. Their livelihoods depend heavily on natural resources and thus their activities have huge effect on natural resource protection, and further biodiversity and the ecological environment. The minorities have formed their own knowledge system on natural resource management through production and life practices over a long time period. The forest related traditional knowledge and culture places an important role on forest protection and management, which includes knowledge on indigenous species, forest management and practice, *Feng Shui* forests and so on. For many minorities who are closely related to the forests, like *Dong* and *Yi*, tree-worship has a long history tradition. They have a great respect to trees and they believe that trees are species with spirituality. Moderate logging is held in esteem in most cases. But under the process of urbanization, globalization and industrialization, a considerable portion of young people move out for off-farm job. The traditions are now facing more and more challenges.

1.2 Land use and land use change

Since the founding of the P.R. China, arable land area has first increased but then decreased. In 1952, it was 107.93 mil ha, increased to 130 mil ha by 1976, and then decreased gradually to 121.7 mil ha in 2008. Whereas forest area has been continuously increased from 82.56 mil ha after the founding of the state to 121.9 mil ha in 1976, then a slight decrease to 115.2 mil ha in 1981 came, followed by another continual increase to 195.4 mil ha in 2008. Grassland area did not change significantly before 1990s, but after that, grassland began to decrease. It has decreased from 266.1 mil ha in 1996 to 262.1 mil ha in 2005. Construction land area has a rapid rise from 4.73mil ha after the founding of the state to 24.07 mil ha in 1996, then to 26.02 mil ha in 2005, which has increased more than four times since 1949 (Figure 1.6).

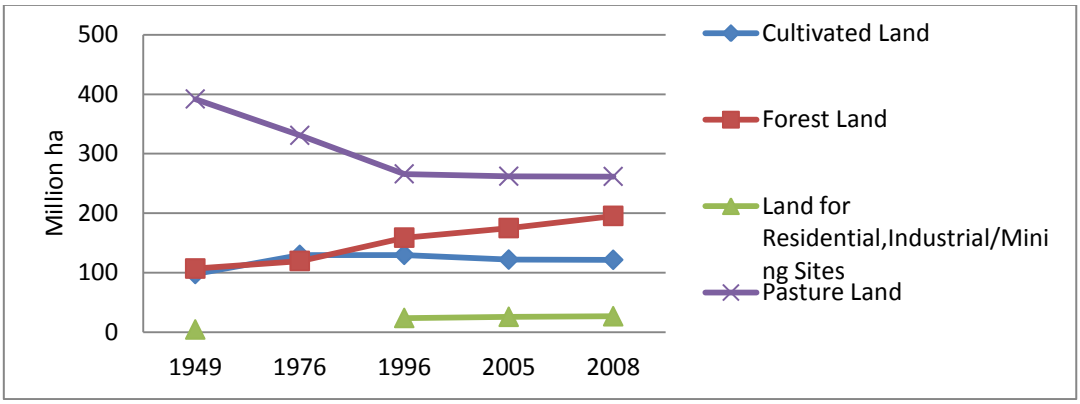


Figure 1.6. Land use change during 1949–2008 in China

Sources: Ministry of Land and Resources, State Forestry Administration of China

1.2.1 Arable land

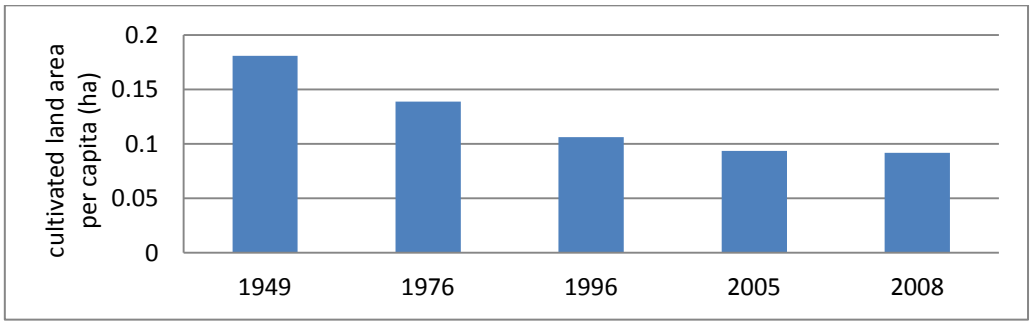


Figure 1.7. Change of cultivated land area per capita

Sources: Ministry of Land and Resources, State Forestry Administration of China

The change of cultivated land area after founding of PRC, was first affected by policy, and then affected by population pressure. After 1990s, rapid development of urbanization became the major factor bringing down cultivated land area. As for per capita cultivated land area decline, rapid population growth was the primary driver (Figure 1.7).

The country's land reform from 1949 to 1952, which greatly mobilized the enthusiasm of peasants for production, not only led to reclamation of abandoned land during the war, but also reclamation of "waste land" including forest and wetland. From 1953 to 1957, China had a large scale land reclamation focusing on Heilongjiang province of Northeast China, and Xinjiang Autonomous Region of Northwest China in various ways, such as rigorously setting up state farms and army reclamation farms, encouraging youth to volunteer reclamation, immigrants' reclamation and peasants' reclamation. In those years, the total land reclamation area amounted to 5.48 mil ha, with the average annual increase of 1.095 mil ha.

During the years 1958–1960, agricultural reclamation developed with the unprecedented speed, and 100 000 demobilized servicemen worked in agricultural construction and production. More than 70 000 of them participated in the reclamation of the Sanjiang Plain of Northeast China. During the large reclamation process, some land unsuitable for reclamation were reclaimed hastily without detailed surveying and planning, leading to some deserted grassland after reclamation. Some reclaimed swamps were abandoned because of flooding. During the 1960s and 1970s, rapid population growth imposed great pressure on cultivated land, leading to gradual expanding of cultivated land area.

From 1986 to 1990, the nett decrease of area of cultivated land is 1.17 mil ha. The State Council decided to implement a comprehensive agricultural development program in 1988, resulting in 1.18 mil ha wasteland suitable for agriculture reclaimed during the next 6 years. After 1996, as China's fast development of the urbanization, area of cultivated land has been decreased continuously, and the area of cultivated land was 122.08 mil ha in 2005 and further decreased to 121.72 mil ha in 2008 (Ministry of Land and Resources).

1.2.2 Forest land

China conducted regular census of forestry and forest resources since 1949 after the Civil War. In 1949, the area of forest is about 107.03 milha, and it increased continuously to 119.78 mil ha in 1976. After some decline between 1976 and 1988, the area of forest increased and reached 195.45mil ha in 2008 (Figure 1.8).

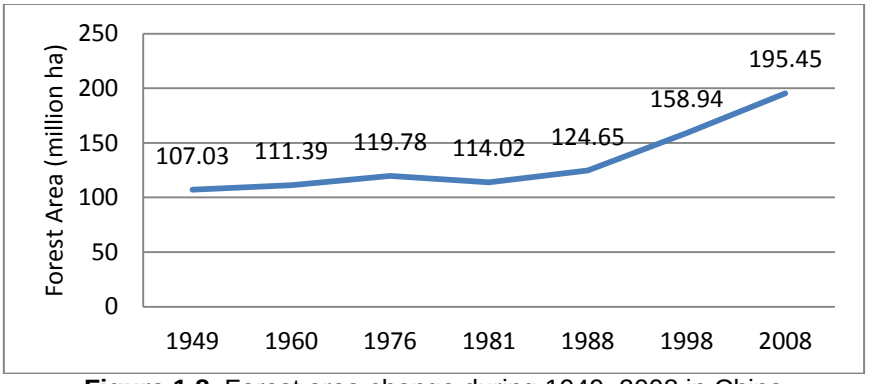


Figure 1.8. Forest area change during 1949–2008 in China
Sources: Institute of Geographic Sciences and Natural Resources Research (1949–1976), Ministry of Land and Resources (1988–2008)

1.2.3 Grassland

There is little change in area of grassland in China since the PRC was founded in 1949. The area of grassland decreased from 266.7 mil ha in 1949 to 266.1 mil ha in 1996. China's grassland is mainly distributed in north China and southwest plateau regions. These regions are either cold with a short growth season, or dry with little precipitation. Affected by monsoon climate, those regions are frequently attacked by natural disasters, of which snowstorms and drought are the most common. Disaster area of grassland is about 5 mil ha each year. Due to the arid climate and widespread overgrazing of pasture, the degradation of arid grassland and desert grassland in arid and semi-arid areas is very serious. There has been nearly 2.35 mil ha grassland degenerating into quicksand since the founding of the PRC (Li 2000). The area of grassland decreased rapidly after 1996, dropping down to 262.1mil ha in 2005 (Outline of China Land Use Overall Plan 2006–2020), and further to 261.84 mil ha in 2008 (Ministry of Land and Resources 2009).

1.2.4 Construction land

After the founding of the PRC in 1949, the construction land area continues to expand and the portion of construction land has become higher and higher. In 1949, the urban and rural residential and industrial land area was only 4.73 mil ha, but it surged to 24.07 mil ha in 1996, increasing by more than fourfold. And the area further increased to 26.02 mil hm^2 in 2005 (Outline of China Land Use Overall Plan 2006–2020) and further to 26.92 mil ha in 2008 (Ministry of Land and Resources 2009). The expansion of construction land is a concrete manifestation of urbanization and modernization, and it has a negative effect on area of arable and forest land.

1.2.5 Unused land

Unused land includes the land which has not yet been used or is difficult to use, mainly including sand, saline-alkali land, marshes, water surface of rivers and lakes, mud flats and so on. Sand, bare land and barren land area is 157.8 mil ha, accounting for 16.6% of the total land area, while the sandy area is 50 mil ha, accounting for 5.3% of the total land area. Since the founding of PRC, China has made great efforts in combating desertification and soil erosion, such as the implementation of Three-North Shelterbelt Construction Project started in 1978, but the sand land expansion trend still continues. In 2005, soil erosion area amounted to 356 mil ha, while degradation, desertification and alkaline grassland area amounted to 135 mil ha (Outline of China Land Use Overall Plan 2006–2020).

1.3 Land tenure arrangement

1.3.1 Transformation of land ownership

(1) *Land reform (1950–1952)*. At the end of 1950, Chinese Government kicked off land reform of privatization through expropriating the surplus land of the landlords and some rich peasants to allocate to the middle peasants, poor peasants and farm labourers, etc. Farmers' land that was received through land reform was issued a land certificate and can be traded freely. The reform was basically completed nationwide by the end of 1952. Land reform eliminated the landlord economy and achieved "land to the tillers", but retained private ownership.

(2) *Cooperative period (1953–1957)*. The Cooperative period went through three phases: Mutual Aid Teams, Primary Co-operatives, and Advanced Co-operatives. At the end of land reform, the center government of China began to encourage communities and farmers to establish and enter Mutual Aid Groups for agricultural production. The members of Most Mutual Aid Groups just cooperate in the busy season and have the rights of ownership and operation decision-making of their own land. Encouraged and intervened by government, Mutual Aid Groups were developed into Primary Cooperatives. Farmers discounted their land into shares and lost management decision-making of agriculture production. In the period of Primary Cooperatives, farmers are still the owner of their land and can receive some bonus. However, when Primary Cooperatives further developed into Advanced Cooperatives due to China government's compulsory requirement, farmers' land became communities' property with nearly no compensation. Advanced Cooperatives brought about transition from private property to common property.

(3) *The People's Commune period (1958–1978)*. The People's Commune Organization is the synthesis of regime and property rights, not only an administrative department but also a productive organization, making land owned by communities lose exclusive rights and becoming unrestricted public property. The People's Commune implemented egalitarian supply system, and land and labour can be allocated unpaid from one community to another community, one People's Commune to another People's Commune. During 1958–1960, China had experienced the *Great Leap Forward*, resulting in severely damage of production, life and ecology. The serious natural disasters and economic difficulties caused by Communization and the *Great Leap Forward* of 1959–1961 compelled the central government to implement a better policy known as the *Four-fixed*: allocating land, labour, livestock and farm tools to production team and establishing the production team as the basic accounting unit. By 1964, the *Four-fixed* policy was basically completed nationwide. Since then, the People's Commune System taking the production team as the basic accounting unit was built up in China. Implementation of People's Commune System developed consciousness of membership right among the villagers.

(4) *Household Contract Management System (1978–)*. Since 1978, the household contract responsibility system began to spread rapidly across the country. In 1981, the Central Work Conference of China acknowledged the legitimacy of the various contract responsibility systems emerging in China. As a result, the household contract responsibility system, with the significant characteristics of "paying first to the state and collective, all the rest belongs to their own", soon replaced the production team collective operation. In 1993, the government decided to prolong the 30-year Land Contract after the first period of land contract expires. In 2008, the central government of China further proposed to maintain the household system for long team.

The implementation of the household contract responsibility system streamlined the relationship of the state, the collective and the individual (Zhang 2012), promoting the rapid development and enormous change of agricultural production. The Household Contract System replaced the People's Commune System taking production team as the basic accounting unit; the nature of collective ownership of rural land during the People's Commune System is still retained. In 1983, forest lands were also contracted out to individuals through implementing the *Three-fixed* policy, and a newly collective forest tenure reform was implemented to further contract out to individuals since 2003.

1.3.2 Land tenure issues

The establishment of Household Contract System greatly promotes agricultural productivity, making China the wonder of the world feeding nearly 22% of the population of the world with less than 10% of the world's arable land. As the arable land was conferred social security functions, the central government insists on maintaining the Household Contract System for long term to prevent farmers from losing their lands. However, along with globalization, industrialization, urbanization and market-oriented promotion, the conflicts between Household Contract System and these trends is inevitable and will become more and more serious. How to reconcile these conflicts and move along a Chinese characterized road in line with China's national conditions of rural livelihoods is the urgent problem China must confront with.

1.4 Major drivers to land use change

1.4.1 Population growth

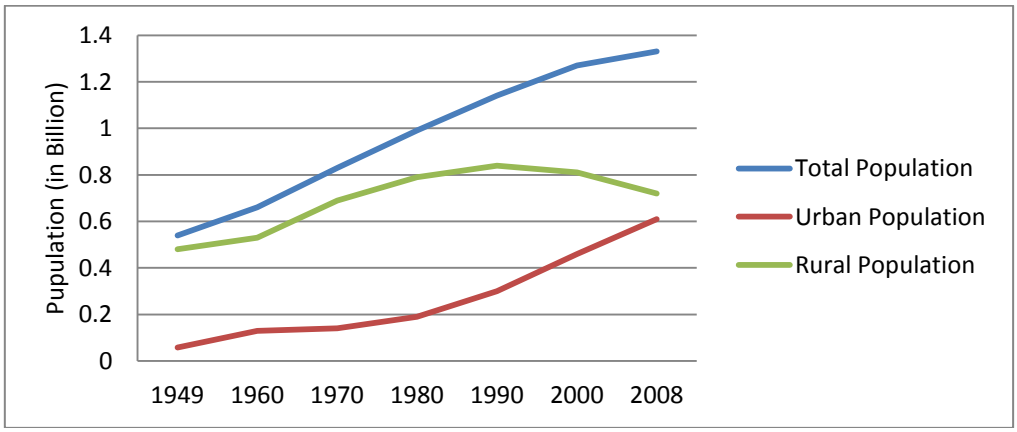


Figure 1.9. China's population during 1949–2008

Since the founding of People's Republic of China, population grew rapidly (Figure 1.9). In order to meet ever growing grain demand, China started large scale reclamation of cultivated land especially between 1950s and 1980s. Grain productivity improved largely after 1980s, reducing pressure for further land reclamation. As the conversion of forest land to farm land, especially land reclamation in slope area, ecological environment degraded in these areas.

In 1999 China started the "Grain to Green" project, gradually transforming croplands on steep slope, which were prone to soil erosion, to forests. This project protected forest land and promoted forest growth. Urban population grew rapidly since 1980s while rural population stabilized and then began to decrease. Rapid growth of urban population brought an increase of urban construction land and encroached suburban farmland, promoting the decline of farmland.

1.4.2 Infrastructure development

Along with the rapid economic growth and modernization progress of China, infrastructure construction developed quickly. Operation length of railway has increased 31.2% in ten years from 53,400 km in 1991 to 70 100 km in 2001 and further to 93 200 km in 2011. Highway began to boom after mid 1990s. In 1998, China had a highway system of 8 700 km. In 2008, highway mileage increased to 60 300 km, 5.93 times of that 10 years ago. By 2011, operating length of highway was

84,900 km a further increase of 40.8% comparing to that in 2008. Reservoir storage in 1985 was 430.1 billion cu m, which has slowly increased to 479.7 billion cu m in 1995. Then from 2005 to 2011, it rapidly increased from 562.4 billion cu m to 720.1 billion cu m in 6 years (NBS 2012). Infrastructure construction not only caused increase of construction land, but also brought decrease of arable land and forest land correspondingly after 1980s.

1.4.3 Urbanization

Process of urbanization in China accelerated after 1980, as urban population increased rapidly and rural population stabilized and began to decrease (Figure 1.9). Accompanied with of population urbanization, proportion of agricultural activities declined and that of non-agricultural activities increased. This was also the process of China's industrialization. Urbanization promoted the conversion of farmland to construction land. The rapid concentration of population in cities and industrial development also brought great pressure on resources and environment. Air and water pollution in cities, industrial and domestic pollution in rural areas, have made ecological and environmental conservation an urgent concern. This has prompted the Chinese Government to carry out integrated forestry projects, contributing to protection and rehabilitation of forest resources.

1.4.4 Expansion of farming

After the founding of People's Republic of China, the Chinese Government established many state-owned farms by reclaiming large tracks of land under the pressure of farmland demand. Among the land reclaimed, some was used for producing grain as in the northeast region, while others were reclaimed for rubber plantation as in Yunnan and Hainan Provinces. Up until 1985, more than 2 700 state-owned farms were established which possessed farmland of more than 4.8 mil ha. Establishment of large-scale farms supported by government was a major factor promoting increase of farmland after the founding of People's Republic of China. Besides, state-owned farms also played an important role in spreading advanced agricultural technology and experiences, cultivating minority talents, supporting constructions in minority area, enhancing national unity, and protecting and constructing frontiers of China.

1.5 Governing land use change

1.5.1 Problems in land utilization:

(1) Urban construction land continued to expand, while it was underutilized. Urban constructions in China mostly occupied high quality land especially farmland in suburbs, which was the main cause of decline of farmland. Part of farmland was underutilized in the process of conversion to urban construction land. By the end of 2004, idle land amounted to 0.26 mil hm^2 across China's cities and towns, accounting to 8% of total urban construction land (Sun 2004).

(2) Urban land has problems of waste and also over-used, while rural construction land was extensively used (Zheng 2009). Many cities were keen to construct the new urban district, leading to waste of land. But at the same time, land was over used in old urban area, causing the problems of air pollution, traffic jam and poor living conditions. Construction land in rural areas was extensively managed, with a low land development intensity and low land utilization rate.

(3) Serious land pollution and ecological environment destruction. With the development of urbanization, lots of cities set up the development zone to attract enterprises. However, effective pollution management of manufacturing enterprises lacked. Besides, traditional high pollution industry was moved out to suburbs during the process of expansion of cities. Poor management and extensive resource utilization in suburb areas resulted in large amount of emissions of industrial wastes (Huang 2007).

(4) Farmers' rights were violated during the process of urban construction expansion. Due to the imperfect land requisition institutions and cheap cost of expropriating rural collectively-owned land, land expropriation was abused and cities were developing at the expense of farmer's interests. Many farmers lost their lands, which had a negative effect on agricultural and rural development.

1.5.2 Laws in land using and management

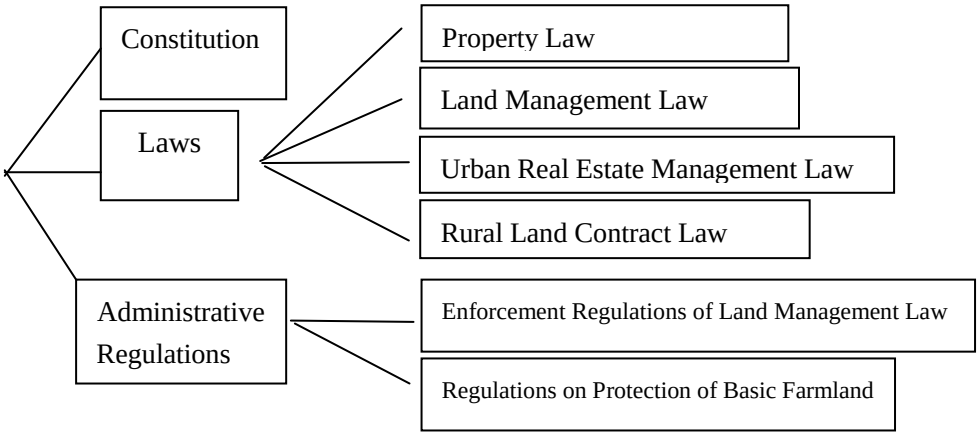


Figure 1.10. Legal systems of land management

Legal system of China's land management can be divided into three levels (Figure 1.10). The Constitution prescribed that, urban land was owned by the state; rural and suburb land was owned by the collective, except for those land that belong to state as stipulated in the law; the state can expropriate land and made compensation according to the law; any organization and individual cannot encroach, deal or transfer land; Right to use the land can be transferred in accordance with the law.

Legal system of China's land management was composed by the following two aspects: first was property regime, which prescribed the private rights on land and land use, and focused on protection of land rights; second was land authority system, which prescribed public power of land from perspective of public law, focusing on public administration of land (Cui 2013).

1.5.3 Administrative organizations for land using management

There are mainly three land- use administrative organizations in China: Ministry of Land and Resources, State Forestry Administration and Ministry of Agriculture. Their main functions are introduced as follows:

(1) Ministry of Land and Resources. It is in charge of developing policies regarding the management , protection and rational utilization of land; enforcing the control over the different purposes of land used for agriculture; protecting capital farmland; supervising the development of unused land and cultivated land, land revitalization and reclamation (Ministry of Land and Resources 2012).

(2) State Forestry Administration. Forestry Administration is the government department in charge of forestry, and is responsible for forestry ecological construction, forestry industry guidance and management, wildlife protection, forest pest control and forest resources protection (State Forestry Administration 2012).

(3) Ministry of Agriculture. It is in charge of guidance and supervision of cultivated land use rights transfer. It also guides development and utilization of cultivate land, fishery waters, grassland, mud flats and wetland.

1.5.4 Policy orientation on land utilization

(1) *Arable land protection*. Chinese Government was determined to maintain arable land area of no less than 120 mil ha. National arable land area maintained 121.2 mil ha in 2010 and would be no less than 120.3 mil ha in 2020. During this period, no less than 104 mil ha basic cropland would be maintained, and the land quality would be improved.

(2) *Balance of arable land*. It was first formally claimed in the Land Management Law in 1998 that wherever and whenever arable land was used as construction land, local government should reclaim or extend the equivalent arable land as supplement. Those who occupied the arable land for

construction must take responsibility for new arable land reclamation and extension. For those who are unable to reclaim and extend arable land, they also should take responsibility for providing all relevant funds for reclamation of new arable land.

(3) *Economical intensive land use*. To set up urban and rural unified land market and create favourable conditions for market mechanism to work. To use more of economic means such as land price and taxes and duties to lower land transfer cost, and improve efficiency of land resource allocation and utilization.

(4) *Coordinating land use and ecological development*. To coordinate short term and long term interests in the process of social and economic development, coordinate economic growth and ecological protection, coordinate local and regional development.

CHAPTER 2 FORESTS AND FORESTRY IN CHINA

Forest land in China referred to arbor and bamboo forest land with canopy cover of more than 0.2, shrub land, cutover land, burned area, young afforested land, land for tree nursery, and suitable land for forest prescribed by governments above county level (Forest Law of People's Republic of China 1998). In the calculation of forest coverage in China, forested land, specified shrub land, and shelter forest for farmland were all included. Forested land or land with forests means that arbor and bamboo forest land with tree canopy cover of more than 0.2.

2.1 Forests in China

2.1.1 Basic status of forest resource

According to Report of the Seventh National Forest Inventory (2004–2008), China has 193.33 mil ha of forests, with a timber stocking volume of 13.36 billion cu m, ranking fifth in the world. This figure includes bamboo and plantation of cash trees, e.g. fruit, rubber and oil seed trees. China has of 61.69 mil ha of plantation forest, the largest globally with stock volume 1 961 mil cu m. The natural forest area is 119.69 mil ha with stock volume 11 402 mil cu m.

China's forest land spans a wide range of latitude, elevation and soil. Consequently, forest species are diverse, ranging from pure larch in the cool-temperate northeast to the complex multi-species mountain rain forest in the tropical south. Forests would be categorized into eight zones based on forest types. They are: cool-temperate cold-resistant coniferous forest zone, temperate-coniferous and broad-leaved mixed forest zone, warm-temperate deciduous broad-leaved zone, northern subtropical evergreen and deciduous broad-leaved forest zone, central and southern subtropical evergreen broad-leaved forest zone, tropical seasonal rain forest and rain forest zone, East Tibet Plateau dark coniferous forest zone and Gan-Xin mountain coniferous forest zone.

2.1.2 Forest types

According to the Forest Law of PRC China, forests are categorized into 5 forest types, divided into protection forest, timber forest, economic forest, fuel-wood forest and special purpose forest. The Forested land area totals 181.38 mil ha, of which protective forest area is 83.08 mil ha, accounting for 45.81%, the special purpose forest area is 11.98 mil ha, accounting for 6.60%, the timber forest area is 64.16 mil ha, accounting for 35.38%, the economic forest area is 20.41 mil ha, accounting for 11.25%, and the fuel-wood forest area is 1.75 mil ha, accounting for 0.96% (see Figure 2.1).

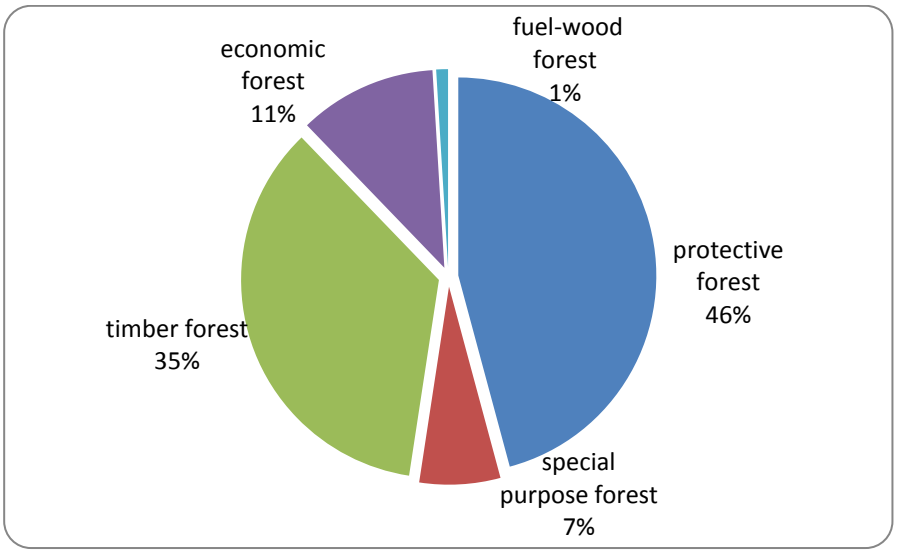


Figure 2.1. Components of forest land area by forest types

Data source: SFA (2009)

Since 1998, the State Forestry Administration (SFA) enacted a new policy: categorized forest management. According to this policy, the forests are also classified into two categories: public welfare forest and commercial forest. Of the total forest land, public welfare forest accounts for 52.41%, and the commercial forest accounts for 47.59%.

2.1.3 Main species

The forest area totals 193.33 mil ha, of which 181.38 mil ha is forested land. The forested area includes 155.59 mil ha of arbor forest, 20.41 mil ha of economic forest and 5.38 mil ha of bamboo forest. In arbor forest, the tree species (group) of oak, Masson Pine, Chinese Fir, Birch, Larch, Poplar, Yunnan Pine, Spruce, Cypress, Silver Fir rank the first ten in terms of area. The total area is 86.21mil ha with the total stock volume of 7.6 billion cu m.

Table 2.1. Area and stock of dominant species in arbor forest

Dominant species	Area(1000 ha)	Stock volume(mil cu m)
Oak	16 100	1 208
Masson Pine	12 040	588
Chinese fir	11 270	734
Birch	10 800	799
Larch	10 630	955
Poplar	10 100	549
Yunnan Pine	4 610	469
Spruce	4 310	1 002
Cypress	3 240	163
Silver Fir	3 110	1 136

The total area of natural forest in China is 119.69 mil ha, mainly in northeast, southwest and, Jiangxi and Guangxi Provinces, taking up 67.02%. The plantations cover an area of 61.69 mil ha, mainly in southwest and southeast regions.

2.2 Characteristics of forest in China

2.2.1 Rapid growth of forest coverage, forest area, and forest stock volume

Between the Seventh (2004–2008) and the First (1973–1977) National Forest Inventories (NFIs), the main changes of the forest resources include the following aspects: the forest coverage has increased from 12.7% in 1973 to 20.36%, forest land area from 121.86 mil ha to 195.45 mil ha, and forest stocking volume from 85.56 billion cu m to 13.72 billion cu m (see Figures 2.2, 2.3, 2.4).As shown in those figures, since the 80's of the last century, China has achieved rapid growth in both forest land area and stocking volume.

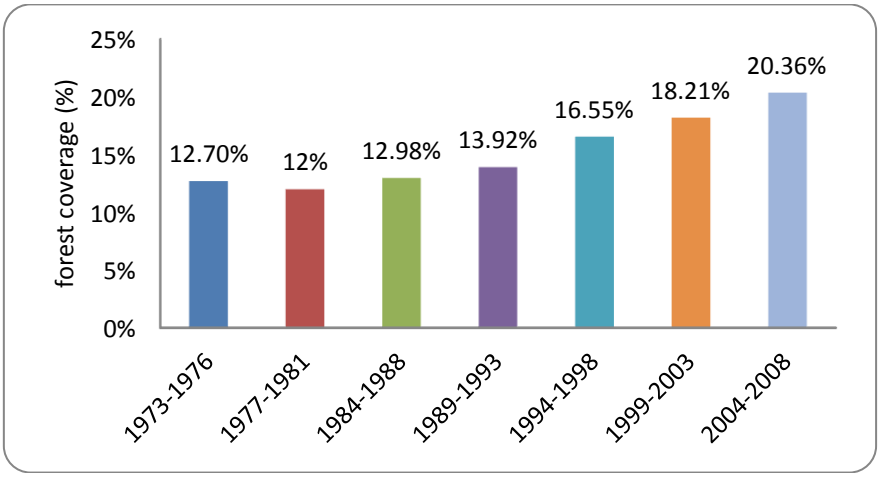


Figure 2.2. Change of forest coverage in China

Data source: SFA (2009)

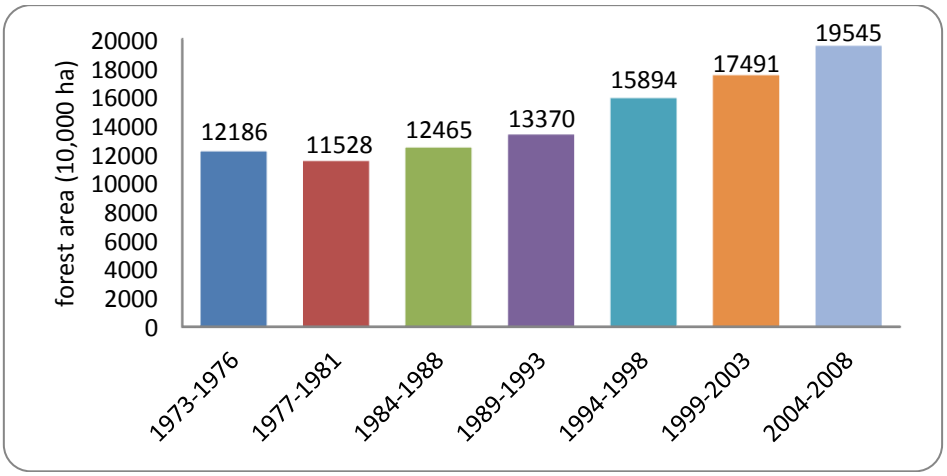


Figure 2.3. Change of forest area in China

Data source: SFA (2009)

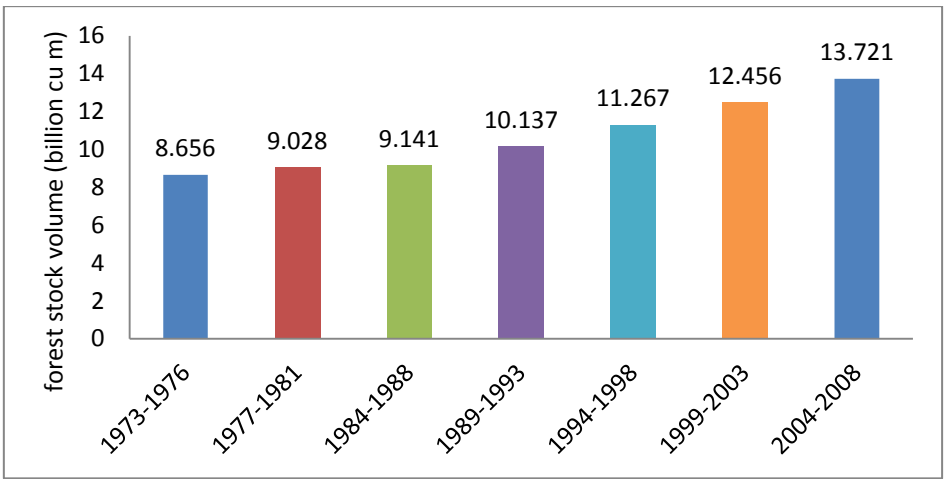


Figure 2.4. Change of forest stock volume in China

Data source: SFA (2009)

A major reason for the growth of forest in China is that Chian has lauched many major ecological programmes since 1978.The plantation forest area has increased by 38.1 mil ha from 1973 to 2008 (Figure 2.5).

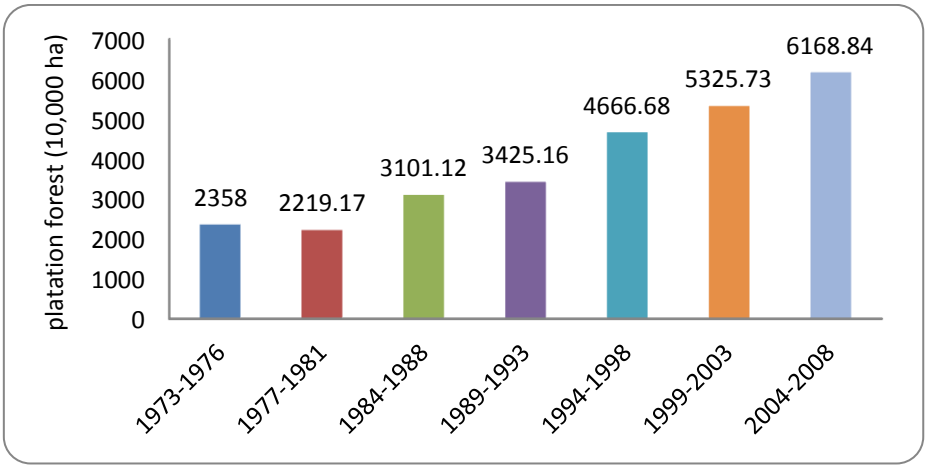


Figure 2.5. Change of platation forest in China

Data source: SFA (2009)

2.2.2 Low quality in forest

In recent years, forest quality has raised to major concern in China's forestry development arena. The forest quality requires improvement. Timber stocking volume amounts only 85.88 cu m/ha, only 74% of the world average, far lower to those with high quality of forests, such as Germany with 268 cu m per ha, Austria with 295 cu m per ha, and even Russian with 100 cu m per ha.

Forest health is relative poor too. In some places, a large area of plantation forests lead to the single structure in forests, which inevitably brings about the issues of low forest ecosystem function and productivity of forests. What is worse, due to poor management, single species, and poor tending, annual forest pests and diseases area reaches 7.33 mil ha, and the amounts of tree growth reduces 17 mil cu m.

Age structure is unbalance. In the forest land, forest stand age structure is not rational enough (Figure 2.6). Of the total arbor forest area, the young forest and middle-aged forest is too high, taking up 67.2%, while the mature forest only accounts for 12.03%.

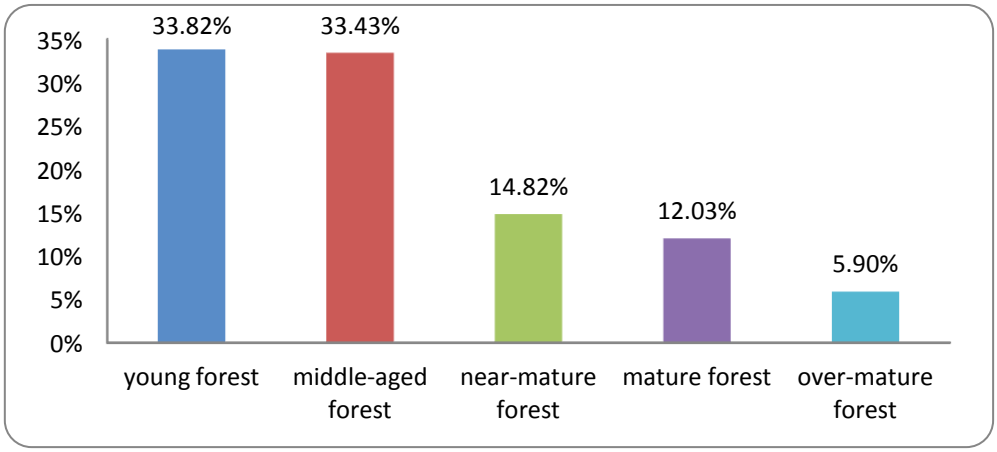


Figure 2.6. Components of arbor forest area by group

2.2.3 Scarcity of forests

Although China ranks in the top five in the world in terms of total forest acreage, its per capita amount is relatively low. The per capita forest acreage is 0.145 ha, only one-quarter of the world's average, and the per-capita forest stocking volume is 10.15 cu m, less than one-seventh of the world's average.

China's forest resources are also small relative to demand. Imbalance in supply and demand has worsened following the government's imposition of a logging ban in large areas of natural forests in 1998 under its Natural Forest Protection Program. Dependence on foreign supply of timber resource in China is increasing year by year, from 23.56% in 1997 to 44.75% in 2011（SFA 2012）. According to SFA report, in 2020, China's domestic wood consumption will rise to 457 to 477 mil cu m, and the timber trade deficit will amount to about 100 to 150 mil cu m (including demand of timber for paper and pulp, funiture, etc.). And this deficit will remain for a long time until subsistantial increase of logging production from improved China's forests. in ths short run, China's dependence on oversea timber supply will continue to increase year by year.

The existing pressure on China's forests and other resources is enormous. More than 30% of the country (about 356 mil ha) is affected by soil erosion. China's desertification area is 2 623 700 sq km, accounting for 27.33% of total territorial land area, and sandification land area is 1 731 100 sq km, accounting for the 18.03% of territorial land area. It can be seen that the quantity, quality and service functions of forest resources could not meet the requirements of social and economic development. The shortage of ecological products, and forest products is still a prominent issue of restricting China's sustainable forestry development.

2.2.4 Imbalances in the distribution of forest resource

The forest land area in China is divided into northeast forest region, southwest forest region, southeast forest region, northwest forest region, and tropical forest region. The highest concentration of standing timber volume is in the southwest and the northeast. In terms of area and volume, forest resources are concentrated in northeast forest region and southwest forest region. These regions account for about 61% of the forest area and a significant 67% of the forest stock volume. Another 39% of the forest area and 33% of the volume is located in other forest region (Figure 2.7). However, as can be seen in Figure 2.7, the regions with scarce forest resource are well known as the ecologically fragile and less developed area in China, Which are posing s serious challenge on China's ecological environment.

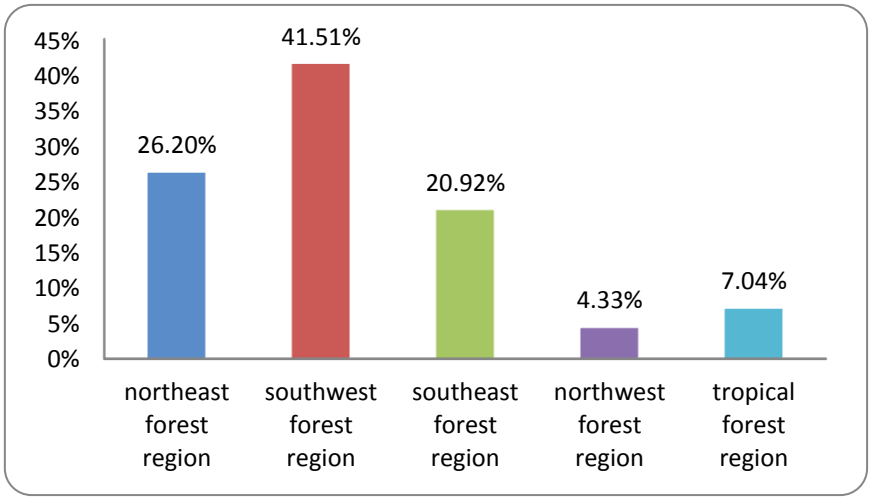


Figure 2.7. The pencentage of forest stocking volumes by forest region

Source: SFA (2009)

2.3 Forest ownership

Officially forest land in China is either owned by the state or by collectives. State forests are owned by the government on behalf of the citizens of China and under the management of provincial, prefectural and county authorities. Administrative villages officially own forest land. In rare cases, in particular the collective areas are essential to flood control, transformation system, water ways, where designated to be managed under township authorities, including township forest technical extension station, and water management station.

The governments in various levels devolved state forest utilization and management responsibilities to state forest enterprises (including state forestry industry bureaus and state forest farms), while collectives have normally retained direct control of their forests during in the commune period. Since early 1980s', these responsibilities have been shifted to very complex forest management and utilization (Liu 2012).

Table 2.2. Change of ownership of production forests in China

Ownership	6th National Forest Inventory（1999–2003）		7th National Inventory（2004–2008）	
	Acreage ($10^6 hm^2$)	Percentage (%)	Acreage (10^6 hm^2)	Percentage (%)
State	35.36	42.36	18.14	28.27
Community	32.68	39.15	22.02	34.32
private	15.43	18.49	24.00	37.40

While the government owns most natural forests, mostly in large scale, the smaller woodlots and individual trees are often privately owned. Private tree ownership has been permitted since 1956 when individuals or groups were given the right to own planted trees in degraded or vulnerable areas, such as along watercourses and roadsides, in household plots and villages. Individuals who plant trees have the right to sell and bequeath them when they die. Since the reform of collective forest tenure system, the forested land area managed by the individuals has increased by 11.39%, up to 32.08%.

Some 62 mil ha of plantations which accounts for 31.8% of the total forests in China has been afforested or reforested according to the Seventh National Forest Inventory (2004–2008) (SFA 2010), largely contributed to China's forest cover increment. Newly afforested areas are mostly owned by a community or privately (see Table 2.3), largely as a result of the reallocation of land-use rights, financial incentives to communities or private sector participation in governmental initiated projects (Liu 2003, Liu and Yuan 2007). The pattern that the state, the collective and the individuals have managed respectively one third of forested land has been basically formed.

Table 2.3 sets out the breakdown in ownership of forest area; natural forests and plantations; and economic and bamboo forests. In terms of forested land area, state forests (which are concentrated in the northeast and southwest) account for the lion's share with 39.38% of the total, but collectives and individual own 60.62% of the forested land. Collectives dominate the area and volume of plantation forests, while state forests have traditionally been primarily composed of old-growth natural forests (see Table 2.3). The relative importance of collectives has been growing over time. For almost four decades (1940–1980) state forests were major suppliers of timber to the economy. Since the early 1980s, however, state forests output has declined dramatically. The decline in forest resources is the direct result of over-harvesting and a lack of investment in reforestation.

Table 2.3 shows that in the forested land area, the state, the collectives and the individuals have managed respectively one third of forested land. In term of forest types, the arbor forest of state owned forest land is larger than that of collectives and individuals, taking up 45.11% of the total. However, its share declined by 3.04% since the Sixth NFI. In the economic forest and bamboo forest, collectives and individuals have a larger proportion, taking up 82.68% and 76.13% respectively. Comparing with the Sixth NFI, although state owned forests have increased, its share declined by 2.13%, while all forest types of individuals have change significantly.

Table 2.3. The land area by property rights (10 000 ha; %)

a. Forested land

Ownership	6th National Inventory（1999–2003）		7th National Inventory（2004–2008）	
	Acreage	Percentage	Acreage	Percentage
State	7016.39	41.51	7143.58	39.38
Community	6389.39	37.80	5176.99	28.54
Private	3496.15	20.69	5817.52	32.08

b. Arbor forests

Ownership	6th National Inventory（1999–2003）		7th National Inventory（2004–2008）	
	Acreage	Percentage	Acreage	Percentage
State	6875.37	48.15	7018.52	45.11
Community	5431.78	38.04	4820.15	30.98
Private	1971.52	13.81	3720.32	23.91

c. Economic Forests

Ownership	6th National Inventory（1999–2003）		7th National Inventory（2004–2008）	
	Acreage	Percentage	Acreage	Percentage
State	109.06	5.10	100.80	4.94
Community	708.76	33.14	252.66	12.38
Private	1321.18	61.76	1687.54	82.68

d. Bamboo forests

Ownership	6th National Inventory（1999–2003）		7th National Inventory（2004–2008）	
	Acreage	Percentage	Acreage	Percentage
State	31.96	6.60	24.26	4.51
Community	248.85	51.39	104.18	19.36
Private	203.45	42.01	409.66	76.13

e. Natural Forests

Ownership	6th National Inventory（1999–2003）		7th National Inventory（2004–2008）	
	Acreage	**Percentage**	**Acreage**	**Percentage**
State	6127.55	52.93	6269.39	52.38
Community	4153.87	35.88	3535.25	29.54
Private	1294.78	11.19	2164.61	18.08

f. Planted Forests

Ownership	6th National Inventory（1999–2003）		7th National Inventory（2004–2008）	
	Acreage	**Percentage**	**Acreage**	**Percentage**
State	888.84	16.69	874.19	14.17
Community	2235.52	41.98	1641.74	26.62
Private	2201.37	41.33	3652.91	59.21

2.4 Major policy elements

2.4.1 Forestry taxation and finance

Taxes and other charges on forestry in China have been much higher than for many other sectors, and this has been a major disincentive for the private sector and other kinds of organizations to be sensitive in forest tenure security and involve in forestry activities. The Central Government is aware of this situation in the forests sector. It has been reducing 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, and between the western China and eastern China. In 2002, China initiated a new round of rural taxation reforms, eliminating many charges related to agricultural products. In 2005 governmental tax on forest products was eliminated. As part of collective forest tenure reform, official charges on forest products were greatly declined to about 5% of timber production value in most provinces in China.

2.4.2 Classified forest management

The classified forest management policy zoned forest land into “commercial” and “ecological” or “public affairs” based on the main functions the forest was to play, in order to achieve multi-functions of forests instead of harvesting for revenue only. Different administrative, management and policy means will be established to so-called commercial forests and ecological forests. Market instruments will be promoted for commercial forests development, and based on this principle, harvest quota regulation and financing policy need to be reformed. The investment for commercial forests depends on markets or commercial loans in most situations. Government will pay great important role in management of ecological forests with investment from public budget and administration for achieving public interests. China’s central government did allocate funds called “ecological compensation fund” to support this policy, but only five CNY per mu (about USD12 per ha). Since 2008 the fund increased to CNY10 per mu (about USD24 per ha) (SFA 2010). In some sea coast provinces, provincial government allows matching fund to support implementation of classified forest management policy.

2.4.3 Harvesting regulation

Harvesting regulation consists of three core elements: planning of harvesting quota, application of harvesting quotas, and harvesting certificate. Forest resource management policies are mainly focused on protecting the remaining forest resources, with all harvesting regulated by annual quotas. Forest resource management policy has been in hot debate since 2003, and reform agenda has been in the formulation stage. The orientation of the reform was expected to support commercial forestry development by approaches of freedom of market economy, with the means of introducing freedom of forest management, extraction, processing and marketing, favor legislative and institutional environments, marketing of environmental services to enhance the private roles in protection forests management. Since 2004, harvesting quota was stopped to apply for bamboo forests. Innovative implementation approaches to regulating harvesting of commercial forests have been in practices in many places in South China Collective forests regions. SFA has piloted a new approach in Fujian province, setting up a maximum forest area which could be harvested annually to replace the maximum volume of timber. The intention of this reform is to provide an incentive for owners of forests

to improve the quality of forests and livelihoods of local inhabitants. Furthermore, it is expected that SFA will promote liberalization of harvesting for commercial forests, replaced by strengthening forest management planning scheme in the operation unit of forest management.

2.4.4 Forest land Protection and Management

As the development of industrialization and urbanization, land demand for all kinds of construction use increased. Illegal occupation of forest land was on the rise. In this case, central government in China was determined to put forest land in the equally important position with farmland, and pay high attention to forest land conservation.

Policy measures covered mainly the two following aspects: first, promoting increase of forest area. Forest protection target was set up at all of state, province, city and county levels. Enhancing forest acreage through afforestation in land suitable for forest and transforming of open forest land was encouraged. Degraded forest land would be restored through forest land restoration project. Secondly control forest land loss. Policy of requisition-compensation balance for forests was carried out to ensure supplementary forest area was no less than those expropriated. Land productivity of restored forest should not be below original level to prevent degradation of natural forests and primary timber production bases.

2.4.5 Forest Tenure Management

China began to implement the Property Law in 2007, and forest property rights were considered as 'the property rights related to forest', including the ownership of forest resources, forest ownership, forest land contract and management rights, etc. According to the Property Law of China, ownership of forest resources and forest land can only be the state or collectives, and the contractor and/or operator have usufructuary rights on forest land, namely the rights of possession, use and benefits. Contractor and/or operator generally should be households, so can be other legal persons and organizations. Contractor and/or operator can apply for 'forest warrants'.

China implemented a new collective forest tenure rights reform since 2003 to further decentralize collective forests to households. By the end of 2012, the ownership of around 190 mil ha, equivalent to 97.7% of the total collective forests in China, has been clarified; and 95.5% of clarified forests has been titled to 89.49 million households (Zhang 2012). In 2013, China kicked off the state-owned forest tenure reform with the core goal of strengthening the ecological forest protection in seven pilot provinces, and nationwide reform is expected to be implemented in the future.

2.5 Main stakeholders in the forestry sector

China has established a comprehensive and well-structured top-down forestry administration system, which is the most important and influential actor among the stakeholders in the development of China's forestry. Along the more depth and width reform carried out towards to market orientation, number of stakeholders has been in increasing, interrelationship among the stakeholders has been in transformation. Private sector seeks to have more roles in marketing of forest related products and services and management of forests. Civil society organizations has been emerging and growing very rapidly, and forestry authority is not yet experienced to work with civil society organizations and to response opinions made by the public on forestry policy. The main stakeholders in the forestry sector can be grouped as:

- *Forestry Administration*: SFA, provincial and prefecture forestry departments, county forestry bureaus and township forestry stations attached with a top-down forestry science and technical extension system.
- *Forest enterprises*: State forest bureau, state forest farm, collective forest farm, share-hold forest farm, small scale household, transnational and national timber related enterprises.
- *Forest industry*: China is one of the largest countries to import and export timber and timber-related products in the world with rapid growth in recent years.
- *Local and International Non-governmental organization (NGOs)*: WWF, TNC, CI, Green Peace, Centre for Community Development, and many others, involving in forest-related environmental campaign and education, promoting best practices and policy for sustainable forest management, etc.

- *Research and educational institutions*: Chinese Academy of Forestry, Renmin University of China, Beijing Forestry University, Nanjing Forestry University, and Forestry Economics and Development Research Centre.
- *Community people and community based organization*: Forest is an important of resources for community people's livelihoods. China has diversity of forest related cultures in ethnic minority regions with rich of traditional forest-related knowledge, including sustainable land use practices, customary regulations, community based organization and culture related forestry practices.
- *International organizations*: including FAO, UNDP, UNEP, and WB, Asia Development Bank, GEF, etc.
- *The youth*: With rapid economic development, less and less people in high education system are interested in the subject related to forests. The great needs on redesigning the educational materials should be highlighted.

2.6 Forest utilization and management

Responsibility in terms of land ownership for forest management is split between state forestry bureaus (enterprises or state forest farms), collectives, family farms, professional investors and individual.

State forestry bureau, which currently has number 135 with each one employing 4 700 staffs on average and jointly controlled by central and provincial governments, were originally set up in the 1950s–1960s to manage forest production from the large nationalized natural forests at Northeast China, Southwest China and Northwest China accounting for 25% of the forest area. They are a type of state enterprise with responsibility for harvesting, forest management and processing activities. In addition, they have significant social responsibilities. For several decades, state forest areas have been over-harvested, causing great natural disasters, as a result, most remaining natural forests are protected and usually inaccessible after 1997. Now they also manage a lot of plantations.

State forest farms, which account for 17% of the total forest area, were established later, aiming to increase forest cover through afforestation and manage smaller secondary forests. State forest farms numbered 4 735 in 2011 all over the country and has 80 staff members each on average. Most of these farms are located in the south of China. State forest farms were normally controlled by county governments in the past, now most of them by provincial governments.

Forestry collectives were introduced in the 1950s by bringing together individual private forests and woodlots that had not been allocated to forestry bureaus or state forest farms. During the period of Cooperative and People's Commune, forestry collectives cover almost all administrative villages in the south of China. The number is over 150 000 and accounting for 58% of the forest area, which represent the largest category of publicly owned forest. Until the implementation of *Three-fixed* policy in 1981，about 69% of collective forests were contracted to households in the south of China (Zhang 2009). The responsibilities and benefits of managing collective forests are endowed to them. As a result, the collective forest areas managed by forestry collectives began to decrease dramatically. With the new collective forest tenure reform since 2003, collective forests had been furthermore decentralized to private sectors and contractors. Each collective is required to manage less than 10% collective forests by central government. However, some communities in the south of China, especially in central Fujian Province, forestry collectives insist in managing collective forests and not allocating the remaining collective forests to households when implementing the newly collective forest tenure reform. They sustainably extract and plant forests according to the situation of communities' forest, and allocate the benefits of wood extraction to villagers with a fixed proportion every year, with the support of local government and villagers.

Family forest farm appeared after the implementation of forestry *Three-fixed* policy. In early 1980s, China central government implemented the policy of '*who afforests who owns'* in order to encourage to eliminate barren hills. Some industrious villagers acquired large tracts of forest land management rights and forest ownership through afforestation on barren hills. Furthermore, through interchange and circulate with other villagers whose forestland near to theirs, they can operate a certain scale and contiguous forest. As China's great population, few forest resources on average, Egalitarianism during implementation of forestry *Three-fixed* policy and the newly collective forest tenure reform since 2003,

the number of family forest farms is very small, primarily formed in 1980s. As the operators of family forest farm usually have good skills on managing forest, the forest of family farm often has a higher quality than others.

Professional investors with their advantages of easy access to information, huge financial capital and influential political capital, had transferred a large number of collective woodlands from village collectives. These were mostly emerged in the 1990s with the implementation of forestry market-oriented reforms in southern collective forest districts, and a few formed during the period of the newly collective forest tenure reform since 2003.The woodlands managed by professional investors usually have no limitation on consanguinity and geographic. Five key factors can be attributed as the cause of the emergence and development of professional investors: four wasteland auction policies in the early 1990s; the liberalization of forestland; widespread communities funding needs for rural public construction; and paying for World Bank loan expires for afforestation in the late 1990s; and collective forestland auctions during the newly collective forest tenure reform since 2003. In the beginning, professional investors just invest forest trees not forestland, now they prefer to invest in forestland and participate in afforestation owing to the standardization and fierce competition of forestland transfer.

Forestry Cooperation Organization mainly appeared in early 2000s since the introduction of the new collective forest tenure reform. In 2003, China kicked off the main reform of collective forest tenure, and then began to implement supporting reforms, one of which is promoting the level of social service. In 2007, a new law, China Cooperation Organization Act, was implemented, directly promoting the emergence of a large number of forestry cooperative organizations. However, due to the long cycle of forestry production and other features, these organizations could not follow the traditional agriculture cooperative organizations in providing pre-producing, transfer and post-production services. In fact, forestry cooperative organizations are close to joint-stock company: different forestry operators convert their forestland into shares through valuation. Decision making of forest management no longer belongs to the original owners, but cooperative organization. Although the official statistics of forestry cooperative organizations show a trend of rapid development, in fact, truly forestry cooperative organizations are far fewer than the official number. However, with the promotion of the marketization and the change of rural forestry management, forestry cooperative organization is expected to have a good future in China.

2.7 Economic, social and environmental contribution of forests

2.7.1 Timber production

Of the world's four major materials (steel, cement, wood and plastic), wood is the only renewable and recyclable material. Wood is closely related to national economy and the people's livelihood.

At present, China is the world's largest wood processing and production base (Table 2.4). China is also one of the largest international wood purchasers. Chian is one of the top producers of composite panels, furniture and wood-based flooring. By far, China is the world's largest importer of logs and other forms of wood fibre. In 2012, China's import was equal to 10% of the total global production of industrial round wood (The State Forestry Administration of China 2013). Although Chinese domestic timber production had decreased since the implementation of Natural Forest Protection Project in 1998, timber production began to increase gradually after 2002 and stayed around 80 mil cu m in recent years (Figure 2.8).

Table 2.4. Variety of timber production of China

Time	Timber production (mil cu m)	Bamboo (mil stalks)	Sawn timber (mil cu m)	Wood-based panel (mil cu m)				
				Total	Plywood, fiberboard, and particleboard			
					Total	Plywood	Fiberboard	Particleboard
2002	44.36	668.1	8.52	29.30	22.72	11.35	7.67	3.69
2003	47.59	968.6	11.27	45.53	37.78	21.02	11.28	5.47
2004	51.97	1098.4	15.33	54.46	43.02	20.99	15.60	6.43
2005	55.60	1151.7	17.90	63.93	51.52	25.15	20.61	5.76
2006	66.12	1311.7	24.86	74.29	60.39	27.29	24.67	8.43
2007	69.77	1397.6	28.29	88.39	71.20	35.62	27.30	8.29
2008	81.08	1262.2	28.41	94.10	75.90	35.41	29.07	11.42
2009	70.68	1356.5	32.30	115.47	93.71	44.51	34.89	14.31
2010	80.90	1430.0	37.23	153.61	127.58	71.40	43.55	12.64
2011	81.46	1539.2	44.60	209.19	179.91	98.70	55.62	25.59

Data sources: China Forestry Yearbook (2011)

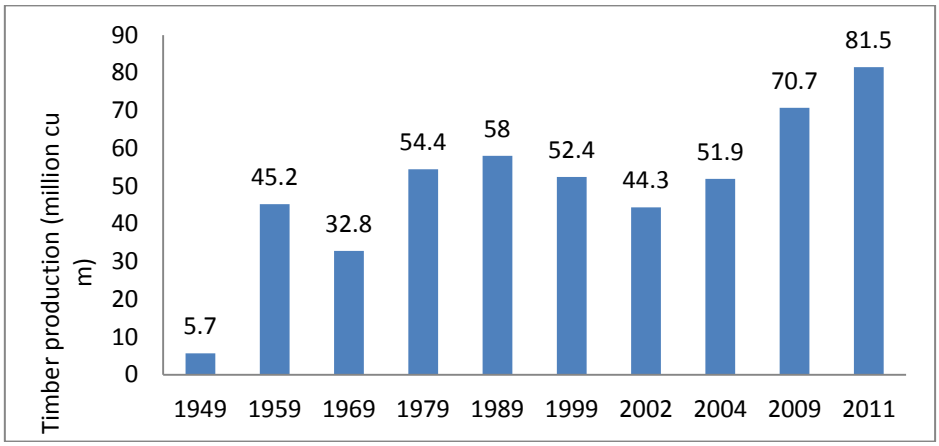


Figure 2.8. Timber production since 1949

Source: China Forestry Statistical Yearbook (2001 and 2011)

2.7.2 NTFP production

The production of non-wood forest products (NWTP) and floral products in China are in a growing trend. In 2011, the production of non-wood forest products was 133.80 mil tons, and fruit, dried fruit, woody herbs and woody oil production were respectively 114.71 mil tons, 9.27 mil tons, 1.44 mil tons and 1.55 mil tons. Among horticultural products, cut flowers and leaf-cutting production amounted to 14.23 billion branches, and ornamental nursery stock production amounted to 12.09 billion plants.

2.7.3 Carbon storage in China's forests

Although there is a significant difference among estimates on forest vegetation storage from different methods applied, the overall trend of carbon storage of China forest vegetation is consistent. Based on the research of Xu *et al.* (2007), the total vegetation carbon storage of Chinese forests in the six periods (1973–1976, 1977–1981, 1984–1988, 1989–1993, 1994–1998 and 1999–2003) is 3.85 Pg C, 3.7 Pg C, 3.76 Pg C, 4.11 Pg C, 4.66 Pg C and 5.51 Pg C, respectively (1 Pg C =1 billion metric tons). In the period of 2004–2008, the total carbon storage of the forest vegetation is 7.81 Pg C. It can be seen from Figure 2.9 that the total carbon storage fluctuated in the early of 1980s, but their trends are on an increase with time. It is worth noting that the carbon density does not increase with time, ranging from 35t to 40t per ha (Figure 2.10). It can be concluded that the trend of carbon storage of China forest vegetation and the little change of carbon density are the result of large-scale afforestation and reforestation in the past 30 years.

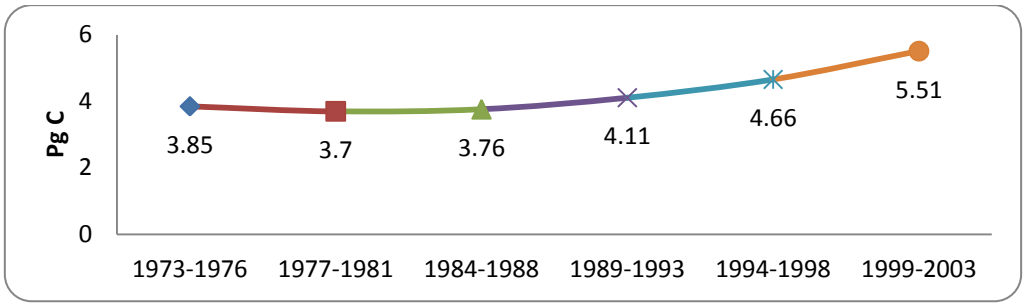


Figure 2.9. Carbon storage of China forest vegetation during 1973–2003

Source: Xu *et al*. (2007)

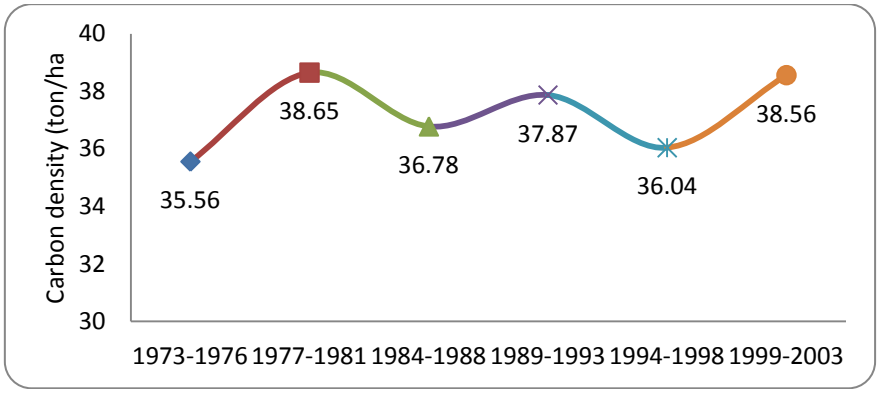


Figure 2.10. Carbon density of China forest vegetation during 1973–2003

Source: Xu *et al.* (2007)

Based on the date of Seventh National Forest Inventor (NFI), the Chinese Academy of Forestry estimated that the total carbon storage of the forest vegetation is 7 811 mil metric tons in the period of 2004–2008, which are equivalent to the carbon emissions produced by 109 mil tons of standard coal. Of the total carbon storage, the carbon storage of arbor forest is 6 654 mil metric tons; open forest, scattered tree and four-side tree is 593 mil metric tons; shrub forest is 358 mil metric tons; bamboo forest is 198 mil metric tons (Figure 2.11). Of the total carbon storage of arbor forest: the natural forest is 5 526 mil metric tons, and the plantation forest is 1 128 mil metric tons. The carbon storage of the forest vegetation is mainly distributed in the region of northeast China and southwest China, with the proportion of 20% and 40% respectively. The tree species of oak, Chinese Fir, Poplar, Larch, Birch are top-ranking in term of the area, accounting for 33% of the total carbon storage of the forest vegetation. The carbon density of arbor forest is 42.82 tons per ha.

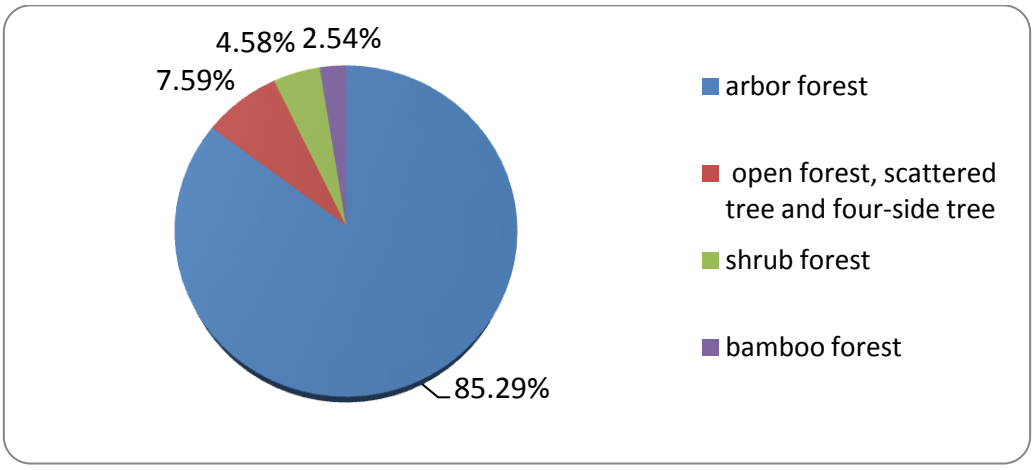


Figure 2.11. Components of the total carbon storage by forest type

Data source: SFA (2009)

2.7.4 Protecting forests' environmental benefits

Forest ecological functions mainly include carbon fixation and oxygen release, water and soil conservation, nutrient accumulation, air purification, biodiversity conservation, wind checking and sand fixation as well as wave breaking etc. Based on the data of the Seventh NFI and according to the assessment result of positioning monitoring of the forest ecosystem by the Chinese Academy of Forestry, the total carbon storage of the forest vegetation is 7 811 mil metric tons. The amount of water conserved by the forest ecosystem annually is 494 766 mil cu m, the annually conserved soil 7035 mil tons, the annually conserved soil fertilizer 364 mil tons, the amount of atmospheric pollutants absorbed annually 32 mil tons and the annually checked dust amount 5 001 mil tons.

In China, the ecological service functions of the forests yield an annual value of CNY10.01 trillion in carbon fixation and oxygen release, water and soil conservation, purification of atmospheric environment, accumulation of nutritious materials and biodiversity conservation. Of the total annual value of ecological service functions of the forests yield, the annual value of carbon fixation and oxygen release is CNY1.56 trillion, water conservation is CNY4.06 trillion, soil conservation is CNY0.99 trillion, purification of atmospheric environment is CNY0.79 trillion and biodiversity conservation CNY2.4 trillion. Among those ecological service functions, water conservation rank the first in term of ecological value, accounting for 40.56% of total annual value, the second is biodiversity conservation, accounting for 23.98%, while accumulation of nutritious materials is the minimum one, only accounting for 7.89% (Figure 2.12).

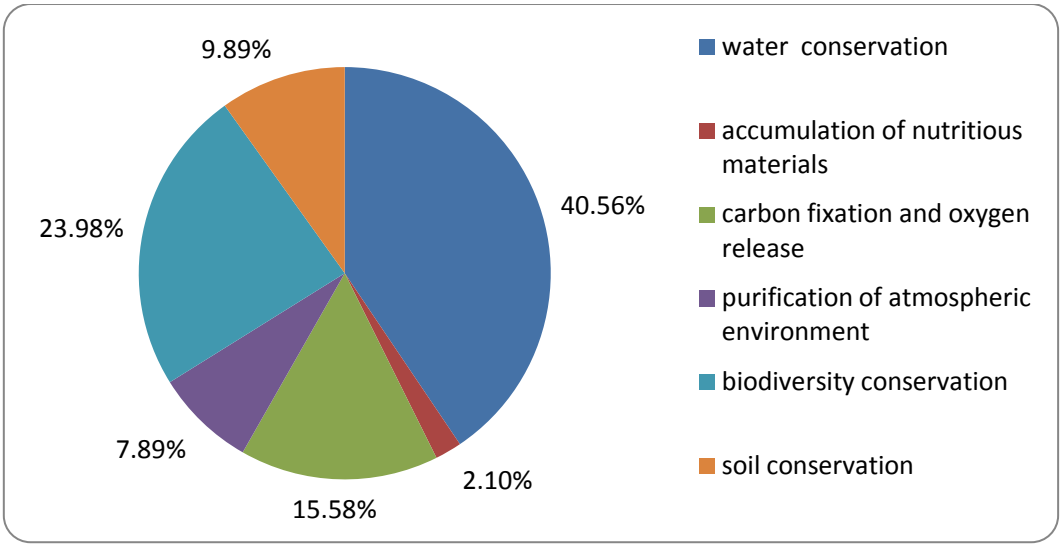


Figure 2.12. Total annual value of ecological service functions of the forests yield

Data source: SFA (2009)

2.7.5 Trade

China's forest products trade value in 2011 accounts for about 25% of the total world trade in forest products. China's forest products trade value is USD120.45 billion in 2011, including wood forest products trade value of USD78.56 billion and the non-timber forest products (NTFP) trade value of USD41.89 billion. Forest products exports are USD55.08 billion, of which USD34.15 billion is wood forest products exports and USD20.93 billion is NTFP exports. Forest products imports reach USD65.37 billion, which consists of wood forest products imports of USD44.41 billion and NTFP imports of USD20.96 billion. The main imported wood forest products are logs, sawn timber, pulp and waste paper, while the main imports NTFP are natural rubber, palm oil, fruit, and so on (see Figure 2.13). Wooden furniture, paper and paper products, plywood and wood products are the key export wood forest products, and fruit, fresh and dried bamboo shoots, fresh and dried mushrooms, rosin and its products are the key export NTFP(see Figure 2.14).

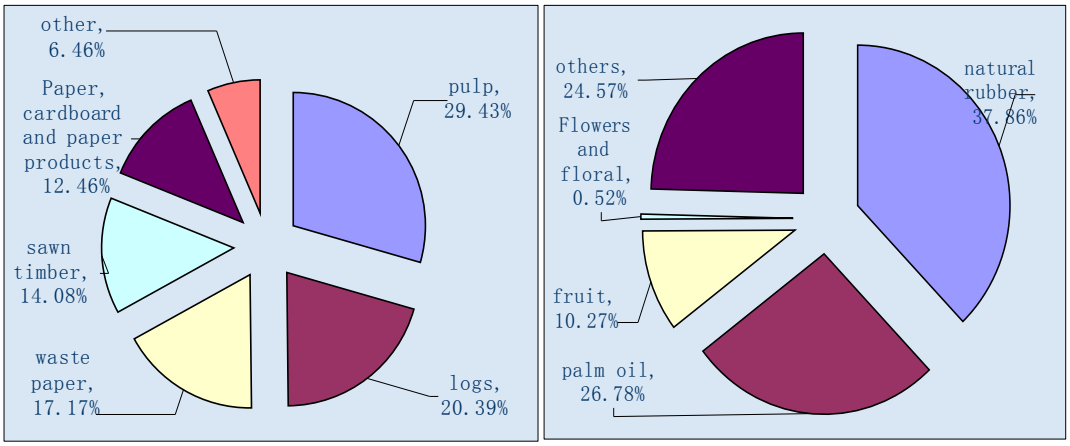


Figure 2.13. Proportion of the main imported wood products and NTFP in 2011

Source: Information Bulletin of forest products international trade of China (2012)

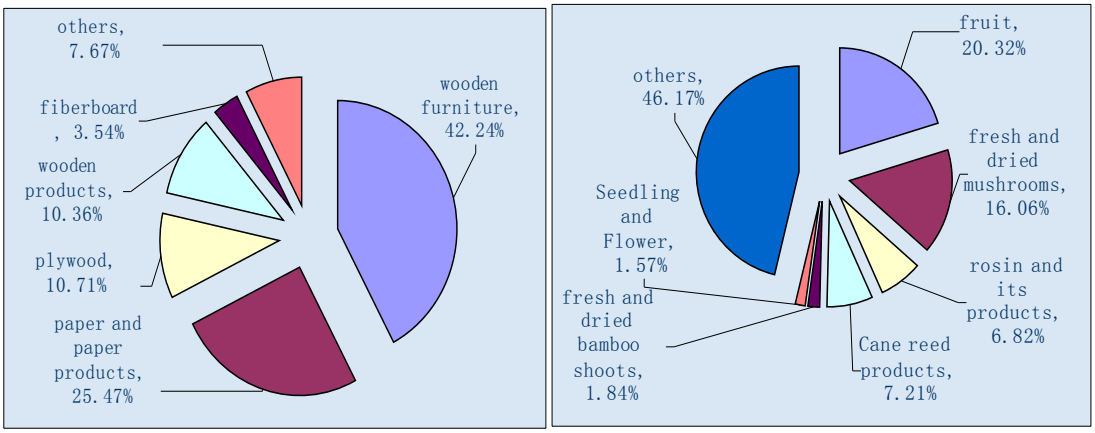


Figure 2.14. Proportion of the main export wood products and NTFP in 2011

Source: Information Bulletin of forest products international trade of China (2012)

2.7.6 Consumption

2.7.6.1 *Wood forest products consumption*

China is a top country in wood forest products consumption. With the development of social and economic development, wood forest products consumption has an increasing trend in the future. According to National Bureau of Statistics of China and related departments' statistic, in 2010 the total consumption of wood products market was equivalent to 431.77 mil cu m round wood. China's construction industry and industrial timber consumption were equivalent to 317.267 cu m round wood as well as farmers own use wood and fuel wood consumption of 36.62 mil cu m round wood. Wood forest products exported were equivalent to 77.88 mil cu m round wood.

2.7.6.2 *NTFP consumption*

China is also a top country in wood forest products consumption. The total consumption of NWTP was USD87.64 billion in 2010, among fruit products for USD53.574 billion, tea, coffee drinks products for USD6.126 billion and forest food for USD7.78 billion and Forest chemical products, raw materials and spices supplements for USD15.878 billion. In 2010, Non-wood forest products consumption was USD65.36 per capital, among fruit products for USD39.95 per capita, tea, coffee drinks products USD4.57 per capita ,forest food product USD5.80 per capita and forest chemical raw materials, products, spices and herbal medicines and other products for USD11.84 per capita.

CHAPTER 3 HISTORICAL REVIEW OF FOREST CHANGE

3.1 Definition of forest

There is no universal definition of forests. Commonly, forest refers to a dense growth of trees, plants, and underbrush covering a large area. Forest in sciences has two sort of definition as: first, forest is synthesis of trees, associated plants, animals and their environments; second, forest is biocenosis dominated by arbors, and is an ecosystem formed by interaction of arbor and other plants, animals, fungus, organisms and inorganic environment.

However as for forest inventory, the definition of forest has to be measureable. International organization and states have adopted a quite different definition of forests. Quite often, these definitions have been changed historically. According to the CDM of the Kyoto Protocol, a "forest" is an area of more than 0.5–1.0 ha with a minimum "tree" crown cover of 10–30%, with "tree" defined as a plant with the capability of growing to be more than 2–5 m tall (UNFCCC 2002). Participating countries can choose from the specified ranges for a "forest" definition tailored to their needs. FAO forest department is multi-national body to officially conduct global forest inventory and produce world forest resource report. FAO definition on forests has been changed since 1980 (Table 3.1). The current, FAO definition of forest is land spanning more than 0.5 ha with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds *in situ* (FAO 1998). It is a land use definition and does not include land that is predominantly under agricultural or urban land use. In China, forest was consisted of arbor and bamboo forest with forest canopy cover of more than 0.2 (Table 3.1).

Table 3.1. Change of forest definition of FAO and China

	Period	Tree crown cover (%)	Minimum area (hm2)	Minimum tree height (m)
FAO	FRA1980	10	-	7
	FRA1990	10	-	5
	FRA2000	10	0.5	5
China	Before 1994	30	-	-
	After 1994	20	-	-

Source: FAO and SFA

3.2 Forest cover changes

3.2.1 Forest land changes

Forest Land in China includes closed forest land, shrub land, open forest land, tree nursery land, slash, suitable land for forest and forestry supplement land. But orchards, mulberry field, tea garden, residential greening land and protection forests around railways, roads and rivers is not included in forest land. Forest land area in 1976 was 257.6 mil ha, which changed slowly afterwards. Forest land grew fast after 1998 and the area of forest land reached 303.78 mil ha in 2008 (see Table 3.2).

3.2.2 Trees outside forests

The definition of trees outside forests in China is different from that of FAO. In the definition of FAO, other wooded land means land either with a crown cover of 5–10% of trees able to reach a height of 5 m at maturity in situ; or a crown cover of more than 10% of trees not able to reach a height of 5 m at maturity *in situ* (e.g. dwarf or stunted trees); or with shrub or bush cover of more than 10% (FAO 1998). Trees outside forests are trees and tree environments on land not defined as forest or other wooded land. In China trees outside forests refer to tree belts and scattered trees, including trees around village, road, water, and house in rural regions, green belts in urban area and also farmland shelterbelt.

3.2.3 Forest cover change

In China, forest coverage has firstly increased to 12.7% in 1976 since the founding of People's Republic of China, then decreased to 12.0% in 1981, and then again gradually increased to 20.36% in 2008 (Figure 3.1).

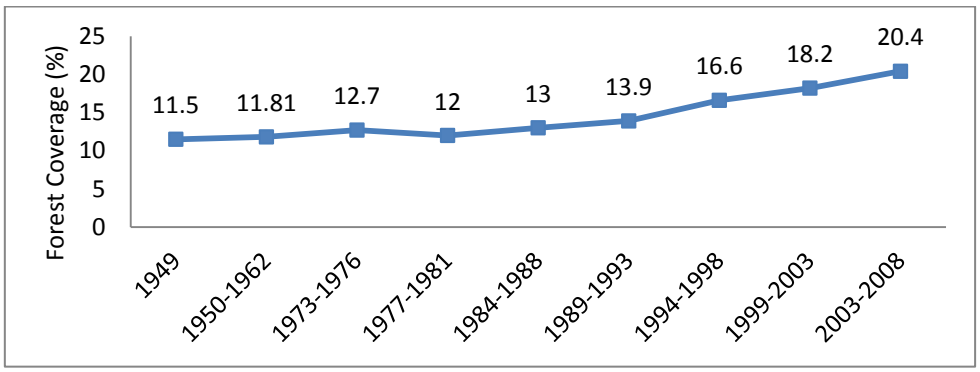


Figure 3.1. Forest Coverage Change in China (1949–2008, %)

Data sources: (1) the Institute of Geographic Sciences and Natural Resources Research (1949, 1950–1962), (2) First to Seventh China National Forest Inventories (1973–2008).

Table 3.2. Forest resources inventory data during 1973–2008

Year	Area of forest land (mil ha)	Volume of standing stock (mil cu m)	Area of land with forests (mil ha)	Volume of forests (mil cu m)	Forest cover (%)
1973–1976	257.60	9,530	121.86	8,660	12.7
1977–1981	267.13	10,260	115.28	9,030	12.0
1984–1988	267.43	10,570	124.65	9,140	13.0
1989–1993	262.89	11,790	133.70	10,140	13.9
1994–1998*	263.29	11,306	158.94	11,267	16.6
1999–2003		13,785	174.90	12,456	18.2
2003–2008	303.78	14,913	195.45	13,720	20.4

Source: The First to Fifth China National Forest Inventories (1973–1998). Forest resource inventories have been undertaken every five years, except for a gap between 1982 and 1984.

The figure below shows a continuous increase of forest area and forest volume in recent 35 years. Forest area increased from 121.86 mil ha in First NFI (1973–1976) to 195.45 mil ha in Seventh NFI (2004–2008), which has increased by 73.59 mil ha, or 60.4%. Forest volume also increased from 86,560 mil cu m to 137.21 hundred mil cu m, increased by 50 650 mil cu m, or 58.5% %. The trend of forest cover change showed that a forest transition has been achieved during the last three decades in China. Large increase of forest cover and forest volume has significant influence on biodiversity and ecological environment of China.

3.3 Quality of Forests

3.3.1 Timber stocking volume

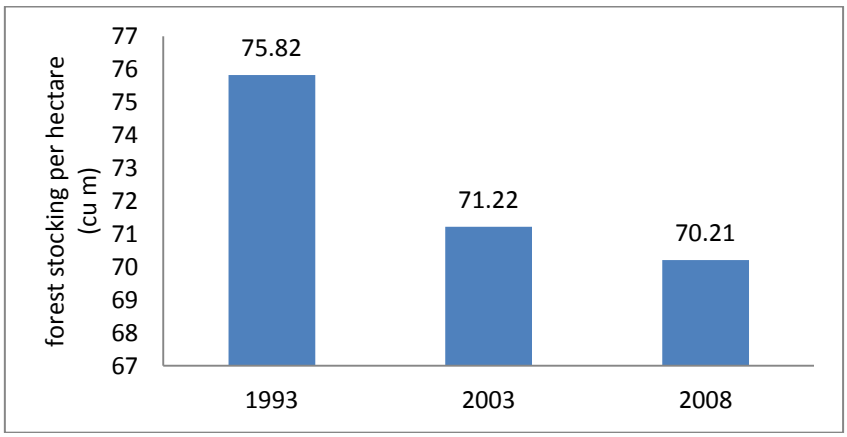


Figure 3.2. Change of forest stocking per hectare

Source: China National Forest Inventory (1998, 2003 and 2008)

Forest stocking per hectare has decreased since the 1990s. The change of forest stocking per hectare could be related to growth cycle of planted forests.

3.3.2 Stand structure

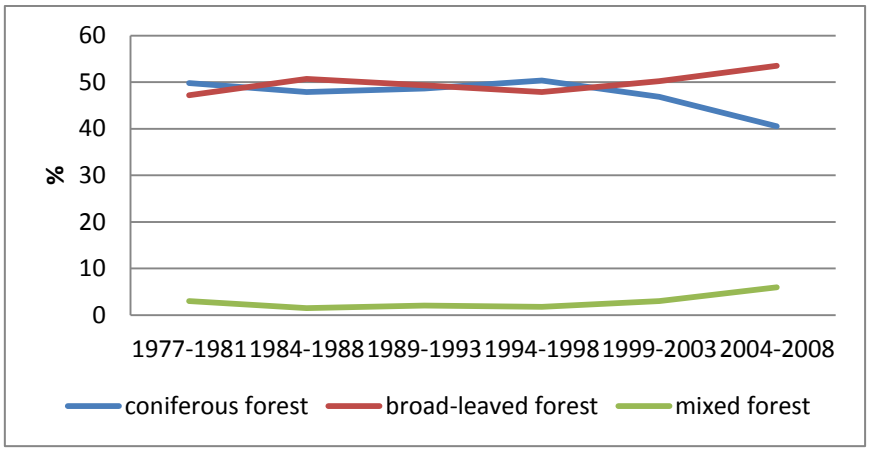


Figure 3.3. Change of stand structure in China

Source: China Forestry Statistical Yearbook (2011)

Since 1990s, the area and percentage of broad-leaves forests and mixed forests have increased rapidly, with a net increase of 19.9 and 6.9 mil ha to date. Area and percentage of coniferous forests have been decreasing correspondingly (Figure 3.3).

3.3.3 Use of trees

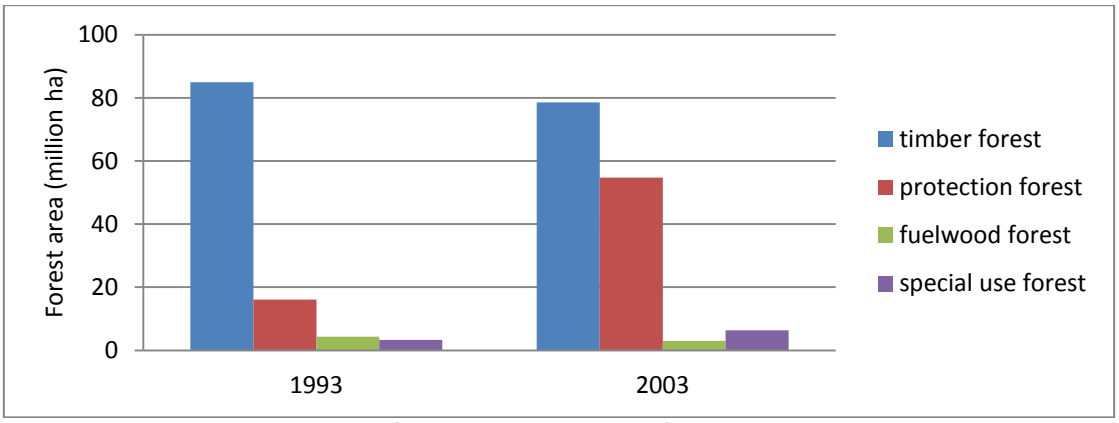


Figure 3.4. Forest use change
.Source: China National Forest Inventory (1998, 2003)

The change use of trees reflected the social and economic change during that period, when much more importance is attached to ecological effects of forests.

3.3.4 Age group structure

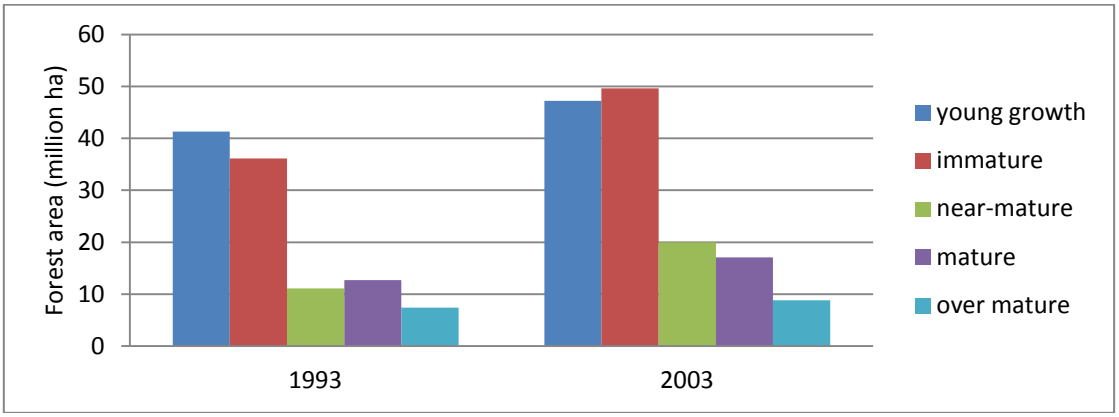


Figure 3.5. Forest age group structure
Source: SFA (2006)

Figure 3.5 suggested that acreage of young growth, immature and near-mature forests grew faster than other age groups. This may indicate that large plantation continued in China and it started to pay off.

3.3.5 Forest fragmentation

Forest fragmentation will change characteristic of forest ecological system and species habitant environment, decrease amount and varieties of species and destroy biodiversity.

Forest fragmentation in China is divided into seven levels according to forest continuous distribution area: under 1 ha; 1–5 ha; 5–10 ha; 10–20 ha; 20–50 ha; 50–100 ha and above 100 ha. In China, forests with continuous distribution area of 100 ha and above accounts for 40.89%, while 28.84% of China's forest is 10–100 ha continuous distribution area, and 30.28% of forest in China is under 10 ha continuous distribution area.

CHAPTER 4 MAJOR DRIVERS OF FOREST TRANSITION

In this chapter some major forces to drive the forest transition are to be discussed.

4.1 Drivers of forest deforestation and degradation

4.1.1 Logging in state forest farms

Constructing a powerful industrial nation has become primary goal for the political leaders in China since 1949. In order to meet the timber demand for industrialization, China placed timber production as the center goal of forestry development. The Chinese Government established 131 forestry bureaus, 25 independent wood processing factories, 598.22 km railway sidings, more than 10 000 km forest railway, and 77 thousand roads in northeast, southwest and northwest primary forest which are abundant with forest resources. The timber productions were going up since 1963 (Figure 4.1). As the biggest timber producer in China, the state-owned forest farms provided a total of 900 mil cu m of wood for the country from 1949 to 1986, accounting for 69.83% of 1.41 billion cu m of total wood production in the whole country during the same period (SFA 1987).

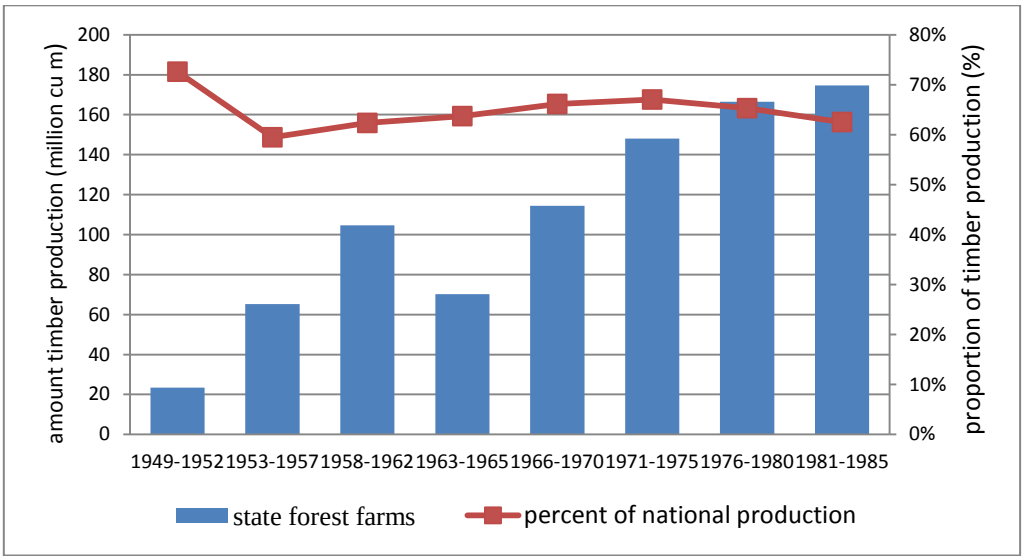


Figure 4.1. The amount and proportion of timber production in state-owned forest farms in 1949–1985
Source: SFA, China Forestry Yearbook (1949–1986, 1987)

However, due to long-term excessive logging and ignoring afforestation, the mix duty between the government and enterprises, state-owned forest resources decreased sharply, problems such as economic profit deterioration and over social burden began to highlight in the 1980s. Many state-owned forestry enterprises were trapped into resource crisis, economic crisis, and social crisis. By 1985, the number of the forestry bureaus with depleted forest resource was 23. According to the amount of forest harvesting in 1985, 14 forestry bureaus would be depleted in 5 years, 29 forestry bureaus would be depleted in 6 to 10 years, and 33 forestry bureaus would be depleted in 11 to 15 years (SFA 1987). In Daxinganling forest region, before the implementation of natural forest protection project in 1998, the living wood growing stock had been decreased from 730 mil cu m at early stage to 510 mil cu m, mature and over-mature stands had been decreased from 460 mil cu m to 130 mil cu m, forest land stock had been decreased from 100cu m/ ha to 78cu m/ ha. In Yichun forest region, due to long-term excessive cutting, the forest stock and mature and over-mature stands decreased by 55% and 98% compared to the early stage. A total of 13 of the 17 forest bureaus had no trees to cut and the remaining also were overcutting (Zhang *et al.* 2008).

In order to solve the resource crisis in the state-owned forest, the Chinese Government took several measures such as implementing the National Forest Protection Project(NFPP), reducing the state-owned forest cutting quota and afforestation after 1998 to reduce the consumption of state-owned forest resources and to promote the recovery of forest resource. NFPP was started in 1998, which contributed a lot to reducing deforestation and enhancing forest rehabilitation in state forest regions. Heilongjiang forest region, as the largest state forest region in China in terms of its acreage in

Northeast China, has reduced amount of annual timber harvested dramatically from 4.19 mil cu m in the year of 1996–1999 to 1.75 mil cu m in the year of 2000–2005. The nearby Jilin state forest region also reduced forest harvesting from 0.3 mil cu m to 0.2 mil cu m during 1998–2005. The amount of timber harvested by state-owned forest Bureau in Northeast Inner Mongolia Autonomous Region has reduced by 7.515 mil cu m in the period 2000–2010 after the implementation of NFPP compared to that during 1991–2000 (SFA 2012).

In 2008, the timber production, log and the fuel wood harvested at state owned forests amounts 11.53, 11.31, and 0.226 mil cu m respectively, accounting for 14.2%, 15.4% and 3% of national total. Transition towards the equilibrium of forest depletion and growth in state forest regions and state forest farms has promoted forest resource rehabilitation and conservation. Though Chinese government put forward many reforms in the state-owned forest region since 1980, these regions are still not completely get rid of the dilemma. The problems such as mixed up functions of the government and enterprises, reduction of forest resource, over-social burden, the non-flexible operating mechanism and over-large transition pressure are still widespread despite of some reform.

4.1.2 Logging in collective forest regions

Collective forest land accounts for 60% of forest area in the whole country. In the period of 1949–1985, through established collective ownership, state forest farms, key forestry counties in collective forest area and carried out mandatory production planning, the government monopolized all timber production, distribution and consumption in collective forest regions in order to serve the demand of industrialization. The driving force of deforestation in southern collective forest regions changed from agricultural expansion to the industrialization demand .The government planned and constructed 158 key forestry countries which designed to serve industrial construction timber. The timber production in these counties accounted for 90% timber production of southern collective forest region. From 1949 to 1986, the southern collective forest region provided 400 mil cu m timber for industrialization, accounting for 28.9% of the whole country's production in the same period. The forest consumption amount in southern collective forest regions was about 100 mil cu m every year which was basically the same as the growth amount. Among the consumption amount, 30 billion cu m are for construction, the rest are for residents, fire wood and natural mortality which is about twice as the amount for construction (SFA 1987).However, farmers lost enthusiasm in forest management and less and less developable forest resource were available due to implementing the policy of state monopoly for purchase and marketing and fixing the yield, species, price, and distribution of timber. For example, 1975–1978, the deforestation in southern collective forest regions was 1.395 mil ha, but the afforestation was only about 0.52 mil ha.

In the period of industrialization, the short-term driver of deforestation in collective forest regions changed from war factors to political changes such as insecure forest land ownership and political movement. Collective forest region have experienced three severe deforestation peaks, that forest resources have been seriously damaged.

During the period of the great leap forward and the *People's Commune* movement from 1958 to 1960, the government assigned the privately owned forest land to the commune collectives for free or at low price due to the government hoped to collect the agricultural surplus together for industrial construction. Due to the political leaders' unrealistic call for putting out steel, opening public canteens and high index call on timber production, forests were excessive logged, a large number of forests were shifted to arable land during this period. Forest resources in southern collective forest region had been seriously damaged. For example, in Sichuan province, the forest coverage rate decreased from 19% in the early 1950s to 9% in the late 1950s. In Anhui Province, 100 000 people went into the mountains to make steel, and the estimated loss were about 2 mil cu m of wood, leading to forest volume decreased rapidly (SFA1987).

During the period of *Cultural Revolution* from 1966 to 1976, due to national unrest, the forestry construction policies had been seriously distorted; forestry regulations and acts were repealed; forestry bureaus at all levels were canceled; a large number of professional cadres and technicians drained; forest resource were damaged more severe and longer than the people's Commune and the great leap forward period. During 1966 to 1977, the number of forest fire was 110 000 nationwide, the average annual affected area was 670 000 ha, the reduction of forest land caused by fire and deforestation was about 6.6 mil ha totally. In addition, from 1967–1978, a large number of forests

areas were cleared and destroyed due to the wrong emphasis on “taking grain as the priority”. Comparison between 1973–1976 and 1977–1981, the forest area reduced 74.55 acres, down 11.2% in southern collective forest region; the forest coverage rate was decreased from 28.4% to 25.3%.Timber forest area decreased 2.17 mil ha, a decrease of 23.3%.Tree-age structure continued to lost balance. The proportion of mature forest area decreased from 13.8% to 9.9% and the average annual decrease is 37.5 mil ha. The total decreased mature forest stock volume was about 180 mil cu m (SFA 1987).

The third deforestation was in the period of *Three-fixed* from 1981 to 1987.The cultural revolution left two problems to the Chinese forestry: One was the serious destruction of forests, excessive consumption, too little cultivation, timber supply and demand contradiction and continuing deterioration of ecological environment; Another was that the forestry policies, forestry bureaus at all levels, forestry administrative management and ownership management all needed to rebuild. In this particular context, the main target of *Three-fixed* policy was to stabilize forest land ownership; draw private hilly land; implement the forestry production responsibility system. The reform tried to reform the planned economy which discouraged farmers’ planting and discouraging forest and gave farmers more manage rights and income rights to reverse the decline trends of forest resources in collective forest regions, and to alleviate the contradiction between timber supply and demand of the country. However, due to the unclear property rights, unstable policy and lag of the government management, the collective forest resource break out after the market-oriented reform of timber in1985. The reform was forced to interrupt due to deforestation. According to the survey, the forest area decreased by 4.1664 mil ha from 1984–1988 to 1977–1981; the total growing stock decreased by 165mil cu m over the same period; the forest area and growing stock both fell (Chen 1988).

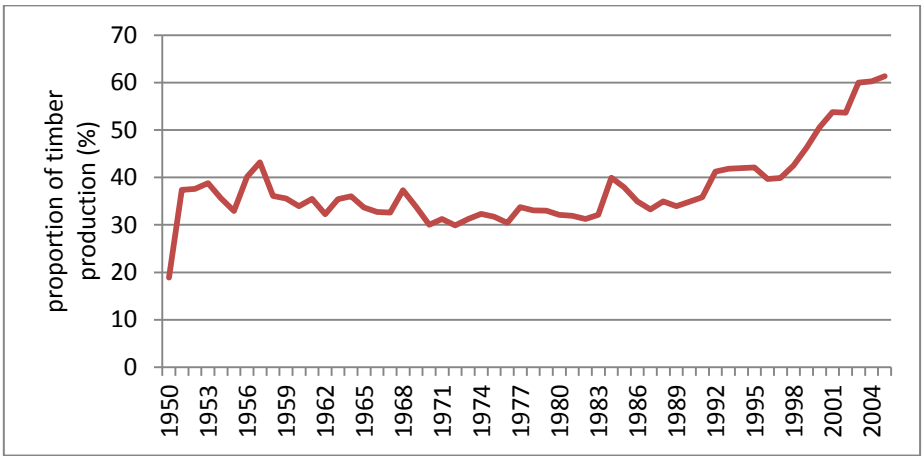


Figure 4.2. The proportion of timber production in the collective forest region since 1950

Source: Liu (2009)

The proportion of timber production in collective forest region maintained at 30–40% before 2000 (Figure 4.2). After the year of 2000, the proportion is increasing, surpassing 60% after 2004. The reason is on the one hand that the timber production in the state-owned forest went down since the implement of national forest protection project, on the other hand that absolute amount of collective forest are going up due to the increasing collective forest planted by the households, enterprises, and professional investors after 1980 are becoming mature.

4.1.3 Fuelwood

Rural straw, firewood and other biomass energy were once the main energy source in rural area in forest region in China. With socio-economic development and the farmers’ improved living standards of China, rural traditional biomass energy utilization has been reduced and fossil energy and electricity has been increased. The proportion of firewood consumption in rural household energy consumption has been declining, down from 39.8% in 1979 to 14.53% in 2008 (Figure 4.3). The energy transformation has positive significance in forest regeneration. Overall, despite the proportion of the traditional straw, firewood and other biomass energy have decreased from 54.91% in 2000 to 40.55% in 2008.

In some rural areas, especially the western rural areas, farmers still rely heavily on forest energy consumption, so the phenomenon of deforestation and ecological destruction still exists.

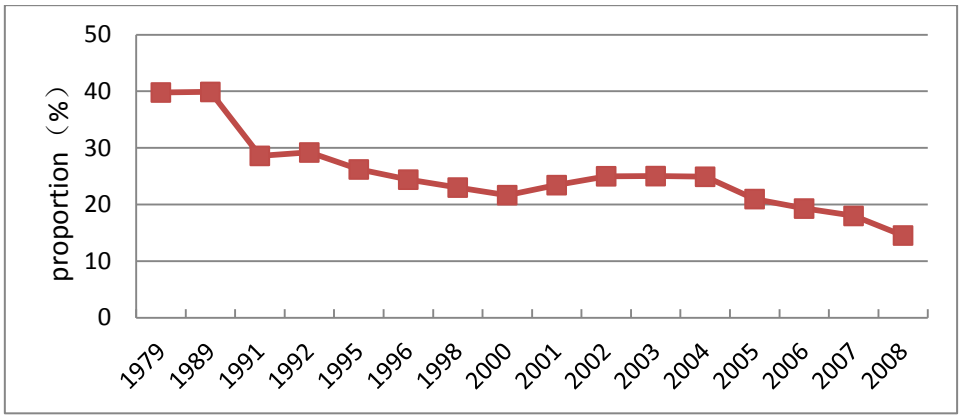


Figure 4.3. Percentage of firewood in rural family energy consumption in China

Data source: China Statistics Yearbook (2009)

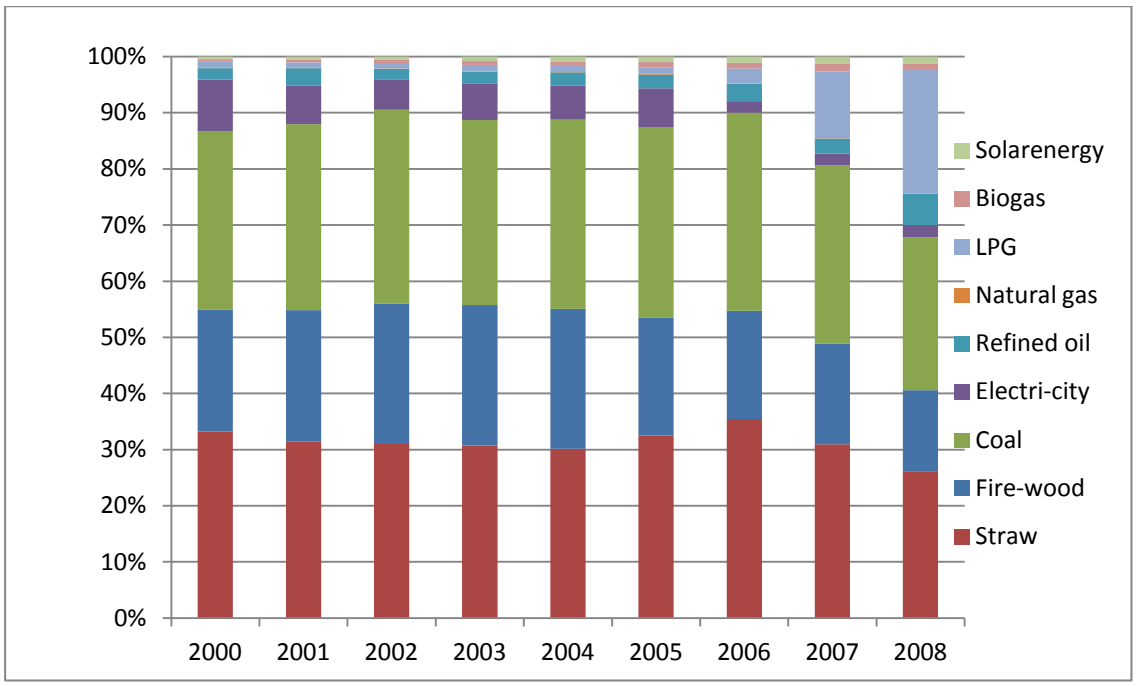


Figure 4.4. China's rural family energy consumption structure

Data source: The Ministry of agriculture of China's rural renewable energy statistics

The main purpose to constructing the fuelwood forests is that to producing wood fuels such as wood and charcoal. The fuelwood forests played an important role in forest resources structure. In China, there is a long history of management and utilization in the fuelwood forests. In 1981, China began a planned fuelwood forests construction, and put it into the plan of the national afforestation and the plan of construction of national rural energy. From 1985 to 1995, China has constructed the national fuelwood forests of 4 948 000 ha totally, playing an important role to alleviate rural energy shortage.

According to the results of the Seventh National Forest Inventory, in our country, the Forestland area is 181 mil ha, the public welfare forest and commercial forest accounted for 52.41% and 52.41% respectively. But the fuelwood forests are just 1.75 mil ha, accounted for only 0.96%. The development of fuelwood forests is not only a technical problem but also the problem that related to policy, economy and administrative organization. In order to solve the problem of the gap of rural demand and supply, China on one hand gradually developed fuelwood forest, on the other hand is trying to formulate the corresponding fuelwood forests protective measures.

4.1.4 Development of non-timber forest products

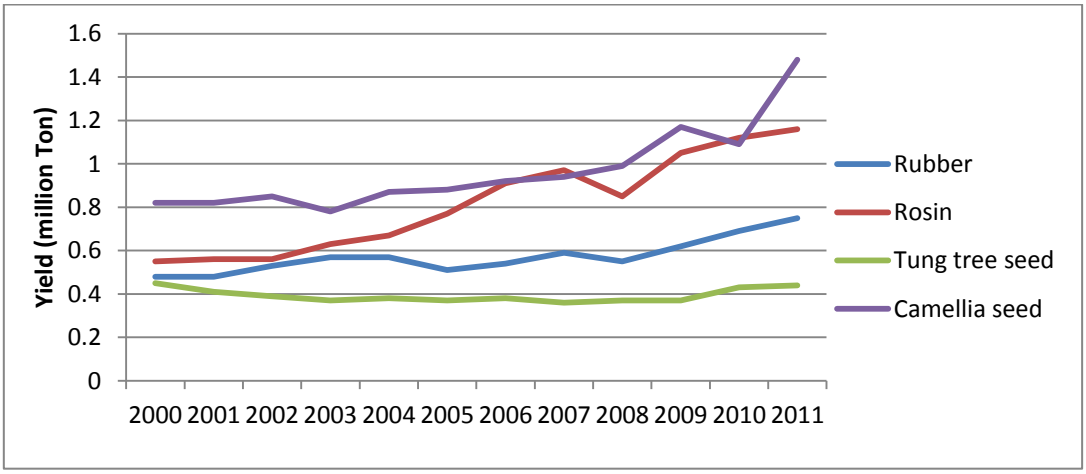


Figure 4.5. Yield of rubber, rosin, tung tree seed and camellia seed

Source: China's Forest Statistical Yearbook (2012)

Figure 4.5 shows that yield of non-timber forest products like rubber, rosin, tung tree seed and camellia seed, have increased greatly since 2000. In the last five years, yield of rubber, rosin and camellia seed grows more rapidly than before, but yield of tung tree seed remains stable. By 2011, yield of rubber, rosin, tung tree seed and camellia seed has reached 0.75 mil t, 1.15 mil t, 0.44 mil t and 1.48 mil t respectively. The average annual increase of yield of rubber was 24 600 t, and rosin and camellia seed was 55 100 t and 59 700 t respectively. The development of non-timber product brought more positive impacts on improving economic environment to forest region and improving forest farmers' income. However, it is also problematic because of unitary forest species and low ecological efficiency. From statistical classification of China, non-timber product forest is also calculated in forest area. The rapid development of non-timber forest industry could contribute to increase forest cover, but its negative effect to biodiversity and ecological services should also be noticed.

4.1.5 Forest fire

Forest fire is at the first place of top three natural disasters to forests, i.e., forest disease, insect damage and forest fire. China has 788.000 forest fires that damaged 38.02 mil ha forest from 1950 to 2010, which accounts to one fifth of the whole national forest area.

From 1950–2011,annual affected forest area of forest fire amounts to 613645 ha. Before 1988, the annual quantity of forest fire was 15932, with annual affected forest area of 947238 ha. After 1988, the annual quantity of forest fire was to 7623, with affected forest area of 94002 ha, decreased by 52.2%, and 90.1% respectively.

The Greater Khingan Range fire

The Greater Khingan Range fire on May 6, 1987 is one of the biggest forest fires in history. The burned area amounts up to 1.33 million ha, plus 1 county, 4 forestry bureau Town, and 5 lumber yards. The fire lasted from May 6th to May 25th when naked flame is gone due to wide-range rainfall on 25th May. The fire finally ended in 2nd June .The direct economic loss of the fire is up to 450 million CNY, and the indirect economic losses of the fire is up to about 8 billion CNY, which does not

Source: http://baike.baidu.com

4.1.6 Damage from forest insect and diseases

Area affected by forest disease and forest insect is doubled every ten years from 1950s to 1980 in China. In 1950s, biological disasters have caused damage to 0.8577 mil ha of forest, and in 1960s, 1970s, and 1980s, damage area was 1.4426, 3.6526 and 8.4729 mil ha respectively. Recently, forest insects and diseases hit 8.519 and 12.097 mil ha of forests in 2000 and 2007 (State Statistic Bureau 2009)

About 10 mil ha of forest in China is now affected by harmful creatures including insects, fungi, rats, bacteria and harmful plants. It caused death of 40 million trees and direct economic loss and ecological service loss of CNY88 billion, i.e., one-tenth of gross forest product in China. The worst-hit area concentrated in the region around Shandong province where afforestation increased the most, by about 10% every year. This region also includes Tianjin, Hebei, Henan, Shanxi, Liaoning, Anhui and Jiangsu. Besides, Ningxia has a higher disaster incidence because of damage of Asian Long-horned Beetle (*Anoplophora glabripennis*) in Poplar afforestation area.

4.1.7 Natural calamities

Ice storm can destroy forest directly and lead a great deal of injured and fallen trees to death, causing decrease of forest canopy density and forest stock, destruction to forest structure and non-forest land. In the Freezing Rain and Snow Disaster in 2008, a lot of tree species were greatly affected, among which masson pine (Pinus*massoniana*), fir (Cunninghamia*lanceolata*) and bamboos were damaged the most, followed by eucalypt (Eucalyptus species) and foreign pines.

Figure 4.6. Damage to main tree species: Slash pine (*Pinuselliottii)* (top left), fir (top right), moso bamboo (*Phyllostachyspubescens)* (bottom left) and eucalypt (bottom right).

The Freezing Rain and Snow Disaster in 2008

In 2008 the rare freezing rain and snow disasters appeared in southern China, 20 southern provinces were affected, which was the biggest harm in the recent 50 years. The rare low-temperature freezing rain and snow weather made the forestry a great loss. The forest damage area was nearly 260 million acres and 354,000 houses collapsed. About 0.34 billion cu m of forest stock volume, that is, 3% of gross forest stock, lost in the disaster. Besides, 3.8 billion bamboos were damaged. The weight of thick ices were a few times of the branches themselves, leading to large areas of falling trees. According to the local government in Luoyang town, RUCNY county of Guangdong province, the forests covered the majority of the town before (more than 500 square kilometers area), but the snow storm destroyed 70% of the whole forests, which ruined the result of afforestation in the recent 2 decades.

Source: National Report of C & I for Montreal Process (unpublished)

Earthquake is another serious natural calamity in China. It causes forest destruction, water and soil loss, environmental damage and isolating wildlife, river blockage, destruction to arable land and severe damage to ecological system and biodiversity.

The Sichuan Great Earthquake in 2008

Sichuan great earthquake occurred on May 12th, 2008. It is the most destructive earthquake after the founding of the People's Republic of China, and it is also the most disastrous catastrophe after the Tangshan earthquake. The earthquake caused a direct economic loss of 845.1 billion CNY in the Sichuan, Gansu, Shaanxi and other provinces, and it has also led to severe damage on the water conservancy, geomorphology, ecology, and ethnic culture. According to the estimation, the effects on forestry of Sichuan province mainly are as follows: 3487 kilometers road of forest zone were damaged, 487 bridges were destroyed, 1782 kilometers of transmission line were damaged, 2501 forest lookout were damaged, 16,000 acres of seedlings base, 13,000 m2 wild animal houses, 120,000 m2 greenhouse and 40,000 sets of equipment were damaged.

Source: National Report of C & I for Montreal Process (unpublished)

The Longmen mountain area, which is the major earthquake region, is also a region with the most abundant forest resources in Sichuan Province. Forest land of this region accounts for 10.4% of the total forest land in Sichuan, and the forest volume accounted for 9.5%. The forest coverage is 13% higher than that of the province as a whole. Due to large area of landslide and collapse in Sichuan Great Earthquake, a huge number of forests were fallen or buried. The achievement of the projects of returning cultivated land to forests and protection for natural forests were severely damaged, and the preliminary statistics of forest damage amounted to about 3.8 mil acres. The earthquake caused vegetation damage and topographic segmentation in Sichuan, and 37 natural protection areas were damaged to different extent. 1.382 mil acres of wild animal habitants were destroyed, and about 10.6% of gallery region were damaged. The ecosystem landscape connectivity decreased significantly while the degree of landscape fragmentation increased significantly, resulting in a number of "island " plaque. The “islet effect” brought big effect to 10 kinds of national Grade I protected animals and 23 kinds of national Grade II protected animals. Earthquake exerted the far-reaching influence to the ecological condition. Not only did the earthquake cause massive mortality, but it also promoted serious habitant isolation, which is the most important reason for the loss of biological diversity.

4.2 Drivers to afforestation and forest rehabilitation

4.2.1 Plantations

Area of planted forest has been increased rapidly in the past 60 years. The acreage of afforestation area amounts to 267 mil ha according to China Forestry Statistic Yearbook (2010) from 1949 to 2010, ranking on the top in the world. Rate of plantation of forest varied during this period. In 1949–1952, annual forestation area was 1.707 mil ha. The peak of reforestation was during the period of 1983–1995, with an annual reforestation area of 5 mil ha. From 1996 to the present, planted area remained between 3.5–6.2 mil ha annually, except 7.77 mil ha in 2002 and 9.12 mil ha in 2003. Forestry Action Plan released by the Chinese Government in 2009 pointed out that the annual planted forest area of China will be more than 5 mil ha from 2010 to 2020.

Main afforestation species in China includes Chinese fir (*Cunninghamia anceolata*), Laricxorgensis, Masson pine (*Pinus massoniana*), *Pinus yunnanensis*, *Larix kaempferi*, *Pinus elliottii*, *Pinus taeda*, *Eucalpytus citriodora*, paulownia (*Paulownia* spp.) and Zhonglin Sanbei-1.

Most of these species were brought from abroad. Afforestation area of foreign poplar was 2 mil ha (Su 2005). Eucalypt afforestation area was 1.5 mil ha including 1.5 billion trees along roads and fields (He and Gu 1998). Foreign pines like *Pinus caribaea*, slash pine and loblolly pine occupy a forest area of over 2 mil ha (Pan 1994, Zheng 2001).

4.2.2 Increased area of protected forests

Number and acreage of the natural reserves has been continuously increased since 1956, much rapid during in 1991-2003. 2599 natural reserves have been established by 2010. The natural reserves cover 149 mil ha or 14.9% of land area of China in total, increasing by 125.8% and 69.1% respectively compared to 1999 (see Figure 4.7). Since 2003, both number and area of the natural reserves has increased in moderate rate.

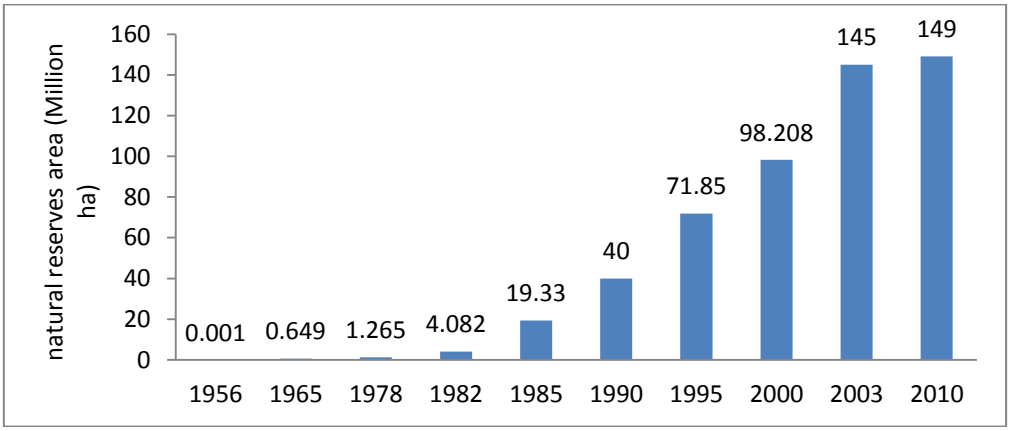


Figure 4.7. Change of natural reserves in China

Besides, so called, small scale Natural Reserve Plots spread out all over China, which amount around 50,000 at 2010 with a total acreage of 15 000 ha, for protecting unique ecosystems of forest, bushes, wetland, and habitats for wild animals and plants, ancient and rare trees, cultural heritages, natural landscapes, etc. These small natural reserves usually locate at high density population region of southern China. The value of small natural reserves is undeniable for supplementing reserves and protecting biodiversity.

4.2.3 Timber-saving technique

China has consistently supporting saving timber through promoting research and extension on wood saving and substitute techniques, including wood preservation, wood anti-mildew, wood protection against pest, wood seasoning, fire-retarding of wood and wood modification. One example is using magnesite, bamboo, wood chip and plastic to make laminated-veneer-lumber, agriculture straw fibreboard, bamboo-plywood, heavy duty corrugated fibreboard, honeycomb paperboard and steel-wood composite structure for substituting wooden packaging of electromechanical products. Statistics

show that 367 mil cu m of timber was saved during 1980 to 2004 which is equivalent to a quarter of commercial timber production in the country in this period. Timber-saving technique has played an important role on meeting demand of forest products, protecting ecological balance and improving sustainable development of forest resource.

4.2.4 Urban Forests

For the past two decades, greenbelt around city, quarantine green forest belt and protective belt, were the most important urban forest construction measures. By 2011, 31 cities had been named as "National-level City of Forest". An investigation to 22 national forest cities shows that forest cover has been increased by 1% in Forest city, twice of the national average (Jia 2011)

4.3 Key Norms supporting to afforestation and forest rehabilitation

4.3.1 Forest resource management system

Since 1980, Chinese Government has established a basic forest resource management system, including harvest, transportation, timber processing, forest law enforcement, fireproof and market management, which become foundation for the government to carry out forestry reform, prevent forest risk, and increase forest area. Firstly, following the principle of consumption of timber forest being less than growth, the forest cutting quota has been implemented by the state government to impose strict controls over the annual forest harvest volume. The quota system was initialed in the year of 1986 and the national cutting quota is revised every five years, which effectively control illegal logging and excessive deforestation. In order to support the cutting quota system, the cutting license, the transportation license, and the processing license has been taken into effect step by step since the year of 1985, through which the harvest, transportation, and processing timber in the forest area are supervised by the forestry authority.

Secondly, an integral forest administration system including forest police, forest stations, and timber check points, was established to strengthen law enforcement. At the end of 1987, there were nearly 59.1% districts and townships where forest stations had not been built yet, including those urgent area that were abundant with forest resources. However, there were 35 537 township forest stations all over the country in 1991, more than half of which were set up during the previous three years (SFA 1991). During the period of 1987 to 1998, the number of forest police stations increased from 4 399 to 6 464 and the number of forest policemen was from 29 661 to 49 855. By the end of 2010; there were nearly 7 000 forest police stations, 4 236 timber check points, and 28 112 township forest stations. Thirdly, timbers in producing area were specially purchased by government, while in selling area prices of timbers are determined by market for customers' diversity demand.

Table 4.1. The amount and loss of illegal forest related cases during 1986–1995

Year	The amount of Illegal forest-related cases (10 Thousands)	Damage area of forest land (10 Thousand ha)	Loss of timber (10 Thousand cu m)
1986	6.78	9.69	252.54
1987	7.46	9.12	140.29
1988	9.21	5.35	109.29
1989	10.71	3.99	——
1990	10.13	1.62	52.1
1991	9.8	1.84	62.96
1992	11.25	3.73	71.32
1993	13.85	3.16	75.59
1994	13.86	1.61	47.22
1995	14.4	2.42	52.66

Source: China Forestry Yearbook (1986 to1996)

Inspection on implementation of the forest cutting quota system of 40 counties (including districts, county-level cities) was executed by the State Forest Administration in 2010. The results shows that total harvest in these 40 counties was 46.2% of their harvest quotas, among which commercial forest harvest was 54.7% of planned commercial forest production. In 1320 chosen sub-compartment, 1150 of them had their harvest within harvest quotas, accounting for 87.1 %, increasing by 10.3% compared to 2008. Over-harvest was under control. Table 4.1 and the Figure 4.8 reveal that with growing capacity of law enforcement in Chinese forest administration, both the loss of forest related cases and the damage area by forest fires continue to decrease to a low level.

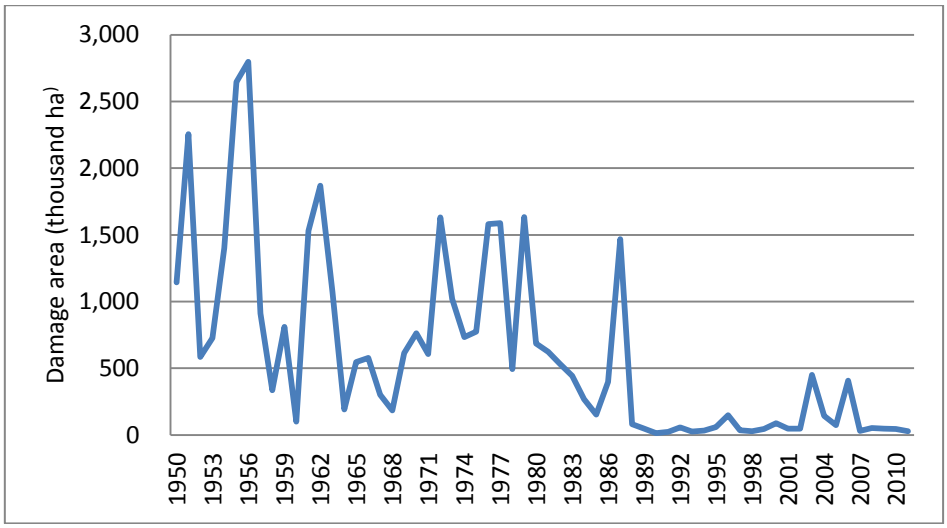


Figure 4.8. Damage area by forest fires in China during 1950–2010

Source: SFA, China Forestry Yearbook (1950–2011)

4.3.2 Forest tenure reform

The market-oriented reform in forest land ownership and forest product market has sharply promotes afforestation in collective forest region since 1978. The forest investment of farmers and private sector has made up the shortage of fiscal investment, and met the demand of forest product in the amount and diversity. On the one hand, the government carried out the household contact responsibility system, gave individual more management freedom, and encouraged diversified operation models in the collective forest region, such as collective management, forest cooperation, professional investor, and forest enterprise. On the other hand, the government has gradually promoted the market-driven reform in forest product, reduced the forestry taxation burden, and implemented the forest tenure mortgage loan and forest insurance policies. As can be seen in the figure, afforestation area in collective forest region maintained at about 40% of national afforestation area before the year of 1978. The afforestation investment and area have been increasing after 1978 (Figure 4.9). In particular from 1988 to 1992, the movement of eliminating barren mountains contributed a lot to the increase of afforestation in the southern China. Due to the increase of fiscal investment after 1998, the proportion of investment in collective forest region declined to some extent. However, the implement of new forest tenure reform and the increasing timber price have been driving the forestry investment and afforestation of farmers and private sector to a higher level since 2003 (Figure 4.10). It is estimated that the forestry investment and afforestation of farmers and private sector will continue to increase.

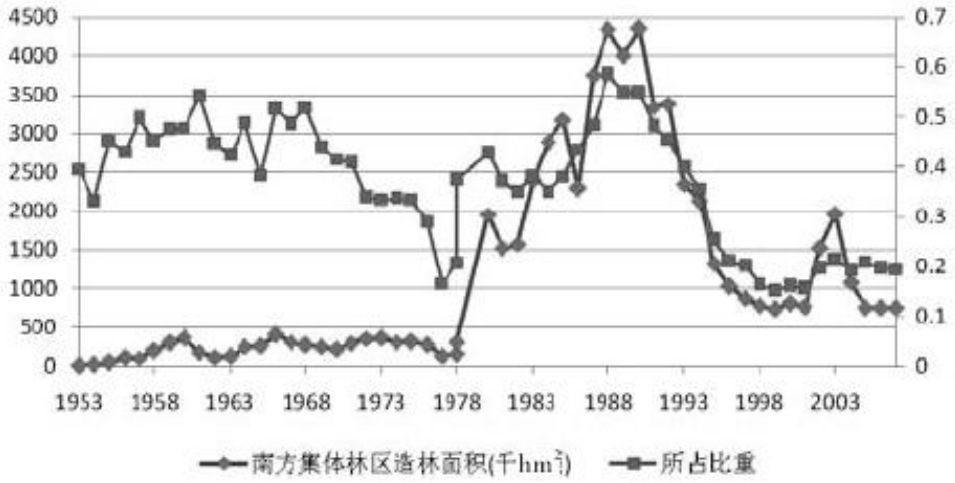


Figure 4.9. The afforestation area in the collective forest region and its share in nationwide
Source: Liu (2009)

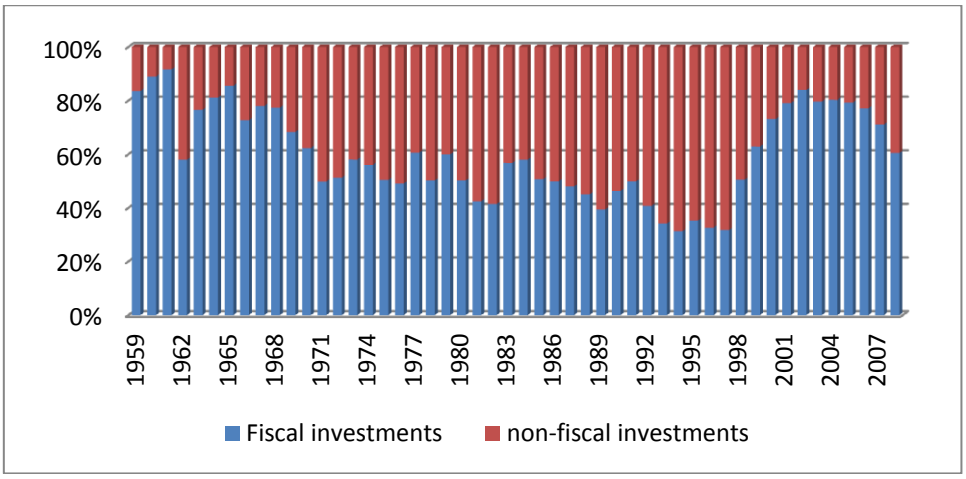


Figure 4.10. The component of forest investment since 1959
Source: China Forestry Yearbook (2006)

4.3.3 State supported Afforestation programs

Like France, Austria, Denmark and other European countries that have experienced forest transition, it is believed that the forest growth of China can't increase without the forestry investment of Chinese government through the efficiently top-down administrative system, which managed to release the natural disaster, forest scarcity and private sector investment shortage. The first Chinese Premier Zhou Enlai (1966) stated that, "China forestry should rely on logging and reforestation, and afforestation is a fundamental task that lasts generation by generation". Four main approaches had been developed by the Chinese Government for forest protection and growth.

Firstly, China Government has adopted the policy of closing forests, and consider it as the same importance as afforestation. A total area of 130 mil ha forest land was closed since 1949. In fact, China started to adopt the closure of forest to protect forest resources date from 4 century BC. Since 1950, China began to regard closing forests as an important way to expand forest resource. The models of closing forests includes full closured, semi-closed and rotation closed, and mainly focuses on the important ecological areas without forest, sparse woodland, shrub land, and low-quality artificial forests. It can be seen from the Figure 4.11, China's annual newly conservation forest area generally maintains at about 5 mil ha since 1981, the area rapidly increased to 10 mil ha after the implementation of the Natural Forest Protection program (NFPP) in 1998 that almost all the important ecological areas are closed to protect. From then on, the annual new closed forest area declines to about 200 mil ha.

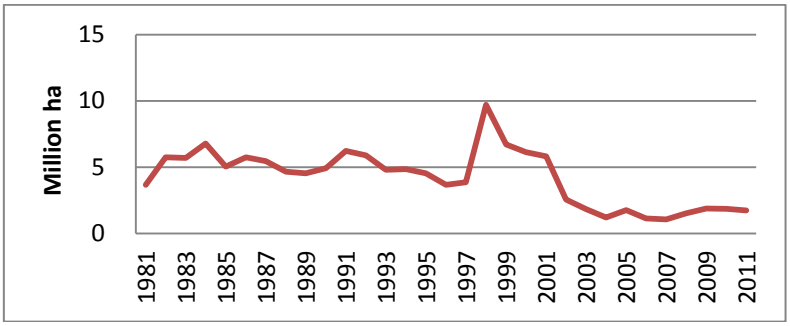


Figure 4.11. The annual closure of forest in China in 1981–2011

Source: China Forestry Yearbook (2012)

Secondly, various types of natural reserves and forest parks have been established to protect the ecology security and biodiversity. In 1956, the first national natural reserve—Tianmu Mountain Natural Reserve in Zhejiang was set up in China. Today, China has set up 2126 forest natural reserves with the total area of 122.69 mil ha, taking up 12.77% in national territorial area (Figure 4.12). Among these natural reserves, the number for forest ecosystem and wildlife accounts for 81%, with the forest area of 14.36 mil ha. The first forest park was set up in 1982, which increase to 2747 with the area of 17 mil ha in 2011 (Figure 4.13).

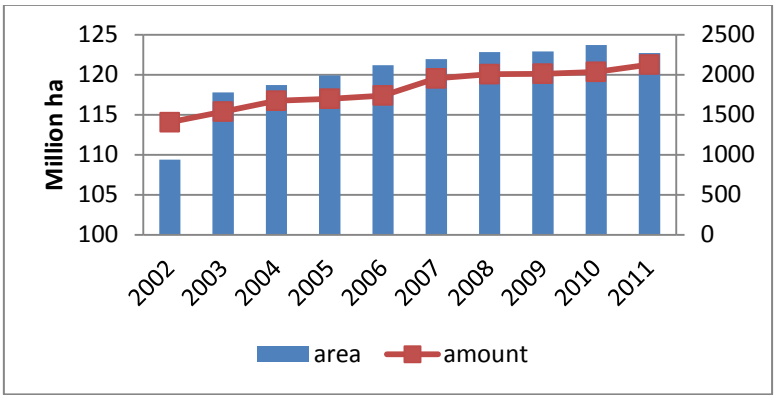


Figure 4.12. The area and amount of natural reserves in China in 2002–2011

Source: China Forestry Yearbook (2012)

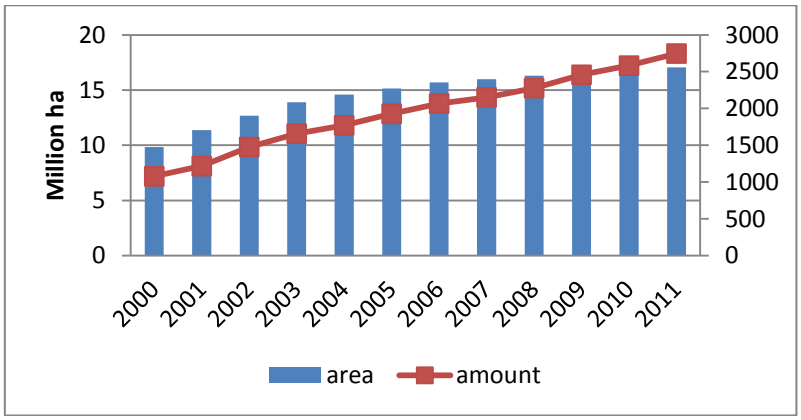


Figure 4.13. The area and amount of forest parks in China in 2002–2011

Source: China Forestry Yearbook (2012)

Thirdly, at the end of the 20th century, the Chinese Government launched six key forestry programmes to improve ecological environment, including National Forest Protection Programme, Conversion of Farmlands to Forests Project, Beijing-Tianjin Sand Source Control, Shelterbelt Programme in Three North and the Yangtze River, Protection of Wildlife and Fast-growing and High-yield Plantation. As a

result, the amount and share of fiscal forestry investment have risen rapidly. Actually, the forestry projects have went through two stages since 1978, marking that China forestry began to transform from timber production to ecological protection and sustainable use of forest. In 1978, “Three North” Shelterbelt System was laughed to treat soil erosion and sand storms in northern China. The project covers 13 provinces, with a total area of 4.06 mil sq km, accounting for 42.4% of national territorial area. During this period, the Chinese Government began to launch several the major rivers shelterbelt project, and developed large-scale forest planting and barren hills elimination movements in collective forest zones. Through those large-scale reforestation projects, China gradually reversed the trend of the decreasing forest resources. In 1998, floods of the Yangtze River, Songhua River and Nen River forced the government to put the ecological construction to the first priority. The central government had integrated the previous forestry ecological projects systematically and determined to implement six key forestry programs. The government forestry investment has increased rapidly (Figure 4.14). It was almost twice in 1998 than that in 1997. From 1998 to 2009, the government forestry investment increases from CNY13.53 billion to CNY137.79 billion, with an average growth rate at 23.48%. Among the forestry investment, Forestry investment from central government accounts for 60% of national forestry investment. By 2011, investment on six key forestry programmes has reached CNY53.221 billion, increased by 380.03% compared to 2000. Among these projects: *Grain for Green Programme* took most part of investment–56.09%, followed by Conservation of Natural Resource Programme–24.33% (Figure 4.15).

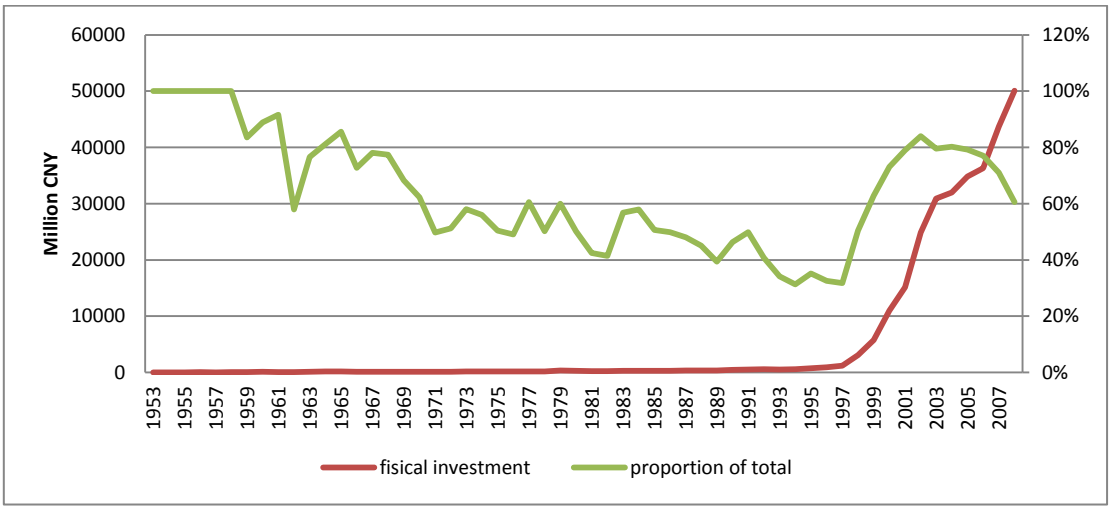


Figure 4.14. The government forestry investment and its share of the total in 1953–2008

Source: China Forestry Yearbook (2009)

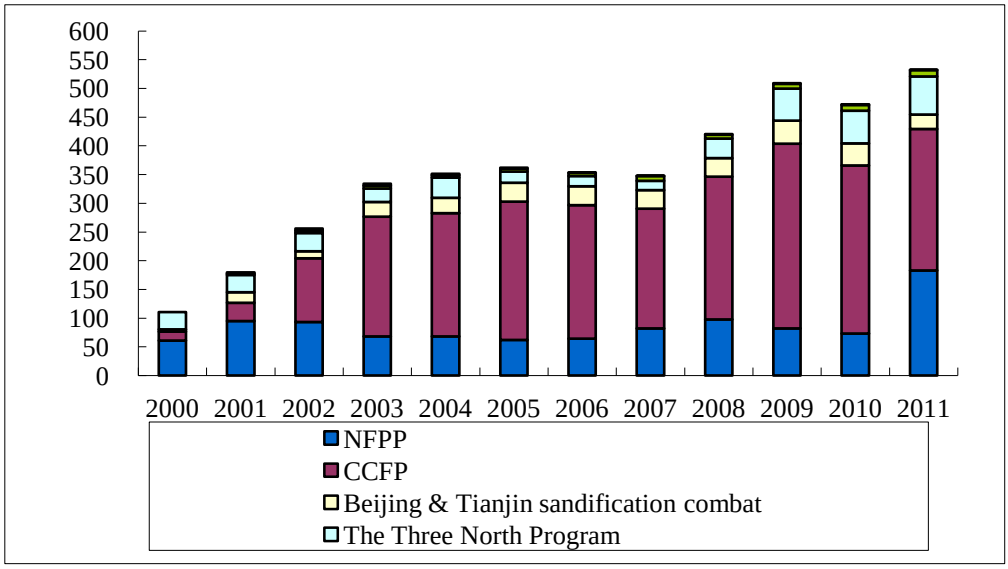


Figure 4.15. Investment on Six Key Forestry Program in 2000–2011

Source: China Forestry Yearbook (2012)

With the purpose of extending the protection to forest resource, Forest Ecological Benefits Compensation System (FEBCS) was initiated in 2001. From 2004, central government started to allocate central finance on it. Compensation area increased from 13.33 mil ha in 2001 to 83.95 mil ha in 2011 by 529.64%, and compensation fund was increased from CNY1 billion to CNY9.679 billion by 867.93% in the same period (Figure 4.16). Implementation of the programme narrowed the gap between social benefit and private benefit caused by forest positive externalities, which could thus enhance forest recovery and protection.

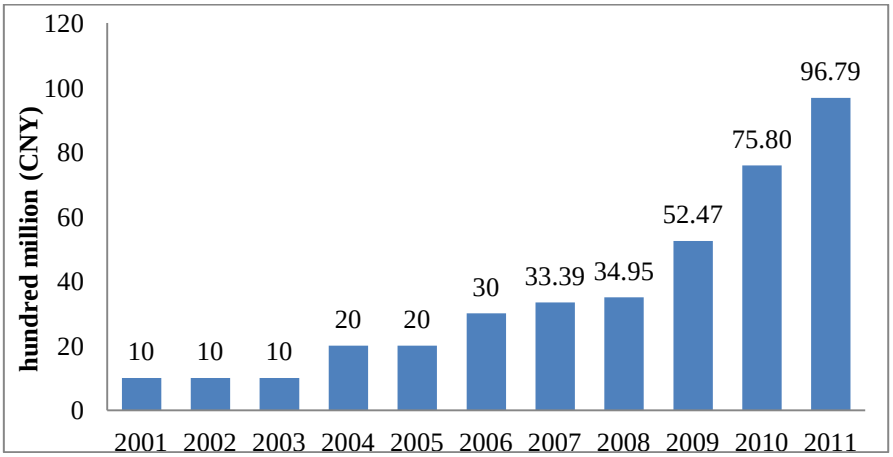


Figure 4.16. Central government funds for Forest Ecological Benefits Compensation System

Source: China Forestry Yearbook (2012)

CHAPTER 5 UNDERSTANDING FOREST TRANSITION IN CHINA

The forest transition did occur in China. Giving China has one fifth of world population and 5% of global forests, rapid economic development, moderate development stage, understanding forest transition in China has great significance to China and to the world as well. Great expansion of forests in the last two decades in China has contributed to global carbon sequestration, biodiversity conservation and in improving local and national environment. In particular, contemporary China has to restructure economy and reform social, political system to safeguard environment, harmonize the nature and social economic system in China as well as address the challenge of limits of natural resources, and pursue new paradigm of development – so called ecological civilization.

China case has global significance too. The loss of forest cover has paid global attention, much beyond forest sector, uplifting to global political concern. In 2007, the *Non-legally Binding Instruments on All Type of Forests* approved by UN declared that, "prevent the loss of forest cover worldwide through sustainable forest management, including protection, restoration, afforestation and reforestation, and increase efforts to prevent forest Degradation" as one of four global objectives, which was reconfirmed by member states. Sustainable forest management and land use practices play a key role in the carbon cycle and need to be addressed in the international climate change arrangement. Under the *Sydney APEC Leaders' Declaration on Climate Change, Energy Security and Clean Development*, member economies agreed to work to achieve a regional inspirational goal of increasing forest cover in the APEC region by at least 20 mil ha of all types of forests by 2020. China's proposal to establish the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation to enhance capacity building and strengthen information sharing in the forestry sector has been adopted.

In this chapter we will provide theoretical interpretation of forest transition in China from the perspectives of economic parameters, institutional parameters and cultural parameter. This could lay a fundamental foundation to understand the dynamic of human-environment systems and provide potential policy recommendation.

5.1 Historical review of China's forest transition

At least half of Chinese territory was once covered with dense forest. In order to prove this, many scholars had estimated China's forest coverage rate in the 20th century BC. Their results range from 49.6% (Ling 1983), 56% (Zhao 1996), 64% (Ma *et al*.1997), to 60–64% (Fan *et al*. 2001). With the increasing number of population and the development of agriculture civilization, the forests in the Loess Plateau[2], which is the source of Chinese civilization, began to be destroyed. Then this deforestation trend extended to the North China Plain and the Yangtze River and Pearl River Basins. By 1700, about half of the forest resources or about 29 130 ha of forests were destroyed and the forest coverage rate decreased to 26% (Ling 1983). Many reasons contributed to the reduction of forest resources in this period. Firstly, deforestation caused by population growth and cultivated land expansion: deforestation areas were extended from the Yellow River Basin to the Yangtze River and the Pearl River Basin. The population was about 30 million in 221 BC, reached to a peak of 90 million to 100 million in the Tang and Song Dynasties. During the early Ming Dynasty in 1393, the population decreased a bit to the level of 80 million. Secondly, endless and frequent dynasty changes and wars led to huge forest destruction. For instance, many forests in the Guanzhong Area were destroyed because of the wars during the Chunqiu and Zhanguo Eras. Thirdly, iron, pottery and other industrial fuels and resident household building materials, were mainly extracted from the forests, resulting in lots of forests in residential area, roadsides and riversides destroyed. In addition, the construction of the palaces also destroyed large tracks of forests. By the time of the late Ming and early Qing dynasties (around 1700), the developed land was mainly located in the Guanzhong Plain, North China Plain and the mid and lower reaches of the Yangtze River. However, there still retained a large number of original natural forests in the northeastern, southern and southwestern parts of China.

[2] Whether there had primary forests in north and northwest of China in twentieth century B.C. was still controversial. Zesi Meng (2009) said that these areas were neither lush forests nor bare gobi, but covered with dense or spares deciduous forest.

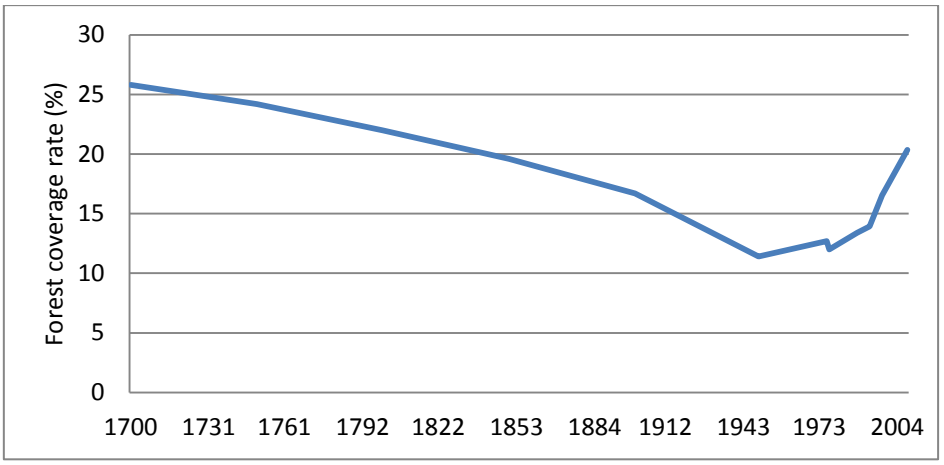


Figure 5.1. Changes of forest coverage rate in China

Source: Data before 1949 – He *et al*.(2007), data after that – SFA (2012)

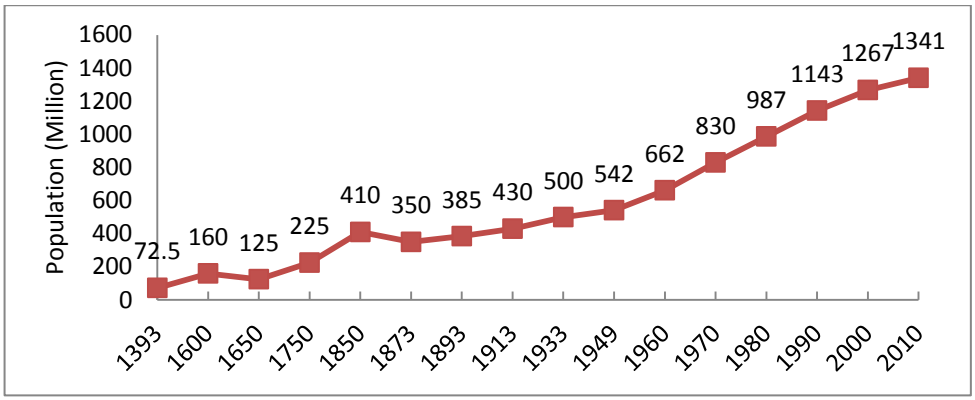


Figure 5.2. Population of China since 1393

Source: Data from 1393 to 1933 – Perkins (1984), data after 1949 – NBS

According to the historical data [3]and the seven NFIs from 1973 to now, the changing trend of China's forest coverage rate in 1700 years could be illustrated as Figure 5.1. It could be seen from the figure that the characteristics of forest transition presented a trend that first decline and then rising. From 1700 to 1949, the forest resources lost at a faster speed than in the past, resulting in the forest coverage rate decreased to 12.5% (Figure 5.1). During the 200 years from 1650 to 1850, the population increased rapidly from 125 million to 410 million (Figure 5.2) and the area of cultivated land enlarged almost double. Cultivated land area increased from 49 mil ha in 1685 to 81 mil ha in 1873, contributing to almost half of Chinese agricultural growth. On the other hand, based on the introduction of new crops, especially the American corn, sweet potato, peanut, potato and so on and with the improvement of water conservancy facilities, the grain yield per unit area increased rapidly. In the meanwhile, an influx of immigrants entered into the border areas to devastate forests for cultivated land. This phenomenon was more serious in northeastern, southern, southwestern and Qinling regions. Especially in the three northeastern provinces of China, large area of original forest had disappeared. Starting from the Opium War in 1840, to the founding of the PRC in 1949, foreign wars and civil wars occurred almost continuously. When there was a war, the forest will be badly destroyed. In the late 19th century and early 20th century, when the northeastern region was under the control of Russia and Japan, the original forests along the roads, railways and rivers were cut down almost totally in the three northeastern provinces of China (Chen and Ling 1982, Ling 1983). During the period of Anti-Japanese War, there were 21 provinces where the forests were directly destroyed in the war and 26 provinces were indirectly influenced. The total losses of national stock volume were up to more than 10% (Chen and Ling 1982).

[3]The maps of Chinese territory in each period are not identical, and there is no forest statistical data, but the historical data may be provided. The forest data prior to 1973 was the forest area measured by He (2007) according to the rich history, local history, travel and other historical materials.

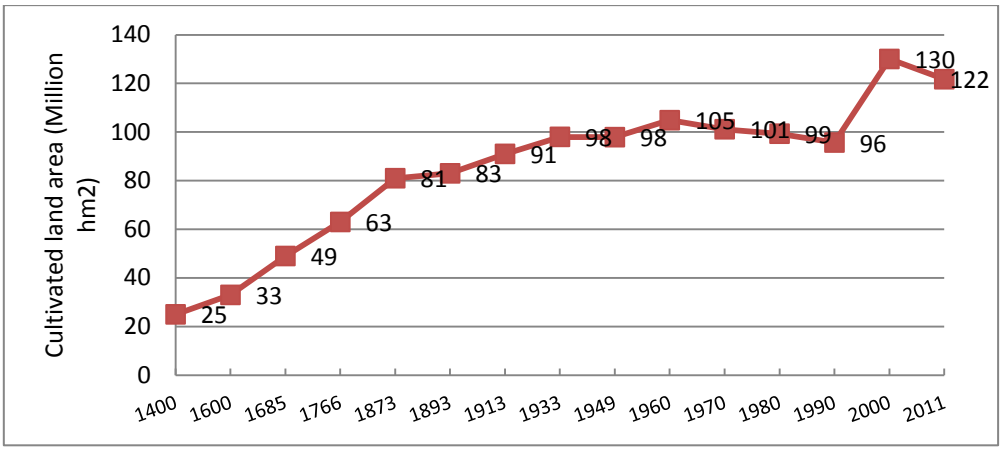


Figure 5.3. Area of China's cultivated land since 1400

Source: Data from 1393 to 1933 – Perkins (1984), data after 1949 – NBS

The forest coverage rate in1949 and in 1976 was 12.5% and 12.7% respectively. This officinal data showed that in this stage, China's forest coverage rate seemed to be in a stable condition although the forest stock volume decreased significantly. During this period, the development of forestry was in unstable state. Deforestation and forest reforestation factors interweaved together, caused the fierce turbulence to China's forests.

- Timber production was the central task in the development of forestry. The Chinese Government had established a number of state-owned forestry enterprises in the northeast, southwest and northwest original forest areas so that the timber production could meet the needs of the national economic growth and industrial infrastructure.
- Increasing of population from 540 million in 1949 to 960 million in 1978, which, of course, resulting in the rapidly increasing pressure between population and land.
- The growth of agricultural output per unit was almost synchronized with the growth of population. Based on the construction of water conservancy and the expansion of seed cultivation, the grain yield per unit and the agricultural productivity had been improved. It then could be used less cultivated land to feed a large population, avoiding the forests were destroyed seriously. But during the period 1958–1961, irrational industrial development plan caused a substantial increase in the demand for energy, leading to massive destruction of the forest. During 1966–1968, the decrease of the agricultural output prompted a large-scale rural-urban migration, resulting in the deforestation became more serious.
- Because of the rise of forest reforestation and the building of collective forest farms in State-owned Forest Region, the decline trend of China's forest had been effectively curbed. In 1978–1983, because of the reforestation speed could not catch up with the long-term excessive deforestation, China's forest coverage rate shown a brief decline.

In 1978, the "Three North" protection system construction project began to implement. It became a symbol that Chinese forestry had gradually changed from timber protection as the central task to laying equal stress on both timber production and ecological construction. Afforestation construction had become a model for Chinese Government to focused social forces to do great things. From the late 1990s to the beginning of 21th century, the Chinese Government had systematically intergraded the original forestry ecological engineering then generated six key forestry engineering. In state-owned and collective forest area, through reforming the original planned economy system, the implementation of decentralization as well as giving the autonomy rights and income rights of forest management to state-owned forest farm and forester, the incentive mechanism and management mechanism of China's forest marketization were established gradually. In 1998, the floods in the Yangtze River, Songhuajiang River and Nenjiang River had brought great losses to Chinese economy and society. It also forced the whole country to have a profound reflection and adjustment on the relationship between forestry ecological construction and economic development. Chinese forestry policy gradually changed from laying equal stress on both timber production and forestry ecological construction to giving priority to forestry ecological construction.

It could be seen from Figure 5.1 that there did exist a “U” shape trend of first decrease then increase in the changes of China’s forest coverage rate, namely forestry transformation. The inflection point occurred in 1950–1990, at which time, the forest coverage rate was about 13%. The forest coverage rate began to increase from bottom up in the late 1980s.

5.2 Descriptive statistics on forest change at provincial level

In this part, we used the forest area data in 1949–2008 from 29 provinces, cities and autonomous regions of Chinese Mainland, except Chongqing and Hainan. In order to ensure the continuity and consistency of the data, in this paper, the statistical data of Hainan was incorporated to Guangdong Province and the data of Chongqing was incorporated to that of the Sichuan Province.

The data of 1949, 1960 and 1976 were from the database of Chinese Academy of Sciences, and the data of 1981, 1988, 1993, 1998, 2003 and 2008 were from the databases of the First to the Seventh National Forest Inventory conducted by the State Forestry Administration. From the Fifth National Forest Inventory, the forest statistics had changed, so the data of 1949, 1960, 1976, 1981 and 1988 were adjusted and modified in order to in accordance with the unified standard.

a. Provinces which have 2 transition points respectively in 1976 and 1981

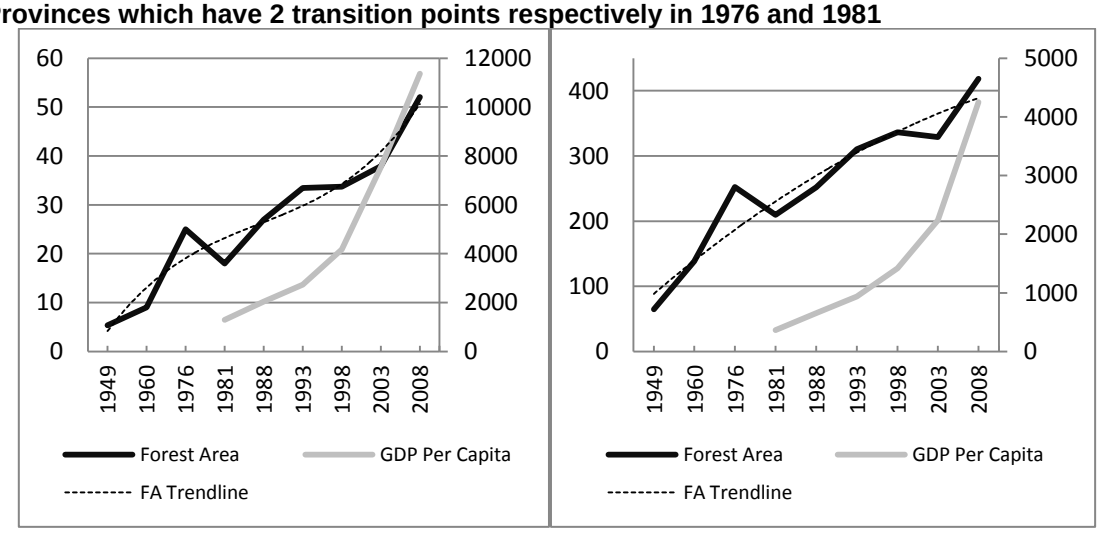


Figure 5.4.1. Trend of forest acreage change across Chinese provinces (Beijing, Hebei)

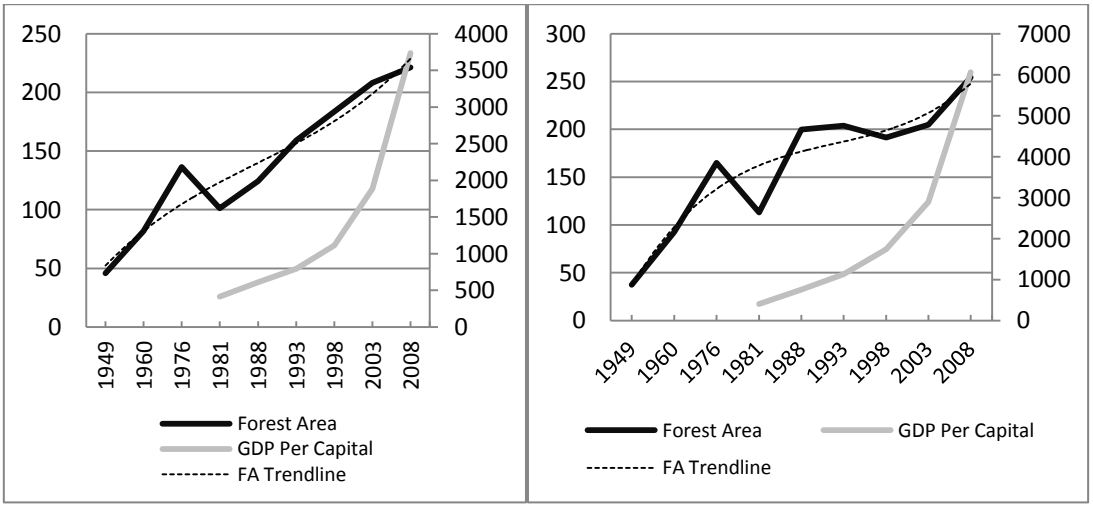


Figure 5.4.2. Trend of forest acreage change across Chinese provinces (Shanxi, Shandong)

b. Provinces which have 2 transition points respectively in 1976 and 1988

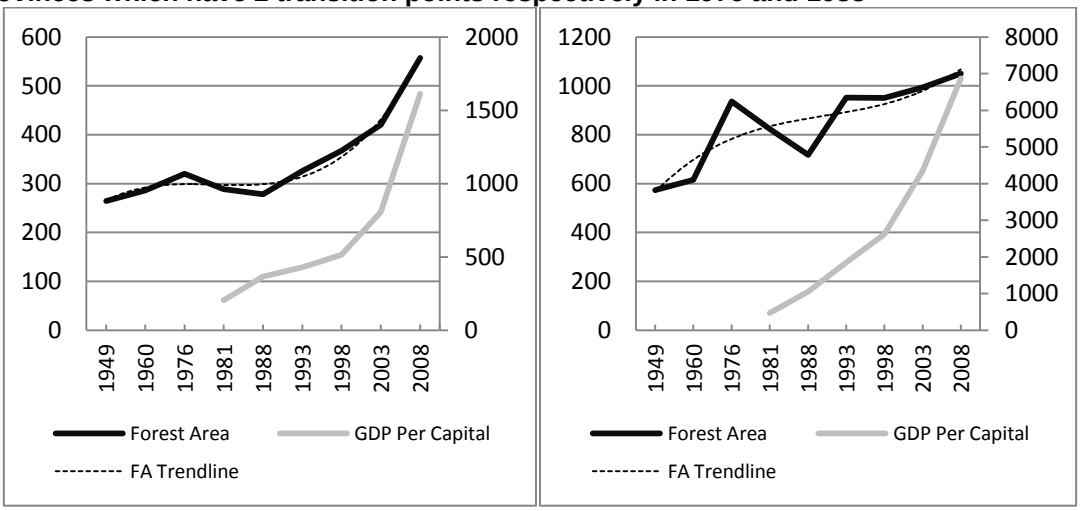


Figure 5.4.3. Trend of forest acreage change across Chinese provinces (Guizhou, Guangdong)

c. Provinces which reach peak in 1976 and reach bottom in 1981, and then increase very slowly

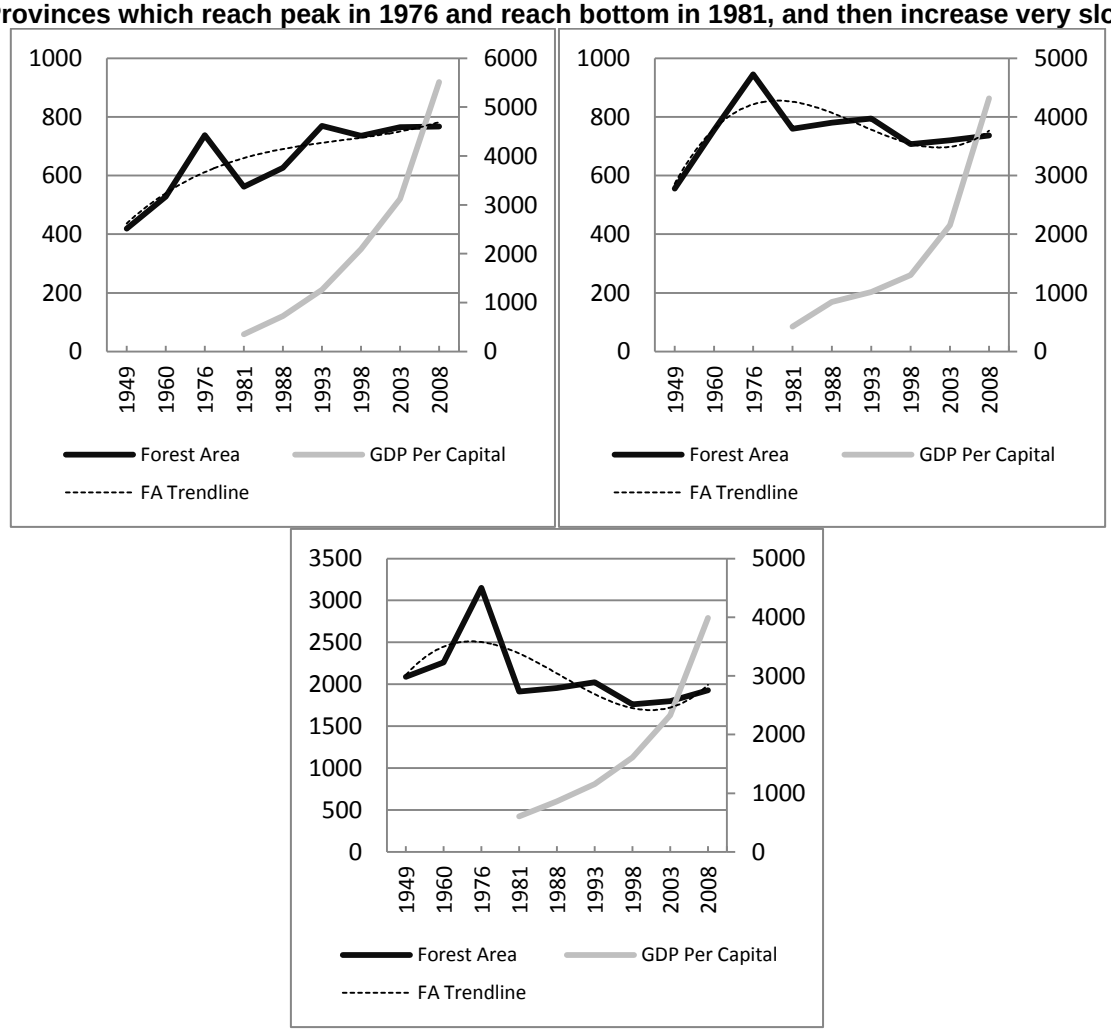


Figure 5.4.4. Trend of forest acreage change across Chinese provinces (Fujian, Jilin, Heilongjiang)

d. Stably but slowly increase, and after 1998 dramatically increase

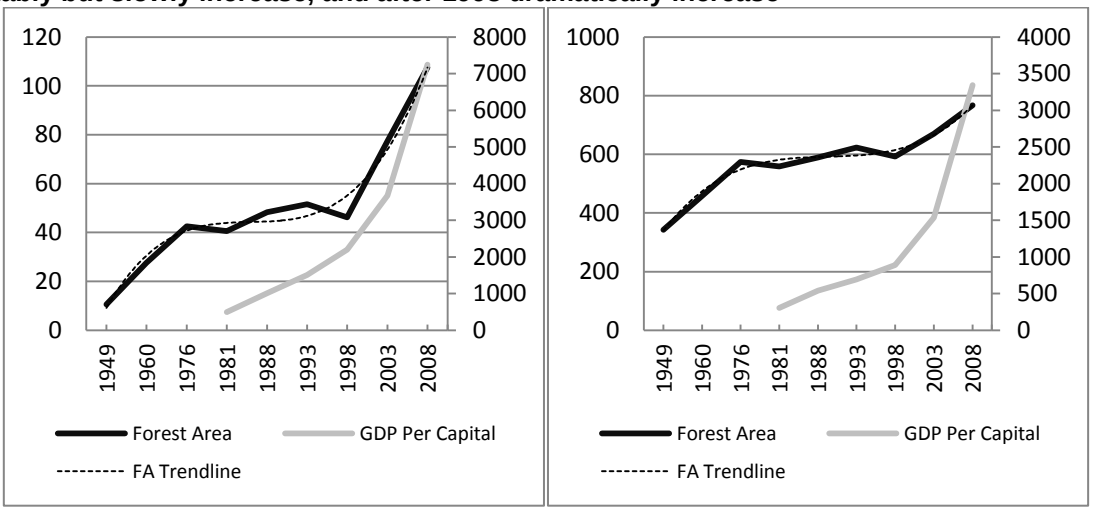


Figure 5.4.5. Trend of forest acreage change across Chinese provinces (Jiangsu, Shannxi)

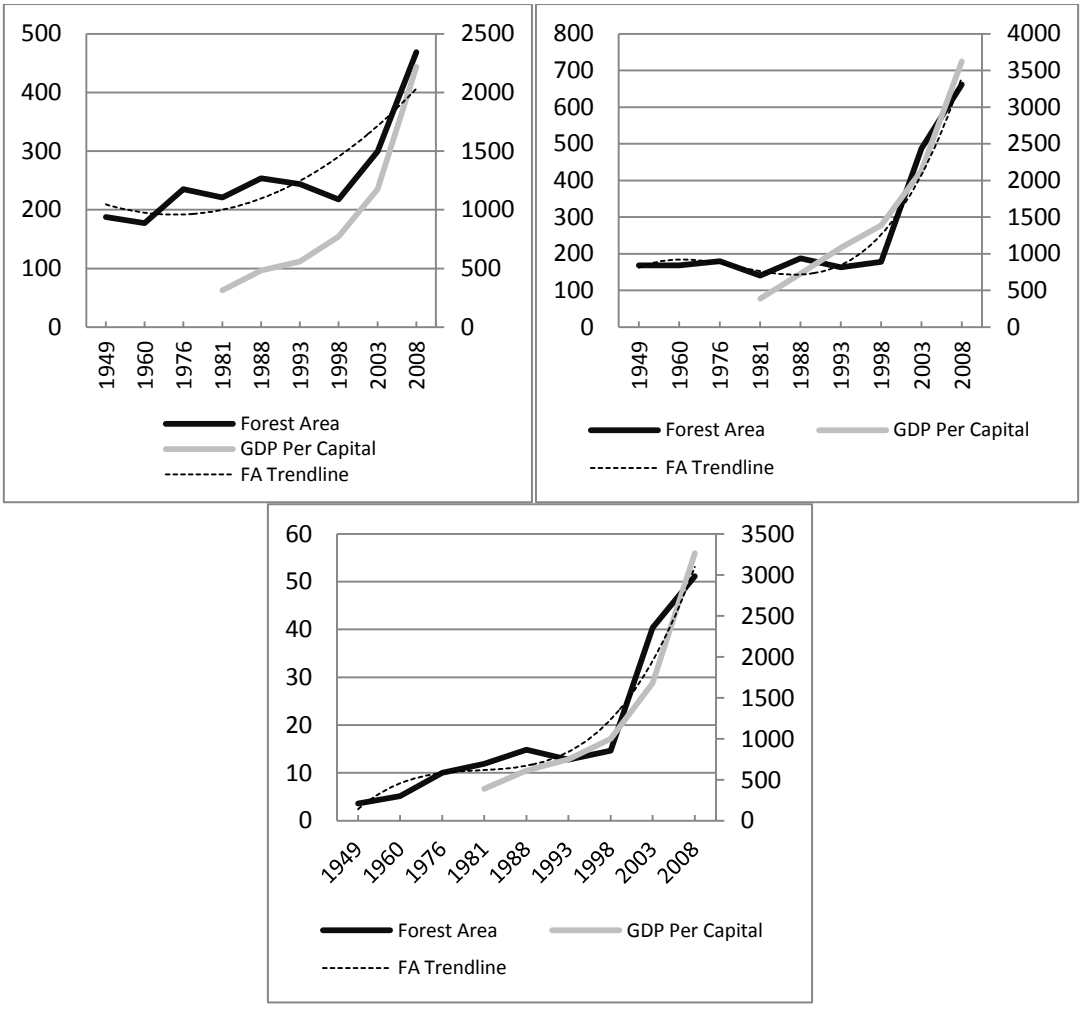


Figure 5.4.6. Trend of forest acreage change across Chinese provinces (Gansu, Xinjiang, Ningxia)

e. Provinces which depict a U-Shape curve and the turning point is around in 1981

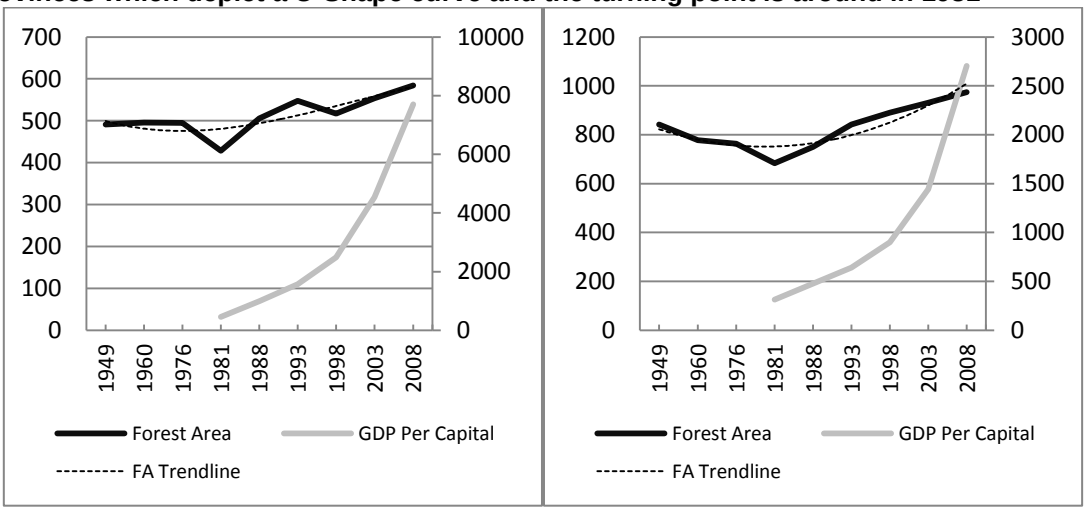


Figure 5.4.7. Trend of forest acreage change across Chinese provinces (Zhejiang, Jiangxi)

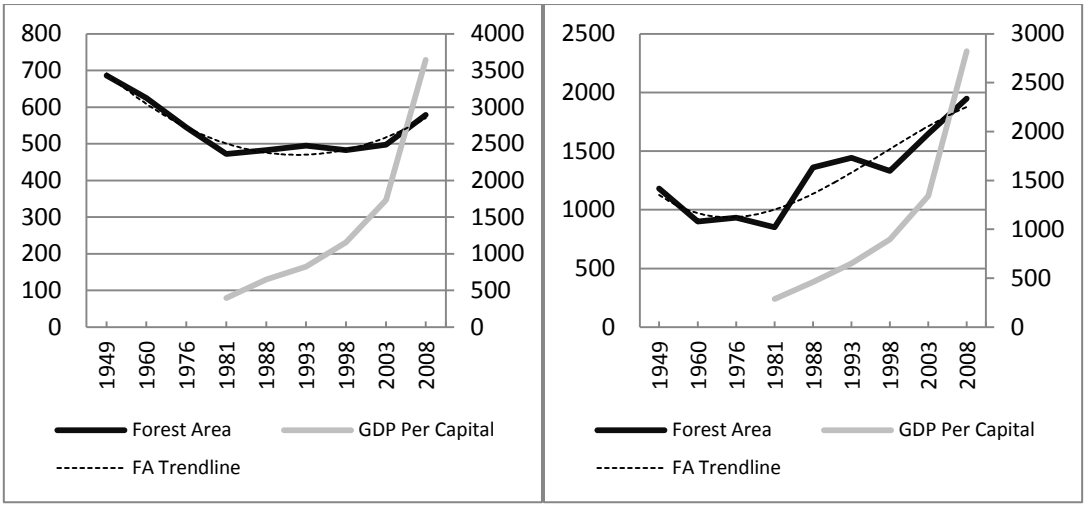


Figure 5.4.8. . Trend of forest acreage change across Chinese provinces (Hubei, Sichuan)

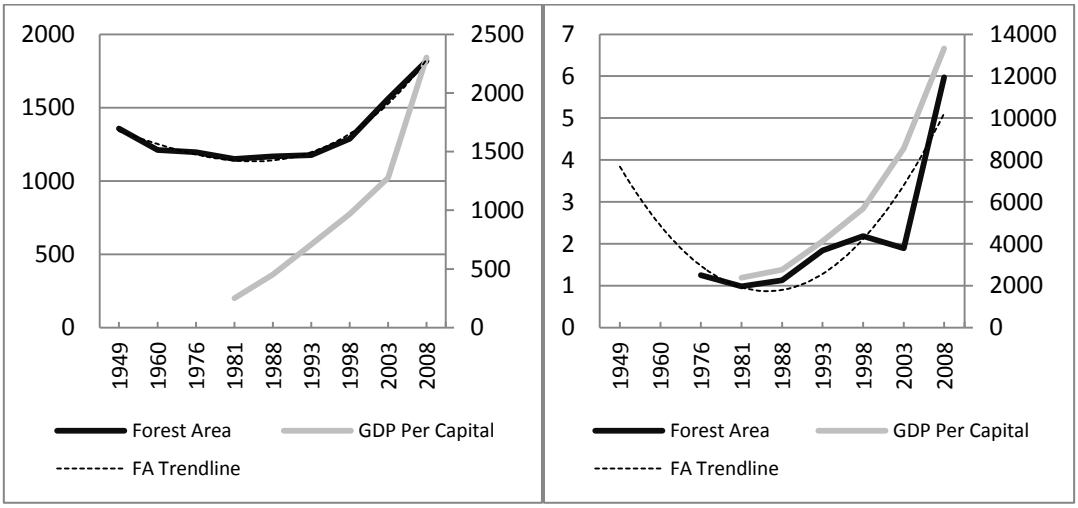


Figure 5.4.9. Trend of forest acreage change across Chinese provinces (Yunnan, Shanghai)

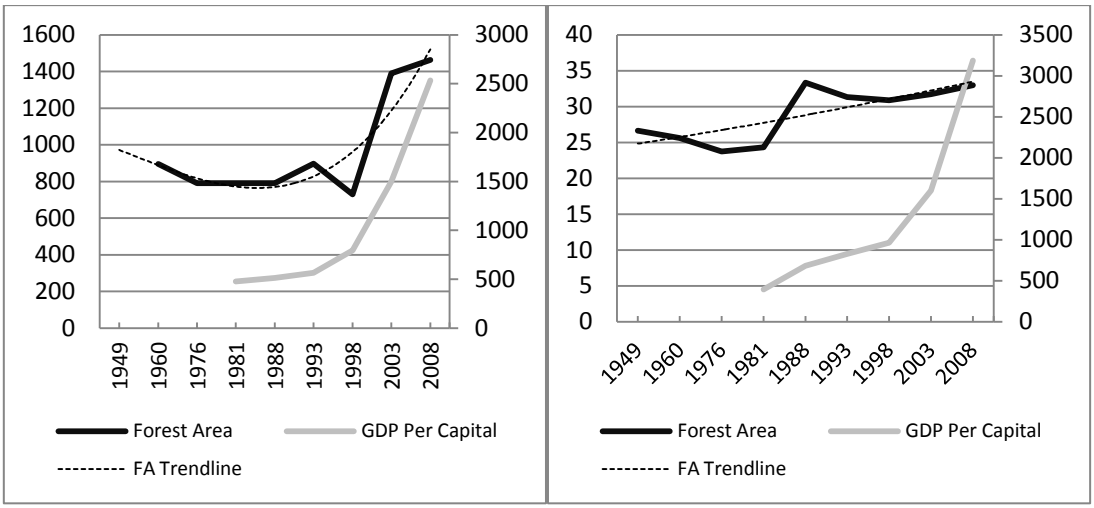


Figure 5.4.9. Trend of forest acreage change across Chinese provinces (Tibet, Qinghai)

f. Provinces which reach a high spot in 1976

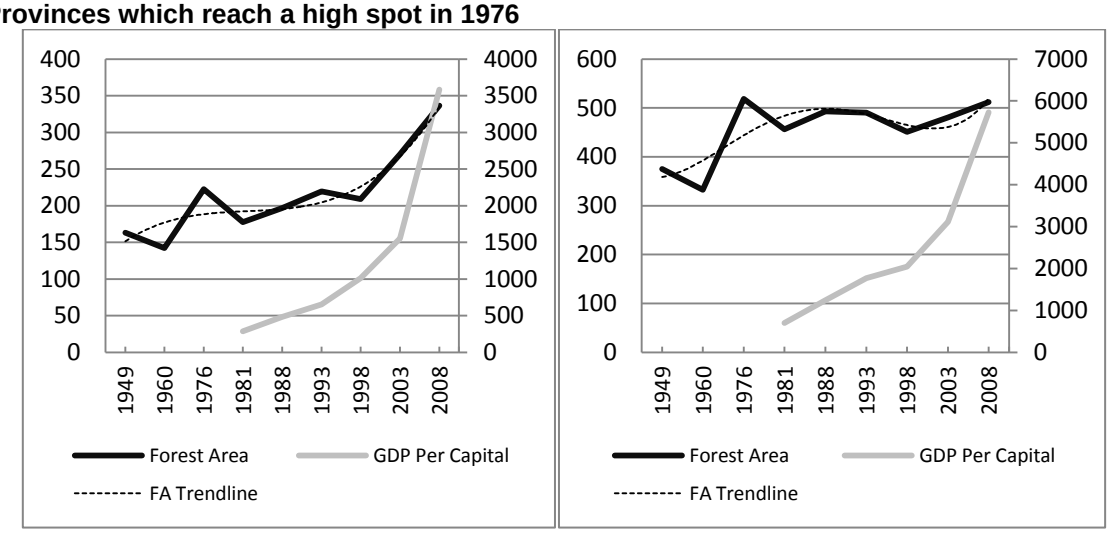


Figure 5.4.10. Trend of forest acreage change across Chinese provinces (Henan, Liaoning)

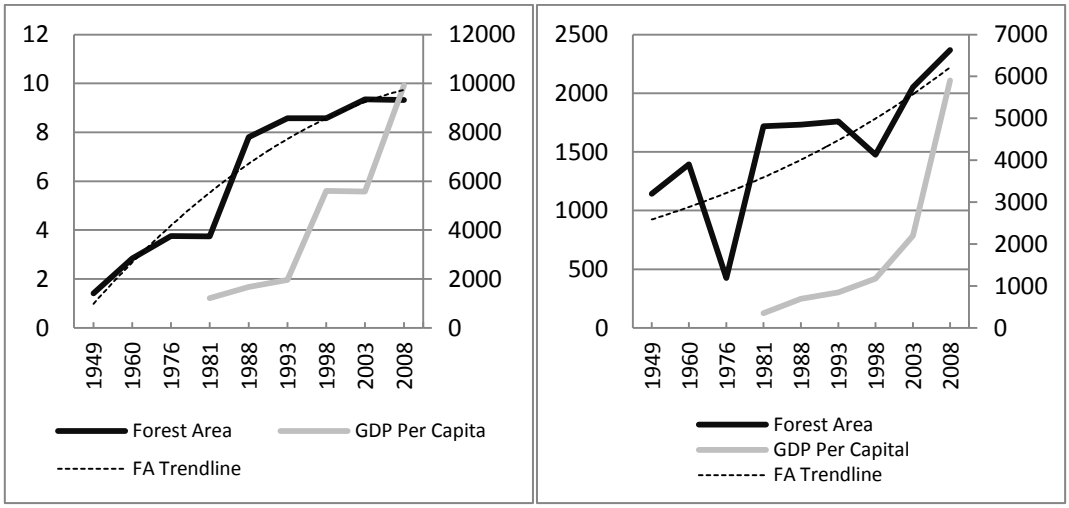
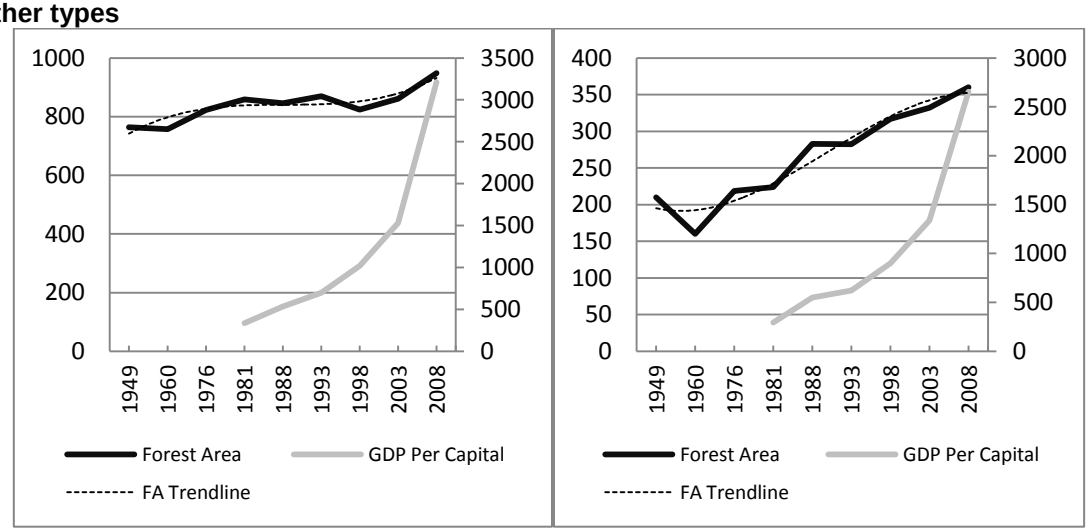


Figure 5.4.11. Trend of forest acreage change across Chinese provinces (Tianjin, Inner Mongolia)

g. other types



Hunan Anhui

Figure 5.4.12. Trend of forest acreage change across Chinese provinces (Hunan, Anhui)

As can be seen form Figure 5.4, due to the huge territory span, China has a diversity of forest change situations, but a similar transition trend. The reasons of causing the differences of forest area changing trajectory between each province might be as follows:

1. The different effects caused by different population pressure in each province. The general researches believed that, the increase of population would increase the grain supply pressure, thereby increasing the possibility of deforestation so that the villagers could transfer the forest land into cultivated land to grow food.

2. The differences in the degree of economic development. The degree of economic development, especially the differences of economic development level in rural areas effected the different degree of dependence on forest resources for each province. The effects of the degree of economic development in rural areas of the forest area were generally positive, the dependence on forest in better economic development areas was smaller, the possibility of deforestation was smaller too.

   Another aspect of the degree of economic development is the level of marketization, which may exist simultaneously in two opposite directions. For instance, the forest decline continued until 1988 in Guangdong Province, as one of the provinces that had better degree of economic development, the forest decline period of Guangdong was much longer than other provinces, and the rising year was later. This may be due to the fact that Guangdong was the biggest wood furniture production province as well as other related factors.

3. The different policies of economies and systems in each province. For example, Fujian Province took the lead in developing the forest right reform, some provinces had the implementation of the natural forest protection project while others did not. In addition, such as Anhui Province, the forest area decreased sharply in 1960, which may be due to that Anhui Province was the harder-hit area of three-year famine.

4. The possible cultural differences. Within a country, there may be existing forest cultural differences on county-level, leading to different treatment and utilization of forest by different counties and nationalities.

5.3 Economic development perspective

Why can China successfully reverse the downward trend in the number of forest in the backgrounds of low level of per capita GDP, population pressure and the expansion of timber demand? In this section, the impacts of the mode of economic growth, rural energy and timber trade to China's forest transformation will be analyzed.

5.3.1 The economic development mode launched in rural areas and focused on farmers

Population pressure is considered to be the direct cause of forest degradation. The greater the population pressure was, the more demand for foods, resulting in deforestation and other activities led to a decrease in the forest coverage rate. Seen from the figure, the population increased from 540 million in 1949 to 1.34 billion in 2011. After 1949, especially 1n 1980s, the pressure of population size on forest resources was gradually reduced. The destructive effects of population size on the forest area were also reduced by other factors. In 1980s the area of cultivated land decreased by 3 mil ha (Figure 5.5). The indexes of population pressure on forests such as grain yield, population size and firewood consumption were decreased rapidly in 1980s with the decrease of cultivated land area. Because of this, it significantly reduced rural poverty and the dependence on the forest for peasants, and promoted the recovery of forest resources.

In the early 1980s, the reform of rural land brought the increasing of grain yield. In 1949, the per capita grain yield in China was only 209 kg, and then in 3 decades it increased to 316 kg in 1978. The family contract responsibility system began in the national scope in 1978, rapidly increased the growth of grain yield. The per capita grain yield increased to 394kg in 1984, which significantly reduced the poverty. Took the period from 1978 to 1985 as an example, the poverty rate dropped from 30.7% in 1978 to 14.8% in 1985, with the impoverished population decreased almost half compared to 250 million in 1978. But in this stage, the per capita GDP only increased less than doubled. So, if only the growth of per capita GDP was used to measure the contribution of the effects of grain growth on reducing the pressure of forest, it would be underestimated. In the middle of 1980s, with the rapid development of township enterprises, the non-agricultural employment of farmers increased. As showed in Figure 5.6, the township enterprises employed 6.295 million people per year. The employment number increased from 92.65 million in 1990 to 130.86 million in 2000, and then it reached to 150.90 million in 2007. In addition, the rural labour force transferred to cities, representing an increasing mode started from scratch and changed from small scale to explosive growth. Despite several returning tide, the transfer of rural labour force to cities increased gradually ever year. In 1984–1988, the average annual number of transfer of rural labour force reached to 11 million people, with an average annual growth rate of 23%. To 1992–1996, the average annual number of transfer of rural labour force was more than 8 million, with an average annual growth rate of 8% (Liu 2004). Since 1997, with the new additional rural labours and the original rural surplus labours transferred to cities, the annual increasing number of migrant workers was between 6 million to 8 million people.

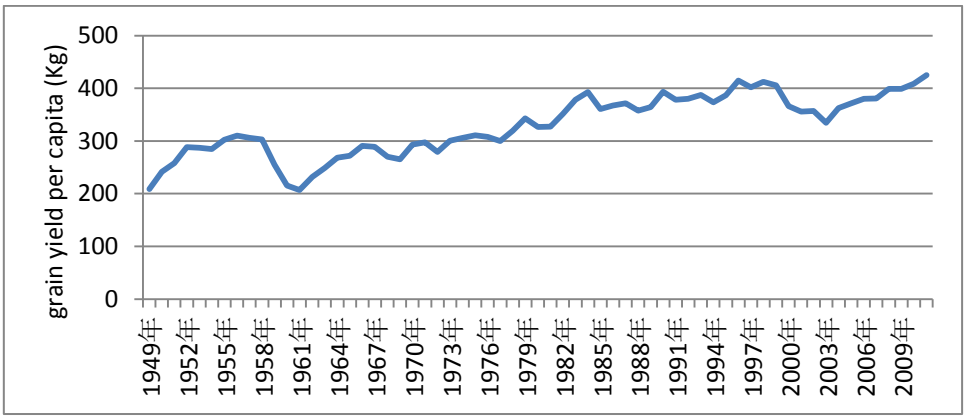


Figure 5.5. The grain yield per capita since 1949
Source: China Agricultural Yearbook (2011)

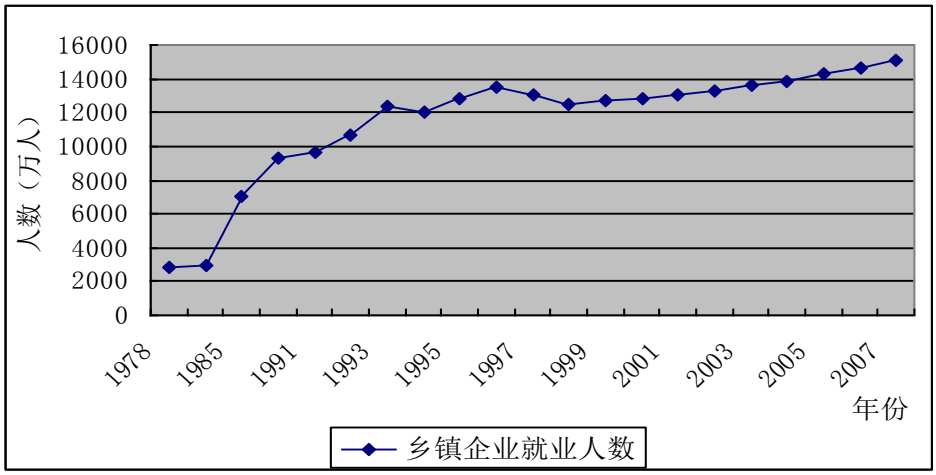


Figure 5.6. The employed number of township enterprises since 1978

Source: China Statistical Yearbook (2010)

The increasing income of the farmers significantly reduced firewood consumption. For a long time, the main fuel used in rural areas was straw, firewood and other biomass energy. In 1980s, the proportion of firewood consumption decreased gradually, with an annual decreasing rate of 1%, from 39.8% in 1979 to 28.6% in 1991(Figure 5.7). Rural energy structure was becoming more and more diverse. The consumption of the two non-commodity energy, straw and firewood, showed a downward trend, while the coal, electricity, oil as well as other commodity energy were increased The changing of the rural energy consumption structure reduced people's dependence on the forest, so that more forests were protected from being destroyed.

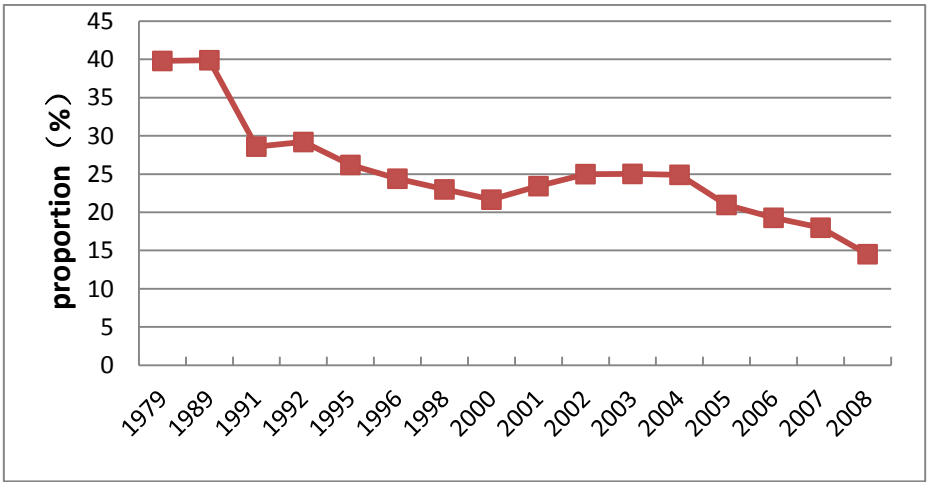


Figure 5.7. The proportion of the rural firewood consumption of household energy since 1978

Source: The Chinese Ministry of Agriculture Rural Renewable Energy Statistics

5.4 Regulative perspective

Over 30 years, China has carried out the economic reform towards to market end. Forest authority has made a great effort to provide favor environmental condition for private sector to participate in afforestation, and forest management. However, the growth of forest, the direct intervention of the government, the strengthening of forest and the control of forest land using played very important roles in promoting the forest transition.

In the early 1980s, under the background of contract system of cultivated land and power decentralization and profit transfer to state-owned enterprises, with power decentralization and profit transfer as a breakthrough, the forestry reformed the micro-operational mechanism, and implemented the production responsibility system in collective forest areas and state-owned forest industrial

enterprises respectively, in order to mobilize the enthusiasm of producers. In rural areas, the government promoted the reformation of forestry *Three-fixed* policy (namely stabilizing the mountain ownership and forest right, delimiting the private hill land and determining the responsibility system of forestry production) and allowed the peasants contract for the collective forest land. By 1986, the area of the forest land managed by family had accounted for 69% of the total area of the national collective forest, and had become the mainly management form for the collective forest land in China. The government decided to cancel the state monopoly over purchase and marketing of the timbers in collective forest areas and open the timber market in 1985. The market started to play an important role in forestry resource allocation. However, after the opening of timber market in collective forest areas, because of the unclear property right, unstable policy and the backward management step, the deforestation problem began to appear so that the government had to stop the reformation of forestry *Three-fixed* policy. The occurrence of deforestation was the representation of the conflict in the forest management objectives between the government and thousands of households of farmers. It also showed that the local forestry department was unable to assume the management and protection functions door to door. Since then, the implement of unified purchase of timber and the constructions of forestry workstations, forest police system and other forestry administrative management systems had become the task of top priority and the key point of the system construction of forestry department.

In 1982, the state-owned forestry enterprises started to implement the decentralization of power and transfer of profits and extended the autonomy of enterprise to promote the production responsibility system and give the enterprises more management rights and jus fruendi aut furctus. However, due to the long-term preference of logging to forestation and the integration of government administration with enterprise in the mid-1980s, the problems of the decline of forest resources in state-owned forest areas, the deterioration of enterprise economic as well as the heavy social burden became more and more serious.. Although experienced many reforms, the sate-owned forestry enterprises actually still not get rid of the dilemma, and the problems of the forest resources decline under the integration of government administration with enterprise system, heavy social burden, and inflexible management mechanism as well as the large stress on forest transition were still ubiquitous.

It was said that the market-oriented reform had not completely achieved the government's desired results. Since the middle 1980s, the Chinese Government had strengthened the control measures and established a set of completed forest resources management system, from harvesting, transportation, processing to law enforcement and market management. It was the cornerstone of the government to promote all forestry reforms, to prevent the risk of forest management and to contain the down trend of forest resources. First, according to the principle that the consumption of timber must lower than the growth, the government established the mechanism of forest cutting quota system to strictly control the amount of forest harvesting, illegal logging as well as deforestation. The forest cutting quota system formally implemented in 1986, and then revised every five years. In order to facilitate the implementation of forest cutting quota system, the institutions of logging with a license, timber transportation with a license and timber processing management system had been established gradually science 1985. Under these institutions, one must applied for a license before logging and a transportation permit in order to transport the timber out of the forest. To operate and process the timber, he also had to be approved by the competent forestry authorities of the government at or above the county level. Second, the government strengthened the constructions of forest police system, forestry workstations, timber check stations and other law enforcement agencies of forestry administration, and established a complete set of administrative management system. By 2010, the vast majority of the cities and counties had their own independent forestry administrative agencies, and most of the towns had forestry stations. According to the statistics, the whole country had nearly 7 000 forest police stations, 4 236 timber checkpoints and 28 112 township forestry stations in 2010. Third, the government set up the timber trade system that the timber in production areas was bought by only one company and the selling price in sales areas was determined by market supply and demand to achieve the marketization of timber management.

The forestry sectors intervened more forwardly in forestry investment. On one hand, the forest resources in state-owned forest areas had become critically depleted, so they had to control the logging in these areas. On the other hand, they expanded the implementation of closed forest and launched projects for protecting natural forests and reforesting formerly cultivated land as well as another six key forestry engineering. Also, they implemented the mechanism of ecological compensation and carried out the responsibilities of ecological public welfare.

The experience of Chinese forestry system: during the process of country transition, on one hand, the main management body should be enlivened and on the other hand, the management should keep the pace and the ecological environment service should be performed. Once the main management body is lack of incentive, the government should keep reforming and increase the investment to make sure the targets be achieved. Thus, under the conditions of scarce resources and industrial demands, the government tried to promote the growth of forest by enlivening the market and increasing the governmental investment. Once the forest continue to decline, the government should keep on enlivening the reform and put more money into the non-profit areas such as windbreak and sand-fixing forests, water and soil conservation forests and the protection forests. If the government managed strictly, the government should increase the investment and implement the reformation to promote the development of private commercial forests. The high market price is not conductive to the development of industry. Forestry development has always been under the guidance of the government, so it cannot be explained only by the development of economic or the government investment. This is a systematic project, the government investment ignores the investment of private sectors, and cannot explain the other half of forest investment.

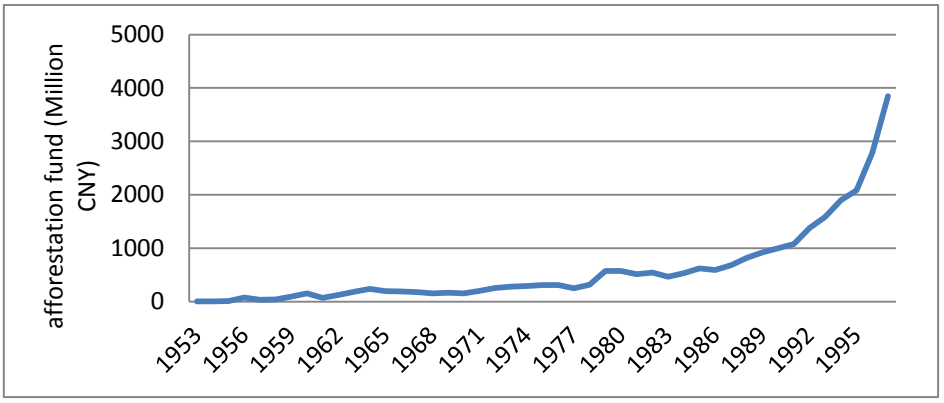


Figure 5.8. Changes of the afforestation fund structure from 1953 to 1995

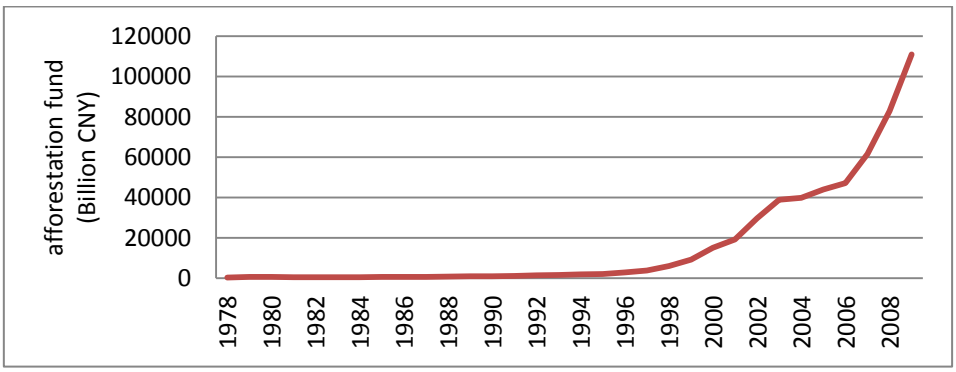


Figure 5.9. Changes of the afforestation fund structure from 1978 to 2009

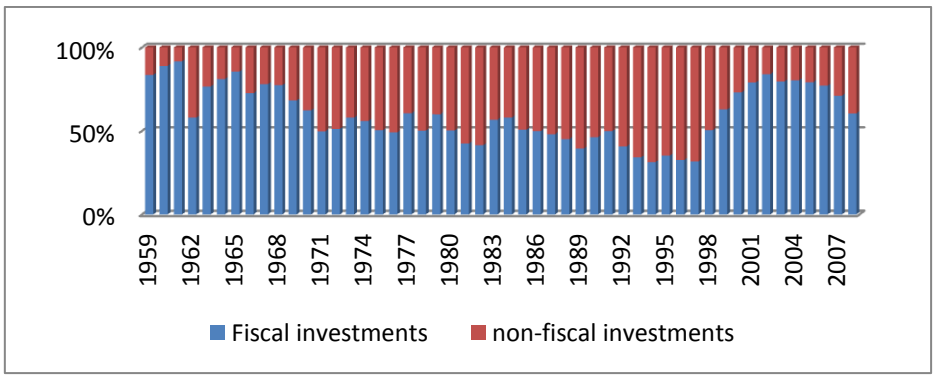


Figure 5.10. Forest investment by public funds and non-public funds

5.5 Globalization and timber trade

The characteristic of resources in China is a large population with relatively little land, which determines that China mainly exports labour-intensive products and import land-intensive products. Since 1949, China began to import timber from abroad, but the quantity of import timber was small till 1980, even in some years the quantity was only 0.1–0.2 mil cu m. Since 1980, due to the opening-up policy, the number of imported timber has increased sharply. In 1981–1985, the amount of imported timber, converted into logs, was 72.94 mil cu m, which accounted for 26.1% of the timber production in China. And the annual growth rate of imported timber was 21.11% (Feng 1990). As could be seen from the graph (Figure 5.12), the production of domestic timber had experienced two 10-year trough periods since 1984. The first one was from 1984 to 1993, and it was not until 1993 that the production of domestic timber recovered to the level of 63 mil cu m in 1984. The second one was between 1996 and 2006, during which time, the lowest yield of domestic timber dropped to 44.36 mil cu m, and then it recovered to a higher level in 2006. In contrast, the amount of imported timber has kept increasing since 1980. Especially due to the projects for protecting natural forests and reforesting formerly cultivated land started in 1998, the policy of reducing the import duties of logs, sawn timber, firewood, board, paper pulp and wasted paper to zero in 1999 as well as the accession to the WTO in 2001, the imported timber increased sharply, and the imported logs took up nearly half of the production of domestic timber. China has become one of the biggest timber production, trade and consumption countries in the world, and is the world's wood products processing base and trading centre. The large amount of imported timber had eased the pressure of timber production and met the shortfall of domestic timber consumption. This had great help to the development of economy, the protection of forest resources and the transition of forest.

In addition, globalization influences Chinese social development and resources management in a more extensive and profound way. After the implementation of the reform and opening policies in late 1970s, the cheap labour and land rent attracted a large number of foreign direct investments (FDI). Because of geographical reasons and policy support, the FDI in China concentrated in the eastern coastal areas as well as the export growth. Exports of goods in 9 eastern coastal provinces took up 86.4 % of total exports in 31 mainland China provinces (NBS 2012)。 These different levels of opening led to the regional variations in the development of China's domestic economy and social. The eastern coastal area has spawned many export-oriented enterprises in the stimulation of FDI, creating a lot of job opportunities. Attractive economically non-farm job opportunities attracted a large number of surplus rural labourers from hinterland, leading to a large-scale labour migration phenomenon from inland provinces to the eastern coastal provinces. The large-scale labour migration, on the one hand reduced the number of peasants in inland provinces, thereby reducing the living dependence on forest for the farmers, such as fuel wood logging and houses constructing. And on the other hand, the emigrated labour force transferred money to their inland family, reducing the farmers' livelihood pressures on forest resources, deforestation and the forest land utilization concentration degree. The increasing job opportunities and the demand for labour force in eastern areas improved the labour price, which, to a certain extent, reduced the farmers' activity in engaging in forestry production. These factors played a positive role on the protection and restoration of forest resources in China.

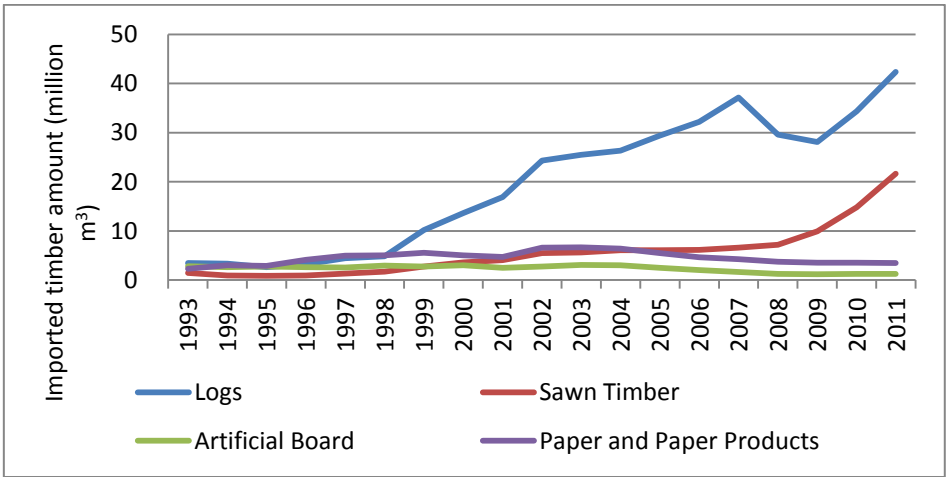


Figure 5.11. Changes of China imported timber from 1993 to 2011

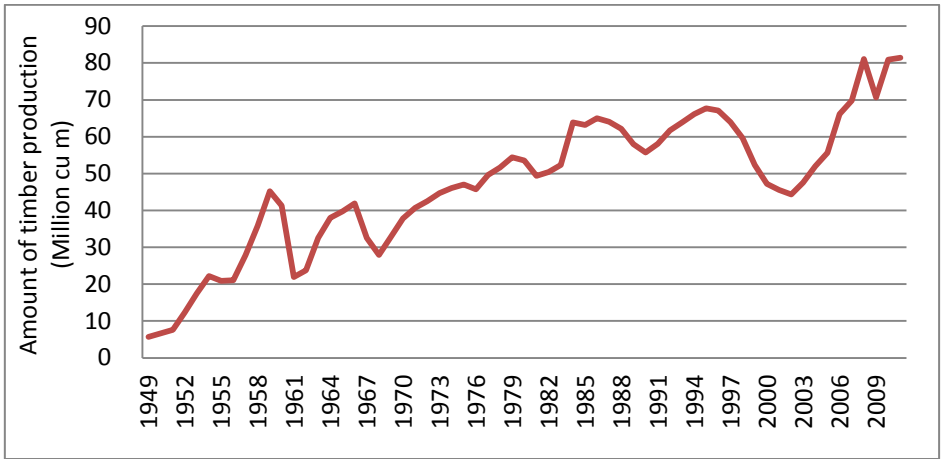


Figure 5.12. Amount of timber production for industry purpose over 60 years in China

5.6 Traditional forest knowledge and Culture

As one of the civilized ancient countries, though China has a long history of farming culture, on the whole the relationship between man and nature is not destroyed, which is summed up by Chinese ancestors as “harmony between man and nature”. China is still one of the world’s biodiversity centers as well as one of the forest diversity centers. This is mainly because of the forest management technologies and systems formed in dealing with the forest in the long-term process and the local ecological society concerted system built by Chinese people.

Forest is the cradle of humankind, which gives birth to the human, and is the starting point of the history of human civilization. Some human civilization flourished and died with the forest, such as Mayan civilization. It is not only the source and place of foods, fuel, timber, hedging and hunting, but also the most important interactive object for human to exchange their emotions. In addition, forest plays a very important role in the formation and the development of local knowledge, primitive religion, grassroots organizations, local rules as well as other economic cultures of the human society. For many years, the Chinese people of all ethnic groups have created diverse knowledge of forest management, utilization and protection and the local rules to correspond to it, and set up different kinds of rich and colorful forest cultural activities during their long-term production periods and life practices. The related researches and practices in recent 20 years have demonstrated the important value of the traditional forest knowledge and culture in the sustainable management of Chinese forest, biodiversity conservation, climate change mitigation, maintaining livelihood diversity and poverty alleviation. Particularly noteworthy is that Korea, Japan and other countries which have cognate civilization with China, can better handle the relationship between maintaining traditions and learning about foreign cultures on the journey of modernization. This should be carefully considered and be used for reference by other regions to promote the development of forestry.

As China is one of the ancient civilizations, traditional forest knowledge and culture have evolved over centuries, and are very rich, diverse and complex due to a great ecological, geographical, social, economic and cultural diversity. Within this rich diversity, traditional forest knowledge and culture had been developed by rural farmers throughout the whole China with great diversity, inherited through people’s livelihood, production, culture, believes and religion.

China is abundant in all kinds of forest species resources, including tall trees, shrubs, herbs as well as animals. There are many different forest management practices, such as daughter fir planted in minority areas of southern China and pollard system; abundant forest management knowledge, like local rules and regulations valid for the whole village; colorful forest cultures, which can be embodied in the Feng Shui forest, sacred trees, forest elements in national festivals and cultures. Some researchers studied the traditional forest utilization technology, management system and forest culture, and showed the characteristics of local, integral and comprehensive as well as its dynamic changing process and unique way of inheritance for traditional forestry knowledge in China, especially in minority areas (He *et al*. 2004, Luo *et al*. 2009, Yuan *et al*. 2009).

In the era of globalization, new knowledge, information and foreign cultures have reached every corner of the world. As a case of Shangxiang Village of Hunan Province, a Dong minority village (through field survey) and a few villages at Wujie township of Yunnan Province (Liu *et al.* 2010) demonstrated that a lion share of forests were managed by traditional forest knowledge and culture, although share of forests has been declining and less and less youngsters respected traditional knowledge and culture. It has to be recognized as any outside intervention has to be reinterpreted by local communities who practices forest management and usage with their own knowledge and culture including traditional knowledge and culture. From macro level, the traditional ideology, including integration of human and haven, and considering managing mountains as a central of country management, do influence China's politics and strategic planning. China's rich traditional knowledge and culture do have a special meaning in forest transition.

5.7 The empirical test on *Environmental Kuznets Curve* of forest transition in China

On the basis of the above analysis, we carry out an empirical test of China's forest transition by using the panel data of 30 provinces and municipalities in China since 1984 and taking the theory of *Environmental Kuznets Curve* as evidence. Considering the effect of per capita GDP and governmental investment on forest coverage exists a lag period, we set one-period lag to these two variables. As some researches on *Environmental Kuznets Curve* found that there existed non U-shaped relationship such as N-type, S-type and logarithm between pollution and per capita GDP, there may also exist such relationship between per capita GDP and forest area. Formula (1) and (2) are respectively the quadratic model and cubic model of per capita GDP, as follows:

$$\ln Y_{it}=a_0+b_1\ln GDP_{i-1t}+b_2\ln GDP_{i-1t}^2+b_3\ln AGP_{it}+b_4\ln FI_{i-1t}+b_5\ln RPOP_{it}+b_6\ln FCV_{it}+u_{it} \quad (1)$$

$$\ln Y_{it}=a_0+b_1\ln GDP_{i-1t}+b_2\ln GDP_{i-1t}^2+b_3\ln GDP_{i-1t}^3+b_4\ln AGP_{it}+b_5\ln FI_{it}+b_6\ln RPOP_{it}+b_7\ln FCV_{it}+ u_{it} \quad (2)$$

In which, Y_{it} refers to forest coverage (%); GDP_{i-1t} refers to lag items of per capita GDP; AGP_{it} refers to per capita food production (kg per capita); FI_{it} refers to governmental silvicultural investment; $RPOP_{it}$ refers to the proportion of rural population, that is, it is the share of population with rural census registration and represents the pressure of population on forest; FCV_{it} refers to lag items of forest coverage; t refers to statistical time; i refers to statistical area, that is, 29 provinces and municipalities in China without Chongqing and Hainan. The data is mainly from China Statistical Yearbook, China Forestry Statistics, and the Compilation of 60 years' Statistics of New China. a_0 and b_i are estimated parameters and u_{it} is the error term.

Column 1 in Table 5.1 shows the estimated results of quadratic model of per capita GDP. The quadratic coefficient (b_2) is less than zero and significant at 1% level. The result is not consistent with the assumption that forest transition follows an environmental *Kuznets U Curve*. The existing researches which use the data after 1978 conclude some estimates similar to these results, which suggest that *Kuznets U Curve* is a necessary process of forest change among the Chinese provinces and China has already been on the right of the inflection point of the U-bend (Zhang *et al.* 2006, Wang *et al*. 2007, Liu 2009). However, they do not explain why the *quadratic term* of per capita GDP is negative? That is, forest coverage may rise to a certain level and then begin to decline. The result derived from its theory is the very reverse of the reality that forests grow continuously in China. Because of the general growth of forest among the Chinese provinces since 1980, it is impossible to bridge the downward trend using the data of forest growth. It is clear that they confuse the relationship between environmental *Kuznets U Curve* and forest transition, and do not incorporate the cube of per capita GDP into the model.

Column 2 in Table 5.1 shows the estimated results of cubic model of per capita GDP. Results show that b_1 is greater than zero, b_2 is less than zero, b_3 is greater than zero, and are all significantly at 1% level. There is an S-curve relationship between per capita GDP and forest area. The coefficients of forest coverage, governmental investment, and the proportion of rural population are positive between 1977 and 1981, while the coefficient of per capita food production is negative, and they are all significant at the 1% level.

Table 5.1. Regression results of the model using the forest coverage rate as the dependent variable

Independent variable	（1） Per capita GDP square model	（2） Per capita GDP Cube model
lnGDP	.8025616 *** （4.34）	8.159964*** （4.71）
（lnGDP）^{2}	-.0568077*** （-3.93）	-1.1683*** （-4.48）
（lnGDP）^{3}		.055527*** （4.27）
FCV（Forest coverage rate in 1977–1981）	.8910984*** （71.38）	.9022197*** （80.01）***
lnAGP（Per capita output of grain）	-.0836679*** （-4.13）	-.0547625*** （-2.89）
lnFI（Government investment of forest management）	.0227488*** （3.35）	.0285074*** （4.10）
lnRPOP(The proportion of rural population)	.0912896** （2.31）	.1464354*** （3.39）
Cons（Constant）	-2.40238*** （-4.76）	-18.98725*** （-4.89）

Note: superscripts***、** and *represent the significant level of α=1% and α=5% respectively

The fact that b_1 is greater than zero, b_2 is less than zero, b_3 is greater than zero, and China's forest coverage is significant as well as the cube of per capita GDP, indicated that there is no *Environmental Kuznets U Curve* between forest area and economic growth in China, but the trend followed a S-type curve. That is, as the economy grows, forest area rises fast initially, and then slows down, and eventually achieves rapid growth. It is consistent with the trend of forest change in China as well. This suggests that forest area in China has not appeared the trend of *deterioration first and improvement afterward* along with the economic growth since 1980, but directly crossed the stage of deterioration, and succeeded in growing from slow to fast. China's annual GDP growth has reached to more than 10% since 1978.

The coefficient of government's silvicultural investments is positive, pointing out that silviculture investments promote the growth of China's forest. It proves that the Chinese Government is an important force to promote forest growth. In addition to investment, the Chinese Government also promotes the growth of forests by enhancing enforcement capacity of the forestry sector as well as establishing forest conservation, nature reserves, forest parks, and forest ecological compensation system.

The impact of per capita food production on forest coverage is negative, significant at the 1% level. The competitive mechanisms of farmland and woodland may play a role, indicating that China has entered the stage of converting farmland to woodland in economic development. Since it reached the highest point (412 kg) in 1998, China's per capita grain output has begun to decline year after year. And it didnot return to the 1998's level until 2009 (Figure 5.13). The reason why China achieves forest growth in the case of a decline of per capita food production is probably that: first, scientific and technological progress in agriculture and professional food production makes it possible to produce the same or even more food on less land and supply more people with less arable land. Second, due to the accelerated process of urbanization, agricultural restructure regulation and the increase of non-agricultural employment, more and more marginal arable is returned to woodland or economic forest. Third, China has implemented a cumulative 403 mil acres of returning grain for green from 1998 to 2009. Thus its forest area has continued to achieve rapid growth despite of the decline in grain output. Figure 5.13 also shows that China's per capita grain output has been restored to an all-time high and

continued to grow since 2010. The contribution of technological progress to food production is significantly over the decline in food production owning to the move to return grain for green, and China has the potential to achieve both grain output and forest growth.

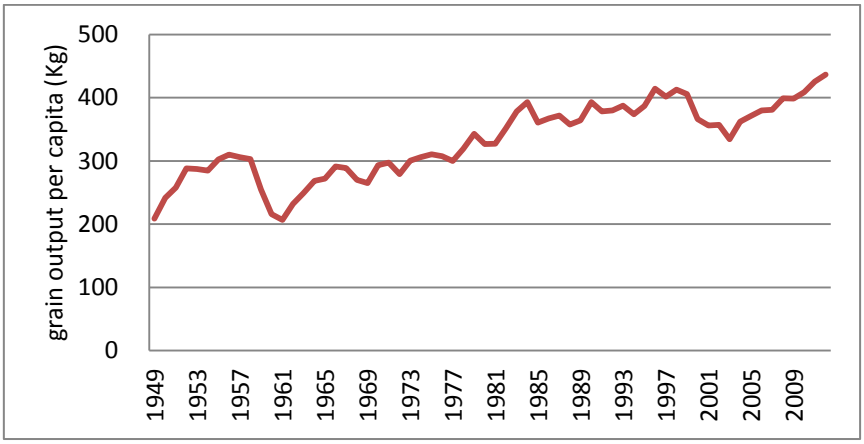


Figure 5.13. China's grain output per capita in 1949–2012

The impact of the proportion of rural population on forest coverage is positive, significantly at 1% level, showing that the bigger rural population is, the faster forest grows. It is in contrast to the situation in which the pressure of rural population on forest is an important factor for deforestation in developing countries. The reasons may be that the statistics on China's rural population and labour force do not fully reflect the transfer of rural labour forces, and the data of econometric analysis with rural population is built on sand. In fact, China is experiencing the largest rural population floating in the world, that is, a large number of rural population shifts from countryside to towns, cities and the southeastern coastal regions in the province. According to statistics, there were only 2 million rural migrant workers in China in 1980, while it increased to 190 million in 2001 and 225 million in 2008, of which 140 million worked out of the province. The statistics on China's rural population and labour force were based on the census registration rather than employment area. Thus 1–2 billion with rural household registration but non-agricultural employment was still counted in the rural population.

In fact, the inter-regional transfer of rural labour force reduced the pressure of population and land, while promoting forest growth of the inflow and outflow places. The inflow place is the eastern coastal area where the economy is the most developed in China. And the level of its economic development is high as well as the demand for forest products. This results in the appreciation of forestland and forest products, and boosts the emergence of commercial afforestation and investment in forestry. So the forest growth belongs to the market-driven one. The outflow place is the midwest region where the rural labour population is the largest in China. With a large number of rural migrant workers, the pressure of population and land is reduced as well as deforestation for a living. Thus the forest in the Midwest can be preserved and grow naturally, and the woodland margins can turn into forestland spontaneously. So the forest growth belongs to the preserved one. Therefore, the spatial mobility of population has created different mechanisms of forest growth in the inflow and outflow places and jointly promoted the forest growth in China's populous provinces.

The effect of forest coverage on forest growth between 1977 and 1981 was positive, significantly at 1% level, indicating that natural geographic environment and resource endowments had a significant impact on forest growth. Forest growth is limited in the West and Northwest where its natural environment is relatively poor, while forest is increasing very fast in the Mideast due to its good natural conditions. The levels of forest transition vary in all provinces of China. However, the West and Northwest serve as important ecological screens in China. So the government needs to increase ecological investment and prompt the ecological environment in the West and Northwest to be improved continuously.

The turning point appeared in forest transition between 1985 and 1998 in China, when the forest coverage rate reached around 13%, and then the forest area began to grow continuously and favorably. The trend did not follow an *Environmental Kuznets U Curve* between forest change and economic growth among the Chinese provinces, but a S-type curve. And forest transformation of Chinese provinces happened at similar times, nor successively with the high or low level of GDP per

capita. Forest transition in China is the result of a combination of political, social, economic and cultural factors. And it cannot be simply explained by "economic development pathway", "forest scarcity pathway" and governmental dominant. Looking to the future, China's economy will continue to grow; the pressure of population and land will continue to decline due to urbanization and demographic transition; food growth will be primarily dependent on the increase of agricultural productivity; and it is estimated that more and more marginal agricultural land will be converted to forestland. Ecological civilization construction has made forestry more important in the developmental strategy of Chinese Government, and it is estimated that governmental investment in forestry will continue to expand. The intensification of the trend of global trade liberalization will continue to create a supportive and stable international environment for timber's imports and exports in China. In summary, the main driving forces of China's forest transition, such as economic growth, urbanization, non-agricultural employment, grain yield, governmental investment, globalization, and forest culture, will not weaken in the future, but continue to improve. Forest transition in China is sustainable and positive.

CHAPTER 6 CHINA'S FOREST AND GOVERNANCE IN THE FUTURE

Will China's forest cover continue to grow, or other alternatives? This chapter will describe China's forest in the future based on the theoretical analysis of forest transition in the previous chapter. In particular this chapter will provide some critiques on China's forest policy and institutional transformation in the future.

6.1 Analyzing major factors to forest transition in the future

6.1.1 Population growth and expansion of farm land

Giving to rapid economic progress and urbanization, and consequence of one child policy implemented since 1980's, China population growth has been slowed down dramatically. According to the National Bureau of Statistics (NBS), Chinese women's fertility rate has decreased from 5.8 (1970s) down to 1.8 (mid 1990s), and China has begun to enter the low birth rate period. Due to the rapid decline of fertility level, the growth rate of China's population constantly slowed. From 1978 to 1990, the average annual population growth rate was 14.4‰; and from 1990 to 2000, it dropped to 10.4‰; while during 2000 to 2010 this rate dropped to 5.7‰. The National Population Development Strategy Research Report indicated that China's population would stop growing by around 2033, and the population peak would then reach 1.5 billion.

Rather than land expansion, the more serious issue China faces is about farming land protection. Therefore, the Chinese Government implement the most stringent farmland protection system – strengthen land quality, and ensure 18.18 mil mu land is farm land (basic farmland not less than 15.6 mil mu). Expanding urban and industrial land, rural housing, and infrastructure take up a lot of arable land. Farmers continually abandon farming land, due to the promotion of ecological restoration policies and a continuous decline farming marginal revenue. The reserve of arable land resources is mostly located in the northern and western arid areas with little distribution of forests. Even those area were developed, the forest area would not be affected.

6.1.2 Globalization and Urbanization

Dependence on forestry resources to develop is decreasing due to urbanization and industrialization in China. With the process of modernization, lots of off-farm jobs are created in cities and towns in China. These work opportunities have drawn thousands of labour out of rural areas, reducing the pressure on the forests and other natural resources. This process will continue and benefit to forest conservation and regeneration.

Globalization has already affected forest transition in China and will continue functioning in the future. Foreign direct investment will help improve economic structure and create many work opportunities that would absorb labour from rural area. These workers would send money back, and reducing dependence on forests and other natural resources. An important part of export increase of China comes from labour-intensive industry which could make full use of extra labour in rural China and enhance the rural-urban migration, thus reducing dependence on forest resources in rural areas.

Following the U.S., China has become the second largest importer of wood raw material. To establish sustainable development of the timber trade is important for China's forestry development. China will develop the alternative products, improve the utilization efficiency of alternative resources, accelerate forest certification, work with the international community to combat illegal logging, improve the efficiency of wood utilization to maintain and achieve sustainable forest management, and take the responsibility of protecting the forests. Now China is in the process of rapid urbanization. At the end of 2012, the urbanization rate of China is 51%; about half of the population lives in rural areas. As a huge gap between rural and urban areas, the rural to urban immigration is a major factor of China's urbanization. The contribution of immigration to urbanization continuously increased. In 1990 the immigration contributed only 67.3% to the new urban population, while in 2009, almost all of the new urban population is migrants, and the urban population natural growth is negligible. In prediction, from 2010 to 2015, the average annual growth of urban population will be 16.58 million people; form 2015 to 2020 it will be14.61 million; while from 2020 to 2025, it will be10.66 million people. The rate of annual urbanization will increase by about 1%. A significant reduction in the rural population will promote the growth of China's forest area.

6.1.3 Rural fuelwood consumption and biofuel energy development

Rural residents still use firewood for cooking and heating. According to the Second National Agricultural Census, fuel for Chinese rural residents are from straw-51.46%, firewood-28.02%, coal-12.83%, electricity accounted for 4.68%, biogas accounted for 1.47%, and liquefied petroleum gas accounted for 1.43% of their energy consumption. In 2010, the energy commodities of rural residents were 204kgce, which was only 65% of urban residents' usage in daily life. It indicated there was a big gap between urban and rural areas. And for rural residents, the proportion of good quality energy is low; moreover, the energy consumption structure is irrational. Clean energy is encouraged in rural China. The government promotes the energy-efficient house, energy-saving stoves. Biogas using household reaches 41 697 000, and the annual biogas production is 13.84 billion cu m. China is the world's largest biogas producer and consumer. China will continue to develop and promote the straw gasification and solid technology, also the solar products. The consumption of fossil fuels and renewable energy in rural China will increase, while the firewood demand will decrease in the future.

Biomass energy development provides a new market space for forests. Forests as energy utilization is mainly firewood, forestry "three residues", wood processing residues, etc., and the amount is about 3.5 mil tons each year. According to the Biomass Energy Development Plan (2011–2015) (National Energy Board), till 2015, 5.2 mil ha shrub land dominated wood energy forest will be established in the semi-desert, sand areas of the "Three North" area, combining ecological establishment; and in the Hainan, Fujian, Sichuan, Guizhou, Yunnan and Hebei Provinces with a 200 mil ha production base of oil palm (*Elaeis guineensis* Jacq) and Chinese pistachio (*Pistacia chinensis*), etc.

6.1.4 Political commitment

Chinese Government will pay more attention to eco-environment construction in the future in order to improve the development quality and achieve sustainable development. With the economic development, there will be more financial resources to be invested in ecological environment in China. As the six major forestry projects continue, and the enforcement of tax cut and other financial support measures, it is estimated that forest area will continue to increase and forest quality will be improved.

Chinese Government focuses on ecological construction, sustainable development, and climate change, while the importance of forestry production is weakening in the government agenda. As the most important guiding document, the CPC Central Committee forestry work report indicated: "Forestry has an important position in sustainable development. Forestry is the primacy in ecological construction, and the foundation of western development, also the special important status in facing climate change "," in order to achieve sustainable development, the development of forestry must be a major part, and the forestry should be the primary task for ecological development. Moreover, forestry must be a strategic choice to tackle climate change and an important way to solve 'three rural' problems". Forestry combines ecological, economic, social, and cultural functions, as well as carbon sinks, and its importance has been realized by the whole society.

"Twelfth National Economic and Social Development Five-Year Plan" indicated that, to 2015, the forest coverage rate should be 21.66%, and the forest stock volume should increase by 600 mil cu m. Moreover, afforestation should be promoted to add 12.5 mil ha of forest area. The natural forest protection project should be continued to implement and the results of returning farmland to forest and grass should be kept; as well as the control of desertification and soil erosion should be promoted. Forest management and protection should be improved. The fire prevention, pest control and nature reserves construction should be strengthened. The collective forest rights and state-owned forest tenure reform should be promoted. The ecological protection and economic transformation should be done in Changbai Mountains and Daxinganling forest area. Forest tourism and forest biomass utilization should be encouraged.

The Chinese Government has a strong desire to increase forest area, to improve the quality of the forest through the system construction, government investment, technological development, and personnel training.

6.1.5 Policy and legislative framework

The direction of Chinese forestry policy is clear-making efforts to improve the quality of forest and forest area. However, China's future forest policy and legal framework still requires a certain period of observation. Limit harvesting quota, forest police system, timber checkpoint system, and forestry station system has played an exceptional role in forest transition in the past two decades. However, these forest management systems are now being blamed by the market-oriented reforms. To some extent, these controls damage the private investors to invest in forestry initiative, creating opportunities for rent-seeking. The forest management system is rigid and inefficient. The state-owned forest and state forest management agencies are increasingly dependent on the government's fiscal investment to survive.

The central government's invested from less than CNY50 billion in 1997 to more than CNY100 billion in 2012 to forestry. This is based the central fiscal revenue to maintain 30% growth in the past 20 years. However, the Chinese Government is facing pressure on the efficiency of government investment, and the requirement of tax cuts is strong; moreover China's economy is facing a structural adjustment and an expecting slowing growth. The local governments' debt will also weaken or erode the central government's ability to invest in ecological construction. Growth in plantation area which is based on financial investment will face to adjust.

The above two points are the important driving force of forest transition in the last 20 years. However, the weakening of the two driving forces will whether or not affect the direction of Chinese Government policy implementation is hard to say. After 2008, China's collective forests promote the market-oriented reform, strengthening the powers of the forest owners. The collective forest reform also promote forest owners and private investors to invest in forest management and improve the forest production through improving forest circulation, reducing taxes and providing forestry finance assistance. It is hard to prove whether this forest reform has achieved its objectives, but it is clear that forest decrease which always happened in the past forest tenure reforms does not happen this time.

China does have some unfavorable factors that need to be noticed for the future forest development. First, the pressure for forest land conservation is increasing. Between 2003 and 2008, 8.31 mil ha of forest land were conversed to non-forest land. In some regions, abuse and disorder cultivation of forest land is serious. Second, difficulty of afforestation increases. Land suitable for forest of good quality only accounts for 13% of the total, while poor quality land accounts for 52% of the total land suitable for forest. 60% of the total land that is suitable for forest is spread in Inner Mongolia and other northwest regions. And an even higher price needs to be paid if China wants to raise forest coverage for every percent in the future.

6.2 Forests in the future

According to NFIs of China in recent three decades, considering the above factors driven forest changes, we can conclude such a trend for change of forest resources in China in the future:

- Forest quantity expanding and forest quality improving. From 2003 to 2008, forest area increased by 20.5 mil ha and forest coverage increased from 18.21% to 20.36%. Forest growing stock increased by 1.12 billion cu m. Forest coverage will steadily increase in near future.
- Natural forests are increasing both in area and in growing stock. From 2003 to 2008, natural forest area increased by 3.93 mil ha and natural forests growing stock increased by 0.676 billion cu m. With the implementation of natural forest protection and nature reserve development project, Natural forests in China will continue to increase in the future.
- Planted forests are increasing rapidly, and there is an increase trend for reserve forest resources. 8.43 mil ha of planted forests increased during 2003 and 2008, and planted forests growing stock increased by 0.447 billion cu m. With the implementation of the grain for green project and other financial incentives, planted forests area will continue to increase in the future.
- Ratio of harvest of natural forests is decreasing while that of planted forests is increasing. In 2008, planted forest harvest accounted for 39.44% of the total forests harvest, while in 2003 the ratio was only 27.17%. Ratio of harvest of planted forests will continue to rise due to the protection of natural forests and the increase of planted forests.
- Forest quality is improving and ecological functions of forests are enhancing. Portion of mingled forests increased by 9.17%. From 2003 to 2008, amount of growing stock per ha of arbor forests increased by 1.15 cu m, and annual increment of arbor forest per hm2 increased by 0.3 cu m.

With the improvement of forest structure and forest quality, ecological functions of forests will further be enhanced in the future.

- The ratio of individual management area is increasing. As a result of collective forest tenure reform, the individual management area of total forest land has increased by 11.39% during 2003 and 2008 to 32.08%. Planted forest under individual management accounts for 59.21% of total planted forests in China. Individuals and rural families in forest regions are playing a more and more important role in forest management.

6.3 Legislative and institutional framework in the future

What will China's forestry legislative and institutional framework look like in the future? As explained in previous section, there would be no clear answer. But however in this session, critiques for future legislative and institutional framework were provided.

6.3.1 Dilemma between regulative framework and means for market ends

China has been on the way to market end, and new term government established in early 2013 has declared to carry out outstanding reform to uplift free economy in China, and supported by institutional reform. In this regards, as discussed in previous section, forest sector has to be part of wave to provide a fair and transparency market environments, including favor legislative framework, institutional framework, and policy framework as well to make liberated economy functioning. Considering forests have positive eternity, various sorts of environmental, social and cultural values, without proper governmental intervention as a visible hand to regulated market, an invisible hand, will lead to market failure, saying deforestation and forest degradation, particularly in the developing countries (Bulte and Engel 2006).

What role government can play, and what sort of governance should be for forests, though theoretically and practically there is no clear answer, at least can be categorized into two orientations. Firstly governance should provide favor condition for marketing of environmental services, and secondly governance should be involved in producing and protecting environmental and social services of forests, which can be considered as public good for safety of society.

6.3.2 Developing favor conditions for marketing of forest services

40 years ago, China was in the plan economy. Over three decades, China has made tremendous progress on developing a favor condition for free market economy, through many aspects including developing framework of institution, legislation and policy. Forestry Law of the People's Republic of China, the key legal document guiding forest resources management, was first issued in 1984 and amended in 1998. According to this Law, forest resources are divided into state and collective forests. The collective forest land is owned and managed by rural collectives, and individuals are given rights to use and benefit from forests distributed to them. Amendments introduced to the Forest Law in 1998 stipulate that timber forests, economic forests, fuel wood forests and their use rights are transferable, though conversion of forests to non-forest uses is prohibited. It also set out a range of government financial incentives for private investment in management, e.g. cheap loans, tax breaks, and also Forest Environmental Benefit Compensation Funds to encourage forest protection.

Transferability of forest land use rights has provided critical flexibility in resource allocation and boosts productivity by allowing labour and capability constrained farmers to sell on their rights to others who have the necessary skills and resources. This flexibility has been particularly important in regions that have seen significant out-migration since it has permitted farmers to sell forest land to those with spare capacity. In some cases, use rights are being sold back to collectives and state forest farms.

State Forestry Administration, which is the main department responsible for forest governance, works together with Ministry of Finance, Ministry of Water Resources, Ministry of Agriculture, Ministry of Environmental Protection and Ministry of Science and Technology to pursue the goal of forest regeneration and biodiversity protection. Forestry funds of research and education has greatly increased since 1980s. Some big technology innovation, including that of re-vegetation, stress resistance crop breeding and pest control, are benefiting to environmental improvement and forest regeneration in China.

Forest policy which promotes forestry investment has played a vital role in forest transition in China. Six major forestry programs have been implemented since 1998, due to the Yangtze River catastrophic floods in 1998. The six major forestry programs, including Grain for Green Project, Natural Forest Protection Project, Yangtze River Shelter Forest Project ,Wildlife Protection and Nature Reserve Development Program and so on, has covered forest resource conservation, desert control, returning farmland to forests, and wildlife protection. The investment budget of the six programs amounted to 109 billion USD (Zhou 2003).

Collective forest tenure reform is another important policy issue that needs to be considered. Official forest land in China is either owned by the state or by collectives. In terms of standing volume, state forests (which are concentrated in the northeast and southwest) account for 68 % of the total, but collectives own 58 % of the forest land. Collectives dominate the area and volume of plantation forests, while state forests have traditionally been primarily composed of old-growth natural forests. Before 1980s, planned economic system is implemented in China. The planned economic structure impeded advances in productivity, hampered efforts to increase investment in new forests, delayed forestry economic diversification, and generally resulted in poor economic and ecological performance. Collective forest tenure reform allows for private family use rights to collective forests. Also, timber forests, economic forests, fuel wood forests and their use rights are transferable, though conversion of forests to non-forest uses is prohibited. It also set out a range of government financial incentives for private investment in management, e.g. cheap loans and tax breaks. Transferability of forest land use rights has provided critical flexibility in resource allocation and boosted productivity by allowing less able and labour-constrained farmers to sell on their rights to others who have the necessary skills and resources.

According to the Seventh NFI of China, protection forests and timber forests account for 45.81% and 35.38% of the total forest land in 2008. About a third of the commercial timber production came from state forest farms and the rest came from collectives (including private households that have leased collective forests), and state forestry industry bureaus. Timber extraction is generally regarded as inefficient. Not only are state bureaus rapidly depleting their harvestable stock, but plantations are also poorly managed and their yields are low (Ministry of Forestry 1995). Improving productivity of commercial timber production is a way to reduce pressure on forests resources and promote forest regeneration in the future.

Globalization is an umbrella term for various processes and outcomes that reflect the increased interconnectedness of the world, whether in terms of people, capital, goods, or ideas (Kull 2007). These interconnections are not just quantitatively larger than in the past, but also qualitatively different, reflecting a deep integration (Dicken 2004, Harris 2002). Globalization, by means of foreign direct investment and export increase, contribute to forest transition in the last 3 decades in China. Foreign direct investment will help improve economic structure and create many work opportunities that would absorb labour from rural area. These workers would send money back, and reducing dependence on forests and other natural resources. An important part of export increase of China comes from labour-intensive industry which could make full use of extra labour in rural China and enhance the rural-urban migration, thus reducing dependence on forest resources in rural areas.

6.3.3 Strengths of Chinese forestry legislation for market end economy towards SFM

It is hard to assess how far China has developed an enabling environments for marketing of forest service although at least in terms China has become a major player in international trade related to forest products and provide sufficient forest products to meet a domestically market demand. We tried to assess Chinese norm system against international agreed standard, and results are shows as following:

- Sustainability as a concept that cross-cuts development is indeed reflected in Chinese environmental legislation. This translates into the acknowledgement of multiple forest functions, benefits and uses (manifest and potential) in the relevant sector legislation. Accordingly, production, protection and conservation are cited as national forest objectives. For this purpose, China maintains and protects a Permanent Forest Estate, and pursues reforestation, forestation, and forest protection. In the legislation the concept of multiple forest functions translates into a functional categorization of ‘classified management’. The legal framework makes reference to China’s role and obligations in international processes, and under relevant legally-binding international instruments.

- The examined documents provide for an interlocking institutional framework, with a clear and transparent assignment of tasks, and shared responsibilities between central-level institutions and decentralized branches of government. Tasks and responsibilities are spelled out in detail in various pieces of subsidiary legislation, down to the level of technical guidelines.
- The findings underline the dominance of state-institutions for both forest-sector development, and environmental management/administration. Many references were discovered stating the universal applicability of legal norms, which means that a more or less uniform level of professionalism and performance is required from all actors actively engaged in forest-sector development. Directly related to rules dealing with the institutional framework, are references to funding arrangements, investment in the forest sector, and the use of financial instruments. Funding arrangements include shared public funding by central and local government, private sector investment, and overseas development aid (ODA).
- Despite the fact that production, conservation and protection are cited as forest–political objectives – to be pursued in parallel – the Chinese legal framework was found to be heavily preoccupied with forest protection and nature conservation, and with the enforcement of controls and restrictions on access to, and use of forests. This includes legal provisions against illegal logging, as well as provisions against illegal trade in forest products.
- Forest protection builds mainly on the establishment of protected areas (including references to state-of-the-art concepts such as ecosystem-protection and in-situ as well as ex-situ conservation of rare and endangered species, also with a view to biodiversity conservation). References to the protection of soil and water indicated concern about the causal relationship between forest degradation and desertification. In this respect, legal provisions for the identification of vulnerable/endangered areas have been put in place, as well as procedures for planning, implementation and enforcement. The Chinese forest-protection approach further emphasized strict, interlocking administrative control mechanisms, restrictions against illegal exploitation and encroachment, and strong law enforcement capacities. Taken together, these features reflect yet another topic in international forest dialogue – Forest Law Enforcement, Governance and Trade (FLEGT) – which is the subject of recent international initiatives, and will in due course be incorporated into the international forest regimes. The aforementioned examples together illustrate vividly the successful integration of cross-cutting environmental issues (many of which are related to Multilateral Environmental Agreements (MEA), such as biodiversity conservation, the struggle against desertification, protection of wetlands, FLEGT, etc.) into the national legal framework of the forest sector. This must be considered a particularly noteworthy achievement with respect to the "substance of internationally acknowledged standards and guidelines".
- The legal framework was also found to provide for (environmental) monitoring and evaluation of protective measures, as well as for precautionary approaches and instruments such as Environmental Impact Assessments (EIA). A particularly noteworthy feature of the Chinese EIA concept (which is of recent origin, and has not yet become effective in its entirety) is that river-basin development projects, re-cultivation of waste-land, large-scale afforestation projects, and large-scale harvesting/transport operations are also subject to EIA requirements.
- Rules concerning forest management chiefly deal with maintenance/protection of forest environments on the one hand and reforestation/afforestation/rehabilitation measures on the other. The findings suggested that the tendency was mainly to preserve existing natural forests, and to establish or extend planted forests for their commercial value as suppliers of forest products, and for the employment they provide.
- Despite the state's apparent dominance, the examined legislation holds references in respect of the rights of the indigenous minorities, forest dwellers, and forest-dependent fringe-communities. While all land-ownership rests with the state or collectives (reflecting the nation's principally socialist set-up), access and use rights (including ownership of revenue and planted trees) of private individuals and groups (including private sector investors) are expressly protected. Private initiative for tree-planting is encouraged.
- That does not suggest, however, that private individuals/groups or civil-society actors would in any way be formally involved in decision-making processes.
- The above observation receives additional backing from findings regarding the promotion of science and technology, and capacity building. While the relevant legislation addresses the need to promote/develop, document, and disseminate scientific discovery and advanced technologies (also by means of education and training), it remains noticeably silent on, traditional forest-related knowledge (TFRK) issues, such as indigenous silviculture systems.

6.3.4 Weakness of Chinese forestry legislation for market end economy towards SFM

- In a similar fashion, the tabular matrix enables an analysis of the 'gaps' (none, or very few references) or 'weaknesses' (references which have been listed as contradictory to international standards/norms).
- The assessment has thus far shown that active participation of non-state actors in forest-sector development and environmental management is recognized and encouraged in the examined legal documents. However, the level of participation is limited to the implementation of norms and plans, and does not extend to agenda-setting / decision-making processes (such as definition of strategic objectives, policy formulation). Furthermore, civil-society groups such as NGOs or community based organizations (CBO), who – in western societies – often act fairly independently as 'watchdogs' and outspoken critics of the state's actions and policies, do not play a similarly significant role. Where national Chinese NGOs exist, they have frequently evolved out of the structural framework of the State or Party, and are officially considered the government's 'partners for implementation'. This is why consultative processes and forums – which, for example, must be considered determining factors in the context of National Forest Programs (NFP) – do not exist in China. Where far-reaching political, legal, economic, and social reforms have taken place in China over the past 15 to 20 years, they have not been the result of public demand, civil opposition or environmentalist initiatives, but have been initiated and shaped by the state's top-level institutions. There are basically non-institutionalised arrangements for public representation, or political participation outside the – decentralised – system of People's Congresses and People's Governments. Implementation of public plans, programs and projects does not require, or depend on, the consent of the governed.
- For this reason, one may hardly speak of a NFP-process (the core-instrument for implementing the IPF/IFF Proposals for Action) in China, despite the fact that most 'NFP-elements'(such as, for example, a National Forest Statement, Policy/Legal/Institutional Reform, Strategy Development, Investment Programs, Action Plans, etc.) have been put in place.
- The apparent lack of official recognition of TFRK and traditional forest management/ land-use systems points in a similar direction. While on the one hand China attaches much emphasis to the protection of minority rights, and actively promotes the expression of their ethnic/cultural/religious identity, their traditional land-use practices are generally considered underdeveloped, primitive, and irreconcilable with the state's 'modern', science-based bureaucratic and technological environment. This becomes apparent from directions such as Article 22 of the "Regulations for the Implementation of the Forest Law", stipulating that:

  > "*Hillsides with a slope of over 25 degrees shall be used for planting trees and grass. Cultivated land on hillsides with a sloping field with a slope of over 25 degrees shall, in the light of the plan formulated by the local people's government, be withdrawn gradually from cultivation and be used for planting trees and grass*".

- However, hillside farming on terraced fields has been practiced by ethnic minorities for centuries without disastrous consequences, and may hardly be condemned per se as detrimental or unsustainable.
- Despite various references to the forest resources' multiple ecological and socio-economic functions and benefits, the concept of multiple-use forestry has been found missing in the examined legal framework. The Chinese system of 'classified forest management' does in fact contradict multiple-use forest management (which is defined as the pursuit of multiple management objectives in one place, and at the same time). In comparison, the Chinese system of 'classified management' is noticeably rigid, as it categorises forests permanently as shelter forests, timber forests, economic forests, firewood forests, and forests for special uses (national defence, environmental protection, and research). This means that at FMU-level, a single management objective is chosen, and adhered to throughout the planning cycle (which arrangement not only has serious implications in respect of poverty alleviation and rural development, but must also be considered prone to conflict).
- Closely related to the difficulties associated with the 'classified management' system, is the apparent spatial / functional separation of management / utilisation and protection. Natural forests are generally earmarked for protection / species conservation. On the other hand, planted forests are designed and managed entirely for production purposes, which means that the concept of "protection through sustainable management and utilization" is not reflected in the Chinese legal framework for the forest sector.
- Similarly rigid and state-driven is the legally prescribed way of determining sustainable harvesting levels (i.e. the 'annually allowable cut'- AAC). According to the forest law, the AAC is to be centrally determined (and subsequently endorsed by the state council) on the basis of a 'sampling

system'. This means that sustainable harvesting levels are not determined individually at the level of individual Forest Management Units (FMU) as the result of careful inventory and management planning (in which case a 'national logging quota' would be determined ex-post, as the sum-total of individual planning results). In China, logging quota are extrapolated, either from reference data of a single state-owned 'enterprise, institution, farm, factory or mine' (in the case of state-owned forests), or from reference data of a county (in the case of forestry-collectives or private tree-owners). Once logging quotas have been determined at the level of provinces, autonomous regions, or municipalities directly under the central government, they need to be endorsed by the People's Government at the respective level of the executive, before they are submitted to the State Council for approval. Besides the system's obvious rigidity and its technical weaknesses, it also seriously curtails the capacity for decision-making and objective-setting of the individual forest farms and tree growers.

- In a similar manner, national afforestation targets (as determined by the State Council), by virtue of Article 24 of the "Regulations for the Implementation of the Forest Law" are to be broken down and enforced by people's governments at the county-level within their respective jurisdiction. While coordinated afforestation efforts deserve much praise in countries with a forest cover as low as in China, the top-down approach stipulated in the "Regulations for the Implementation of the Forest Law" is hard to reconcile with the concept of bottom-up, integrated participatory rural development (which, according to the logical hierarchy of sustainable development, is closely related to sustainable forest management).
- Whereas forest certification has only recently been introduced to China (and presently remains at an experimental stage), some national rules for environmental labelling and certification have already been developed. Dating from 1994, the "Measures on the Certification Management of Products bearing Environmental Labels" are listed as 'on trial' in the national Chinese codex of environmental law (published by the State Environmental Protection Administration – SEPA – under State Council). However, while certification universally is considered a non-state, market-based instrument, the freedom of action for certifying bodies (such as, for example, the Forest Stewardship Council – FSC) is restricted considerably by the rules of the above mentioned 'measures'. This means that while applicants may voluntarily apply for certification, certifiers and certifying bodies must conform to state-specifications and are subject to state control. Article 13 even stipulates that the inspection of the applicant's business operations shall be done by a state-run inspection group under the directions and on behalf of the State Certification Committee's secretariat. It remains doubtful whether independent certification by an internationally well-established, non-governmental certifying body such as FSC would at all be possible under these circumstances. This would depend mainly on whether Chinese authorities interpret the "Measures on the Certification Management of Products bearing Environmental Labels" as applicable only to national Chinese labels, or as applying uniformly to all kinds of certification and labelling procedures.
- While the rather detailed discussion of 'weaknesses' and 'gaps' might suggest that a lot of serious contradictions and incompatibilities exist between the examined Chinese legislation and international standards and guidelines for sustainable forest management, such a conclusion would nevertheless be exaggerated. A closer look at the 'weaknesses' and 'gaps' discussed reveals that Chinese rules do not actually contradict relevant international standards, but that those standards in China have been interpreted in a different way, and from a different view-point than that of many other countries.

6.4 Governmental role in supporting forest transition

On-going research does not consider politicization of global environmental issues. And considering newly developed international convention related to forests, biodiversity, desertification control, climate change, endangered species, and domestically political nature, including greening movement, arousing public concerns on forests and environment, growth of NGOs, and SCR. These indeed push forest transition in China, although hard to demonstrate a clear picture how these factors contribute to China's forest transition through development theoretical framework. It can be illustrated through a few factors taking by Chinese Government:

- Greening National movement. Since mid 1960s', tens of billions of volunteer labourers have been mobilized to engage in afforestation.
- Rapid increasing of forests for public purpose, including forest park, nature reserves, and recreation forests which is for diversity conservation purpose and recreation and education purpose, and so called forests for ecological purposes, including soil and water erosion control, landscape beauty, etc. In total, around 60% of forests was categorized as for above mentioned purpose, totally and partially restrict production capacity.
- Political commitment. Internationally, China's president committed to increase forest cover and forest timber stockings to address the climate change concern, and domestically, local government committed to list forest cover increasing and quality improvement as one of local government priority. And upper level governments would assess performance according to these targets. Thus pushing various level governments to take various means greening their governing territories, which has demonstrated a functional method in China before and still functioning now.

CHAPTER 7 CONCLUSIONS AND POLICY RECOMMENDATIONS

7.1 Conclusions

7.1.1 China is among the countries with forest transition

The turning point appeared in forest transition between 1985 and 1998 in China, when the forest coverage rate reached around 13%, and then the forest area began to grow continuously and favorably. Historically, at least half of Chinese land was once covered with thick forests. Along with population growth, wars and increasing demand for fuel, the forest resources in China has reduced by about half by 1700, which was estimated at 291.3 mil ha. And the forest coverage rate fell to 26%. Over the more than 200 years from 1700 to 1949, the rapid increase in population, expansion of arable land and constant battles in China has accelerated the loss of forest resources, and the forest coverage has decreased to about 11.4% in 1949. In the early industrialized construction from 1949 to 1985, China resisted the pressure of industrial demand and population growth on forests, and the trend of a long-time decline in forest area came to a halt preliminarily and appeared a wave-type development. However, China didn't completely reverse the downturn and turn to a stable and sustained growth of forests until 1978,when there came a stable political environment, sustained economic growth and an open society after reform and opening-up. The driving forces to prompt forests to grow continuously, such as economic growth, grain production increase, non-agricultural employment increase, government afforestation, reform of collective forest right, reform of state-owned forest industrial enterprise, wood imports, forest harvesting quota system, forestry law enforcement and governance, began to accumulate and function together after 1985, while the driving forces to destroy forests, such as moving deforestation and industrial logging got control gradually at this time.

The history of forest transition in China has two important significances on forest transition theory: first, China was the largest developing country that succeeded in forest transition over the last few decades, when China's per-capita GDP was around USD2000, which was lower than that of many developing countries in deforestation period at that time (Mather 2007). Especially consider the great population pressure everywhere in China for thousands of years, the scarcity of forest resources, the land environment that natural disasters occurred frequently, and demands for timber in industrialized construction. In the1990s when its economic took off preliminarily, China curbed forest decline successfully and achieved a rapid and sustained growth, which has made a great contribution to the growth of forest resources in the world. Second, the period that a country completely reversed the downturn and achieved forest transition successfully may not necessarily just be a node, but a process. That is, it may be a long period that forest coverage came from falling to rising. It would not rise immediately at the lowest point, but until the political, economic, social and technical power which benefited to forest growth accumulated and functioned together.

7.1.2 Dynamical mechanism of forest growth or reduction is different in different periods

Inoue (1992) and Nagata *et al*. (1994) divided the relationship between human beings and forest resources into four stages: the stable civilization stage of hunting and gathering, the deforestation stage arising from agriculture and population growth in agriculture civilization, the stage of large-scale development on forest in the industrialization period, the stage of forest growth arising from the demand for leisure and nature protection in post-industrial societies. In the period of agricultural society, forest destruction paced with population growth and migration. Demands for food and firewood arising from population growth became the main and long-term driving force of deforestation. After 1949, the pressure of population and land, which was once the main and long-term driving force of deforestation, gave way to industrial demand. However, China's forest area has grown in the take-off stage of industrialization, rather than after the industrialization. This was different from the four stages, and underscored the impact of political and cultural factors on forest transition in addition to economic growth. At the same time, the research on forest transition and the division of various stages could not ignore the destruction of forest resources caused by the short-term shocks and fluctuations: in an agricultural society, dynastic changes, peasant uprisings, imperialist aggression, and internal and external wars has caused serious destruction of forest resources, while entering the industrialization development stage, the factors for war gradually gave way to internal political changes such as land reform and political movements.

Deforestation for farmland reclamation is the main line of agricultural societies, but the history of China's forest is not only one logic and direction of reducing forest. Reforestation, the management and protection of forests, and the development and heritage of forest culture are also important parts of China's forest history. After 1949, achieving a sustainable supply of timber and improving ecological environment has been the two main drivers of the Chinese Government. State-owned forest region and mass afforestation, key ecological forestry projects and marketization reforestation avoided the sharp decline of forest resources in the industrialized construction, and promoted the sustainable growth of China's forest. That is, forest transformation did not happen in a social environment where there was robust demand for market ecology and appeared nature conservation movement. But the government firstly realized the importance of forests to industrial construction and ecological environment, and then dominated the forest growth. Therefore, it has particular significance that how China can succeed in upgrading the long-term driving force and reducing short-term volatility as well as coordinating economic growth and government intervention, on this day when forest reduction exists in developing countries continuously.

7.1.3 Forest change and economic growth among the Chinese provinces do not follow an *Environmental Kuznets U Curve*, but an S-type curve.

Many studies which used the data after 1978 suggested that *Kuznets U Curve* was a necessary process of forest change among the Chinese provinces, and was on the right of the inflection point (Zhang *et al.* 2006, Wang *et al*. 2007). This study which used GDP per capita cubic regression showed that forest changes in every province of China did not follow an Environmental Kuznets U Curve, and certainly not on the right of the inflection point of the U-bend, but along the S-type curve. That is, as the economy grew, forest coverage rate rose fast initially, and then slowed down, and eventually achieved rapid growth. The data of forest changes in China's provinces showed that although the coverage level in forest transition was inconsistent, forest transformation of Chinese provinces happened at similar times, nor successively with the high or low level of GDP per capita. The fact that forest changes in Chinese provinces did not follow an *Environmental Kuznets U Curve* and the inflection point of the same level of GDP per capita contradicted the efforts that tried to prove that forest changes all over the world obeyed the same *Kuznets U Curve* or track of forest transition. That is, in the long run, the "damage then grow" forest transition may be a necessary process of modernization in a country, but the hypothesis which thought that the world obeyed the same track of forest transition ignored the different forestry endowment, political, economic and social conditions in all countries .

7.1.4 Forest transition in China is the result of a combination of political, social, economic and cultural factors

China realized forest transition in lower levels of GDP per capita. Explanation for forest transition in China required multiple and comprehensive perspectives of political economy and social culture, rather than a single perspective. Rudel *et al*. (2005) summarized the *economic development pathway* and *forest scarcity pathway* which simplified the dynamical mechanism of forest transformation, and was far from the reality of China's forest transition. There was no doubt that the government response to the scarcity of forest resources in the process of industrialization and ecological construction promoted the growth of China's forest. Our study suggested that China has also experienced a *economic development pathway*, but this pathway also could not interpreted China's forest transition totally. This does not imply that economic growth, as well as demographic transition, the increase of urbanization rate and the adjustment of energy structure in rural areas which associated with economic growth, has not contributed to forest transition. But it would be more meaningful to explore these factors on the background of China's development, especially the development of China's rural regions, such as China's urban-rural dual system, country marketizaton reform, anti-poverty, opening-up, and especially the big increase of non-farm employment opportunities.

The direct involvement of the Government, by strengthening regulation of the use of forest and woodland, played a very important role in the transformation of the forest. Over 30 years, China has carried out the economic reform towards market economy. Forest authority has made a great effort to provide favor environmental condition for private sector to participate in afforestation, and forest management. However, a complete system of forest resources management was set up which included from logging, transport, processing to law enforcement and market management. The system relied on the systems of forestry police, forest cutting quota, wood inspection station and forestry

station. And it was a cornerstone for the government to promote forestry reform, to prevent forest risk and to curb the decline of forest resources. The government controls got the legitimacy in the fast-rising government investment. Meanwhile, the significant increases in government investment can make up for the lack of private investment, and the decline of the government's mobilization ability which is the legacy of the planned economy era. Similarly, Mather (2007) remarked that "the government was the key to explain Chinese forest" also failed to take into account the economic, social and cultural factors.

Giving China is one of the ancient civilization countries; traditional forest knowledge and culture have evolved over centuries, and are very rich, diverse and complex due to a great ecological, geographical, social, economic and cultural diversity. Within this rich diversity of conditions, traditional forest knowledge and culture has been developed by rural farmers throughout the whole China with great diversity, inherited through people's livelihood, production, culture, believes and religion. These economic and institutional changes are in fact based on the background of traditional forest-related knowledge and culture in China.

Therefore, forest transition cannot be explained by single factor in China. It is the result of a combination of political, economic, social and cultural factors, and it is difficult to break down the severity of various factors. Forest transition of every country must be rooted in its resource endowment and political, economic, social and cultural conditions. Countries should have their own roads of transitions, and take comprehensive measures rather than relying on any single reform.

7.1.5 Forest transition in China is stable, and forest quantity and quality in China will continue to improve

The major factors to promote Chinese forest growth and quality improvement, such as political commitment, demographic transition, economic growth, urbanization, nonfarm payroll employment, globalization and the demand for wood energy, will continue a developmental trend to promote forest growth in the foreseeable time. The continual improvement of forest resources' conservation in major timber-exporting countries of the world has constituted a potential risk to forest long-term growth in China, which in turn prompted China to pay more attention to its cultivation and utilization of forest resources. We have reason to believe that forest transformation in China is stable and forest quantity and quality will continue to be improved.

7.2 Policy recommendation

China enjoyed a large increase in forest area in the last three decades and the forest transition in China contributes to global carbon sequestration, biodiversity conservation and in improving local and regional environment. In this report we consider ecological concerns (e.g. six major forestry projects, tax cut, forest tenure reform and financial support), economic growth (e.g. modernization, urbanization and rural-urban migration) and globalization (e.g. foreign direct investment, export and import increase) as the most important factors that drive forest transition in China.

Although great achievements have been made in forest generation and conservation in China, China is still a country short of forest resources as a whole and with poor quality of forests. Forest coverage in China is only 66 % of that of world's average level. Forest area per capita is 0.145 ha in China, less than a quarter of that of the world's average. Amount of growing stock of arbor forests per hectare is 85.88 cu m in China, only reaching 78 % of world average level. Ecological problem is still one of the most prominent problems that restrict sustainable development in China. Ecological products are the scarcest products, and the disparity is most obvious in ecological conditions between China and developed countries.

In order to enhance forest resources conservation and quality, and to strengthen both economic and ecological forest functions, the following policy recommendations are presented:

First, is to advance steadily the development of urbanization and to ensure that farmers are the largest beneficiaries of urbanization. To speed up the reform of household registration system and associated welfare system so that migrant workers can enjoy the same treatment as urban residents in some respects, such as the employment permission system, labour welfare, social security and school

children, thus to realize the equalization of basic public services. To optimize and extend the primary industry chain and prompt labour-intensive industries to move to inland areas and smaller cities; To speed up the development of tertiary industry, so as to promote the transfer of rural labour force and employment; To accelerate the development of modern agriculture, to ensure food security, and to promote the rate of agricultural scientific and technological progress to increase continuously. To advance the reform of rural land system, to give people more stable and reliable land property rights, to establish a land circulation market, to promote formula management of land, and to make farmers get sufficient capital from the land circulation, thus to remove their worries to move into the cities and towns.

Second, is to continue the implementation of forestry major engineering, and to strengthen the governance and restoration of ecologically fragile areas. To strengthen and continue the implementation of forestry key engineering, such as natural forest protection, returning grain for green, water conservation forest and sand break forest, avoiding forest degradation caused by the decline of project quality and funding shortfalls. To take full advantage of the opportunity of the national construction of ecological civilization, to increase continuously the investment in forestry ecological construction and form a stable fund investment channel. Second is to strengthen ecological restoration in key areas and to comprehensively deal with stony desertification and promote vegetation in ecological fragile areas.

Third, strengthening the domestic timber supply, and making full use of the timber market in the world. Strengthening capacity of domestic timber supply. Scientifically making forest development plans, to optimize development layout and to enhance cultivation of forest resources. First, is to continue to build bases of fast-growing and high-yield plantation, industrial material forest and precious large timber in south collective forest regions. Second, is to increase financial subsidies and high-tech investment, focus on improving the quality of afforestation and forest quality, to rebuild young growth tending and low-quality and low-effective forests, and to increase wood production per unit area. Third, in the process of urbanization, to set a “land red line”, and strictly restrict the land to turn to construction land and agricultural land; To ensure that the destroyed forests, abandoned land and idle land recover and regenerate in time; To put into practice the strict basic forest land conservation system. Fourth, is to strengthen forestry cooperation with developing countries, in order to provide for capital, technology, and talent support, to help China to form a stable relationship of wood supply and demand with major timber exporting countries.

Fourth, specifying the division of government and market in order to prompt market to play a greater role in forestry. The forestry department should phase out of the intervention in commercial-forest production and circulation, and be mainly responsible for ecological engineering construction, the management of ecological forest, forest resources protection and forest management. Thus let the market play a major role in the allocation of commercial forest. Deepening the reform of collective forest rights, giving operators more stable and sufficient rights, such as income right and the power of alienation, to enable farmers to share the appreciation of forestland. Government should gradually raise subsidies for seedlings, planting, tending, and ecological forest, standardize forestland circulation, relax logging quota system and prompt social subjects such as enterprise and professional major to afforest actively. Perfecting forest management. Third is to reform and perfect cutting management, to scientifically make and strictly enforce forest management plans and to build a new mechanism of sustainable forest management.

Fifth, promoting decentralization of forest management and stakeholder participation. Considering China is complex among the regions in terms of social, cultural, economic and natural condition, as illustrated in the document, different political, socio-economic and cultural factors are at work in different places under different conditions and even when the same driving factors are functioning in different places, they may work in quite different ways. Different political, socio-economic and cultural factors are at work in different places under various conditions and while there are the same driving factors in different places, the factors may function in quite different ways. That requires a wide room for local stakeholders to pay in forest management, which can guarantee sustainable management of forests.

CASE STUDY A FOREST CHANGE IN SHANGXIANG VILLAGE, HUNAN PROVINCE

1. Overview of Shangxiang Village

Shangxiang village is a remote mountain village in Tongdao Dong Minority County in the southwest of Hunan Province, south China. The village lies in the subtropical zone with mild climate and plentiful rainfall, which provide favorable natural conditions suitable for growing of various tree species including Chinese Fir and Masson Pine. This area is known as an important region for developing timber forests and economic forests. There are 191 households, 805 persons living in the village till 2011. The village has 59.3 ha of paddy land, 3.8 ha of dry land, and 629.5 ha of forest land. Of the total forest area, the area of natural forest is 279.3 ha, plantation forest is 350.2 ha; the area of public welfare forest is 170.5 ha, the commercial forest is 459 ha; the forest land run by collective is 14.7 ha, the forest land run by household is 614.8 ha. Agriculture and migrant working are two major income sources in Shangxiang Village, with per capita income of 2000 CNY in 2011, much lower than the average of China.

2. Afforestation in Shangxiang Village

Based on the data collected from 30 households and their 156 pieces of forest land, a curve about afforestation since 1960s is drawn (Figure A.1). Before 1960, most forests in the village which were mainly camphor, maple, pine and Chinese fir, were natural and rarely developed. As drawn in the Figure A.1, there are three peaks of afforestation since 1960: the period of people's commune, elimination of barren hills movement in 1990, and after 2008.

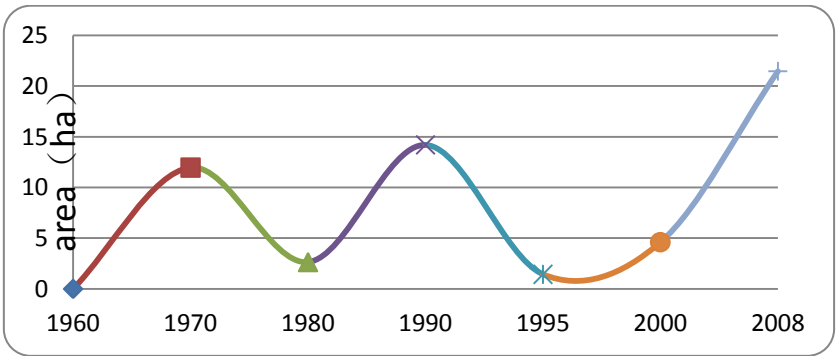


Figure A.1. Afforestation area change in Shangxiang Village since 1960

In the period of people's commune, the woodland was owned and operated by the so-called production team of Shangxiang. It is estimated that about 133.3 ha of forest along river and road were fallen and then regenerated by the village under the call of Boyang People's Commune. Among those forests, about 11.9 ha of forests were allocated to the respondent villagers in the *Forest Three-fixed* reform which aimed at delimiting plot of hill for private purpose, protecting mountain rights and forest rights, determining production responsibility system. In 1982, the village launched the *Forest Three-fixed* reform, under which the collective forest lands were allocated to the households. However, the reform did not motivate farmers' enthusiasm on afforestation as government had expected. Due to concern of instability and insecurity of property rights, only 2.65 ha of land was afforested by the respondent villagers in the whole of 1980s. In 1990, an agreement signed between Forestry Bureau of Tongdao County with Shangxiang Village decided that, the local government would provide an afforestation subsidy of CNY1500 per ha. It brought about the first afforestation peak in Shangxiang Village since *Forest Three-fixed* reform, and more than 13.3 ha of Chinese fir were grown by the respondent villagers. Due to the low timber price and high tax and fee, only 6 ha of land were afforested from1995 to 2007. In 2008, a piece of forest land for grazing, which was under dispute with neighbouring village, was decided to be allocated to the villagers. The villagers began to plant trees so that they can establish their property rights according to the local custom. In addition, timber price increase shapely, from CNY400/cu m in 2008 to CNY850/cu m in 2011, which makes afforestation more profitable. As a result, about 21.5 ha of land have been afforested, with an average of 0.71 ha per household.

The afforestation in periods of People's Commune and elimination of barren hills movement were mainly led by the local government, while afforestation after 2008 was mainly market-driven. In fact, local government was the major driver of afforestation before 2008. The spontaneously afforestation scale by farmers was low because of low timber price, high tax and fees, and instability of property rights. However, the spontaneously afforestation driven by market price after 2008 is huge and sustainable.

3. Deforestation in Shangxiang Village

Dong minorities live in the wood houses for generations. The main use of timber for villagers is to build wood houses. In general, each wood house consumes 20 cu m of timbers that are selectively cut from about 0.3 ha of woodland. As can be seen in Figure A.2, the forest area for building wood house is small, with an average of 2 ha each ten year since 1982, which is much less than the afforestation area in the same period. In addition, the data from local forestry station show that there are 4 households per year who could apply for the civil timber eligibility for building wood house in Shangxiang Village. Therefore, the timber demand for woodhouse is not a driver of deforestation, but a driver of afforestation as more trees are planted and better-managed to meet their need.

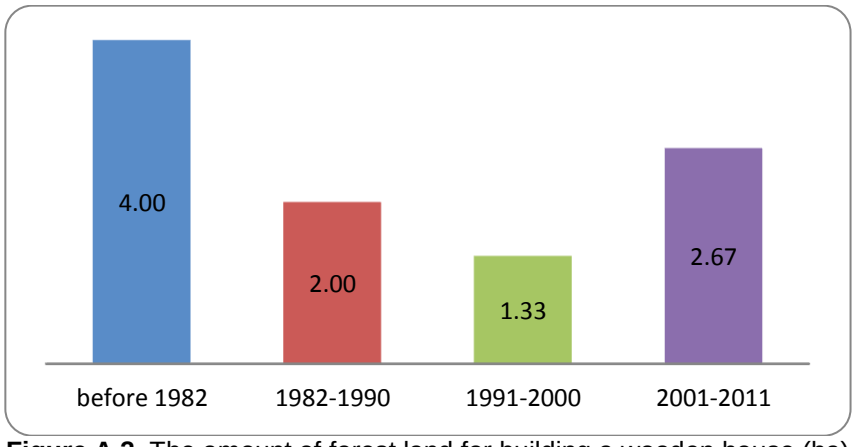


Figure A.2. The amount of forest land for building a wooden house (ha)

The past 30 years have witnessed a trend that timber in Shangxiang Village has been increasingly sold in the market. There has been 14 commercial logging since 1982 (Figure A.3). Of those commercial logging, one was between 1982 and 1990, and 4 was in the 1990s, and 9 was in the 2000s. However, the logging after 2000 mainly occurred in forests planted in 1990. In March 2012, 48 houses were destroyed by a fire. After the disaster, 27 houses were uniformly rebuilt by local government using timber material bought from market. This would greatly accelerate the commercialization process of timber in Shangxiang Village.

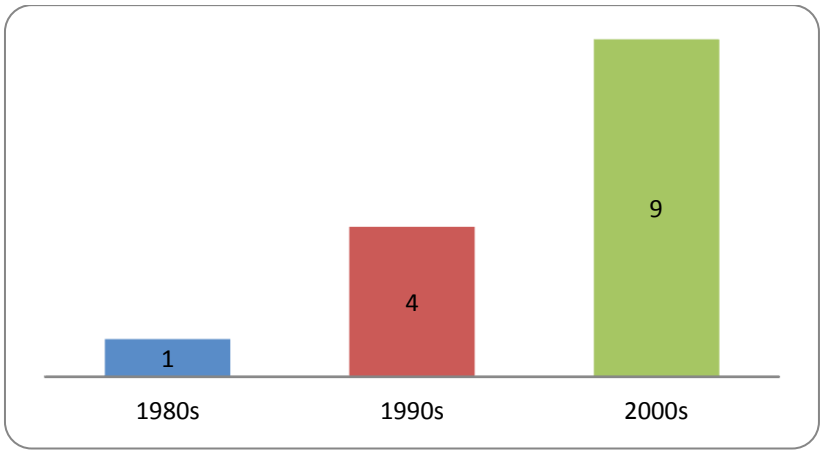


Figure A.3. Number of commercial logging in Shangxiang Village since 1980

Since 1949, there are two periods of large-scale logging of forests in Shangxiang Village. The first is period of People's Commune when more than 67 ha of forests along river and road were cut down under the request of government. The second one happened in the last three years when more than 17 ha of forests were logged because the forests planted in 1990 have been mature. However, the phenomenon that land converted from forest to farmland did not happen in the village. Once the natural forests are cut, villagers regenerate the Chinese fir immediately because the Chinese fir brings a higher profit and the government prohibit conversion of forest land to farmland. In 2007, 170.5 ha of forest area along river and road were classified as public welfare forest. According to the regulation of public welfare forest, no one was allowed to log for commercial purpose. Therefore, villagers choose to cut some of big trees secretly when they want to build wood house. There is a saying by a timber buyer that" Shangxiang Village has no large-scale forest for commercial logging". The reason is that the trees planted by households are mainly at a cultivation stage, public welfare forests are forbad, and most trees planted in 1990 have already been logged. In addition, due to lack of road, most natural forests were not economical attractive to log.

4. Government-oriented forest transition

To sum up, the issue of forest transition in Shangxiang Village can be summarized as the following table, which can convey a relative clear conclusion.

Table A.1. Forest transition in Shangxiang Village

	Before 1960s	**1960–70s**	**1980s**	**Early 1990s**	**Late 1990s**	**Early 2000s**	**2008 – now**
GDP (based on the level of 1960–70s')	-	1	2.57	4.75	9.66	19.78	56.22
Policy background	Before "4 fixes"	the period of people's commune	After "Forest Sanding" reform	Elimination of barren hills movement	Forestry market-oriented reform		Collective forest land tenure reform
Timber price / Tax & fee	-	-	-	-	Low timber price / high tax & fee		Soaring timber price
Afforestation	Natural growth	Organized afforestation about 133 ha	Low ebb in afforestation	Signed with county for granted afforestation about 13.3 ha	Low ebb in afforestation		Growing trees on disputed land bout 13.3 ha; Afforestation 21.5 ha for future income
Nature (Ideology) of afforestation	Natural and undeveloped	Political movement	Risk aversion	Organized behavior for economy	Market-oriented behavior		Rights protection by traditional means; Spontaneous market-oriented behavior
Deforestation	Building houses	Organized deforestation more than 67 ha	-	-	-	-	Logging 17 ha trees grown in early 1990s
Nature (Ideology) of deforestation	Nature resource for living	Political movement	-	-	-	-	Spontaneous market-oriented behavior

Source: 1. Data of GDP is calculated based on the average of the indicator of GDP (Current US) provided from World Bank;
2. Other contents are summarized by authors.

Based on the case in Shangxiang Village, some implications that could be concluded are as follows. First, government is a major driver of afforestation and logging in Shangxiang Village before 2008. The implement of the afforestation programs, public welfare forest project, forest land protection and management project, the cutting license, and regeneration institution have played an important role in increasing forest area and controlling deforestation. Government has a great influence on the time and scale of China forest transition. Secondly, It is noted that economic development do not bring about the deforestation and forest degradation in Shangxiang Village, and forest growth driven by local people lag far behind the forest transition driven by government. Last but not least, in the past thirty years, what Shangxiang Village has been experiencing is a change from self-sufficiency to commercialization, and also from barren mountain and natural forest to commercialized forests.

CASE STUDY B FINANCING FOREST TRANSITION IN CHINA

It is hard to give a full picture of forestry finance policy in China, not only due to the great variation among the regions across China, but also the great transformation in a region as fast growing of China's economy and governmental revenue. In this case study, authors intended to provide a general picture of forestry taxation and charge policy, fiscal policy, finance policy, and their challenges. In order to allow the readers to understand the macro situation on forestry expenditure policy, China's fiscal policy has been explained in annex. Figure B.1 illustrated governmental cash flow in the forestry sector.

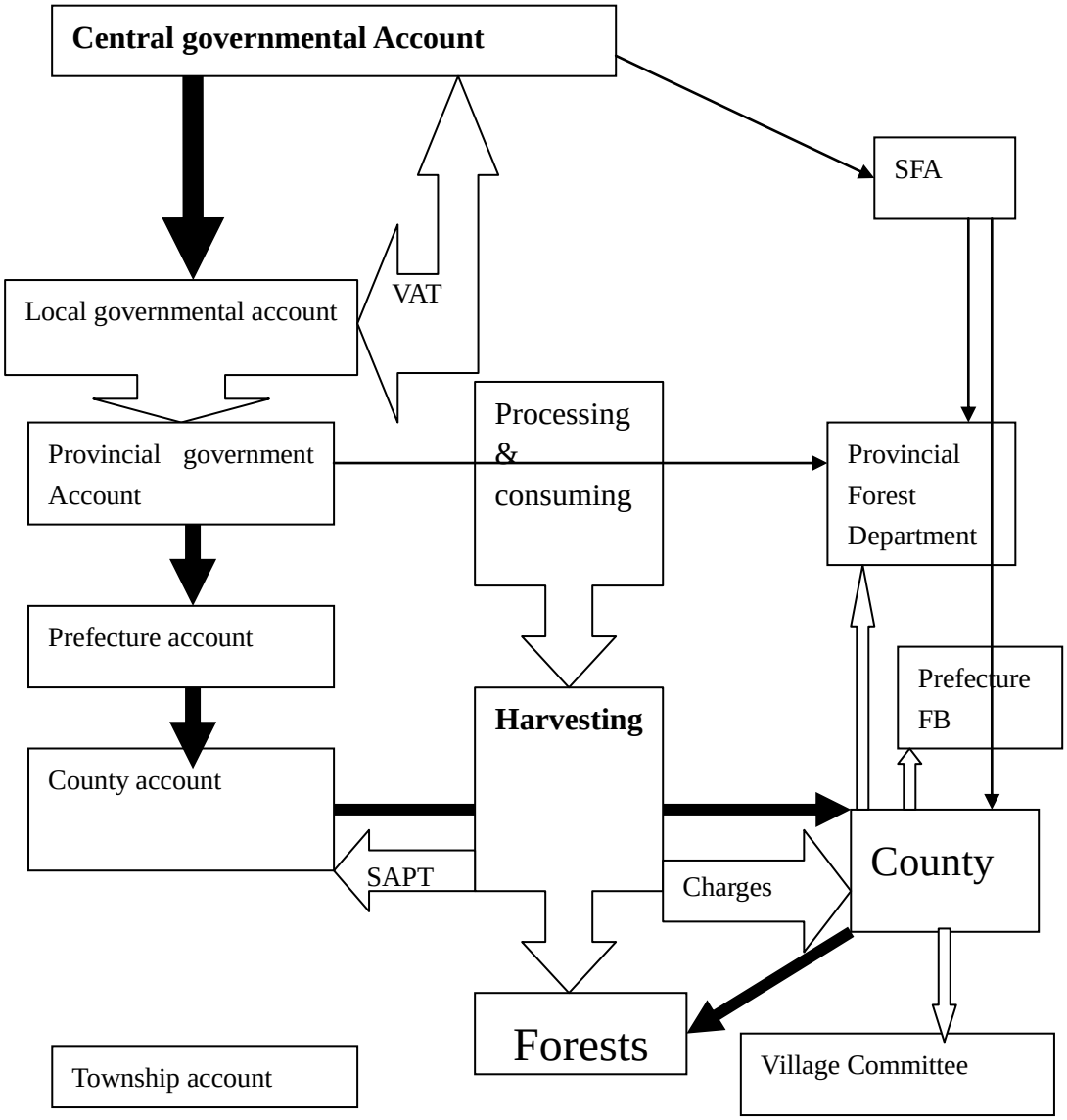


Figure B.1. Cash flow in forestry revenue and expenditure system

1. The history of forestry investment

Worldwide, the use of forest resources has went through three progressive stages: exploitation, massive deforestation and forest conservation. In the earlier history of the People's Republic of China, the high demand for timber led to exploitation of forests mainly for timber, while forests ecological functions were ignored. This process continued till the early 1990's. Since then, serious ecological degradation was observed in terms of soil erosion, desertification, grassland degradation and frequent ecological disasters. Ecological degradation has become a major obstacle to socioeconomic development in China, and forest loss is believed to be closely associated with ecological degradation. Consequently, forest conservation has gained increased attention. In particular, the Natural Forest

Protection Programme and the Sloping Farming Lands Conversion Programme signify a fundamental transition from valuing only the forests' economic benefits towards valuing their economic, ecological and social benefits.

1.1 Quantitative changes of forestry fiscal expenditures

We noticed that, since the planned economy period, the fiscal input to forestry development has continuously increased, but the level was still low. However, it has still been characterized by some fluctuation in various economy periods. Especially after 1997, fiscal investments sharply increased, mainly because of the increased ecological forestry projects inputs. See Figures B.2, B.3.

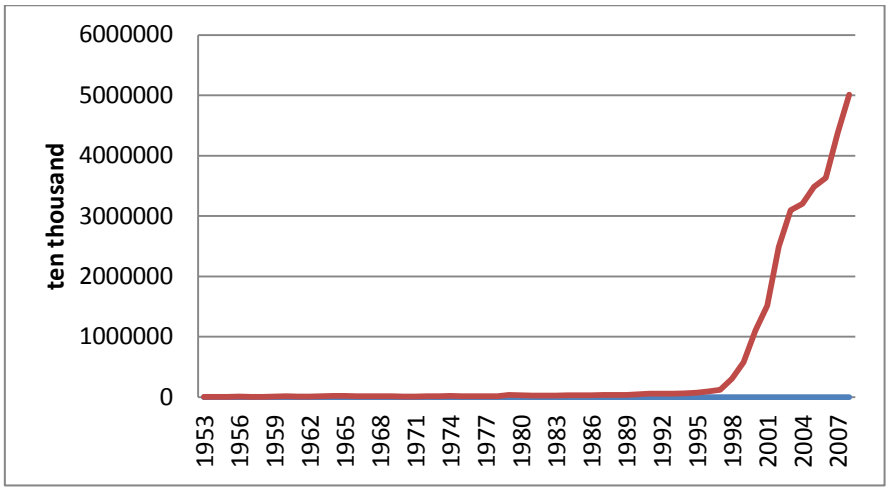


Figure B.2. Fiscal investment on afforestation (CNY)

Source: Forestry Statistic Yearbook (1953–2008)

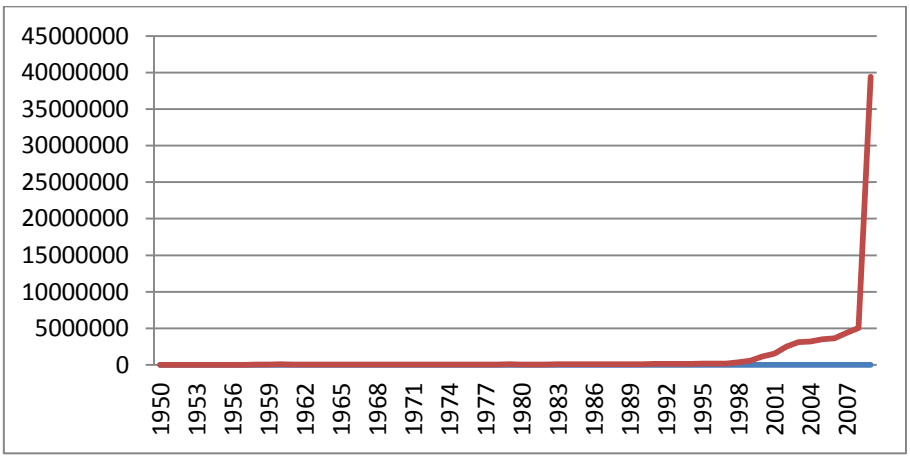


Figure B.3. Fiscal investment on forestry infrastructure (CNY)

Source: Forestry Statistic Yearbook (1953–2008)

1.2 Structure change of forestry fiscal expenditures

Fiscal investments and non-fiscal investments in afforestation

During the planned economy, fiscal investments took 80 % of the total afforestation investments. After 1970, non-fiscal investments gradually increased. After China transited to a market economy (after 1992), the afforestation financial structure changed and non-fiscal investments exceed fiscal investments. However, after 1997, fiscal investments in afforestation sharply increased again as several ecological projects were implemented after 1997 (See Figure B.4).

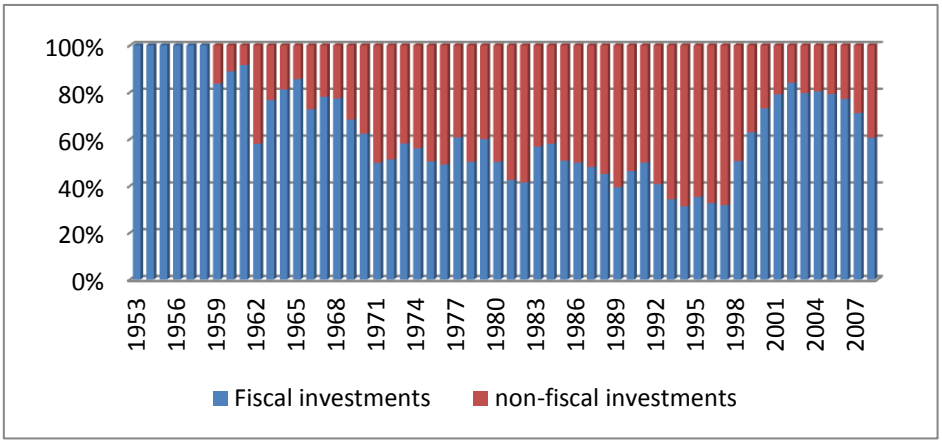


Figure B.4. Changes of the afforestation fund structure

Fiscal investment distribution between afforestation and forestry industry

In terms of internal distribution of fiscal funds in forestry, we found that in the planned economy, the fiscal input mainly focused on forestry industry in response to timber cutting. Before 1976, fiscal investments in afforestation were only half of those in forestry. However, the fiscal funds distribution between forestry industry and afforestation changed, because of the attention paid to environmental construction. In 1988, fiscal investments in afforestatation exceeded those in forestry industry for the first time. Generally speaking, fiscal investments in afforestation have continuously increased in recent years (Figure B.5)

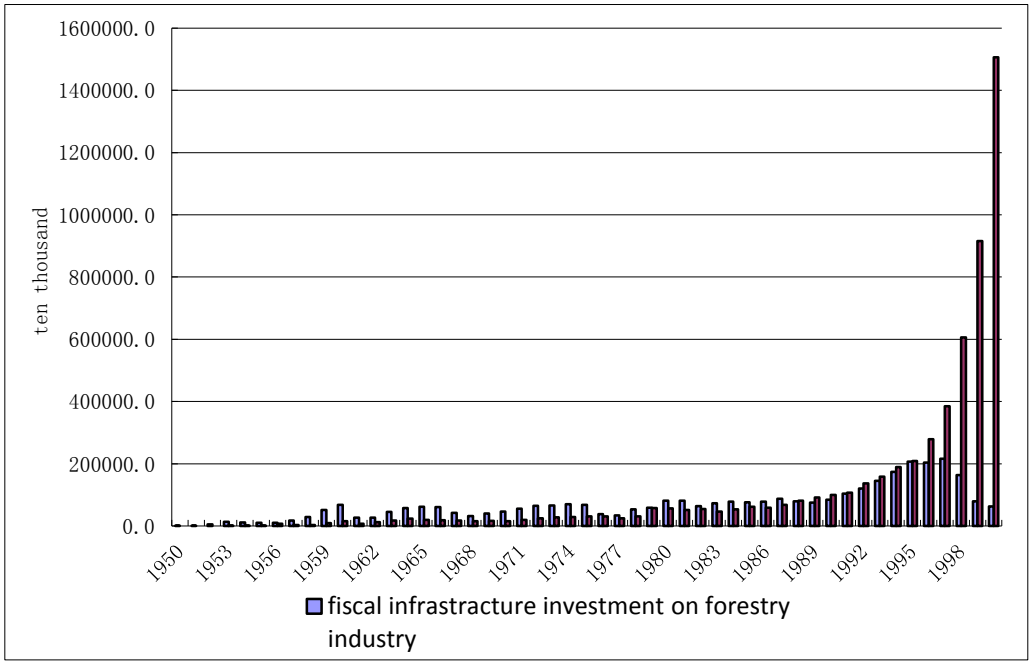


Figure B.5. Fiscal investment distribution between forestry industry and afforestation(CNY)

Source: Forestry Statistic Yearbook 1950–2000

Fiscal investments in ecological forestry construction

Since 1998, the Chinese Government continued to strengthen ecosystem restoration and protection by initiated key forestry ecological programs like the Natural Forest Protection Programs. All these programs were invested mainly by the government at different levels and implemented by the forestry sectors. In the year of 2000, CNY11.04 billion were input on priority forestry programs by government, accounting for80% of total project investment, and 65.95% of China' total investment in forestry. The number rise to CNY53.22 billion in the year of 2011, an increase of 380.03% form 2000, accounting for

82% of total project investment, and 20.2% of China' total investment in forestry. Among those priority forestry programs, the highest investment is The Conversion of Cropland to Forest Programme (CCFP), and then is Natural Forest Protection Programme (NFPP), with the proportion of 56.09% and 24.33% respectively (Figures B.6, B.7)

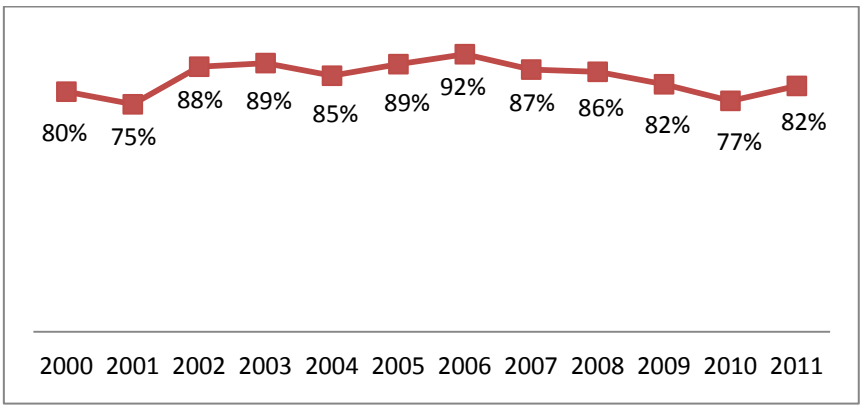


Figure B.6. The share of fiscal investment on Priority Forestry Programmes

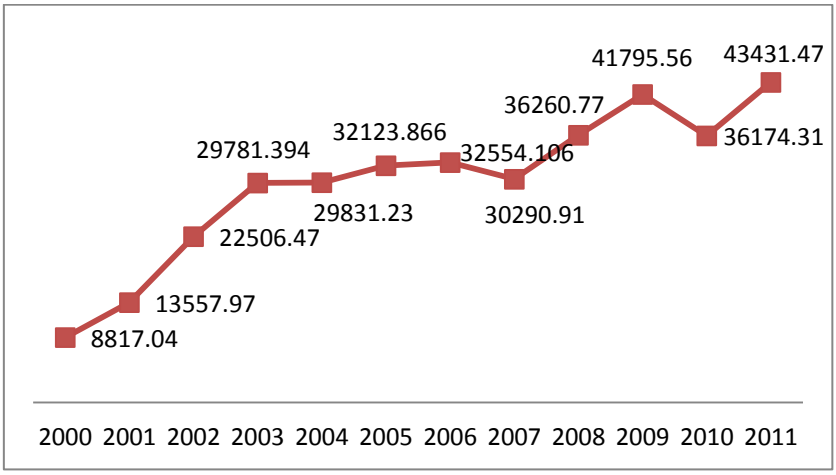


Figure B.7. The actual input on Priority Forestry Programs during 2000–2011(million CNY)

The main purpose of fiscal investments in forestry is to prompt sustainable forest management and maximize environmental, social, and economic benefits. Based on this standard, our findings are as follows:

- Fiscal investments in forestry during planned economy (1953–1981) supported the forestry development based on forest resources consumption. The government treated the forestry department as a pure fundamental industry. Timber supply was the main task of the forestry department in this period. The result was the quick decrease of forest resources.
- Fiscal investments in forestry, during the transition period from planned economy to market economy (1982–1991), began to pay more attention to afforestation and ecological benefits of forestry.
- In the market economy period(after 1992)，the government increased the fiscal investments in afforestation, especially in ecological forestry construction. From 1998, several national ecological forestry projects began to be implemented all around China. This indicated that the fiscal investments were used as main support for ecological forest system recovery and sustainable development.
- The original fiscal investment system for forestry department caused unsustainable forestry development. Forest resources decreased and ecological and environmental systems were seriously destroyed.

2. Forestry tax and fee policy

Although some tax reduction policies were implemented, before the year of 2003 when New China's Collective Forest Tenure reform launched, in some places forestry taxes and fees still account to 50–70% of the sell prices. We noticed that taxes and fees covered by laws and regulations in collective forests in South China mainly include: special produce tax (8% of the sell prices for producers and purchasers respectively) and the additional tax (1.6%) collected by the local governments, sapling funds (12–15% of the sell prices and the first sale prices), maintenance fee (renovation fee before 1994, 8–10% of the sell prices or of the first sale prices) and forestry construction protection fee (CNY 5/cubic meter or 1% of sell price) collected by forestry departments. Taxes and fees took 43.6% of sell prices in the manufacture and sale sections, if counted at the highest limits, far exceeding the actual average level of the national economic departments, which was of 25–30%. Cancellation and reform should be implemented to various arbitrary fees, no matter if they are collected by local governments, forestry departments or other functional departments. Commercial forestry shall enjoy a fair starting point and good environment for competition.

China's collectively owned forests total approximately 170 mil ha and are home to more than 400 million people .Since 2008, central government promoted collective forest tenure integrated reform. In the reform, a series of preferential tax policies for timber and non-timber products production were issued to attract social investment in forestry.

- Decreasing the level of regeneration fee from 20% to 10% of the total sale income of timber products since July 1, 2009.
- Continue to implement the policy which stipulated the value-added tax for wood integrated products of taxpayer will be partly returned from January 1 of 2006 to December 31 of 2008. The wood integrated products are the products made of the residuals from logging, cross-cutting and wood processing or small diameter log or fuel wood. Since 2009,this favorable policy will be consistent and the value-added tax will be returned 100% in 2009 and 80% in 2010.

Take Jiangxi province as an example. The tax and fee change before and after the collective forest tenure reform was listed as follows:

Table B.1. The tax and fee change before and after the Collective forest tenure reform in Jiangxi province

Project	**1 cu m 12cm Chinese fir**		**1 cu m 12cm pine logs**		**A moso bamboo with 33cm circumference**	
	Before reform	**After reform**	**Before reform**	**After reform**	**Before reform**	**After reform**
Total tax and fee	230.91	73.6	204.37	72.72	3.17	1.02
Taxes on special agricultural products	35.9	0	37.02	0	0.63	0
Regeneration fee	95.81	71.66	88.06	70.78	1.27	1
Phytosanitary fee	1.98	1.94	1.98	1.94	0.12	0.02
Management fee of forestry enterprises	5.52	0	5.52	0	0.13	0
Fees by the county	41.17	0	31.02	0	0.35	0
Fees by the township	25.01	0	20.52	0	0.27	0
Fees by the village	19.02	0	14.19	0	0.27	0
Else	6.5	0	6.06	0	0.21	0
Proportion of total tax and fee by timber price	54.9	15.3	48.8	16.7	46.8	10.3

Source: Liu *et al*. (2008)

3. The fiscal supporting policies

The main purpose of the fiscal supporting policies for forestry is to compensate the externality of forestry activities and to create a fair competition environment for forestry development. The current fiscal supporting policies for forestry include the following aspects:

3.1 Forest Ecological Benefits Subsidy Funds (FEBSF)

Based on operations of forestry classification, excluding the areas covered by the nature forest protection program, the forestry department confirmed that there were 0.8 6 billion mu of forests and special usage forests, that required crucial protection mainly located in river sources areas and around the big reservoirs. From 2004, Central Compensation Fund was established for the key national ecological forests and the government subsidy was CNY 75 per ha annually and the compensation for those forests which were managed by farmers households has been risen to CNY150 per ha since 2010. Comparing with 13.33 mil ha and subsidy of CNY1 billion in the year of 2001, the central financial compensation for farmers for ecological public welfare forest reached 83.95 mil ha and subsidy of CNY9.679 billion in 2011.The compensation level will be increasing gradually.

Compensation funds in local level are established for local ecological forests by local government's budget. Until 2012, 24 provinces have set up ecological public welfare forest compensation system which covered an area of 298 mil mu and had fund of CNY3.392 billion.

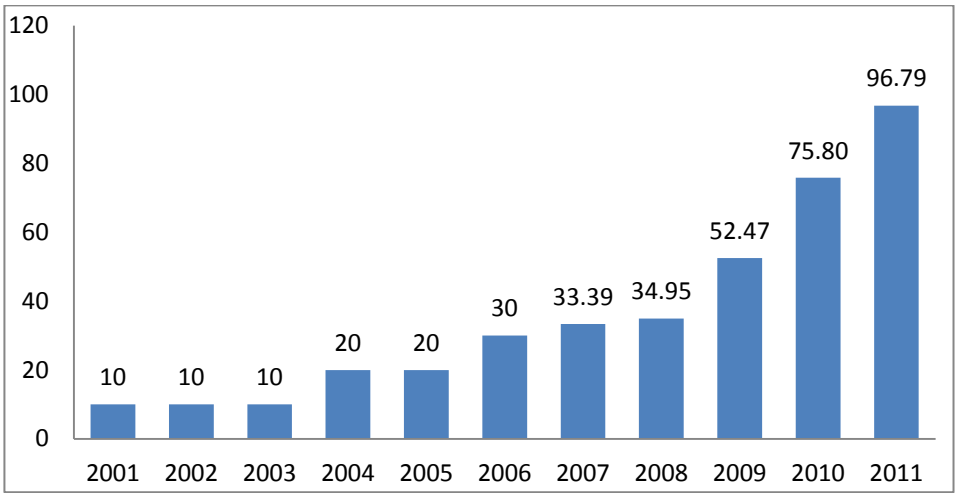


Figure B.8. The central financial compensation for farmers for ecological public welfare forest during 2000–2011 (CNY100 million)

3.2 Fiscal and credit supporting policy

Since 1986, the central government began to subsidize forestry projects with rate loans. Subsidized rate loans for forestry projects, for sand prevention, for comprehensive development in mountainous areas were initiated. The subsidized objects include enterprises, state-owned forest, and farmer who join the related forestry project. Since 2009, the discount interest rate of central fiscal is 3% per year. In general, the interest subsidy covers three years if the loan period is more than three years (inclusive).

For example, in 2010, the SFA assigned a proposed plan of CNY18 billion to discounted loan forestry project. The actual allocation of discounted loan from the state budget was CNY760 million. In 2010, the actual allocation of discounted loan for forestry was CNY16.203 billion, accounting for 90.02% of the loan plan in the same period. Out of the total, the allocated loan for industrial raw material forest projects (including woody oleiferous plants and crop planting in sandy, stony and desertified land areas) was CNY5.437 billion, accounting for 33.56% of the total; the allocated loan for economic forest projects was CNY4.058 billion, accounting for 25.04% of the total; the allocated loan for other crop farming projects amounted to CNY1.278 billion, accounting for 7.89%;and the allocated loan for diversified economy projects was CNY5.430 billion, accounting for 33.51% of the total.

3.3 The subsidy for forest management

Since 2009, the subsidy for forest management started as the part of central budget for the key national ecological forests. In 2009, central government input CNY500 million for subsidizing middle and young-aged stands tending in 11 pilot provinces and Daxing'anling special forest zone, covering 333,300 ha. The sum increased to CNY2 billion and the coverage was enlarged to 27 provinces covering an area of 1 333 300 ha. Until 2012, the total of subsidy for forest management have reached CNY7.63 billion, covering 4.73 billion ha.

3.4 Forest tenure mortgage

In 2009, Bank of China, the Ministry of Finance, China Banking Regulatory Commission, China Insurance Regulatory Commission and the State Forestry Administration jointed issuing *the Guidance on Financing Services to Support Forestry Development in Context of Collective Forest Tenure Reform*. It includes the policy that allow farmer households to get loan from banks by mortgaging the standing timbers on their contracted forest lands to the banks or some other mortgagees. Micro credits for farmers were supported and the duration was extended 10 years. The duration for fast-growing and high-yield plantations, camellia forest, bamboo grove and bio-energy forests and related forest industries was extended to 15 to 20 years. By the end of 2012, 27 provinces had launched forest tenure mortgage program, cover ing an area of 2.41 mil ha and the total loan amounted to CNY5.3 billion.

3.5 Forest insurance

The aim of forest insurance policies is to improve farmers' capabilities in resisting natural disasters. From 2009, central government carried out pilot of premium subsidies to forest insurance in Fujian, Jiangxi and Hunan Provinces. Central government subsidizes 30% and provincial government subsidizes 25% of the premium and the other 45 % were paid by the managers themselves. By the end of 2012, forest insurance policy have been implemented in 20 provinces, covering 772 mil mu with an insured amount of CNY327.977 billion, premium of CNY792 million and policy subsidies of CNY676 million.

4. Appraising current forestry budgetary policies

While the current forestry budgetary polices promotes forestry development, weaknesses still exist.

4.1 The Shortage of fiscal Capital in forestry

While in China the awareness of the importance of forests' ecological benefits for the social well-being has become strong, the quantity and quality of ecological forests that provide such benefits has been far from adequate for a long time. This has much to do with the lack of investments. The task of forestry development in China is still arduous. There is a growing demand for funds. It could be explained by the trend of forest coverage and financing shown by the Figure B.9 that investment increase dramatically in recent decades. On the other hand, under the current conditions, forest coverage rate increases by one percent, the cost rises dramatically mainly caused by the labour cost rising and worse of soil condition.

Specifically, investments in ecological forestry have mainly been made in the day-to-day maintenance of ecological forests and in large-scale ecological forestry programs. The annual budgetary allocations and various forms of earmarked special funds provided funds for the management of ecological forests. Each year about CNY0.65 billion would be made available to ecological forestry farms for maintenance. This falls far short of what is needed to well manage all the ecological forests in China, as a much larger portion of ecological forests is located outside the forestry farms. Likewise, large-scale ecological forestry programs have been financed by public finance and have been widely under-funded. The lack of adequate and reliable capital input has become a major bottleneck for the development of ecological forestry in China.

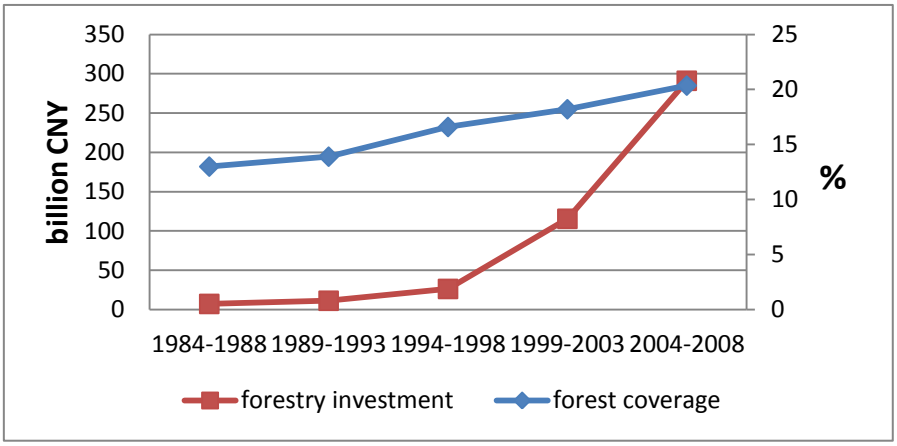


Figure B.9. The trend of forest coverage and forestry investment in China

4.2 Structural Imbalance

From view of forestry investment structure, the contradiction between increasing demand for forestry development from the society to the insufficient forestry investment is intense. This can be seen from following aspects (Table B.2).

Table B.2. Forest sustainable management investment status and gaps

Content of investment		Investment demand and gaps
Afforestation & reforestation	Afforestation	Afforestation invest is low. Take forest shelterbelt as an example, in 2009, afforestation invest is 200CNY/mu，but real needs is around CNY600–800/mu.
	Reforestation	Low reforestation subsidy, bad operation condition, reforestation measures cannot meet the requirement of forest management, structure of forest type is not good and structure of standing volume is not reasonable.
	Seedling project	High quality seedling was no more than 30%. In 2010, high quality seedling subsidy pilot is set to start. Subsidy standards are as follows: CNY600 per mu for seedling nursery and seedling resources storage; 300CNY per mu for tress collection garden and CNY100/mu for seeds forest and experiment forests.
Forest management	Low yield forest improvement	Some 1.6 mil mu of oil tea forests has been improved, and other forests hasn't yet start pilot projects.
	Young and middle age forests tending	Subsidy is CNY100 per mu, about half of the cost; start trial in 2009 with 5 mil ha, 0.32% of total young and middle aged forests area
Forest protection and management	Forest guarding	The standard of forest guarding subsidy in the Natural Forestry Protection Program is CNY1.75–2.22/mu since 1997, only 3% of local daily wage. Backward infrastructure, backward working and living condition for forestry workers.
	Forest fireproofing	In some places, supporting policy didn't reinforce; organization was incomplete, lack of staff and investment, and with bad firefighting equipment.
	Forest diseases and insects protection	Backward technique and infrastructure, lack of monitoring, prevention and cure, quarantine equipment and transportation communication instruments, insufficient quarantine station.
	Forestry working station	57% staff wage come from government budget, 43% come from forestry taxation and fee and other resources. 21.5% of forestry stations don't have offices, 39.9% of the station don't have vehicle and 19.7% of the stations don't have communication equipment.
	Forestry policy	Lack of investment and some place had to raise funds from penalty; poor infrastructure and in some places, there are not transport vehicle and office buildings.
	Forestry inspection and timber checking stands	Checking equipment is backwards with simple building. Lack of investment and penalty often replaced inspection. In some places, timber checking stands have become fee collection stands.

Source: SFA

Project investment takes a great share of the current forestry budgetary structure. The requirements for financing are enormous, but the financial input from the state all have time limits. Furthermore, the instability of program-based finance would affect the establishment of long-term care and tending of forests. Finally, the fluctuations in the government fiscal revenue, would make their funding flows vulnerable. The FEBCS, on the other hand, is expected to become a regular financing mechanism for the day-to-day management of ecological forests that provides a stable cash flow towards the management of ecological forests.

After the fiscal decentralization reform in 1994, the revenue of local government generally decreased. The current forestry fiscal investments mainly come from the state level (Figure B.10). However, as a part of national public finance system, the local government still needs to take certain forestry construction tasks.

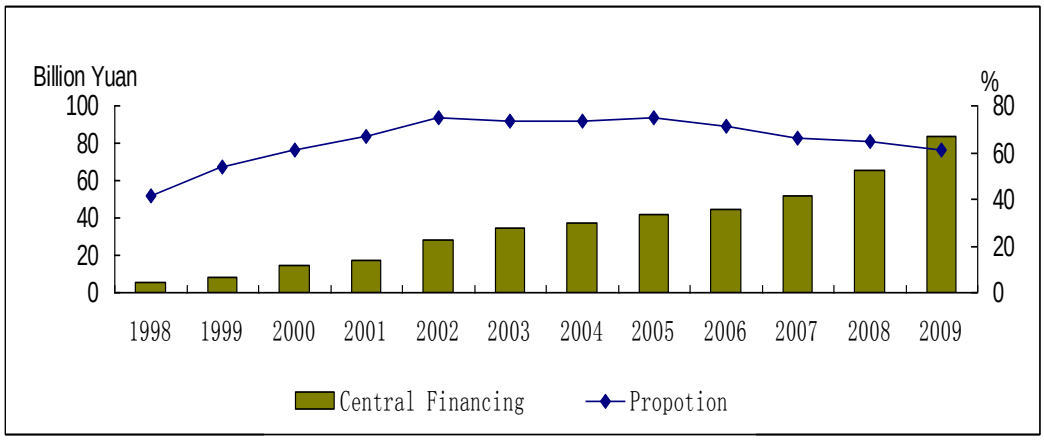


Figure B.10. Central government investment shares in total forestry funds

4.3 A different Forest Ecological Benefits Compensation Funds need to be found

FEBSF is not a compensation arrangement to forest owners or landholders for benefits forgone or costs incurred by maintaining their forests for ecological protection; rather, it subsidizes owners/managers for managing their forests as ecological forests. Subsidy is different from compensation. Therefore, it is important to note that the FEBSF is not the ideal FEBCS that could promote the forestry sector. In its original design, FEBCS would provide a mechanism for the realization of the market value of the environmental benefits of ecological forests. However, FEBSF is just a subsidy scheme; it is intended for encouraging or enhancing the practice of ecological forest management. While a subsidy may subsidize for certain key inputs in managing ecological forests, it should be regarded as an expedient arrangement practiced when the state's ability to pay for the environmental services is limited. In addition, there has simply been no usage of market-based instruments or mechanisms in the implementation of the FEBSF.

It is interesting to note the evolution from FEBCS to FEBCF and to FEBSF. There are mainly three types of expenses/investments in ecological forestry: planting, tending and revenue lost resulting from restricted forest use (opportunity cost).While the FEBCS is designed to be an institution for compensating all three types of investments, the FEBCF is designed as a public fiscal arrangement to generate such compensation. FEBSF, nevertheless, can be viewed as an incomplete fiscal compensation scheme, i.e., only the investment on tending will be subsidized. More delicate design and assessment is needed to the framework of FEBSF.

5. Forestry budgetary policy recommendations

5.1 Fiscal expenditure should mainly be used for resolving "market failure", rather than taking place of market mechanism.

We noticed that local forestry department is sometimes involved in economic activities. For example, in some forest areas local forestry bureau set up hospitals, schools and other commercial organizations.

Take the grain for green program as an example, part of project fiscal funds are designed to purchase seedlings for relative farmer. The result is that, at the beginning of the project, state owned lots or forestry bureau owned nurseries are established. However, seedling supply can be operated more efficiently by the market. Allowing the forestry bureau to undertake this task will cause a low efficiency of capital use and "seeking rents" problem.

Another example is that the central government makes clear limitations on the proportion between ecological forest and economic forest. When the farmers use retiring lands to plant vegetation, they must strictly abide by this regulation (70% ecological forest and 30% economic forest), otherwise, farmers will be punished by paying extra money to local forestry bureau. Actually, the government can choose to use fiscal policies to encourage local farmers to plant more ecological forest (for example adjusting the tax level to forest economic production or increasing the ecological benefits compensation) rather than using administrative regulations or some types of punishment.

5.2 Fiscal expenditure should pay attention to equity and lead local people to manage forests in a sustainable way

The current fiscal expenditure treats the state-owned collective and private units in a different way. This obviously betrays the basic objective of the fiscal policy. In addition, referring to the fiscal expenditure policy, we think that the government needs to consider using diversified instruments to lead local people to manage forests in a sustainable way, instead of only fiscal subsides.

5.3 Fiscal expenditure needs a stricter and more efficient management system

- **Guarantee fiscal funds to be released on time.** We learned from local staffs of forestry bureau and local farmers that delay of fiscal funds release is common for most ecological forestry projects, especially for the Grain for Green Program. This problem has negatively impacted the normal project implementation.
- **Guarantee fiscal funds to be used efficiently.** Without the necessary supervision and a strict management system, the results of fiscal expenditure can hardly be guaranteed. The practice in Bao ji, Chun hua County indicated that, in order to accomplish the objectives of ecological project, it's time to improve the capability to manage fiscal funds at the local level.

5.4 Establishing a proper fiscal transfer payment system

The two counties we selected are located in western China. Local economy was undeveloped, compared to eastern China. So local governments' fiscal revenue is low, and there are still many local farmers living in poverty. However, because of the fragile environment system in this area, they have to take on heavy forestry ecological construction task. Therefore, establishing a proper fiscal transfer payment system between central and local government is very important to improve the results of ecological construction.

Based on the analysis and several case studies, we would like to point out again that the key of fisca policy should not simply focus on increasing the expenditures, but should also embody the role of policy orientation and incentive and prompt a sustainable forest management.

5.5 Enhance financing ability

It is necessary to seek more local government investment. Bring forestry into local government's development plan and strengthen local government forestry investment via forestry key programs which fit local needs. Bring infrastructure construction in the forest region into related development plan of related government sectors. We shall effectively attract social forestry investment via reform and formulating incentive forestry policy.

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