National Report
on Sustainable Forest Management

State Forestry Administration, P.R.China

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Preface

Forests are the main body of the terrestrial ecosystem and have important multiple functions, such as biodiversity conservation, climate change mitigation, combating land degradation, water and soil control, and satisfying diversified social and cultural needs. At the same time, forests provide important supplies to industry, employment opportunities, and are the essential basis for poverty eradication and social and economic development in mountain areas and forest farms. Sustainable forest management has become one of the major areas of global concerns and played a more and more important role in promoting social and economic development in the global context and enhancing ecological civilization.

China is one of the member countries of the international process of criteria and indicators for the conservation and sustainable management of temperate and boreal forests, in short the Montreal Process. It is the obligation, as a member country of the Montreal Process, to provide the national report of sustainable forest management of China, and the action to implement a series of forestry development decisions and the Non-Legally Binding Instrument on All Types of Forests. The National Report of Sustainable Forest Management in China (herein after referred to as "the Report") is the first one which comprehensively reflects the progress of sustainable forest management at current time. From an international and prospective view, this report describes the basic information of forests in China, in particular the major progress in sustainable forest management in the past 20 years and the comprehensive review on national status of forests.

The report elaborates the forest development strategy focused on ecological development, efforts made in afforestation and forest resources management, the achievements made in maintaining increase in both forest area and standing stock, protection of natural forests and conservation of endangered species, and the improvement of forest institutions and livelihoods of forest farmers. All these show that the awareness on the role and status of forests and forestry from the central government and public society has been greatly enhanced. The Report extensively elaborates on the continuous improvement of forest management policies and management system, including the forest resources management system, the reform on forest property right, the establishment of payment for ecological services system, and the introduction and development of forest certification in China. The report shows that forests in China have made a great contribution. Under the circumstances of decreased global forest resources, China has become the country with the fastest increase of forests in the world. The forest area has reached 195 million ha, with standing stock volume of 14.91 billion m^3 and forest cover of 20.36%. From 2000 to 2011, the total forest product volume has increased by 7.61 times and reached 3.06 trillion RMB. In 2011, the non-timber forest product volume totaled 631.99 billion RMB with an increase of 147.77% from 2006. The development of green forest products, including non-timber forest products and forest tourism, provides great opportunities to forest employment in its scale and approach. The carbon storage of Chinese forest coverage has reached 7.81PgC. The area of protective forests accounts for 45.81% of the total land area. The annual logging ratio of commercial forests between natural forests and plantations has changed from 81:19 to 56:44. All these data show the achievements and potentials of sustainable forest management in China. The Report also warns us that there are still a lot of challenges, for instance, the implication of climate change upon forests, forest products, forest fire and forest health. In a certain period of time, we are still short of timber supply and need to address the problems on ecological conservation and economic development. The data in the report will help us analyze, tackle and address these challenges.

The Report was compiled by the State Forestry Administration, using the criteria and indicators of the Montreal Process, and based on the outcome of national forest inventories and specific inventories, the national forest statistics and management data. Taking reference of authoritative documents and academic reports, it has taken comprehensive analysis, intensive research and thorough deliberations to reflect the status of sustainable forest management in China from multiple aspects. I would like to take this opportunity to thank all the persons and agencies involved in this process for their hard work and best efforts. I hope this report will further facilitate the deliberations on the role of forests, the problems facing and the future development of sustainable forest management in China. I wish this report will be an important reference for policy-makers and stakeholders.

Yin Hong
Vice Minister
State Forestry Administration, P.R.China

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on Sustainable Forest Management

1

Sustainable Forest Management (SFM): from Concept to Practice

The concept of sustainable development has been accepted and spread rapidly since the release of the Brundtland report *Our Common Future* in 1987. The value of sustainable development has laid the foundation by many countries to guide national strategic plans and design policy process after the United Nation (UN) Conference on Environment and Development in 1992. The efforts to enhance sustainability have been made through the relevant plans and policies. We are facing various challenges, such as global warming, biodiversity loss, land degradation, desertification aggravation, frequent occurrence of flood and drought, severe soil erosion, shortage of water resource, sustainability (green development) has become the global common concern in 21st century, thus traditional development way mainly focusing on economic growth has been gradually transferred to the model of sustainable development, which fully considering economic, social and environmental elements.

The objective of sustainable development is to meet the needs in present, without harming future generations or compromising the ability of future generations to meet their own needs. Sustainable development consists of the elements pertaining society, economy, population, resource and environment concerns. It is a systematic management that requires positive changes of criteria and indicators for these elements (strong sustainable development), or at least overall change trend does not show as negative (weak sustainable development).

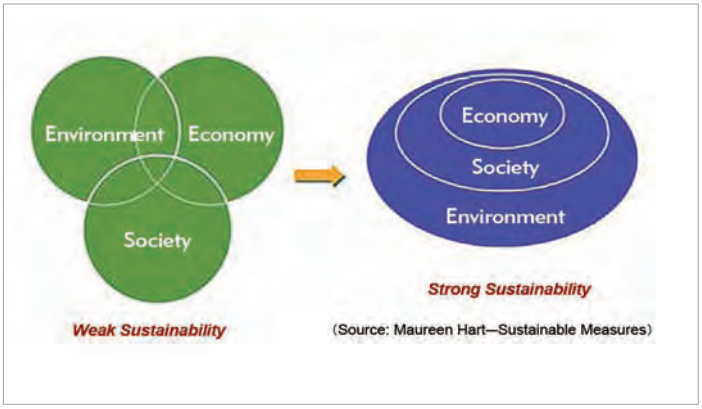


Figure 1-1. Evolution of Sustainable Development Concept (USDA, 2011)

The contents of sustainable development are changing constantly with the human being's demands for environment expanded and the knowledge of ecology and environment improved. From a systematic point of view, sustainable development shall consider ecological environment first, then it is possible to achieve social and economic sustainable development (Figure 1-1).

1.1 Concept and content of SFM

1.1.1 Concept of SFM

Forest has crucial ecological, economic, social functions as the important source of world lives and life supportive system. SFM became a hot issue in the UN Conference on Environment and Development held in Rio de Janeiro in 1992 and it was the first time that particularly addressed the sustainable forestry development in the world, and built up the strategic planning for sustainable development at global level. Some important documents such as *Agenda 21, Convention on Biological Diversity, Non-legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of All Types of Forest* provide the international guidelines for SFM.

SFM defines as to manage forest resources and forestland in the ways to meet social, economic, ecological, cultural and spiritual needs of current and future generations. It is a long-term complex systimatially project and involves

social and economic activities related to demands and responsibilities of various stakeholders. Generally, SFM contains two basic elements or two key components: "demands" and "restrictions on demands". The basic demands of residents in forest areas who live on forests shall be the first priority, and then consider the others' in greater extent. "Restrictions on demands" shall be designed to limit the harm to forest capacity due to the increasing human demands to forest resources. Once forest capacity is destroyed, it will definitely endanger forest ecosystem that supports world lives, as well air quality, water body, soil that closely related with forests.

Different organizations approach SFM from different perspectives. FAO considers SFM as all kinds of administrative, economic, legal, social, technical and scientific actions that relates to natural forests and plantations. They are various planned artificial interventions with the objectives of protecting and maintaining forest ecosystem and its multi-functions. ITTO recognizes SFM as a permanent process of managing forest land, so as to achieve one or several clearly defined management objectives, and continuous production of forest products and services in demand without reducing its interior value and future productivity of forests, or/and negative impact on physical and human environment. Pan-Euro (FE) identifies SFM as managing and utilizing forests and forest land in certain models and speeds to conserve forest biodiversity, sustain forest productivity, its regeneration capacity, and health and vitality of forest ecosystem, as well ensure the potential of current and future generations' demand for ecological, economic and social functions of forests at local, national and global levels without the damage on forest ecosystem.

Although different definitions mentioned above exist, the quite common recognitions of SFM may be identified as: SFM shall be scientific and reasonable management to maintain health and vitality of forest ecosystem, conserve biodiversity and its ecological process to meet the demands for forest products and its environmental services beyond social and economic development, and enhance sustainability of population, resources, environment, society and economy within a system.

1.1.2 Basic principles and features of SFM

At least four basic principles have been identified for sustainable forest management. They are (1) the development principle that sustains harvest of wood products and non-wood products; (2) the coordination principle that enhances comprehensive capacities of forest ecosystem; (3) the quality principle that limits negative human disturbances; and (4) the justice principle that balances benefits and costs in a short and long run while exploring and utilizing the forest resources. Hence, SFM has the significant features as following:

(1) It does not only emphasize timber production, but also endeavor to realize the actual integration of ecological, economic and social benefits; it is more important to improve and maintain comprehensive functions of the forest ecosystem.

(2) Forestry develop shall comply with or aim at overall sustainable development objectives of the nation, as well as meeting the increasing demands for its products and ecological services due to economic development and the living standards improvement at the national level.

(3) It stresses participatory forest management, and strives to balance the benefits of various stakeholders at individual, community, national and global levels, especially the residents living in forest areas, which makes SFM possible and practical.

(4) It emphasizes to improve supporting system for SFM, including the institution framework, policies and regulations, scientific training, and efficient response system to deal with emergent accidents, such as extreme drought, severe pests and diseases, etc.

(5) It addresses international issues, such as benefit and cost allocations (for instance, carbon circulation and biodiversity conservation), ecological effects and product trades, environment protection policies across the national borders, etc. The international forest issues have become one of important components in global politics and diplomacy.

1.1.3 Objectives of SFM

SFM aims to improve forest quality and its services. The structures of forest ecosystem determine diversifications, scales of its functions, and effects of ecological services. People have been engaging in the activities of pursuing higher productivity of timber per forestland units in certain time. As a matter of fact, many factors may increase the high productivity, for instance, management condition improvement, man-made nitrogen sedimentation, soil rehabilitation after over exploitation, extension of growth period due to climate change, high water resource utilization efficiency by increasing CO_2 concentration, genetics and solar radiation conditions, etc. The high forest productivity is beneficial for improving productive function in the land, but whether it can maintain high productivity greatly depends on how these factors.

SFM may improve productivity, also bring some unexpected risks, for example, it may jeopardize multiple ecological functions. In addition, different tree species, geographic environments or site conditions, management methods, and environment changes may bring significant impacts on ecosystem functions (Figure 1-2). Human demands and social values directly influence the changes of forest productivity or ecological functions. Therefore, SFM needs to develop under the influence of a hypothetic environment and man-made factors, and in consideration of the reactions of forest ecosystem in the stable or unstable conditions, so as to identify and evaluate management countermeasures from the point of view in multi-function or multi-purpose forest management.

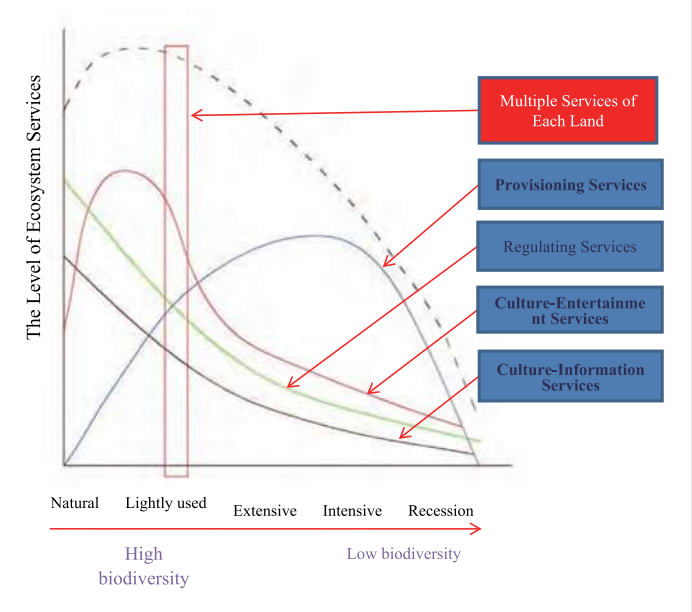


Figure 1-2. Relationship between production and services of forest ecosystem (Braat, et.al., 2008)

Social objectives of SFM: in general, a major objective is continuously providing diversified forest products, so as to meet the demands for various products in forest ecosystem which are closely related to basic necessities of living during the survival and development process of human beings. Social objectives of SFM also include creating job opportunities for the society, increasing income, meeting the spiritual needs of human beings (such as purposes for fine arts, taste cultivation, education, culture, scientific research, religious, tourism, etc).

Economic objectives of SFM: four aspects can be considered; first of all, sustained forestry may motivate development of other industries, improve the economic benefits of relevant industries, and make contributions for national or regional social and economic development. In some developing countries or regions with abundant forest resources, one of the objectives of forest management is to provide original accumulation for the development of other industries, therefore forestry also plays a vital role in national economic development; secondly, forest managers and management authorities can gain sustained economic benefits. The goals of SFM is hard to be achieved without sustained economic income, or if economic conditions can not be improved fundamentally; thirdly, it may improve capacities of disaster prevention and relief in different scales at national, regional (e.g. watershed) levels; fourthly, the main objectives of SFM in most of developing countries is to develop their economy and eliminate poverty.

Environmental objectives of SFM: it depends on the knowledge of human beings on environmental functions and forest values, including ecological services for the survival and development of human beings, such as soil and water conservation, water source conservation, CO_2 storage, climate improvement, biodiversity conservation, etc, and well ecological scenery and environmental services so as to meet various demands of human beings, such as spiritual, cultural, religious, recreational, etc.

1.2 SFM: an important approach to address global challenges

1.2.1 Addressing the challenge of climate change

In 21st century, global climate change became one of the biggest ecological and environmental problems. At present, developing low carbon economy and realizing green development have become government strategic options to deal with climate change. Low carbon economy is designed to reduce CO_2 emission, and absorb CO_2 in the atmosphere, in order to keep its balance. Two ways are applied for low carbon economy development. One is to reduce emission of greenhouse gases through advanced technologies, and the other is to fix and store greenhouse gases in the atmosphere, which can be realized with industrial means, as well as through biological carbon sequestration. Advanced technologies for storing greenhouse gases cost highly and is difficult to applied widely; technically, biological carbon sequestration is easy to practice with low cost and create multiple effects in the regions. Therefore, it has great potential and will play a critical role in developing low carbon economy and realizing green development.

Forest is a huge carbon pool and it is widely accepted to build and maintain forest's carbon sink capacity through SFM, forest conservation, afforestation and reforestation at the global level. The functions of REDD espeeially in the countries with abundant forest resources and their important roles in global climate change have been recognized. REDD become important "spots" when making the international negotiations and compromises to deal with climate change. In December 2010, COP16 of *UN Framework Convention on Climate Change* (UNFCCC) was held in Mexico, the principles and measurements of REDD+ mechanism, monitoring methodology, reporting and verification were approved at the conference. The implication of REDD+ is reducing emission from deforestation and forest degradation in developing countries, and increasing carbon storage by forest conservation and SFM. However, giving full play to forest still depends on many elements, including effective forest management, ensuring forest carbon right, and integrating relevant action plans into climate change policies and projects. Energy saving and emission reduction is only a reduction of CO_2, improving carbon sink capacity of forest is the source to expand carbon capacity. Therefore, we should improve carbon sink capacity of forest, conduct multi-function utilization of forest, and develop renewable sources[1] (Yin Weilun, 2012).

The Chinese government improves its understanding in the roles of forest for addressing climate change, and promoting sustainable development of economy, society and environment, and elevates it to the national policy and strategic level. On September 22, 2009, President Hu Jintao gave a speech in the UN Climate Change Summit: China will "endeavor to increase forest carbon sink, and strive for the objective that by 2020, forest area will increase 40 million ha over 2005, and forest stocking volume will increase 1.3 billion m^3 over 2005". China owns a large area of plantations. Afforestation and forest management is an important way to realize the 40%-45% decrease of CO_2 emission in unit GDP by 2020 over 2005. In particular, the area of middle and young age forest in China reaches 105 million ha, accounting for 67.25% of the total arbor forest area, among nearly 57

[1] *http://www.cngreen.net/news/shownews.asp?id=52110*

million ha of middle and young age forest needs tending due to high density. Implementation and fulfillment of SFM strategy will greatly improve forest quality and carbon contribution of China; on the other hand, China has 195 million ha of forest at present, if its carbon fixation capacity can be improved to the average level in middle and high latitude region, it can newly add 12.88 billion ton of carbon fixation capacity, so as to improve China's economy growth and sustainable development[2].

1.2.2 Relieving shortage conditions of global forest resources

Forestry is a fundamental industry of national economy and the basis to establish ecological civilization. As a kind of traditional resources, forest also becomes the strategic resource that is increasingly drastically struggled by all countries, like energy, water and food. Although forest is a kind of renewable resource, forest resources are still relatively limited at the global level. Currently, world forest area is about 4 billion ha, accounting for 31% of total land area of the world; timber supply accounts for over 9% of the total supply of global primary energy, and it is the major energy for cooking and heating for 2 billion people (*State of the World's Forests 2012*). There is an increasingly severe supply and demand contradiction between the countries with traditional forest resource and the ones with great forest resource consumption, which will make a long-term challenge to the economic and ecological development of some countries.

The world population is estimated to reach 9 billion by 2050; it is evidently unsustainable to rely merely on the diminishing natural resources. As a kind of natural production system, if forest can be managed sustainably, then it can provide stable supply of relevant products and services. SFM not only contributes to the expansion of economic development in rural areas, but also contributes to the improvement of renewable resource utilization, thus it can become a sustainable component in economy and environment in the future.

China is a big country with very limited forest resources. Now the coverage of forest in China is only 2/3 of the world average level, ranking 139th in the world. Forest area per capita is 0.145 ha, less than 1/4 of world average; forest stock volume per capita is 10.151 m^3, only accounting for 1/7 of the world average stock volume per capita. The average stock volume per ha of arbor forest in China is 85.88 m^3, just accounting for 78% of the world average level, with the average DBH of 13.3 cm, the average stock volume per ha of plantation arbor forest in China is only 49.01 m^3. At present, the suitable land for forest with high quality land only accounts for 13%, while low quality land accounts for 52%. In additions, 60% of suitable land for forest in China is allocated in Inner Mongolia and Northwest region, where the afforestation is increasingly difficult. China is facing the great challenge for forestry development and will exert greater efforts to increase every 1% of forestland in future.

Therefore, improve forest productivity and realize SFM are significant in mitigating the supply and demand contradiction of forest resources, and even solving deep ecological, social and economic problems.

1.2.3 Promoting national social and economic sustainable development in global background

Global economy has developed rapidly at the cost of sacrificing the sustainability of natural resources in the past 20 years. The most obvious example is deforestation. During 2000-2010, population growth led the acceleration of deforestation, resulting in 5.2 million ha of annual net forest loss and the forest will disappear in the world after 775 years at this speed. Forest may provide stable products and services, meet population's growing demand on resources in the future, and promote sustainable national economic development through SFM (FAO, 2012).

The report *Stepping to Green Economy*[3] confirms ten sectors which are extremely crucial to global green economy, including forestry. Compared with

[2] *http://www.forestry.gov.cn/portal/main/s/72/content-573441.html*
[3] *It can improve human welfare and social equity, and significantly reduces environment risk and solves economy of ecological scarcity.*

conventional model, green economy in agriculture, construction, forestry and transportation, may better promote the sustainable economic and social development, such as providing more job opportunities, ecological conservation, poverty alleviation, etc (UNEP, 2012). In RIO+20 Conference, FAO reckoned: "world forest plays a major role in the transition towards new green economy", we should "set forest in a core status in green economy". IUCN proposes the viewpoints including "fundamental role of forest in realizing green economy". UNEP considers that "forestry is the basis and key of green economy". In the development of green economy, forest can be regarded as assets for management and investment, so as to achieve various benefits. Forestry plays a crucial role in green economy: firstly, it is a production plant (producing daily necessities from timer to food); secondly, it is ecological infrastructure (providing public products from climate adjusting function to water resource conservation); thirdly, it is a provider of innovation and insurance services (biodiversity conservation).

The measures to realize forest's contribution to future sustainable development include: improving forest quantity and quality through afforestation and investment in ecosystem service; promoting the development of forest associated medium and small enterprises, so as to decrease rural poverty population; adding long-term value of wood products by recycling utilization of wood products; strengthening coordination and integration strategies between natural landscape and artificial landscape[4] (FAO, 2012). Each country should reform current policies, laws and institutions, in order to create a beneficial environment that can protect and increase current forest resources; meanwhile, each country should strengthen international cooperation in SFM, ensure the participation of all parties like governments, citizens, society and private sectors, keep on optimizing forest governance, monitoring, evaluation and management (*State of the World's Forests 2012*).

1.2.4 Promoting ecological civilization development

Ecological security is the biggest challenge for the survival and development of human beings. Living environment for human beings is deteriorating due to various factors including war, and production, living, survival and development of human beings for a long time. Human beings' violent pillage and destruction to resources, such as over logging and reclamation of forest and grassland, over collection of underground water, mass emission of wastes and greenhouse gases, etc, have resulted in ice melting, aggravation of desertification, biodiversity loss, prevalence of pestilences and diseases, etc, all these facts explain that human beings are not only creators and builders of fortune and civilization, but also pirates and destroyers of fortune and civilization, the biggest challenges of ecological civilization and ecological security are the behaviors of human beings themselves.

Forest is the main body of terrestrial ecosystem, and plays an irreplaceable role in improving ecological environment, maintaining ecological balance, and protecting "basic environment" for survival and development of human beings, forestry holds main functions for ecological development and conservation, as well green production. It is crucial to develop a ecological civilization. At present, quantity and quality of world forest are far from meeting the society's growing and diverse demand on forestry, ecological issue is still one of the most prominent problems that constrain sustainable development, nowadays society still seriously lacks ecological products, and the major difference between developing countries and developed countries is still the ecological gap.

Ecological civilizations sets sustainable development as the core value, stresses that humans' subjective initiative should be given full play in material production and spiritual civilization, it should accord to the objective rules of natural ecosystem and social ecosystem, so as to establish the healthy operation mechanism between humans and nature and between humans and society, and harmonious and coordinated social civilization. Developing ecological civilization should highlight the main body status of forestry, give play to the leading role of forestry, exert forest's functions and roles in ecological services and conservation, depend on forestry, which is the biggest green industry and circulation economic entity, develop green economy, and promote the development of ecological civilization.

[4] *http://env.people.com.cn/n/2012/1205/c74877-19802449.html*

1.3 International processes and national actions on SFM

1.3.1 International theoretical and technical development of forest management

Historically, forest successively experiences predatory management, sustainable management, and multi-function management with the constant development of understanding and values of forest. In the 1980s, the experts proposed an ecosystem approach of forest management, namely ecosystem management, which gained attention and support from scholars and government officials in each country, and thus it develops a new approach from simple to complex, from single to comprehensive, and from micro to macro, which integrates humans' demand on forest products and services and long-term demand on environment quality and forest ecosystem health. The approach has demonstrated an important transition in the history of forest management. Obviously its development is closely related with the development of contemporary system science. Since the 1990s forestry developed countries conduct overall adjustment of forest management models in succession, for example, National Forest Service of USA implements "new forestry" policy and forest ecosystem management strategy in state forests; Canada turns to "sustainable forest land management"; Germany vigorously promotes close-to-nature forest management, etc. The objective of these countries is to balance various social values, conserve biodiversity, maintain forest health and long-term forest productivity through implementation of SFM. Forestry developed countries and regions like Canada, New Zealand, Australia, Europe, etc, successively raise advanced forest management concepts, models and techniques such as forest health and rehabilitation, multi-function utilization of forest, intensive management of plantation, which have gained significant achievements in developing management systems and mechanisms which accord to market economy operation rules.

1.3.2 International processes of SFM

SFM was proposed in the UN Conference on Environment and Development held in Rio in 1992, different regions and organizations positively promote the international process of SFM, and develop nine international processes, namely Montreal Process, Pan-Euro Process, ITTO Process, African Timber Organization Process, Tarapoto Process, Drought Africa Process, Near East Process, and Drought Asia Process. All these processes have identified the development of each region and features of their own forests, established SFM Criteria &Indicators (C&I) system to fit local regions. The development of these processes greatly motivates rapid extension of SFM concept in the world, and promotes global forest management.

Study, formulation, application, verification, and reporting of SFM C&I have become the basic theoretical framework and methods to monitor and evaluate SFM conditions and promote global SFM process at the international level.

Working Group on C&I for the Conservation and Sustainable Management of Temperate and Boreal Forests, namely Montreal Process (MP) was initiated in 1994. Montreal Process includes twelve countries as MP membership (USA, Canada, China, Russia, Japan, Australia, South Korea, New Zealand, Chile, Argentina, Mexico, Uruguay), covers 90% of boreal and temperate forest in the word, 50% of global forest

area, 45% of trade in wood and wood products, and 35% of global population; in 1995, MP set C&I system for the conservation and sustainable management of temperate and boreal forests, which includes seven criterias and 67 indicators for the member countries to analyze and evaluate SFM process in their own countries respectively. In 2003, each country applied Montreal Process C&I system and published the first edition of country report, as well formulated Montreal Process 2003 Review Report on the basis of 12 country reports. Based on the experiences from process reports and the latest development of international society (for instance, the establishment of UNFF), 12 member countries approved Quebec Declaration in September 2003. The Declaration reviewed the progress of MP during 1995-2003, defined vision objectives of MP for 2003-2008, specified to adopt a series of actions to strengthen the role of MP, including the review and amendment of new MP C&I system. In 2007, SAP (strategic action plan) for MP was approved to guide development direction of the process. After nearly 5 years' revision and improvement, the new C&I system was approved in the Working Group Meeting held in Russia in November 2008. The new system includes 7 criterias and 54 indicators. Comparing with the previous C&I system, the new one is more operational, and is easier for statistics analysis, monitoring and reporting.

Since C&I system has been applied to measure and evaluate a country's development progress towards SFM, governments and researchers in different countries have been recognizing its importance. However, the current basic data needed for C&I system is neither systematic, continuous nor complete, the national reports on SFM progress reflected by C&I system are not able to be submitted in time or in full version, which affects the progress of SFM. Hence, each country tries to use a set of available system data, combining the report of MP C&I system (MPC&I), and other reports like forest resources evaluation report, CBD country biodiversity conservation report, UNFCCC, UNFF national report, so as to develop a systematic national comprehensive report that can meet diverse reporting objectives. For this purpose, MP cooperated with FRA working group of FAO, Forest Europe, ITTO Process, to initiate the efforts to report the status quo and development trend of world forest and SFM with coordinated and uniform methods since 2011, and has achieved significant progress.

Seven thematic elements, also named as seven thematic elements of Non-legally Binding Instrument on All Types of Forests (NLBI) of UNFF, have become the important basis for Global Forest Resources Assessment (FRA). These elements include forest resources, forest biological diversity, forest ecosystem health and vitality, productive functions of forest resources, protective functions of forest resources, socio-economic functions of forests, legal, policy and institutional framework, etc. Forest related issues encompass not only various environmental and development problems, but also great opportunities to recognize the forest values at a large scope.

1.3.3 Development and actions of forest management in China

China has a vast territory, Its natural geographical, biological and climate resources differ greatly between different regions, thus they provide diverse conditions for forestry development. However, forest resource distribution is extremely unbalanced in space. Forest resource is quite concentrated in the regions of Greater Khingan Mountains, Lesser Khingan Mountains, Changbai Mountains in northeast China, west and south Sichuan, greater part of Yunnan, and southeast Tibet in southwest China, low mountains and hills area in southeast and south China, and Qinling Mountains, Tianshan Mountains, Altai Mountains, Qilian Mountains, and southeast Qinghai in northwest China. Forest resource is less in northwest region, middle and western part of Inner Mongolia, and greater part of Tibet with vast territory, and north China, central plain region, and middle and lower reaches of Yangtze River and Yellow River with dense population and developed economy. In addition, China has a large population and the total amount and per capita of forest resources are low. In modern time, forest coverage in China never exceeds 2/3 of the world average level, forest area per capita is less than 1/4 of world average, forest stock volume does not exceed 1/7 of world forest area per capita.

China is a mountainous country, mountain area accounts for 2/3 of total land area; China is also a country with the widest distribution of loess and the biggest area of desertification land in the world, and among the countries with biggest river basin area. Topographic

relief is evident in mountainous, hilly and loess area. Without protection of vegetation, loess or incompact weathering crust is easily eroded. Most areas in China belong to monsoon climate with concentrated rainfall in summer. Rainfall in rain season usually accounts for 60%-80% of annual rainfall, and there are always rainstorms. In addition, due to the large population, China faces great pressure from the demand on food, household fuel and economic development, and conducts predatory reclamation and destruction on land, resulting in the destruction of forest resources and land degradation, etc.

Special natural resource endowment and economic and social development history make China become a country with fragile ecological environment, and severe land degradation and soil erosion, and directly determine the special process of China in forest resources conservation, rehabilitation and development. From the founding of new China to the late 1970s, China was in the development stage with focus on timber production. Timber forest accounted for 70%, while protection forest and special purpose forest accounted for less than 10%. China ceaselessly studied and took references of forest management theories and techniques from other forestry developed countries, which played a certain promotion role for forest management in China, however forest management theory and technique system which accords to China's characteristics have not been established.

From the late 1970s to the late 1990s, China came into a rehabilitation development stage focusing on both timber production and ecological development. The national proportion of timber forest decreased to 60%, and the proportion of protection forest and special purpose forest increased to about 15%. Aimed at existing problems of forest resources and ecological environment in China, the Chinese government successively issued a series of documents and guidance ideas for strengthening forest management and sustainable forestry development, released *China's Agenda 21— Forestry Action Plan*, vigorously promoted forestry ecological programs construction, adopted national forest conservation and rehabilitation plans, such as ten forestry ecological programs, and afforestation and greening standard plan in southern collective forest area, implementation zoning for forest resources, and conducted forest logging quota system, which promoted constant increase of forest area. China made full use of international and domestic resources, positively promoted the dissemination of SFM concept in China, and strengthened capacity building of SFM. In afforestation, regeneration and tending management, China emphasized on the mixture of softwood and hardwood forests and development of forest structure with diverse tree species, multi-levels, uneven age and reasonable density, and promoted the rapid increase of area and promotion of softwood and hardwood mixture forest. For example, in east China with relatively developed economy, the areas with severe damage from water erosion, pests and diseases, China increased the proportion of hardwood and softwood mixture forests, enhanced forest's capacity in disaster prevention and relief, and comprehensively improved stability of China's forest ecosystem by implementing management plans such as "leaving hardwood trees and replanting hardwood trees", "leaving hardwood trees and replanting softwood trees", "enrichment and replanting", "afforestation under canopy".

Entering 21st century forestry development steps into a stage of which the focus shifts from timber production to ecological development, the Chinese government further realizes the status and role of forestry in sustainable economic and social development, formulates the laws and regulations, establishes target responsibility system for forest resources conservation in office terms of governments at different levels, maintains the strategy of "strict protection, positive development, scientific management, sustainable utilization", strictly conducts forest logging quota system, and endeavors to develop forest resources. China promotes the implementation of forest ecological benefit compensation system, gradually conducts classified management of forestry, and enhanced tending and maintenance of forest resources.

In 2002, State Forestry Administration (SFA) issued *Criteria and Indicators for Sustainable Forest Management in China*, and explored by pilot demonstration to achieve SFM objectives, revise forest management model and adjust forest management policies, with the focus on exploring systems, mechanisms, models and channels of SFM in different regions, so as to promote the research and development of SFM in China. Meanwhile, China accomplished *A Study on Sustainable Forestry Development Strategy in China*, which raises strategic direction and values of sustainable forestry development and SFM in China.

In 2003, China issued *A Resolution on Accelerating Forestry Development by Central Committee of the*

Communist Party of China and State Council, which establishes the forestry development strategy focusing on ecological development, proposes countermeasures to solve problems regarding mechanisms, systems and policies of forestry development, and gradually rationalize production relationship of forestry; implements strategy of strengthening forestry by talents, revitalizing forestry through science and technology, and managing forestry according to laws, and raises new and higher requirements on sustainable forestry development. In order to carry out the *Resolution* to promote sustainable utilization of forest resources and development of forestry industry, SFA determined to fully implement the forestry development strategy focusing on ecological development and conducted positive practices and development in SFM based on overall strategy principles and management functions.

In 2004, SFA issued *Planning Outline of Forestry Industry Development in China*, setting a series of supporting policies and measures for forestry industry and forest tourism; published *Guidelines on Implementation Zoning of Forest Resources Management and Governance in China*, launched demonstration work of national SFM pilot sites, formulated *Work Plan for the Development of National Sustainable Forest Management Pilot Demonstration Sites*, determining to spend 20-25 years or even longer time (such as a rotation period), to establish the long-term SFM pilot demonstration areas, so as to explore techniques, models and indicator evaluation systems of SFM in the main state owned forest areas and southern collective forest area.

In 2005, China issued the draft of *Guidelines on Sustainable Forest Management in China*, which identifies basic requirements and priority areas of SFM practices in China in macro view, determines objective model and channel of SFM in China, explores management and governance mechanism of forest resources, revises forest management model and adjusts forest management policies, improves forest management guidelines, and provides guidance and action standard for establishing and improving SFM guarantee system and information supporting system. Meanwhile, the Chinese government has engaged to launch the importance of SFM activities by overseas Chinese enterprises. SFA allied with Ministry of Commerce to issue *Guidance on Sustainable Management and Utilization of Overseas Forests by Chinese Enterprises*, so as to strengthen guidance on management and utilization of overseas forests by Chinese enterprises, and while positively promoting international cooperation of forest resources utilization, ensure and promote SFM.

Since 2006, SFA has successively issued a series of guidance documents in order to promote sustainable management of forest resources. The documents include *Outline for Drafting and Implementing Forest Management Plans*, *Guidelines on Drafting Sustainable Forest Management Plans at County Level*, *Guidelines on Drafting and Implementing Forest Management Plans*, *Implementation Outline of National Sustainable Forest Management*, *Technical Regulations on Concise Forest Management Plan*, etc.

In September 2007, SFA issued two forest management standards, namely *Forest Management in Forest Certification of China*, Chain of Custody in Forest Certification of China, which have been upgraded to national standards in 2012. Meanwhile, SFA initiated zoning of forestry development in China, and accomplished this work in 2010. Forestry development zoning plays a positive role to identify forestry development conditions in different regions, determine forestry development directions in different regions, make an overall plan of productivity layout of forestry ecological products, material products and ecological culture products, and formulate forestry development policies and management strategies. It is also conducting the future forestry development directions, improving forestry development quality, gradually forming a modern forestry structure with coordination between population, economy, resources and environment, and promoting ordered development of forestry.

In 2009, *Forestry Working Meeting by Central Committee of the Communist Party of China* confirmed a series of important policies and management measures, and requested to establish subsidy mechanism for forest tending, and conduct forest tending subsidy pilots by central finance to promote SFM. For this purpose, SFA launched forest tending subsidy pilots by central finance, issued several mechanism standards, like *Management Methods for Forest Tending Subsidy Pilots*, *Regulations on Forest Tending Operation and Planning*, *Methods for Forest Tending Checking and Acceptance*, *Implementation Methods for Monitoring of Forest Tending Subsidy Policy Results (Trial)*, etc. Currently,

Special column: A brief introduction on SFM demonstration in China

Basic idea: Select county (bureau) level forest management institutions as units, by establishing wide demonstration pilots, positively explore techniques, models and criteria evaluation systems of SFM in different regions, discuss channels of forest management units to achieve SFM, so as to promote sustainable forestry development and ecological environment development in China.

Specific objectives: Provide a testing platform to realize ecological rehabilitation and sustainable management of natural resources; based on requirements of forest management, explore management techniques, models and mechanisms of forest management which accord to the requirements of sustainable development; develop criteria system on SFM for forest management units, so as to provide basis and experiences for establishing forest certification mechanism and entering international wood product market; give play multi benefits of forest resources.

Overall layout: Give consideration to: different regions in south, north and west China; different management features in state owned forest and collective forest; forest types in different origins. Identify 200 forest management units as pilot units for SFM management in China, including 138 county (regimental) level administrations, 30 forest industry bureaus (forestry management bureaus, forestry general farms), and 32 state owned forest farms.

Demonstration features

Pilot sites	Forest condition	Demonstration features
Wangqing Forestry Bureau, Jilin Province	Among forest enterprises with the longest development history, forest cover reaches 96%.	Maintain the concept that focuses on tending and integrates logging and tending, for natural secondary forest, implement management techniques focusing on both logging and tending, gradually develop a complete management technique system for logging and tending forest.
Yongan Municipality, Fujian Province	Forest cover reaches 83%, typical southern mountain area, collective forest land area accounts for 69.3%.	Forest farmers depend on forestry, forest resources are effective materials for forest farmers' income generation and enrichment, Hongtian Village of Hongtian Township of Yongan Municipality is "No.1 village of forest tenure reform in China".
Linan Municipality, Zhejiang Province	Collective forest accounts for 95%, forest cover reaches 76.55%, a typical representative of southern collective forest areas.	Integrate improvement techniques on degraded forest land and social and economic development means, win the prize of "Outstanding Example of Forest Management in APEC Region" awarded by FAO.
Xiaolongshan Forestry Experimental Bureau, Gansu Province	Water conservation forest area, typical natural secondary forest area. Forest cover reaches 63.6%.	Maintains " based on silviculture, focus on forest, integrate forest and by forest industry, focus on tending, integrate tending and utilization, comprehensive management, sustainable utilization", primarily develops a technical system of secondary forest comprehensive tending.
Qianyuan County, Liaoning Province	Timber forest and water conservation forest, northern collective forest, forest cover reaches 71.1%, collective forest accounts for 80.8%.	Diverse models of under-forest economy, advanced forest resources monitoring system, integration of logging, sales and transportation management of trees and management forest tenure and forest land, draft and implement village level forest management plans.
Jinggangshan Municipality, Jiangxi Province	Forest cover reaches 77.7%, national key scenic spot.	Shift from the forest resources consumption model for surviving, towards a forestry development road led by forest tourism, bamboo shoots, economic fruits, flower and seedlings, forest tourism products, etc.
Jingan County, Jiangxi Province	Collective forest area, with the forest cover of 84.1%.	Income source mainly depends on mountain area resources, especially tourism resources, the biggest advantage of ecological resource is forest resources.

forest tending subsidy pilots have been developed from eleven provinces to the whole country. Meanwhile, China issued industry standard of *Guidelines on Forest Management Certification and Verification*, and launched forest certification capacity building pilot work in eighteen provinces, which laid the fundamental basis for establishing and improving forest certification system in China.

In October 2010, SFA issues *Guidance on Accelerating Forest Certification by State Forestry Administration*, which further defines direction, working principles and major tasks of forest certification in China, and conducted forest certification verification pilot work, thus provided a practice platform for fully checking forest certification criteria in China.

In 2011, SFA selected 200 forest management units as pilot sites for drafting and implementing forest management plan according to the practical needs on China's forest by social and economic development, and ecological environment development and conservation, integrating with distribution and structure of forest resources and realistic foundation of SFM in China. Meanwhile, SFA fully promoted mutual recognition with The Pan-Euro Forest Certification Council (PEFC), which will strongly promote mechanism development of SFM in China.

In 2012, SFA selected 15 sample bases of forest management in China and 12 demonstration bases for implementing NLBI on the basis of various forest management pilot demonstrations, which will further promote construction and development of policies, management and technical system of forest management with China's features, build a responsibility for better implementing international conventions associated with forest issues, and accumulate valuable experiences for international SFM.

In 2012, the report of 18th National Congress of the Communist Party of China stated that forestry is an important supportive sector for conservation the cultural development. The report indicated to realize sustainable forestry development is an objective requirement for developing ecological civilization and promoting the harmony between humans and nature, which fully demonstrated China's important understanding and strong determination for promoting SFM.

National Report
on Sustainable Forest Management

2

Conservation of
Biological Diversity

Biological diversity, which includes the diversities within species, among species and that of ecosystem (Convention on Biological Diversity), means the variability of live living organisms from all kinds of sources, which include land, ocean and other aquatic ecosystem, as well as the ecology synthesis composed by them. As the biology basis of sustaining ecosystem function and material basis of ensuring the anti-interference capability, self-repairing capacity and environment adaptive capacity of ecosystem, biodiversity maintains the running of ecosystem on complex spatial and temporal scale. Forest biodiversity is the main content of this part. Forest, especially nature forest, is the significant carrier of tellurian diversity and the habitat of land species. To protect the biodiversity and the habitat of creatures is important to maintain the stability of forest ecosystem, assure forest function and sustain forest productivity. Conservation of biodiversity is the essential part of forest ecosystem management.

With the transformation from traditional forestry led by "sustained forest harvest" to sustainable forestry focusing on "sustainable forest management", forest classification management system is built in China to vigorously promote forest ecosystem management. As the important content of forest sustainable management, conservation of biological diversity is one of the key strategic mission to modern forestry construction.

2.1 Ecosystem diversity

Forest ecosystem refers to an integration of forest organisms and their environment within certain space and time period, which is the largest ecosystem with the most contribution to the biodiversity among all kinds of terrestrial ecosystems. It is so called the resource bank of biological diversity. The complex natural geography environment in China generates diversified forest ecosystems including taiga, temperate mixed broadleaf-conifer forest, warm-temperate broadleaved deciduous forest, subtropical evergreen broadleaf forest, tropical monsoon forest and tropical rainforest. China is one of the countries with the most diversified forest ecosystems in the world. Strengthening cultivation, protection and management of forests, increasing forest areas, and improving forest quality with expansion of habitat areas are all important for the biodiversity not only within nature reserves but also worldwide. Furthermore, it also plays a key role in the maintenance of ecological balance.

2.1.1 Area and percent of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure

Rational and significance

The forest type, age-class structure and succession stage respectively reflect the difference degree between the composition of forest ecosystem, age distribution and zonal primeval climax forest type. The changes of area and proportion are the embodiment of the quality, function, operation state and succession process, which determine the stability and sustainability of forest ecosystem. The forests with different ownerships have been operated and managed with different methods, and also have certain different impacts on biodiversity.

Sources of data

National forest inventories[5]

[5] *National forest inventories were conducted: 1st (1973-1976); 2nd (1977-1981); 3rd (1984-1988); 4th (1989-1993); 5th (1994-1998); 6th (1999-2003); 7th (2004-2008). Hong Kong, Macao and Taiwan were not included in national Forest inventories.*

Table 2-1. Areas and proportions of arbor forests in China by types of forest vegetation Unit: 10,000 ha, %

Statistical Unit	Origin	Arbor forests	Coniferous forests		Broad-leaved forests		Coniferous and broad-leaved mixed forests	
		Area	Area	Proportion	Area	Proportion	Area	Proportion
State	Total	15558.99	6302.29	40.51	8327.84	53.52	928.86	5.97
	Natural forests	11559.12	3988.19	34.50	6837.77	59.16	733.16	6.34
	Plantation	3999.87	2314.10	57.86	1490.07	37.25	195.70	4.89

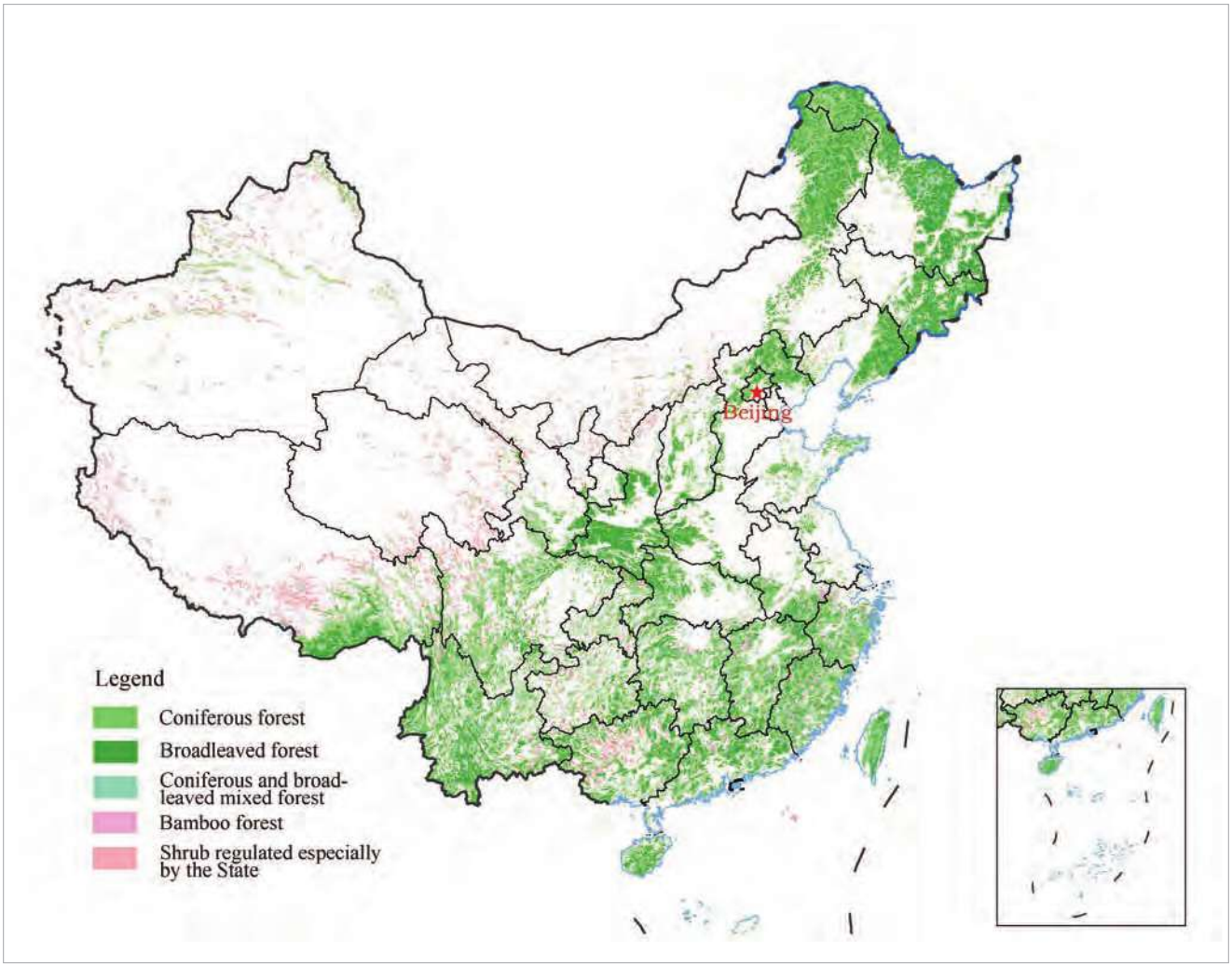


Figure 2-1. Distribution of coniferous forests, broad-leaved forests, and coniferous and broad-leaved mixed forests

The analysis of current situation and tendency

The information on forest ecosystem succession is missing in the Forest inventories in China. Nevertheless, the forest succession phase in China can be reflected and analyzed through the effects of human disturbance on forests with naturalness survey data in the 7th Forest Resource Inventory.

(1) Areas and percent of arbor forests by type of forest vegetation

According to composition of species, arbor forests can be categorized into coniferous forests, broad-leaved forests and coniferous and broad-leaved mixed forests (Figure 2-1). The total area of arbor forests reached 155.59 million ha in China, among which coniferous forests

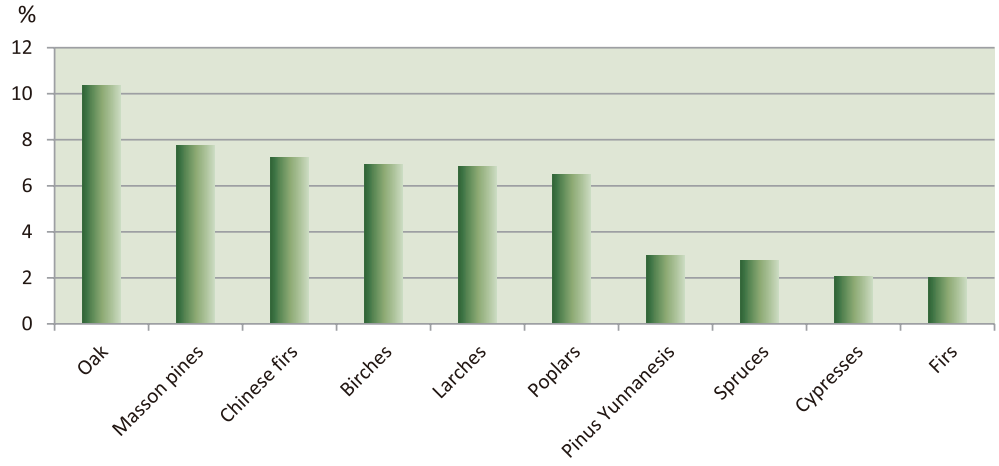
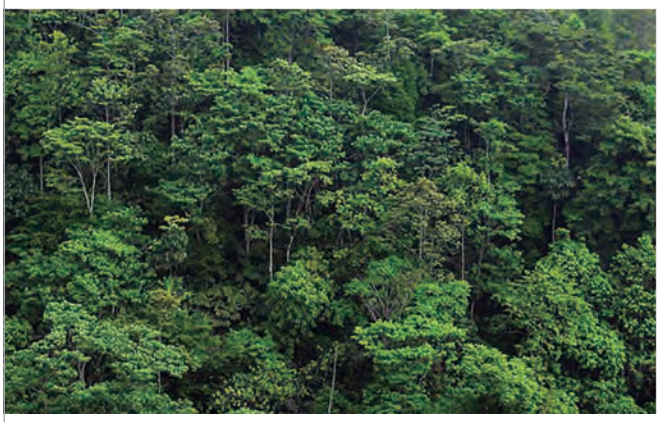


Figure 2-2. Area proportion of major dominant tree species (groups) in arbor forests

Subtropical evergreen broad-leaved forests

Bamboo forests



Tropical monsoon forests

Temperate coniferous forests

accounting for 40.51% (63.02 million ha), broad-leaved forests accounting for 53.52% (83.28 million ha), and coniferous and broad-leaved mixed forests accounting for 5.97% (9.29 million ha). On the basis of origins (Table 2-1), broad-leaved forests cover a relatively large area in natural forests with the ratio of 59.15%, while coniferous forests is more dominant in plantations by 57.85%. According to dominant tree species (groups) (Figure 2-2), there are ten tree species (groups), such as oaks, masson pines (*Pinus massoniana*), Chinese firs,

birches, larches, poplars (*Populus*), *Pinus yunnanensis*, spruces, cypresses and firs, totally cover 86.21 million ha of area, which present for 55.40% of total arbor forests nationwide.

All 12 provinces (autonomous regions, and municipalities; herein after referred to as "provinces") including Heilongjiang, Inner Mongolia, Yunnan, Sichuan, Tibet, Guangxi, Jiangxi, Jilin, Hunan, Guangdong, Fujian and Shaanxi and so on, have a relatively large area of arbor forest, accounting for 67.52% of the total.

According to the origins, natural forests are mainly distributed in 8 provinces, such as Jilin and Heilongjiang in northeast China, Sichuan, Yunnan and Tibet in southwest China, and Jiangxi and Guangxi, summing up the total coverage to 67.20% nationwide; while the plantations are mainly distributed in other 8 provinces, including Guangdong, Hunan, Fujian and Jiangxi in mid and east China, and Guangxi, Sichuan, Inner Mongolia and Heilongjiang, accounting for 54.56% of the total nationwide. According to types of forest vegetation, the provinces like Sichuan, Yunnan, Jiangxi, Hunan, Tibet, Inner Mongolia, Heilongjiang and Guangxi have a relatively large area of coniferous forests, accounting for 64.80% of the total; while other provinces like Heilongjiang, Inner Mongolia, Yunnan, Jilin, Guangxi, Shanxi, Guangdong and Sichuan have a relatively large area of broad-leaved forests, accounting for 59.02% of the total; in particular, Heilongjiang and Yunnan have a relatively large area of coniferous and broad-leaved mixed forests with more than 100,000 ha of areas.

Among the top ten dominant tree species (groups) with the largest coverage (Figure 2-3), oaks and poplars are both distributed in all provinces; masson pines are mainly distributed in Jiangxi, Guangxi, Hunan, Hubei,

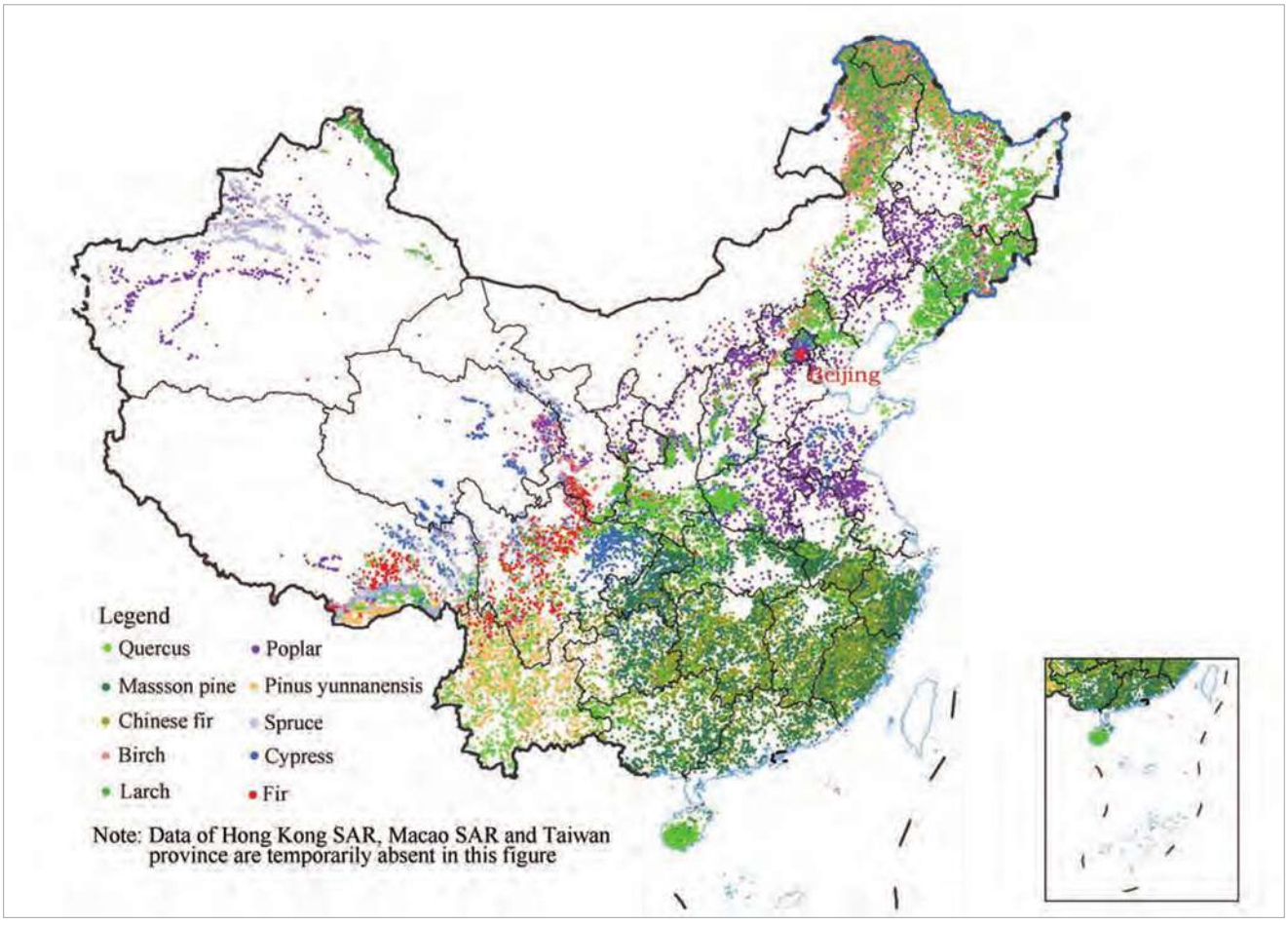


Figure 2-3. Distribution of top 10 dominant tree species (groups) with the largest coverage (from the 7th NFI)

Zhejiang and Fujian; Chinese firs, Hunan, Jiangxi, Fujian, Guangxi and Zhejiang; and birches and larches are concentrated in Heilongjiang, Jilin, Liaoning, and eastern Inner Mongolia.

The tendency of area and proportion changes of various forest vegetation types are shown below (Figure 2-4). From the 1970s to the mid-1990s, with the initiation of some key projects such as "Three-North" Shelterbelt project, the activities of afforestation to reduce wasteland and green campaigns to reach the relevant standards were conducted in collective forest regions in south China. Meanwhile, forest logging quota system was implemented nationwide to enhance the forest resource management, which induced the continuous sustained growth of forest area. As a result, area of both coniferous forest and broad leaved forest have been increased. At the end of the 1990s, with the development of ecological construction, silviculture and regeneration, emphasise was put on mixing the tree species of broad-leaved and conifer ous forest, multi-tree-species, multi-level, different-age and the structure of reasonable-density stand, and improving the stability of the forest ecosystem. Thus, the areas and proportions of broad leaved forest and mixed broadleaf-conifer forest have been increased significantly. The areas of broad leaved forest and mixed broadleaf-conifer forest expanded respectively by 19.90 million ha and 6.93 million ha, and their percentage are increased respectively by 5.65 per cent and 4.19 per cent. The ratio of conifer forest, broad leaved forest and mixed broadleaf-conifer forest changed from 50:48:2 into 40:54:6. The central and eastern provinces are comparatively developed areas in China but having more severe problems such as water erosion and forest insect pests than other regions. Implementing operation measures such as "reserve broad leaved forest and supplement broad leaved forest", "reserve broad leaved forest and supplement conifer forest", "supplement planting", and "plant trees under crown canopy" can raise the ratio of mixed broadleaf-conifer forest area, as well as enhance the ability of forest disaster resistance and alleviation. The percent of mixed broadleaf-conifer forest area especially in Zhejiang, Fujian, Jiangxi and Hunan has been increased by over 9 per cent. China's forests are shifting from simple-structure, unstable coenotype to complicated-structure and high-stability coenotype.

(2) Area and percent of arbor forests by degree of naturalness

According to the differences between actual forest type and zonal primeval climax forest type or secondary forest type in the succession phase, the naturalness of arbor forests can be divided into five grades (Table 2-2).

In the area of arbor forest in China (Figure 2-5), the grade of naturalness I occupies 5.01% with less human disturbance at the state of primeval or near primeval and mainly distributed in Sichuan, Tibet, Yunnan in the southwest region, Xinjiang and Gansu in the northwest region, and part of Heilongjiang and east

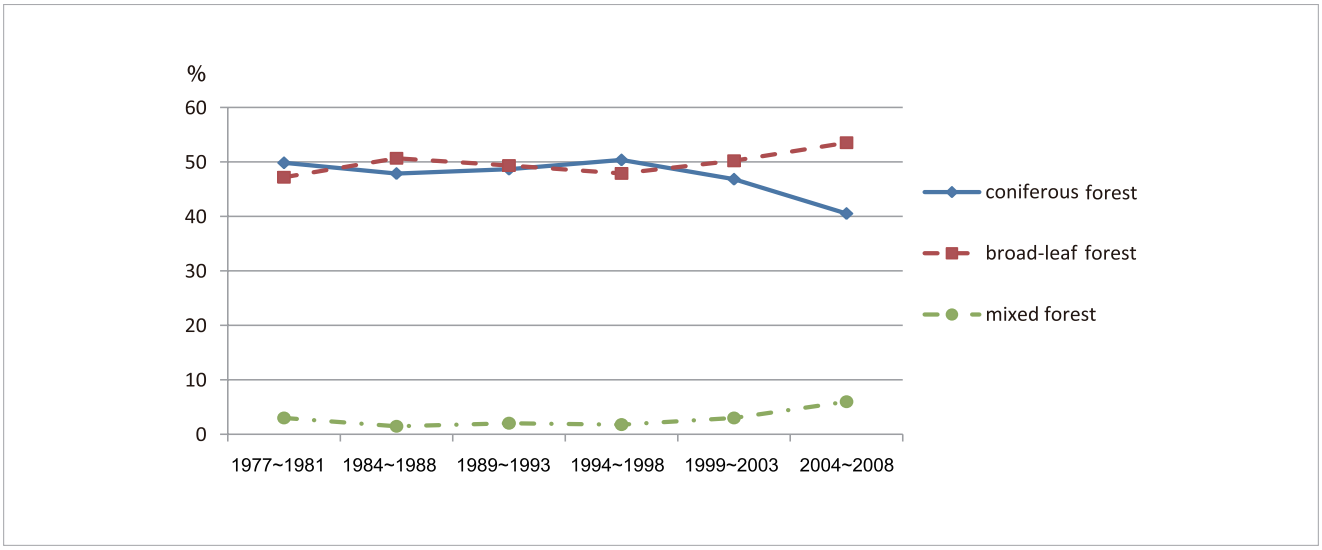


Figure 2-4. Change of area proportion of all types of forest vegetation since the late 1970s

Table 2-2. Naturalness Grading Standard

Naturalness degree	Grading Standard
I	Primary forest type or near Primary forest type which has the least human interventions
II	Natural forest type is obviously disturbed by human interventions or secondary forest type at the late phase of succession. The majority species are the ones with high adaptive value of zonal, climax, among which the climax tree species can be seen obviously.
III	Secondary forest type is at late phase of secondary succession, and secondary forest type involves more human interventions. Except the pioneer tree species, some climax tree species can be seen as well.
IV	Extremely bad secondary forest stages with large human interventions and reversed succession.
V	Forest types with serious and sustained human interventions; the zonal forest types are nearly destroyed; and at the late phase of unrecovered retrograde phase of succession, where various plantation types are included

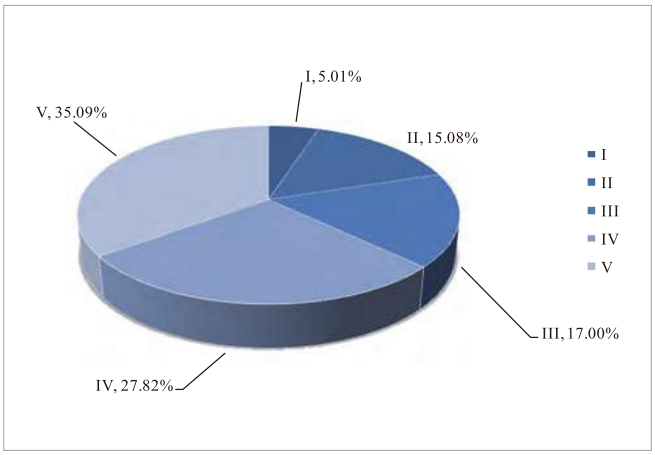


Figure 2-5. Percent of arbor forests area by naturalness degrees

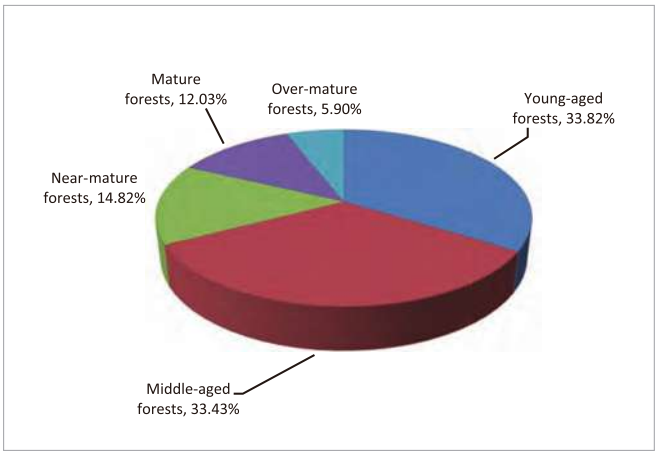


Figure 2-6. Percent of arbor forests area by age classes

of Inner Mongolia. The grade of naturalness II means that the natural forest is obviously disturbed by human interventions or secondary forest at the late succession phase, which occupies 15.08% and mainly distributed in Heilongjiang, Jilin, Liaoning, Inner Mongolia in the northeast region, Tibet and Sichuan in the southwest region, and Shanxi and Fujian. The area, which is seriously disturbed by human interventions at the secondary state or planted forest type, occupies 79.91% of the total. A small proportion of arbor forests are at primary or near-primary states, covering less than 8 million ha, and most arbor forests are at the secondary succession stage.

(3) Area and percent of arbor forests by different age classes

According to different properties of tree species, in terms of biological characteristics, growth processes, management and utilization, arbor forests can be categorized into young-aged forests, middle-aged forests, near-mature forests and over-mature forests. In China's total area of arbor forests (Figure 2-6), young-aged forests cover 52.62 million ha, accounting for 33.82%; middle-aged forests cover 52.01 million ha, accounting for 33.43%; near-mature forests cover 23.05 million ha, accounting for 14.82%; mature forests cover 18.71 million ha, accounting for 12.03%; and over-mature forests cover 9.19 million ha, accounting for 5.90%. 67.25% of China's arbor forests are young and middle-aged forests, most of which are at a fast-growing period with large increase potential of forest resources.

Near-mature, mature and over-mature forests are mainly distributed in Tibet, Sichuan and Yunnan in southwest China, Heilongjiang and Jilin in northeast China, and east Inner Mongolia, covering 67.02% of China's total area of over-mature forests. Western provinces such as Tibet, Xinjiang, Sichuan, Qinghai, Shaanxi and Gansu, and Jilin have a relatively large area of near-mature, mature and over-mature forests, accounting for over 40% of the total. Among it, Tibet and Xinjiang account for 82.22% and 70.75% respectively; central and eastern provinces have generally large area proportions of young-aged forests, among which, the area of young-aged forests in Beijing, Tianjin, Hebei, Shanghai,

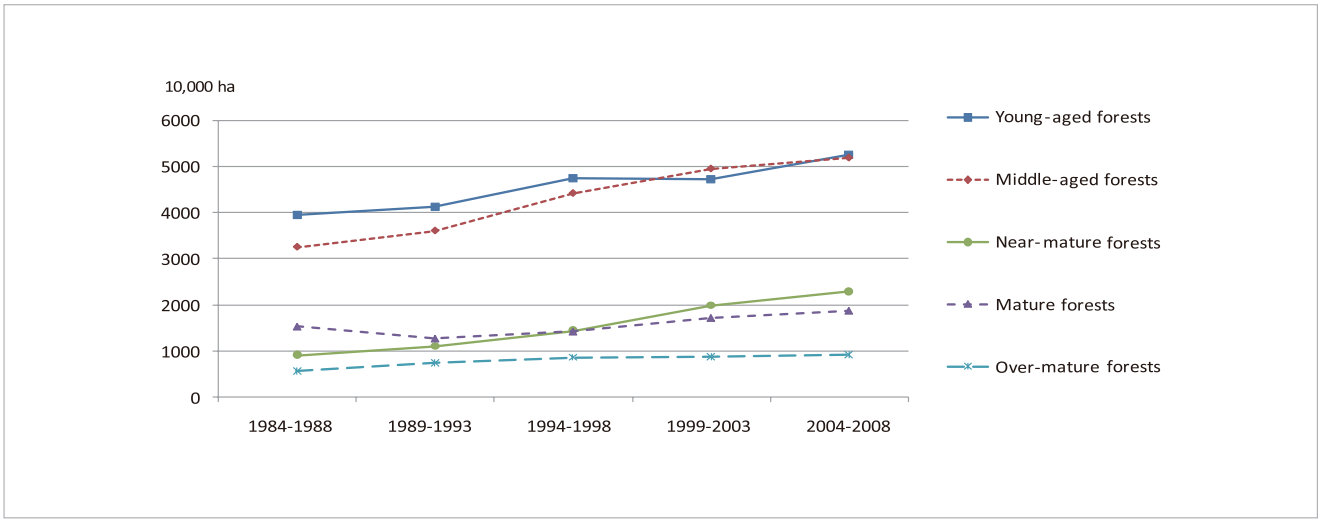


Figure 2-7. Area change of arbor forests by age classes

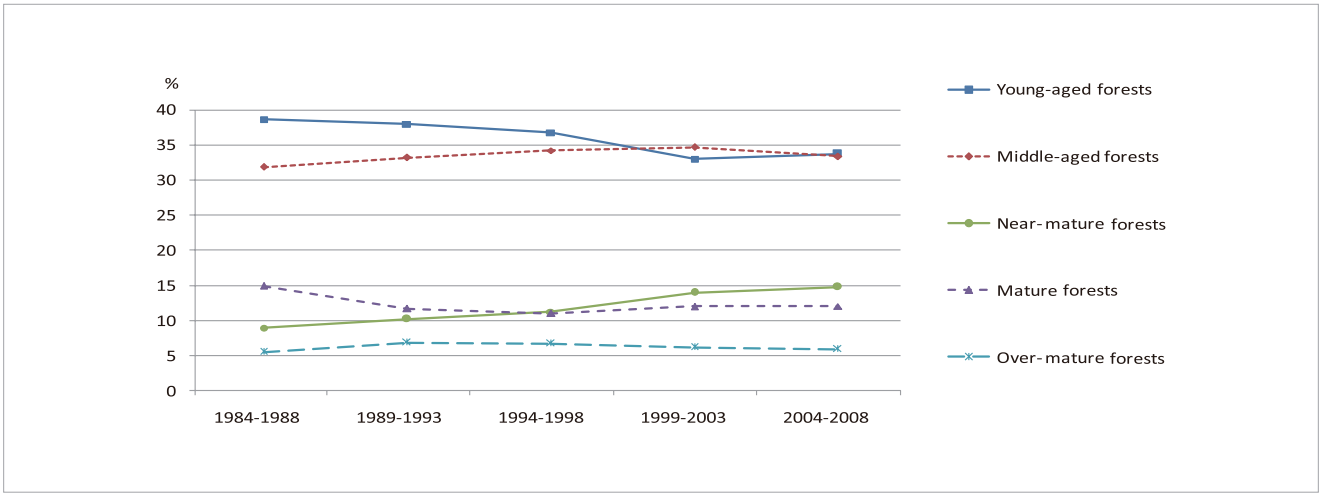


Figure 2-8. Area proportion change of arbor forests by age classes

Shandong, Henan and Hubei account for more than 60% of their total coverage respectively.

(Note: During 1st and 2nd NFI, forests were categorized into young-aged forests, middle-aged forests and mature forests; since 3rd NFI, forests had been categorized into young-aged forests, middle-aged forests, near-mature forests, mature forests and over-mature forests.)

In terms of arbor forest area changing and percentage of different age classes (Figure 2-7 and Figure 2-8), the area of young-aged forests has been growing constantly with the drive of large-scale afforestation since the 1980s; the declining area of mature forests was reversed in the mid-1990s; and the area of near-mature forests increased by 152.77%, which rise by 6 per cent in total arbor forest area in China. Moreover, the stands of plantation gradually become mature after the P. R. China founded.

(4) Area and percent of forested land by ownership

The forest resources ownership includes land ownership and forest ownership, among which land ownership is categorized into state-owned ownership and collective ownership. Mean while forest ownership is categorized into state-owned, collective and individual (including individual and others) ownership. According to the composition of China's forest area, the forest land (including arbor forest, economic forest and bamboo forest) has land ownership and forest ownership.

Case: The growth of forest resources in Lin'an is increasing steadily

Lin'an is located at the western suburb of Hangzhou, which is the source of Taihu Lake and Qiantang River. The area of Lin'an is 3126.8 km^2 and has a population of 530,000. In terms of the development characteristics, Lin'an is a typical representative of southern collective forests. The forest land area of Lin'an is 260,000 ha (the collective forest land area occupies 95% of the total forest area), the forest stock volume is 10.20 million m^3, and the forest cover 76.55% of total land area. Lin'an has two state-level nature reserves -Tianmu Mountain and Qingliang Peak, which is called "Hometown of Bamboo" and "Hickory Capital" in China.

Compared the status of resources in Lin'an in 2005 with that in 2010, Lin'an has established ecological public-welfare forest which take natural forest as the major part of 86,000 m^3; the forest coverage rate has improved by 1.62 per cent, the forest stock volume keeps increasing, and the stumpage has reached to 10.29 million m^3 with the average annual increase of 389,000 m^3; growing stock has reached to 10.2 million m^3, with the average annual increase of 395,000 m^3; the quality of the forest is going to be improved. Every ha growing stock of arbor forest increase by 11 m^3, from 45 m^3 to 60 m^3; the forest structure tends to be rationalization, and the proportion of broad leaved forest and mixed broadleaf-conifer forest with strong ecological function has increased from 39% to 57%.

Case: The structure of forest resources in Yong'an changes sharply

Yong'an city is one of the important forests districts in Fujian Province, which has a famous name of "90% for mountains, 5% for water, 5% for farmland", and it is a typical southern mountain area with 79.50% forest coverage rate. Among the current forest land, the collective forest land area is 2.65 million mu, occupying 69.30% of the total. The large area of collective forest determines that forestry is majority industry, which is a key resource to increase income for local farmers. From 2007 to 2011, with the improvement of forest management knowledge and intensity, the area changes of tree species present that the areas of fir, eucalyptus, soft broad-leaved forest and rare tree species show an uptrend in China, the total area rises from 24.90% to 27.80% with average annual increase of 0.60%. The areas of pine, hard broad-leaved forest, bamboo forest and economical fruit tree show a decline.

In recent years, the age-group structure of forest resources in Yong'an has been changed smoothly. Furthermore, with the deepening development of ecological construction in China, the forest age structure is revealed to turn into older phase. For example, the total proportion of young, middle-aged and near-mature forests was 51% in 2007, however, it was down to 46% in 2011, with the annual decrease of 1%; on the contrary, the proportion of mature and over-mature forests went up by 1% annually, from 49% to 54%, and is continued to increase.

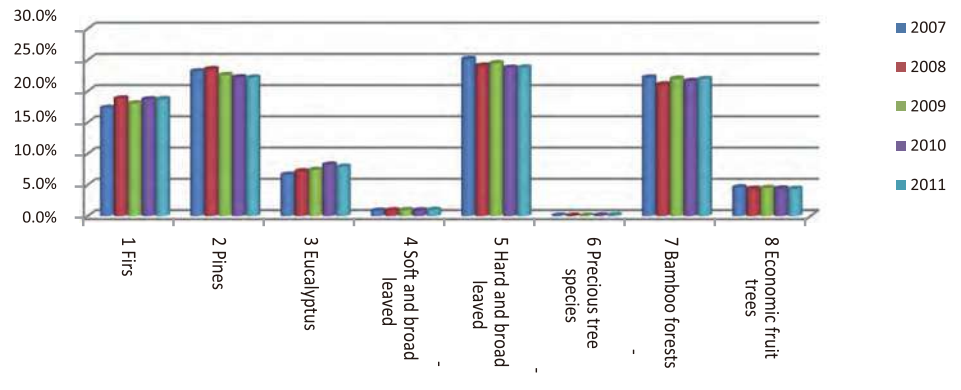


Table 2-3. Area and percent of forested land by forests ownership Unit: 10,000 ha, %

Categories	State-owned		Collectively-owned		Individual-owned	
	7th NFI	6th NFI	7th NFI	6th NFI	7th NFI	6th NFI
Forested land	7143.58	7016.39	5176.99	6389.39	5817.52	3496.15
%	39.38	41.51	28.54	37.8	32.08	20.69
Arbor forests	7018.52	6875.37	4820.15	5431.78	3720.32	1971.52
%	45.11	48.152	30.98	38.04	23.91	13.81
Economic forests	100.8	109.06	252.66	708.76	1687.54	1321.18
%	4.94	5.1	12.38	33.14	82.68	61.76
Bamboo forests	24.26	31.96	104.18	248.85	409.66	203.45
%	4.51	6.6	19.36	51.39	76.13	42.01
Natural forests	6269.39	6127.55	3535.25	4153.87	2164.61	1294.78
%	52.38	52.93	29.54	35.88	18.08	11.19
Plantations	874.19	888.84	1641.74	2235.52	3652.91	2201.37
%	14.17	16.69	26.62	41.98	59.21	41.33

If categorized by land ownership, the proportion of state-owned forest land and collective forest land is 4:6. State-owned forests are mainly distributed in Heilongjiang and Jilin in northeast China, east Inner Mongolia, Tibet, Sichuan and Yunnan in southwest China, and Shaanxi, Gansu and Xinjiang in northwest China. These regions are dominated by state-owned forests. On the other hand, collective forest lands are mainly distributed in Guangxi, Hunan, Jiangxi, Guizhou, Hubei, Zhejiang, Anhui, Fujian and Guangdong. Except Jiangxi, the percent of collective forest lands are relative high in these regions, where the area of collective-owned forest lands being more than 90% of the total provincial forest area.

The area proportion of state-owned arbor forest is larger (table 2-3), occupying 45.11% of the total arbor forest area in China; economical forest and bamboo forest are mainly operated by individuals, the respective percentage is 86.68% and 76.13%; in natural forest, the state-owned natural forest areas occupy 52.38%; while in plantation forest, the individual-owned plantation forest areas occupy 59.21% of the total planted forest areas.

As can be seen from Table 2-3, the area of collectively-owned forested land decreased by 9.26 per cent while individual-owned forested land increased by 11.39% by comparison of the results from two Forest inventories. The ratio of the area of state-owned, collectively-owned and individual-owned forested land was changed from 41:38:21 into 39:29:32. Furthermore, the area of individual-owned plantations increased by 18 per cent. The reform of collective forest rights system has induced the contracted management rights and the ownership of collectively-owned forest lands to the forest farmers. Thus, the collective forest could be managed in multiple ways. Moreover, the individual forest managers are becoming the dominant group, especially for whom of plantations.

2.1.2 Area and percent of forest in protected areas by forest ecosystem type, and by age class or successional stage

Rational and significance

Nature reserve is a certain area where determined by law to provide special protection and regulation for representative natural ecosystem, the natural concentrated area distribution with rare and endangered fauna and flora species, and the land, water inland or sea area where protect significant natural relic. Establishing nature reserve is a strategic implementing to protect typical forest ecosystem, wet land ecosystem and desert ecosystem, promote forest cover recovery, expand habitat area, save rare and endangered wildlife,

stabilize biodiversity and enhance ecological value. Analyzing and evaluating forest types, age class and succession state in the nature reserve objectively reflects the progress which country emphasize on the protection of typical ecosystem and forest cover. Moreover, it also promotes the publicity of biodiversity protective functions and effects, improves the public's recognition of importance for forest protection and impelled nature reserve construction in the future.

Sources of data

National forest inventories

Annual Report of Nature reserves Statistics in National Forestry Systems (2012)

The analysis of current situation and tendency

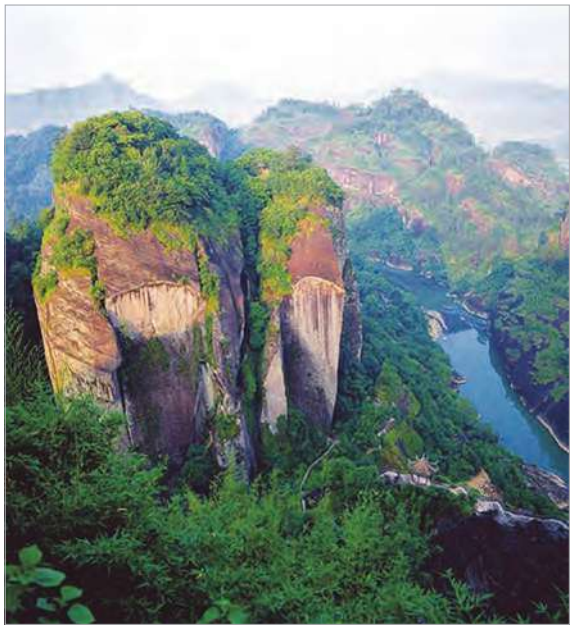
As the statistics shortage on forest area and proportion which categorized by forest ecosystem types, succession stages and age classes in conservation zones, the report uses the data from the 5th to the 7th national Forest inventories, and extracts the corresponding data from some sample areas in forestry natural reserves to carry out a statistical analysis from a macroscopic point of view.

(1) The construction of forestry natural reserves

In China, the construction of nature reserve was started from 1956. According to the instructions of the State Council, the State Forestry Administration promulgated the *Draft of Planning of National Natural Reserve Forests (Nature reserves)*, which initiated nature reserve in China. By 2012, 2150 forestry natural reserves in different types and grades has been established with total area of 124.87 million ha accounting for 13% nationwide.

There are 286 national-level nature reserves covering 77.13 million ha by levels of nature reserves, while the other 1864 local-level (provincial, municipal and county-level included) nature reserves is covering 47.74 million ha. If by types of nature reserves, there are 1336 conservation zones can be categorized into the type of forest ecosystems covering 33.45 million ha, which are distributed mainly in Guangdong, Jiangxi, Hunan, Anhui and Fujian in mid and east China, and Yunnan, Guizhou, Liaoning, east Inner Mongolia, etc., meanwhile, 369 conservation zones can be categorized to the type of wetland ecosystems covering 31.74 million ha, which mainly distributed in the regions with rich natural wetland resources such as Heilongjiang, Inner Mongolia, Sichuan, Guangdong and Jiangxi. The number of conservation zones categorized to the type of desert

Huanglong nature reserve, Sichuan



Wuyi Mountain national-level nature reserve, Fujian

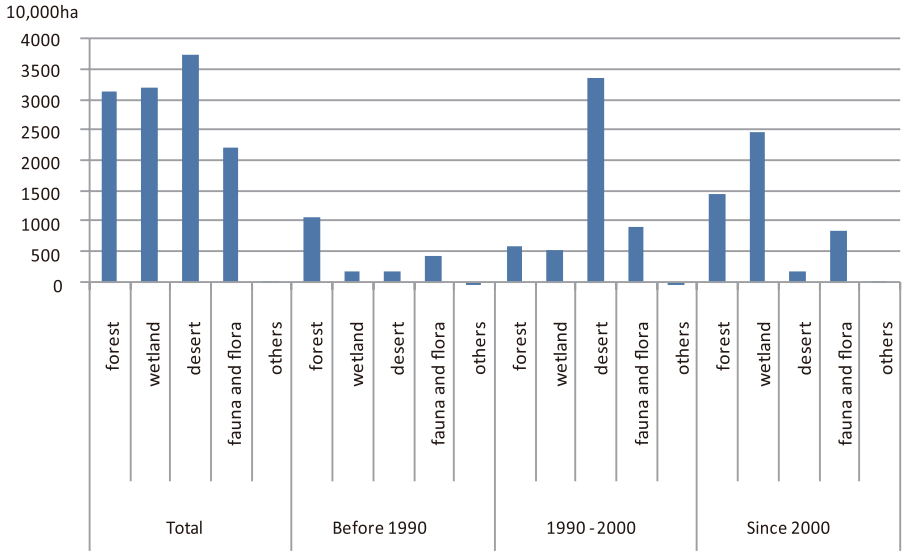


Figure 2-9. Area changes of forestry natural reserves

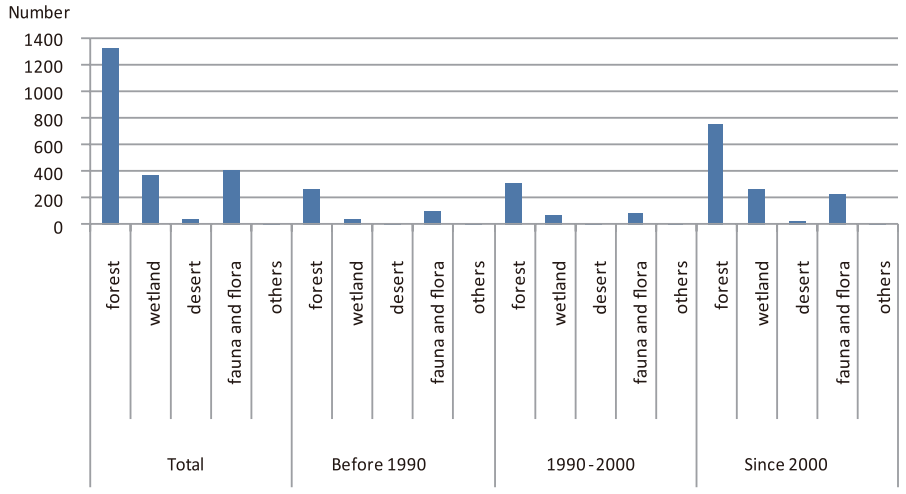


Figure 2-10. Number changes of forestry nature reserves

ecosystems is 33 which is covering 37.28 million ha and concentrated in west Inner Mongolia, middle and west Tibet and arid and semi-arid regions in northwest China. There are 287 conservation zones (wild animal types) and 116 nature reserves (plant types respectively), each is covering 20.76 million ha and 1.35 million ha and mainly distributed in the regions with rich biological diversity such as Sichuan, Heilongjiang, Tibet, Jiangxi, Shaanxi, Shanxi, Chongqing, Yunnan and Fujian. Furthermore, there are over 50,000 small conservation zones with various types which is covering more than 1.50 million ha in total.

The construction area and numbers of forestry natural reserves in different periods (Figure 2-9, Figure 2-10) are shown as above. The majority of desert ecosystem type

conature reserves were established in 1990; then since 2000, the construction of nature reserves with forest and wetland ecosystems types has been accelerated. As a result, the number with construction permit has exceeded the summation of all built before 2000. The total area of the forest ecosystem has grown as much as 1.56 times compared with the areas built before 1990 while 2.82 times of the period between 1990 and 2000 respectively. The area of wetland ecosystem has been built as 12.17 times as of that before 1990 while 4.68 times of that between 1990 and 2000 respectively. The network of forestry natural reserves in China has been preliminarily formed, which effectively protects 90% of terrestrial ecosystem types, 85% of wild animal communities and 65% of advanced plant communities.

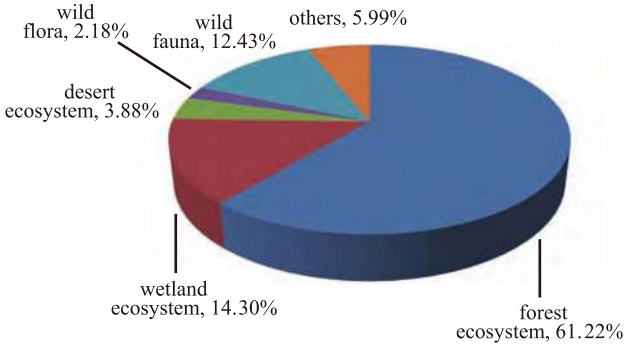


Figure 2-11. Area and proportion of forestry natural reserves by type

(2) Forest area and percent in forestry natural reserves

The forest area in forestry natural reserves is 14.37 million ha, accounting for 11.71% of the total area of nature reserves. Among that, the arbor forests cover 10.27 million ha, and bamboo forests 140.5 thousand ha. In terms of the types of nature reserves (Figure 2-11), the forest ecosystem conser nature reserves account for 61.22% of the total, while that of wildlife types present14.61%. If categorized by levels of nature reserves, those at national levels account for 51.75% while local levels presenting 48.25%.

With the constant development of wildlife protection and nature reserves construction, the area of forestry natural reserves has been expanded since the late 1990s, and more and more forests have been categorized into reserves. The reserved forest area has expanded from 5.99 million ha to 14.37 million ha (Figure 2-12).

(3) Area and percent of arbor forests within reserves by forest ecosystem

Coniferous forests account for 39.51% in the total arbor forest area within the forestry natural reserves, of which

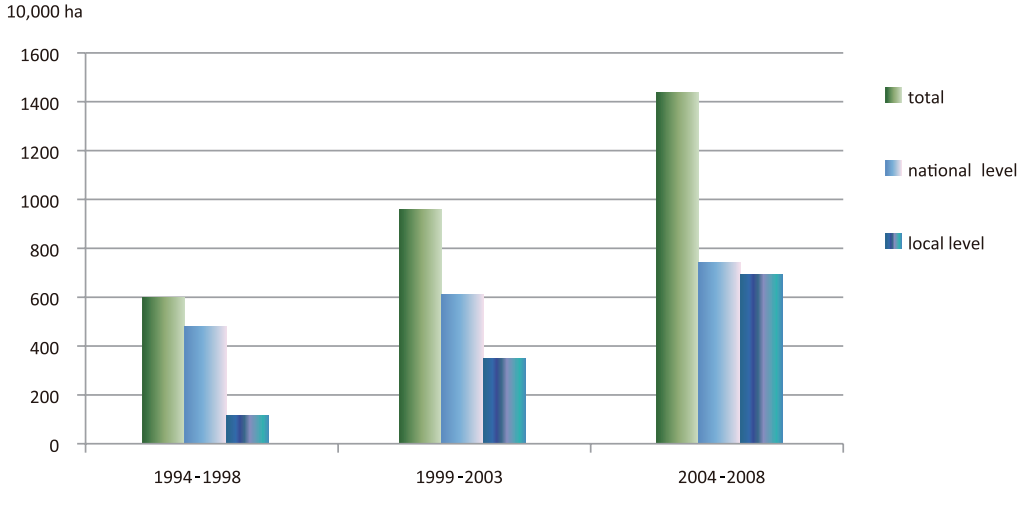


Figure 2-12. Changes of forest area in forestry natural reserves by levels

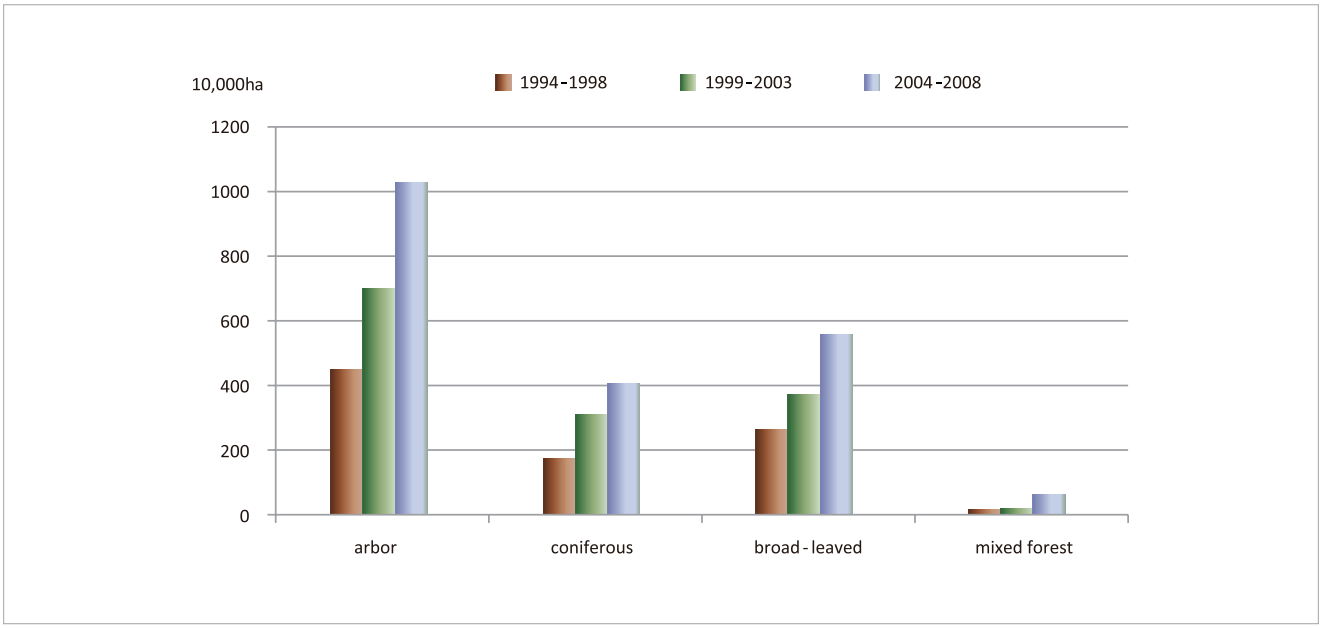


Figure 2-13. Area change of arbor forests in forest ecosystems reserves

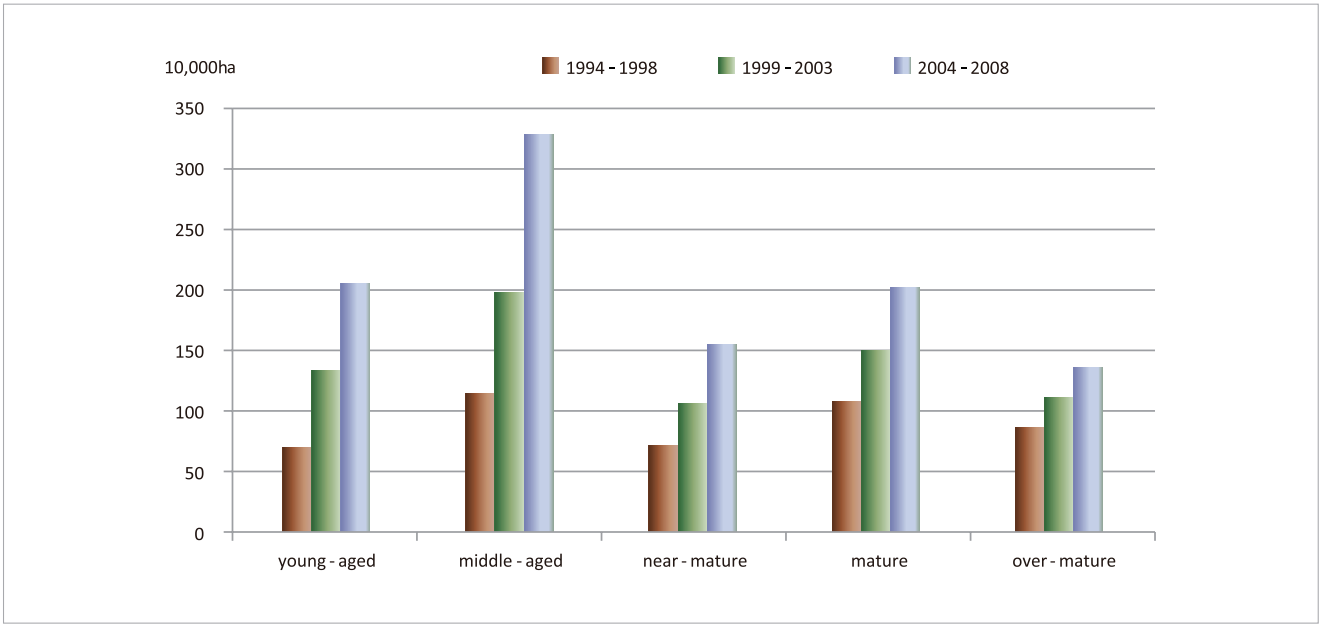


Figure 2-14. The arbor forest area changes in forestry nature reserves by age class

broad-leaved forests present 54.40%, and coniferous and broad-leaved mixed forests account for 6.09%. In national-level nature reserves, coniferous forests account for 36.03% while broad-leaved forests 56.54%, and coniferous and broad-leaved mixed forests 7.43%. In local-level nature reserves, these forests account for 42.89%, 52.23% and 4.78% respectively. In forest ecosystems, coniferous forests account for 41.42%, broad-leaved forests 53.47%, and coniferous and broad-leaved mixed forests 5.11%.

Comparing with the end of 1990s, all types of arbor forests areas, which are managed in nature reserves, have been increasing massively (Figure 2-13). The areas of coniferous forests, broad-leaved forests and coniferous and broad-leaved mixed forests increase by 1.34 times,

1.13 times and 3.26 times respectively. The area ratio of coniferous forests vs. broad-leaved forests vs. coniferous and broad-leaved mixed forests changes from 39:58:3 into 40:54:6 respectively. The growth margin of the mixed forest area is obviously larger than those of coniferous forests and of broad-leaved forests. More and more typical forests with complex structures and high stabilities have been effectively protected.

(4) The area and percent of arbor forests in reserve by age class

Within the total arbor forest area in forestry natural reserves in China, young-aged forests account for 20.00%, middle-aged forests 31.97%, near-mature forests 15.10%, mature forests 19.71%, and over-mature forests 13.22%. The total area of near-mature, mature and over-mature forests accounts for 47.53%. In national-level nature reserves, near-mature, mature and over-mature forests account for 55.15%, which is 14.01 per cent higher than those in local nature reserves.

Since the late 1990s, the area of arbor forests at all age classes in nature reserves has increased constantly (Figure 2-14), of which, the increase margins of young and middle-aged forests are larger than those of near-mature, mature and over-mature forests. The area ratio of all types of forests changed from 16:25:16:24:19 to 20:32:15:20:13. The buffer zones and experimental zones of young and middle-aged forests categorized into nature reserves become an ecological shelter in key zones. Furthermore, it is can also be utilized for scientific research and experimental observation, so that to support the exploration and exploitation of forest resources.

Case: Fenglin National-level Nature reserve, Heilongjiang Province

The Fenglin national-level nature reserve in Heilongjiang province is the only global forest-type biosphere reserve in north China. It is located at the north part of the south slope on the lever khingan Mountains in the north of Heilongjiang and belongs to the lever khingan Mountain sub-region of Changbai Mountain flora region. It is under the administration of Wuying District, Yichun City, Heilongjiang Province. Fenglin Reserve is 20 km long from east to west, and 16 km long from south to north.

The majority forest types in the nature reserve are Korean pine forests, spruce-fir forests and larch forests, among which, Korean pine forests have the largest proportion. Its stock volume accounts for 2/3 of the whole region. The representative rare and endangered plants include hericium erinaceus, subdivision of basidiomycotin, agaricomycetes, polyporales, hydnaceae (with fleshy fruit body, block structure, 5-10cm in diameter, narrow root, white, light brown after dried), except for the root, other parts are dense and fleshy with needle-like thorns; and amur corktree bark, the national 3rd grade protected plant, also called cortex phellodendri chinensis, rutaceae. The deciduous tree has thick bark, soft wood, and deep slit, which can be supplied as aero materials and for joiner timber and medicines.

The central area of the nature reserve is located in the east of Lowland River, west of 688 Dagang Watershed. The area is 4,165 ha with 1,082,990 m^3 forest stand volume, which is a well-preserved and representative primeval broad-leaved Korean pine forest ecosystem, and a concentrated area with the distribution of rare and endangered animals and plants. The buffer zone is located at the west of the core area with 3,812 ha and the forest stand volume is 1,108,540 m^3, where the primeval broad-leaved korean pine forest, coniferous mixed forest and spruce-fir forest dominants. The place only allows entering for the purpose of scientific research and observation activities. The experimental zone is located in the east of the core area with 10,188 ha and forest stand volume is 2,420,030 m^3. The type of forest include broad-leaved Korean pine forest, mixed broadleaf-conifer forest, coniferous mixed forest, spruce-fir forest, soft broad-leaved forest, aspen and birch forest, larch forest and oak forest. Moreover, natural landscape, cultural landscape and scientific facility are mainly set down here. Scientific researching, teaching and practice, scientific investigation, wild animal taming and breeding, business activities and forest tour are conducted in this area.

The establishment of the Fenglin National Nature Reserve plays an important role in protecting the special forest ecosystem type in Northeastern China, abundant biodiversity and the forest rare plants and animals dependent on the forest.

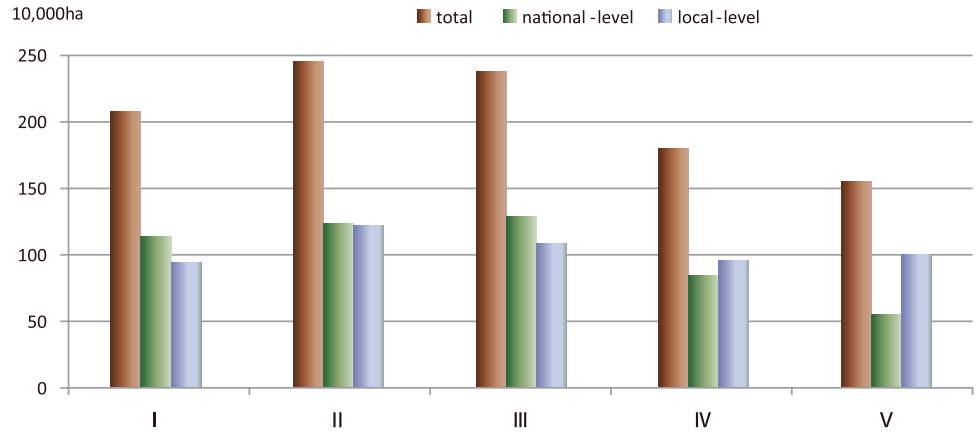


Figure 2-15. Area and proportion of arbor forests in forestry nature reserves by naturalness degree

Table 2-4. List of national key protected wild plants in nature reserves

No.	Families	Species	Latin names	I	II	Remarks
1	Taxaceae	Taxus chinensis var mairei	*Taxus wallichiana* var. *mairei (Lemee et Levl.) Cheng et L. K. Fu*	I		Rare
2	Ginkgoaceae	Gingko	*Ginkgo biloba* L.	I		Rare
3	Bretschneideraceae	Bretschneidera sinensis	*Bretschneidera sinensis* Hemsl.	I		A little
4	Cyatheaceae	Alsophila denticulata	*Gymnosphaera hancockii (Copel.)* Ching		II	Little
5	Cyatheaceae	Gymnosphaera metteniana	*Gymnosphaera metteniana* (Hance) Tagawa		II	Little
6	Taxaceae	Chinese torreya	*Torreya grandis* Fort. ex Lindl.		II	Rare
7	Taxaceae	Pseudotaxus chienii	*Pseudotaxus chienii* (Cheng) Cheng		II	Rare
8	Hamamelidaceae	Semiliquidambar cathayensis	*Semiliquidambar cathayensis* var. *fukienensis* Chang		II	Rare
9	Magnoliaceae	Chinese tulip tree	*Liriodendron chinense* (Hemsl.) Sarg.		II	Rare
10	Rubiaceae	Henry Emmenopterys	*Emmenopterys henryi* Oliv.		II	Rare
11	Pinaceae	Pseudotsuga gaussenii	*Pseudotsuga gaussenii* Flous		II	Rare
12	Lauraceae	Phoebe bournei	*Phoebe bournei* (Hemsl.) Yang		II	Rare
13	Lauraceae	Phoebe chekiangensis	*Phoebe chekiangensis* C. B. Shang		II	Rare
14	Lauraceae	Cinnamomum pedunculatum	*Cinnamomum japonicum* Sieb.		II	Rare
15	Cupressaceae	Fokienia hodginsii	*Fokienia hodginsii* (Dunn) Henry et Thomas		II	A little
16	Leguminosae	Ormosia hosiei	*Ormosia hosiei* Hemsl. et Wils.		II	A little
17	Meliaceae	Toona ciliata var. pubescens	*Toona ciliata* var. *pubescens* (Franch.) Hand.-Mazz.		II	A little
18	Polygonaceae	Wild Buckwheat Rhizome	*Fagopyrum cymosum* (Trev.) Meisn.		II	A little
19	Magnoliaceae	Magnolia officinalis	*Magnolia officinalis* ssp. *biloba* Cheng et Law.		II	A little
20	Myssaceae	Camptothecin	*Camptotheca acuminata* Decne.		II	A little
21	Leguminosae	Ormosia henryi	*Ormosia henryi* Prain		II	Much
22	Sapindaceae	Eurycorymbus cavaleriei	*Eurycorymbus cavaleriei* (Levl.) Rehd. Et Hand.-Mazz		II	Much
23	Hydrangeaceae	Platycrater arguta	*Platycrater arguta* Sieb. et Zucc.		II	Much
24	Ulmaceae	Waterelm	*Zelkova schneideriana* Hand.-Mazz.		II	Much
25	Dicksoniaceae	Cibotium barometz	*Cibotium barometz* (L.) J. Sm.		II	Common
26	Leguminosae	Glycine soja	*Glycine soja Sieb*. et Zucc.		II	Common
27	Lauraceae	Camphor tree	*Cinnamomum camphora* (L.) Presl.		II	Common
28	Nelumbonaceae	Lotus	*Nelumbo nucifera* Gaertn.		II	A little
Total				3	25	

(5) The area and percent of arbor forests in nature reserves by naturalness degree

Among the area of arbor forests within the forestry natural reserves in China, the naturalness degree I forests account for 20.24%, degree II 23.89%, degree III 23.18%, degree IV 17.55%, and degree V 15.14%. In the national-level nature reserves, degree I forests present 22.50% of the total, which is 4.45% larger than that in local-level nature reserves. The naturalness degree I forest areas occupy 26.66% of nationwide arbor forests which is in primary and near-primary conditions. The naturalness degree I arbor forest in the nature reserves are mainly distributed in east Inner Mongolia, Heilongjiang and Jilin in northeast China, and Tibet, Yunan and Sichuan in southwest China (Table 2-4).

2.1.3 Forests fragmentation

Rational and significance

Forest fragmentation refers to a process in which a landscape is changing from a simple to a complex form due to human or natural disturbances. The landscape is changed from a simple, homogeneous and continuous integrity to a complicated, heterogeneous and intermittent plaque mosaics, as a result the features of forest ecosystem and species habitat environment have been altered narrowing down the living space of organism, and aggravating the invasion of alien species. Thus, the number and variety of species decrease which causes the decline of biodiversity and gene bank loss. The analysis on Forest fragmentation situation by relevant monitoring results with practical cases is helpful to reveal the forward-direction (anabatic) or backward (alleviative) evolution progress of forest fragmentation situation in certain area. Moreover, it also reflects the important role of enhancing the competency of ecosystem self-regulation through strengthening forest cultivation management and expanding forest cover in protecting ecological corridor, preventing habitat degradation.

Sources of data

7th National forest inventory

Ecology and Environment Supervision Communique of Three Gorges Project (2011)

The analysis of current situation and tendency

(1) Grade distribution of national forest vegetation categorized by the area

According to the continuous distribution of forests, there are 7 grades are categorized, i.e. below 1 ha, 1-5 ha, 5-10 ha, 10-20 ha, 20-50 ha, 50-100 ha and >100 ha. A continuous forest distribution of over 100 ha accounts for 40.89% of the national forests (Figure 2-16), the area between 10 and 100 ha accounts for 28.84%, and that below 10 ha totals 30.27%.

In the areas like Heilongjiang, Jilin, Tibet, Yunan, Gansu, and east Inner Mongolia, forests are distributed in a large scale, and the proportion of continuous distribution (>100 ha) exceeds 50%. In some of 18 provinces like Jiangxi, Fujian and Guangdong, the proportion of continuous distribution (>10 ha) exceeds 50%. In the areas like Shanghai, Jiangsu, Anhui and Shandong, the percent of continuous distribution (<10 ha) exceeds 50%.

(2) National forest fragmentation situation at county-level

Thanks to GIS technology, the forest area proportion can be calculated in every grid unit which is defined as 100 ha (1km*1km) with overlaying the forest distribution map. The forest fragmentation situation at

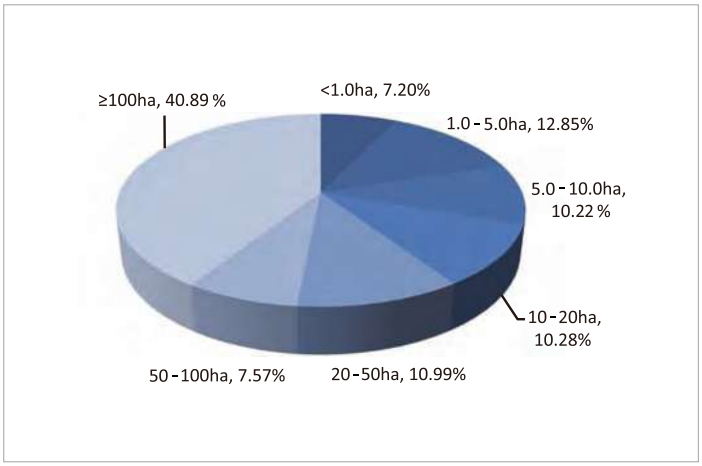


Figure 2-16. Area proportion of forests by continuous distribution area

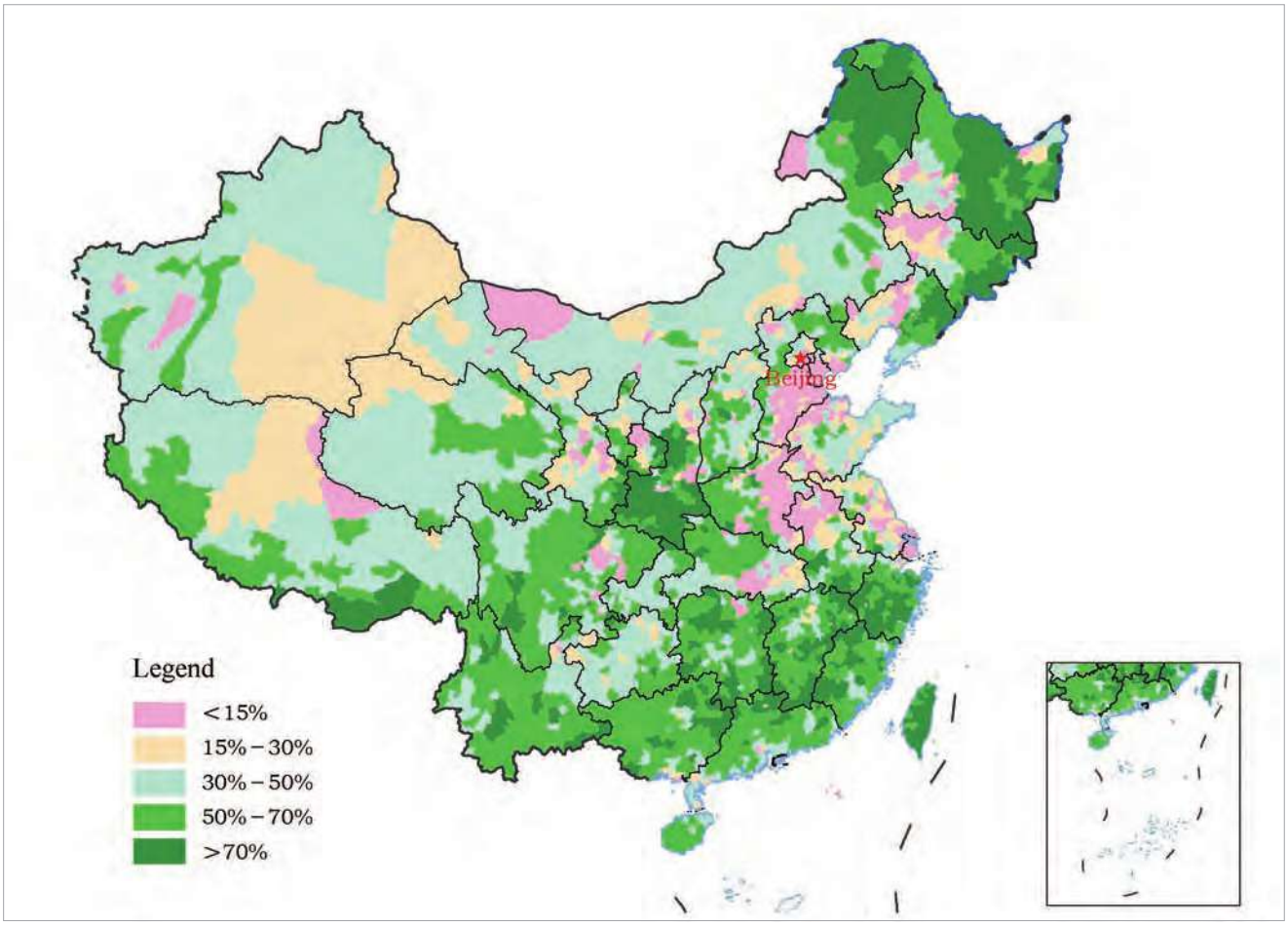


Figure 2-17. Ratio of grid units with forest area proportion larger than 90% at county-level

county-level can be illustrated by taking the county-level administrative region as the unit in order to analyze the proportion of the forest area with one unit over the 90% of the grid cell.(Figure 2-17). 11.52% of counties have over 70% of grid units with a forest area percent higher than 90%, concentrating in Heilongjiang, east Jilin, Liaoning and Inner Mongolia; while in areas like Zhejiang, Fujian, Jiangxi, Hunan, north Guangdong and Guangxi, east Tibet, south Shaanxi, where the degree of forest fragmentation is rather low. In farmlands and desertification areas in the middle and west of northeast China, the plain farmlands in the mid and east China, and desertification counties in northwest China, landscapes have displayed as forest strips. In these areas, the proportion (<15%) of grid units with forest area proportion over 90% is rather low showing a high degree of forest fragmentation.

Case: Forest fragmentation in the Three Gorges Reservoir area is reverted

The Three Gorges Area is located at the joint part of the Sichuan Basin and the Middle-Lower Yangtze Plain, which cross mountain area and canyon in the central of Hubei province and ridge-and-valley zone of eastern part of Sichuan province, next to the Daba Mountain in the north and the Sichuan-Hubei Plateau in the south. The

area which inundated by Three Gorges Project and 20 counties (cities) with migration task involves 27 counties (districts, cities) in total, with total area 5.77 million ha. It is one of the four largest steep cultivated slope lands in the Yangtze River Basin and belongs to high-level sediment transport region, which is national major area for soil and water control. Since the 1990s, while constructing the Three Gorges Project, the state government implemented important ecological projects such as the Yangtze River Basin Shelterbelt Project, Natural Forest Resource Protection Project, and Grain for Green Project, Three Gorges Green Belt Project and Yangtze River Forest Project. Governments also build forest for conservation of water supply and forest for water and soil conservation, so that ecological security assurance in Three Gorges area is established, to achieve the purpose of impoundment and soil reinforcement in order to prevent geological disasters such as collapse, landslide and debris flow. In 2010, the forest area of the Three Gorges is 2.51 million ha and the forest cover greath rate is 43.50%. By considering remote-sensing analyses since 1990, the result present that the growth rate of forest area during the two decades has exceeded 80% and the forest cover in the Three Gorges has expanded rapidly.

At the beginning of the 1990s (Figure 2-18), the forests of the Three Gorges are mainly distributed in the northern and southwest areas. The ratio which the proportion of forest area exceed 70% of the grid cells (1km×1km) number only have 29%, which dominated by strip forest and small scale forest and the level of forest fragmentation is high. early this century (Figure 2-19), forest area is expanded, The ratio which the proportion of forest area exceed 70% of the grid cells (1km×1km) number have reached to 35%, as the result the forest fragmentation has been relieved. In recent years (Figure 2-20), the coverage of forest area has an impressive increase and forest area illustrate an incessant distribution. The ratio which the proportion of forest area exceed 70% of the grid cells number rise by 15 per cent, to 44% comparing with, the early 1990s. The ecological security system of territory has been initially established with the majority part of forest vegetation combining grass in Three Gorges area, which plays an important role in geological disaster renovation, biodiversity protection, the water and soil conservation of mountain area in shore in and ecological restoration.

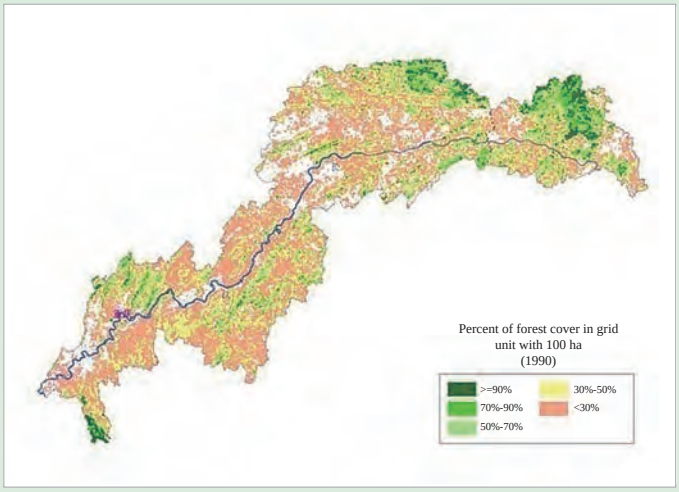


Figure 2-18. Forest area proportion of the Three Gorges reservoir area with 100 ha grid units in 1990

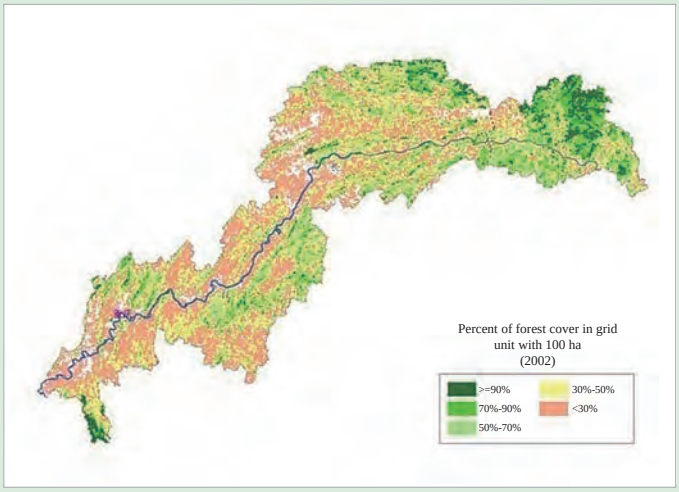


Figure 2-19. Forest area proportion of the Three Gorges reservoir area with 100 ha grid units in 2002

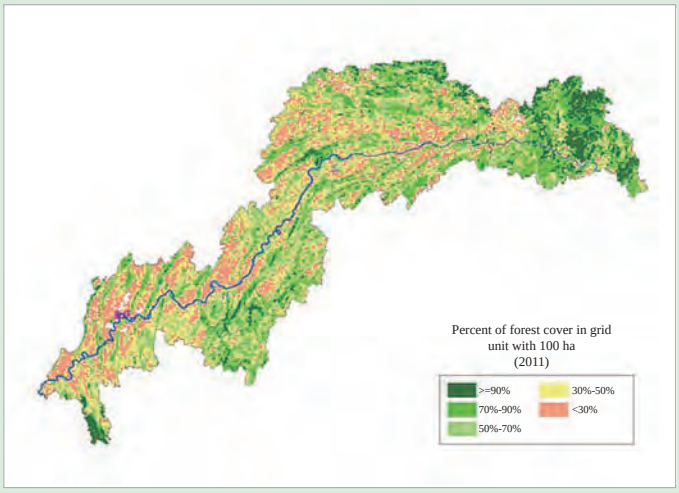


Figure 2-20. Forest area proportion of the Three Gorges reservoir area with 100 ha grid units in 2011

2.2 Species diversity

Species diversity refers to the richness level of species on the earth, such as animal, plant and microorganism, which is the most important and easiest indicator to be recognized. Biodiversity protects and relieves the population degradation, species depleted and extinction which caused by human disturbance. The alteration of species population level and distribution population, as well as the number of growth from invasive alien forest species, can indicate the change of ecosystem stability and the adaptation ability.

2.2.1 Number of native forest associated species

Native species refers to local species, which balances local natural condition specially the weather and soil condition. Moreover, species naturally possess the adaption ability for original local habitat. The native species play an important role in the vegetation reforming and biodiversity protection because of their strong ability of adaptation to and reforming of the local environment.

Rational and significance

This indicator can provide the stability and health information of forest ecosystem via analyzing the quantity of local forest species. The study of native species number could give prominent to the functions of some forest types, which are targeting in protection objective and understanding the relationships between the species within the ecosystem. The fluctuation of species number can provide valuable information for the health and productive status of the entire ecosystem.

Sources of data

China Vegetation

Records of China's Trees

China's Forests

The National Report of China's Biodiversity Status

The analysis of current situation and tendency

The origin of Chinese flora could cast back to ancient time, which has plentiful plant species and the great number of special species. China has over 34,000 advanced plant species, ranking the third in the world, next to Brazil and Columbia, and accounting for 10% of the plant species worldwide. There are angiosperm 243 families, 3,182 genus, and about 29,230 species, which account for 61% of the families, 31% of the genus and 12%of the species in the world. In addition, China has the richest gymnosperm worldwide with 12 families, 42 genus and 245 species, which respectively account for 80%of the families, 51.22% of the genus and 28.82% of the species in the existent gymnosperm all over the world.

Moreover, China is also one of the countries with abundant animal species. Nowadays, there are 6,588 species of vertebrate recorded in China, which is about 14% of the total species in the world. The species contained by 607 mammal species, 1,332 birds, 452 reptile, 335 amphibians and 3,862 fish species.

The majority mountainous region in Southern China, Central China and Southwest China haven't been influenced by Quaternary Glacier. As a result, many ancient relic species, which had been extinct for a long time in other regions of the Northern Hemisphere, such as *Metasequoia glyptostroboides* and *Cathaya*

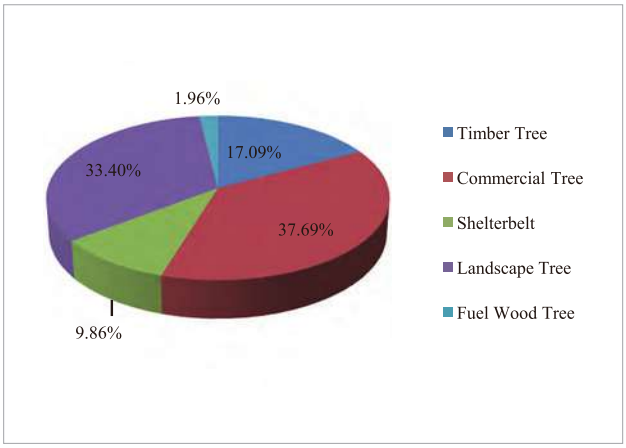


Figure 2-21. Area proportion by main tree type in China

argyrophylla are preserved. China has about 1,100 endemic tree species such as *Pseudolarix amabilis* and *Pseudotaxus chienii*. There are about 1,000 tree species with important economic value, among which more than 300 species are for afforestation. The tree species that has great impact on human's life can be divided into commercial tree species, economic tree species, protective tree species, landscape species and fuel wood tree species according to their main functions and utilization purposes (Figure 2-21).

2.2.2 Number and status of native forest associated species at risk, as determined by legislation or scientific assessment

Rational and significance

This indicator provides the volume and the information of protection condition of forest species, which are at risk or being degradation. The volume and condition of species at risk are indicators to measur the health status of forest ecosystem and protecting biodiversity. Such species need specific actions or intervention to ensure their survival.

Sources of data

List of the Rare and Endangered Plants Protected in China

China Species Red List

National Key Protected Wild Plants List

The analysis of current situation and tendency

The diversity of forest types bring the huge economic, ecological and social benefits due to retaining the abundant species and genetic resources. However, many species are facing extinction or endangered. In 2004, State Forestry Administration carried out an investigation on 189 national key protected wild plants, among which 57 species were severely endangered (critical), 47 species were endangered (imminent). It shows that the situation of endangered species is still grave (Table 2-5).

2.2.3 Status of *in situ* and *ex situ* conservation of species diversity

Rational and significance

In situ conservation is called original habitat protection, which is a major measure to protect biodiversity, including plants, and mainly implemented nature conservation in China. *Ex situ* conservation is a protective measure for species beyond wild habitat, aiming at preventing individual species or population

Table 2-5. Statistics of National Key Protected Plant Species		
	1987 ①	1999 ②
Blue Algae	/	1 species
Fungus	/	3 species
Ferns	13	14 species and 4 kinds
Gymnosperm	71	40 species and 4 kinds
Angiosperm	305	361 species and 5 kinds
Total	389	419 species and 13 kinds
Statistics of Protection Level of National Key Protected Plant Species		
	1987 ①	1999 ②
National Key Protected Plant (Level I)	8 species	67 species and 4 kinds
National Key Protected Plant (Level II)	159 species	352 species and 9 kinds
National Key Protected Plan (Level III)	222 species	/
Total	389 species	419 species and 13 kinds

from extinction danger. The indicator provides information of *in situ* and *ex situ* actions that can describe species diversity conservation. Some species or habitats have degraded to certain degree that needs human intervention to ensure their survival and development.

Sources of data

National Forestry Authority

Microbial Conservation Center, State Forestry Administration

The analysis of current situation and tendency

(1) Biodiversity Conservation

① ***In situ* conservation**

In situ conservation is a necessary measure targeting at the species which have the demand of protection for biodiversity. China, as one of the earliest countries adopting *in situ* conservation, mainly implements nature

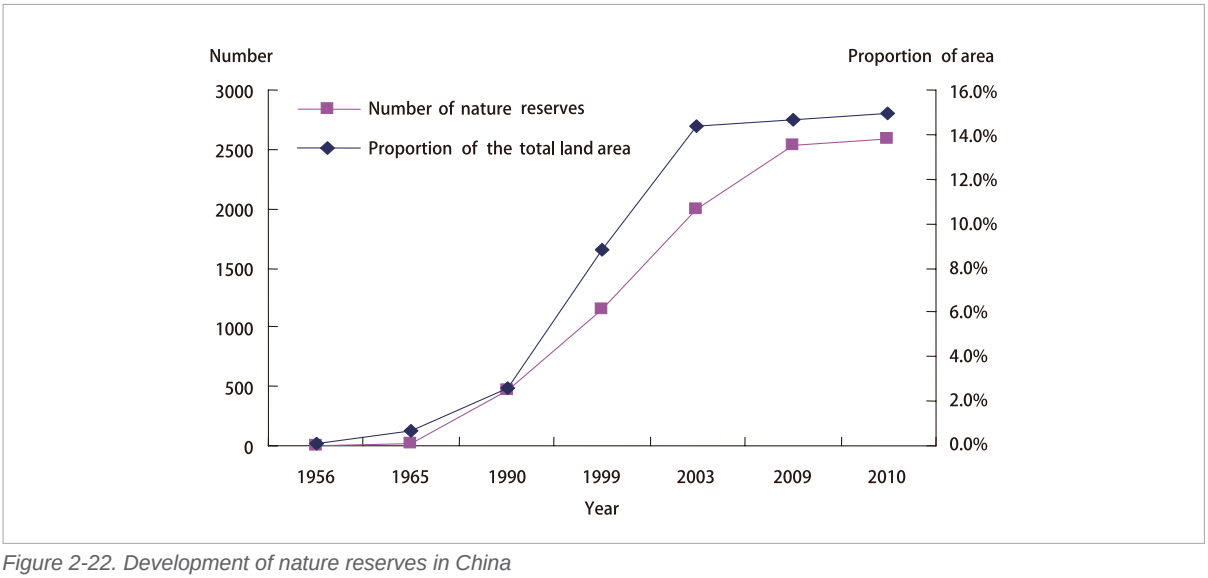


Figure 2-22. Development of nature reserves in China

reserve. With concerns of public and government in recent years, *in situ* conservation develops rapidly and has gained significant achievement. China has built 2,640 various nature reserves with 149.71 million ha (about 14.97% of national territorial area) in total by 2011. There are 2126 forestry nature reserves with 122.69 million ha in total (about 12.77% of national territorial area) (Figure 2-22). The development of nature reserve has gradually become stable in terms of the number and area.

The construction of nature reserve has effectively protected 90% terrestrial ecosystem types, 85% of wild animal species and population and 65% advanced plant species and population in China. It covers 20% primeval forest, 50.3% natural wetlands 30% typical desertification land in China. Thus, the nature reserve plays a significant role in maintaining the ecological biodiversity and inducing the sustainability

In situ conservation of forestry microbial resources diversity is primarily realized by the overall protection of forest ecosystem, which can protect the diversity of microbial resources while protecting forest species and groups. This *in situ* conservation is a more comprehensive protection system than other protective measures, which enables to protect forest population and the diversity of microbial resources at the same time. At present, there is no such protective measure only targeting for microorganism protection. The implementations of nature reserve and forestry projects in China provide not only the good conditions and foundation but also to ensure the protection of microbial resources origins and to maintain microbial population, species and diversity.

There are over 50,000 various types of small conservation plots in national forestry system with the total area over 1.50 million ha. They are protecting forest ecology, wet lands, wild animals and plants and their habitat, ancient trees, cultural heritage, and natural landscape and so on all over the country. Most of these small conservation plots are not suitable to construct within nature reserve, and distributed in densely-populated region in Southern China with small area. However, they have great protective value, as the effective supplement to nature reserve construction and biodiversity maintenance.

② ***Ex site* conservation**

Ex situ conservation is a protective measure for species beyond wild habitat, aiming at preventing individual species or population from extinction danger. Since it can keep active for a long period within each phase (seed, spore, pollen, etc.) of plant life cycle, *ex situ* conservation is suitable to protect plant diversity, especially for some rare individual species or population which can't prevent extinction in the wild by only depending on *in situ* conservation. Thus, *ex situ* conservation becomes an effective supplement to *in situ* protection. The common *ex situ* conservation measures include: botanical garden, genetic resource field collection garden, seed bank, gene bank and tissue culture and so on.

Case: Germplasm Bank for Wildlife in the southwest China

Genetic Resource Center for Wildlife in southwest China is the first Chinese genetic resource center for wild plants, animals and microorganisms, which plays a significant role in the biology development in China. Moreover, the preservation of these germ plasm resources is a key on protecting China's wildlife genetic resources. It also provides a good opportunity for the science to conduct researches related to germ plasm resources.

The construction of germ plasm bank was between March 22 in 2005 and February 8 in 2007, then the operation started on October 29 in 2008. By the end of 2009, there are 74,641 germ plasm resources had been preserved, covering 8,444 species of wild plants, wild animals and microorganism in total. By 2010, 66,500 germ plasm resources had been preserved, covering 6,450 species. By 2020, 190,000 germ plasm resources will be preserved, covering 19,000 species.

There are over 160 botanical gardens and arboreta conserving a great number of species resources in China. The botanical gardens of the Chinese Academy of Sciences (CAS) have about 20,000 species of high plants. Even though the varieties in botanical gardens and arboreta are numerous with the inter-specific diversity as the farget of conservation, the number of conserving individuals within species is few, and the function of genetic resources is limited.

At present, there's no national-level cryopreservation bank in China, however, some provinces and regions have built small-scaled cryopreservation bank with undeveloped facilities. The Forestry Research Institute of CAF (Chinese Academy of Forestry) built a small-scaled cryopreservation bank with 30m^2 seed bank and 0-5˚Cas the design temperature, which preserved tree seeds such as *Picea asperata* and *Pinus bungeana* in 2001. In 2011, bamboo and rattangerm plasm resource center completed the construction of a seed bank with xx m^2 area and -x˚C and x˚Cas the design temperature.

"China Forestry Microbial Conservation Center" was established in 1985 preserves15,122 (603 genus and 2,072 species) forest plants such as fungus, bacterium and virus from 32 provinces (including Taiwan), covering 279 regions, 438 counties and cities. It also contains microbial resources from over 10 countries including the USA and Japan and so on. The resources preserved in this center almost cover the current existing forest microbial resources' diversity in China, which can represent the features and advantages of microbial resources' features. Academy of Forestry at provincial level and some regional Forest Research Institutes also take part in the researches related to preservation of microbial resources, however, the scale is small and scattered.

China has protected over 1,000 rare or endangered special plants in the northeast, northwest and southwest regions through *ex situ*. There are about 400 wild plants germ plasm resource conservation bases were established as the plant germ plasm resource protection centers (bases) for domestic *Cycas revoluta*, Orchidaceae, Magnoliaceae and *Trachycarpus fortunei*. To strengthen the artificial cultivation technology research and provenance construction for rare wild plants, there are over 10 rare wild plant species such as *Tricholoma matsutake*, *Saussurea involucrata* kar. *et* kir. *et* maxim, rare orchidaceae plants and so on which have large market demand, are supported and are carried out artificial cultivation technology research and provenance construction. There are 280 rare wild plant cultivation bases being established to assure thousands of wild plants have stable artificial populations. Different departments from Forestry, Construction and CAS build up various botanical gardens and arboretums to implement the effective *ex situ* conservation on rare and endangered plant resources.

2.3 Genetic diversity

Genetic diversity or genetic variation within the population and species is the most fundamental origin of biodiversity at all levels and the key to ensure forest ecosystem perform in a healthy way. The elements endangering the stability and safety of gene bank include climate change, disaster incident, human activities and pressure.

The loss of genetic variation weakens the species' ability to adapt to the environmental changes and also reduce the availability levels of medical herbs and other biomass resources for society. Moreover, it restricts the potential ability of forest species to exert the largest benefits. The high level of genetic diversity within the population is the normal method to measure the greatness of potential survival of this population. Meanwhile, the loss of genetic variation within the species also reduces the adaptation capacity of forest ecosystem.

2.3.1 Number and geographical distribution of forest associated species at risk of losing genetic variation and locally adapted genotypes

Rational and significance

The indicator provides the proportion and distribution information of the forest species at risk of genetic variation within the populations. The loss of genetic variation will weaken the species adaptability to environmental changes, and be easier to extinct. Some local populations having single gene bank may have danger of submergence by deliberately, accidentally or naturally introduced greater population. Furthermore, this indicator provides the proportion and distribution information of forest species at degradation or facing threat and having localized population or subspecies. It emphasized the protection condition of species and their subspecies, local population and genotype in detail.

Sources of data

National Rescuing&Protecting Project on Small Populations of Wild Plants

The analysis of current situation and tendency

(1) Plants

① The quantity of species

Small population wild plants refer to endangered wild plants which are distributed in narrow area and disturbed by the external threats; population is degrading and and number of individual species is reducing, which are smaller than the minimum viable population (MVP) survival the limit for surival. These small population wild plants include: the small population of quantity, critically endangered and tend to extinct; have special habitat requirements, narrow ecological amplitude; have unclear potential gene value and small population quantity, and also the species if the extinction will cause gene loss, biodiversity decrease, and the great loss of social economic value.

The State Forestry Administration determined to take 120 small population wild plants to rescue and to protect in project phase I, and to conduct saving and protection pilots (Table 2-6). Among the 120 small population wild plants, there are 36 species are national level-I protective plants, 26 species are national level-II protective plants and 58 species are important provincial protective plants. Among the 120 species plants, there are 9 species, which have less than 10 wild stands, including 3 national level-I protective plants (*Carpinus putoensis* Cheng, *Abies beshanzuensis* and *Ostrya rehderiana* Chun) and 6 national level-II protective plants (*Gleditsia vestita*, *Erythropsis kwangsiensis*, *Acery angjuechi*, etc.).

There are 29 species, which have 10 to 99 wild stands, including 7 national level-I protective plants such as *Bhesa sinensis*, *Manglietiastrum sinicum* Law and *Parakmeria omeiensis* Cheng, 9 national level-II protective plants such as *Carpinus tientaiensis*, *Pterospermum kingtungense* and *Magnolia zenii* Cheng, and 13 important provincial protective plants such as *Euryodendron excelsum* and *Acer miaotaiense*. There are 46 species, which have 100 to 999 wild stands, including 4 national level-I protective plants such as *Cycas hongheensis*, *Cycas taiwaniana*, *Glyptostrobus pensilis* and *Abies yuanbaoshanensis*, 3 national level-II protective plants such as *Betula halophila*, *Pinus dabeshanensis* Cheng et Law and *Changiostyrax dolichocarpa*, and 39 important provincial protective plants such as *Camellia pubipetala*, *Camellia impressinervis* and *Paphiopedilum armeniacum*.

There are 33 species, which have 1,000 to 9,999 wild stands, including 19 national level-I protective plants such as *Cystoathyrium chinense* Ching, *Cycas debaoensis* and *Calycopteris floribunda*, 8 national level-II protective plants such as *Myristica yunnanensis* and *Ulmus elongata*, and 6 important provincial protective plants such as *Oncodostigma hainanense*, *Coptis quinquesecta* and *Camellia terminalis*.

In addition, 3 species having more than 10,000 wild stands, like *Taxus cuspidate*, *Taxus fauna* and *Hopea hainanensis* are all national level-I protective plants.

② Current Distribution

Among the 120 small population wild plants, there are 54 species have only one wild distribution point, such as *Abies beshanzuensis*, *Ostrya rehderiana* chun and *Cycas szechuanensis*, while some of 21 species have only two wild distribution points such as *Bhesa sinensis*, *Cycas hongheensis* and *Cycas taiwaniana*. In addition, some

Table 2-6. Quantity and distribution of small proportion wild plants

Field population	Distribution Areas					Species population
	1 Area	2 Areas	3-4 Areas	5-9 Areas	≥10 Areas	
<10	*Abies beshanzuensis, Pseudotsuga xichangensis, Carpinus putoensis, Ostrya rehderiana, Gleditsia japonica var. velutina, Erythropsis kwangsiensis, Acer yangjuechi, Firmiana danxiaensis, Petrocosmea qinlingensis*					9
10-99	*Cycas szechuanensis, Pinus morrisonicola, Carpinus tientaiensis, Magnolia zenii, Manglietiastrum sinicum, Parakmeria omeiensis, Vatica guangxiensis, Euryodendron excelsum, Paranephelium hainanense, Pterospermum kingtungense, Sonneratia hainanensis, Nyssa yunnanensis, Calanthe sieboldii, Cymbidium wenshanense, Dendrobium huoshanense, Paphiopedilum gratrixianum, Paphiopedilum spicerianum, Paphiopedilum helenae*	*Pterocarpus indicus, Bhesa robusta, Camptotheca acuminate, Paphiopedilum emersonii, Phalaenopsis lobbii*	*Pinus wangii, Acer miaotaiense, Berchemiella wilsonii, Mussaenda anomala*	*Acer catalpifolium, Craigia yunnanensis*		29
100-999	*Abies yuanbaoshanensis, Pyrus hopeiensis, Sinojackia huangmeiensis, Sinojackia microcarpa, Paraisometrum mileense, Cypripedium micranthum, Paphiopedilum singchii, Eria quinquelamellosa, Gastrochilus rantabunensis, Geodorum eulophioides, Holcoglossum omeiense, Holcoglossum rupestre, Nothodoritis zhejiangensis, Paphiopedilum tranlienianum, Paphiopedilum wenshanense, Phaius hainanensis, Sunipia hainanensis, Thrixspermum odoratum*	*Cycas hongheensis, Cycas revoluta, Betula halophila Camellia impressinervis, Camellia pubipetala, Taihangia rupestris var. ciliate, Lumnitzera littorea, Changiostyrax raxdolichocarpa, Cypripedium palangshanense, Dendrobium hainanense, Dendrobium strongylanthum*	*Bulbophyllum hainanense, Cypripedium forrestii, Eria tomentosa, Ceratostylis hainanensis, Euphorbiamarginata Pursh, Cymbidium insigne, Dendrobium sinense, Doritis pulcherrima, Gastrochilus acinacifolius, Paphiopedilum armeniacum*	*Pinus dabeshanensis, Ilex kaushue, Cypripedium lichiangense, Cypripedium margaritaceum, Dendrobium changjiangense*	*Glyptostrobus pensilis, Annamocarya sinensis*	46
1000-9999	*Cystoathyrium chinense, Magnoliaceae glanca Blume, Myristica yunnanensis, Coptis quinquesecta, Calycopteris floribunda, Rhododendron protistum var. giganteum, Dayaoshania cotinifolia, Primulina tabacum*	*Cycas changjiangensis, Cycas shiwandashanica, Cycas diannanensis, Thuja koraiensis, Camellia pinggaoensis var. terminalis*	*Cycas debaoensis, Cycas diannanensis, Thuja sutchuenensis, Metasequoia glyptostroboides, Kmeria septentrionalis, Horsfieldia tetratepala, Hopea chinensis, Shaniodendron subaequale, Dipteronia dyeriana*	*Cycas multipinnata, Cycas micholitzii, Cycas taiwaniana, Oncodostigma hainanense, Abies ziyuanensis, Cathaya argyrophylla, Horsfieldia hainanensis*	*Ulmus elongata, Michelia wilsonii, Tsoongiodendron odorum, Madhuca pasquieri*	33
>10000	*Taxus fuana*				*Taxus cuspidata, Hopea hainanensis*	3
Species population	54	21	23	14	8	120

Case: Protection of wild fruit forest in Yili, Xinjiang

Yili city in Xinjiang province possesses quite rich forest resources, which mainly consist of large amount of primeval forest and secondary forest. It is the most important and interconnected part of Middle Asia Tianshan wild fruit forest. There are abundant resources of wild fruit trees within the area, of which the total area reaches 300,000 mu. The species of wild fruit trees are various, such as wild apple, Chinese walnut, wild prunus armeniaca and Prunus cerasifera Ehrhart, where the wild apple area occupies about half of the total area of wild fruit trees. The area of wild apple in Yili is 144,400 mu, which makes it as an important part of gene bank of wild apple in the world. The "*Malus sieversii*" has great value on scientific protection and research, which can help studies on genetic diversity and gene evolution of temperate fruit trees, as one of the important constituent parts of world wild apple gene bank, *Agrilus mali* Mats appeared in Yili in 1990s. Later on, *Agrilus mali* Mats spread rapidly, and spread to the wild apple forests over 1000 m in Tokkuztara County, Nilka County and Tekes County. The mature *Agrilus mali* Matscan lay 60 to 70 eggs each time within about 11 days in the egg-laying period and the spread is fast. In 2003, *Agrilus mali* Mats in Yili River Valley had distributed to 750,000 mu, where the disastrous area of wild apple forest reached 730,000 mu (some of 50.5% total area of wild apple forest in Yili). At the end of 2003, The Institute of Ecology of Xinjiang Academy of Forestry and Yili Forest Protection Station cooperated to tackle the techniques to anti *Agrilus mali* Mats. After 3 years, they have mastered the regular pattern, distribution range, harmful degree, biological characteristics and the disaster reason of *Agrilus mali* Mats in Yili. By now, the attack from *Agrilus mali* Mats has been controlled.

of 23 species have three to four wild distribution points such as *Piuns wangii* Hu et Cheng, *Acer miaotaiense* and *Cycas debaoensis*, while 14 species have five to nine wild distribution points such as *Acer catalpifolium*, *Pinus dabeshanensis* Cheng et Law and *Abies ziyuanensis*, and the rest of 8 species have more than ten wild distribution points such as *Glyptostrobus pensilis*, *Ulmus elongata* and *Tsoongiodendron odorum*.

③ **Conservation Status**

Among the 120 small population wild plants, only 15 species are all distributed within the national-level nature reserves, such as *Gleditsia vestita*, *Abies beshanzuensis* and *Acer yangjuechi*; 33 species are partially distributed within the national-level nature reserves, such as *Acer catalpifolium*, *Ulmus elongata* and *Pinus dabeshanensis* Cheng et Law; 16 species are all distributed or partially distributed within provincial-level, municipal-level or county-level nature reserve, such as *Euryodendron excelsum*, *Magnolia zenii* Cheng and *Calycopteris floribunda*; and the rest of 56 species wild plants, such as *Carpinus putoensis* Cheng, *Bhesa sinensis* and *Vatica guangxiensis*, which residual wild populations are all distributed outside the nature reserves.

④ **Threatening Factors**

The main factors that influence the diversity of forest genetic resources include: the overexploitation and unreasonable utilization of forest resources, habitat deterioration, changes of land utilization pattern, genetic erosion and extreme climate events and so on.

The overexploitation and irrational utilization of forest resources cause the natural forest fragmentation, severe degradation, loss of genetic resources of numerous rare tree species and sharp fall of genetic diversity of tree species. For instance, tree species such as *Pterocarpus indicus*, *Phoebe bournei*, *Erythrophleum fordii*, *Dalbergia hupeana*, *Thuja sutchuenensis* and *Castanopsis hystrix*, only have few defective natural forest stands in the local regions. A partial natural resource has almost run out and the genetic resources suffered severe threat.

Habitat deterioration and the change of land utilization pattern result in the destruction of forest species' living condition, the reduction of the species adaptability and the acceleration of the forest genetic resource loss. During 2004 and 2008, the area of forest land converted to non-forest land was 8.32 million ha due to

deforestation, natural disasters and construction projects, among which 85% turned to other types of agricultural lands. Partial forest land was turned into non-forest land. As a result, forest primeval habitat was deteriorated gradually, which accelerated the loss of the forest genetic resources.

The simplification of afforestation midels and inadquate number of species, large-scale plantations with single species or single varietions and the unreasonable allocation of seeds, which aggravate the genetic erosion. It causes the decrease of tree species diversity and genetic diversity. In the existing planted forests, more than 20 tree species are used in afforestation. Among them, the area of Chinese fir, *Poplar*, *Pinus massoniana*, *Larix* and *Eucalyptus* occupies over 40% of planted forest. The diversity planted forest presents a downtrend and weakens the stability of standing forest, which potentially threatens the sustainable forest management.

Extreme climate (such as frost, snowstorm and persistent drought), plant diseases and insect pests and forest fire are also factors to decrease the genetic resource diversity of forests. At the beginning of 2008, the Southern China suffered from snow and ice disaster, which affected forest area 18.60 million ha. At the end of 2008, there were severe drought in many regions hit by in China, the affected forest area reaching 7.86 million ha. The area of forest infracted by pest reached 11.57 million ha because of various factors such as extreme climate in 2009. With rapid afforestation development, the plantation area expands rapidly. Because the high-incidence season of plant diseases and insect pests is approaching, the damage to forests will be more severe. Therefore, the selection and cultivation of disease-resistance species of forest genetic resource are more and more important.

(2) Animals

Rational and significance

The population cluster of wild animals can be split into small and isolated groups due to various factors, such as inbreeding and genetic-drifts which could easily reduce the animals' genetic mutation and its diversity. Within the small population groups, many alleles are lost or fixed because of the random drifts which can cause the reduction of genetic mutation and the decline in evolutionary potency eventually. Meanwhile, deleterious gene mutations are fixed as a result of random drifts.

When the effective population size (Ne) is below 100, it might even lead to mutation disaster. Therefore, the small population species have a great risk of genetic variation and the loss of localized genetic.

Sources of data

National Key Protected Wild Animals List

The National Report of China's Biodiversity Status, 1998

The analysis of current situation and tendency

China is one of the top 12 countries that have the richest biodiversity. In China, there are 6,445 kinds of vertebrates, which make up 13.70% of the world's total number of species (*Conservation Strategy and Action Plan for China's Biodiversity*, 2011). China stands out not only because of the richness of species, but also the high degree of endemism. More than 500 kinds of vertebrates are endemic species in China, including the giant panda (*ailuropoda melanoleuca*), snub-nosed monkey (*rhinopithecus*), takin (*budorcas taxicolor*), tibetan antelope (*pantholops hodgsonii*) and so on.

The endangered degrees of China's animal species are as follows: mammalian—23.06%, aves—14.63%, reptilia—4.52%, amphibia—2.46%, and pisces—2.41%. According to *China Red Data Book of Endangered Animals*, 2004, the vertebrate species in the IUCN's (International Union for Conservation of Nature and Natural Resources) endangered category has reached to 35.92% of the total. The *Conservation Strategy and Action Plan for China's Biodiversity*, which was published in 2011, states that 233 vertebrate species are threatened with extinction, about 44% of the wild animals have shown a downward trend in population, and the wild animals which are not under the national special protection decline significantly in terms of population.

According to the first national terrestrial wildlife resources survey between 1995 and 2003, 12 of the total 20 kinds of primates have populations less than 1000. Especially, red-shanked douc (*pygathrix nemaeus*) was not found at all, and only 25 gibbons (*hylobateslar*), 14 siberian tigers (*pantheratigrisaltaica*), 17 indochinese tigers (*pantheratigriscorbetti*) and 10 bengal tigers (*pantheratigristigris*) were found during the survey (Table 2-7).

China provides legal protection for endangered or threatened animals, including most of China's endemic species. There are 96 kinds of wild animals of Level I national protection including 4 reptiles, 42 birds and 50 mammals; 231 kinds of wild animals of Level II national protection including 7 amphibians, 10 reptiles, 158 birds

Table 2-7. Quantity and distribution status of wildlife species: part of mammalia, amphibia and reptilia under national special protection

Name	Level of protection	CITES appendices	Quantity	Distribution status
Mammalia				
Loris tardigradus	I	I	630	Yunnan, Guangxi
Nycticebus pygmaeus	I	I	90	Yunnan
Macaca assamensis	I	II	8200	Guangxi, Yunnan, Tibet
Macaca nemestrina	I	II	1700	Yunnan
Rhinopithecus roxellana	I	I	12000	Sichuan, Shaanxi, Hubei, Gansu
Rhinopithecus bieti	I	I	2150	Yunnan, Tibet
Rhinopithecus brelichi	I	I	700	Guizhou
Trachypithecus francoisi	I	II	3000	Guangxi, Chongqing, Guizhou
Semnopithecus entellus	I	II	760	Tibet
Trachypithecus pileatus	I	I	250	Yunnan
Trachypithecus phayrei	I	II	700	Yunnan
Leucocephalus	I	II	600	Guangxi
Hylobates lar	I	I	25	Yunnan
Hoolock	I	I	680	Yunnan, Tibet
Nomascus concolor	I	I	820	Yunnan, Hainan
Nomascus leucogenys	I	I	165	Yunnan
Ailurus fulgens	II	I	8000	Sichuan, Yunnan, Tibet
Ailuropoda melanoleuca	I	I	1596	Sichuan, Gansu, Shaanxi
Gulo gulo	I		180	Inner Mongolia, Heilongjiang
Neofelis nebulosa	I	I	2600	Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi,
Panthera pardus	I	I	3310	Beijing, Hebei, Shanxi, Inner Mongolia, Jilin, Heilongjiang, Zhejiang, Jiangxi, Henan, Hubei, Hunan, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Ningxia
Elephas maximus	I	I	180	Yunnan
Tragulidae	I		60	Yunnan
Moschus moschiferus	I	II	3500	Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Xinjiang, Ningxia
Axis porcinus	I		25	Yunnan
Cervus eldii	I	I	760	Hainan
Amphibia and reptilia				
Tylototritonverrucosus	II		73000	Yunnan, Tibet
Hoplobatrachus tigerinus	II	II	4900	Shanghai, Zhejiang, Jiangxi, Henan, Hubei, Hunan, Guangdong, Hainan, Guangxi, Guizhou, Yunnan
Varanus salvator	I	II	19000	Guangdong, Yunnan
irrawadicus		II	100	Yunnan
Shinisaurus crocodilurus	I		700	Guangxi
Python	I	II	62000	Guangdong, Guangxi, Yunnan, Tibet

Source: State Forestry Administration, *China's Key Terrestrial Wildlife Resources Survey*, 2009, China Forestry Publishing House.

Table 2-8. Statistics of the quantity and distribution status: part of Aves under national special protection

Name	Level of protection	CITES appendices	Quantity		Distribution status
			Winter	Summer	
Egretta eulophotes	II		640	8100	Inner Mongolia, Jilin, Liaoning, Hebei, Henan, Yunnan, Anhui, Zhejiang, Jiangsu, Shanghai, Guangdong, Guangxi, Fujian
Gras leucogeranus	I	I	4000	10	Heilongjiang, Jilin, Liaoning, Shandong, Henan, Jiangxi, Anhui, Hubei, Hunan
Ciconia nigra	I	II	470	1800	Heilongjiang, Inner Mongolia, Jilin, Liaoning, Hebei, Tianjin, Beijing, Henan, Shanxi, Xinjiang, Gansu, Tibet, Ningxia, Shaanxi, Hubei, Hunan, Anhui, Yunnan, Sichuan, Jiangxi, Jiangsu, Fujian
Nipponia nippon	I	I		147	Shaanxi
Platalea leucorodia	II	II	7800	160	Heilongjiang, Inner Mongolia, Jilin, Liaoning, Hebei, Tianjin, Henan, Xinjiang, Ningxia, Shaanxi, Hunan, Guizhou, Anhui, Yunnan, Sichuan, Jiangxi, Jiangsu, Jiangxi, Zhejiang, Guangxi, Guangdong, Fujian
Platalea minor	II		120	9	Liaoning, Jiangsu, Jiangxi, Zhejiang, Shanghai, Guangxi, Hainan, Fujian
Aix galericula	II		12000	14000	Heilongjiang, Inner Mongolia, Jilin, Liaoning, Hebei, Tianjin, Beijing, Henan, Shandong, Shanxi, Gansu, Ningxia, Shaanxi, Hunan, Guizhou, Guizhou, Anhui, Jiangxi, Jiangsu, Chongqing, Zhejiang, Shanghai, Sichuan, Yunnan, Guangxi, Guangdong, Fujian
Mergus squamatus	I		300	380	Widely distributed
Pernis ptilorhynchus	II	II	100	5500	Widely distributed
Milvus migrans	II	II		35000	Widely distributed
Accipiter gentilis	II	II	70000	250000	Widely distributed
Accipiter nisus	II	II	100000	250000	Widely distributed
Accipiter virgatus	II	II	6600	100000	Widely distributed
Butastur indicus	II	II	1600	6000	Inner Mongolia, Liaoning, Jilin, Heilongjiang, Zhejiang, Hubei, Guangdong, Sichuan, Yunnan, Shaanxi, Fujian
Aquila chrysaetos	I	II	2200	27000	Widely distributed
Spilornis kinabaluensis	II	II		4400	Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Hainan, Yunnan, Tibet
Falco peregrinus	II	I	2300	43000	Widely distributed
Falco subbuteo	II	II	17000	100000	Widely distributed
Falco tinnunculus	II	II	23000	840000	Widely distributed
Aviceda leuphotes	II	II		4100	Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Yunnan
Tetrao parvirostris	I			6500	Heilongjiang, Inner Mongolia
Lyrurus tetrix	II			17000	Inner Mongolia, Jilin, Hebei, Xinjiang
Bonasa bonasia	II			810000	Inner Mongolia, Heilongjiang, Jilin, Liaoning, Xinjiang
Tetrastes sewerzowi	I			13000	Gansu, Qinghai, Sichuan, Tibet, Yunnan
Tragopan temminckii	II			54000	Gansu, Shaanxi, Chongqing, Sichuan, Tibet, Yunnan, Guizhou, Guangxi, Hubei, Hunan
Tragopan caboti	I	I		9900	Zhejiang, Jiangxi, Guangdong, Fujian, Guangxi, Hunan
Lophophorus sclateri	I	I		320	Yunnan, Tibet
Lophophorus lhuysii	I	I		12000	Tibet, Qinghai, Sichuan, Yunnan
Crossoptilon mantchuricum	I	I		20000	Shanxi, Hebei, Shaanxi
Syrmaticus humiae	I	I		3500	Guangxi, Yunnan
Syrmaticus ellioti	I	I		28000	Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Guizhou
Polyplectron bicalcaratum	I	II		2800	Yunnan, Hainan, Tibet
Pavo muticus	I	II		1000	Yunnan

Source: State Forestry Administration, *China's Important Terrestrial Wildlife Resources Survey*, 2009, China Forestry Publishing House.

and 56 mammals.

There are quite a few kinds of endemic species among mammalia in China, such as the giant panda (*Ailuropoda melanoleuca*), snub-nosed monkey (*rhinopithecus*), eld's deer (*cervuseldii*), southChina tiger (*pantheratigrisamoyensis*) and so on. China has established a large number of nature reserves for these rare endemic species in order to protect them as well as their habitats. A set of distinctive centers were also founded to rescue, raise, train and breed wildlife, such as the Chengdu Giant Panda Breeding Center, and *in situ* and *ex situ* conservations of endangered species were well combined.

China is one of the countries that have the world's richest aves resources. China's unique geographical landscape provides natural environment for many endemic aves species. For instance, *tetraophasis, chrysolophus, crossoptilon* and *ithaginis* of galliformes are all endemicspecies in China, among which, 9 taxa of them are endemic bird species in China. In China, the endemic bird species is categorized to the wild animal species which are under national prior protection. In particular, all endemic bird species are enlisted either in *Thelist of China Terrestrial Wild Animals under National Protection, which are Beneficial, Economically or Scientifically Valuable*, which was published by the State Forestry Administration, or in *National Key Protected Wild Animals List* (Table 2-8). *Tragopan caboti* is China's endemic *tragopan*. To protect its pristine habitat, Wuyanling National Nature reserve and Fengyang Mountain National Nature reserve in Zhejiang, Wuyi Mountain National Nature reserve and Guan Mountain National Nature reserve in Jiangxi were established. Beijing Normal University has successfully bred *tragopan caboti* in artificial conditions and has already started the scientific research of wild reintroduction.

China possesses rich endemic amphibia and reptilia resources (table 2-9). East China and south China are the dominant distribution areas for amphibia and reptilia. The rapid economic development has severely affected the survival of amphibia and reptilian in China. The main threats are concerning the environmental and water pollution, therefore, the fragmentation and destruction of habitats, sharp decline in population are caused by over-fishing and illegal hunting. In China, *Alligator sinensis* is a rare endemic reptile species and is under Level I national protection. *Alligator sinensis*es were once widely distributed historically in the middle and lower reaches of the Yangtze River. However, along with the agricultural development and utilization of wetlands, wild *alligator sinensis* population has been reduced drastically. Only 27 *alligator sinensis* were observed in the wild during the 1999 Sino-US joint investigation, which shows that the wild *alligator sinensis* are in danger of extinction. In order to save this endangered species, the National Alligator Nature reserve was established in Xuancheng in Anhui province by the State Forestry Administration, meanwhile, the researchers tried their best to carry out its artificial breeding and wild reintroduction. After years of hard work, the quantity of wild *Alligator sinensis* has now risen to 150, and the artificially bred *Alligator sinensis* has exceeded ten

Table 2-9. Statistics of China's endemic terrestrial wildlife (vertebrate) species

Animal category	Number of known species	Number of unique species	percentage (%)
Mammalia	607	110	18.13%
Aves	1332	76	5.71%
Reptilia	452	80	17.70%
Amphibia	335	236	70.45%
Total	2726	502	18.42%

thousand. Thus, the trend of its species extinction was effectively curbed.

About 100 kinds of terrestrial wildlife species in China have been assessed as "in the state of tiny population" (Table 2-10), including 12 amphibians, 10 reptiles, 28 birds, 50 mammals. Among these species, 59 were under Level I national protection, 14 were under Level II national protection. 37 were enlisted in Appendix I in *Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)*, 26 in Appendix II. According to *China Red Data Book of Endangered Animals*, 2 species became extinct in the wild, 1 species is regionallyextinct, 36 species are in the critically endangered state, 37 are endangered and 16 are vulnerable.

Most of the tiny population species are distributed extremely narrow. 43 species are distributed only in one province, 21 in 2 provinces, 9 in 3 provinces, 4 in 4 provinces, and 23 in 5 or more provinces. In terms of the distribution pattern, the tiny population species are distributed in all provinces of China, covering 1,372 counties in 32 provinces, municipalities and autonomous regions, but most of them are concentrated in Yunnan and Tibet. 22 tiny population species are distributed in the Mengla county in Yunnan, making it the place where inhabit more tiny population species than anywhere else. There are altogether 187 counties or municipalities where inhabit 5 or more tiny population species.

Among all tiny population species, three were extinct in the wild or within the regions. The population quantity of some species is unclear so far. There are 5 kinds of birds and 7 kinds of mammalsless than 50, while 2 kinds of amphibians, 5 kinds of birds and 9 kinds of mammals have a population of 50 - 250. In addition, 6 kinds of amphibians, 3 kinds of reptiles, 12 kinds of birds and 14 kinds of mammals have a population of 250-2,500. Moreover, 4 kinds of amphibians, 1 kind of reptile, 3 kinds of birds and 13 kinds of mammals have a population of 2,500-10,000.

Many species in the state of critically endangered were saved and bred in wildlife rescue centers, zoos and safari parks. At present, the artificially bred South China tiger (panthera tigris amoyensis) has reached a population of 73, Siberian tiger (*pantheratigrisaltaica*) 1,532 respectively. China has established 3 crested ibis (*nipponia nippon*) artificial breeding groups, reaching a population of 544. China's alligator sinensis has reached a population of 13,777 from merely more than 200. Artificially bred wild horse (*equus ferus*) has reached a population of 221.

In recent years, China has conducted wild reintroduction experiments on a few tiny population species. The wild reintroduction of *Alligator sinensis* turned out to be a great success, as well as wild horse (equus ferus) and milu deer (elaphurus davidianus), which have established rather stable wild groups. In addition, China also intensively studied the possibility of wild reintroduction of South China tigers (panthera tigris amoyensis), andorganized groups of domestic and foreign experts to carry out the background investigation and the assessment on purposed reintroduction areas in order to confirm the actual reintroduction areas, laying a firm foundation for the reintroduction of South China tigers (panthera tigris amoyensis).

2.3.2 Population levels of selected representative forest associated species to describe genetic diversity

(1) Plants

Rational and significance

This indicator embodies the information that describes the genetic diversity of the representative forest species at the population level. Some forest species strongly support or rely on particular forest structures, forms, associations and processes. Monitoring population levels of such species will indicate the general status of the forest genetic diversity. These representative forest species that measure genetic diversity include the keystone species, basic species, flagship species and other indicator species. This indicator chooses the main tree species for afforestation in China as the representatives to explain the differences between various forest ecosystem types or within the forest itself.

Sources of data

National Forestry Authority

The analysis of current situation and tendency

① **Geographic Variations**

Most tree species in China are still living wildly and are distributed widely with diverse habitats. After a long time of adaptation, evolution and development, there are significant differences in morphology, growth, adaptation, etc., which gradually forms the abundant intra-population genetic variation. Since the provenance trials were comprehensively carried out in the early 1980s, China has so far conducted systematic provenance trials on over 70 important tree species for afforestation, including *Pinus tabulaeformis, Pinus massoniana, Pinus taeda, Pinus koraiensis, Larix principis-rupprechtii, Pinus elliottii, Pinus yunnanensis, Larix gmelinii, Pinus armandii, Casuarina equisetifolia, Picea koraiensis, Taxodium distichum, Taxodium ascendens, Taiwania flousiana, Platycladus orientalis, Sassafras tsumu, Acacia mearnsii, Betula platyphylla*, and *Ulmus pumila*. The trials showed that most of China's tree species have prominent or extremely significant inter- and intra-population genetic variation, and the variance components of the two kinds of genetic variation vary greatly for different tree species; that an overwhelming majority of tree species demonstrated obvious geographic variations, mainly shown in morphological features, growth, adaptation and wood properties, and that the growth and adaptation of tree species are related to provenance and climate factors, most of the tree species having relatively great latitudinal variations and some exceptions having two-way variations in both latitude and longitude. The typical intra-population variations of tree species are listed as follows:

Chinese fir is one of the major timber species in the subtropical areas in China. The research on the genetic variation of Chinese fir shows that most of Chinese fir's properties change gradually from south to north. In addition, the adaptive characters, such as the phenological phase and cold tolerance, have a negative linear correlation with latitude. The growth and stress resistance are depending on the climate and ecological condition of a certain tree's habitat, and also mainly on the latitudinal variations. Furthermore, the growth, wood properties and branching features of Chinese fir change in a clinal way.

Masson pine is a major timber species in the subtropical areas in China. The provenance trials show that different provenances have varying degrees of variations on growth, growth rhythm, phonological phase, disease, pest resistance and so on, and these variations are related to the latitudes of provenances. The intra-population genetic variation generally changes from south to north. The basic wood density of masson pines also shows obvious variations among provenances and strong correlation with latitude, which decrease from north to south, but nothing to do with longitude.

Pinus tabulaeformis, a major species for afforestation and landscaping, is mainly distributed in north China. The provenance trials on *Pinus tabulaeformis* indicate that this tree species with different provenances has great geographic variations in terms of germination, phenology, growth, morphology, cold tolerance and other properties, and their variations feature a continuous variation model. In line with the climatic ecotypes and the variations of its parental generation, *Pinus tabulaeformis* is categorized into 9 seed zones and 22 seed sub-zones.

Populus tomentosa is an endemic species of China and mainly distributed in Huang-Huai-Hai watershed as, and is an important species in the forestry production and ecological construction in downstream Yangtze River. The provenance trials show that *Populus tomentosa* has abundant variations in phenotypic characters, and obvious genetic variation existing both between different provenances and within a certain provenance, which were 80.26% and 19.74% respectively. *Populus tomentosa*'s genetic diversity mainly comes from genetic variation between different clones within one provenance. This tree species has many natural variation types, such as arrow shaft *Populus tomentosa*, Yi county *Populus tomentosa*, tower-shaped *Populus tomentosa*, *Populus tomentosa* var. *truncata* y.c.fu et c.h.wang, small-leafed *Populus tomentosa*, Henan *Populus tomentosa*, dense-stomate *Populus tomentosa*, Jingxi *Populus tomentosa*, etc.

② **Genetic Diversity**

The analysis of isozyme and DNA markers shows that most tree species have abundant genetic diversity, and that their intra-species genetic diversity is mainly reflected within populations (accounted for 60% to 90%), such as *Pinus tabulaeformis, Larix principis-rupprechtii, Larix gmelinii, Larix olgensis* and *Pinus koraiensis*. The inter-population diversity varies from species to species,

among which *Pinus massoniana* and *Larix gmelinii* have no inter-population variations, and *Pinus tabulaeformis*, *Pinus armandii*, *Larix olgensis*, *Pinus koraiensis* and *Quercus mongolica* have obvious inter-population variations. In the past decade, a genetic diversity evaluation (Table 2-12) has been conducted on isozyme or DNA markers of more than 100 tree species, including *Pinus massoniana, Pinus tabulaeformis, Chinese fir, Ulmus pumila*, *Davidia involucrate*, *Larix*.sp, *Populus* and *Picea*.sp. The analysis results on the representative tree species are listed as follows:

The RAPD markers analysis on 12 geographic provenances of Chinese firs shows that the genetic distance of different provenances ranged from 0.1932 to 0.4667. The cluster result turned out that Xinyi of Guangdong Province, Wuzhou of Guangxi Province, Huitong of Hunan Province, Jianghua of Hunan Province, Jinping of Guizhou Province and Quannan of Jiangxi Province clustered as a group, Shaxian of Fujian Province, Kaihua of Zhejiang Province, Xianning of Hubei Province and Xiuning of Anhui Province clustered as a group, Ya'an of Sichuan Province and Nanzheng of Shanxi Province each forms an individual group. The isozyme analysis on the natural populations of Masson pine demonstrates that Masson pine has abundant genetic variation within population yet with low degree of inter-population variation. To be specific, most of the variation is reflected within a geographic population, while only 2% is inter-population variation. As a result, population variation has no obvious connection with geographical distance.

(2) Animals

Rational and significance

To protect a species, especially its genetic diversity or evolutionary potential, is the essential of biodiversity protection. Genetic factors have close relations with the endanger extinction and the high risk of extinction. A species can be retrogressed to extinct due to the synergy of genetics, statistics and environmental factors (including accidental events and environmental disasters). Therefore, the typical, endemic, rare and endangered species in China are selected to illustrate the current status of genetic diversity and its changing trend as the scientific foundation to formulate the effective protection strategies, and ultimately to achieve the sustainable development of species.

Source of data

National Forestry Authority

The analysis of current situation and tendency

The giant panda, golden monkey, cervus eldi Hainanus, etc. are very typical species that live on forests. These threatened species have been studied through a large amount of relevant researches on the topics of ecology and genetic diversity.

In order to ascertain the resource condition of wildgiant panda, the Chinese government has conducted three background investigations respectively in Sichuan Province from 1974 to 1977, Shaanxi Province from 1985 to 1988, and Gansu Province from 1999 to 2003. These three provinces are the places where the giant pandas distribute. The panda population were shown as of 2400, 1114 and 1596 respectively in three investigations, while now it has been estimated to be more than 2000 (Table 2-10 and Table 2-11).

Based on the field surveys, China has built a number of nature reserves for giant panda (Figure 2-23).

The surveys on the genetic diversity of giant pandas in

Table 2-10. Population and habitat of the giant panda distributed in nature reserves

Years	Total Area of Giant Pandas' Habitat (km^2)	Total Area of Giant Pandas' Habitat in Nature reserves (km^2)	Population of Giant Pandas Nationwide (head)	Population of Giant Pandas in Nature reserves (head)
1960s	50000	1460	3800	100
1970s	36730	8050	2400	864
1980s	22220	9160	1114	379
1990s	23050	18600	1596	640
2010s	34000	29000	2000	1000

Source of data: Hu Jinchu, etc., 2011

Table 2-11. Number and distribution of nature reserves nationwide for the giant panda

Provinces	Mountain Systems	Counties	Grade and Number of Nature reserves			Total Number of Nature reserves	Number of Giant Pandas in Nature reserves (head)	Percentage in the Total Number of Giant Pandas (%)
			National	Provincial	County-level			
Shaanxi	Qinling	11	6	10	0	18	275	16
	Minshan		1	0	0			
Gansu	Minshan	4	1	5	0	7	117	7
	Qingling		0	1	0			
Sichuan	Minshan	12	6	12	2	20	591	77
	Qionglai	7	2	5	1	8	473	
	Xiangling	6	1	3	0	4	61	
	Liangshan	7	2	3	2	7	115	
	Total	47	19	39	5	64	1596	100

Source of data: Hu Jinchu, etc., 2011

Table 2-12. Parameter Analysis of the Genetic Diversity of Giant Pandas in Six Mountain Systems

Mountain Systems	Number of Individuals		Similarity Coefficient SD	Band-Sharing (X)	Average Allele Frequency (g)	Average Heterozygosity Ho (%)
	Number of Bands	SD				
Qinling	24.0148	2.4713	0.5744	0.5819	0.3534	64.66
Minshan	35.6207	3.5621	0.5536	0.3635	0.3393	66.07
Qionglai	36.3341	3.4530	0.5128	0.5227	0.3091	69.09
Liangshan	33.1455	2.8329	0.6751	0.6852	0.4389	56.11
Small Xiangling	28.2524	2.1628	0.7217	0.7336	0.4839	51.51
Big Xiangling	29.8300	0.1700	0.7881	0.7904	0.5422	45.78
All Combined	30.5993	4.1532	0.4009	0.4111	0.2326	76.74

Source of data: Hu Jinchu, etc., 2000

the above six mountain systems, such as Qinling Mts. and so on, show that the panda populations between different mountain systems have the obvious genetic differentiations at genetic level (Table 2-12).

The golden monkey of Sichuan is an endangered endemic species in China and distributes only in three regions, where are Western Hubei and Eastern Chongqing, Southern Shaanxi, and Southern Gansu and Central Sichuan. The respective areas of their habitat is about 1300 km^2 in Mount Minshan, 10000 km^2 in Mount Qionglai, 2000 km^2 in Daxue Mountain and the small Liangshan Mountain, 3600 km^2 in Mount Qinling (Figure 2-24, Figure 2-25), 7447 km^2 in Shennongjia, and 2137.5 km^2 in the north slope of Mount Mountain. According to the statistics on wild animals, there are about 25000 golden monkeys in the four provinces (Quan Jiaqiang & Xie Jiabi, 2002; Li B & An R, 2002; Wang et al.,1995). The golden monkey of Sichuan and the golden monkey of Yunnan, both are native species in China and belong to *rhinopithecus*. Species. Li Haipeng et al. compared the average heterozygosis of many other species of non-human primates and found out that the golden monkeys of Sichuan has the lowest level of genetic diversity (Li Haipeng, etc., 1998; Li et al., 2003).

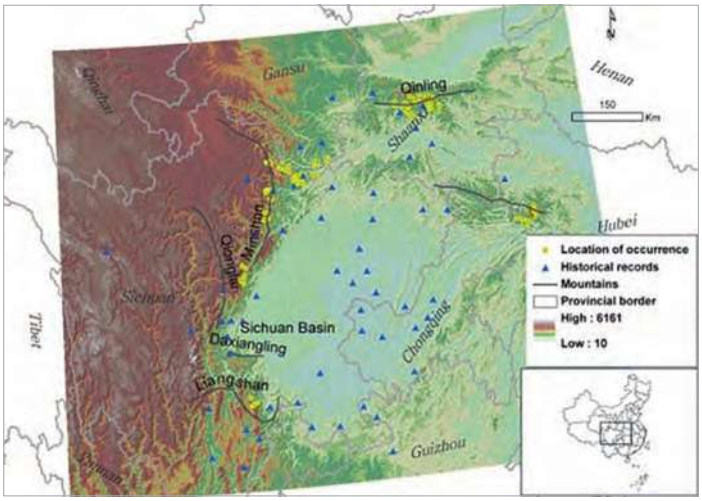


Figure 2-23. Distribution of Golden Monkeys of Sichuan (Liu Fang, 2012)

Figure 2-24. Golden monkey of Sichuan (Gu Qingsheng, 2008)

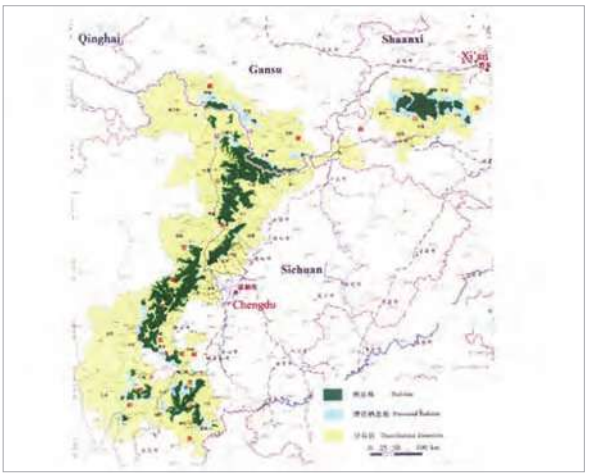


Figure 2-25. Habitat and potential habitat for the giant panda (Yan Ju, 2005)

Another analysis on RAPD data by Li Ming showed that the golden monkey of Shennongjia has a quite low level of genetic diversity (Li et al., 2001). Pan and others (2009) conducted some complementary studies by their DNA control region to describe the genetic diversity of golden monkeys in different places and the results turned out that the golden monkeys in Shenlongjia have lower level of genetic diversity than those in other test areas while those of Sichuan have a rising trend of genetic diversity. They also discovered that the mitochondrial haplotypes of golden monkeys of Yunnan are divided into two branches (A and B) from the perspective of molecular system evolution, among which A has 26 haplotypes and B has 4. The genetic distance of A and B is 11.0%. Compared with other primates, the golden monkey of Yunnan has the moderate level of genetic diversity.

Cervus eldi hainanus is an endemic species only indigenous to the Hainan Island in China. It is listed as one of the wild animals under priority protection in China. In the 1970s, the number of its wild population once declined to about 40. In order to protect this endangered species, the SFA established Datian National Nature reserve in Hainan to conduct the relevant surveys on monitoring the habitat and ecological habits of cervus eldi hainanus. Some protection measures, such as building fences, digging water pool, adopting food attraction method, building salterns, burning vegetation for regeneration, dwarfing shrubs and planting high-quality pasture were taken. In addition, cervus eldi hainanus was introduced to the wild in the conservation stations in Mount Mihou in order to expand its distribution area. Meanwhile, the forestry natural reserve of Mount Datian was incorporated into Datian National Nature reserve, and a habitat corridor was built to ease the deer's pressure to survive in Datian National Nature reserve. By 2001, the wild population of cervus eldi hainanus has numbered over 1,000, which symbolizes that this species has got rid of the risk of extinction. Zhang Qiong et al. (2009), through analyzing the DNA sequences of one source population and five *ex situ* population of cervus eldi hainanus, found that the deer' populations share one kind of haplotype, which means these species have a very low level of genetic diversity. Therefore, although its population had been recovered, the genetic diversity is still a big concern.

2.3.3 Status of *in situ* and *ex situ* conservation of genetic diversity

(1) Plants

Rational and significance

This indicator contains the information on the activities that aim at *in situ* and *ex situ* conservation of genetic diversity. Because of the declining population and the shrinking distribution areas, some species have suffered damages due to the loss of genetic variation. The continuous loss of genetic variation will jeopardize their

survivability, and ultimately accelerate the degradation that leads to extinction.

Sources of data

National Forestry Authority

Plan of China Rare Species Protection

The analysis of current situation and tendency

① ***In situ* Conservation**

China stipulated relevant technical standards, including the *Technical Regulations on in situ conservation of forest germplasm resources*, which provides detailed regulations about choosing tree species and populations for *in situ* conservation, the area of sample plots, observation indicators of surveys, collection of samples, and follow-up protection measures.

The establishment of *in situ* conservation forests protects endangered or vulnerable populations of species. The unit is taken as the tree samples within a tree population where 30 to 50 target trees can bloom and bear fruit regularly. Since 2003, the National Platform of Forest Germ-plasm Resources has established 51 *in situ* conservation forests (each with an area of 3-10 ha) in some provinces, where population is taken as the conservation unit. These forests population contain more than 40 tree species, such as *Pinus bungeana, Thuja sutchuenensis* and *Tetraena mongolica*. Moreover, the protection and monitor measures, such as investigation, taking pictures, collecting seeds and tagging, were conducted for both the stands and individuals every 10 years. *In situ* conservation forests can be set up both inside and outside the nature reserves. For instance, only one of the six *Pinus bungeana* conservation forests currently established lies inside the nature reserve.

In addition, there is a total area of 500,000 ha forest containing more than 100 tree species for seed collection, the natural stands of them are basically *in situ* conservation stands. The information and resourses of the conservation stands can be shared throug providing services.

Because of some certain restrictions, there are a large amount genetic resources of *in situ* conservation forests which haven't been systematically studied or fully utilized. The technical system of *in situ* conservation still needs to be improved further due to the shortage of the techniques which can be as the bases for determining the *in situ* conservation unit.

② **Ancient and precious trees**

By 2009, China has 2.85 million ancient and precious trees, excluding those allocated in the nature reserves, forest parks, and state-owned forest areas in the northeast and southwest, which was 7 times more than that of 1999 (339,000 trees). Among the total, the ancient trees numbered 2.85 million, occupying 99.8%; while the precious trees numbered 5,758, accounting for the rest of 0.2%. Based on the national ancient trees grading standards, the national Grade I trees (aged older than 500 years) numbered 51,000, taking up 1.8% of the total nationwide; national Grade II trees (aged from 200 to 500 years) numbered 1.04 million, 36.6% of the total; national Grade III trees (aged from 100 to 200 years) numbered 1.75 million, 61.6% of the total (Table 2-13).

Based on the census of ancient and precious trees, a national level database and photo gallery was established to develop the management software, therefore to build a nationwide information network for protecting and managing ancient and precious trees.

Table 2-13. Statistics of old precious trees species in China

Grades	Age (years)	Number	Percentage of the Total
Grade I Ancient trees	≥500	51000	1.80%
Grade II Ancient trees	200-499	1043000	36.60%
Grade III Ancient trees	100-199	1753000	61.60%
Subtotal		2847000	99.80%
Precious Trees		5758	0.20%
Total		2853000	100%

③ ***Ex situ* conservation**

The system for *ex situ* conservation of forest genetic resources includes *ex situ* conservation banks and facility storage. The former comprises comprehensive banks, special banks, regional banks and display banks.

④ **Comprehensive banks**

The comprehensive banks are built by the National Platform of Forest Germplasm Resources as conservation banks, which were early-established, typical and representative with a large amount of resources. Thus it is playing a fundamental and core role in conserving forest genetic resources. There are 22 comprehensive banks has been established in the mid-temperate zone, warm-temperate zone, subtropical zone and tropical zone so far in China. The total area of conserved forests is 420.6 ha (Table 2-14) with more than 2000 tree species, including over 120 key species. In addition, the collection, reproduction and conservation experiments have been conducted at species/population,

Table 2-14. System for *ex situ* Conservation of Forest Genetic Resources in China

Conservation method	Type	No.	Name of the Conservation Bank	Area (ha)	Conserved Tree Species	Number of Key Trees Species	Resource Quantity (Portion)
ex situ conservation	The Comprehensive Banks	1	The Bank of Forest Germplasm Resources in the Mid-Temperate Zone (Heilongjiang)	20.1	Main Tree Species of the Mid-Temperate Zone	22	4420
		2	The Bank of Forest Germplasm Resources in the Northwestern Part of Warm Temperate Zone (Inner Mongolia)	12.3	Xerophytic Arbor and Shrub Species	10	1680
		3	The Bank of Forest Germplasm Resources in the Plains and Mountainous Regions of Warm Temperate Zone (Beijing)	9.3	Main Commercial and Ornamental Tree Species	25	984
		4	The Bank of Forest Germplasm Resources in the Central Part of Warm Temperate Zone (Shanxi)	22.5	Main Afforestation and Economic Forest Tree Species	15	2534
		5	The Bank of Forest Germplasm Resources in the Eastern Part of Warm Temperate Zone (Shandong)	21.0	Main Afforestation and Economic Forest Tree Species such as populus	16	2000
		6	The Bank of Forest Germplasm Resources in the Southern Part of Warm Temperate Zone (Henan)	17.0	Native Tree Species	25	2211
		7	The Bank of Forest Germplasm Resources in the Western Part of Warm Temperate Zone (Shaanxi)	14.1	Peculiar Native Tree Species & Rare and Endangered Tree Species	12	620
		8	The Germplasm Resources Bank of Economic Forests Indigenous to Deserts in Warm Temperate Zone (Xinjiang)	3.3	Tree Species of the Special Economic Forests	7	222
		9	The Bank of Forest Germplasm Resources in the Northern Part of the North-Subtropical Zone (Mount Jingshan of Hubei Province)	56.7	Peculiar Native Tree Species & Rare and Endangered Tree Species	24	10023
		10	The Bank of Forest Germplasm Resources in the Eastern Part of the North-Subtropical Zone (Nanjing and Xuzhou of Jiangsu Province)	15.8	Afforestation Tree Species in plains such as Populus, Salix and gingko	12	2450
		11	The Bank of Forest Germplasm Resources in the Southern Part of the North-Subtropical Zone (Hunan)	8.3	Peculiar, Exotic and Economic Tree Species	15	858
		12	The Bank of Forest Germplasm Resources in the Eastern Part of the Mid- Subtropical Zone (Zhejiang)	9.2	Tree Species of Economic Forests and Precious Tree Species	12	8208

(Continue)

Conservation method	Type	No.	Name of the Conservation Bank	Area (ha)	Conserved Tree Species	Number of Key Trees Species	Resource Quantity (Portion)
ex situ conservation	The Comprehensive Banks	13	The Bank of Forest Germplasm Resources in the Western Part of the Mid- Subtropical Zone (Sichuan)	26.2	Main Afforestation and Precious Tree Species	26	8000
		14	The Bank of Forest Germplasm Resources in the South-Subtropical Zone (Guangxi)	20.1	Main Afforestation, Precious and Exotic Tree Species	18	1089
		15	The Bank of Forest Germplasm Resources in the Subtropical Zone (Jiangxi)	46.8	Peculiar Native Tree Species &Rare and Endangered Tree Species	26	2000
		16	The Bank of Forest Germplasm Resources in the Tropical Zone (the South-Subtropical Zone included) (Guangxi)	23.9	Precious Tree Species	16	1300
		17	The Exotic Tree Species Bank of the Research Institute of Forest , Chinese Academy of Forest		Exotic Tree Species	12	1100
		18	The Flowers Bank of the Research Institute of Forest , Chinese Academy of Forest		Ornamental Trees and Woody Flowers	46	3170
		19	The Bank of Evergreen Broadleaf Forests in the Mid-Subtropical Zone (Zhejiang)	12.0	Peculiar Tree Species	22	1788
		20	The Bank of Peculiar Tree Species in the Tropical Zone (Guangdong & Hainan)	19.0	Tree Species Indigenous to Tropical Areas	30	2444
		21	The Bank of Economic Tree Species in the Southwest China (Yunnan)	23.0	Economic Tree Species	18	2858
		22	The Bank of Bamboo and Rattan Resources (Anhui & Hainan)	40.0	Bamboos and Rattans	15	582
		Sub-total		420.6			60145
	The Special Banks	1	The National Germplasm Bank of *Castanea mollissima*		*Castanea mollissima*		
		2	The National Germplasm Bank of *Populus*		Populus		
		3	The National Germplasm Bank of *Pinus massoniana*		*Pinus massoniana*		
		4	The National Germplasm Bank of *Camellia*		Camellia		
		5	The National Germplasm Bank of Bamboo		Bamboo		
		6	The National Germplasm Bank of Chinese fir		Chinese fir		
		7	The National Germplasm Bank of *Pinus massoniana*		*Pinus massoniana*		
		8	The National Germplasm Bank of *Camellia oleifera*		*Camellia oleifera*		
		9	The National Germplasm Bank of *Populus*		Populus		
		10	The National Germplasm Bank of *Alsophila spinulosa*		*Alsophila spinulosa*		
		11	The National Germplasm Bank of Spruce		Spruce		
		12	The National Germplasm Bank of *Lyeium chinense*		*Lyeium chinense*		
		13	The National Germplasm Bankof *Pinus sylvestris*		*Pinus sylvestris*		

(Continue)

Conservation method	Type	No.	Name of the Conservation Bank	Area (ha)	Conserved Tree Species	Number of Key Trees Species	Resource Quantity (Portion)
ex situ conservation	The Regional Banks	Seed Bases	Seed Gardens	19600	131 of which are National-level Key Seed Bases		
			Cutting Orchards	18100			
			Trial and Demonstration Forests	222100			
			Seed Production Stands	146100			
		Seed-Collect-ing Bases	Seed-Collecting Bases at All Levels	630000			
	The Display Banks		160 Botanic Gardens and Arboretums				
The Facility Bank	The LT Banks		The Low-Temperature Banks for Forest, Bamboo and Rattan		Peculiar Tree Species	20	4107

Table 2-15. Forest genetic resources conserved by the National Platform of forest Germplasm Resources

Parge of accession numbers	Conserved Tree Species		Conserved Resources	
	Number of species	Percentage	Number of accessions	Percentage
>1000	7	0.33%	17408	35.14%
100-999	82	3.88%	23282	47.00%
50-99	34	1.61%	2299	4.64%
10-49	123	5.82%	2551	5.15%
1-9	1869	88.37%	3996	8.07%
Total	2116	100%	49536	100%

population/family, population and individual levels.

Since the 1980s, a great quantity of forest genetic resources have been collected and conserved, among them, 60,000 accessions by the National Platform of Forest Germplasm Resources alone (Table 2-15). The 60,000 accessions cover 2,116 tree species, among which 7 main afforestation tree species enjoy over 1,000 accessions of resources, namely Chinese fir, Chinese pine, masson pines, *Pinus sylvestris* L. var. *Mongolica*, *Larix olgensis*, *Larix kaempferi* and *Betula alnoides*; 82 tree species enjoy 100 to 999 accessions of resources, 94% native and 6% exotic. There are also a large amount of genetic resources conserved in the seed bases at all levels.

⑤ **Special Banks**

Special banks are established by the State Forestry Administration (SFA) through special project construction and they conserve the systematically collected genetic resources of single tree species. The special banks serve as the expanded functions of comprehensive banks and are mainly used in forming the base populations for tree breeding projects. The national germplasm banks have been established, for 13 species as Chinese firs, *Masson pines*, *Poplars*, *Spruces*, *Pinus sylvestris*, *Bamboo*, *Castanea mollissima*, *Lyeium chinense*, *Camellia japonica*, *Camellia oleifera* and *Alsophila spinulosa*.

⑥ **Regional Banks**

Regional banks, consisting of seedling bases, seed bases and so on, are the places to collect and store the conserved breeding materials or superion reproduction materials. It can be seen as the combination of conserving genetic resources and breeding. Up to now,

409,100 ha of forest seedling bases and 630,000 ha of seed-collecting bases have been established, among which, 131 are national-level key forestry seed bases (161 seed-collecting forest stands) conserving main timber tree species like Chinese fir, masson pines, *Pinus tabulaeformis* and *Larix gmelini*, and 44 tree species/genus with other functions. The plant germplasm bank, established in Kunming, Yunnan, has a collection of numerous forest genetic resources.

⑦ **Collection and Conservation Methods**

Collection and conservation of genetic resources from research projects on genetics and breeding. More than 100 tree species have been genetically improved, including *Chinese fir, Pinus, Larix, Populus, Salix, Paulownia, Juglans regia, Castanea mollissima, Camellia oleifera* and *Phyllostachys pubescens*. During the improvement process, many provenances, superior trees, families, clones and varieties were conserved.

Collection and conservation of genetic resources from research projects on genetic resources. Since the 1980s, a special research project on the collection and conservation of forest genetic resources has been initiated in China, which built a coordination network nationwide and constructed the conservation banks. 22 forest genetic resources banks in different climate zones of China has been established up to now, mainly conserving the population/provenance, family and individual/clone of native tree species such as *Chinese fir, Pinus massoniana, Pinus sylvestris, Pinu bungeana, Pinus tabulaeformis, Spruce, Larix, Populus, Salix, Juglans mandshurica, Liriodendron chinense, Alnus cremastogyne, Ginkgo biloba, Melia azedarach, Castanopsis hystrix* and *Gleditsia sinensis*.

Collection and conservation of genetic resources from seedling construction projects and construction projects of germplasm banks. In recent years, China has established a batch of national high quality forest seed bases and national forestry germplasm banks. In 2009, SFA has announced the establishment of the first 131 national high quality seed bases and 13 national forestry germplasm banks. Moreover, several special projects such as the Construction Project on the Germplasm Bank of Tropical Forests and the Construction Project on the Germplasm Bank of Subtropical Forests have been launched. These special banks collect and conserve a large number of native tree species, including bamboo, *Schima superba, Camellia oleifera, Lycium chinensis, Castanea mollissima* and *Camellia japonica*.

Collection and conservation of genetic resources from research projects on introduced exotic tree species. China has introduced *Eucalyptus, Acacia, Pinus elliottii, Pinus taeda, Pinus caribaea, Populus, Tectona grandis, Casuarina equisetifolia* and so on. During the process of introduction and cultivation, genetic resources, including provenances, varieties and clones, are collected and conserved.

Collection and conservation of genetic resources in botanic gardens (arboreta). There are over 160 botanic gardens and arboreta all over China, where a large amount of forestry genetic resources are systematically collected and conserved with each species as the unit.

Main problems and demands

① *In situ* conservation is fundamental and systematic work involving a long period of time, in terms of collection, conservation, research and information processing of the genetic resources. Therefore, it has strong demand on strengthening capacity building with a stable group of personnel in order to achieve the overall improvement.

② The technologies for *ex situ* banks and low-temperature facility banks concerning the safe and high-efficient storage for longer term still need to be improved. Those concerning resources monitoring, evaluation, utilization, etc. are still undeveloped. Thus, to set up a national coordination group working on the conservation, evaluation and utilization of forestry genetic resources is strongly needed to enhance the coordination management, and to formulate a complete set of systems of technical standards. Furthermore, a stable and long term investment mechanism is required to set up for establishing national low-temperature facility banks as well as the matching supporting facilities.

③ The technologies for building *ex situ* conservation banks and facilities are relatively backward. Thus, the theoretical and technological studies are needed accordingly to maintain the genetic diversity of *ex situ* conservation forests and to prolong the vitality and germination rate of seeds in the banks.

(2) Animals

Rational and significance

The *in situ* and *ex situ* conservation of species are two important means in protecting the genetic diversity. The essential method of *in situ* conservation in China is to establish the nature reserves, which is good for protecting genetic resources. The key methods of *ex situ* conservation are to build zoos (animal exhibition areas), wild animal rescue (breeding) centers (bases), centers for conserving the germplasm genes of endangered wildlife and other institutes for conserving genetic resources. Only by protecting the species' genetic diversity, will the species have higher adaptive ability to the environment and larger potency of evolution consequently. Thus, the species diversity and the whole eco-system can be protected to achieve the sustainable development.

Sources of data

National Forestry Authority

The analysis of current situation and tendency

① ***In situ* Conservation**

In China, *in situ* conservation of animals is done mainly through establishing various types of nature reserves, including scenic spots. According to it, China protects the habitat of the wild giant pandas to ensure this endangered species will thrive and live in their native habitat. The giant panda, as a typical animal species that lives on forests, mainly distributes in the forest of mountains in Sichuan, Shaanxi, Gansu and other provinces. There are 64 nature reserves in the above three provinces targeting to protect the giant pandas so that the fragmented habitat of giant pandas will be recovered. The pandas in different conservation zones have the possibility to communicate with each other. According to the latest statistics, the number of wild giant pandas in China has gradually increased to over 1,800, larger than the 1,000 in the 1980s. It is one of the successful cases that the endangered species have been saved from the *in situ* conservation. In addition, ten wild animals such as crested ibis, yangtze alligator, shinisaurus crocodilurus and tragopan caboti have changed their living environment from the captive breeding grounds to the wild. The natural propagation of crested ibis, wild horse, etc. is also realized after they are released in the wild.

② ***Ex situ* Conservation**

The *ex situ* conservation of wildlife and of germplasm resources enjoys relatively fast development, of which the methods include establishing zoos, wild animal parks, wild animal rescue (breeding) centers (bases), centers for conserving germplasm genes, etc. Specifically, there are 77 wild animal rescue centers of various types, 171 zoos (animal zoos within the parks included), and 16 wild animal parks established nationwide.

Based on the sample survey on 68 zoos (table 2-16), there are 789 wild animals species raised in the sample zoos, and the species of those in Beijing Zoo, Shanghai Zoo and Guangzhou Zoo exceed 400 (Fang Hongxia et al., 2010). Among all the wild animals raised in these sample zoos, there are 234 species of wild animals under the national protection and 254 species are listed in CITES appendix. The Level I and Level II key wild animals under the national protection respectively take up 70.57% and 47.09% of the total; the number of Chinese animals raised in these zoos which are listed in Appendix I, II, and III account for 64.21%, 60.86% and 50% respectively of the total Chinese animals in these three appendixes.

Some of the professional institutes, such as The National Center for the Protection of Endangered Wildlife Germplasm, the Key Laboratory on the Genetics Conservation and Reproductive Biology of Endangered Wildlife, the SFA Detecting Center of Wildlife and so on, all have so far completed the establishment of genetic banks for nearly 1,000 species at five levels, namely the sample bank of organs and tissues of endangered wildlife, germ cell bank, clone, genomic DNA document bank and cDNA document bank. They collected nearly 200,000 sample genes, which helps to shape them into irreplaceable resource platforms. If take the National Center for the Protection of Endangered Wildlife Germplasm as an example, it has established genetic resources banks for almost 50 endangered wild animal species, such as the giant panda, crested ibis and South China Tiger.

Table 2-16. Analysis on forest wild animals in the sample zoos

Order	Number of China's Species in the Order	Number of China's Species in Sample Zoos	Family	Number of China's Species in the Family	Number of China's Species in these Zoos
Beasts					
Proboscidea	1	1	Elephantidae	1	1
Primates	52	49	Hylobatidae	6	5
			Cercopithecidae	36	34
			Lemuridae	1	1
			Cebidae	7	7
			Lorisinae	2	2
Rodentia	242	16	Cirretidae	85	1
			Castoridae	1	1
			Hystricidae	4	2
			Castoridae	2	2
			Muridae	63	1
			Sciuridae	40	7
			Caviidae	2	2
Artiodactyla	84	62	Cervidae	24	15
			Camelidae	1	1
			Bovidae	52	42
			Suidae	2	2
Perissodactyla	13	12	Equidae	9	9
			Rhinocerotidae	4	3
Insectivora	93	1	Erinaceidae	9	1
Carnivora	101	72	Ailuridae	1	1
			Procyonidae	4	4
			Viverridae	12	5
			Felidae	30	26
			Herpestidae	2	2
			Canidae	16	16
			Ur sidae	4	4
			Mustelidae	24	9
Lagomorpha	37	3	Leporidae	13	3
Chiroptera	135	2	Pteropodidae	11	2
Birds					
Coraciiformes	37	15	Upupidae	1	1
			Ramphastidae	3	3
			Bucerotidae	13	11
Columbiformes	37	9	Columbidae	34	9
Gruiformes	39	15	Otididae	3	2
			Gruidae	13	11
			Rallidae	20	2
Galliformes	65	37	Tetraonidae	8	1
			Phasianidae	57	36
Guculiformes	17	2	Cuculidae	17	2
Piciformes	42	6	Capitonidae	9	2
			Picidae	33	4
Passeriformes	721	155	Alaudidae	14	2
			Pycnonotidae	21	9
			Laniidae	10	1
			Turdidae	88	11
			Irenidae	6	1
			Timialiidae	141	36
			Sturnidae	20	10
			Remizidae	2	1
			Frinfillidea	13	3
			Motacillidae	11	5
			Paridae	21	8
			Cisticolidae	9	1
			Nectariniidae	12	2
			Ploceidea	9	7
			Muscicapidea	40	8
			Emberizidae	27	3
			Zosteropidae	3	2
			Certhiidae	4	1
			Corvidae	32	8
			Fringillidae	61	22
			Sylviidae	88	8
			Ploceidae	3	3
			Dicaeidae	6	1
Falconiformes	65	27	Falconidae	13	4
			Accipitridae	52	23
Psittaciformes	56	47	Psittacidae	56	47
Apodiformes	10	1	Apodidiae	9	1
Amphibians and Reptiles					
Caudata	41	4	Ambystomatidae	1	1
			Salamandridae	20	2
Anura	285	21	Bufonidae	20	5
			Pelobatidae	68	2
			Rhacophoridaae	48	4
			Microhylidds	17	3
			Ranidae	112	2
Serpentes	220	53	Biodae	10	8
			Elapidae	10	5
			Colubridae	156	30
Lacertilia	175	30	Gekkonidae	35	4
			Chamaeleonidae	2	2
			Varanidae	3	3
			Lacertidae	23	2
			Scincidae	40	5

National Report
on Sustainable Forest Management

3

Maintenance of Productive Capacity of
Forest Ecosystems

The productive capacity of forest ecosystem, as one of the important indicators, can be utilized to measure the growth condition of trees as well as to reflect the quality and structure of forest ecosystem. It determines not only the production of timber and non-wood products and the exertion of ecological protection but also the supply capacity of ecological cultural products. From the 1950s to the late 1970s, forestry sector played a key role in rehabilitation, development and construction of national domestic economy. However, giving priority to timber utilization led to the consumption exceeded increment of forest resources. Since the 1980s, forestry management shifted from focusing on timber utilization to "focusing on timber utilization with taking ecological development into account". Accordingly, logging quota system was conducted, and plantation tending was strengthened. Thus, forest resources have been protected effectively, meanwhile the forest area as well as the stock volume achieved the so called "double increments". In particular, forestry development has adhered the priority of ecology construction to achieve the sustainable development since the 21st century. In addition, the construction of key forestry projects and especially the sustainable forest management has been emphasized, thus, the productive capacity of forest ecosystem gets improved gradually.

3.1 Area and percent of forest land and net area of forest land available for wood production

Rational and significance

Wood production can directly reflect the supply of wood products and their direct economic benefits. The area and percent of forest land and net area of forest land available for wood production are the basic indicators for assessing the potency of timber supply. The dynamic change of the forest area and proportion can reflect the changes of wood production capacity which meets demands from the society. It is greatly helped with revealing the policies impacts on timber tending, in terms of forestry development, forest management, etc. Forest land area for timber production in this report especially refers to the state-owned timber forest area.

Sources of data

National forest inventories

The analysis of current situation and tendency

There are five forest categories in China, including protection forest, timber forest, economic forest, fuel wood forest, special purpose forest, etc. According to the 7th national forest inventory, China has 303.78 million ha of forest land, accounting for 31.64% of total land area. Timber forest land area is 64.16 million ha, accounting for 21.12% of forest land area and 35.37% of forested land area respectively. Furthermore, arbor timber forest area is 60.07 million ha (93.63% of total timber forest area), while bamboo forest area is 4.09 million ha (6.37% of timber forest area).

(1) Change of area and percent of timber forest

In all arbor timber forest area, the hardwood forest is accounting for 46.74%, softwood forest is accounting for 45.75%, and mix forest of hardwood and softwood is accounting for 7.51%. Timber forest in China is mainly distributed in Hunan, Guangdong, Fujian, Jiangxi, Heilongjiang, east Inner Mongolia, Yunnan, Guangxi, etc, with the accumulated area presenting 63.49% of total timber forest area in China. Forest land in the middle and eastern regions has great potential

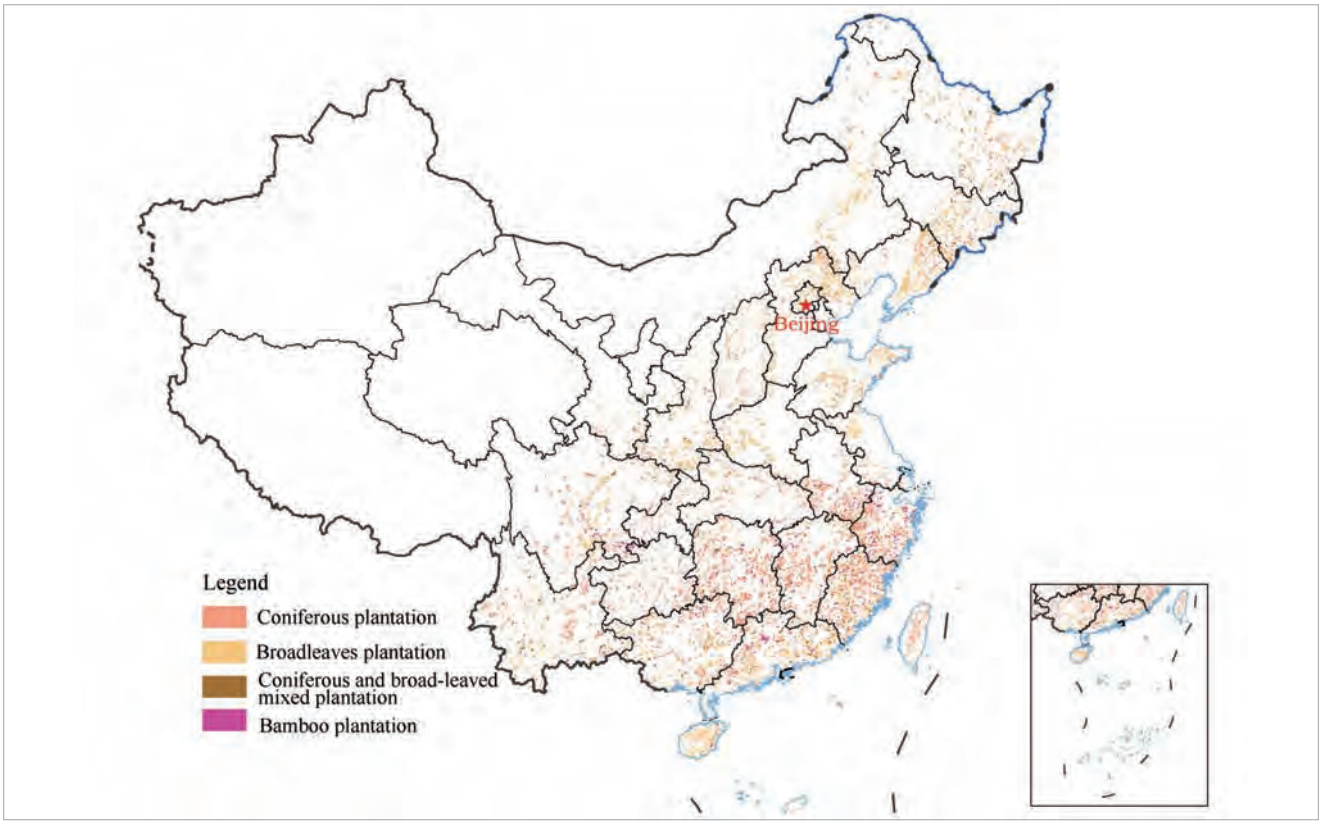


Figure 3-1. Distribution of plantation

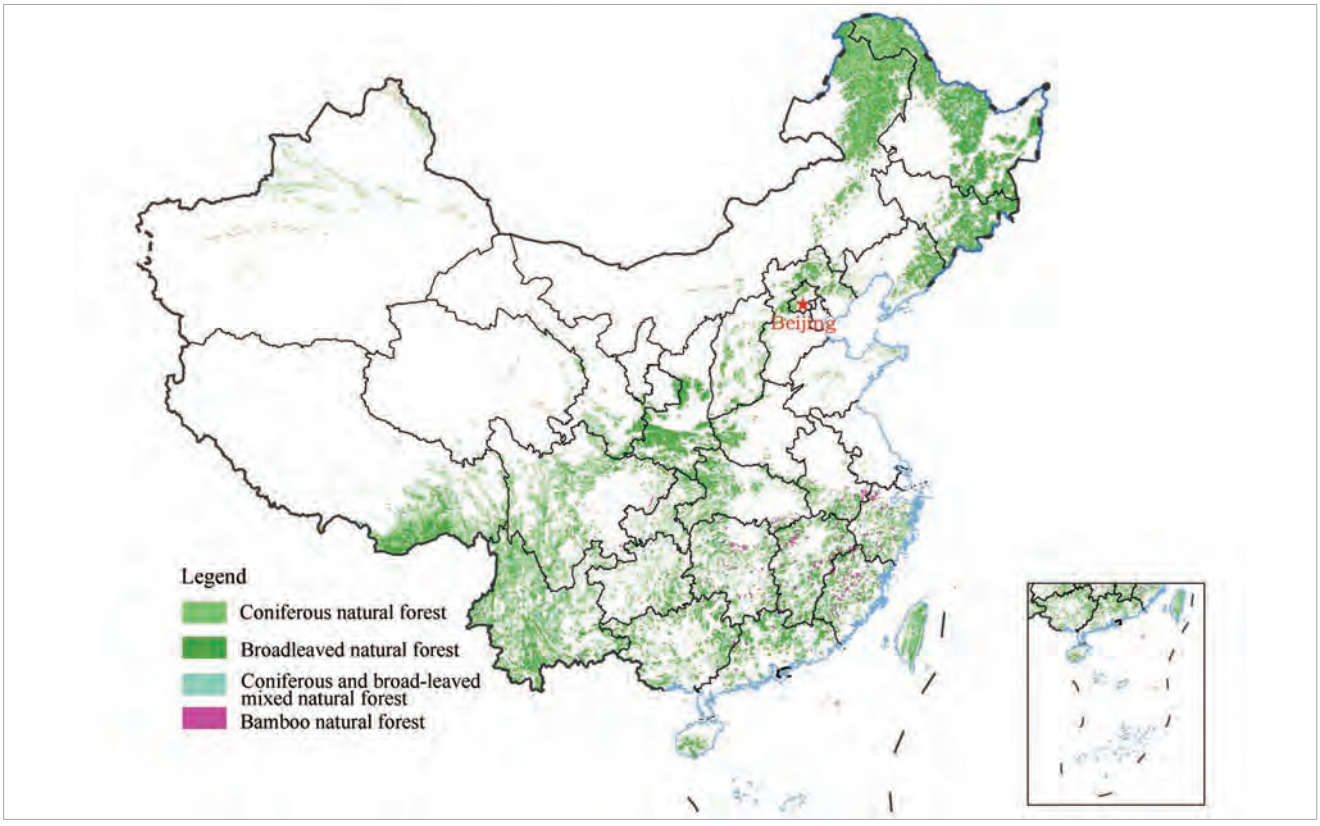


Figure 3-2. Distribution of natural forest

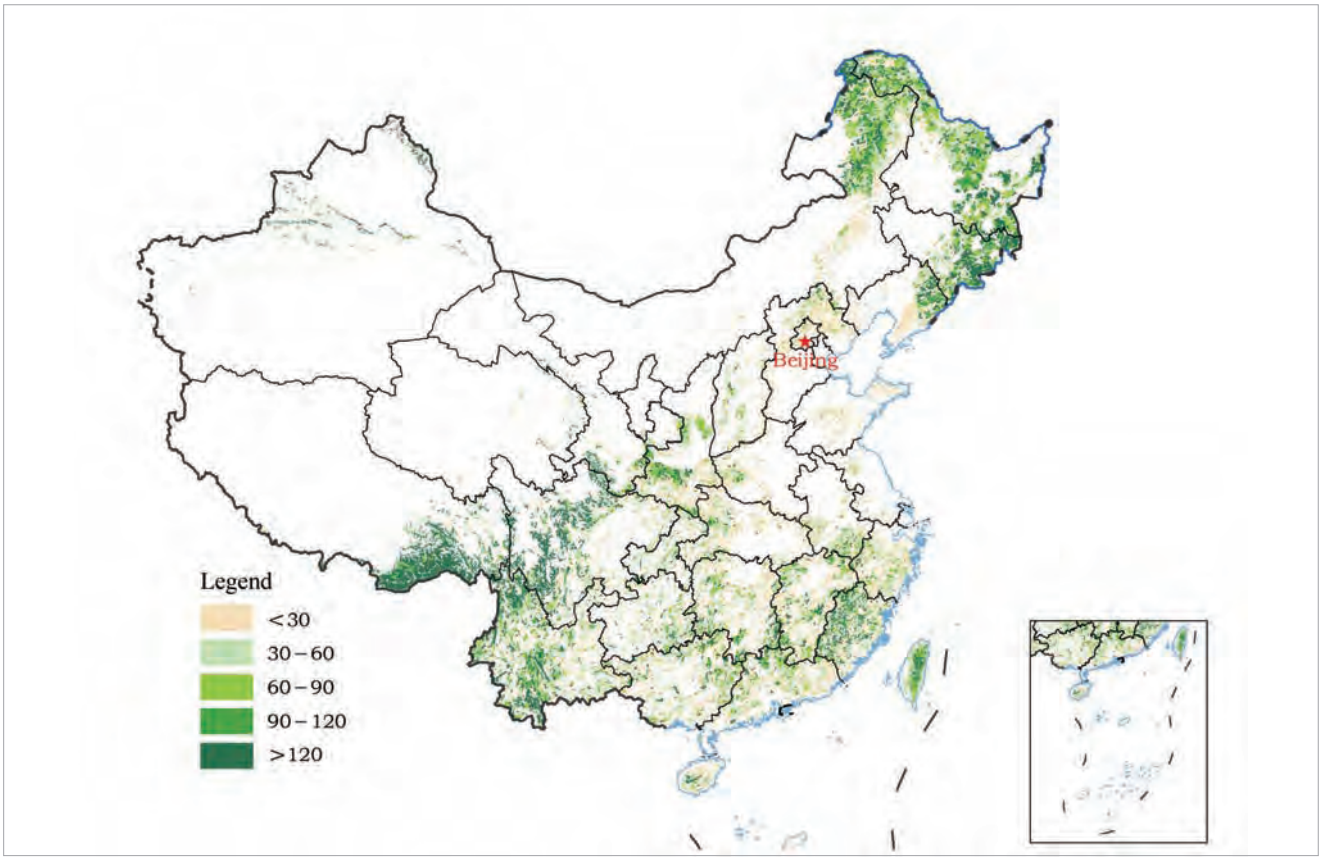


Figure 3-3. Stock volume level per ha of arbor forest

on production, which is suitable for tending timber forest. In general, the proportion of timber forest area is relative high. Especially in the provinces like Fujian, Anhui, Guangdong, Zhejiang, Jiangsu, Hunan, etc, the percentage of timber forest area exceeds 50%. However, the western provinces, such as Gansu, Qinghai, Ningxia, and Xinjiang and so on, has lower proportion of timber forest area, which is less than 5%, because of that the western regions emphasized on the national ecological development, and rather tending protection forest than other forests.

In the 1980s and early days, forestry was focus on timber development and utilization, which resulted in providing timber as the main function of forest. The area of timber forest increased consequently, whose percentage in forested land area maintained over 70% (Figure 3-4). China issued *Forestry Zoning in China* in 1987, and implemented Natural Forest Protection Program (NFPP) since 1997 in state-owned forest farms in northeast region and Inner Mongolia, upper reaches of Yangtze River and upper and middle reaches of Yellow River. Since 2001, forest ecological benefit compensation has been initiated to be implemented. Hereafter, in accordance with ecological locations and forest leading functions, China gradually categorized the forest like upper and middle reaches of big rivers where the important ecological locations areas ecological public welfare forest. Therefore, the forest category structure has been adjusted to categorize a great amount of timber forest as protection forest for management. As a result, the proportion of timber forest area declined dramatically. Compared with the 1970s, the percentage of timber forest in forested land area decreased by 47.34 per cent; especially in Xinjiang, Qinghai, Tibet, Gansu, Guizhou in western region, and in provinces like Heilongjiang, Inner Mongolia, Hubei, Shanxi, Hebei, Beijing, etc, the decreasing rate exceeded 50%.

(2) Area and percent of timber forest by origin

With the progress of NFPP and the development of

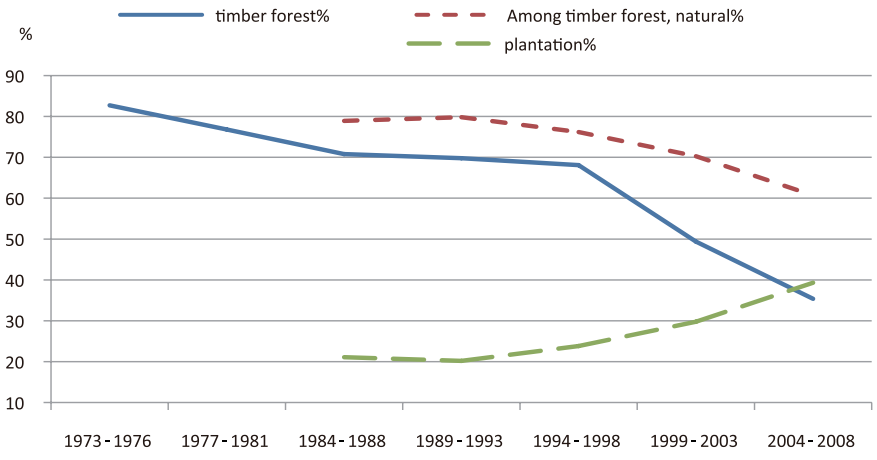


Figure 3-4. Area proportion change of national timber forest by origin

ecological public welfare forest, the area proportion of natural timber forest (Figure 3-4) showed a decreasing trend through adjustment of forest category structure; meanwhile, the plantation area kept increasing by planting a large area of fast growing and high yielding forest, such as poplar, eucalyptus, Chinese fir, and short rotation timber forest and bamboo forest. In mid-1980s, the percentage of natural timber forest area occupied 78.91% of the total timber forest area, but dropped to 60.68% in the 7th forest resource inventory; the proportion of timber plantation increased by 18.23 per cent, reaching to 39.32%.

Natural timber forest is mainly distributed in provinces as Yunnan, Heilongjiang, Inner Mongolia, Guangxi, Jilin, Jiangxi, Hunan, Fujian, etc, where the sum of area occupies 70.97% of the total natural timber forest area nationwide in China. Timber plantation is mainly distributed in central and eastern regions, including Guangdong, Hunan, Fujian, Jiangxi, Zhejiang, Anhui, Henan, and other provinces like Guangxi, Sichuan, Yunnan, etc, the total area sum up to 70.34% of total natural timber forest area nationwide in China.

(3) Area and percent of dominant tree species (groups) in arbor timber forest

If categorized by dominant tree species (groups), the top 10 in terms of area proportion (Table 3-1) are Chinese fir, masson pine, poplar, quercus, larch, birch, eucalyptus, *Pinusyunnanensis*, slash pine and cypress, which sum up the area of 35.89 million ha (accounting for 58.05% of total forest area nationwide in China). Chinese fir forest is mainly distributed in Hunan, Jiangxi, Fujian, Guangxi, Zhejiang, etc, masson pine forest is mainly distributed in Guangxi, Hunan, Fujian, Zhejiang, etc, and poplar forest is mainly distributed in Inner Mongolia, Shandong, Henan, etc. Quercus is mainly distributed in Yunnan, Heilongjiang, Jilin, etc, and larch is mainly distributed in Inner Mongolia, etc. Birch is mainly distributed in Inner Mongolia, Jilin,

Table 3-1. Area and percent of dominant tree species (groups) in arbor timber forest

Main tree species	Area (10,000 ha)	Area (%)
Total	6007.44	100.00
Chinese fir	827.09	13.77
Masson pine	652.13	10.86
Poplar	451.66	7.52
Larch	339.75	5.66
Quercus	331.65	5.52
Birch	248.36	4.13
Eucalyptus	233.75	3.89
Pinusyunnanensis	223.24	3.72
Cypress	95.16	1.58
Slash pine	85.78	1.43
Other tree species	2518.87	41.92

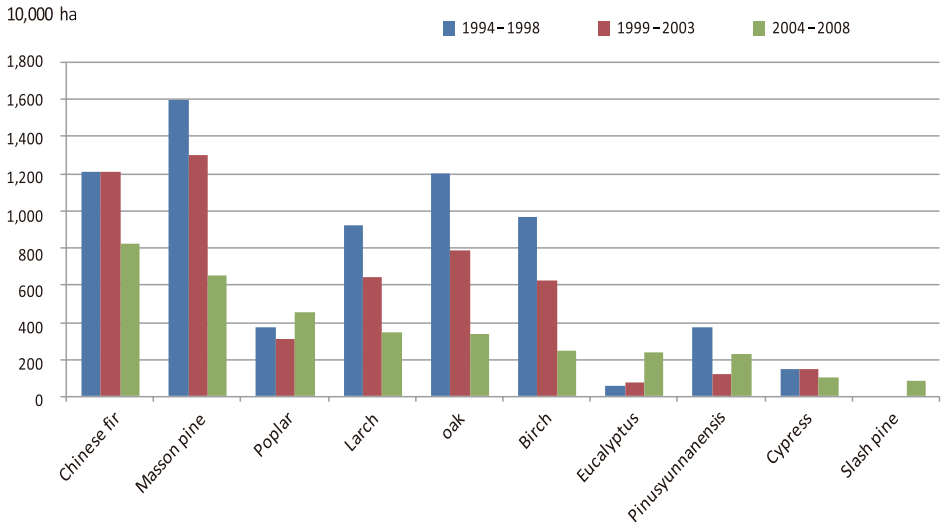


Figure 3-5. Area change of dominant tree species in arbor timber forest

Table 3-2. Change of trees ownership structure in timber forest

Ownership of trees	7th NFI		6th NFI	
	Area (10,000 ha)	Area percentage (%)	Area (10,000 ha)	Area percentage (%)
State owned	1814.16	28.27	3535.64	42.36
Collective management	2202.33	34.32	3267.74	39.15
Individual management	2399.67	37.40	1543.46	18.49

etc, *Pinusyunnanensis* is mainly distributed in Yunnan, Sichuan, etc, and slash pine is mainly distributed in Jiangxi, Guangdong, etc, and cypress is mainly distributed in Sichuan, Tibet, etc.

Since the late 1990s, due to the division of ecological public welfare forest and the adjustment of forest seedling structure, timber forest areas of the species like Chinese fir, masson pine, larch, quercus, birch and cypress all decrease (Figure 3-5). *Pinusyunnanensis* is an important tree species for resin tapping and timber producing in provinces like Yunnan. Because of its high economic value, the timber forest area started to enlarge instead of declining. In addition, eucalyptus and poplar are two major fast growing species in south and north China. Due to the fast growth, short rotation, and high economic benefit, the plantation areas expand constantly.

(4) Timber forest area and the proportion according to timber forest ownership

Since the late 1990s (Table 3-2), the percentage of state-owned forest areas drop by 14.09%, while the proportion of individual management up by 18.91%. The ratio between state-owned, collective management and individual management has changed from 42:39:19 to 28:34:38. In central and eastern provinces, contractual management right of collective forest land and ownership of trees are allocated to farmer households through conducting the reform of collective forest tenure system. Therefore, the timber forest area proportion under individual management significantly rises, especially in provinces like Tianjin, Hebei, Shanghai, Jiangsu, Anhui, Fujian, Jiangxi, Shandong, Henan, Hunan, etc, the proportion of individual management exceeds 60%. Nevertheless, individuals have become the major entity of timber forest management.

Case: Adjustment of forest category structure in Qingyuan County

Qingyuan Man Autonomous County, located in the eastern mountain area of Liaoning, is a key forestry county in Liaoning Province. Forest land area in Qingyuan County is 312,561.9 ha, with the forest cover of 71.4%, accounting for 79.59% of total county land area. Qingyuan County is a pilot demonstrati *in situ* of national forest administration, where the forest category division work started in the late 1980s. In recent years, based on the strategic objective of "developing themajor ecological county in Liaoning", Qingyuan County strengthens the development of forestry ecological system, which is starting from developing "green ecological shelter zone" and "clean water source" of urban agglomeration around Shenyang. First, it allocates 182,000 ha of public welfare forest, where the national public welfare forest area is 86,700 ha with strict conservation; second, it suspends commercial logging on 95,300 ha of natural forest; as of the third, it establishes Liaoning Hun River Source Provincial Level Nature Reserve with the area of 18,900 ha with standardized management; fourth, it conducts mountain closure in fragile ecological area, with the closure area of 33,000 ha, which ensuring the closure area will grow to mature forest; last, it launches public plantation and greening campaign, and endeavors to develop forest reserve resources, which has accumulatively afforestation of 43,300 ha since 2006.

By several zonings/divisions and gradual adjustment of forest category structure, public welfare forest proportion in Qingyuan County has risen from 9.6% in 1990 to 42.1% in 2010, while the proportion of commercial forest has dropped from 90.4% to 57.9%. The detailed information are shown as follows:

forest category structure adjustment in Qingyuan County

Year	1 Protection forest	2 Special purpose forest	3 Timber forest	4 Fuel wood forest	5 Economic forest	Total
1990	9.0%	0.6%	83.8%	3.4%	3.2%	100.0%
1995	7.6%	0.5%	80.7%	8.2%	3.0%	100.0%
2000	43.0%	0.4%	49.3%	4.5%	2.8%	100.0%
2005	40.9%	0.4%	54.6%	1.3%	2.8%	100.0%
2010	41.8%	0.3%	53.9%	1.3%	2.6%	100.0%

The forest stock volume of Qingyuan County in 2007 was 25.52 million m^3, and then increased to 26.94 million m^3 in 2011, of which the increase rate is 5.3% with the net increase of 1.42 million m^3 during these five years. The forest resources has been constantly increased as a whole, meanwhile, the quality of standing forest has been improved greatly.

Based on forest resource condition in Qingyuan County and applicable growth rate table, the total increment of forest stock volume is calculated to about 956,000 $m^3 \cdot a^{-1}$, among which the total increment of that in the region for commercial timber is 725,000 $m^3 \cdot a^{-1}$, accounting for 75.84%. The area suitable for commercial timber is less than 2/3, while its increment accounts for 3/4 of total increment. The major reason is that the timber forest mainly consists of young and middle aged and near-mature forest with high growth rate; while protection forests mainly consist of mature and over-mature forest with quite low growth rate.

Qingyuan County successively issued *Regulations on Forest Resources Protection in Qingyuan County, Management Methods on Comprehensive Development in Mountain Area, Management Methods on Directed Seedlings in Mountain Area*, and drafted *Plan for Forest Land Protection and Utilization* and Plan for *Green Mountain Protection*, which provide the reliable policy guarantee for sustainable forest management. In order to adapt diverse entities of forest ownership after the reform of collective forest tenure system, Qingyuan County converts from overall logging quota management to sub-item control, and allocates annual logging quota to households and sub-compartments. At village level, the announcement system was implemented by posting the notice of allocation list for supervision by forest farmers.

Currently, annual stock consumption of logging quota in Qingyuan County is about 240,000 m^3, which equals 1/3 of total forest stock volume increment in the commercial timber region.

Statistical table of logging quota situation in 2000, 2005, and 2010 Unit: ha, m^3

Year	Commercial forest total		Final felling		Tending		Regeneration logging		Improvement		Other logging		Timber for own use	
	Area	Stock volume	Area	Stock volume	Area	Stock volume	Area	Stock volume	Area	Stock volume	Area	Stock volume	Area	Stock volume
2000	5732	242254	1282.5	147779	4012.8	64034			436.2	30441				
2005	5453.5	167814	637.1	83199.0	4274.0	57658.9	3.9	278.5	538.5	26678.0			730.5	5935.0
2010	8443.6	237868.3	677.1	88376.4	7098.9	100575.9	6.9	899.5	466.7	30751.8	194.0	17264.7	738.4	13852.9

Remark: average outturn percentage is over 70%, less than 75%.

3.2 Total growing stock and annual increment of both merchantable and non-merchantable tree species in forests available for wood production

Rational and significance

Forest growing stock volume refers to the total timber volume of tree trunks in a certain forest area. Forest increment refers to the total increment of forest stock volume in a certain period of survey - interval. The stock volume of timber tree species reflects total forest resources scale and richness which could use for timber production. Annual increment reveals average annual growth of forest stock volume for timber production, which is intimate connection with annual timber harvesting. Moreover, it is an important foundation to measure sustainable forest management. In China, the timber forest is divided based on the distinctions of ecological locations and cultivation objectives rather than as merchantable and/or non-merchantable tree species. In this report, forest with merchantable and non-merchantable tree species for timber production refers in particular to timber forest in China.

Sources of data

National forest inventories

The Analysis of current situation and tendency

(1) Stock volume and annual increment of timber forest

Stock volume of timber forest in China is 4.23 billion m^3, accounting for 31.63% of total national forest stock volume (13.36 billion m^3). The timber forest stock volume per ha is 70.63 m^3, which is 15.52 m^3 lower than stock volume per ha arbor forest (85.88 m^3). Annual increment of timber forest is 372 million m^3, accounting for 62.22% of annual total increment of arbor forest (598 million m^3). The annual increment of per ha timber forest is 6.20 $m^3 \cdot a^{-1}$, which is 2.35 $m^3 \cdot a^{-1}$ higher than that of arbor forest (3.85 $m^3 \cdot a^{-1}$).

Most plantations in China are in middle and young aged stage, with low stock volume per unit but high annual increment. The stock volume of plantations per ha (54.04 m^3) is 26.82 m^3 lower than that of natural forest (80.86 m^3), however, its annual increment per ha (6.66 $m^3 \cdot a^{-1}$) is 0.76 $m^3 \cdot a^{-1}$ higher than that of natural forest (5.90 $m^3 \cdot a^{-1}$).

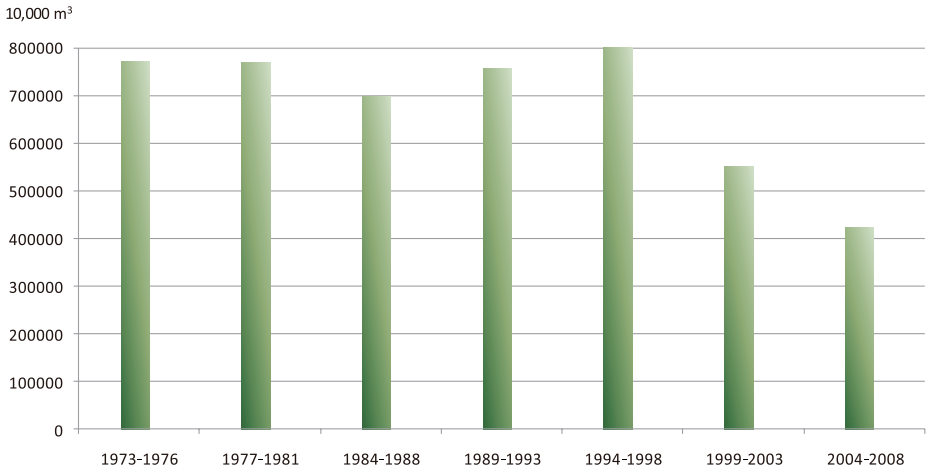


Figure 3-6. Change of stock volume of timber forest

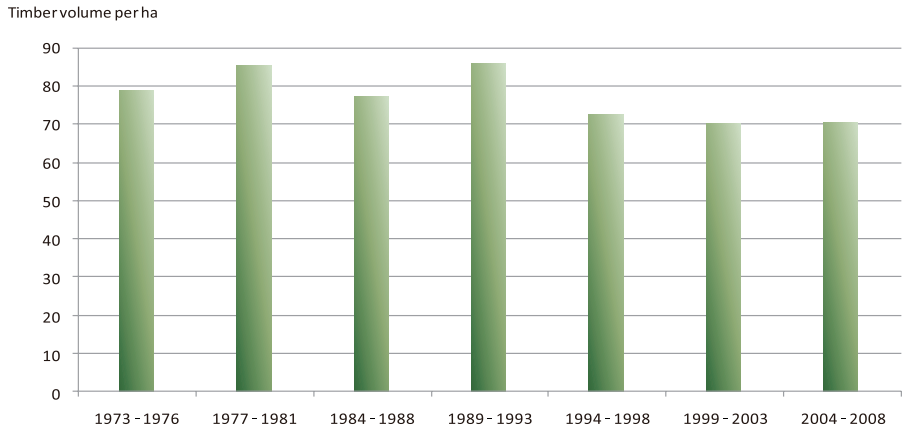


Figure 3-7. Change of stock volume per ha in timber forest

From the 1970s to the mid-1980s, stock volume of timber forest reflected a decreasing trend (Figure 3-6,), and gradually rehabilitated in the mid-1990s. The stock volume of timber forest illustrated cleclining from the late 1990s, which was affected by the adjustment of forest structure and public welfare forest area. Meanwhile, the negative impacts caused by the reduction of timber forest area on timber production have been conquered via planting fast growing tree species like poplar, eucalyptus, Chinese fir and so on. Moreover, the fast growing and high yielding forest has been mainly to be planted, with implementing and intensive management for forest land. As a result the growth condition of standing forest has been improved, and the stock volume per ha shifts from decreasing to increasing. Furthermore, the quality of tree has been enhanced (Figure 3-7). Thus, the total annual increment exceeds 372 million m^3 which has a net increase of 168 million $m^3 \cdot a^{-1}$ (81.85%) compared with the 1970s (Figure 3-8). The capacity of timber supply has been increased.

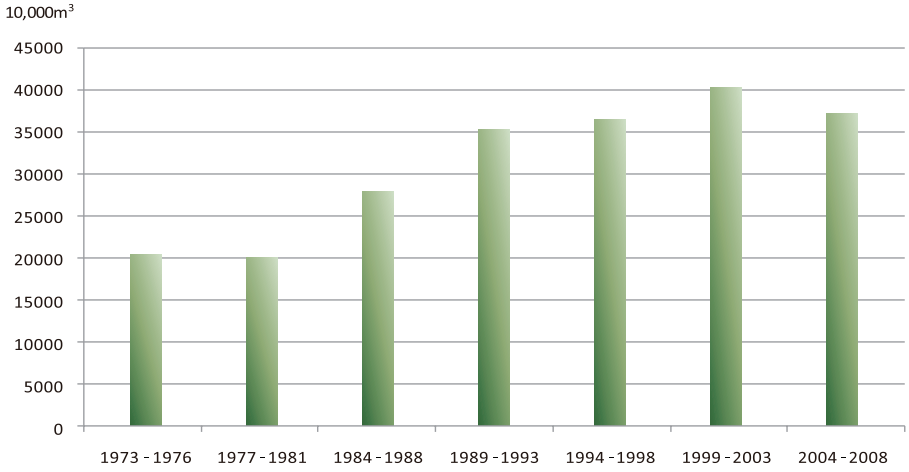


Figure 3-8. Change of annual increment of timber forest

Table 3-3. Stock volume and annual increment of top 10 dominant timber forest species (groups) in terms of area proportion

Dominant species	Stock volume		Stock volume per ha ($m^3 \cdot ha^{-1}$)	Annual increment		Annual growth rate (%)
	10,000 m^3	Ratio%		10,000 m^3	Ratio%	
Chinese fir	57921.86	13.70	70.03	8447.84	22.69	9.48
Masson pine	33823.26	8.00	51.87	5972.50	16.04	8.91
Poplar	21537.22	5.10	47.68	2928.98	7.87	11.13
Quercus	26646.47	6.30	78.43	1888.41	5.07	3.51
Larch	26494.72	6.27	79.89	2661.24	7.15	4.16
Birch	19038.24	4.50	76.66	1390.18	3.73	2.94
Eucalyptus	4065.52	0.96	17.39	574.77	1.54	18.18
Pinusyunnanensis	19620.93	4.64	87.89	492.86	1.32	5.16
Cypress	4793.71	1.13	50.38	525.27	1.41	7.56

(2) The stock volume and annual increment of major timber species of timber forest

The top 10 dominant tree species (groups) in terms of area proportion (Table 3-3) are Chinese fir, masson pine, poplar, quercus, larch, birch, eucalyptus, *Pinusyunnanensis*, cypress and slash pine[6]. Their total stock volume is 2.17 billion m^3 and total annual increment is 249 million m^3, which account for 51.42% and 66.93% nationwide respectively. Eucalyptus, Chinese fir, masson pine and poplar all have high average annual growth rate, and eucalyptus can reach 11.26%.

Quecus, larch, birch, *Pinusyunnanensis* and cypress are mainly distributed as natural forest (Figure 3-9), of which are mainly used for the general timber forest cultivation with high stock volume per ha. Chinese fir and masson pine are mainly distributed as plantations, of which the main purpose is to cultivate general timber forest or fast growing and high yielding timber forest. Plantation timber forest such as eucalyptus and poplar is mainly for producing industrial wood materials like pulp wood, which adopt oriented cultivation and

[6] *Separate statistics of slash pine started from 7th forest resource inventory*

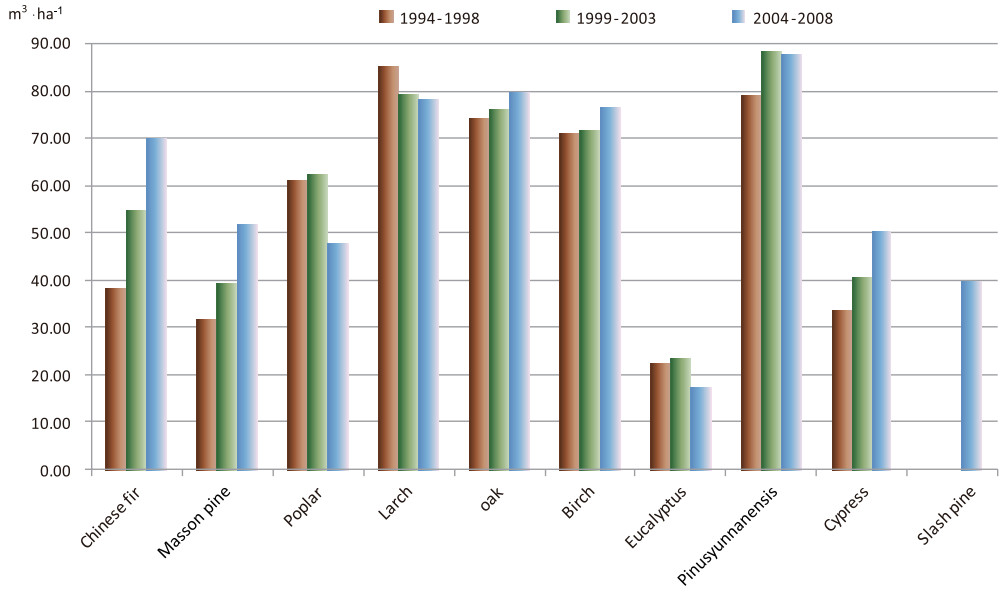


Figure 3-9. Change of stock volume per ha of major species (groups) of timber forest

intensive management due to the features as of short life cycle and lower stock volume per ha. Since the 1990s, forest management has been strengthened, thus the amplification of stock volume per ha has been enlarged. The Chinese fir has increased 33.27 $m^3 \cdot ha^{-1}$.

3.3 Area, percent, and growing stock of plantations of native and exotic species

Rational and significance

The area, percent and growing stock of native species and exotic species can reveal the wood products supply for the current and for the future, the productive capacity of forest land as well as the change of local ecosystem and cultural demand and so on. Tending plantation is an effective way to improve the living environment, to release the conflict of forest products' supply and demand, and also to incent the local economic development. It plays a significant role in recovering and rebuilding the forest ecosystem.

Sources of data

National Forestry Authority

National forest inventories

The Analysis of current situation and tendency

All the species, such as Slash pine, loblolly pine, Caribbean pine, *Casuarinaequisetifolia, Taxodiumdistichum, Taiwaniaflousiana*, Japanese larch, *Eucalyptus grandis, Eucalyptus globulus, EucalyptusuropllyllaS.t Blake, Acacia spp., Liriodendron tulipifera*, etc, have played an important role in forestry production and greening constructionin China. Especially the importance of some exotic species like eucalyptus, slash pine, *Robiniapseudoacacia, Populus*, etc, has become the consensus to all foresters.

The base area data of Chinese fir and masson pine as the native species in China is quite big, which showed a decline trend between 2 inventory periods (Figure 3-11), while the area of other native species is relatively small. The area of Chinese fir was 9.22 million ha in the 6th forest resource inventory, while it decreased to 8.54 million ha in the 7th forest resource inventory. Masson pine dropped from 5.83 million ha of area in the 6th forest national inventory to 3.36 million ha in the 7th forest national inventory. The area of Korean pine and *Pinusyunnanensis* forest decreased, on the contrary, the area of Chinese pine, cypress, *Pinusarmandii*, quercus and Japan cedar increased (Figure 3-10).

Exotic species, especially poplar and eucalyptus, developed quite rapidly in China in the recent 20 years (Figure 3-11), with fold increasing trend showed in both of the 7th and the 6th national forest inventory. The significance and utilization condition of exotic species and native species differ in various countries and regions. The USA plants a large area of plantations with its own excellent native species like douglas fir, slash pine and loblolly pine to meet the demand on timber. Scots pine and European spruce are major afforestation species in European countries, where native species are dominant species. However, many countries in the southern hemisphere introduce monterey pine, eucalyptus, etc, as the major plantation species. It can not only meet the domestic demand, but also help with the exports of the forest products abroad. The major selecting native species or exotic species are: the adaptability for climate and soil condition in introducing area; production, quality of timber and other wood products are superior to native species or can meet the basic requirements; comprehend plantation and silviculture techniques, and seedling supply is guaranteed; social and cultural aspects are also taking into account. With the proper utilization of exotic species, the great benefits can be achieved with less cost within shorter period, however, it would be risky to the failure of plantation if select species and their sources wrongly.

China has started to introduce foreign poplar since 19th century, and has conducted a lot of species introduction in the 1970s. There were 331 the latest *Populusaigeiros*

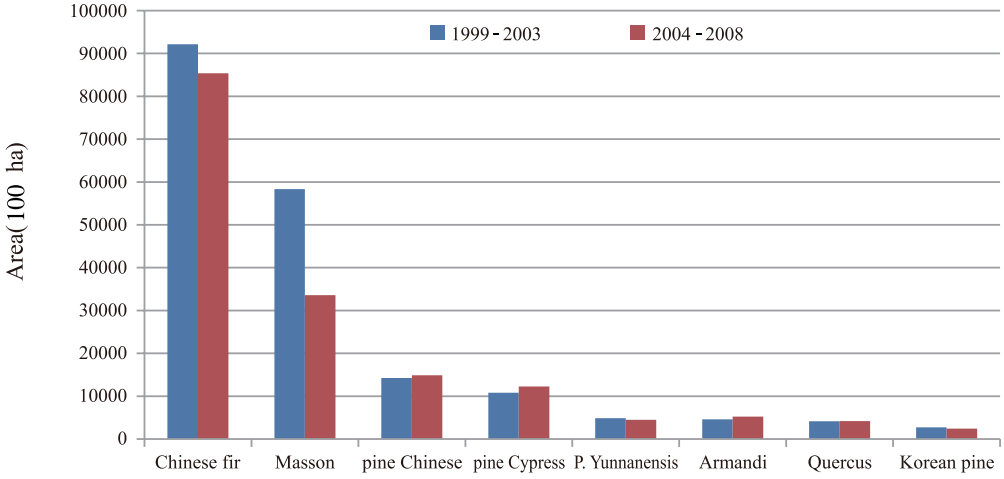


Figure 3-10. Area change of major native species in China

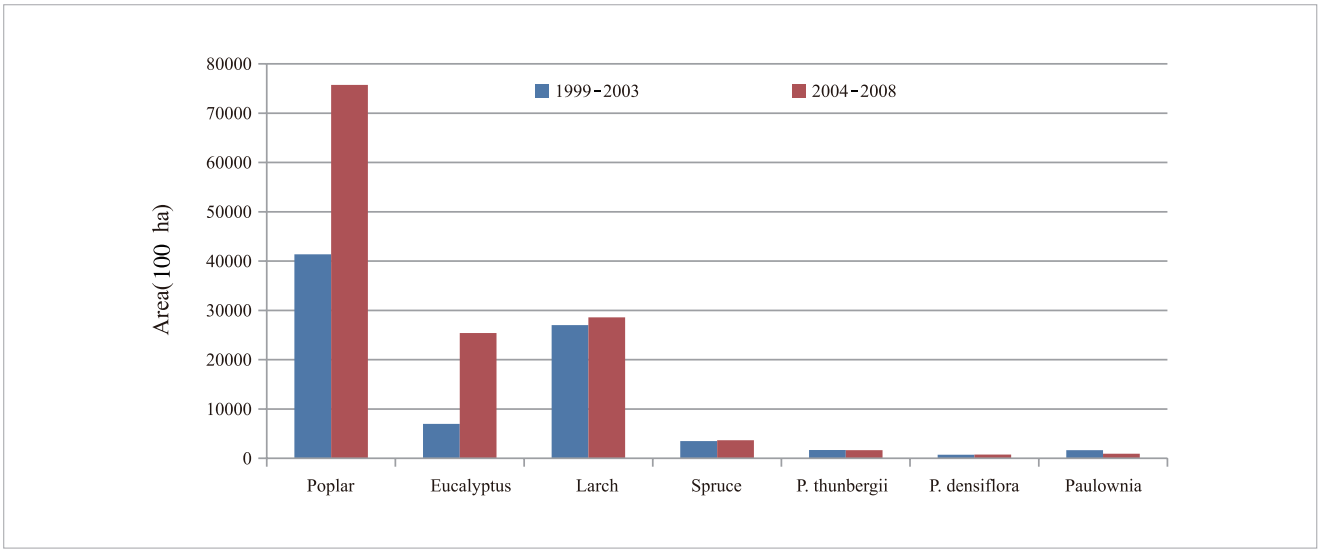


Figure 3-11. Change of plantation area of major exotic species in China

clones has been introduced from 17 countries in the 1980s, the accumulated number of poplar clones has reached 500, and the area has reached 2 million ha after the extension in large areas (Su Xiaohua, etc, 2005). The introduction of eucalyptus started in 1893, which altogether over 300 species were introduced with 1.5 million ha of plantation area in over 600 counties in 16 provinces, and 1.5 billion 4-sides trees have been planted (He Shanan, Gu Yin, 1998). According to Pan Zhigang, etc.,(1994) and Zheng Yongqi, (2001), the plantation area of foreign pine like Caribbean pine, slash pine and loblolly pine is over 2 million ha.

Economic-environmental-cultural value of exotic tree species

Exotic tree species possess crucial economic, ecological and cultural values. Major exotic tree species planted in China have played a tremendous role in timber production, ecological development and landscape culture development. In sustainable social and economic development of plantation in China, exotic tree species are indispensable in many regions, especially the following exotic species: *Pinus spp*., eucalyptus, poplar, *Acacia spp.*, *Casuarinaequisetifolia*, *Robiniapseudoacacia*, larch, *Heveabraziliensis*, etc.

3.4 Annual harvest of wood products by volume and as a percentage of net growth or sustained yield

Rational and significance

The annual harvest of timber refers to the annual timber amount harvested from forest, and the net increment of forest refers to that annual total increment of forest stock volume in the interval deduct mortality consumption of stock volume in the same period. The proportion and the changes of annual harvest of timber in net forest

increment can reflect whether the logging and utilization of forest resources in a certain area is in line with the sustainable principle. In addition, it also demonstrates scientific nature of forest management plans and rationality of management activities, with crucial significance in evaluating self-regeneration and sustained timber supply capacities, adjusting unreasonable forest structure in reality, and promoting sustainable development and utilization of timber resource.

Within the five Chinese forest categories, timber forest is mainly for producing wood products; fuel wood forest is mainly for providing fuel wood products; protection forest and special purpose forest can harvest some dimension wood products with commercial value through forest management activities like tending, thinning, regenerated cut etc. In this report, based on the leading forest function, the net increment of timber yield refers to logging consumption volume and net increment of timber forest in particular.

Sources of data

National forest inventories

The Analysis of current situation and tendency

According to the result of the 7th national forest inventory, annual logging consumption volume in China is 379 million m^3 (Table 3-4), accounting for 66.33% of net increment, which exceeds logging consumption volume with the surplus of 190 million m^3.

Annual logging volume of timber forest (Table 3-5) accounts for 67.81% of its net increment, which exceeds consumption volume with the surplus of 105 million m^3. Among the surplus, natural timber forests occupy 48 million m^3, and that of timber plantations have the rest of 57 million m^3.

The accumulated annual logging volume of timber forest in the provinces of Fujian, Guangdong, Hunan, Guangxi, Heilongjiang, etc., exceeds 1 million m^3, accounting for 51.40% of total nationwide. The total net increment of other provinces, except Guangdong and Tibet, exceeds logging consumption volume with the surplus over 500,000 m^3, especially in some of 12 provinces like Jilin, Heilongjiang, Zhejiang, Anhui, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou and Yunnan. The other ten provinces like Heilongjiang, Jilin, Inner Mongolia, Yunnan, Tibet, Shaanxi, Tibet, Zhejiang, Jiangxi, Hubei, apply natural forest logging as the major model, while plantations logging is applied in other provinces exceptionally.

The result of the 7th NFI shows that the total logging volume of the top 10 dominant tree species (groups) in area proportion wise (Table 3-6) totals 157 million m^3, accounting for 68.15% of net increment (220 million m^3) with the surplus of 63 million m^3. The above top 10 species are Chinese fir, masson pine, poplar, quercus, larch, birch, eucalyptus, *Pinusyunnanensis*, and cypress and slash pine. The logging volume of larch, quercus, birch and poplar is quite high in Heilongjiang, Jilin, Inner Mongolia and Liaoning, and so on. In the regions of Yunnan, Tibet and Shaanxi, etc, the logging volume of quecus, *Pinusyunnanensis*, *Pinuskhasya*, birch and fir is relatively high. The logging volume of Chinese fir and masson pine is high in central and eastern regions, including Zhejiang, Jiangxi, Hubei, Anhui, Fujian,

Table 3-4. Annual logging consumption volume Unit: 10,000 m^3

Category	Forest	Arbor forest	Open forest	Scattered forest	Trees in 4 ends
Annual logging consumption volume	37910.71	31154.4	433.72	2582.64	3739.95

Table 3-5. Annual logging volume and increment of timber forest

Statistics unit	Timber forest	Natural timber forest	Plantation timber forest
Logging volume (10,000 m^3)	22129.58	12428.68	9700.9
Net increment (10,000 m^3)	32632.45	17278.5	15353.95
Proportion of logging volume in net increment (%)	67.81	71.93	63.18
Surplus (10,000 m^3)	10502.87	4849.82	5653.05

Table 3-6. Annual logging volume, increment and surplus of top 10 dominant tree species (groups) in area wise (unit: 10,000 m^3)

Name of tree species	Annual logging volume	Net increment	Surplus
Chinese fir	8339.89	6263.36	2076.53
Masson pine	5788.38	4276.36	1512.02
Poplar	2579.7	1088.21	1491.49
Quercus	2210.35	1431.79	778.56
Larch	1002.74	1112.26	-109.52
Birch	634.34	683.44	-49.1
Eucalyptus	533	342.9	190.1
Pinusyunnanensis	400.31	281.05	119.26
Cypress	514.7	182.54	332.16
Slash pine	36.58	10.59	25.99

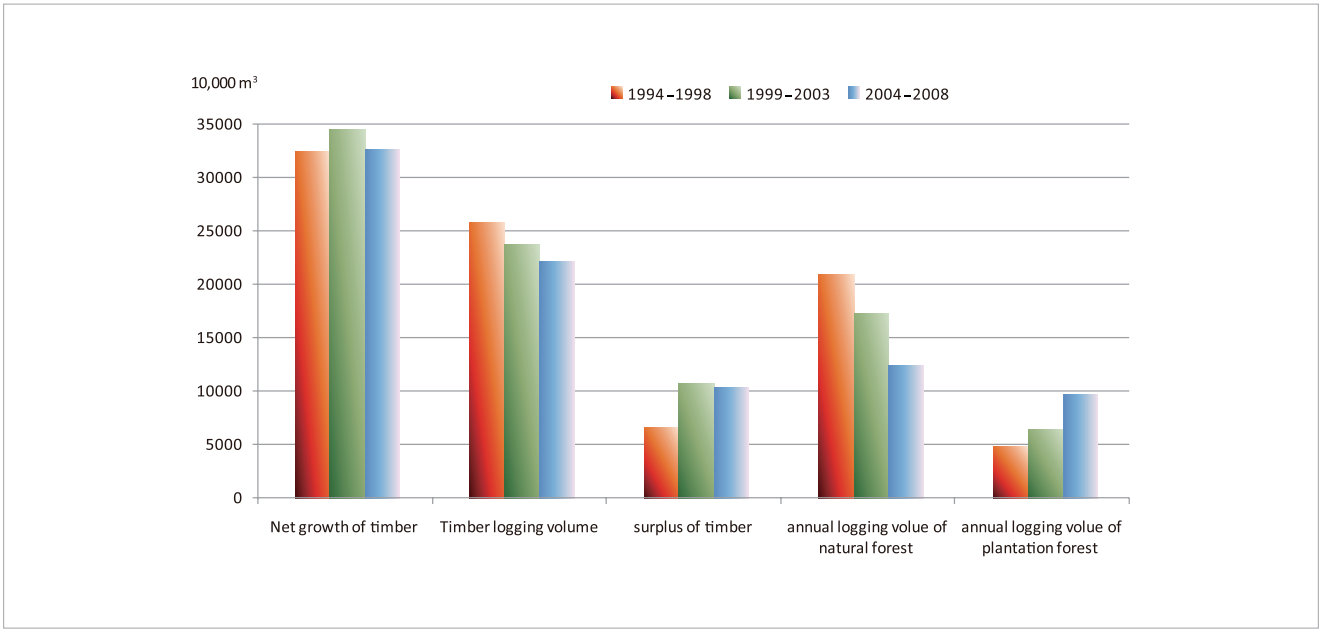


Figure 3-12. Change of annual logging volume of timber forest

Guangdong, Guizhou, Hunan, Guangxi, etc.; meanwhile the logging volume of poplar is relatively high in Shandong, Jiangsu, Hebei, Henan, etc. Eucalyptus logging is mainly distributed in the provinces of Guangdong, Hainan, Guangxi, etc.

Since late the 1990s, while endeavoring to promote afforestation and plantation, and expanding the area of timber plantation, China also carries out forest logging quota system, conducts "logging by license" and "transportation by license", strengthens administration on timber processing to improve the scientific forest management, which promotes the forest growth at the same time. With the reduction of timber forest area, the annual net increment of timber forest still maintains over 320 million m^3, the surplus increases from 67 million m^3 to 105 million m^3, which means that the timber supply capacity has constantly been enhanced (Figure 3-12).

In recent years, the focus of timber forest consumption in China has transferred from natural forest to plantations. Regarding the annual logging volume of timber forest in the 7th inventory compared with the 5th forest inventory, the logging volume of natural forest reduces by 40.71%, while the logging volume of plantations increases by 100.38%. The logging volume ratio between natural forest and plantations has changed from 81:19 to 56:44. Especially in some key ecological development region,

including Xinjiang, Ningxia, Qinghai, Gansu, Liaoning, Sichuan, Yunnan, etc., the logging volume has reduced by over 70%. Concerning the total logging volume in central and eastern provinces including Fujian, Jiangxi, Guangdong, Hunan, Hubei, Anhui, Zhejiang, Henan, Hainan, Shandong, Jiangsu, Guangxi, etc., the percentage in national total volume has increased by 22.72 per cent to 63.57 per cent as total. Thus, the central and eastern regions have surpassed western and northeastern regions to become the major regions for timber production in China.

3.5 Annual harvest of non-wood forest products

Rational and significance

The indicator reflects the harvesting level of non-wood forest products (NWFPs) and their status in community life and national production, as well as the diversity and sustainability of forest resource utilization. NWFPs (FAO) refer to the products and services that can meet the living and production demands of human beings and gained within the biomass which centralized on forest resources. It includes plants, animals and service products. NWFPs make great contribution to the human society, especially in the poverty-shicken areas of developing countries. Developing the NWFPs is an important approach to get rid of poverty and to improve the life standard. Meanwhile, it has vital significance in promoting sustainable forestry development.

Sources of data

China's Forestry Statistical Yearbook (2007-2012)

China Statistical Yearbook (2012)

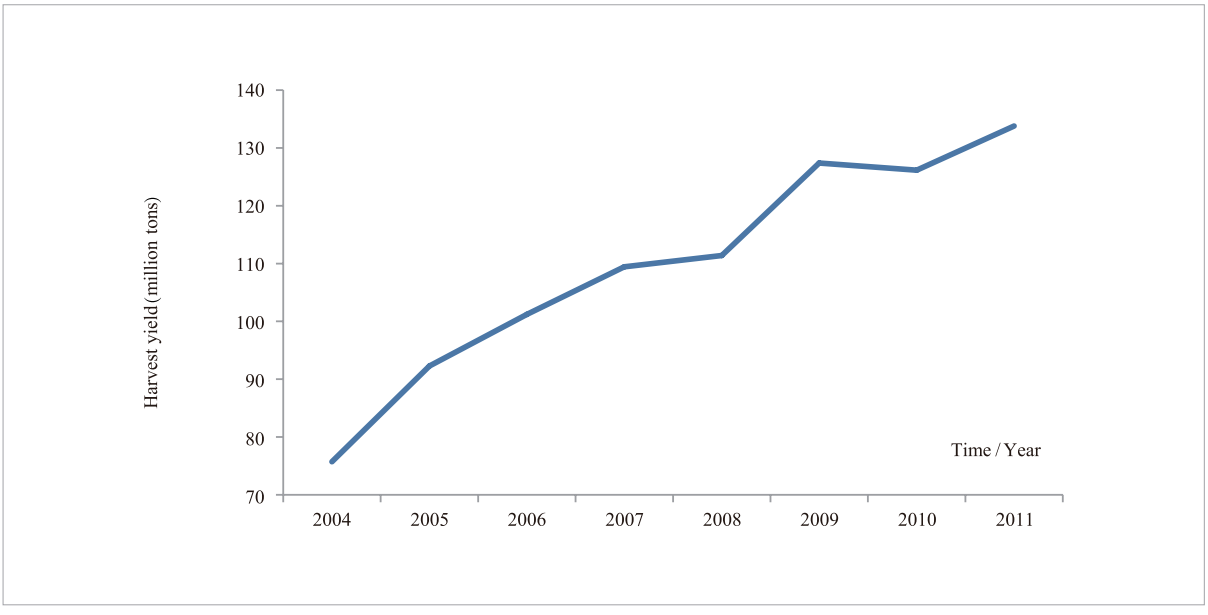


Figure 3-13. Harvest volume of NWFPs

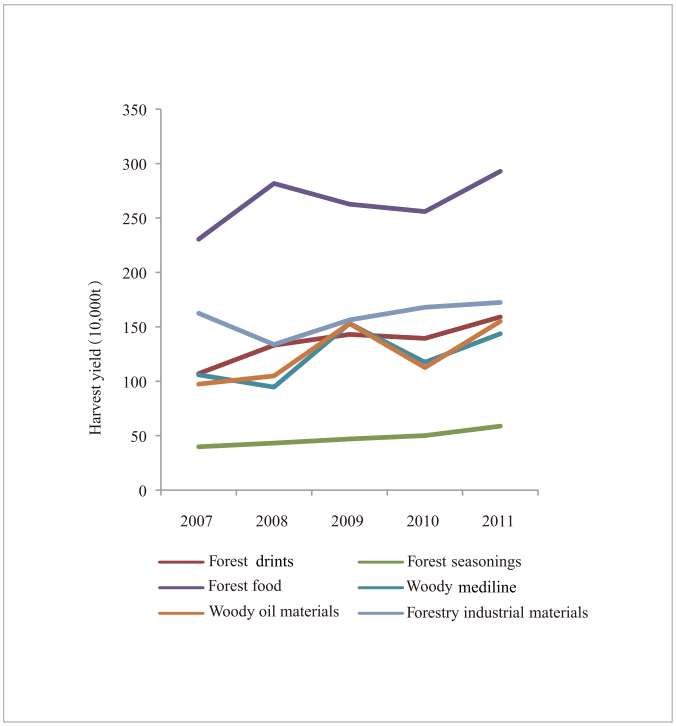


Figure 3-14. Production of NWFPs (except fruits)

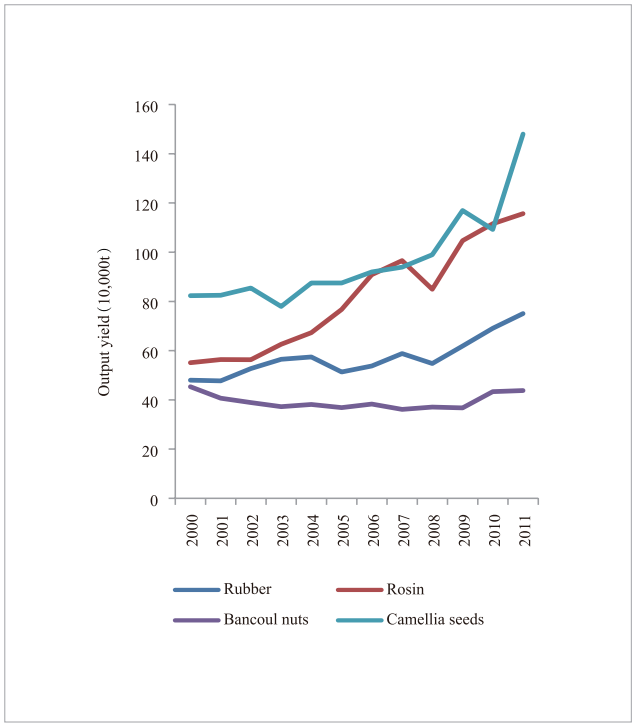


Figure 3-15. Production of rubber, rosin, bancoul nuts, and camellia seeds products

The analysis of current situation and tendency

The harvest of NWFPs shows an increasing trend in general. In 2011, the harvest of NWFPs is 13.38 million t, which is increasing by 22.26% over the year of 2007. The harvests of fresh fruits, dried fruits, woody medicinal materials and woody oil plants were 114.71 million tons, 9.27 million tons, 1.44 million tons, and 1.55 million tons respectively, increasing by 18.00%, 93.14%, 35.70% and 59.29% compared with the year of 2007 respectively. Regarding flower products, the harvest of cut flower and cut foliage was 14.23 billion stems, and the harvest of ornamental seedlings was 12.07 billion stems, increasing by 14.95% and 172.44% over the year of 2007 respectively (Figure 3-13).

The harvest of NWFPs (except fruits) continuously increases to 9.82 million tons in 2011 (Figure 3-14).

The production volume of forest beverages, forest seasonings, forest food, woody medicinal materials, woody oil plants, and forest industry materials were 1.59 million tons, 587,000 tons, 2.93 million tons, 1.40 million tons, 1.55 million tons, and 1.72 million tons respectively, increasing by 49%, 47%, 27%, 36%, 59%, and 6% over the year of 2007 respectively.

The production of rubber, rosin and camellia seeds in China keep increasing while that of bancoul nuts basically maintains stable. In 2011, the production of rubber, rosin, bancoul nuts, and camellia seeds products were 750,900 tons, 1.16 million tons, 437,700 tons and 1.48 million tons respectively. The annual increment of rubber was 24,600 $t \cdot a^{-1}$, and annual increments of rosin and camellia seeds were 55,100 $t \cdot a^{-1}$and 59,700 $t \cdot a^{-1}$ (Figure 3-15).

National Report
on Sustainable Forest Management

4

Maintenance of
Forest Ecosystem Health and Vitality

Maintaining health and vitality of forest ecosystem is the basis for SFM. Maintenance of forest health and vitality depends on forest's capacity of rehabilitation from disturbance or adaption of disturbance. Even though many disturbances and key events are components of forest ecosystem succession, some will completely destroy functions of forest ecosystem, fundamentally change form, structure and process of forest and reduce its ecological function. Recession of forest ecosystem health and vitality will bring important economic and ecological impacts on society, including loss of forest benefits and decrease of environment quality. Analysis on biological, non-biological process and media impact associated with forest health and vitality will be beneficial for scientific decisions of SFM.

4.1 Area and percent of forest affected by biotic processes and agents (e.g. disease, insects, invasive species) beyond reference conditions

Rational and significance

The indicator aims to specify biological process and event's impact on forest. Except communities with the main body of forest, a lot of other biomess also exist in forest ecosystem, without severe disturbance, diverse system structure can accomplish stable self-adjustment, maintain natural balance between each biotic population and community, and keep health and vitality of forest ecosystem.

Due to different causes, some bio species population density increase significantly, health and vitality of forest ecosystem evidently changed, which result in the reduction or loss of forest's rehabilitation capacity, which are collectively referred to as bio-disasters. Monitoring and grading levels and degrees of different kinds of bio-disasters can provide references for analyzing historical causes of disasters, and provide valuable information for setting SFM that reduces disaster risk.

Sources of data

National Forestry Authority

National forest inventories

Current situation and trend analysis

Rapid economic development, invasion of exotic species and climate change are important factors of still quite high occurrence level of forestry pests in China.

From the 1950s and the 1980s, the occurrence area of forest diseases, pests, and rodent damage in China reflected a trend of double increase every 10 years. In the 1950s, annual occurrence area of forest bio-disasters was 857,700 ha, it was 1.44 million ha in the 1960s, 3.65 million ha in the 1970s, and 8.47 million ha in the 1980s. Since the 1990s, due to the extension and application of sustainable disaster control and management techniques against forestry pests, and increase of fund investment, occurrence of diseases, pests and rodent damage tends to reduce. In recent 10 years, total occurrence area of forestry pests in China maintains slow increase trend, among diseases, insect and rodent damage, forest insect always maintain the highest proportion, while area of forest rodent damage significantly increases, with a gradual aggravation trend (Figure 4-1, figure 4-2). Species occurrence of forestry exotic species disasters is directly related with economic development of each province, more exotic species disasters occur in coastal provinces than inland region, it is severer in south China with advanced economic development than in

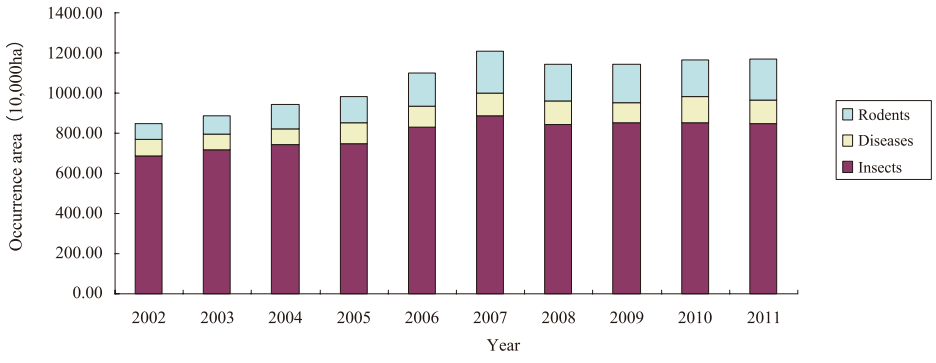


Figure 4-1. Occurrence area of forest pests during 2002-2011

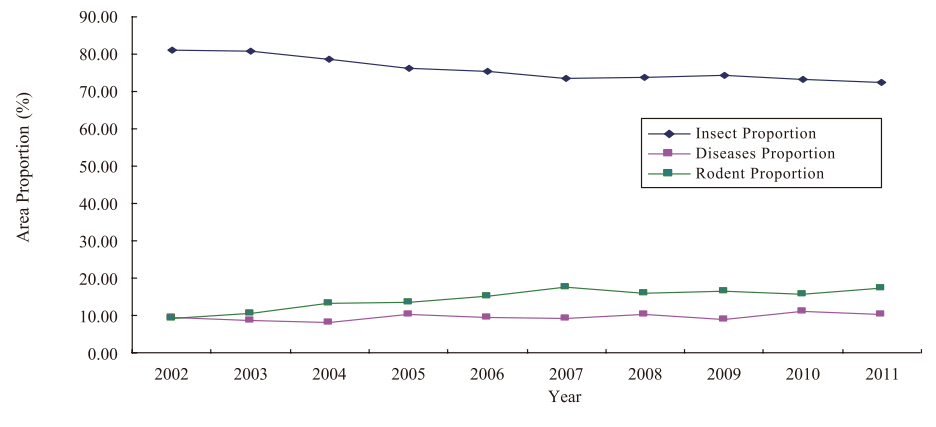


Figure 4-2. Occurrence area proportion of diseases, insects and rodent damage in total occurrence area of forestry pests in China during 2002-2011

north China, especially Guangdong and Guangxi are the provinces that suffer severest exotic species invasion.

Among over 8,000 species of forestry pests in China at present, there are over 5,000 harmful insect species, about 3,000 pathogen species including fungi and bacteria, over 160 rodent damage species, and 150 harmful plants. Among 300 species that can cause certain damage, 150 species can bring severe damage. In pests with severe damage, there are 86 harmful insect species, 18 pathogen species, 37 harmful plant species, 12 rodent damage (hare) species, the annual occurrence area is over 10 million ha, causing death of over 40 million stems of trees, the direct economic loss and ecological service value loss total 88 billion yuan, accounting for one tenth of gross output of China's forestry, which seriously threatens land ecological safety and constrains sustainable forestry development.

The proportion of forestry pests occurrence area in total forest area (namely occurrence rate) differs greatly in each province. In southwestern and northeastern natural forest areas, occurrence rate maintains below 4% of forest area. High occurrence area is in north and central China, centering on Shandong, and including Tianjin, Hebei, Henan, Shanxi, Liaoning, Anhui, Jiangsu, etc, with the occurrence area proportion over 10%, mainly by defoliator of Chinese pine and poplar. A large area of

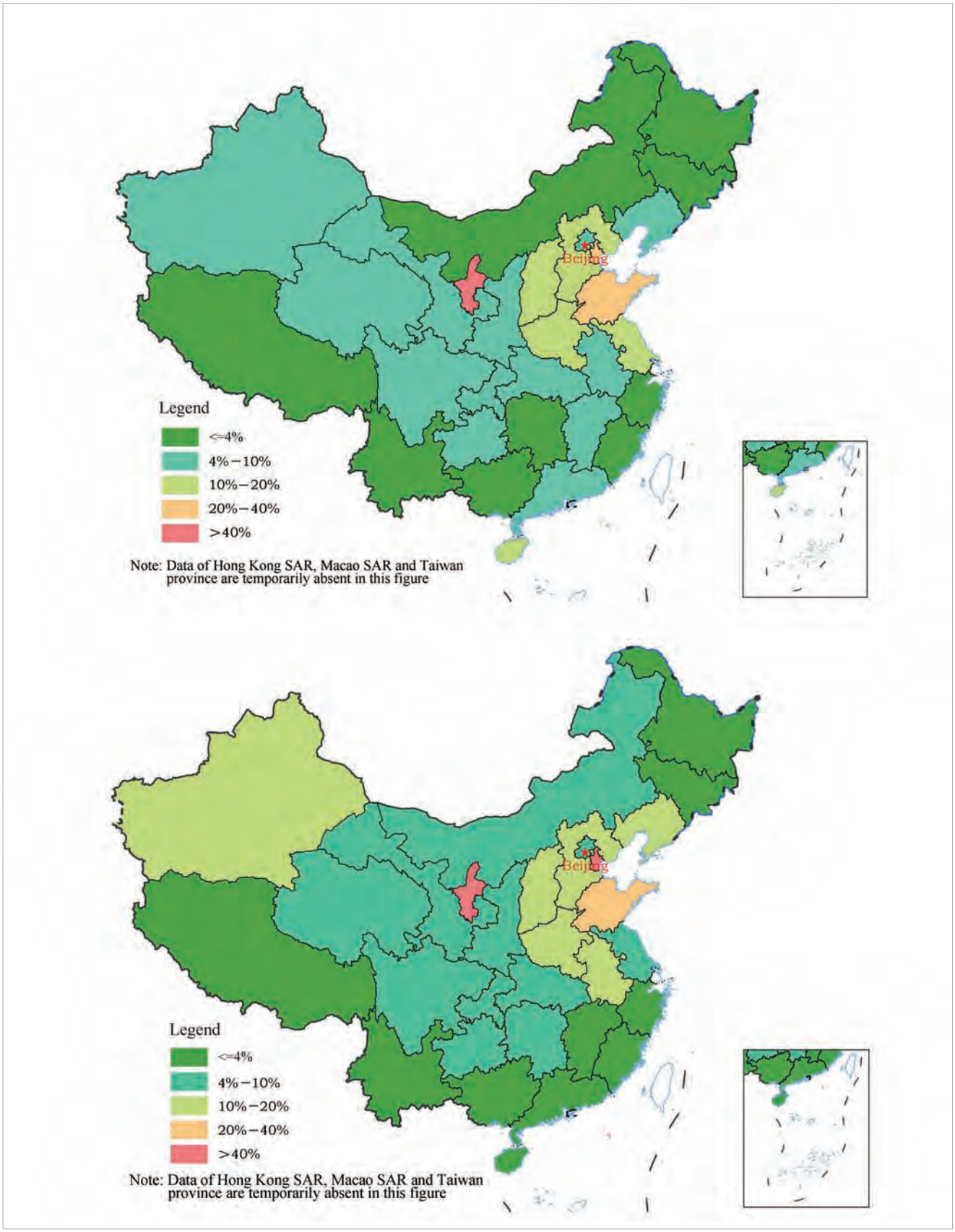


Figure 4-3. forestry pests occurrence area's proportion in forest area by province in 2005 and 2011 respectively

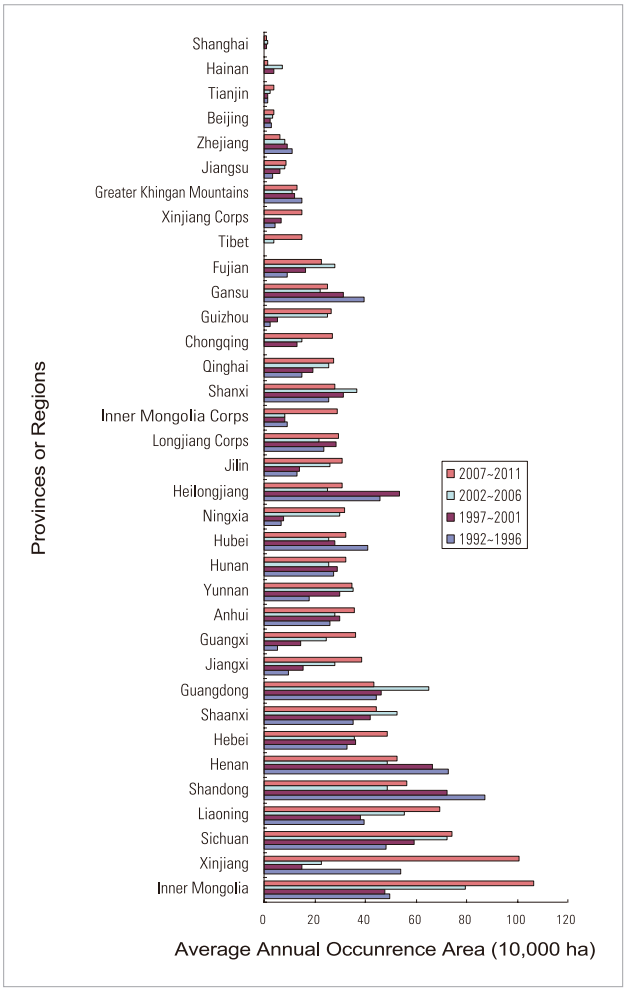


Figure 4-4. Average forestry pests occurrence area by every 5 years (10,000 ha)

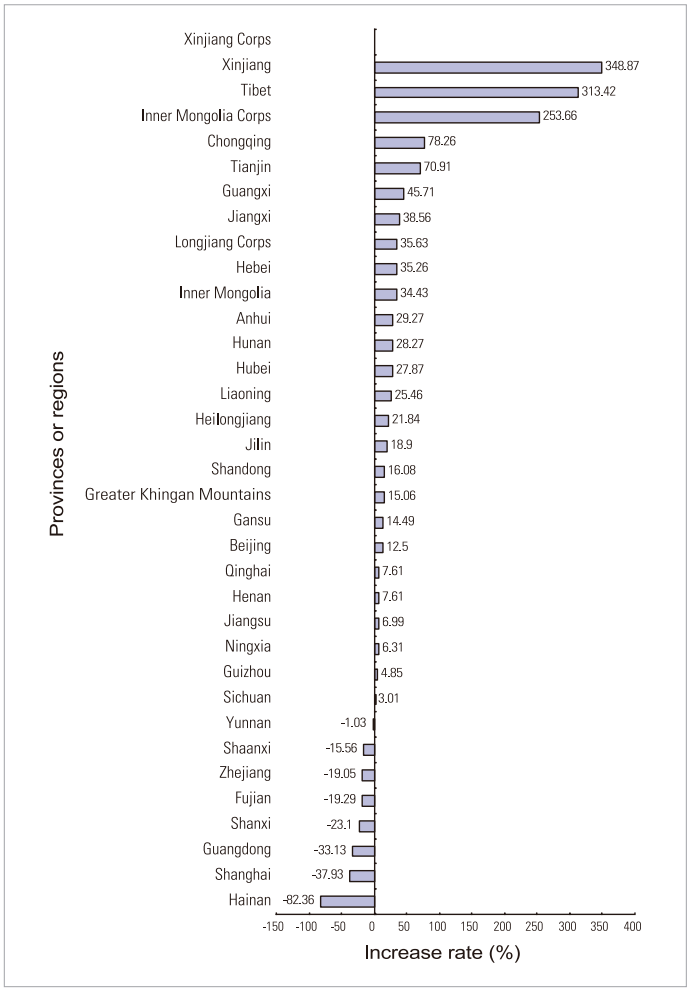


Figure 4-5. Increase rate of average pests occurrence area by province during 2007-2011 over 2002-2006 (%)

poplar plantations in Ningxia has long suffered severe damage by *Anoplophora glabripennis*, with the highest occurrence rate in China.

The general pattern of forestry pests occurrence rates in 2005 and 2011 shows that there is no evident change in basic situation. Southeastern coastal provinces like Guangdong, Jiangxi and Jiangsu reflect a decreasing trend (Figure 4-3). In northern region including Xinjiang and Inner Mongolia, due to the aggravation of forest rodent damage, the damage rate significantly increases.

During 2007-2011, total forestry pests occurrence area in China increases by 22.25% over 5 years ago (Figure 4-4). The top 10 provinces in terms of occurrence area are Inner Mongolia, Xinjiang, Sichuan, Liaoning, Shandong, Henan, Hebei, Shaanxi, Guangdong, and Jiangxi. Concerning increase rate of occurrence area (Figure 4-5), western and northern provinces like Xinjiang, Tibet and Inner Mongolia have the highest increase rate, while the occurrence area increase rate is negative in southeastern coastal region, including Zhejiang, Fujian, Guangdong, Shanghai, etc. The rate in Shanxi and Shaanxi greatly reduces, exotic species *Dendroctonus valens* disaster in that area in 1998 has been controlled sustainably in recent years.

Higher frequency, more species, rapid extension and expansion of damage area of exotic forestry pests invasion

Among 35 exotic invasion species causing severe damage, 16 species were before the 1980s, and 19 species were after the 1980s, including 10 species after

2000, which reflects a distinct trend of accelerated speed and deteriorated damage.

Except the increase of new invasion species, invasive forestry pests have gradually formed a stable ecological invasion pattern, and spread to their ecological adaptable

Case: Monitoring system and grading of forestry pests in China

At present, China has established a five level forestry pests monitoring system with the main body of state, provinces, municipalities and counties, and based on ground level forecasting, and has established a pests monitoring network system covering whole China led by national forecasting center, with provincial forecasting centers as hubs, 1000 national central forecasting sites as backbone, over 1000 provincial key forecasting sites, and 24,861 normal forecasting sites. There are over 600 pest species under monitoring and investigation in China.

Damage degree and level of forestry pests in China are measured by the population quantity in explosion condition, and can be categorized as three levels, namely light, medium and severe.

Occurrence and Disaster Standard of Forestry Pests in Forestry Industry Standard of People's Republic of China LY/T 1681-2006 has set different quantity standards on 56 frequent forestry pests, including branch infestation rate, disease infection index, diseased plant rate, damaged plant rate, species that are not listed all take similar species as references for grading damage degree and level.

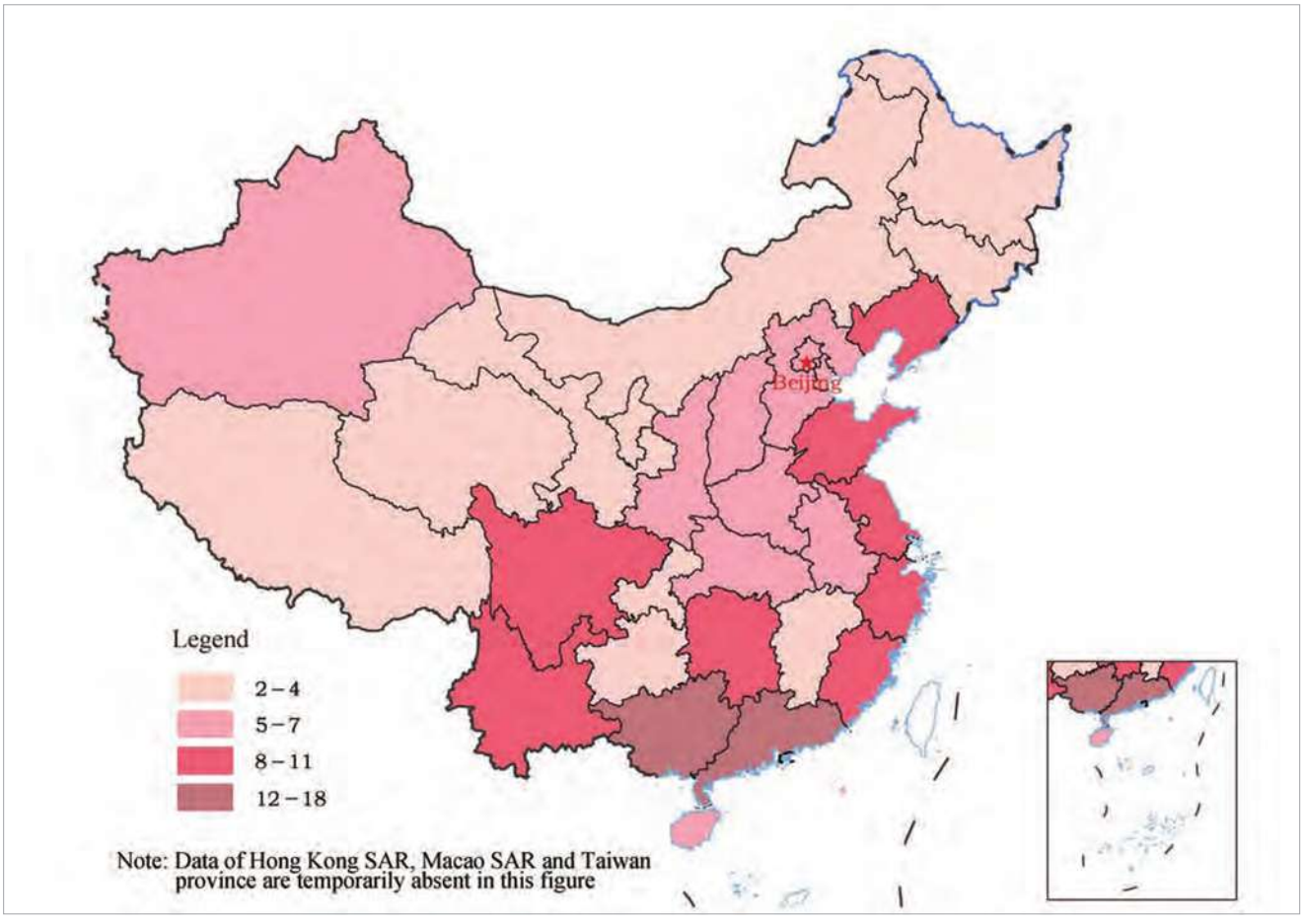


Figure 4-6. Number distribution of key exotic pests disaster species in each province

region step by step, with the expansion of damage area, such as pine wilt disease, fall webworm, etc.

Species occurrence of forestry exotic species disasters is directly related with economic development of each province (Figure 4-6), more exotic species disasters occur in coastal provinces than inland region, it is severer in south China with advanced economic development than in north China, especially Guangdong and Guangxi are the provinces that suffer the severest exotic species invasion. Located the central region of western development, Sichuan and Yunnan have close economic relations with ASEAN countries, so exotic species reflect an increase trend. It is noteworthy that with the increase of communication with Central Asia countries, exotic invasion in western Xinjiang also reflects a rising trend.

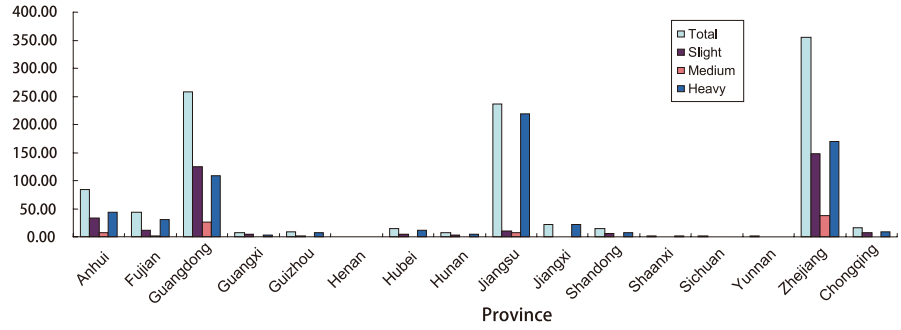
Case: Pine wood nematode *Bursaphelenchus xylophilus*

Pine wood nematode belongs to Aphelenchoididae, Tylenchida, Nematoda, Nemathelminthes. It can cause pine wilt disease, which is called pine cancer, it is a destructive disease. It has the following features: multi transmission routes, hidden pathogenic sites, rapid disease developing speed, long latent time, hard control difficulty, etc.

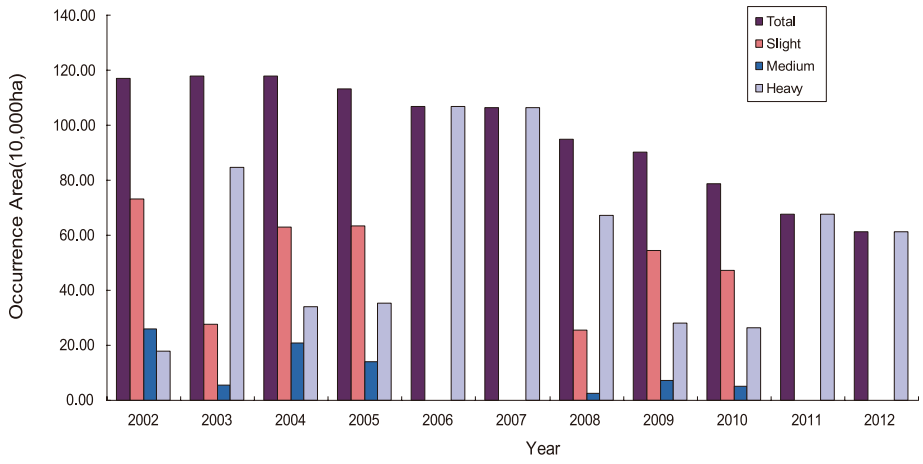
Pine wood nematode is an exotic species in China. In 1982, it was firstly detected in Nanjing, Jiangsu, and rapidly spreads since then, now it has been distributed in 15 provinces, causing wither death of over 1 million pines, and making destructive threat on several million ha of pine forest in south China.

Damage condition of pine wood nematode (Host: Masson pine, 2007.10 Zhejiang)

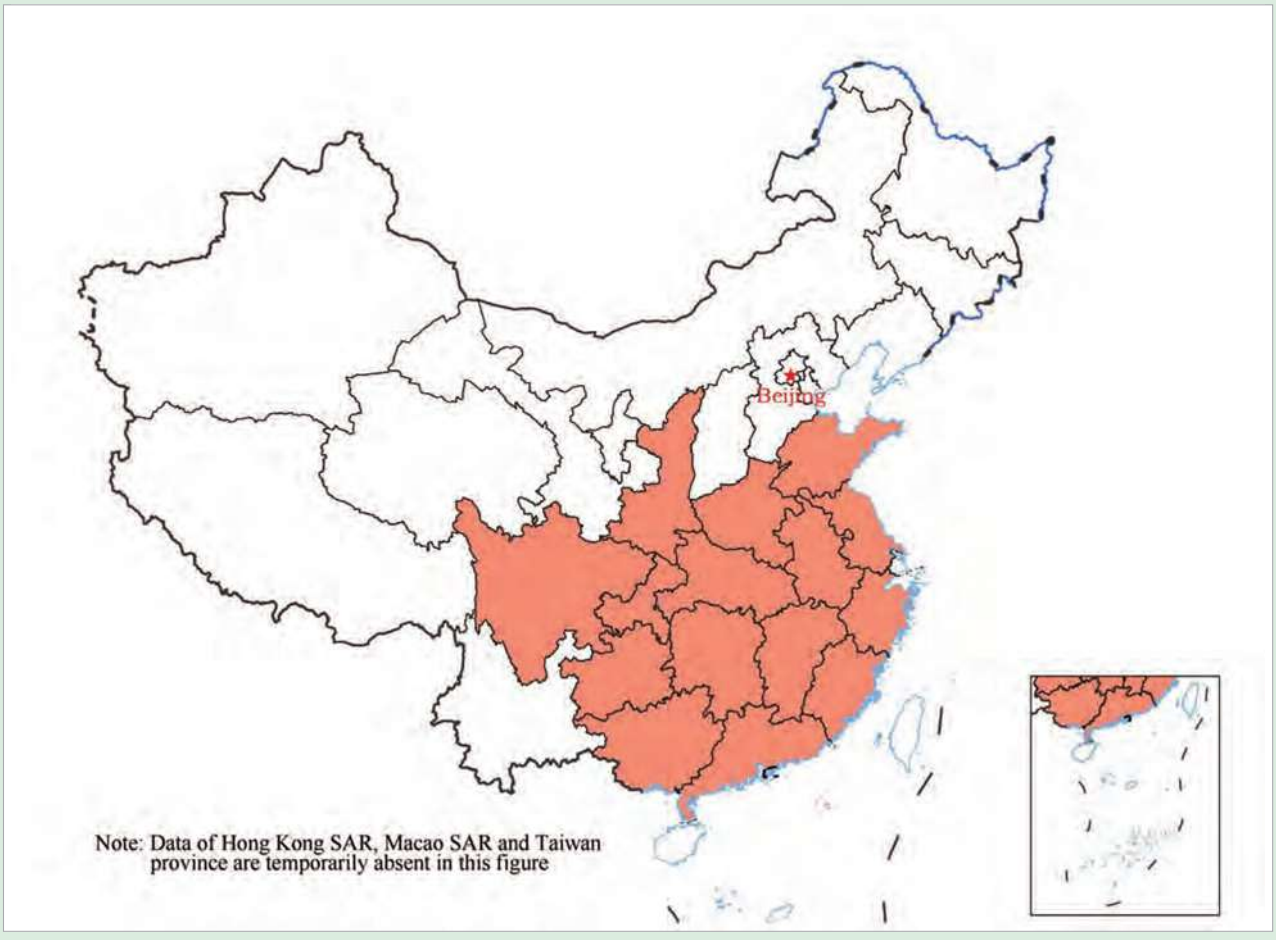
Regarding the development trend, although there are measures like quarantine clearance and removing epidemic spots in the process, it has spread from the eastern and southern provinces at the beginning to western and northern provinces in the form of punctate epidemic spots. With more invaded provinces, concerning general damage situation, severe damage occurrence reflects a gradual decrease trend, currently damage is mainly occurred in Jiangsu, Zhejiang, and Guangdong.



Statistical chart of accumulated occurrence area of pine wood nematode in each province since2002 (10,000 ha)



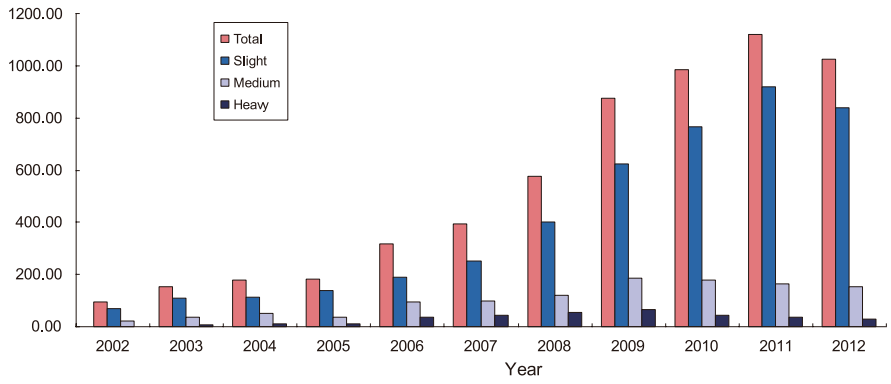
Occurrence area and change trend of pine wood nematode disaster in China during 2002-2012 (10,000 ha)



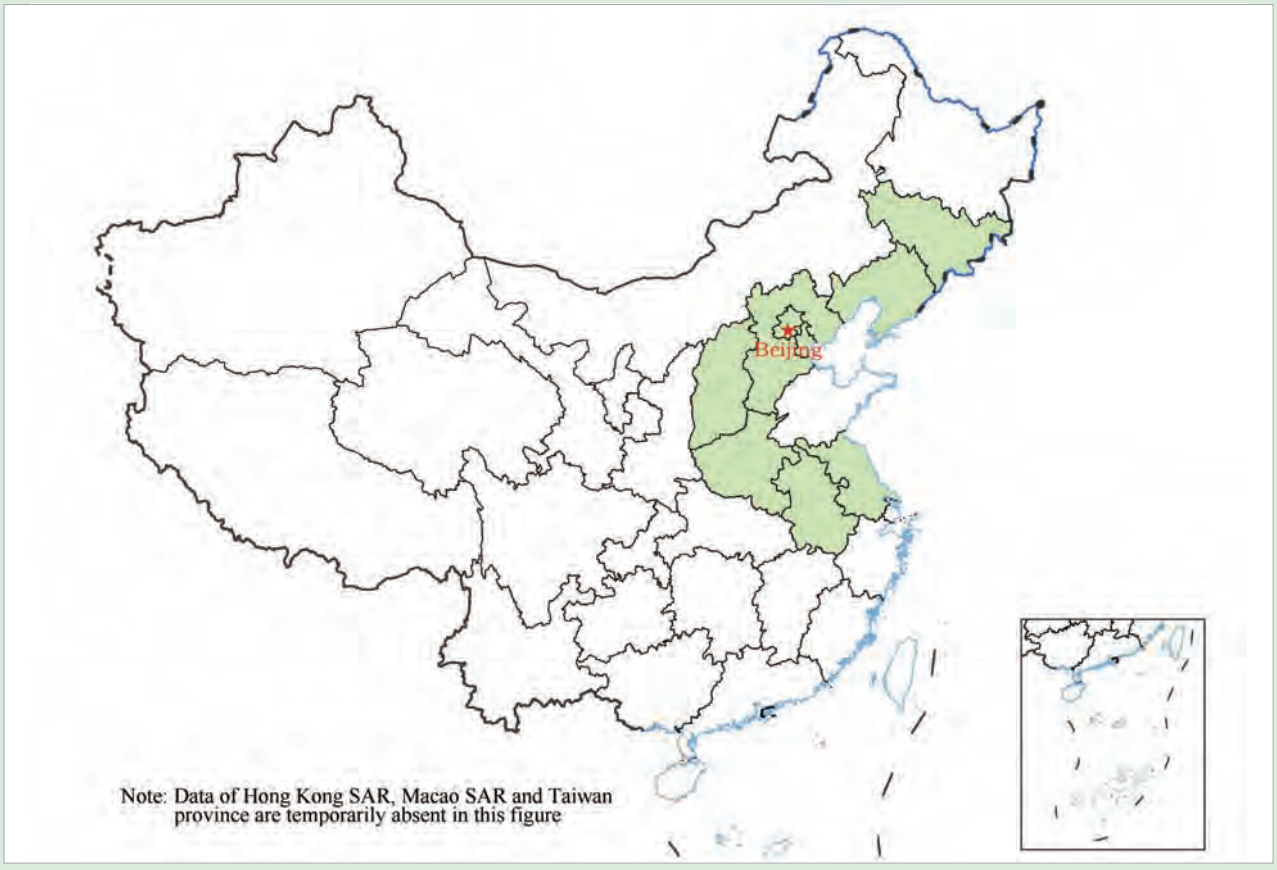
Distribution of pine wilt disease epidemic areas and epidemic spots in provinces

Case: Fall webworm, *Hyphantria cunea*

It belongs to Arctridae, Lepidoptera. It is a worldwide quarantine pest, mainly damaging fruit trees, street trees and ornamental trees, especially on deciduous trees. It causes severe damage in ornamental trees, economic forest,



Occurrence area and trend of fall webworm disaster in China during 2002-2012 (10,000 ha)

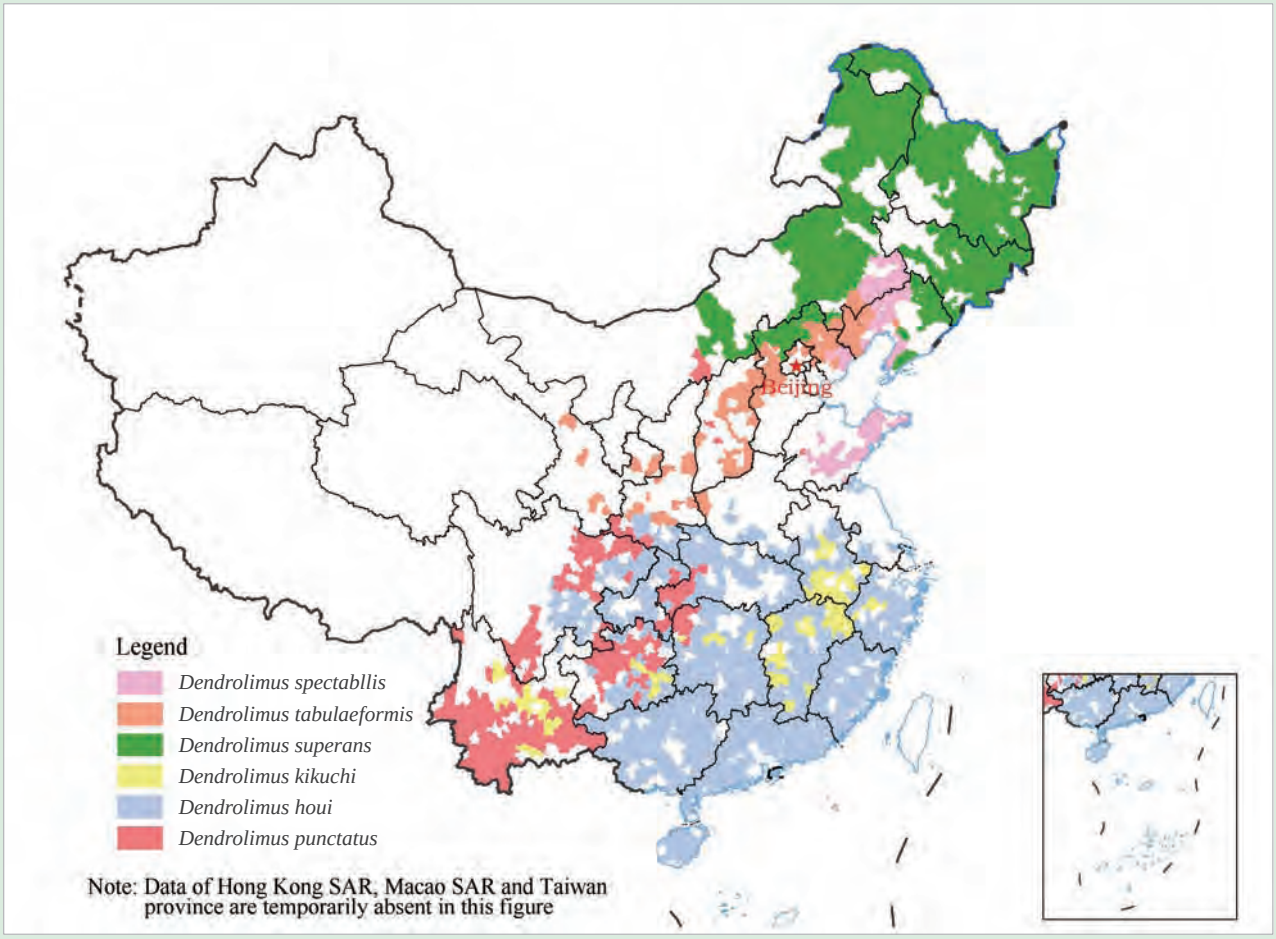


Occurrence distribution of fall webworm in 2012

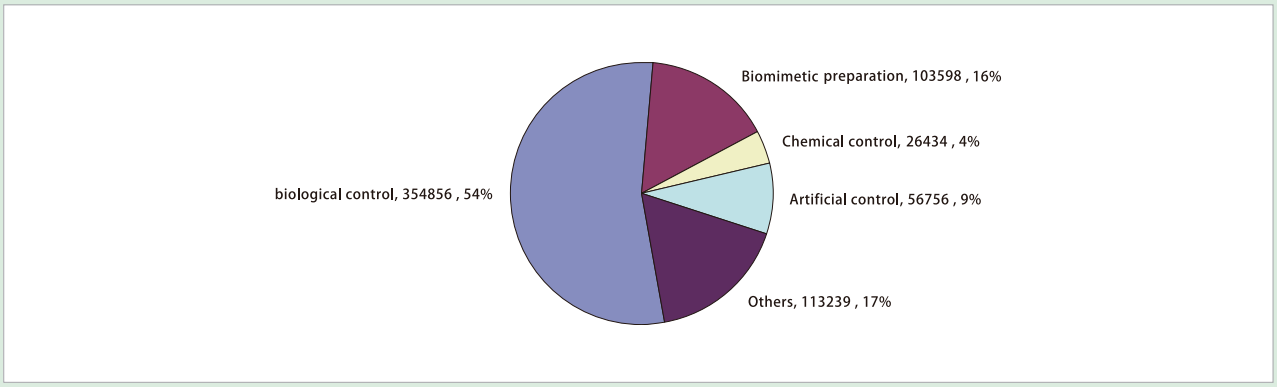
farmland shelter forest, etc. It invaded China from Dandong, Liaoning in 1979, and gradually spreads with the expansion of damage area. In 2012, it caused damage in 9 provinces.

The constant increase of occurrence area is mainly reflected in the expansion of light occurrence area, while there is no obvious increase in medium and severe occurrence area.

Case: Pine caterpillars, *Dendrolimus* species



Occurrence area of 6 major Dendrolimus species (1990-2011)



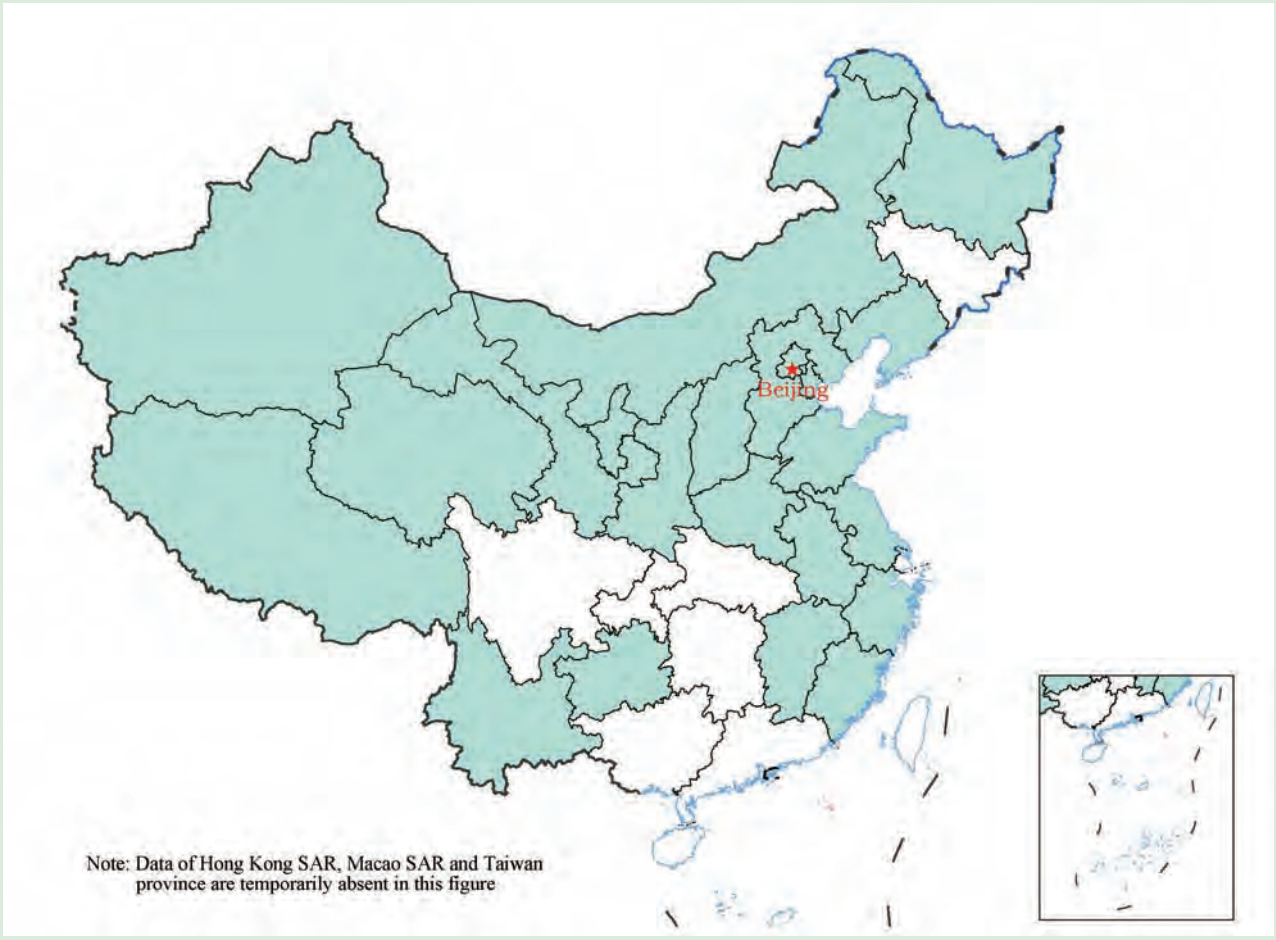
Application area (ha) and proportion of sustainable control technique on Dendrolimus disaster in 2011

The genus *Dendrolimus* are the forest pests with the longest duration, largest occurrence area, widest distribution and greatest impact in forestry production, including 27 species and subspecies. Their occurrence area covers 25 provinces (autonomous regions), including Xingan Mountains in north, Hainan Island in south, Altay of Xinjiang in west, and coastal area in east. The annual occurrence area of Dendrolimus species fluctuates around 1.4 million ha, highest figure reaches 2 million ha. It seriously affects forestry production.

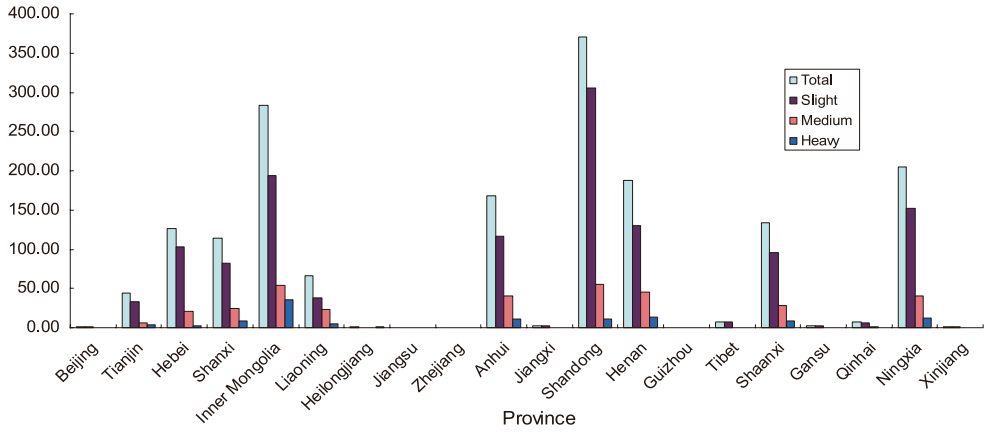
Case: Asian longhorn beetle, *Anoplophora glabripennis*

Poplar trunk borers are the major pests of poplar plantations in China, with many species, among *A. glabripennis* and *Saperda populnea* make severest damage. Due to the damage of *A. glabripennis*, nearly all trees of protection forest planted in Three North Shelterbelt Forest Program Phase I, while most of them are poplar trees, have been cut, and change tree species.

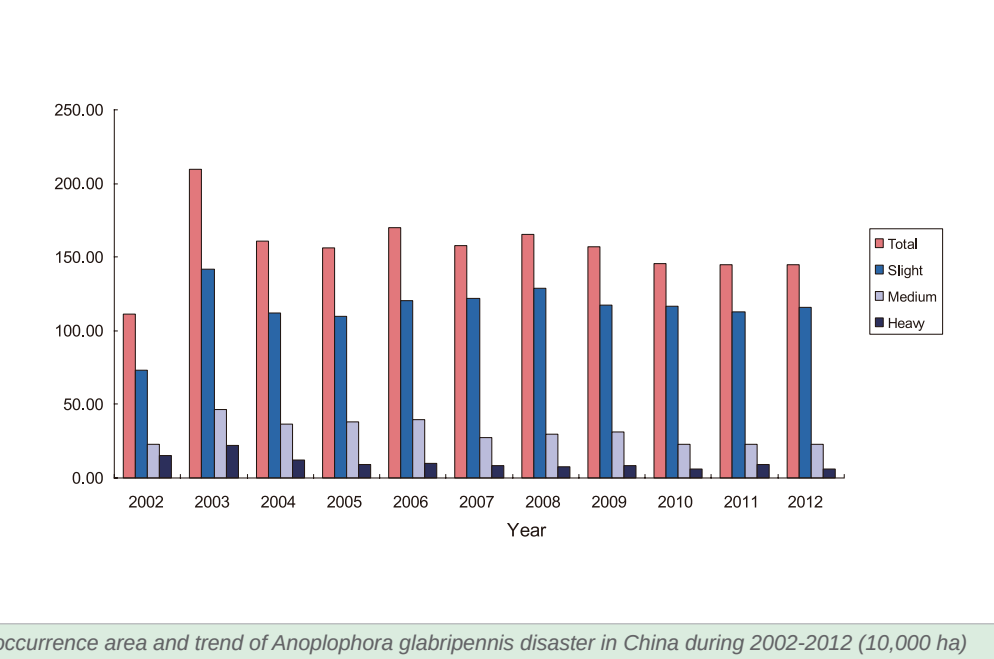
A. glabripennis has wide distribution in China, nearly in every province, the major occurrence area is in three north shelterbelt forest area in Inner Mongolia and Ningxia, and northern plain shelterbelt forest area in Shandong, Henan, Anhui, Hebei, Shaanxi, Shanxi, Liaoning, etc.



Distribution of Anoplophora glabripennis disaster in provinces since 2002



*Statistical chart of accumulated occurrence area of **Anoplophora glabripennis** in different degrees in each province since 2002 (10,000 ha)*



Accumulated occurrence area and trend of Anoplophora glabripennis disaster in China during 2002-2012 (10,000 ha)

Frequent indigenous forestry pests cause sustained damage and explode to disasters periodically

Indigenous major forestry pest species like *Dendrolimus punctatus*, poplar trunk borers and forest rodent (hare) explode to disasters in the long term. With the deterioration of forestry ecological environment due to factors like global climate change, pest species which have been effectively controlled in the past explode to disasters again, and cause severe damage.

Occurrence features include: more accidental pest species and frequency, secondary pests in the past have upgraded to major pests

poplar defoliators like *Apocheima cinerarius* and *Clostera anachoreta* in a big area of poplar plantations have become major accidental species, and reflect a gradual increase trend; with climate change and control of major pests, some secondary pests have upgraded to major species, species that rarely cause disasters in history such as *Massicus raddei*, *Ips typographus*, *Tomicus*, etc, explode in succession and bring severe damage.

Pest species in economic forest and bamboo forest increase with expansion of occurrence area

Severe economic forest pests include chestnut blight, *Laspeyresia pomonella*, crown gall, jujube witches broom, cinnamon twigs disease, *Eurytoma samsonovi*, *Eulecanium gigantean*, *Quadraspidiotus perniciosus*, *Curculio davidi*, *Sucra jujuba*, *Carposina niponensis*, *Atrijuglans hetaohei*, *Biston marginata*, etc. Ordinary pests in bamboo forest include bamboo snout, bamboo locust, bamboo Caterpillar, *Artona funeralis*, aphid, coccid, bamboo mite, scarab, cutworm, mole cricket, cricket, slug moth, *Oligia vulgaris*, *Pegomyia phyllostachys*, *Cyrtotrachelus longimanus*, etc; ordinary diseases include *Balansia take Hara*, bamboo rust, *Ceratosphaeria phyllostachydis*, etc.

Pests in shrub forest and desert vegetation cause increasingly distinct damages

Widely distributed in northeastern, northwestern, and southwestern China, shrub forest and desert vegetation with important ecological values suffer great damage from forestry pests, which brings serious ecological disaster to the fragile ecosystem. Since 2003, annual occurrence area in these regions exceeds 2 million ha. Species like *Holocerus hippophaecolus*, Haloxylon looper, *Orgyia ericae*, gerbil jird, etc, bring severe damage in vast shrub forest and desert vegetation of northeastern and northwestern China, and explode to disaster in some sites; in Tarim Basin of Xinjiang, accumulatively 200,000 ha of *Populus euphratica* forest has been destroyed by pests damage.

Rapid spread of harmful plants

After invasion, exotic harmful species quickly breed in the occurrence area and spread, appear as a single advantage plant community all over mountains and plains, violently exclude native plants, seize barren land suitable for forest, affect growth and regeneration of trees and growth of cultivated plants, block ditches

Special column: Sustained control of pests

Aiming at occurrence and damage trend of forestry pests, in order to maintain health and vitality of forest ecosystem, Chinese government has adopted a series of control measures:

(1) Since 1992, forestry pests control in China conducts target management with the major assessment content of four rates, namely occurrence rate, control rate, monitoring cover rate, and seedling site quarantine rate.

(2) China has issued Solutions on Accidental Forestry Pests Events, and Emergency Plan for Major Forestry Pests Disasters, and has established mechanism like Warning Notification of Forestry Pests and Connection Report of Forestry Pests, so as to conduct addressing management and control of accidental disasters.

(3) Implement project control for major forestry pests control, endeavor to realize disaster control and relief objective. Currently project control has been conducted in species like pine wilt disease, fall webworm, red turpentine beetle, pine caterpillar, poplar longicorn, forest rodent damage, etc.

(4) Coordinate synchronous planning and integrated control between pests control in each province, so as to achieve joint control.

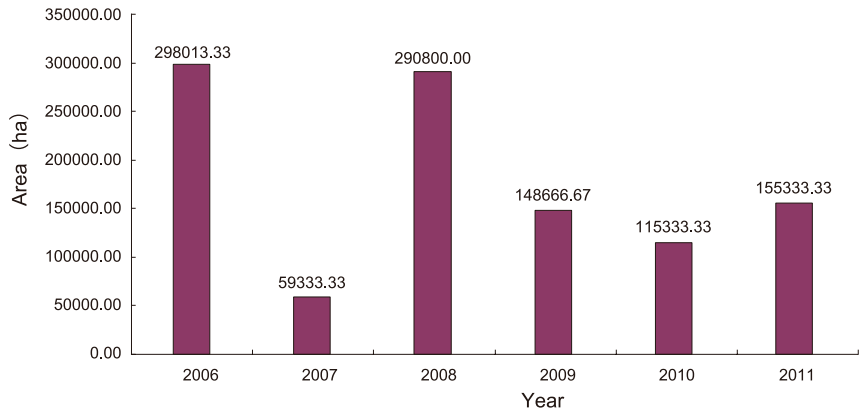


Figure 4-7. Occurrence area of harmful plants during 2006-2011

and hamper traffic, which cause huge loss on local biodiversity and agriculture and forestry production. China conducts single item statistics of exotic plant disaster since 2006, on the occurrence area of China every year (Figure 4-7). Invasive plants mainly include Eupatorium odoratum, *Eupatorium adenophorum*, *Mikania micrantha*, etc. The major occurrence area is in south China, including Guangdong, Guangxi, Hainan, Hubei, Hunan, etc.

4.2 Area and percent of forest affected by abiotic events (e.g. fire, storm, land clearance) beyond reference conditions

(1) Forest area and proportion affected by forest fires

Rational and significances

Fire is an important disturbance factor in forest ecosystem, too many burnings will result in structure change and function degradation of forest ecosystem. Forest fire is affected by climate, fuel, fire source, and control capacity of humans. To understand the changing process of forest regime is the basis for conducting scientific management of forest fires.

Forest fires refer to all fires in forests, trees, and forest land except in urban areas. *Regulations on Forest Fire Control* (2008) has regulated that based on burned forest area and population of injury and death, forest fires can be categorized in to 4 levels, namely ordinary forest fire, big forest fire, heavy forest fire and catastrophic forest fire (Table 4-1).

Table 4-1. Grading of forest fires

Level	Definition
Ordinary forest fire	Forest fire with burned forest area below 1 ha or in other forest land, or death number between 1-3, or severe injury number between 1-10.
Big forest fire	Forest fire with burned forest area between 1-100 ha, or death number between 3-10, or severe injury number between 10-50.
Heavy forest fire	Forest fire with burned forest area between 100-1000 ha, or death number between 10-30, or severe injury number between 50-100.
Catastrophic forest fire	Forest fire with burned forest area over 1000 ha, or death number over 30, or severe injury number over 100.

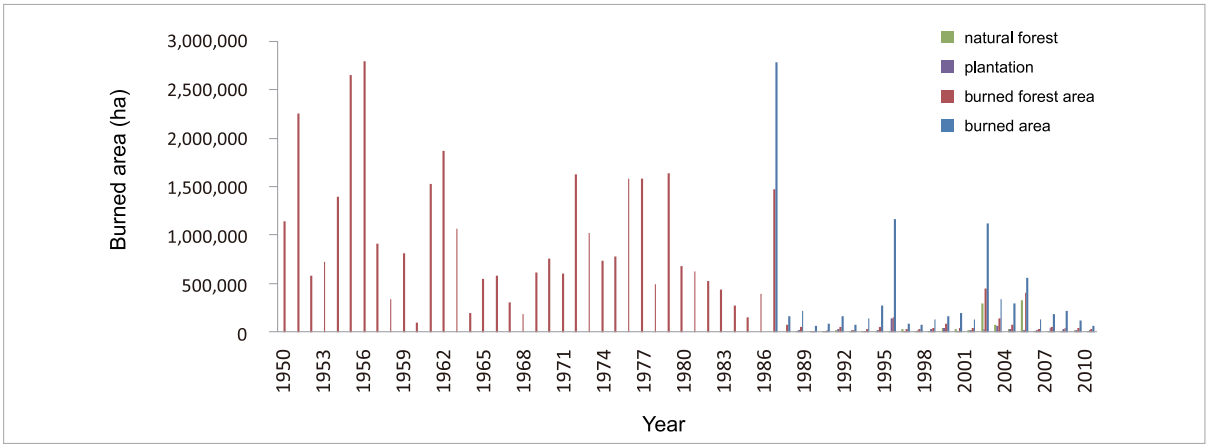


Figure 4-8. Burned areas in China during 1950-2011

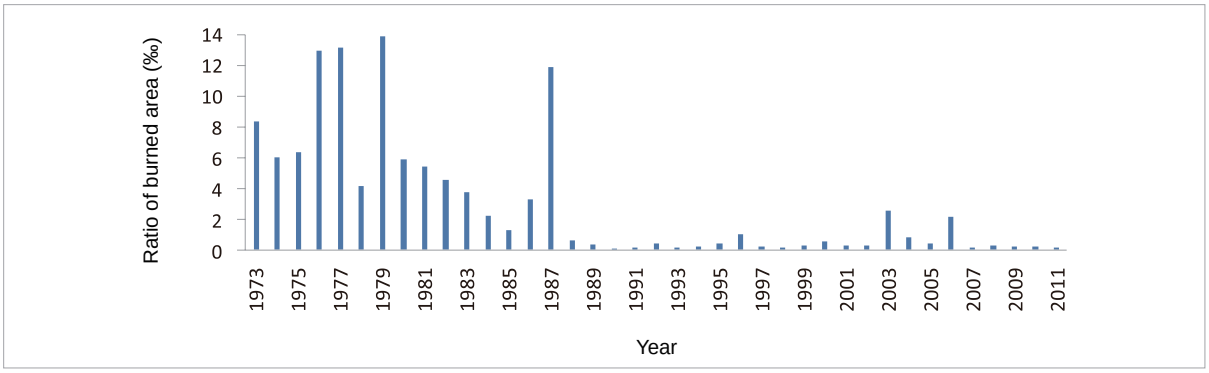


Figure 4-9. Ratio or proportion of burned area during 1973-2011

Sources of data

National Forestry Authority

Current situation and trend analysis

During 1950-2011, average annual occurrence of forest fires is 12,810. In which ordinary forest fires, big forest fires, heavy forest fires and catastrophic forest fires are 4,630 3,614 28 and 4 respectively, with the annual burned forest area of 613,645 ha.

During 1989-2011, average annual occurrence number of forest fires is 7,415. In which forest alarms, ordinary forest fires, heavy forest fires and catastrophic forest fires are 4,197, 3,198, 18 and 3 respectively, with the annual burned area of 260,580 ha, including burned forest area of 85,674 ha, in which annual burned area of natural forest and plantations are 41,135 ha and 29,477 ha respectively (Figure 4-8). Annual burned area accounts for 0.13% of total forest area in China, in which burned forest area accounts for 0.04% of the total, and burned forest and plantations area account for 0.03% and 0.05%

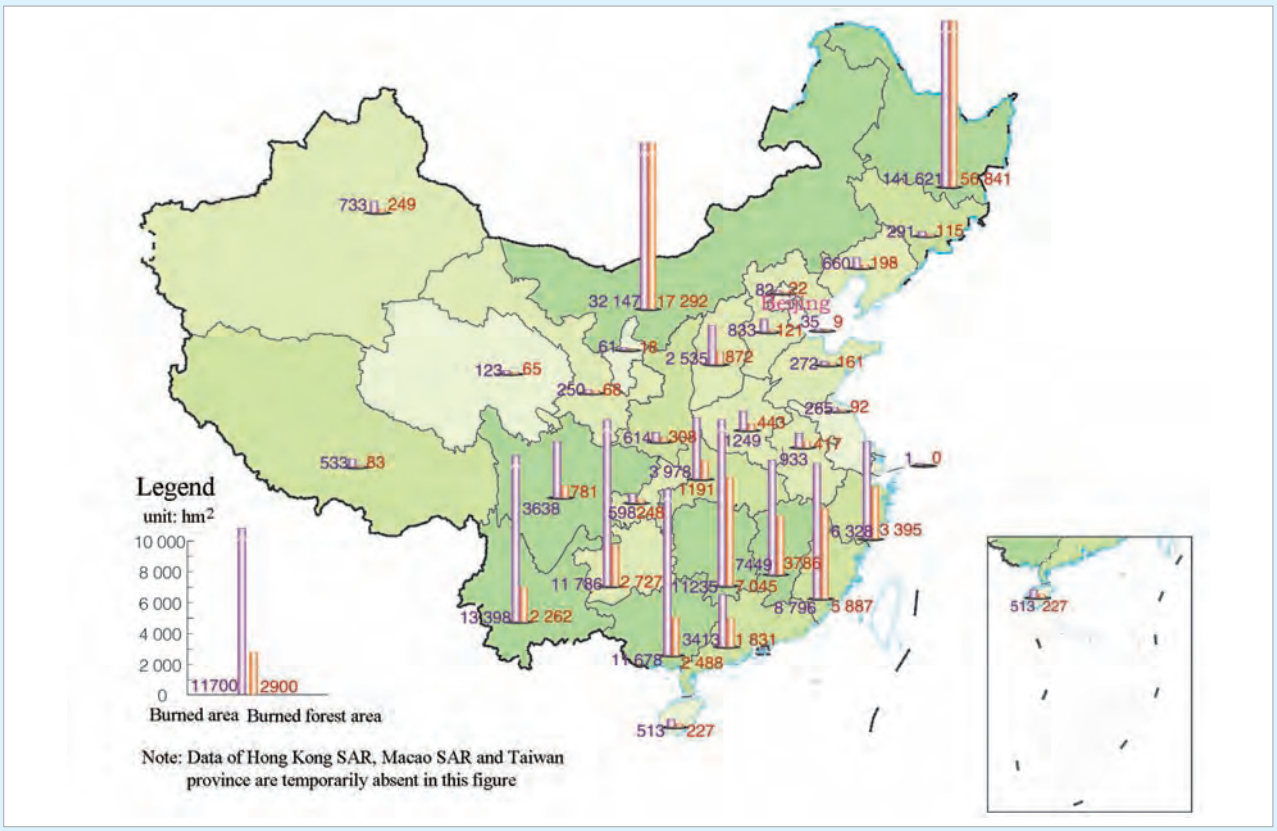
Special column: forest fire in China

Based on 6 forest fire risk factors, including tree species (groups) burning type, agricultural population density, average temperature in fire season, average rainfall in fire season, average wind velocity in fire season, and road network density, and according to county level administration zoning, forest in China has been categorized in to 3 forest fire risk grades [Grading of Forest Fire Risk Zoning (LY/T 1063-2008)]. Fire is easily occurred in the region with high forest risk grade, which also is key forest fire control areas.

The features forest fires present different in regional. Forest fires in northeastern and Inner Mongolia forest areas always occur in spring (mid March-mid June) and autumn (mid September - mid November), in most area of southern, northern and northwestern China, fire season is mid November - May in next year. In forest area of Xinjiang, fire season is April-October. Concerning occurrence region, provinces with the most occurrence numbers are southern provinces like Zhejiang, Fujian, Jiangxi, Hunan, Guangdong, Guangxi, Sichuan, Yunnan, etc. Their total occurrence number accounts for over 80% of total number in China. The biggest burned areas are in Heilongjiang and Inner Mongolia, where burned forest area accounts for 70% of total burned area in China.

Analyzing the causes of forest fires, 95% of forest fires come from artificial factors like burning on wasteland, visiting graves and burning paper, smoking in field, etc. In addition, 14 countries border China, including North Korea, Russia, Mongolia, Myanmar, etc, every year there are some fires originated from foreign countries. In Greater and Lesser Khingan Mountains region, lightning stroke is also a key cause of fires.

As a result of climatic anomaly and increase of forest vegetation in recent years, and with social and economic development, three major changes take place in forest fire control of China: firstly, due to frequent extreme weather events, fire season in most areas extend; secondly, with



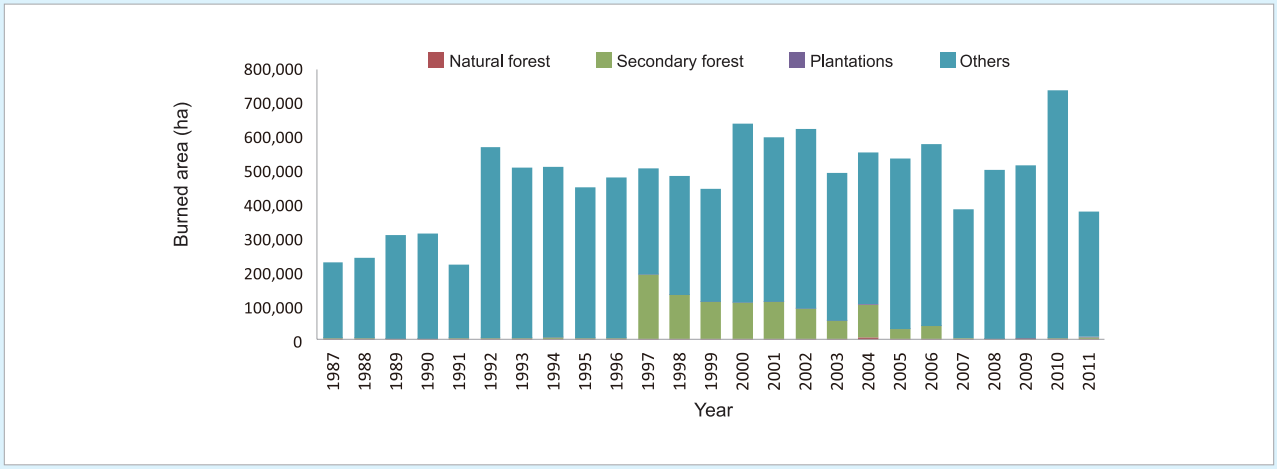
Statistics of forest fires in China in each province

the accelerated implementation of forestry key programs, forest cover in China significantly increases, resulting in the transition of forest fire occurrence from relatively concentrated regions (mainly key forest areas) to all regions with rich vegetation; thirdly, due to frequent natural fires like lightning stroke in recent years, preventing lightning stroke has also become a major content of forest fire control.

Special column: Change of forest fire management policies in China

In the early days of the founding of P.R.C, forest fire control in China just initiated, lacking effective forest fire management, so forest fires were very severe. Since 1952, the earliest forest conservation authorities such as armed forest protection brigade were established in northeastern key state owned forest areas, some forest fire control techniques and measures were gradually implemented in key forest areas. However, at that time, control capacity for bigfires in remote area was still lacking. Forest fires in 1955 and 1956 were quite severe, the annual forest burned rate reached 24‰. In January 1957, Forest Fire Control Office was set up in Ministry of Forestry, and forest fire control organizations in various local levels were established step by step, forest fire control entered a stage "giving priority to public prevention and control, integrating public and professional fire control". In 1961, 1962 and 1963, forest fires were quite heavy, with the annual forest fire victim rate of 10‰. On February 9, 1982, State Council issued A Notification on Strengthening Forest Fire Control. On March 8, 1982, Central Committee of the Communist Party of China and State Council jointly issued A Resolution on Several Issues Regarding Protecting Forest and Developing Forestry, forest fire control organizations, professional teams and infrastructure development were enhanced, forest fire control still focused on public control with quite original control means. Owing to the reinforcement of management on field fire sources and other aspects, during 1980-1985, number of forest fires in northeastern and Inner Mongolia forest areas decreased, especially in some key areas, nearly no heavy forest fire occurred. However in 1986, 2 forest fires successively occurred in Anning County and Yuxi Municipality of Yunnan Province, causing a major accident of 80 deaths and nearly 100 injuries. In May, 1987, a catastrophic forest fire occurred in Greater Khingan Mountains of Heilongjiang, with the burning area of 1.33 million ha. Taking the fire in "5.6" 1987 as a turn, forest fire control in China was comprehensively strengthened, the organization system for prevention and disposal of forest fires has been further improved, forest fire control function of each department and each industry has been given further play, forest fire emergency management enters a new stage of standardization, legislation and scientization, the concept of forest fire management has also converted from pure forest fire prevention and fighting towards scientific forest fire management, frequency and loss of forest fires significantly reduce.

With the change of forest fire management policies, China strengthens management of inflammable matter, and

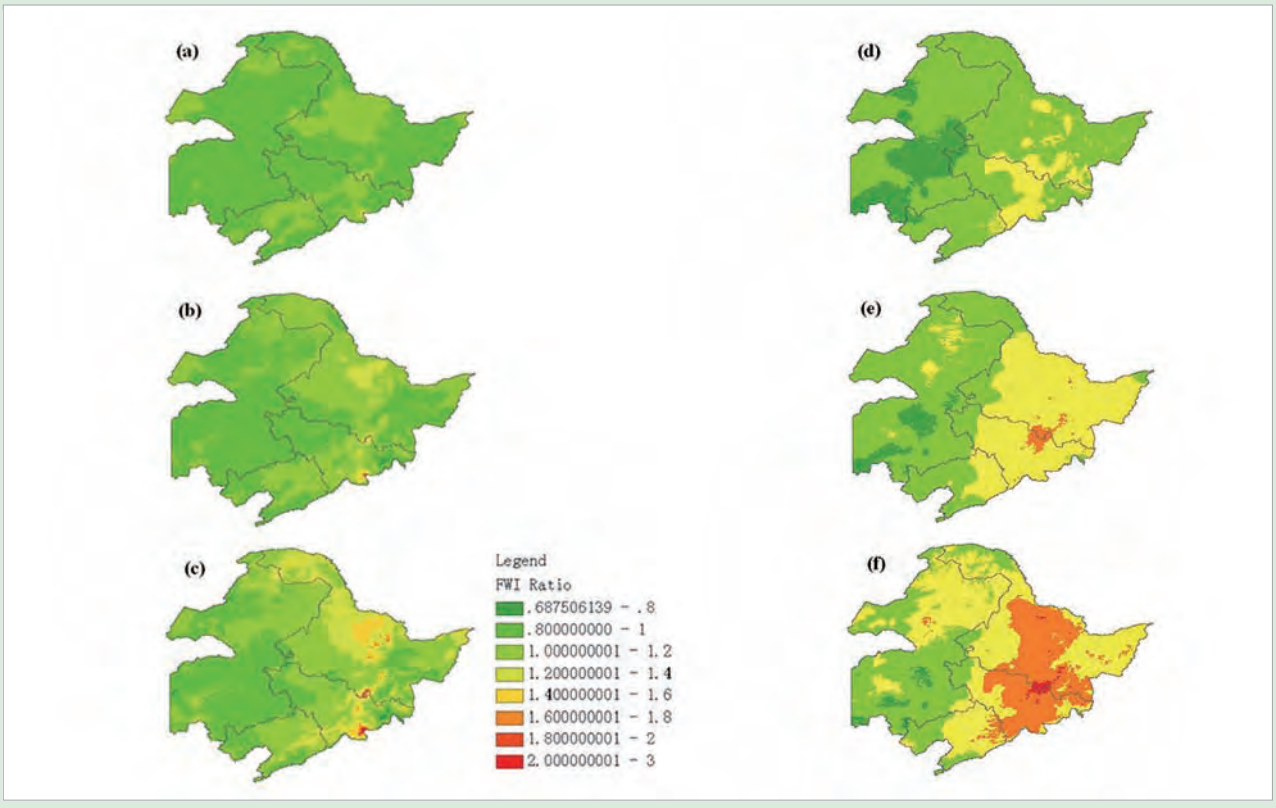


Prescribed burning area of Heilongjiang Province during 1987-2011

conducts the development of fuelbreaks, especially China has planted abundant fuelbreaks in southern forest area, by 2011, the accumulatively length of fuelbreaks totaled 820,000 km, which plays a vital role in forest fire control. In areas with advanced forest fire control techniques, prescribed burning is vigorously conducted, especially since the 1990s, a lot of prescribed burning tests have been conducted in northeastern and southwestern forest areas, relevant technical standard has been set up, prescribed burning technique has been extended in key forest areas, and has gained wide application especially in northeastern forest area. Take Heilongjiang Province for example, an annual burned area of 472,711 ha was planned during 1987-2011, among the prescribed burning areas of natural forest, secondary forest, plantations and other vegetation types (mainly including ditch, pond and meadow) are 1,046 ha, 39,892 ha, 251 ha and 431,523 ha respectively. The annual prescribed burning area of Heilongjiang during 1998-2011 is 533,843 ha, while the annual burning area in the same period is 141,621 ha, the prescribed burning area is about 3.8 times of forest fire burning area. During 1997-2006, prescribed burning area for secondary forest is quite large, the annual planned area is 96,153 ha, but reflecting a distinct decreasing trend. Concerning secondary forest in 1997, the prescribed burning area accounted for 37.87% of total burning area in that year, while this proportion was 6.9% in 2006. In other years, prescribed burning was mainly for other vegetation like fire lanes, grass pitch and meadow, accounting for over 98% of total burning area, prescribed burning for secondary forest was below 1.2%.

Case: Climate change's impact on forest fire regine in northeastern China forest area

Climate change will bring significant impact on future forest fire regine of China, especially in northeastern region. In periods of 2020s (2011-2040), 2050s (2041-2070), and 2080s (2071-2100), (FWI) Mean values, of will increase 0.26-0.60,

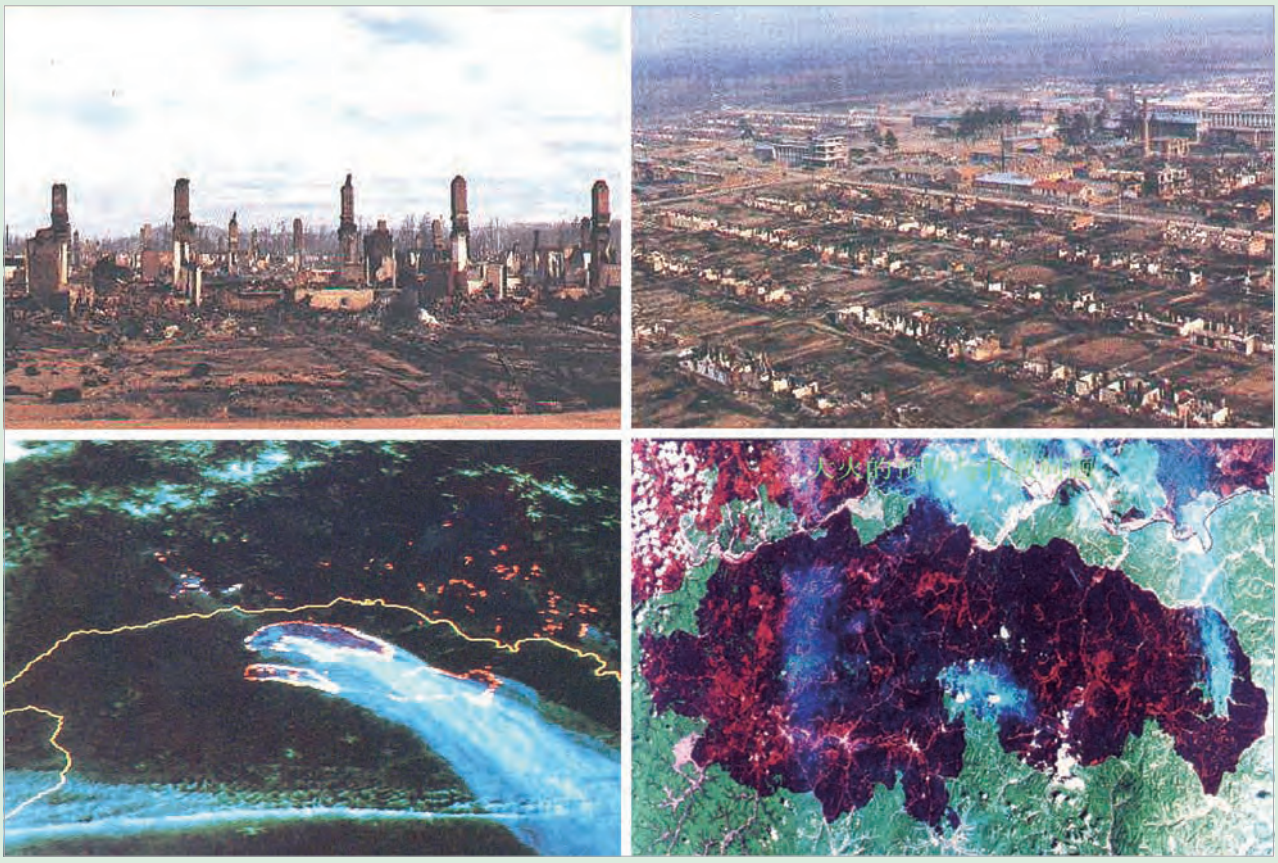


1.32-1.54, and 0.40-2.56 respectively. In 2080s, potential burned area will increase by 10%-18%, and fire season will extend 21-26 days (Tian et al. 2011).

Case: Catastrophic forest fire in Greater Khingan Mountains on May 6, 1987

Greater Khingan Mountains is the key forest area and a major timber production base in China, with the total area of 22.68 million ha, including forested area of 13.44 million ha, forest stock volume is 1.25 billion m^3. 1987 is a year with extremely drought climate in north China. A catastrophic forest fire occurred during May 6-June 2, with the burning area of 1.33 million ha, including forested area of 700,000 ha. The fire destroyed 850,000 m^3 of timber stock in lumber yard; 2,488 equipment, including 617 big equipment like vehicles and tractors; 67 bridges, with the total length of 1,340m; 9.2km of railway siding, 483km of communication line; 248 km of power transmission lines; 3.25 million kg of grain; 614,000 m^2 of houses, including 400,000 m^2 of residence houses; 56,092 people of 10,807 households fell victim to the disaster; 231 died and 226 injured, over 50,000 people of 10,000 households became homeless, the direct loss reached 500 million yuan (Du Yongsheng, 2007).

After the disaster, Greater Khingan Mountains forest area has established a complete rehabilitation and regeneration system, and conducts burned area regeneration and ecosystem rehabilitation through various approaches like afforestation, artificial regeneration, natural regeneration, mountain closure, etc. After 20 years' rehabilitation, in burned area of 4 forestry bureaus in northern Greater Khingan Mountains, the highest regenerated forest of larch, spruce and Mongolia pine has exceeded 20m, forest regeneration, forest structure and biodiversity have obviously improved.



Special column: Main forms of damage on trees by ice storm

1) Uprooting: When ice and snow load in on trees, it will cause bending or inclining of trunks, and when bending resistance capacity of stem exceeds roothold, uprooting occurs. Uprooting is the most serious form of ice storm damage on trees, it causes exposure of most root system, and causes secondary damages to neighbor trees, most uprooting trees die 1-2 years after ice storm.

2) Stem Breakage or Decapitation: When breaking resistance capacity of stem is weaker than roothold, stem breaks off, that is stem breakage or decapitation. It causes crown canopy loss, if breakage happens in lower part of standing tree, the tree will die; if breakage happens in upper part of tree, and the tree possesses quite strong sprouting capacity, after several years of stem breakage or decapitation, lots of dormant buds remaining in stems will sprout, a part of crown canopy will recover, but increment will reduce, although some damaged trees can recover very well, but this damage will still bring direct timber loss.

3) Branch Breakage: For some broadleaf tree species with thick and big branches and open crown canopy, branches with big branching angle will break off when they can not sustain ice and snow load, then branch breakage occurs. It will cause a part of loss in crown canopy and reduction of current biomass, and bring negative impact on future growth.

4) Stem Bending: Stem bending is the slightest form ice storm's impact on forest. In general condition, small diameter and young tree tend to suffer from bending instead of other damages. Stem bending has two types, namely upper stem bending and root stem bending. Stem bending by ice storm and accumulated snow may last several years or just several months, and in some extreme conditions, the trees can not recover. Stem bending not only affects tree growth, but also easily result in inclining in bending points or developing into uprooting.

5) Physiological damage: Low temperature with ice storm may also bring physiological damage on trees, for example, low temperature fluctuation can cause embolism in xylem and reduce conductivity of xylem, thus results in wilt disease of trees, low temperature may also cause brown cambium, etc.

6) Subsequent damage: After suffering from a large area of ice storm attack, trees will have weak growth and reduction in resistance, which will easily induce some pests and diseases; meanwhile, existence of lots of fallen roundwood, broken branches and litter provides a well breeding environment for some pests, which provides an advantage for the occurrence of forest pests. Ice storm results in mass forest litter, lots of inflammable matter is accumulated in forest, so forest fire risk increases.

respectively (Figure 4-9).

(2) Forest area and proportion affected by ice storm

Rational and significances

The indicator describes the damage situation on forest by ice storm[7] event that exceeds certain strength or intensity with certain scale. Ice storm's damage on trees comes from mass ice and snow accumulated in trees. Ice storm makes front assault to forest, causing lots of trees damaged or fallen, even dead, the forest canopy density decreases, even converting to non-forest land, forest stock volume decreases, forest structure is destroyed, and forest ecological function weakens, so ice storm is an important disturbance factor that affects SFM.

Sources of data

Assessment Report on Forest Resource Loss by Ice Storms and Earthquakes (SFA)

National Forestry Authority

Current situation and trend analysis

China has a vast territory and diverse climate types, no

[7] *Ice storm is a disturbance weather phenomenon featured with ice rain or freezing liquid precipitation.*

Special column: Assessment method on ice storm's impact on forests

Damage in trees can be categorized in 5 grades: I frost death; II stem breakage; III tip broken; IV branch breakage 1 (branch breakage proportion ≥50%); V branch breakage 2 (20%≤ branch breakage proportion < 50%).

Loss stems (stock volume) = grade I stems (stock volume) + grade II stems (stock volume) + grade II stems (stock volume)*1/4.

Loss damage grades

Trees loss damage grade is defined according to the proportion of damaged stems or stock volume, with the following grading standard:

Loss proportion ≥60%, grade "heavy";

Loss proportion ≥30% and loss proportion < 60%, grade"medium";

Loss proportion < 30% and loss proportion ≥10%, grade"light";

Loss proportion < 10%, grade"tiny".

Loss proportion =loss stems (stock volume)/total stems (stock volume).

Damage area: the total area of grade heavy, medium and light areas.

Table 4-2. Damage area and proportion of different forest types affected by ice storm in 2008

Forest type		Area (10,000 ha)	Proportion (%)
Total		1764.91	100
Arbor forest	Subtotal	1347.9	76.37
	Masson pine	402.15	22.79
	Foreign pine	53.65	3.04
	Chinese pine	363.2	20.58
	Eucalyptus	16.3	0.92
	Poplar	6.7	0.38
	Softwood and hardwood mixture	115.26	6.53
	Other arbor	390.64	22.13
Bamboo forest		242.58	13.74
Economic forest		174.43	9.88

matter in northern region or in vast subtropical region, extreme ice storm may occur, especially under the background of global climate change, extreme climate events occur more often with higher intensity, and severer impact on composition, structure and functions of forest community. In 2008, central and southern China suffered from catastrophic ice storm, which is a typical incident that affects forest management and governance in China (Table 4-2).

Catastrophic ice storm in 2008 involved 1,370 counties, 2,140 state owned forest farms and over 800 nature reserves in 19 provinces of China, causing the forest damage area of 17.65 million ha, accounting for 10% of forest area in China; stock volume loss was about 340 million m^3, accounting for 3% of standing stock volume of China; 3.8 billion stems of bamboo were damaged; among damage forest land area, heavy damage, medium damage and light damage accounted for 27.93%, 35.23%, and 36.84%(Figure 4-10). Direct economic loss of forest resources was about 62 billion yuan.

In 19 affected provinces, Hunan, Jiangxi, Yunnan, Hubei and Guangxi had the largest damage areas, which were 4.53 million ha, 3.97 million ha, 1.66 million ha, 1.52 million ha, and 1.51 million ha respectively, accounting for 23.34%, 20.46%, 8.53%, 7.88% and 7.81%of total damage area respectively; regarding forest loss area,

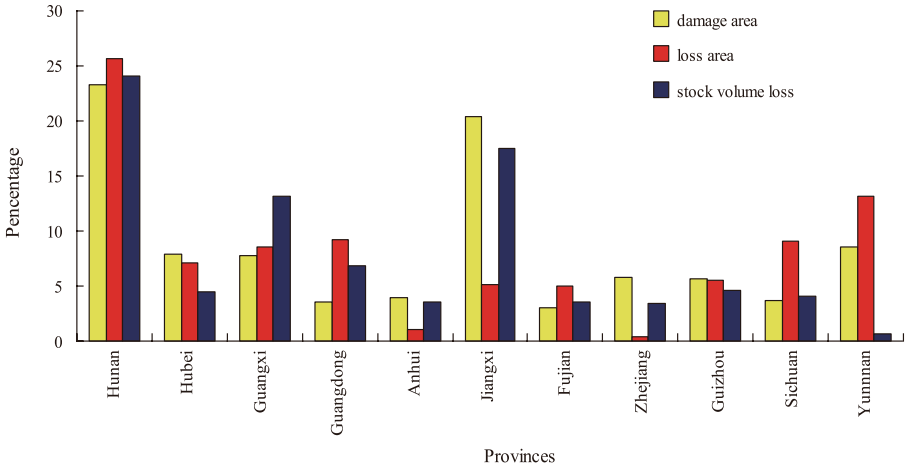


Figure 4-10. Damage area, loss forest area and standing stock volume loss in some provinces

Figure 4-11. Damage situation of major tree species: slash pine (upper left), Chinese fir (upper right), bamboo (left lower), eucalyptus (right lower)

Hunan, Yunnan, Guangdong, Sichuan and Guangxi suffered most with the areas of 780,000 ha, 400,000 ha, 280,000 ha, 279,000 ha, and 260,000 ha respectively; ranking by standing stock volume loss, Hunan, Jiangxi, Guangxi, Guangdong and Guizhou were in top 5, the figures were 81.85 million m^3, 59.48 million m^3, 44.65 million m^3, 23.40 million m^3 and 15.77 million m^3 respectively (Figure 4-10).

Among affected forest, arbor forest, bamboo forest and economic forest accounted for 76.37%, 13.74% and 9.88% respectively. Among masson pine and Chinese fir suffered from the biggest damage area, accounting for 22.79% and 20.58% of total forest damage area, eucalyptus and foreign pines were also seriously affected. Damage area and proportion, and performance after disaster differ in each species (Figure 4-11).

Inspirations from ice storm in 2008 on SFM

Through analysis on the relationship between ice storm in 2008 and forest damage, it is found that topographic factor, forest structure factor, individual features of trees, forest management measures all bring great influence in damage degree of trees. Difference in slope, aspect, and altitude will cause difference in microclimate, which means the difference in temperature, wind velocity and snow and ice accumulation, thus causes difference in trees damage degree. Forest stand density significantly affects development of shape structure of trees, which further brings great influence on its capacity to resist ice storm. Individual size and age of trees are important factors that affect strength and flexibility of trunks, and they are also important factors that affect ice and snow load capacity of trees. In addition, management measures (such as resin tapping, thinning, etc) also play an important role in forest damage degree.

From the case study of ice storm in 2008 and its impact on forest, we can conclude experiences and lessons regarding SFM.

1) In order to effectively resist attack by potential ice storm or other extreme climate events, indigenous tree species should be given priority in large scale of plantation practice.

2) Reasonable management practices are effective measures to reduce impact from extreme weather events like ice storm.

3) With regard to forest resource utilization, sustainable utilization of non-wood products should take full consideration of potential impact of ice storm.

National Report
on Sustainable Forest Management

5

Conservation and Maintenance of

Soil and Water Resources

Forest acts as an ecological screen in soil and water conservation to fight against desertification and other natural disasters. Rational forest management can significantly improve regional soil and water quality and associated water habitats; while unconsionable operations can cause soil hardening and erosion, loss of riparian buffers, then resulting in runoff changes, riverbed silt, loss of water habitats, which increase the risk of floods and other natural disasters.

China faces frequent natural disasters covering water erosion, wind erosion, freeze-thaw erosion, landslides, mudslides, a wide range of serious water and soil erosions, etc. In order to withstand natural disasters, China adopts strategic measures of afforestation, forest conservation, increasing vegetation cover and restoring forest ecosystems and launches a series of key ecological projects to strengthen the integrated management of soil and water in vital areas such as river basins and regions which suffer desertification and rocky desertification. Thanks to that, China has made remarkable achievements in improving regional environment.

5.1 Protective function

Forest affects microclimate, slows wind speed, and prevents sand storm and desertification. It also improves and retains soil through huge roots' networks, intercepts rain by canopy, absorbs water through litter layer, disperses, stagnates and filters surface runoff to reduce rainwater erosion of soil, floods, avalanches, landslides and mudslides. Forest plays a significant role in making a difference in water regulation and storage, soil conservation and disaster prevention and mitigation.

5.1.1 Area and percent of forest whose designation or land management focus is the protection of soil or water resources

Rational and significance

The changes of forest area and proportion for the purpose of soil and water conservation can reflect that the social recognition is more focus on the importance of forest function of conserving ecosystem and soil resources, which are anembodiment of bettering forest development policies. Furthermore, the changes also

reflect the adjustment of the objectives, principles and practices of forest management, as well as the shifting to maximizing integrated ecological functions such as soil and water conservation, etc. In this report, forest area for the purpose of soil and water conservation refers specifically to the area of shelter forest, which is to maintain water and soil, regulate the amount of water, control soil erosion, mitigate natural disasters and play other ecological conservation functions.

Sources of data

National forest inventories

The analysis of current situation and tendency

In all the areas of national forests (Table 5-1) that of shelter forest amounts to 83.08 million ha, occupying 45.81% of forest area and 8.65% of total national land area in China. In shelter forests, the area of three types of the largest forests, which are water supply conservation forest (30.56 million ha), water and soil conservation forest (43.72 million ha) and windbreak and sand-fixing forest (2.99 million ha), accounts for 93.00% of the total area of shelter forest and 42.60% of forest area. Among the above three types, the previous two are mainly natural forests while the latter one is plantation-based, most of which are stands planted in northeast, north and northwest areas of China since the late 1970s. Windbreak and sand-fixing forests are mainly distributed in the Inner Mongolia autonomous region, Xinjiang, Hebei, Shanxi, Liaoning and Jilin provinces, etc. Calculated by forest ownership, area of private managed windbreak and sand-fixing forests accounts for 19.00% of the total.

The shelterbelts in China concentrate in 11 provinces: Heilongjiang, Inner Mongolia, Sichuan, Tibet, Yunnan, Shaanxi, Jiangxi, Hubei, Jilin, Guizhou and Hunan, etc., where areas total 62.36 million ha, accounting for 75.05% of the national shelterbelts.

In the provinces, located in the upper and middle reaches of the Yellow River and the Yangtze River, and suffering from suffer serious sand storms, such as Inner Mongolia, Shanxi, Shaanxi, Gansu, Chongqing, Sichuan, Guizhou, Hubei, Xinjiang, Heilongjiang, etc., the proportion of conservation forest area exceeds 55% of all the woodland area (Figure 5-1).

National protected forest area and its proportion enjoys sustained growth (Figure 5-2, 5-3).

From the 1970s to the 1990s, shelterbelts enjoyed an average annual net increase of 615,200 ha with the increasing rate of 7.08 per cent in terms of the proportion of forest land area. Since the late 1990s, China has launched a large number of key ecological projects: conservation of natural forest resources, shelterbelts planted in northeast, north and northwest areas of China and in the Yangtze river basin, conversing farmland to forests, controlling sandstorm sources of Beijing and Tianjin, etc. Meanwhile, it has adopted a variety of measures to cultivate shelterbelts such as forest conservation, afforestation by aerial seeding, plantations, complementary planting, integrating both management and conservation and so on. In addition, the forests were divided into vital ecological areas and ecologically fragile regions as forests for public welfare. Thanks

Table 5-1. Area and proportion of shelter forest by types and by ownerships

Calculation unit	Shelter forest	Type		Ownership		
		Natural forest	Plantation	State-owned	Collective-owned	Private
Area (10,000 ha)	8308.38	6756.07	1552.31	4293.58	2436.57	1578.23
Proportion (%)		81.32	18.68	51.68	29.33	19.00

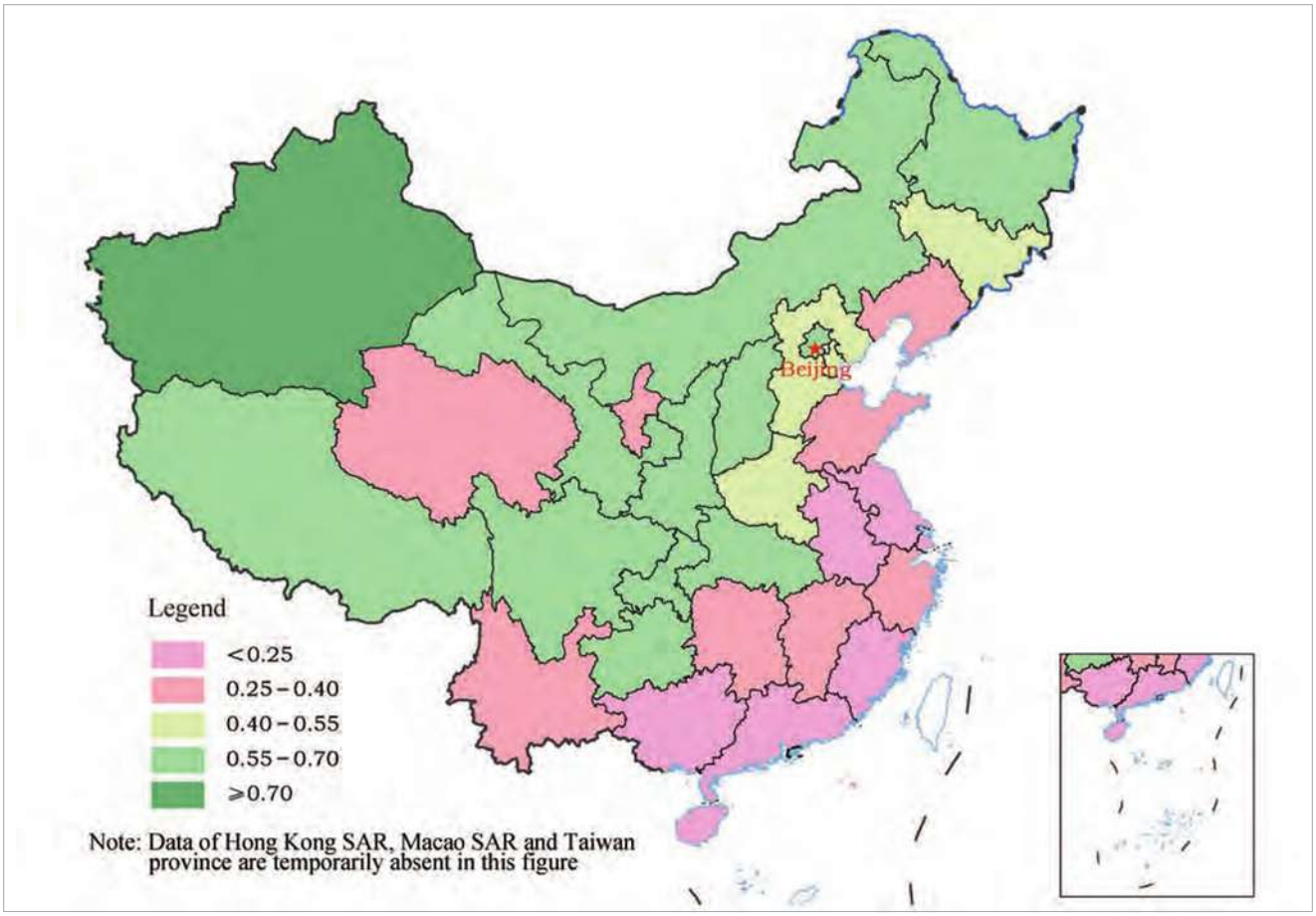


Figure 5-1. Shelterbelts' ratio of forest areas in China

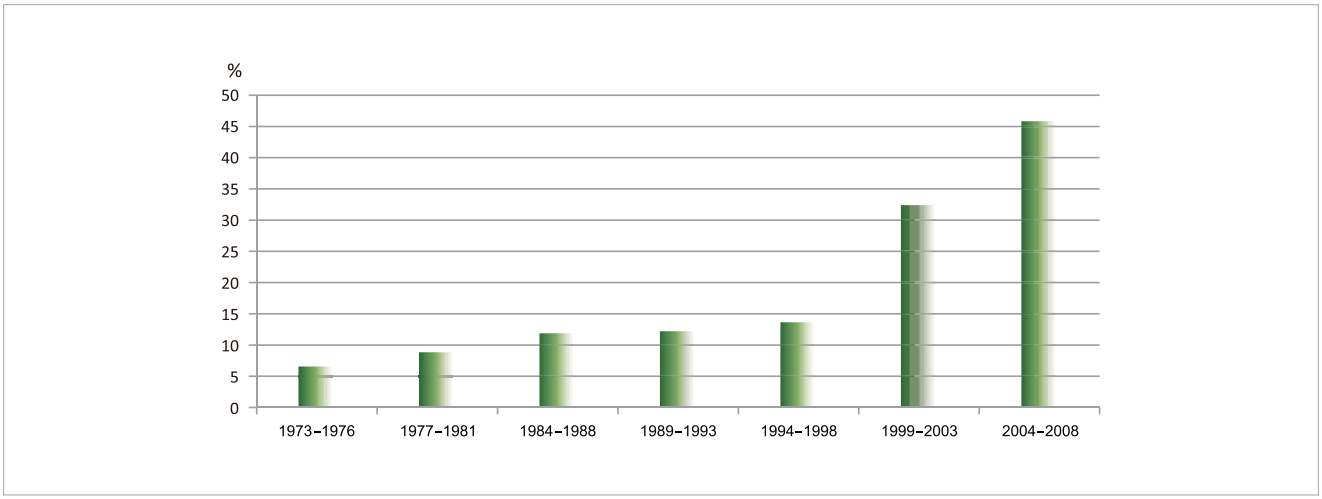


Figure 5-2. Ratio changes of shelterbelts' area

to that, shelterbelt areas witnessed an average annual net increase of 6.17 million ha and up by 3.22 per cent annually in the proportion of forest land area.

It can be concluded that the priorities of ecological construction in China concentrate in the arid and semi-arid regions of southwest and northwest regions as well as the central and western Inner Mongolia, where the

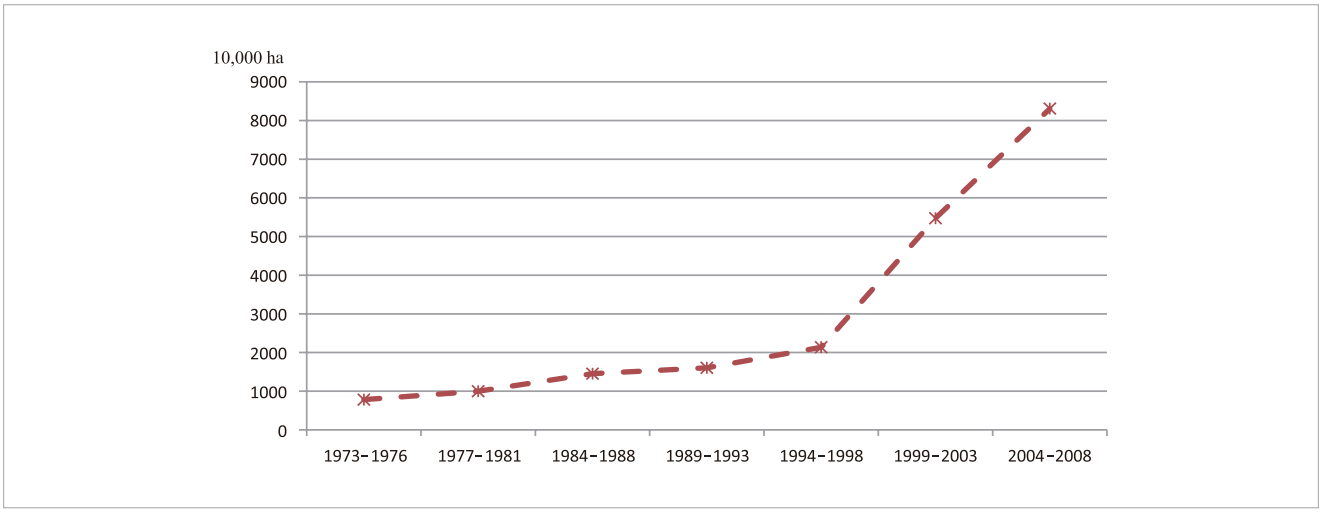


Figure 5-3. Changes of shelterbelts' area

ration of shelterbelt areas is generally higher than in other regions. State-owned forests in Northeast China's Heilongjiang, Jilin, Liaoning, and eastern Inner Mongolia perform as major timber production bases of the country, where shelter area ratio shows a sharp increase along with the construction and implementation of Natural Forest Conservation Projects. The focus of forest function shifts from producing wood products into enjoying the ecological benefits. While in central and eastern provinces where the hydrothermal conditions is promising and suitable for developing commercial forest, thus, the area ratio of shelter forest is relatively low with small change.

In China, areas of soil erosion extend to 2.95 million km^2, in which water erosion covers 1.29 million km^2, and wind erosion covers 1.66 million km^2. Soil and water conservation measures are launched in the areas of 991,600 km^2, in which measures of vegetation conservation cover 778,500 km^2, accounting for 78.5% of the total.

5.2 Soil

Forest soil has the capacity of maintaining and providing moisture and nutrients, as well as storing the organic matters to offer habitats for roots and organisms. It supports for the forest productivity and also for other hydrological functions of ecosystems. Forest management could ameliorate forest soils, water quality and aquatic environments, while unreasonable operations can cause soil hardening and topsoil erosion, loss of

riparian buffers, habitat degradation and destruction, etc. All these can result in weakening the forest health and declining the supply of other environmental services.

5.2.1 Proportion of forest management activities that meet best management practices or other relevant legislation to protect soil resources

Areas of serious soil erosion are usually located in the middle and upper reaches of major rivers and headwaters. In order to effectively conserve and utilize the soil resources in China's forests, all the following contain clauses of conserving soil resources such as China's *Forest Law* and its implementing regulations, *Water and Soil Conservation Law* and its implementing regulations, and *Land Reclamation Act* and so on. *Forest Law P.R.C.* stipulates that only cutting for tending and reforestation is allowed in shelterbelts, and any harvesting is forbidden in natural forest conservation zones, and that forestry authorities should be responsible for formulating forest management plans, etc. *Water and Soil Conservation Law* specifies that measures shall be adopted in felling areas and skid trails to prevent soil erosion, and timely reforestation should be conducted after harvesting; water and soil conservation measures are needed when preparing for afforestation, meanwhile, tending young growth, and cultivating Chinese herbal medicines should be implemented on hillsides with a

Special Column: Forest management in line with the best practices of soil resources conservation or other relevant legislations

Laws / Regulations	Technical Regulations / Standards	Conservation of Land and Water Resources / Forest Management
Forest Law of the People's Republic of China (1998) *Regulations for Implementing the Forest Law of the People's Republic of China (2000)*	• Technical Regulations on Reconstruction of Low-function forest (LY/T 1690-2007) • Technical Regulations on Zonation of State-level Non-commercial Forest (LY/T 2084-2013) • Guide for Audit of Engineering Design Base on effects to Forest Ecosystem - Part I: General Principles (LY/T2154.1-2013) • Guide for audit of Engineering Design Base on Effects to Forest Ecosystem - Part II: Forest Harvesting (LY/T2154.2-2013) • Guide for Avdit of Engineering Design Base on Effects to Forest Ecosystem - Part III: Forest Road (LY/T2154.3-2013) • Technical Regulations for the National Afforestation Verification (LY/T 2083-2013) • Code of Forest Harvesting (LY/T1646-2005) • Regulation for Tending of Forest (GB/T 15781-2009) • Requirements on Forest Tending Design (2012) • Technical Regulations for Inventory for Forest Management Planning and Design (GB/T 26424) • Non-commercial Forest Regulation of Plan and Constrction Design (GB/T 18337.2-2001) • Guide Principle (GB/T 18337.1-2001) • Technical Regulations of Non-commercial Forest construction (GB/T 18337.3-2001) • Artificial Afforestation Technical Regulations (GB/T 15776-2006) • Design Code for Afforestation Operation (LY/T 1607-2003)	(1) Non-commercial forests: specific requirements are proposed on building non-commercial forests such as selecting tree species, seedlings, type of afforestation, models, technologies, etc., and on managing forests such as forest conservation, woodland management, wildlife conservation, pest, disease and fire control, etc., as well as on types, objects, conditions, and methods of tending, reform and regeneration. Technical requirements are proposed on infrastructure covering conservation of forests, water, soil, slopes and silvicultural facilities. (2) Site preparation: overall site preparation is prohibited. Whether and how to launch partial land preparation depends on the site and tree species. (3) Technical requirements are proposed on plantation design, reforestation method, tree species of afforestation, planting density, soil preparation, planting, tending and management minor stands, inspection and acceptance, etc. (4) Design and preparation of afforestation: organization and management, preparation, method of preparation, text and format of attached tables and figures of afforestation design. (5) Logging: types and conditions of harvesting; harvesting planning, survey and design in cutting areas, approval of timber harvesting, inspection and acceptance in cutting areas, etc. (6) Non-commercial forest management: building, management, guidance, supervision, inspection, and standardization of national non-commercial forests; standardization, and enhancing scientific researches of ecological forestry projects
Water and Soil Conservation Law of the People's Republic of China (2011)	Regulation of Technigues for Comprehen Sive Contral of Soil Erosion (GB/T 16453.1-16453.6-1996) Technical Code on Soil and Water Conservation of Development and Construction Projects (GB 50443-2008)	(1) Specifies measures and techniques of conserving water and soil resources and vegetation. (2) Specifies measures of conserving water and soil resources by vegetation in development and construction projects.

slope of above 5 degrees.

Conserving soil resources in forests proves to be an integral part of sustainable forest management which includes harvesting and regeneration, conservation (covering pests, diseases and fire control), cultivation, tending, woodland management, etc. In practice, soil conservation is clearly defined in all technical regulations or standards related to forest management.

Rational and significance

National laws and regulations such as *Forest Law*, *Water and Soil Conservation Law* and *Regulations on Implementing Forest Law*, etc. are to standardize forest management activities or measures to conserve woodland soil resources (including land preparation and harvesting). In accordance with the *Forest Law*, as separate forest species, the main objective of shelterbelts is conserving water and soil (land) resources through forest management measures.

Methods such as forestry technical regulations, norms, measures and management guides turn out to be binding or recommended technical standards, which through the whole process of standardization in design, soil preparation, planting, fire prevention and control, as well as tending aim at conserving woodland soil resources.

Sources of data

State Forestry Authority

Monitoring reports of national key ecological projects

National forest inventories

The analysis of current situation and tendency

China has launched a series of major ecological projects such as shelterbelts in northeast, north and northwest areas of China, natural forest conservation, returning farmland to forest, fighting against desertification, wildlife conservation and building nature reserves, etc., in which up to 2010 Grain for Green Project saved 340 million mu (15 mu equals one hectare) land of soil erosion and 400 million mu of decertified lands, resulting in an average annual drop of 260 million tons of sand going into the Yangtze River and the Yellow River.

The forest land areas for conserving soil and water resources are estimated as follows by forest functions (Table 5-2).

Since 2001, China has had the division of state-level non-commercial forests up to over 105 million ha and has launched a total area of over 122 million ha of nature reserves, 2,151forest parks with total management area of 15.97 million ha and 4,466 state-owned forest farms. Wildlife conservation and nature reserves include national forest parks, wildlife sanctuaries and nature reserves. Forest management, free from disturbance and harvesting, partially maintains soil and water resources.

Through formulating technical standards, specifications and procedures related to forest management, forest management plans and guidance are launched to facilitate building 200 different types of management pilots in 31 provinces. The preparation and implementation of forest management plans and technologies are carried out in every forest area. As measures of conserving forest land soil resources, a series of preventive programs are launched which cover the process of afforestation, tending, harvesting, as well

Table 5-2. The changes of forest land area and its proportional for soil and water resources conservation and sustainable forest management in China

Area: 10000

Management Classification	1990	2000	2005	2010
Forest area within protected areas	467.52	1697.03	2310.73	2467.08
Forest area under SFM	3610.33	6122.04	12065.93	13590.11
Forest area with management plan	3399.95	5358.37	11372.71	12849.98
Forest area for protection of soil and water	1836.77	3294.68	5293.17	6047.99
Total	15714.07	17700.05	19304.39	20686.06
Ratio of area for conserving soil resources (%)	11.7	18.6	27.4	29.2
Ratio of area sustainably managed (%)	23.0	34.6	62.5	65.7

Case: increasing and maintaining groundcover can significantly reduce soil erosion

In the Loess Plateau, when the vegetation coverage reach to 50%, there won't be serious soil erosion even the storms occur; then the stand function of reducing soil erosion is close to its maximum with 70% of vegetation coverage (Wang Yanhui, 1986). In chines pine forests, after removal of litter layer, turing into farmland, or harvested the upper layer trees but maintaing the gramd cover and litter layer, the erosion was increased by 15.4, 8.4 and 949.9 times respectively, and surface runoff increased by 3.6, 2.7 and 5.5 times (Zhao Hongyan et al, 2002). The Annual soil erosion was 1054 $t \cdot km^{-2}$ in barren covered by thrubs and grasses, while it droped to 1 $t \cdot km^{-2}$ in forested catchments (Wu Xinxiao and Zhao Hongyan, 2000).

In subtropical regions, when average vegetation coverage is 35.1%, 48.3%, 60.9%, 69.2%, and 83.1%, the corresponding erosion is 927.8, 587.2, 207.6, 103.2, and 32.0 $t \cdot km^{-2} \cdot a^{-1}$; 10% higher vegetation coverage signifies doubling the decrease of soil erosion; a vegetation coverage higher than 60% could control the soil erosion below 200 $t \cdot km^{-2} \cdot a^{-1}$ (Shui Jianguo, 2001). As for soil erosion modulus (t/km^2), it was bare land (7744.2) > slope land (3826) > dry land (942.2) > sparse woodland (336.5) > typical forest stand (10.2) (Zhao Hui et al, 2008).

In general, the best forest management practices are to increase and maintain a high vegetation cover and avoid interfering on vegetation coverage, in both afforestation or forest management activies in whole China.

as corresponding with technical regulations and norms of conserving forest land soil resources.

(1) Planning and designing the development and construction in forest farms should reduce soil erosion caused by afforestation, for instance, all should be avoided before afforestation including site preparation (or site-clearing), deep cultivation of soil, tending by digging, etc.

(2) Overall site preparation on steep slopes or tending by digging is prohibited. The afforestation projects should be designed and constructed in accordance with standards for conserving water and soil resources on slopes to avoid soil and water erosion in young forest lands.

(3) Intercropping leguminous herbs in sparse forest lands can increase the vegetation coverage, which can control soil erosion on sparse forest lands. In addition, building terraces, horizon stairs and grooves and borders on slopes could prevent or reduce soil erosion; afforestation on steep slopes should be conducted by adopting methods to conserve soil such as building fish-scale pits or reversed terraces to reduce soil erosion and area-source pollution.

5.2.2 Area and percent of forest land with significant soil degradation

Rational and significance

Soil degradation refers to the decline in productivity due to recession of soil fertility, which is manifested by reduced organics, soil erosion, and desertification, salinization and acidification, etc. Soil degradation in forests will alter hydrological and ecosystem processes, which results in recessed productivity and impacts negatively on ecological, economic, social and cultural benefits of forests as well as sustainable forest management.

Sources of data

Standards of Classifying and Grading Soil Erosion (SL190-2007)

Notice of Soil Erosion in China

Bulletin of Soil and Water Conservation in China in 2009

The analysis of current situation and tendency

(1) Soil erosion in the nation and in key regions

At the end of the 1990s, the total area of soil erosion in China registered 3.56 million km^2, accounting for 37% of the total land area, of which 1.65 million km^2 was caused by water erosion, 1.91 million km^2 induced by wind erosion, and 0.26 million km^2 caused by both wind and water erosion.

Water erosion occurs mainly in the northwest Loess Plateau, hilly areas with black soil in northeast China, and hilly regions with red soil and rocky mountain in South China and northern mountainous areas; wind erosion occurs mainly in sandy areas and grasslands in northwest in China (Figure 5-4). Areas suffering from terrible soil erosion accounts for 32.02% of the total; the total amount of lost soil weighs 5 billion tons, in which 60% comes from the Yangtze River and the Yellow River basins. Serious soil erosion happens in some regions, which rises to over 10,000 t·km^{-2}.

At the end of the 1990s, some forest areas with vegetation coverage suffered from soil erosion (Figure 5-5), in particular in Liaoning, Shandong, Jiangxi, Fujian, Shaanxi, Shanxi, Gansu, etc. Strongly eroded areas could exceed 10% in the proportion of forests areas.

Comparison of the same place before and after soil erosion control

The nation's major river basins in 2009 (Table 5-4) showed less amount of the soil erosion than the average annual volume, and a sharp drop in sands flowing into water and sand content in main streams, covering Yangtze River, Yellow River, Haihe River, Huaihe River, Pearl River, Songhua River, Liaohe River, Minjiang River, Tarim River, Heihe River, etc., in which the soil erosion amount of Yangtze River and Yellow River occupied 32.76% and 8.56% of the annual average.

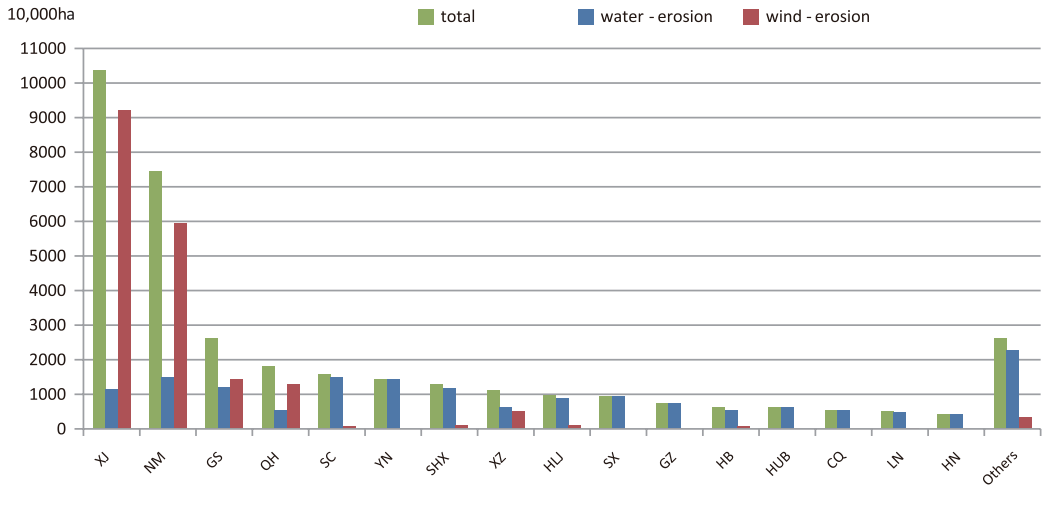


Figure 5-4. Provinces suffering from serious soil erosion at the end of 1990s

(Note: XJ- Xinjiang, NM-Inner Mongolia, GS- Gansu, QH- Qinghai, SC- Sichuan, YN- Yunnan, SHX- Shan'xi, XZ- Tibet, HLJ- Heilongjiang, SX- Shanxi, GZ- Guizhou, HB- Hebei, HUB- HuBei, CQ- Chongqing, LN- Liaoning, HN- Hunan)

Moreover, soil erosion area in Yangtze River dropped by 15%. In a decade between 1999 and 2009, China witnessed continuously decreasing decertifiedand sandy lands, in which decertified land areas was down by 50,400 km^2 and sandy lands drop by 15,000 km^2.

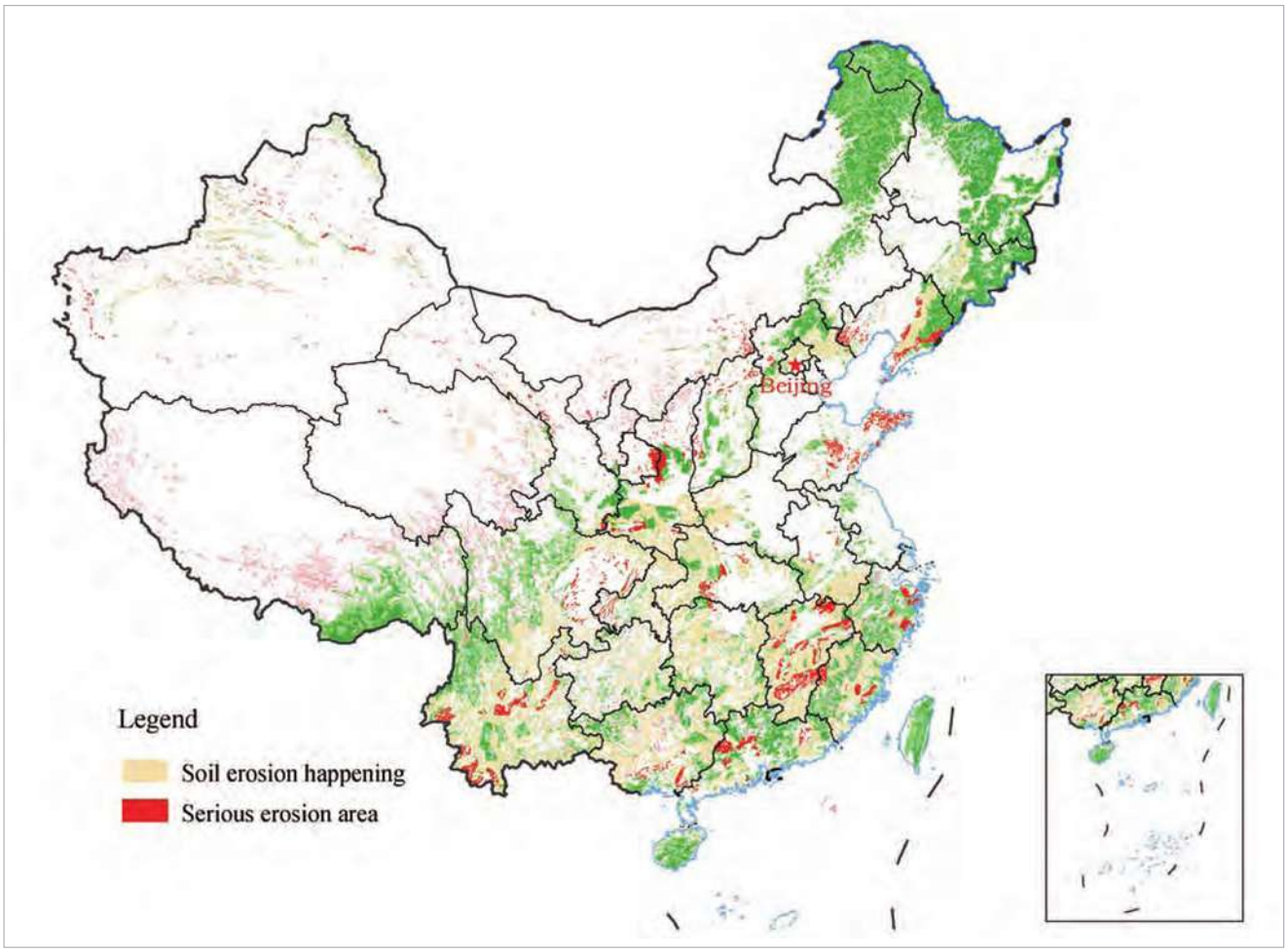


Figure 5-5. Distribution of forest soil erosion in the late 1990s

Table 5-3. Soil erosion in the major river basins of 2009 in China

Name of watersheds	Soil erosion area (10,000 km^2)	Total amount of erosion (100 million ton)			
		Multi-year average	2009	2010	2011
Yangtze River	142.26	23.87	7.82	10.18	4.20
Yellow River	49.15	16.00	1.37	2.89	1.58
Haihe River	18.20	2.01	0.0006	0.0096	0.0108
Huaihe River	20.10	1.58	0.23	0.22	0.0312
Pearl River	41.52	2.20	0.46	0.69	0.35
Songhua River	52.83	0.19	0.30	0.26	0.12
Liaohe River	22.00	1.53	0.05	0.33	0.17
Qiantang River	5.56	0.11	0.12	0.30	0.29
Minjiang River	5.85	0.12	0.008	0.21	0.0086
Tarim River	11.73	1.30	0.36	1.11	0.59
Heihe River	4.39	0.16	0.01	0.0086	0.0201

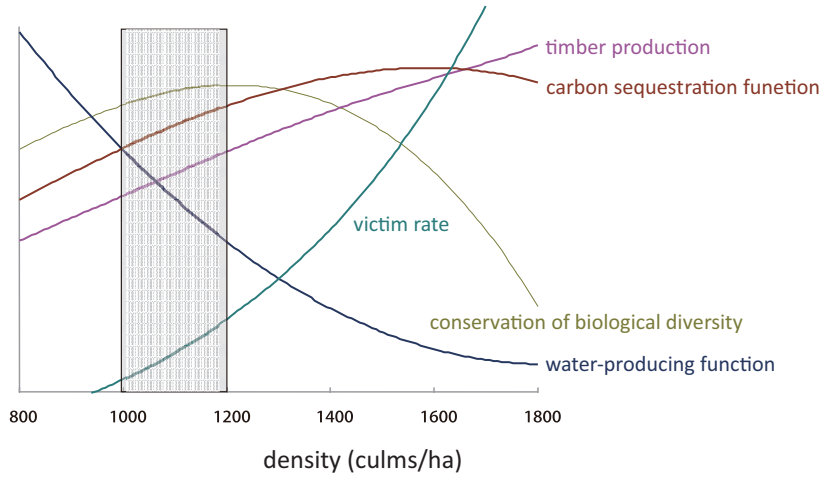
5.3 Water

5.3.1 Proportion of forest management activities that meet the best management practices, or other relevant legislation, to protect water related resources

The forest management model to exert the hydrological functions mainly covers erosion control, runoff regulation, improving soil hydrological properties, water quality protection, etc. At present, these models have not yet transformed into a series of best management practices, nor are regulated by regulations or technical standards. Hence it's difficult to calculate the proportion of best practices in conserving water resources or forest management concerning relevant legislations

Case: Multi-functional impact and sustainable management density for water-retention forests of larch (*Larixprincipis-rupprechtii*)

How to sustainably design and regulate forest stand structure, especially in terms of density range, turns out to be a major and urgent need to achieve sustainable forest management and maximize the overall function of forasts



Stand density and multi-functions of larch plantations in Liupanshan Mountains in Ningxia, China

for regional the relation between development. This case is based on the research results of the relation between tand density and multi-functions of larch plantations (17-35 years old with the average age of 26 years) in Liupanshan Mountains in Ningxia, China, The main conclusions are:

The water-yielding function of stands has a negative correlation with stand density. Canopy interception and water consumed by forest transpation during the growing season has a positive correlation with stand density. The water-yielding amount from forests non-linearly increases with dropping stand density. It remains low with less variation (109.7-106.9mm) when the density rises above 1,500 culms ·ha^{-1}; The water-yielding amount rises slowly, with an increase of 6.6mm when the density drops by 100 culms ·ha^{-1}, within the density range of 1,300-1,500 culms ·ha^{-1}; however, the water yielding amount rises sharply, with an increase of 11.7mm when the density drops by 100 culms ·ha^{-1}, within the density range below 1,300 culms ·ha^{-1}. Hence, if it's to increase water production by reducing stand density, it's better to maintain the stands with the density below 1,300 culms ·ha^{-1} for the age of the studied forests.

It's recommended to control the stand density below 1,300 culms per ha in terms of studyed forest age to maintain the dominent function of water production in water-retention forests of larch, and to control the stand density between 1,000-1,200 culms per ha when taking into account other functional requirements. (Haojia, 2012)

Forests can affect the water amount; it shows that large-scale afforestation in the Loess Plateau will cause a significant reduction of water yield (Wang Yanhui et al, 2011). Integrated management of forest vegetation, water resources and multiple functions of forests are needed for the future forestry development. Some practical technologies are already forming the technical supports for integrated management of multifunctional forest and water resources in the future.

5.3.2 Area and percent of water bodies, or stream length, in forest areas with significant change in physical, chemical or biological properties from reference conditions

Rational and significance

Forests with their complex structures affect amount of hydrological and biogeochemical processes, where the change of water quality is correlated to forest management activities. Rational forest management can improve rather than damage water quality which is vital to both of the survival of human being and health of aquatic ecosystem. Indicators of water quality include physical indicators such as temperature, turbidity, etc., and chemical indicators covering dissolved oxygen, nutrient enrichment, pH value, etc., and harmful algae, other organic components and so on.

The assessment is rarely conducted over the river or lakes located in the forest areas, thus, it is difficult to evaluate the size, length or proportion concerning the significant changes of water quality in the forest areas. It can only be preliminarily summarized and evaluated from some scattered research materials. To strengthen the monitoring and research of water quality in the forests lists as a priority in ecologically environmental monitoring of forestry in the future.

Source of data

The first bulletin on national water census (2010-2012).

The analysis of current situation and tendency in the miyum watershed of Beijing

Forests act as a great purifier of water. Studies have shown that the turbidity of surface water and the indicator of ammonia nitrogen declined with an increase in forest area and dropping of farmland fertilizaer appeication since Grain for Green Project launched in 2000 (Li Wenyu et al, 2004). The different layers in forest ecosystems could incroase the water pH-value under slightly acidic precipitation. The content of Cd, Pb, Mn and Zn in the rainfall could be reduced respectively by different layers of forest ecosystems, espeaally the canopy which reduee the contents of above

mentioned elements at the rate of 83%, 76.7%, 54% and 99% respectively. Generally speaking, canopy proves to be the key in water purification assisted by soil layer (Zhang Shengli and Li Guanglu, 2007). The quality of polluted rain water has been upgraded from Category II to I, up by 88.40%, in the forest ecosystems of oak (*Quercusalienavar. acuteserrataMaxim*) in Huoditang Forest Farm of Qinling Mountain, China (Lei Ruide, Lu Yuliang, 2003). Chemical Oxygen Demand of arable lands in the Three Gorges Reservoir Area turned out to be 3 to 4 times of that in woodlands; the loss amount of P was 1.6 times of the latter; pH-value rised from 5.71 to 7.39. As forest cover dropped from 63.23% in 1973 to 61.63% in 1985, river's water temperature, pHvalue, and the content of NH_4^+, NO_2^-, NO_3^- increased for Xiangxi River basin in Yichang, Hubei province (Wang Lixian, Xie Mingshu, 1997).

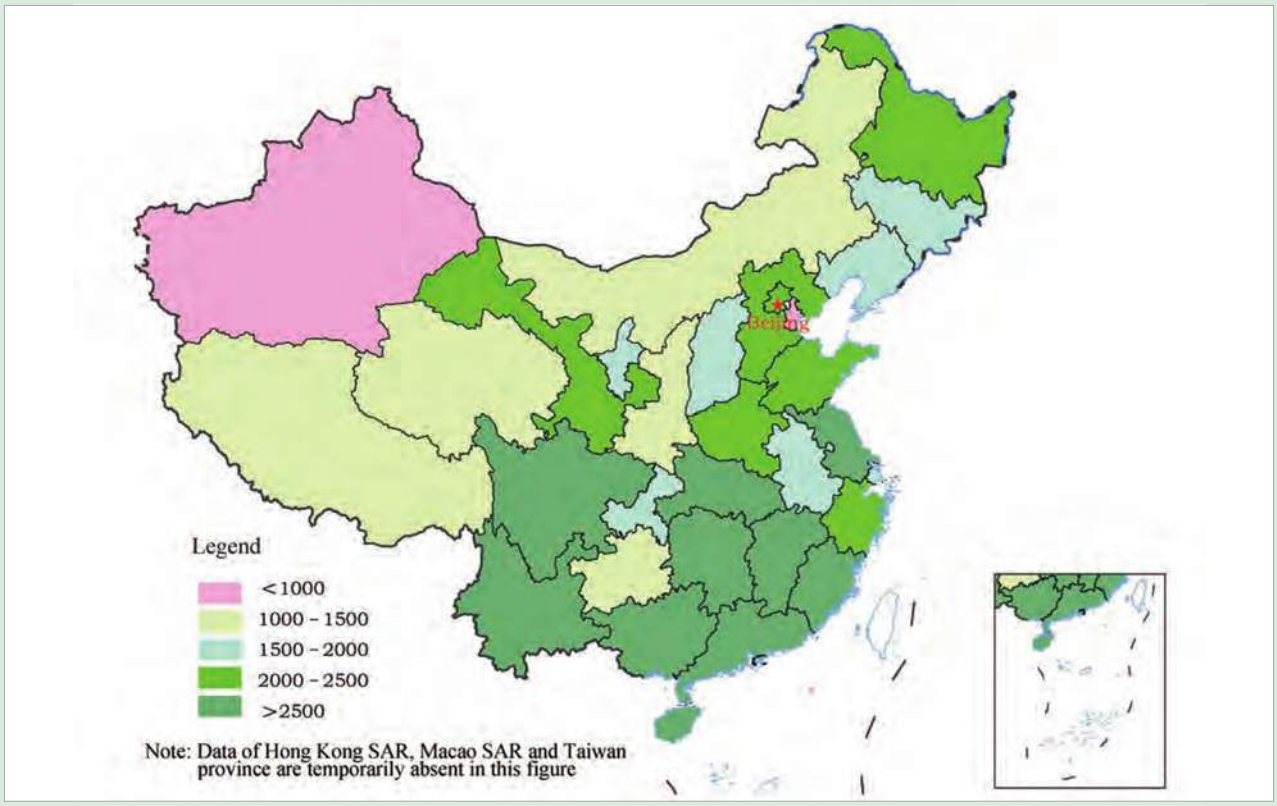
Forest soil could buffer the input of acid deposition, but in a limited range; meanwhile it lead to a soil acidification and undermine the improvement function of forest to water quality. For instant, acid deposition had caused severe soil acidification in Tieshanping, Chongqing, China (Li Zhiyong, 2008). The pH-value Li Zhiyong in catchment runoff proved to be lower than that in precipitation because of soil acidification in Dinghushan, Guangdong province (Ouyang Xuejun et al, 2002); Al^{3+} concentration in catchment runoff and soil solution at the depth of 30 cm was 5 and 8 times high of that in the precipitation. Acid rain has also led to an increase in pine forest mortality and their defoliation (Wang, et al. 2007), which jeopardized the stability of forest ecosystem and its regulatory function to conserve water and soil. Application of alkaline agent for soil remediation (Li Zhiyong, et al. 2008) and antiacid tree species in forest structure coversion can be greatly helpful to restore the forest health and hydrological regulatory function.

Case: Protective function and value assessment of soil and water conservation of national forests

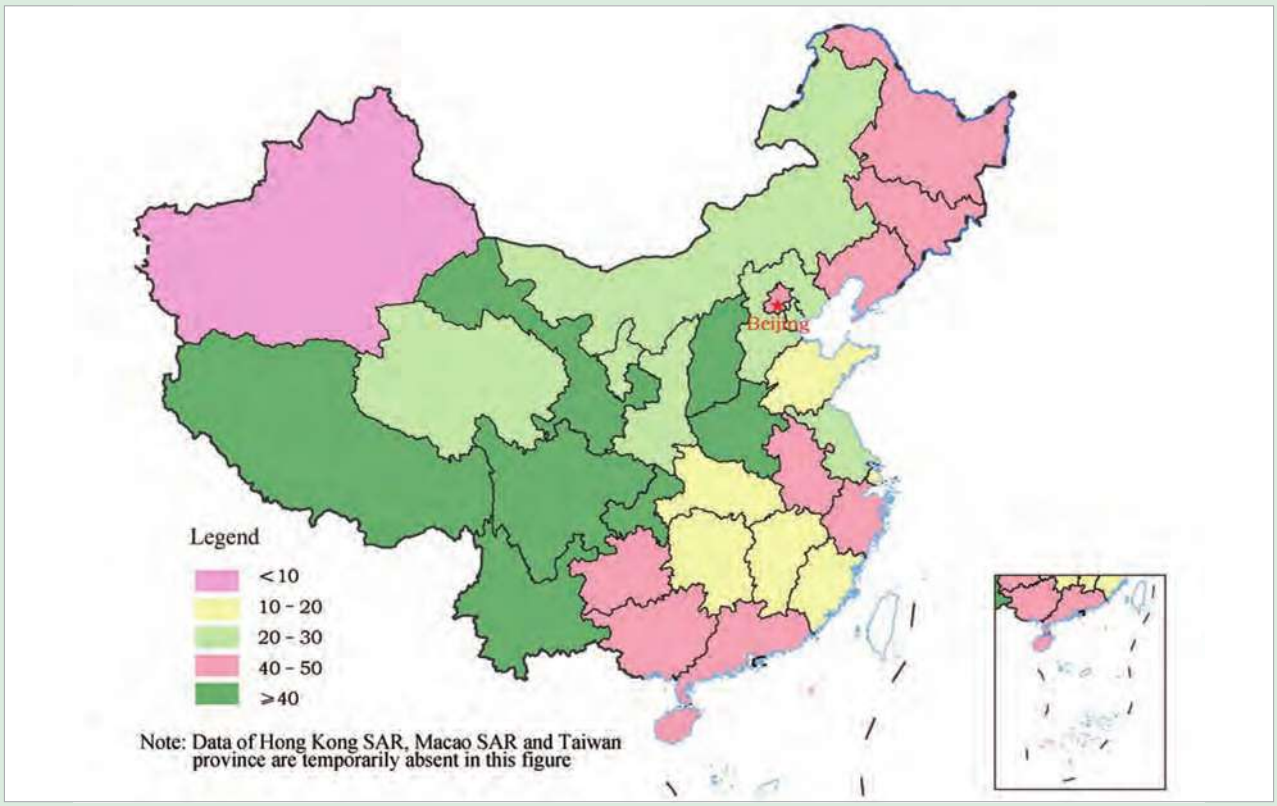
According to the results in the 7th national forest resource inventory and multi-years observation by China Forest Ecosystems Research Network (CFERN), State Forestry Administration (SFA), and using the *Specifications on Assessing Forest Ecosystem Services* (LY/T 1721-2008) issued in 2008, the functions of forest ecosystem services in national and provincial-level was assessed. The document defines that the volume of water conserved per unit forest area is the difference between annual precipitation, annual evapo-transpiration and surface runoff. The economic value is calculated as the product of water conservation volume and the unit volume cost for building reservoir. The value of purified water is the product of water conservation volume and the cost for purifying unit volume water. The assessment results illustrated that the total annual volume of water conservation in whole China forest ecosystems is 494.77 billion m^3, the value of regulating water is 3.02 trillion Yuan, the value of purifying water is 1.03 trillion Yuan, and the total value of water conservation is 4.06 trillion Yuan.

The soil conservation service of forests has been assessed in each province and whole China in 2009, using the indicators of soil reinforcement and fertilizing. The volume of soil reinforced per unit forest area refers to the difference between the soil erosion modulus of non-forest land and that of forest land. The value of soil reinforcement is calculated as the product of soil reinforced volume and the costs of digging and transporting per unit earthwork. Annual fertilizing value in forest stand is the cost of nitrogen, phosphorus, and potassium reinforced in soil and organic, calculated by the price of diammonium phosphate, diammonium phosphate, and potassium chloride. The assessment results illustrated that the annual capacity of soil reinforcement in whole China forest ecosystems is 7.04 billion tons, with a correspinding value of 86.15 billion Yuan; the value of fertilizing is 905.90 billion Yuan, and the total value of soil conservation is 992.06 billion Yuan.

The forest in Sichuan, Yunnan and other provinces in South China have stronger ability in water conservation with regulating water volume over 2,500 $t \cdot ha^{-1} \cdot a^{-1}$. While the forests in north China (for exampee Tibet, Gansu, Ningxia, Shanxi,



Distribution of water conserved per unit of forest area in China (Ton)



Distribution of soil reinforced per unit of forest area in China (Ton)

Henan and so on) have stronger ability in soil reinforced, the volume of soil reinforced is above 40 $t \cdot ha^{-1} \cdot a^{-1}$.

The total annual volume of water conservation in forest vegetation nationwide reached to 494.77 billion tons, which increased by 90.80 billion tons (22%) compared with 403.97 billion tons in the late 1990s. The total annual volume of soil reinforcement in China was 7.04 billion tons, which increased by 2.5 million tons (26%) compared with 5.56 billion tons in the late 1990s. Moreover, reducing the loss of N, P, K and organic matters by 364 million tons, which was 73 million tons (25%) more compared with 291 million tons in the late 1990s. China's forest has been improved in the functions of water conservation and soil reinforcement. Furthermore, it also plays an important role in preventing soil degradation, improving soil fertility, protecting ecological security, ensuring people's livelihood and promoting social and economical sustainable development.

National Report
on Sustainable Forest Management

6

Maintenance of Forest Contribution to

Global Carbon Cycles

Forest ecosystem, renewable, is a mega-giant carbon pool in the terrestrial ecological system, vital to the cyclic process of global carbon sequestration and carbon emissions. Under the background of global climate change, the rising temperatures shape the structure, distribution, productivity and health of forests in temperate and boreal regions, which enhances the carbon sequestration capacity of forests. However, more extreme weathers lead to forest fires, pests and diseases as well as storm disasters with higher frequency and intensity, resulting in more carbon emissions. The land use change, in particular deforestation, releases carbon sequestered in forest biomass and soil into the atmosphere, exacerbating the trend of global warming. Therefore forest is both an important sink of CO_2 and a vital source of CO_2 emissions.

6.1 Total forest ecosystem carbon pools and fluxes

Rational and significance

The forest carbon pools typically include: biomass (aboveground and underground biomass), litters, dead trees as well as soil organic carbon pools. HWPs are also important carbon pool. The launching of relevant measures such as boosting forest area, enhancing management practices, etc. to increase and sustain carbon stocks of HWP so as to improve the carbon cycle and flow, which can effectively increase forest carbon stocks and reduce CO_2 emisson to the atmosphere. Currently, China only estimates forest biomasscarbon stocks based on the seventh national forest inventory but has no data on annual carbon sequestration by forest ecosystems.

Source of data

National forest inventories

Current situation and trend analysis

According to the results of China's 7th NFI, it's estimated that the total amount of carbon stocks in forest vegetation stands at 7.81 Pg C, in which forests register 85.29% (6.66Pg C), trees out of forests register 7.59% (0.59Pg C), shrubs (particularly those fix in the definitions issued by China) occupy 4.58% (0.36Pg C), and bamboos (including monopodial bamboos) register 2.54% (0.20Pg C) (State Forestry Administration, 2010).

6.2 Total HWP carbon pools and flux

Rational and significance

This indicator reflects the contribution of carbon stocks and carbon stock change in Harvested Wood Products (HWP) to the carbon cycle in forest ecosystems. As renewable resources, HWP, vital in reducing or mitigating carbon emissions, can replace energy-intensive products and extend the life expectancy

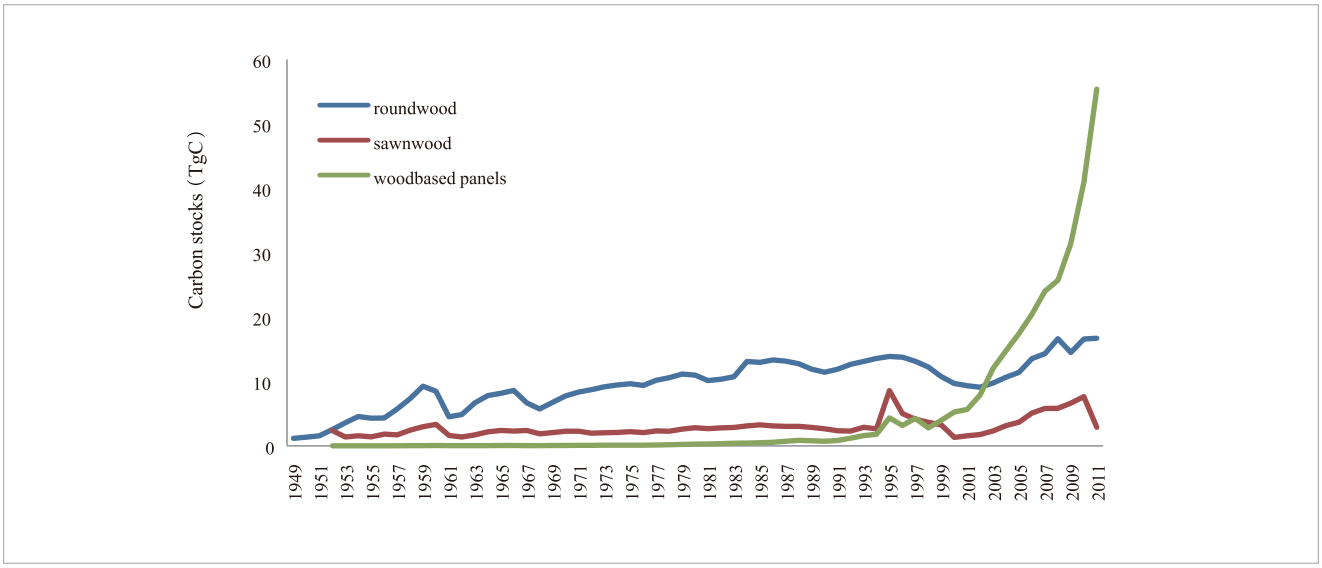


Figure 6-1. Carbon stocks in roundwood, sawnwood and wood-based panels (TgC)

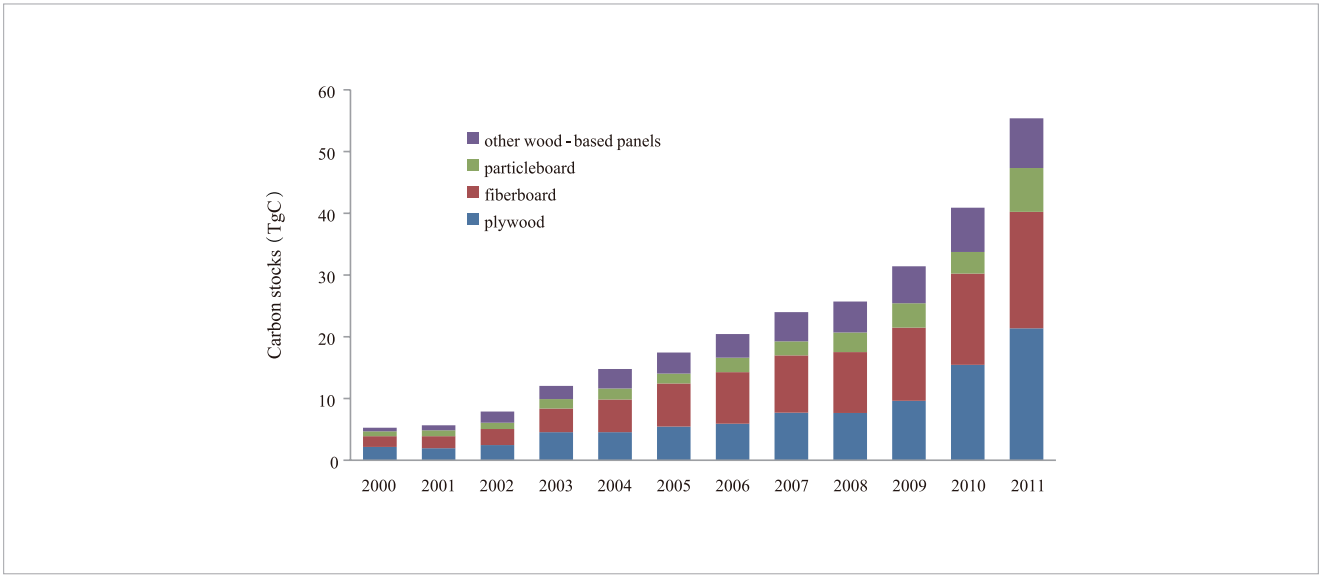


Figure 6-2. Carbon stocks and related changes in different wood-based panels (TgC)

of products. Therefore carbon flow in HWP is more recognized in global carbon cycle. This report only studies carbon stocks and related changes in roundwood, sawnwood, wood-based panels, papers and cardboard, and bamboos, excluding final products such as furniture, etc.

Sources of data

State Forestry Anthority

China Forestry Statistics Yearbook (2000-2011)

Current situation and trend analysis

(1) Carbon stocks in HWP

China's roundwood and sawnwood witnessed a fluctuating increase (Figure 6-1) in carbon stocks, while wood-based panels saw a slow rise between 1949 and 1990, and a sharp increase after the 1990s.

Compared with the level in 1949, carbon stocks in roundwood grew to 16.69TgC in 2011; carbon stocks in sawnwood rose to 7.63TgC in 2010 but dropped to

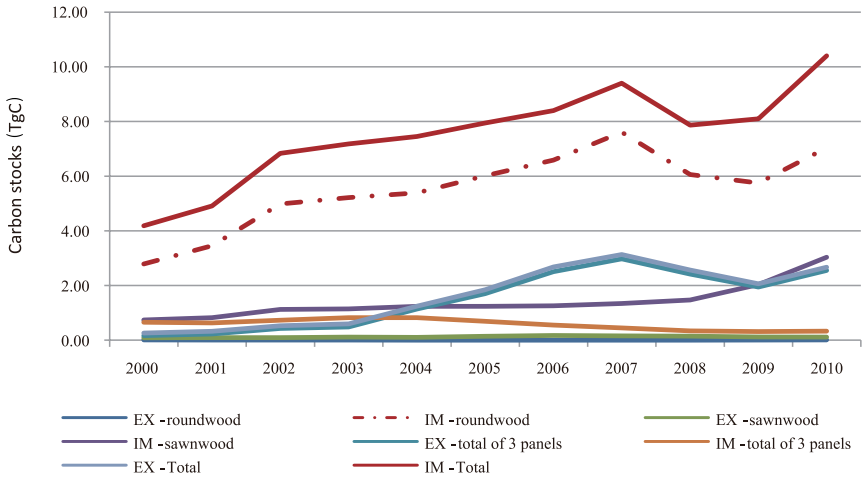


Figure 6-3. Carbon stocks in roundwood, sawnwood, wood-based panels, plywood, and fiberboards (TgC)

2.89TgC in 2011; carbon stocks in wood-based panels rocketed to 55.39TgC in 2011 from the level in 1952. Carbon stocks in plywood and fiberboard combined accounted for 70% of the total of wood-based panels: carbon stocks in plywood stood at 21.37TgC, carbon stocks in fiberboard registered 18.87TgC, and carbon stocks in particleboard amounted to 7.09TgC, the least of the three (Figure 6-2).

(2) The amount of carbon stock changes in HWP

During 2000-2010, carbon stocks in imported HWP overtook exported forest products, signifying that carbon stock changes in HWP were net import which grew continually. Carbon stocks in imported roundwood and sawnwood, in general, increased; carbon stocks in exported roundwood and sawnwood remained limited. Carbon stocks in imported wood-based panels, plywood, and fiberboards saw a year-on-year decline, while carbon in imported goods, in general, increased, which was higher than imported carbon content (Figure 6-3).

Compared with the level in 2000, in 2010 carbon stocks in exported roundwood, sawnwood, wood-based panels, plywood, and fiberboard grew to 2.67 TgC from the original 0.26TgC while carbon stocks in the imported goods rose to 10.40TgC; carbon stocks in imported roundwood grew to 7.04TgC from the past 2.79 TgC; carbon stocks in exported sawnwood rose to 0.11 TgC from the original 0.08TgC while the imported grew from 0.74 TgC to 3.03 TgC; carbon stocks in exported wood-based panels, plywood, and fiberboards rose to 3.55 TgC from the original 0.17 TgC while the imported dropped from 0.66 TgC to 0.33 TgC.

(3) Carbon stocks in paper and paperboards

During 2000-2011, carbon stocks in paper and paperboards saw a continual growth; the exported carbon mounted generally with a sharp rise after 2009 while the imported showed a fluctuating decline. The year 2008 signified a shift from net import to net export for paper and paperboards (Figure 6-4).

During the decade, carbon stocks in paper and paperboards grew from 9.00TgC to 30.00TgC with an annual average growth at 1.75TgC. Exported paper and paperboards mounted to 1.40TgC while the imported dropped from 1.90TgC to 0.80TgC.

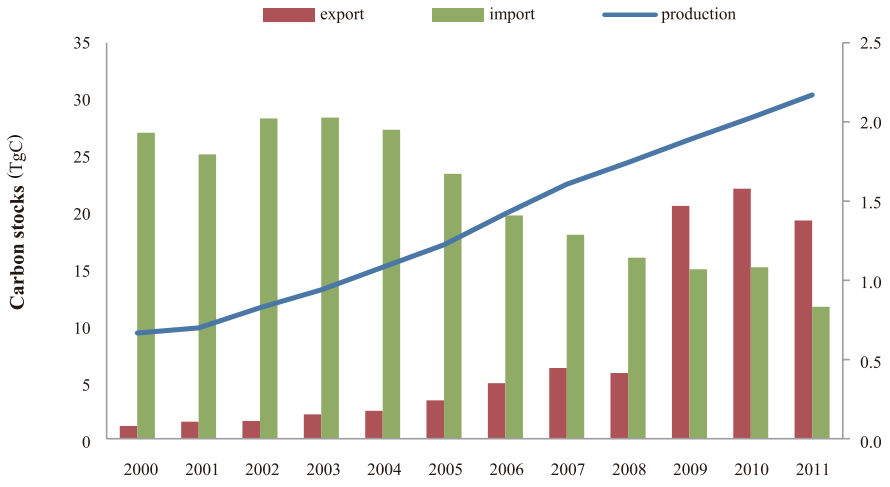


Figure 6-4. Carbon stocks in imported and exported paper and paperboards (TgC)

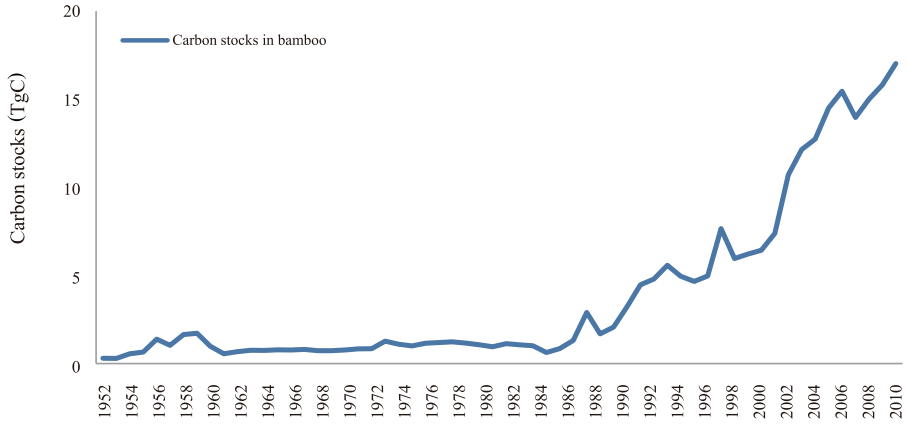


Figure 6-5. Carbon stocks in China's bamboo forests (TgC)

(4) Carbon stocks in China's bamboo

The calculation of carbon stocks in China's bamboo is based on the biomass per bamboo culms (Nie Daoping, 1994) and carbon fraction in bamboo biomass (Zhou Guomo et al., 2004).

Carbon stocks in China's bamboo were constantly growing, which rose from 0.3TgC in 1952 to 17.02TgC in 2011 and skyrocketed after 1986 (Figure 6-5). The average of bamboo carbon stocks registered at 0.93TgC·a^{-1} during 1952-1985 and at 7.79TgC·a^{-1} during 1986-2011. Due to excellent characteristics of bamboo products, continuous growth is expected in bamboo carbon stocks in the future.

6.3 Avoided fossil fuel carbon emissions by using forest biomass for energy

Rational and significance

This indicator provides information on the total amount of energy produced by forest biomass and its supplementary role to fossil fuels, which could contribute to global carbon budget by reducing carbon emissions. The analysis of the indicator reflects the status quo and potential of forestry biomass energy in China in reducing carbon emissions by replacing fossil fuels.

Sources of data

China Forestry Statistical Yearbook

Planning of China's Forestry Biomass energy (2011-2020)

Current situation and trend analysis

(1) The definition of biomass energy

Bio-energy refers to organisms formed through photosynthesis, including all of the flora, fauna and micro-organisms. The biomass energy, a renewable energy and the only renewable carbon source, is a kind of solar energy stored in biomass in the form of chemical energy, signifying biomass as its carrier, which is derived directly or indirectly from the photosynthesis of green plants and can be converted into conventionally solid, liquid and gaseous fuels. Biomass energy, derived from solar energy, is embedded in the living organisms such as plants, animals, and micro-organisms. Other than fossil fuels, all the energy derived from plants and animals belongs to biomass, covering wood, forest and agricultural waste, aquatic plants, oil-bearing crops, urban and industrial organic waste, animal manure, etc. According to different sources, biomass suitable for biofuels is divided into five major categories: forests, agricultural resources, domestic sewage and industrial organic wastewater, municipal solid waste, and manure of livestock and poultry.

The forestry bio-energy refers to energy provided during the growth of forests and producing process, which comes mainly from firewood forests, residues from forestry production, rejuvenating shrubberies by trimming, twigs and undersized logs from thinning and tending of forests, cuttings left in afforestation, trimming of urban landscape trees and fences, etc. Besides, some woodlands are designated to produce biomass energy: oil-bearing forests refer to those extracted of oil and fats to be converted into bio-diesel or other chemical alternatives; timber forests refer to those extracted of timbers to be converted into solid, liquid and gaseous fuels for direct electricity generation.

(2) Status quo of resources for forestry bio-energy

Bio-energy is a clean, renewable and widely distributed energy that produces low carbon emissions with rich biofuels in various forms. At present, according to its energy equivalent, bio-energy ranks the fourth, second only to coal, petroleum, and natural gas. Based on the estimation of International Energy Agency and the United Nations Intergovernmental Panel on Climate the Change (IPCC), 77% of global renewable energy is derived from biomass in which forestry biomass occupies 87%. At present, biomass saw a low utilization rate in China, accounted for about 9% of China's total primary energy in 2009, even lower rate for utilizing forestry biomass. However, China enjoys rich forestry biomass. Currently, China's forest area stands at 195 million ha with the total amount of forestry biomass potentially at 18 billion tons, in which three categories

could be utilized as biomass resources: wood-based fuel resources, woody oil resources, and woody starch resources.

Wood-based fuel resources, estimated by current scientific, technological and economic conditions, could be obtained from firewood forests, forest tending, rejuvenating shrubberies by trimming, cuttings left in afforestation, twigs from tending of economic forests and urban landscape trees, fruits of oil-bearing trees, residues from forestry production (harvesting, cross-cutting, and processing), etc. All the resources could be collected and used as timber energy stand at over 350 million tons (Table 6-1), if fully developed, a replacement of 200 million tons of standard coal.

In China's identified woody oil plants, over 150 species can bear seeds with over 40% oil; over 30 kinds of

Table 6-1. Types of wood-based fuel resources and biomass estimation

Types of timber resources	Area (10,000 ha)/ Growing stock (100 million m^3)	Total biomass (100 million ton)	Available biomass (100 million ton/ year)
1 Forests	14200/124.6	153-166	6-7 (timber, protection, designated and energy forests)
Mature forests	1470/27.4	36-40	3-3.5 (harvesting residues and clean-up of dead woods)
Near-mature forests	3540/50	62-66	1.8-2 (tending & pruning)
Middle-aged forests	4430/34.3	40-42	1-1.2 (tending & thinning)
Young forests	4760/12.9	15-18	0.2-0.3 (tending)
2 All kinds of woodlands	3300	9-12	0.4-0.8
Fruiters & economic forests	2140	6-7	0.1-0.2 (pruning)
Bamboo forests	500	1-2	0.1-0.2 (residues)
Scattered trees	660	2-3	0.2-0.4 (tending & pruning)
3 Shrubberies	4530	3-4	0.8-1 (trimming every other year)
4 Other timber resources		15-18	0.8-1.2
Understory thickets		8-9	0.4-0.5
Saplings in nursery		3-4	0.2-0.3 (cuttings)
Urban landscape trees & hedgerows		4-5	0.2-0.3 (tending & thinning)
Total	22030/136.2	180-200	8-10

Source: Lu Wenet al. (2005).

Table 6-2. China's fruit yielding from major oil trees

Tree species	Area (10,000 ha)	Fruit yield (10,000 t)	Amount of processing (10,000 t)	Mainly distributed regions
Tung oil tree	106	56.4	11.2	Guizhou, Hunan, Shaanxi
Chinese tallow tree	40.6	18.6	0.7	Guizhou, Hubei, Sichuan
Toxicodendron verniciflum (Stokes) F. A. Barkl.	22	4.2	2.2	Shaanxi, Guizhou, Hubei
Walnut tree	102	36.5	3.3	Hebei, Shaanxi, Shanxi, Xinjiang
Camellia oleifera	230	82.3	37	Hunan, Fujian, Zhejiang
Jatropha curcas	1.1	0.5	0.3	Sichuan, Yunnan, Guizhou
Chinese pistache	2.5	1		Shandong, Hebei, etc.
Olive (Olea europaea), Elaeagnus mollis Diels, Tetraena mongolica Maxim., Xanthoceras sorbifolia Bunge, palm	300	25		China
Total	804.2	224.5	54.7	

Source: Lu Wen et al. (2005).

trees and shrubs species could be nurtured in a large-scale manner. Six important oil-bearing tree species include Jatropha curcas (*Dendrocnide urentissima (Gagnep.) Chew*), Chinese pistache (*Pistacia chinensis*), Swida wilsoniana, shinyleaf yellowhorn (*Xanthoceras sorbifolia Bunge*), tung oil tree (*Verniciafordii (Hemsl.)*), and Chinese tallow tree (*Sapium sebiferum*), cover an area of over one million ha and annual fruit yielding over one million tons. If fully processed and utilized, this could generate over 400,000 tons of biofuel. However, limited by the current low utilization rate, it is estimated that an annual fruit yielding over two million tons could produce 550,000 tons of biomass (Table 6-2).

Woody starch resources are rich in China. Oak trees, the most widely distributed with the largest plantations, produce fruits with over 50% starch, covering 16 million ha with an annual yield between 1,500-2,250 $kg \cdot ha^{-1}$, mainly distributed in Inner Mongolia, Jilin, and Heilongjiang.

China also witnesses great potential of land for the growth of forestry bio-energy: about 44.04 million ha of wastelands and barren hills for afforestation, as well as nearly 100 million ha of marginal lands such as saline-alkali soil, sandy land, and reclamation lands of mining or oil fields.

(3) Production of forestry bio-energy

Industrial production of firewood

Firewood forest is one of the top five forests in China, also a main source for forest biomass. Every province or region in China, except Tianjin and Shanghai, has the presence of firewood forests, which top the lists are Yunnan, Shaanxi, Liaoning, Jiangxi, Inner Mongolia, Guizhou, Hubei and Hebei, accounting for over 70% of the national total.

According to results of the National Forest Resources Inventories, area and growing stock of China's firewood forests saw a decline with the current figures respectively at 1.75 million ha and 39.12 million m^3. Since the 21st century, annual industrial fuel wood production accounts for about 7%-10% of the total lumber production in

Figure 6-6. Changes in China's industrial fuel wood production

Special column: Development and Utilization of Forestry Bio-energy in China

1) Bio-diesel: China has launched over 30 bio-diesel plants, but on a smaller scale, with production volume below 20,000 tons·a^{-1} and raw materials mainly of waste oil and fats. Currently, China is building a group of bio-diesel factories with annual production volume at about 0.1-0.2 million tons. Hence the total output could amount to 3.5 million tons. In 2007, State Forestry Administration (SFA) signed with Petro China Company Limited a Framework Agreement on Jointly Developing Forestry Biomass. Starting from setting up an area of 1.8 million mu (15 mu equals one hectare) forest bases of bio-diesel raw materials in Yunnan, Sichuan, Inner Mongolia and other regions, both sides planned to integrate forests and oil which can provide raw materials for plants on a steady scale. In 2008, approved by the National Development and Reform Commission (NDRC), Petro China Company Limited, China Petrochemical Corporation (Sinopec Group) and China National Offshore Oil Corporation (CNOOC) could launch Jatropha-based bio-diesel demonstration projects in Sichuan, Guizhou and Hainan. In recent years, a batch of private enterprises also explored how to better cultivate forest bases for raw materials, comprehensive processing and industrialization of forestry bio-diesel.

2) Ethanol fuel: Since 2001, China began to build ethanol fuel projects produced by stale grain in Heilongjiang, Jilin, Henan, Anhui, etc. with output at 1.29 million tons in 2007. Each ton of ethanol products enjoys a subsidy of over 1,300 CHY from the national budget. Since September 2007, a group of ethanol fuel projects produced by non-grain stuff such as tuber crops and sweet sorghum were launched because a stop in ethanol by corn. Cellulose and woody starch are promising raw materials for ethanol fuels. Starch in seeds of Quercus mongolica, after testing, could be transformed into ethanol fuels. Currently an area of one million mu of Quercus variabilis is cultivated in Shaanxi province as a raw material base for ethanol fuels. Technologies of producing ethanol fuel by lignocellulose saw major breakthroughs in recent years, but still facing obstacles in industrialization; its commercialization is expected to be realized in next five to10 years.

3) Power generation by biomass. Power generated by Inner Mongolia Maowusu Thermal Power Plant was formally integrated into national grid in November 2008. With residues from trimming shrubs as its main raw materials, the Plant now provides over 110 million kilowatt-hour of green electricity, reducing carbon emissions by more than 160,000 tons. Thanks to the investment in building forest bases for raw materials, 0.33 million mu of sandy lands were ameliorated, generating over one million mu of young trees, offering over 7,000 jobs for local farmers and herdsmen who witnessed an annual income increase at over 13,000 CHY. In 2010, the Plant worked out how to breed Spirulina by carbon dioxide generated after combustion, which extended the industry chain of power generation by biomass and improved related economic benefits. A biomass power plant, built by Guoneng Biomass Power Co., Ltd. in Shan county, Shandong province, enjoys an installed capacity of 25,000 kilowatts based on burning straws and branches. It performs well since the integration into the national grid two years ago. At present, the state budget gives a 0.25 CHY/kilowatt-hour subsidy to the electricity produced by biomass and integrated into the national grid, as well as a 0.1 CHY/kilowatt-hour subsidy of temporarily adjusted electricity price.

4) Solid fuels: During 2009-2011, over ten enterprises specialized in biological pellet fuels were launched in areas with rich resources. Hongri New Energy Co., Ltd. in Huinan county, Jilin province provides heating for an area of 800,000 m^2, covering enterprises, residential areas, hotels, office buildings, schools, etc. by using residues from forestry production (harvesting, cross-cutting, and processing) and relying on the model of integrating resource collection, processing biomass pellet fuels, design and ancillary devices of boilers, as well as heating services, which proves to be a boost to economic growth and environmental protection. Tsinghua BP Clean Energy Research & Education Center invented a cold compression molding technology which is currently on a pilot project in the rural households of Huairou district, Beijing. The technology, cost-effective and flexible with high energy efficiency, offers promising prospects for solid fuel of forestry biomass in replacing coal for power generation in industrial boilers. At the same time, Beijing Forestry University, together with enterprises

from Beijing, Hebei, Jiangsu, Guangdong, etc., sees some breakthroughs in the research, development and production of solid fuel of forestry biomass.

China with the absolute production volume shows a rising trend, reaching 6.96 million m^3 in 2011 (Figure 6-6).

Consumption of rural firewood

As a developing country, China faces prominent rural energy problems. It is urgent to tackle residential energy shortage for 800 million rural residents (over 170 million households) in China. 75%-80% of China's total population are rural residents, half of whom dwell in mountainous areas, mainly depending on timber resources for residential energy. A composite energy structure dominated by biomass and supplemented by various energies comes into being because of China's vast territory, complicated natural conditions, unevenly distributed resources, imbalanced economic development, etc. Among the 170 million rural households, about 47.7% suffer from a serious shortage of firewood, implying that 80-100 million households run out of firewood for one or two quarters in a year. In the total energy consumption in rural areas, residential energy consumption occupies 80% while production energy consumption covers 20%. In the structure of residential energy consumption, straws cover 43.3%., firewood 39.8%, biogas 0.2%, electric power 0.6%, and coal 12%; biological energy consumption accounts for over 80%. Currently, despite a per capita need for firewood at 675kg yearly, the actual supply is 146kg. It's estimated that every household runs out of firewood for 80 days in a year.

Development and utilization of forestry bio-energy

At present, there are mainly four categories of terminal products generated from development and utilization of China's forestry biomass: 1) Bio-diesel transformed from oil and fats contained in seeds. Woody oil and fats proves to be the most promising raw materials for bio-diesel. At present, China enjoys rather mature technologies of producing bio-diesel by seeds of Jatropha curcas (*Dendrocnide urentissima (Gagnep.) Chew*), Chinese pistache (*Pistacia chinensis*), Swida wilsoniana, etc. with a small amount of production. A reliable supply of affordable raw materials turns out to be core obstacles restricting growth of forestry bio-diesel. It's known from researches on pilot-scale production lines of bio-diesel that prices of raw materials of oil accounted for over 75% of the cost of bio-diesel. Therefore, the key to boost the growth of bio-diesel industrialization lies in ensuring the production of sustainable and affordable raw materials of oil. 2) Ethanol fuel transformed from woody starch and lignocellulose. Raw materials of ethanol fuel mainly come from sugar, starch and cellulose (processing residues from agricultural and forestry sectors) with the former two kinds going into industrialization while the latter one remaining a direction and hot spot of research and development. 3) Power generation and heating by wood-based fuels. Power generation by biomass, especially by straws blossom in recent years along with the promulgation of regulations on prices, cost-sharing, and management of power generation by renewable energy in China. A group of power generation projects by wood-based fuels rise in relevant provinces and cities. 4) Processed wood-based solid fuels. Biomass solid fuels, convenient for storage, transportation and utilization, clean and environmentally-friendly with high combustion efficiency, could be used for not only cooking and heating in rural households but also dispersed heating supply in cities.

The future of forestry bio-energy

Forest is not only an ancient and traditional energy source, but also a modern and clean energy without pollution. The World Energy Commission (WEC) predicts that, a production area of 0.7-1.35 billion ha for biomass, accounting for 20% -39% of global forest area of 3.45 billion ha, could balance the global energy supply and demand in the 2050s. Given that, development and utilization of forest energy is the way out for all the countries in the world. As a giant in both population and energy consumption, China consumed a total amount of 3.25 billion tons of standard coal in 2010, in which coal occupied over 75%, an equivalent of 2.45 billion tons of standard coal, While the share of forestry bio-energy was too little to be accounted. As the socio-economic front moves on, China will face increasingly prominent

challenges in balancing energy demand and supply as the average annual consumption of fossil fuel deepens. On the other hand, with the deepening of ecological civilization and forestry, forestry biomass enjoys a bright prospect. According to *the Planning of China's Forestry Bio-energy (2011-2020)*, the area of forests energy for will reach 8 million ha till 2015. With the utilization rate of forestry residues above 15%, forestry biomass could replace an amount of 10 million tons of standard coal in petrochemical energy, accounting for 1.52% of renewable energy. By 2020, with the area of energy forest at 16 million ha, forestry biomass could be alternative to 20 million tons of standard coal in petrochemical energy, accounting for 2% of renewable energy.

Table 6-3. Development goals of forests for energy in China

Year	2015	2020
Energy forest area (10,000 ha)	800	1600
Standard coal equivalent (10,000 tons/year)	1000	2000
Proportion in renewable energy	1.52%	2%
Among, biomass thermal utilization	90%	70%
Biodiesel	10%	25%
Bioethanol	-	5%

National Report
on Sustainable Forest Management

7

Maintenance and Enhancement of Long-term Multiple Socio-economic Benefits to Meet the Needs of Societies

Forests provide various kinds of products as well as environmental services, which can satisfy the increasing material and environmental demands of the society. The chapter reflects the multiple benefits of forests and their contributions to the sustainable development of socio-economy in the following aspects: production and consumption of forest products, investment and employment in the forestry sector, forest recreation and tourism plus other social and cultural values of forests, etc.

7.1 Production and consumption

7.1.1 Value and volume of wood and wood products production, including primary and secondary processing

Rational and significance

This indicator offers information on the yield and output of timber and wood products provided by forests in every stage of processing, in the hope of reflecting the contributions to national economy by forests and wood processing industry. The primary wood products in China consist of roundwood bamboo and firewood. Its major wood products consist of sawnwood, wood-based panel, paper and paper products, etc. Its secondary processing products are mainly composed of wood furniture. The output of China's forestry includes the output of afforestation, wood processing and service businesses like forest tourism. The output of wood processing comprises of the following parts: the output of timber logging, transporting and processing; the output of the manufacturing industry of timber, bamboo, palm and rattan products; the output of timber, bamboo

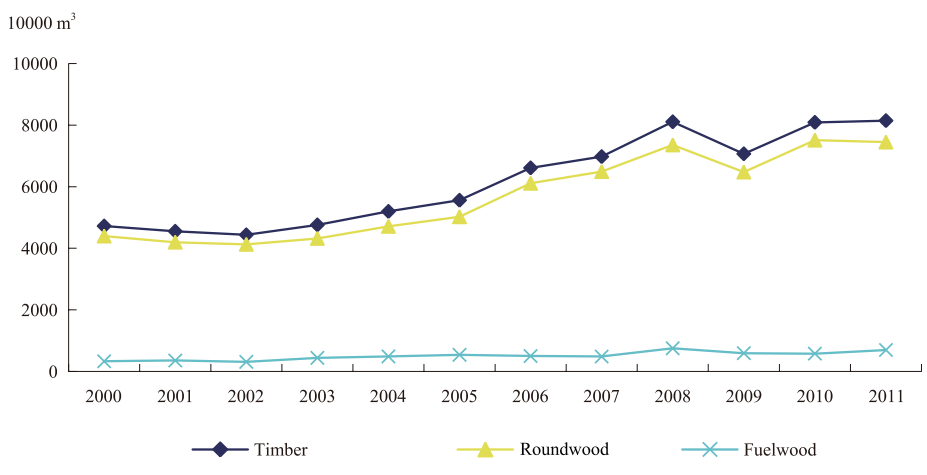


Figure 7-1. China's timber volume during 2000-2011

Table 7-1. Top 10 provinces in timber volume and their proportion in national wood production (unit: 10,000 m^3)

Top 10 Provinces		Timber volume in 2000	Proportion (%)		Timber volume in 2005	Proportion (%)		Timber volume in 2011	Proportion (%)
1	Heilongjiang	581.59	7.14	Fujian	627.88	11.29	Guangxi	1525.92	18.73
2	Jilin	456.82	5.61	Guangxi	503.26	9.05	Guangdong	735.51	9.03
3	Fujian	406.44	4.99	Jiangxi	503.17	9.05	Hunan	599.93	7.36
4	Hunan	368.19	4.52	Heilongjiang	495.73	8.92	Fujian	563.26	6.91
5	Inner Mongolia	327.79	4.02	Hunan	488.45	8.78	Yunnan	533.03	6.54
6	Guangxi	315.17	3.87	Jilin	422.08	7.59	Anhui	494.85	6.07
7	Anhui	299.95	3.68	Guangdong	362.15	6.51	Jilin	434.27	5.33
8	Guangdong	274.51	3.37	Inner Mongolia	340.97	6.13	Shandong	347.98	4.27
9	Jiangxi	237.93	2.92	Anhui	327.51	5.89	Heilongjiang	336.79	4.13
10	Zhejiang	212.19	2.60	Yunnan	222.41	4.00	Hubei	292.15	3.59
	TOTAL	3480.58	42.73		4293.6099	77.22		5863.70	71.98

and rattan furniture production; and that of the paper industry of timber, bamboo and reed pulp. The complete statistics of the output of timber processing is rendered at national level since 2003.

Sources of Data

China Forestry Statistical Yearbook (2000-2011)

China Pulp Industry Analysis 2011 (2011)

Current situation and trend analysis

(1) Timber volume

China's timber volume grows steadily, despite great decrease in natural forests logging since China's implementation of Natural Forests Protection Program (NFPP) in 1998. The increase in timber volume owes to large-scaled afforestation and the strengthening of fast-growing and high-yield plantation development as well as sustainable forest management. Timber volume soared from 47.24 million m^3 in 2000 to 81.46 million m^3 in 2011, at an increase of 72.44%. Among these, Roundwood production was increased by 69.47% and firewood production 112.12% (Figure 7-1).

Timber production in China is mainly conducted in northeast China as well as central and southern provinces, which is in line with the distribution of China's timber forests. In recent years, the central and southern provinces, blessed by their fine hydrothermal conditions and great potential forestland productivity, has exceeded the northeast and Inner Mongolia regions in timber volume, becoming the major timber production areas in China. Meanwhile, timber supply in China is notably centralized. In 2000, Heilongjiang Province ranked first in timber volume. The top 10 provinces in timber volume amounted to 42.73% of the national yield. In 2005, Fujian Province ranked first. The volume of the top 10 provinces increased to 77.22% of the total. In 2011, Guangxi province ranked first, with a proportion of 18.73% of the national production. The volume of the top 10 provinces remained at around 70% of the total. Provinces not enlisted in the key areas of timber production began to enter top 10, such as Shandong and Hubei Province (Table 7-1).

(2) Bamboo volume

Bamboo forest is referred to as "a second forest" in China. It is an important substitute for timber and a significant part in the green development of China's forestry. Since 2000, the bamboo volume in China is steadily increasing due to national policy support, together with the deepening of bamboo processing and variation of bamboo products. In 2011, the national bamboo volume reached 1.54 billion pieces. The total yield in 2010 was increased by 308.68% from that of 2000 (Figure 7-3). Miscellaneous bamboo products amounted to 11.77 million tons. The major bamboo volume provinces are Fujian, Guangxi, Zhejiang,

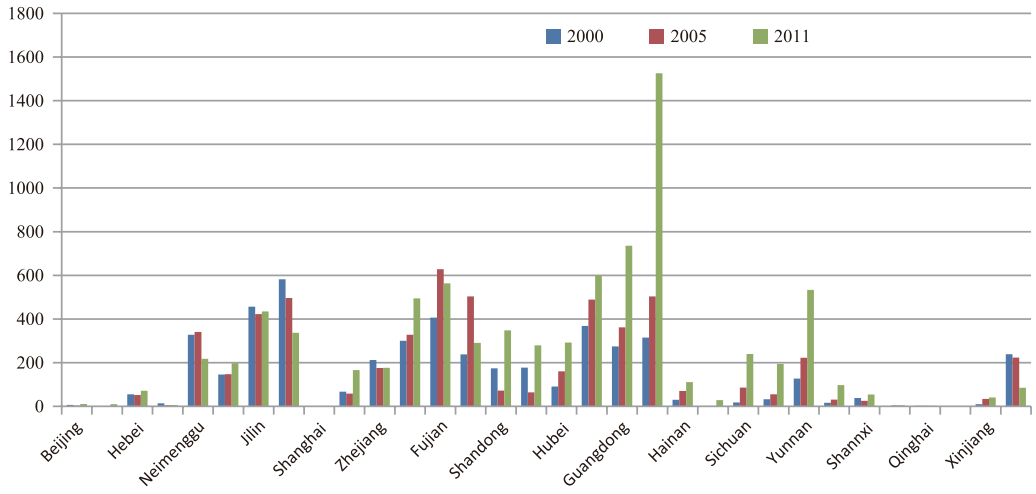


Figure 7-2. Changes of timber volume of each province (10,000 m³)

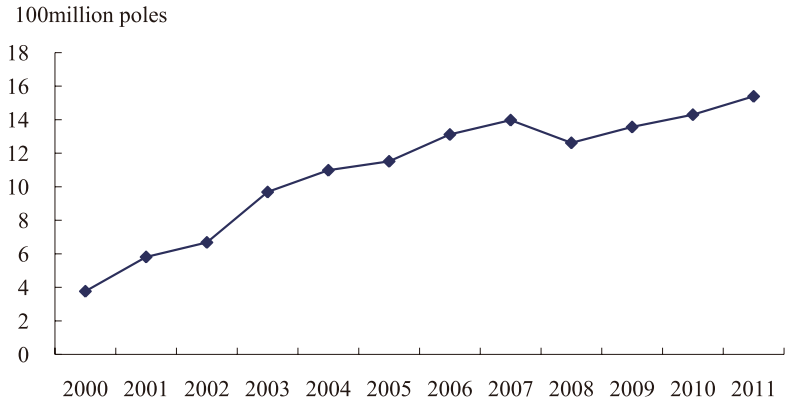


Figure 7-3. China bamboo volume during 2000-2011

Yunnan, Guangdong, Anhui and Jiangxi, etc. In 2011, the bamboo volume in these provinces took up 93.80% of the national yield.

(3) Output of sawnwood , wood-based panel, and wood and bamboo floor board

Thanks to China's economic boom especially in real-estate market in recent years, the output of processed wood products in China, particularly wood-based panel and wood and bamboo floor board, has been growing drastically. Compared with the output of 2000, in 2011, sawnwood grew at an increase of 603.02%, while wood-based panel 945.10%, and wood and bamboo floor board 1795.26% (Figure 7-4).

The major sawnwood producing provinces in China are Zhejiang, Shandong, Guangxi, Hunan, Jilin, Fujian and so on. In 2011, the output of sawnwood of Inner Mongolia and Heilongjiang soared significantly.

The manufacturing of wood-based panel is concentrated in Shandong, Jiangsu, Zhejiang, Hebei, Guangdong, Fujian and Guangxi, etc. The top 5 provinces of wood-

based panel output in 2000 were Shandong, Zhejiang, Jiangsu, Hebei and Guangdong, which rendered a total 11.78 million m^3 of wood-based panel, making up 58.85% of the national output of that year. In 2011, the top 5 provinces were Shandong, Jiangsu, Guangxi, Henan and Hebei. These provinces produced 146.06 million m^3 of panel, amounting to 69.82% of domestic output.

Wood and bamboo floor board production is highly concentrated. The top 10 provinces in wood and bamboo floor board output together produced 96.02% of the total domestic output in 2000. In 2011, the proportion dropped slightly to 90.45%. The manufacturing regions have changed significantly since 2000, from major timber producing areas like the northeast and southwest China to southeast China where the trading market is much developed. In 2000, the top 10 provinces in wood

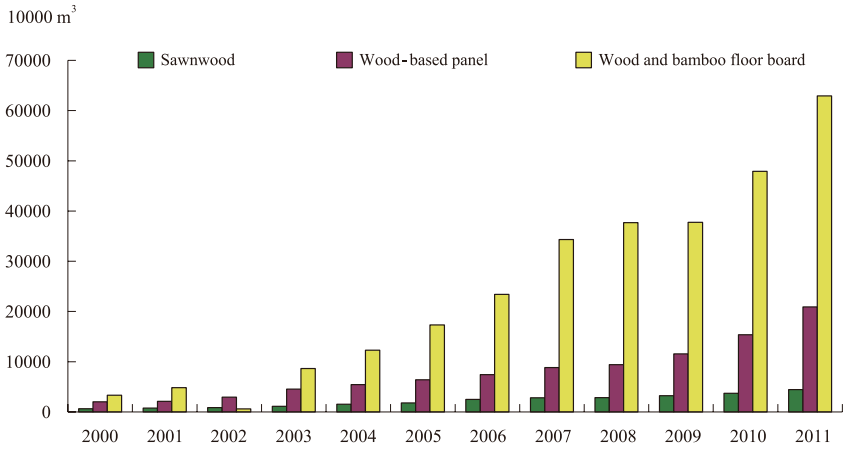


Figure 7-4. output of sawnwood, wood-based panel and wood and bamboo floor board in China during 2000-2011

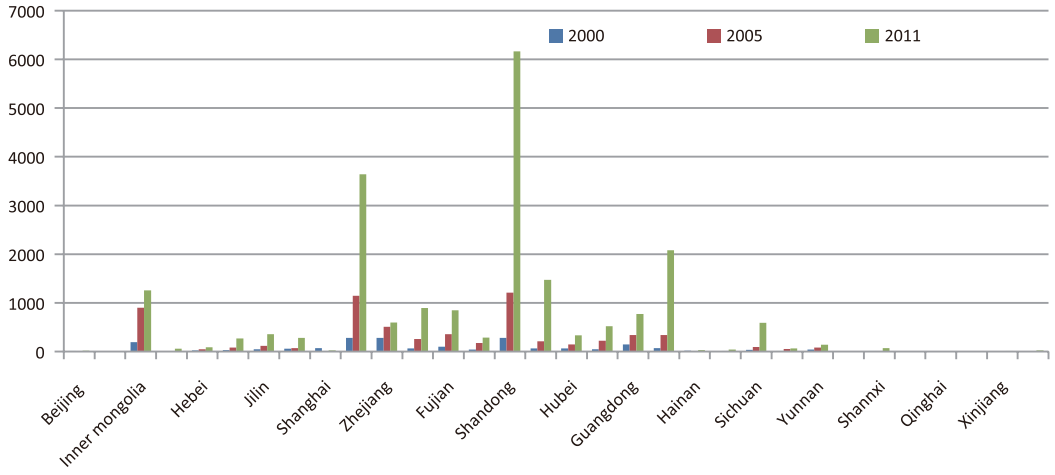


Figure 7-5. Changes of wood-based penal output of each province (10,000 m^3)

Table 7-2. Top 10 provinces in wood and bamboo floor board output and changes Unit: 10 thousand m^3

Top 10 Provinces	Rank of 2000	Yield (10000 m^3)	Rank of 2005	Yield (10000 m^3)	Rank of 2011	Yield (10000 m^3)
1	Liaoning	1680.09	Zhejiang	5113.84	Jiangsu	18342.39
2	Jilin	268.63	Jiangsu	2157.67	Zhejiang	11486.20
3	Zhejiang	195.51	Sichuan	1641.26	Anhui	5234.62
4	Yunnan	186.59	Anhui	1156.97	Shandong	4378.74
5	Sichuan	186.15	Heilongjiang	1077.60	Guangdong	3492.04
6	Fujian	184.92	Jiangxi	1018.11	Shanghai	3383.54
7	Heilongjiang	177.21	Liaoning	983.96	Jilin	3117.74
8	Shandong	119.42	Jilin	961.16	Hubei	2881.33
9	Guangxi	111.44	Hunan	950.00	Liaoning	2414.57
10	Hunan	77.28	Fujian	890.55	Jiangxi	2169.24
Total		3187.24		15951.12		56900.41
Proportion of National output (%)		96.02		92.08		90.45

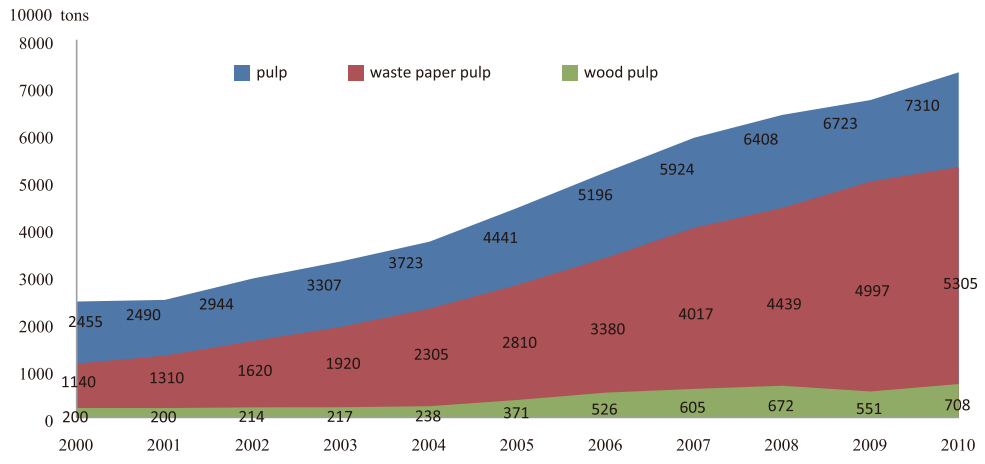


Figure 7-6. Paper pulp and wood pulp output during 2000-2010

and bamboo floor board production consisted mainly of major timber producing provinces such as Liaoning, Jilin, Heilongjiang, Yunnan, Sichuan and Fujian. In 2011, the top 10 provinces changed to developed areas like Jiangsu, Zhejiang, Anhui, Shandong, Guangdong and Shanghai. Only Jilin and Liaoning, among the major timber producing provinces, remained in top 10.

(4) Wood pulp and paper pulp

China's pulp output experiences a steady growth due to its domestic needs. Meanwhile, with the deepening implementation of resource conservation policy, the proportion of waste paper pulp in national pulp output rises rapidly. Pulp output grew from 24.55 million tons in 2000 to 73.10 million tons in 2010, at an increase rate of 197.76%. Among which wood pulp output rose from 2 million tons to 7.08 million tons at an increase rate of 254.00%, while waste paper pulp output increased by 365.35%. In the meantime, the proportion of waste paper pulp in total pulp output grew from 46.44% in 2000 to 72.57%, and wood pulp output grew from 8.15% to

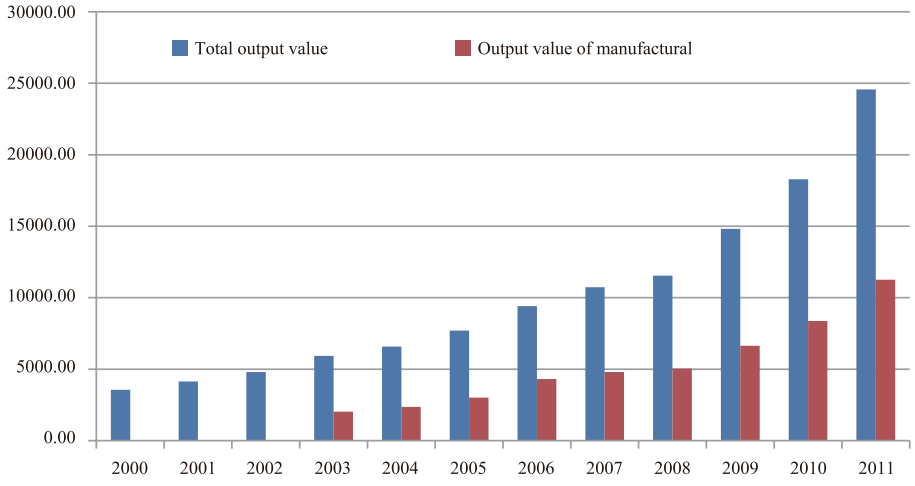


Figure 7-7. China's forestry output and timber processing output and their changes (10,000 m³)

9.69% (Figure 7-6).

(5) Output of Forestry Industry

With the rapid expansion of afforestation and timber processing, the output of China's forestry has been growing significantly since 2000. The total output of forestry industry, including afforestation, timber processing and forest tourism, etc, was 355.55 billion yuan in 2000. The number reached 2456.65 billion yuan in 2011, with an increase of 590.95% (inflation adjusted). Timber processing output increased from 202.91 billion yuan in 2003 to 1125.68 billion yuan in 2011 by 454.78% (inflation adjusted) (Figure 7-7).

7.1.2 Value of non-wood forest products produced or collected

Rational and significance

The Indicator shows the importance of non-wood forest products in national economy and in the lives of local residents. The value of these products will ultimately put influence on sustainable forest management. This indicator summarizes the value and changes of produced or gathered non-wood forest products, as well as the proportion of different categories of products. It includes the values of fruits, tea, coffee beverage, woody medine, forest food and other products.

Sources of data

National Forestry Authority

China Forestry Statistical Yearbook (2006-2007)

Current situation and trend analysis

The output value of non-wood forest products in China is on an ever-increasing course of growth (Figure 7-8). In 2011, the output value of non-wood forest products reached 631.99 billion yuan, increasing 156.76% from that of 2006. Fruits cultivation and collection contributed an output of 415.52 billion yuan, at an increase of 156.76% from 2006. The output value of tea drinks was 55.21 billion yuan, growing at an increase rate of 133.14% from 2006. The output value of cultivation and collection of woody medine amounted to 40.88 billion yuan, growing at an increase of 167.43% from 2006.

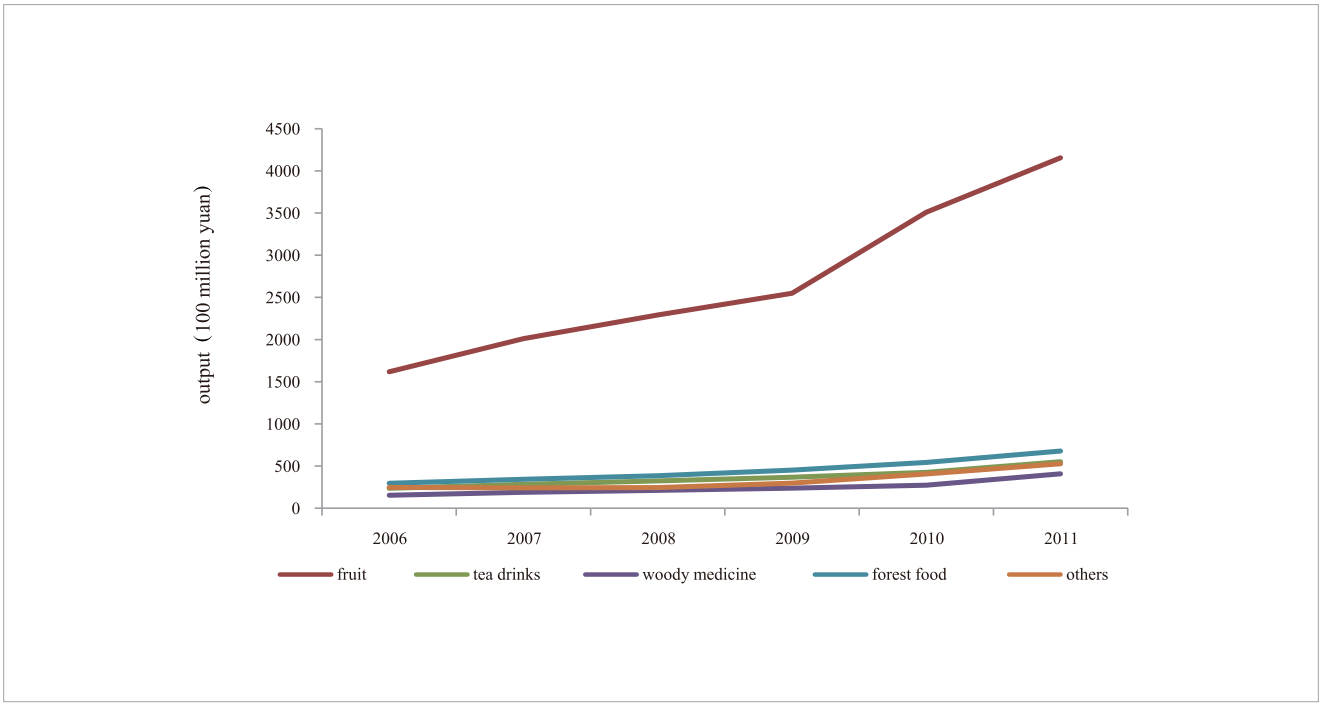


Figure 7-8. Changes of output value of China's non-wood forest products

The output of cultivation and collection of forest food was 67.73 billion yuan, increasing by 128.73% from 2006. The cultivation and collection of other non-wood forest products offered an output of 52.66 billion yuan, increasing by 113.46% from 2006.

7.1.3 Revenue from forest based environmental services

Rational and significance

The indicator offers information on the economic benefits of forest ecological services in terms of money. The revenue of forest ecological services is an important contribution to national economy served by forests. In this report, the revenue of forest ecological services refers in particular to two parts: the compensation fund of forest ecological benefits issued by central finance and the income of forest tourism. The central financial compensation fund of forest ecological benefits refers to the special fund given to subsidize the expenses of construction, cultivation, protection and management of major national public benefit forests. The compensation range of this fund covers the major national public benefit forests recognized by the State Forestry Administration. The income of forest tourism is the general tourism income of forest parks.

Sources of data

China Forestry Statistical Yearbook (2000-2011)

China Forestry Development Report (2001-2012)

Current situation and trend analysis

(1) The central financial compensation fund of ecological benefits of forests

In order to strengthen the protection of forest resources, the Chinese government began experiments of a compensation system covering ecological public benefit forests. The central financial compensation fund of ecological benefits of forests was officially launched in 2004. The acreage covered by the compensation grew from 13.33 million ha in 2001 to 83.95 million ha in 2011, increasing by 529.64%. The compensation fund

rose from 1 billion yuan in 2001 to 9.68 billion yuan in 2011, increasing by 867.93% (Figure 7-9).

(2) Revenue of Forest Tourism

Forest tourism in China grows fast thanks to the increase of national income. The income of forest tourism enjoys a boost. With the inflation factors adjusted, the income of forest tourism soared from 1.29 billion yuan in 2000 to 37.64 billion yuan in 2011, with an increase of 29.11 times (Figure 7-10)

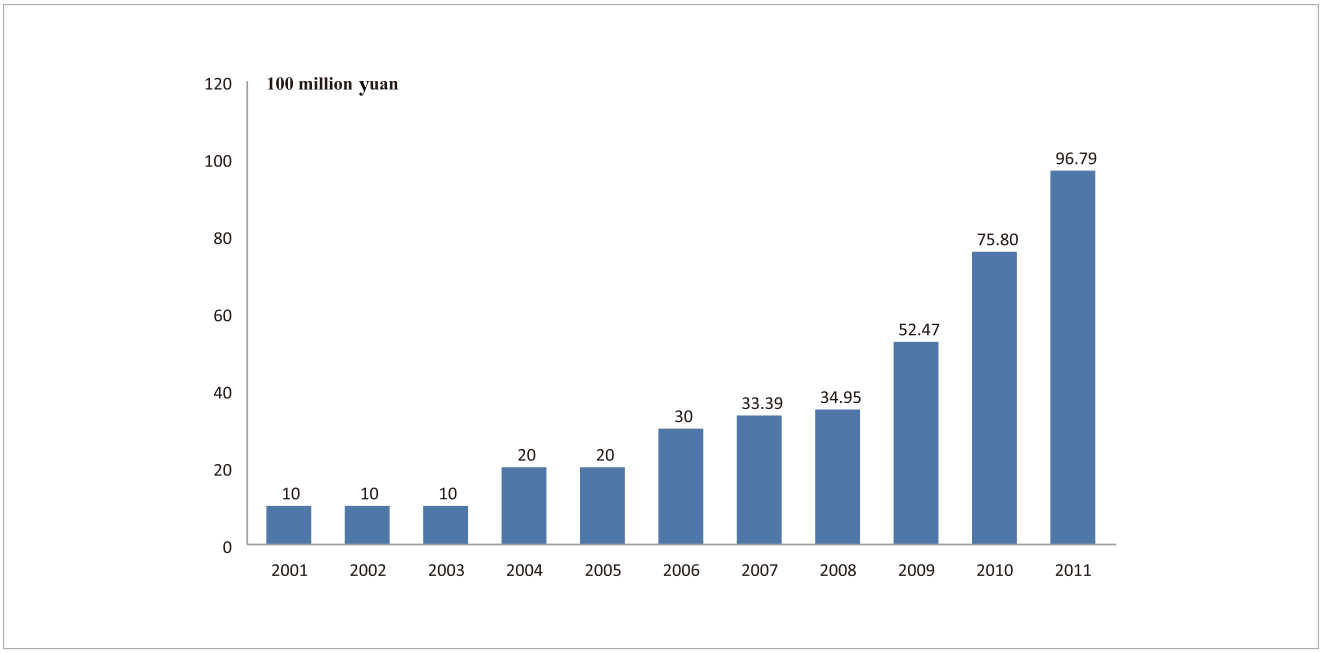


Figure 7-9.The central financial compensation fund of ecological benefits of forests during 2001-2011

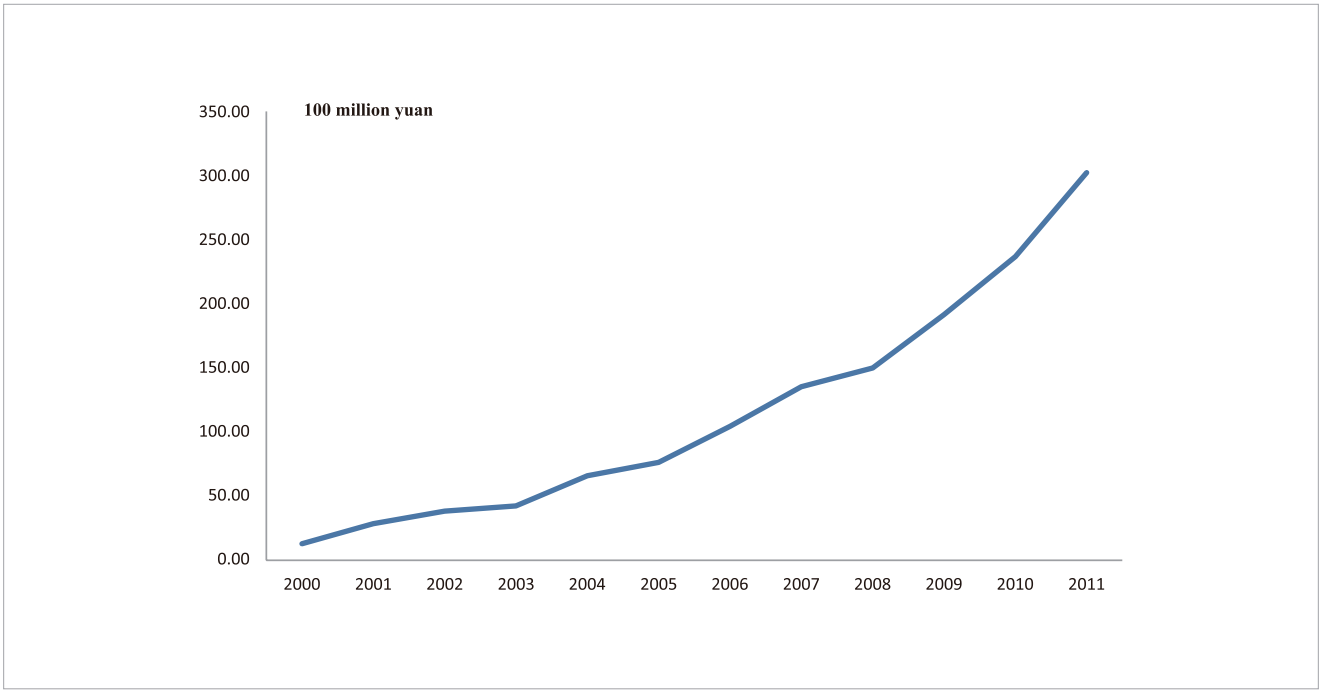


Figure 7-10. Revenue of forest tourism during 2000-2011

7.1.4 Total and per capita consumption of wood and wood products in round wood equivalents

Rational and significance

The indicator offers information on the per capita consumption of timber and wood products. The consumption of timber and wood products shows the society's degree of dependence on forests. The balance between supply and demand can be reflected through the comparison of consumption and production volume of timber and wood products. The consumption volume of timber and wood products is calculated by subtracting the export volume from the total consumption volume including import. The domestic consumption volume covers that of fuel wood. In China, the market consumption of wood products comprises of domestic consumption as well as export volume. Domestic consumption itself consists of the consumption of industrial and building materials, farmer's reserved timber and fuel wood. The consumption of industrial and building materials includes the consumption of construction materials, furniture materials, paper industry materials, coal industry materials and vehicle manufacturing materials, etc. Farmer's reserved timber consists of farmer's housing materials and fuel wood, the consumption volume of which is calculated according to logging quota. The equivalent export timber includes the exporting roundwood, wood-based panel and equivalent timber of furniture. China began its systematical collection of the total consumption of timber and wood products in terms of roundwood volume since 2003.

Sources of data

China Forestry Statistical Yearbook (2000-2011)

China Forestry Development Report (2001-2012)

Current situation and trend analysis

(1) Total consumption and per capita consumption of timber and wood products in terms of roundwood volume

Driven by continued domestic economic growth, the total consumption volume of timber and wood products has kept a rising trend since recorded, but the speed is gradually slowing down. In 2011, the total consumption of timber and wood products in terms of roundwood volume reached 500 million m^3, at an increase of 118.85% than 2003. Deducting equivalent export volume, the number was 414 million m^3, increasing by 105.84% than that of 2003. The comparative growth of overall timber consumption showed a declining trend. The consumption of industrial and building materials occupied 77.83% of the overall timber consumption in 2011, while farmer's reserved timber and fuel wood occupied 5.90% of the total, and export volume took up 17.16%. In 2011, china imported 224 million m^3 equivalent of timber of wood forest products, which accounted for 44.76% of its total timber consumption. In the same term, the per capita consumption of timber and

Table 7-3. Total consumption and per capita consumption of timber and wood products in terms of roundwood volume

Unit: 10000 m^3, m^3/person

Year	Total consumption volume including import	Consumption of Industrial and building materials	Farmer's reserved timber and fuel wood	Equivalent export timber	Real consumption volume	Consumption per capita
2003	22843.00	17127.66	3562.56	2724.26	20118.74	0.17
2004	30710.47	22482.69	4286.20	3940.97	26769.50	0.22
2005	32576.10	23090.18	4585.55	4899.68	27676.42	0.21
2006	33738.83	24496.96	2993.17	6248.27	27490.56	0.22
2007	38249.42	28202.58	3158.34	6888.49	31360.93	0.25
2008	37144.73	27640.13	3670.66	5833.94	31310.79	0.24
2009	42189.48	32516.47	3199.83	6473.18	35716.30	0.29
2010	43177.04	31726.53	3662.19	7788.33	35388.71	0.27
2011	49991.91	38907.77	2951.85	8580.00	41411.91	0.30

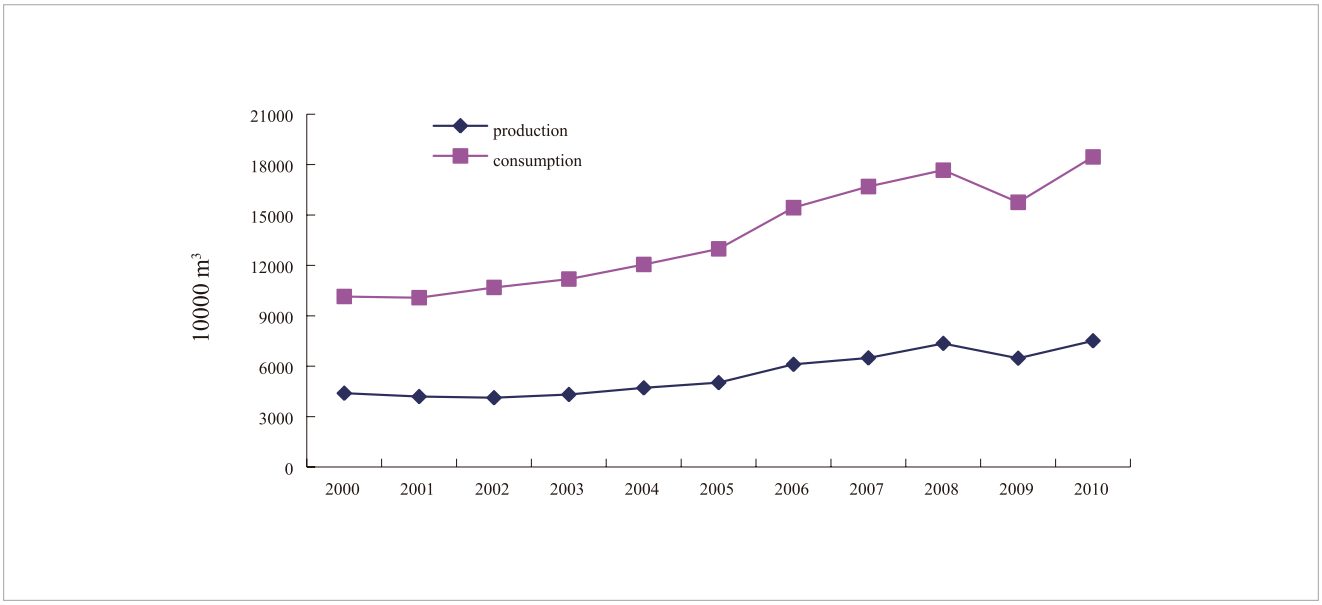


Figure 7-11. Roundwood production and consumption during 2000-2010

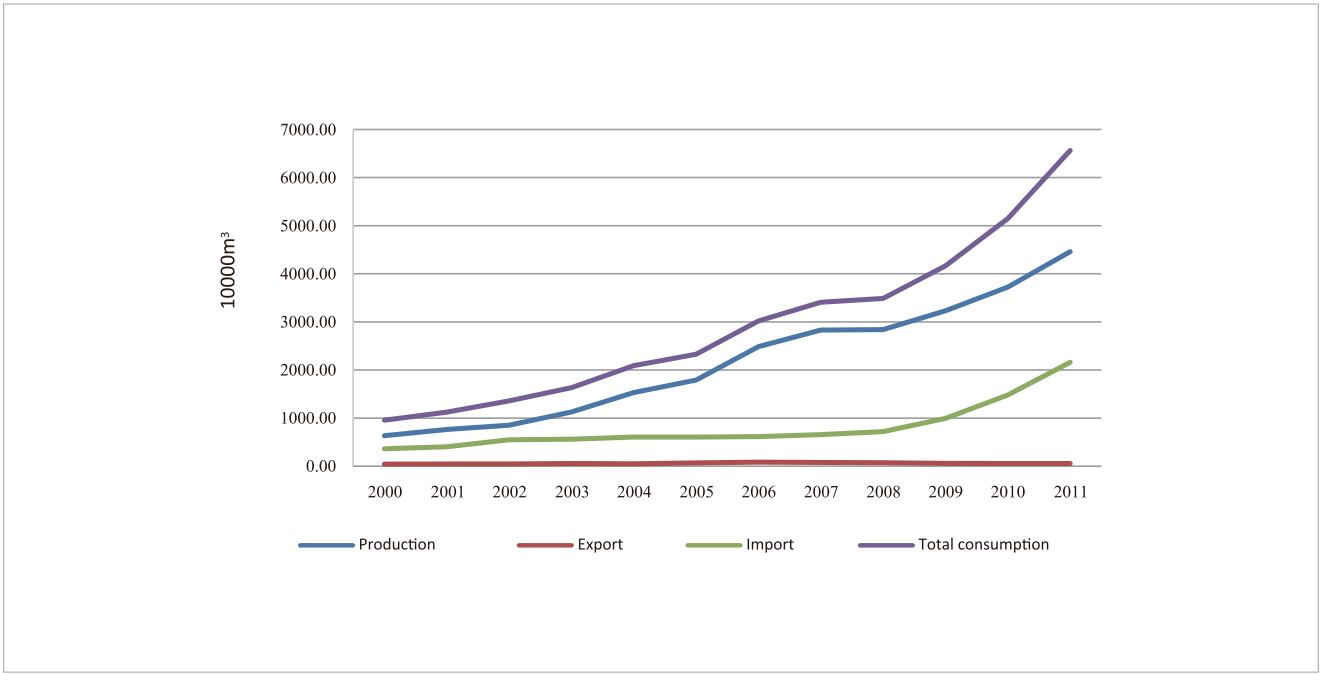


Figure 7-12. Total production, trade and consumption of sawnwood during 2000-2011

wood products rose from 0.17 m^3 to 0.30 m^3 per capita (Table 7-3).

(2) Total and per capita consumption of roundwood

Between 2000 and 2011, the total and per capita consumption of roundwood gradually increased due to domestic demand (figure 7-11), though falling back in individual years. In the same period, China's per capita consumption of roundwood grew from 0.0429 m^3 to 0.0845 m^3, at an increase of 96.90%.

(3) Overall and per capita consumption of sawnwood

Like the growing trend of roundwood consumption,

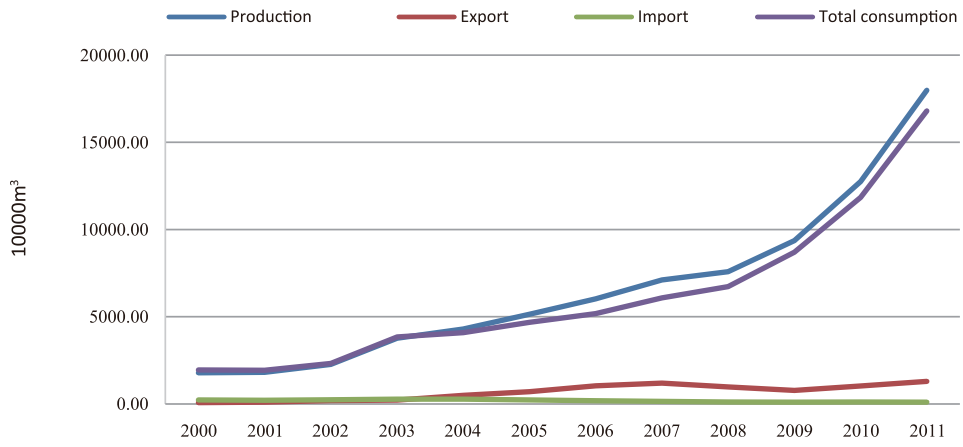


Figure 7-13. Production, trade and consumption of wood-based panel during 2000-2010

between 2000 and 2011, the overall and per capita consumption of sawnwood rose remarkably and the consumption continued to overwhelm that of production (figure 7-12). This insufficiency was mainly replenished by import. In 2011, China's overall sawnwood consumption reached 65.67 million m^3, growing from 44.60 million m^3 in 2000 at an increase of 588.04%. The per capita consumption rose from 0.0071 m^3 to 0.0507 m^3, increasing by 612.25%.

(4) Total and per capita consumption of wood-based panel

China's total and per capita consumption of wood-based panel, namely plywood, fiberboard and shaving board, enjoyed a sustained growth during 2000 and 2011, consistent with its domestic economic boost. The production of wood-based panel has overwhelmed consumption since 2003. The extra part of production was mainly exported (figure 7-13). China's total consumption of wood-based panel was 19.55 million m^3 in 2000. It rose to 168.00 million m^3 in 2011, at an increase rate of 759.40%. In the meantime, the production of wood-based panel grew from 17.94 million m^3 to 179.91 million m^3, increasing by 903.00% and the export volume soared from 0.75 million m^3 to 12.95 million m^3, increasing by 1630.00%. The per capita consumption of wood-based panel rose from 0.015 m^3 to 0.091 m^3 between 2000 and 2011, at an increase rate of 789.64%. Its extent of growth is in line with the increase in total consumption.

7.1.5 Total and per capita consumption of non-wood forest products

Rational and significance

The indicator analyzes the two aspects of non-wood forest products, namely total and per capita consumption, in the hope of reflecting the public demand for non-wood forest products as well as its influence and importance upon the lives of people especially local community residents. The change of supply and demand of non-wood products shall ultimately exert impact on the development of national economy.

[8] *The great variety of non-wood forest products leaves simple addition meaningless. Moreover, the scope of production statistics of such products differs from that of import and export, making it difficult to acquire the consumption volume. In this report, consumption volume is replaced by the value of consumption.*

This indicator sketches out the changes of non-wood forest products consumption, both total and per capita. Total Consumption[8]= Production Value + Import Value - Export Value. Per Capita Consumption=Total Consumption / Total Population.

Sources of data

National Forestry Authority

China Forestry Statistical Yearbook (2009-2010)

Current situation and trend analysis

The total and per capita consumption of non-wood products in China is rising sharply in recent years. The total consumption of non-wood products in 2010 was 87.64 billion USD, which saw a rise of 44.28% from that of 2009. Specifically, the total consumption of fruit products was 53.57 billion USD, increasing by 50.80% from 2009; the consumption of tea and coffee drinks was 6.13 billion USD, increasing by 28.32% from the previous year; forest food consumption in 2010 amounted to 7.78 USD, increasing by 24.23% from 2009; the consumption of raw materials of forest chemical products together with seasoning and tonic was 15.88 billion USD in 2010, growing at an increase rate of 48.21% from 2009.

The structure of total consumption of non-wood forest products remains stable. The total consumption of fruits and traditional Chinese medicine and tonic enjoyed a distinct rise from 2009 (Figure 7-14). Among the structure of total and per capita consumption, fruit products (including fruits, nuts and dried fruits) still owned an absolutely large proportion. The proportion of fruit products was 64.00% of the total consumption of non-wood forest products in 2010, while forest food consumption occupied 9.00% of the total; tea beverage took up 8.00% and other non-wood forest products shared 19.00%.

The per capita consumption of non-wood forest products in 2010 exceeded that of 2009, with fruit products taking the largest proportion (Figure 7-15). The per capita consumption of non-wood products was 65.36 USD/person, increasing by 43.61% from 2009. Amid which fruit products consumption enjoyed a rise of 50.11%, reaching 39.95USD/person; tea and coffee beverage consumption was 4.57USD/person, growing at an increase of 27.73% from 2009; forest food consumption was 5.80 USD/person, increasing by 24.23% from 2009; the consumption of raw materials of forest chemical products together with seasoning and tonic and other products amounted to 11.84USD/person, rising at an increase of 47.53% from 2009.

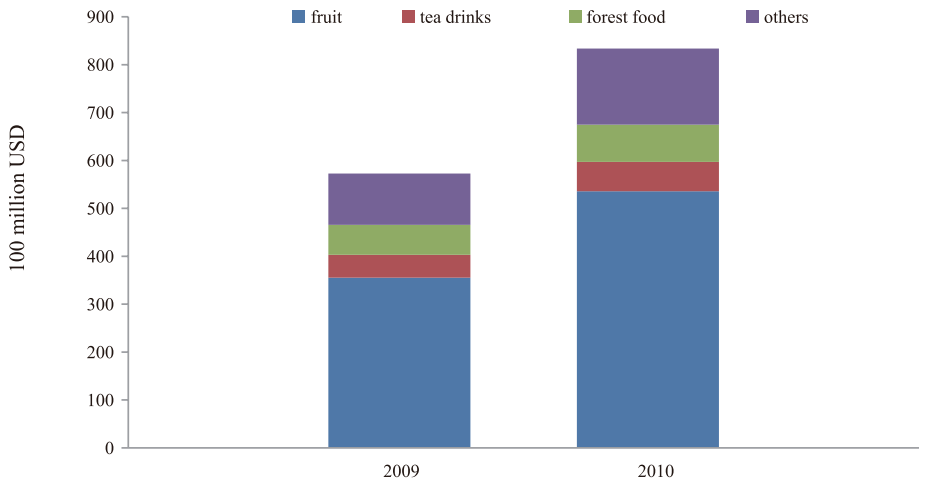


Figure 7-14. Comparison of total consumption of various kinds of non-wood forest products

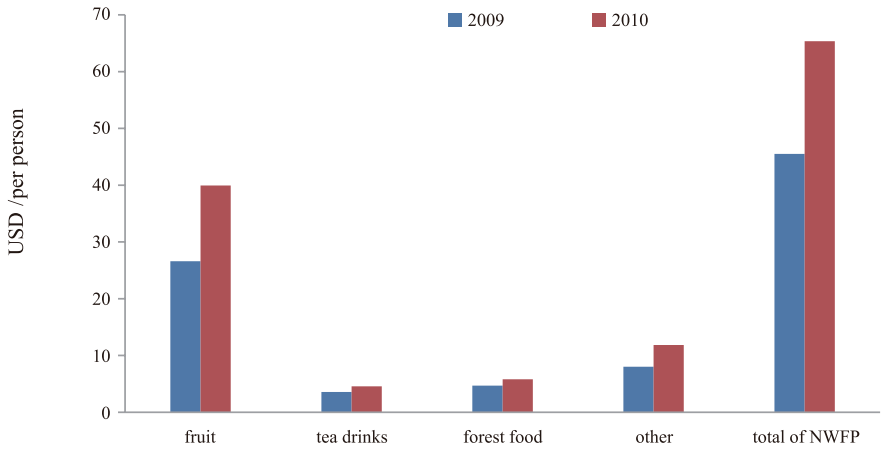


Figure 7-15. Comparison of per capita consumption of various kinds of non-wood forest products

7.1.6Value and volume in round wood equivalents of exports and imports of wood products

Rational and significance

Forest product is a constituent of social commodities. According to international statistical caliber, it comprises of timber out of forest resources and various kinds of products out of timber, namely roundwood, sawnwood, wood-based panel, manufactured and semi-manufactured wood products, wood pulp, paper and paper products originated from timber, forest chemical products, etc. Forest products in *China's Statistical Indicator of Forestry Analysis* is defined as "all tangible biological products and forest services relying on forest resources, including wood forest products, non-wood forest products and forest services".Wood forest products consist of roundwood, sawnwood, wood-based panel, wood pulp, paper and cardboard, charcoal, wood chip, crushed and leftover materials. Non-wood products comprise of non-wood tangible biological products from forests, other woodland as well as trees outside forests, which means plants and plant products plus animals and animal products. Forest services can be classified into two parts: one is the service offered by forest resources themselves such as forest tourism, ecological service, etc; the other is the service for forestry production in its process aiming at the forest resources themselves, like forest fire prevention and pest control, etc. According to *China Forestry Development Report (2011)*, forest products in China are classified into wood and non-wood forest products. Wood forest products are put into 8 categories: roundwood and swan timber (including materials of special profile), wood-based panel (including veneer, shaving board, fiberboard, plywood and densified wood), wood products, paper (including wood pulp, paper and paper products, printed materials), furniture, wood chip, others (fuel wood, charcoal, etc). Non-wood products are classified into 7 categories: saplings, fungi, bamboo shoots, wild vegetables, fruit products, tea and coffee, seasoning and medicine and tonic, forest chemical products (rosin, etc), rattan and softwood (including rattan furniture).

For the sake of the comparability of files, the wood products in this report refer to the statistical caliber of *China Forestry Development Report (State Forestry Administration, 2011), China Forestry Statistical Yearbook (2011) (Department of Statistics of State Forestry Administration, 2012), Customs statistical Yearbook (General Administration of Customs of the People's Republic of China, 2012) and FAO Forest Products Yearbook*, and are defined as shows in Table 7-4.

The volume and value of import and export are

Table 7-4. Definition of Wood Products

Product Name	Customs Code
Roundwood	4403
Sawnwood	4406–4407
Veneer	4408
Semi-manufactured furniture	4409
Shaving board	4410
Fiberboard	4411
Plywood	4412
Woodwork	4413–4421
Wood Pulp	47–4707
Waste paper	4707
Paper and cardboard	48
Paper products	49
Wood furniture	94016100–94036099

indicators of trade scale after adjusted for price fluctuations. China has become a major production base, importer and exporter of wood products. The import and export of wood products has a bearing on the ecological construction and the sustainable development of society and economy of China. It is a clear and objective picture of forestry economy by analyzing these indicators, introducing the situation of import and export, and summarizing the development of trading.

Sources of data

China Forestry Statistical Yearbook (2011)

China Forestry Development Report (2001-2012)

Statistical Yearbook of China's General Administration of Customs (2011)

2010 Yearbook of Forestry Product by FAO

Current situation and trend analysis

(1) Volume and value of import and export of wood products

China's forestry is undergoing the historical transformation from timber production to ecological construction. However, domestic demands for timber are increasing rapidly with the surging of economy and investment in fixed assets. China has to rely on imports to reduce the great gap between demand and supply. In 2001, China became the largest importer of industrial timber, and the second largest importer of forest product, second only to the US. China is becoming a trading power and a processing center of forest product. China's increasing export of forest products (plywood, wooden furniture, and timber floor) is exerting profound influence on global trading structure of forest products and forest development of the world.

In 2011, we imported 223.75 million m^3 wood forest products, among which 42.33 million m^3 are roundwood, 28.12 million m^3 sawnwood, 2.34 million m^3 veneer and artificial board, 137.34 million m^3 paper pulp and paper (wood pulp, paperboard, waster paper and printed matter), 11.82 million m^3 wood chip and 1.81 million m^3 furniture, woodwork and charcoal. In 2011, we exported 85.80 million m^3 wood forest products, among which 14,400 m^3 are roundwood, 1.27 million m^3 sawnwood, 30.60 million m^3 veneer and artificial board, 19.35 million m^3 paper pulp and paper (wood pulp, paperboard, waster paper and printed matter), 31.81 million m^3 furniture, and 2.76 million m^3 woodwork and charcoal (Figure 7-16).

In 2011, trading volume of wood forest products totaled 80.96 billion USD, among which 40.56 billion dollars are exports and 40.40 billion dollars are imports. In product mix, exports are mainly furniture, paper pulp

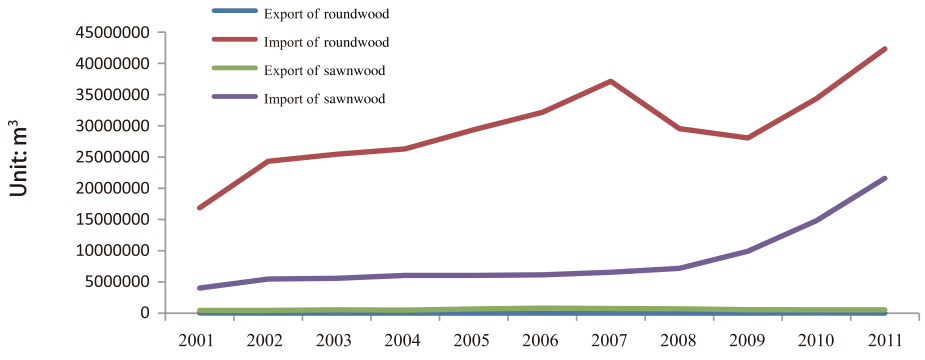


Figure 7-16. Import and export volume of roundwood and sawnwood during 2001-2011

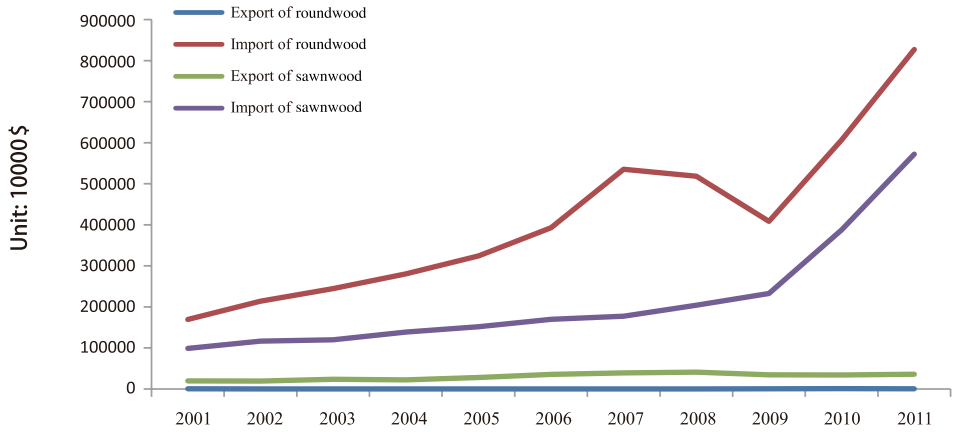


Figure 7-17. Import and export value of roundwood and sawnwood during 2001-2011

and paper, artificial board, and woodwork with the first two occupying 70%; imports are mainly paper pulp and paper, roundwood, and sawnwood, occupying 95% (figure 7-17).

7.1.7 Value of export and import of non-wood forest products

Rational and significance

This indicator shows the role and position of import and export value of non-wood forest products in international trade. Changes in the export and import of non-wood forest product are related with changes of prices in international market and domestic supply. This indicator generalizes changes in the import and export value of non-wood forest products in 2010 as against 2009.

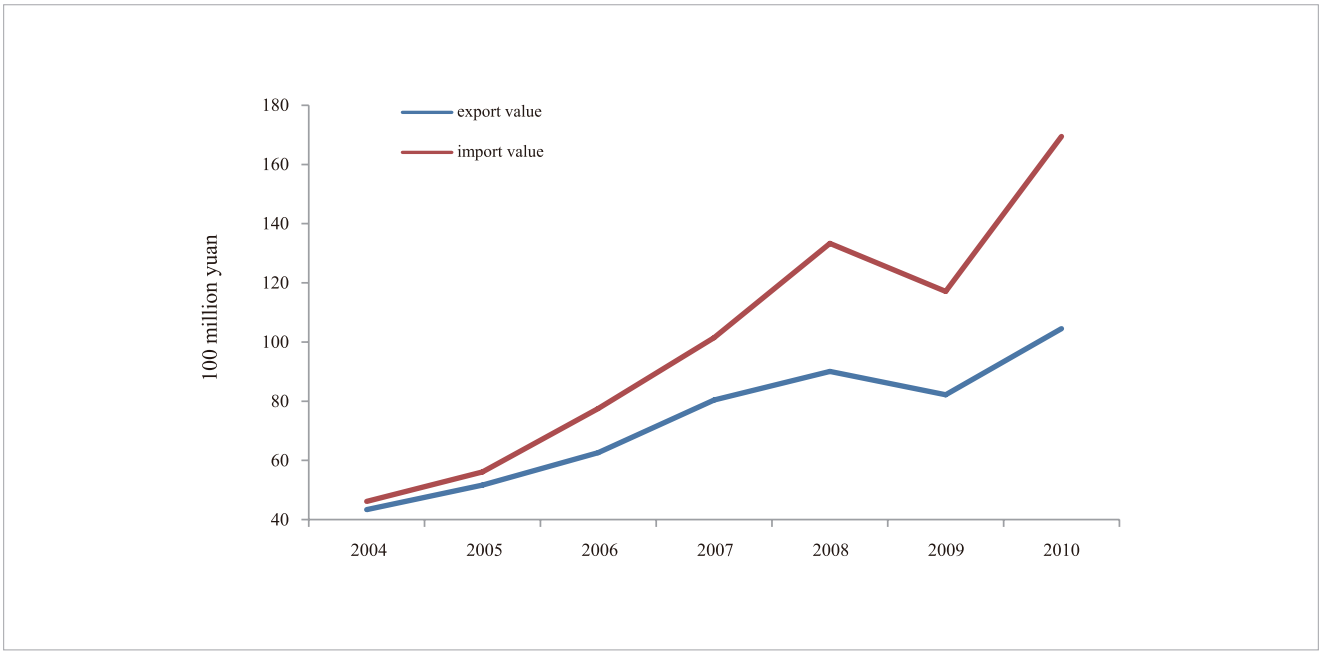


Figure 7-18. Import and export value of non-wood forest products

Sources of data

China Forestry Statistical Yearbook (2000-2010)

China Forestry Development Report (2011)

Statistical Yearbook of China's General Administration of Customs (2009-2010)

Current situation and trend analysis

Recent years have witnessed rapid growth in the import and export of non-wood forest products with the growth of import outpacing that of export, major changes in the export product mix and minor changes in import product mix. In 2010, imports registered 16.95 billion dollars, and exports registered 10.45 billion dollars, increasing by 267.14% and 141.12% respectively as compared with 2004. The import and export value of non-wood forest products accounted for 40% and 20% of that of forest products respectively. (Figure 7-18)

In 2010, the import and export of fruits increased rapidly with the growth of import outpacing that of export by a large margin. In product mix, dried fruit and nuts took the top spot, but were decreasing in their shares (Figure 7-19). In 2010, imports were 3.19 billion dollars, and exports were 4.76 billion dollars, increasing by 369.76% and 156.05% respectively as compared with 2004.

In 2010, import and export of forest food increased by a large margin with the growth of export outpacing that of import. In 2010, the import stood at 1.22 bilion dollars, and export 1.96 billion dollars, with export increasing by 103.96% as compared with 2004. In 2010, the growth of imports of beverages like tea and coffee outpaced that of exports. In 2010, imports of beverages like tea and coffee were 594 million dollars, and exports were 1.17 billion dollars, increasing by 264.42% and 107.80% respectively. Imports were mainly coffee and cocoa, and exports were mainly tea and cocoa.

In 2010, the growth of imports of spice, herbal medicine, and tonic outpaced that of exports by a small margin. Imports stood at 321 million dollars, and imports 1.1 billion dollars, increasing by 494.44% and 155.12% respectively as compared with 2004. Import and export of forest chemical products registered 11.53 billion dollars and 1.26 billion dollars, increasing by 212.30% and 174.45% as compared with 2004.

In 2010, the import and export of nursery stock products

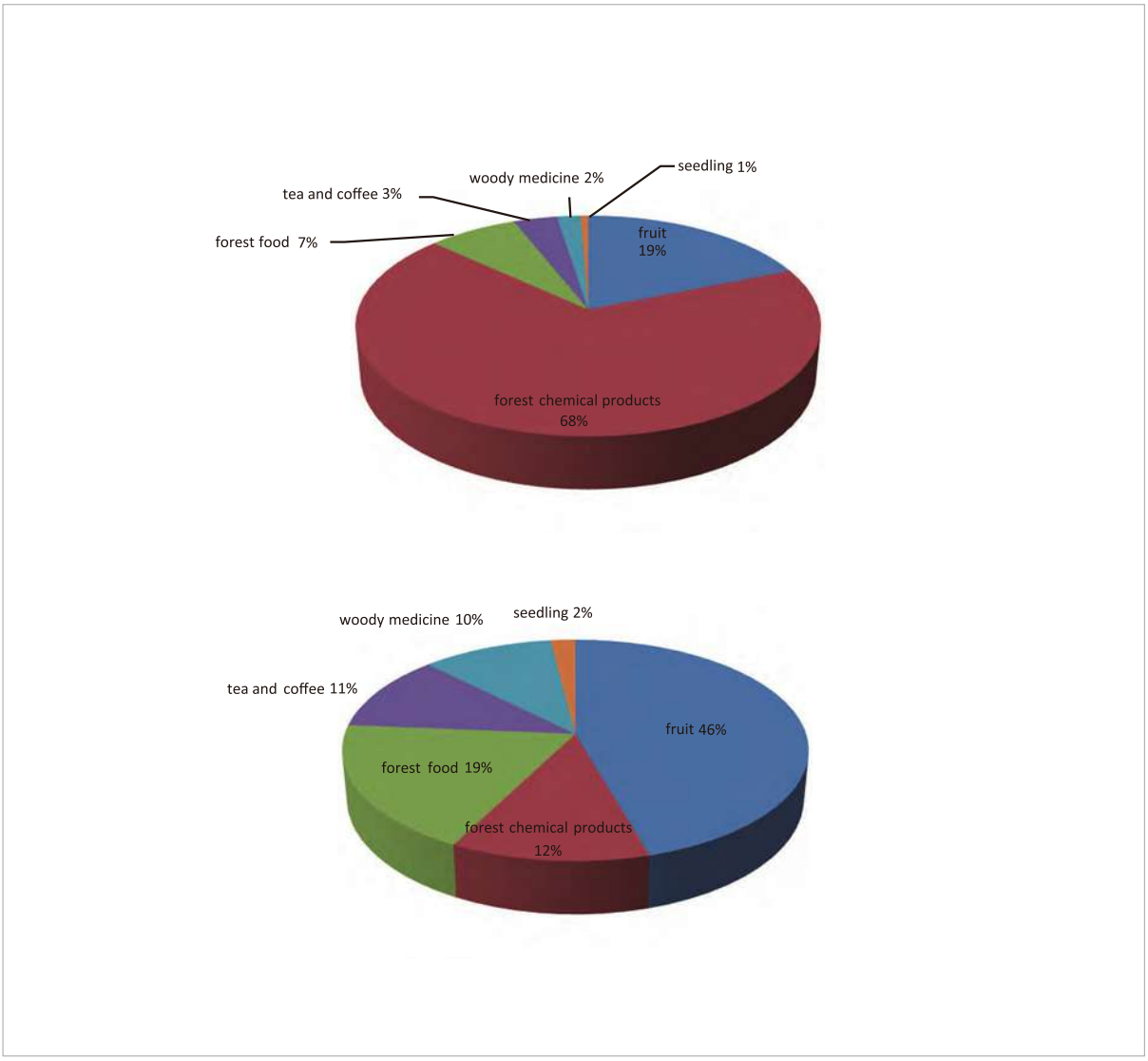


Figure 7-19. Import and export structures of non-wood forest products in 2010 (based on values, top is export and next is import)

increased by 300.00% and 226.98% respectively as compared with 2004. In 2010, imports of wild animals stood at 288 million dollars[9], and exports stood at 565 million dollars. Imports of wild plants stood at 5.02 billion dollars and exports 1.6 billion dollars.

Rosin is an important forest chemical product in China and holds an important position in China's import and export. Imports have grown from 2.30 million dollars in 2000 to 6.10 million dollars in 2009, increasing by 165.85%. Exports have grown from 138.77 million dollars in 2000 to 181.73 million dollars in 2009, increasing by 30.96%. Changes in the import and export of rosin from 2000 to 2009 show that imports are increasing, exports are increasing from 2000 to 2006 and exports began to decrease since 2007. From 2000 to 2009, the average imports were 4.17 million dollars a year with an annual growth of 0.42 million dollars. Average exports are 209.14 million dollars a year. Average annual growth of exports from 2000 to 2006 was 37.75 million dollars. Since 2007, the export of rosin is decreasing with annual average growth of minus 61.18 million dollars (Figure 7-20).

[9] *Remarks: exchange rate of USD to RMB is 6.3649*

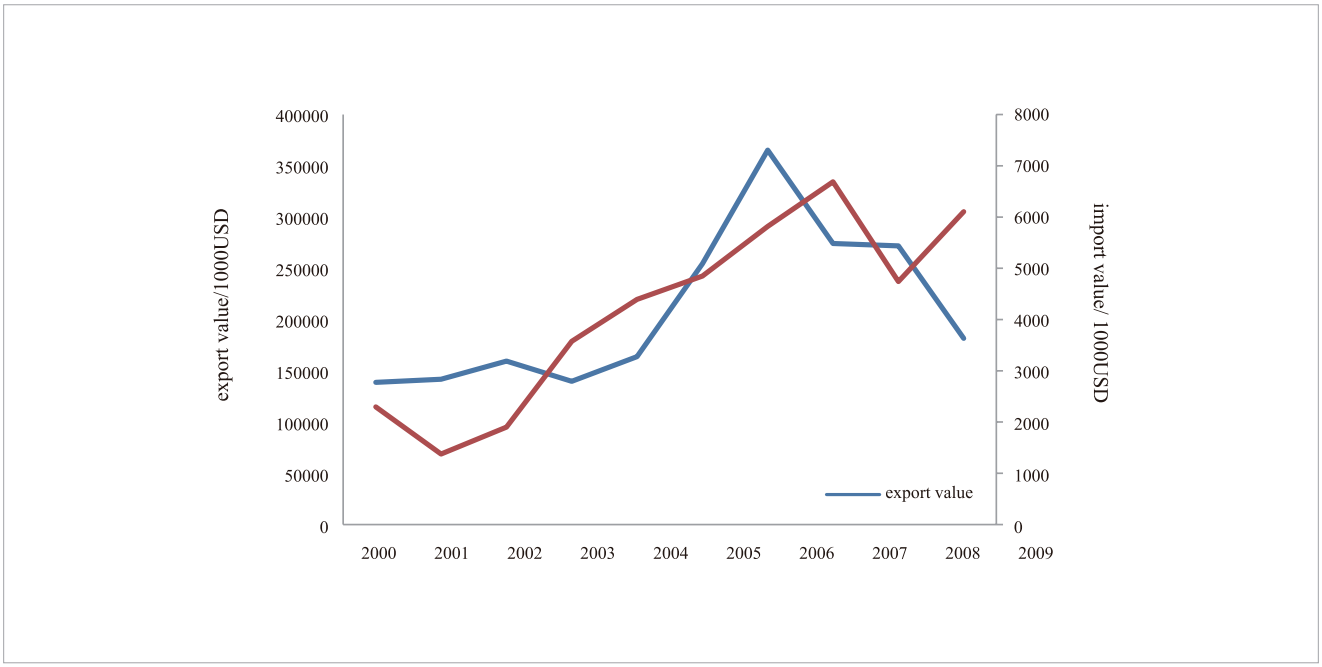


Figure 7-20. import and export value of rosin

7.1.8 Exports as a share of wood and wood products production and imports as a share of wood and wood products consumption

Rational and significance

Export share of production means the share of products and processed products exported in the product and processed products produced by one country. This indicator shows the dependency of the country's production on foreign trade. Import share of consumption means the share of imported products consumed by one country in a country's total consumption. This indicator shows the dependency of the country's consumption on foreign trade. Now, China relies on the foreign trade to some extent to meet domestic demand. Meanwhile, China exports wood products, driving the development of forest industry. It is a clear and objective picture of forest products trading by analyzing this indicator and introducing the structure of import and export of wood products.

Sources of data

China Forestry Statistical Yearbook (2011)

China Forestry Development Report (2012)

Statistical Yearbook of China's General Administration of Customs (2012).

Current situation and trend analysis

Wood product market in China is supplied domestically and internationally. Domestically supplied products include commercial timber, fuel wood for farmers, wood fiber board, and chipboard. Imported products include roundwood, sawnwood, veneer, artificial board, furniture, wood pulp, chip, paper and paper product, waste paper and other products. In 2011, the total supply of wood products was 500.04 million m^3. The production of commercial timber was 81.46 million m^3 among which the production of roundwood was 74.5 million m^3, and the production of fuel food was 6.96 million m^3. The supply of fuel wood for farmers was 40.37 million m^3, and the supply of wood fiber board and chip board was 136.5 million m^3. Our imports of wood forest product were 223.75 million m^3.

The consumption in the wood product market is composed of domestic consumption and export. Domestic consumption includes consumption by the industry and construction, and consumption by farmers. Exports include roundwood, sawnwood, veneer, artificial board, furniture, wood pulp, chips, paper and paper products and other wood forest products. In 2011, the total consumption in wood product market was 499.91 million m^3. According to the data of National Bureau of Statistics of China and other departments, in 2011, construction and industry consumed 389.08 million m^3 and farmers used 29.52 million m^3 as fuel wood and other uses. China exported 85.8 million m^3 of wood forest products.

In conclusion, export share in the production of timber and wood products was 17.16% in 2011 and the import share in the consumption of timber product was 44.76% in 2011.

7.1.9 Recovery or recycling of forest products as a percent of total forest products consumption

Rational and significance

This indicator shows the recovery rate of timber, wood products and paper products. Recycled wood fiber and wood products include paper, solid wood, and wood fiber used by producers and end users as raw materials. Recycled wood fiber can be used within and out of the forestry. They can be used to make landscape and wood-plastic composite. It also includes timbers recovered from buildings and recovered forest products which can be transferred into energy through burning.

Sources of data

Annual Report on China's Comprehensive Utilization of Resources (2012)

Current situation and trend analysis

In recent years, China has improved the comprehensive utilization of forestry resources in expanded areas. In 2011, 90 million m^3 of timber have been conserved through the comprehensive utilization of wastes. Over 100,000 enterprises are engaged in recycling renewable resources with 300,000 recycling centers and more than 18 million personnel.

China's fiscal and taxation departments have adjusted preferential policies of added-value tax for the comprehensive utilization of resources, and continue to provide tax preferences for the comprehensive utilization of forestry wastes and fuel woods. The Chinese government released *Points for Action against Climate Change in Forestry during the 12th Five Year Plan Period*, promoting the transformation of forestry waste into energy, and taking advantage of the technology of biomass conversion. This project has been included as national major projects. In 2011, 200 million tons of three forestry residues and fuel wood were produced, among which 15% are harvesting residues, 5% are construction residues, and 50% of them are processing residues. 190 million tons of them have been comprehensively utilized. Annual usage of paper making, artificial board, edible mushrooms and biomass are 50 million tons, 110 million tons, 10 million tons and 20 million tons respectively.

China issued *12th Five-Year Plan for the Development of Paper Industry and List of Technology, Crafts* and *Equipments of Recycling Economy Encouraged by the Central Government* to promote paper projects with the waste paper as raw materials. Pulp made from waste paper can be used to produce most of the paper and paper boards and even high-grade papers. The usage of waste paper in China can match with international standards. In 2011, China used a total of 70.15 million tons of waste paper with 71.2% comprehensive utilization rate. Among them, 43.47 million tons are recycled domestically, and 26.68 million tons are imported. The recycling rate has increased from 27.2% in 2001 to 44.57% in 2011. The total recycled volume has increased from 10.02 million tons to 43.47 million tons. The utilized volume has increased from 16.38 million tons to 70.15 million tons.

The National Development and Reform Commission compiled and released documents of national standards like *Manual on Timber Conservation, Standards on the Management of Recycling of Discarded Wood Materials* and *Standards on the Protection and Management of Timber*. In 2011, 60 million tons of timber were discarded, which were 85 million m^3. The comprehensive

Case: Utilization of Forestry Waste in Zhejiang Province

According to surveys, the consumption of forestry product in Zhejiang province keeps increasing and as a result, many wastes like chips, waste paper, disposable chopsticks, and wood shavings are produced. In 2006, a total of 1 million m^3 of wood materials were discarded, 94,000 of which were waste paper. In rural areas, the farmers sell or burn these wastes or use them to produce biomass energy. As to discarded wood products, due to the insufficient recycling system, immature technologies, underdeveloped second-hand furniture markets, and consuming concepts, most of them are either burned as fuel wood, or buried as waste. The recycling rate is only 30%. The recycling rate of waste paper is 79.5%, higher than the global average of 44%, and national average of 38%. However, without uniform sorting standard and testing method, recycled paper are of low quality, and efficiency is low due to the lacking of processing plants. They failed to make the best use of value of waste paper and result in secondary pollution.

utilization rate was as high as 65%, and these wastes were mainly used to produce wood artificial board, pulp, ethanol, and wood-plastic composite.

7.2 Investment in the forest sector

This indicator provides information on investment in the management of forest, forestry and personnel on a yearly base or long-term base. Capital investment plays a crucial part in maintaining the efficiency of forest.

7.2.1 Value of capital investment and annual expenditure in forest management, wood and non-wood forest product industries, forest-based environmental services, recreation and tourism

Rational and significance

This indicator provides information on investment in forest management, processing of forest products, and environmental services and shows capital sufficiency in the sustainable management of forest. There are several categories of forestry investment. Forest investment covered by this indicator includes forestation, logging, processing, and manufacturing of bamboo, rattan, palm fiber, and reed. Investment in forestation includes investments in natural forest protection programs, ecological projects, reserves and environmental services. Investment in forestry comes from governments, the private sector, loans, and foreign sources.

Source of data

China Forestry Statistical Yearbook (2000-2011)

Current situation and trend analysis

(1) Changes in total investment and investment structure

Due to the attention given by the central government on ecological construction in forestry and driven by the increasing demand for forestry products, China's investment in forestry keeps growing since 2000 (Figure 7-21). Total investment in forestry (deducted inflation

factor and taken 2001 as 100) has grown from 20.96 billion yuan in 2001 to 121.75 billion yuan in 2010, increasing by 480.97%. In the same period, investment in forestation increased by 299.31%, investment in harvesting timber and bamboo increased by 598.51%, investment in timber processing and processing of

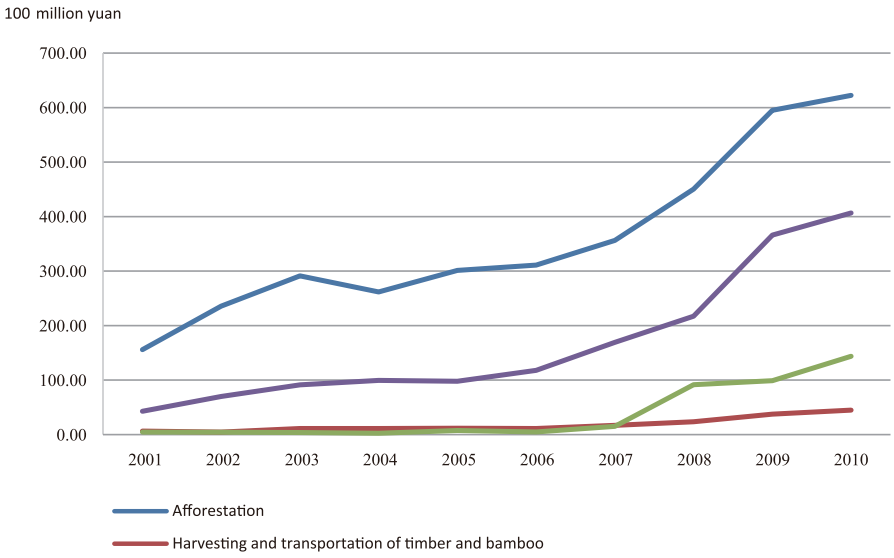


Figure 7-21. Investment in forestry 2001-2010

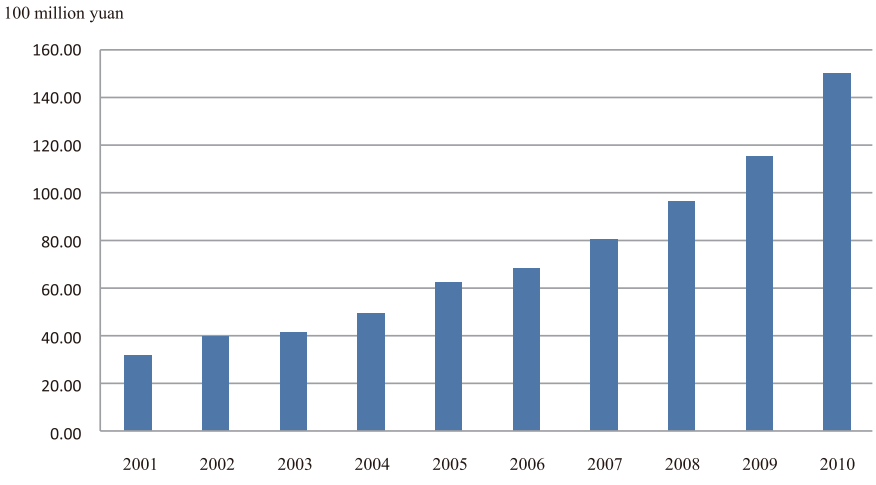


Figure 7-22. Changes of investment in China's SFM

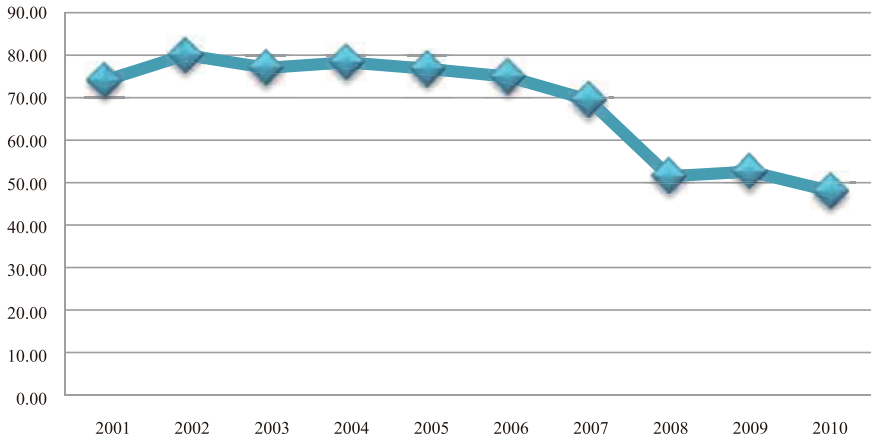


Figure 7-23. Changes of the share of government investment in forestry investment (%)

bamboo, rattan, palm fiber and weed increased by 3093.09%, and the investment in other sectors increased by 850.70%.

While the total investment is increasing, the investment makeup is developing in a direction favorable for sustainable development of forests. This trend is shown in two areas. First, more investment is made in the management of forests. From 2001 to 2010, investment in SFM[10] grows from 3.17 billion yuan to 15.03 billion yuan, increasing by 373.58% (Figure 7-22). Second, in the total investment, the share of governmental investment is decreasing, and the share of private investment is increasing, showing the establishment of a market-based management is being sped up. The share of governmental investment in the total investment has decreased from 74.04% in 2001 to 47.98% in 2010 (Figure 7-23).

(2) Investment in the Key Forestry Programs

At the end of the 20th century, the Chinese government launched key forestry programs represented by Natural Forest Protection Project (NFPP). It is an important turning point for China's forestry development, marking the transformation of China's forestry from timber production to ecological protection and sustainable use of forest. Since 1998, the Chinese government has invested a lot in these key projects. In 2000, China invested 11.064 billion yuan in these 6 major projects: NFPP, Conversion of Cropland to Forests Program (CCFP), Sandification Control Program for Areas in the Vicinity of Beijing and Tianjin, The Three North Forest Shelterbelt Program ,Wildlife Conservation and Nature Reserve Development Program, Fast-growing and High-yield Plantation Program. These investments accounted for 65.95% of the total investment. In 2011, 53.22 billion yuan was invested in these 6 projects, increasing by 380.03% as compared with 2000. Among these 6 projects, the investment in Conversion of Farmlands to Forests Project is the largest, accounting for 56.09% of the total, and investment in NFPP is the second largest, accounting for 24.33% (Figure 7-24).

[10] *SFM investment in this report includes: investment on reforestation, low production forest improvement, tending of young-and-middle-aged forests, forests management and protection, forest fire prevention, forest pest control, forest parks, wildlife protection and nature reserves construction.*

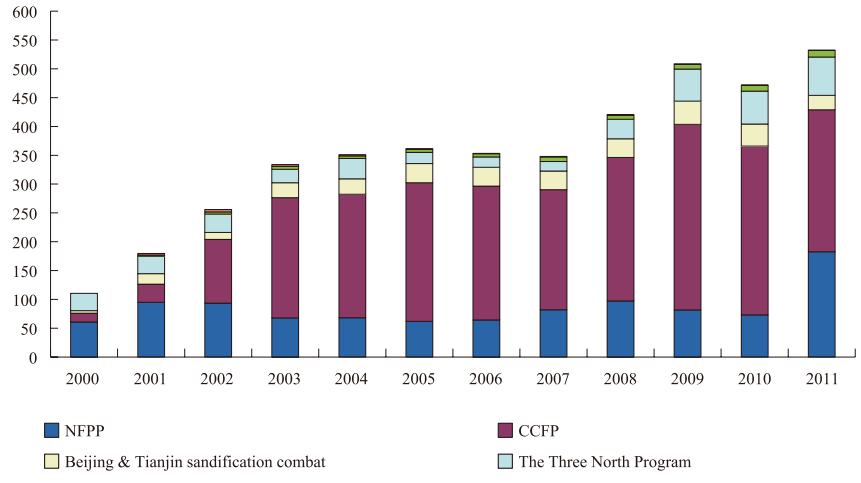


Figure 7-24. Investment in 6 major projects during 2000-2011 (100 million yuan)

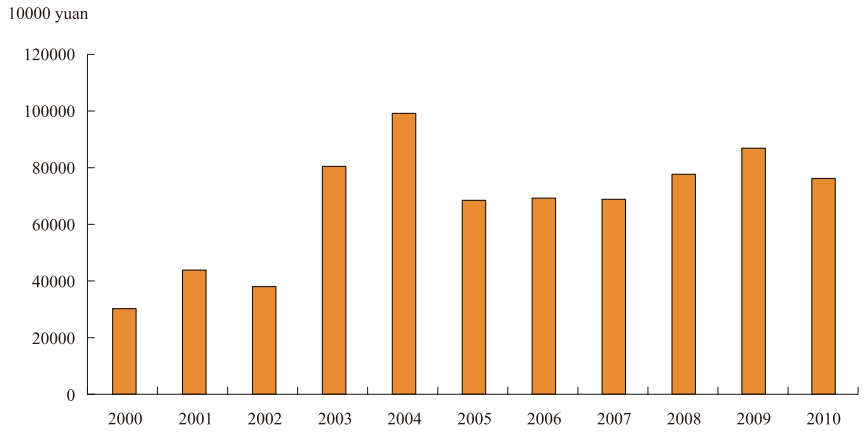


Figure 7-25. Investment in education and science and technology during 2000-2010

7.2.2 Annual investment and expenditure in forest-related research, extension and development, and education

Rational and significance

This indicator provides information on investment in research, promotion, development and education. Investment in research and development and education is composed of two parts, namely investment in education, science and technology and key labs, excluding investment by other departments like the Ministry of Science and Technology and the Ministry of Environmental Protection.

Source of data

China Forestry Statistical Yearbook (2000-2011)

Current situation and trend analysis

From 2000 to 2010, investment in research, promotion, development and education kept growing. Total investment grew from 303 million yuan in 2000 to 762 million yuan in 2010, increasing by 151.80% (Figure 7-25)

7.3 Employment and community needs

Forest based and forest-related employment provides information on the level of forestry employment and its quality as well as community reaction capability, subsistent forestry and distribution of forestry income. It is an efficient way to measure forest's contribution to the state and local social and economic development by using the indicator of forestry employment. The wage level and work-related injury rate are indicators on the quality of forestry employment. As for communities whose economic income and livelihood are dependent on the forestry and its related industries, they are more susceptible to the long-term or short-term adjustments of the forestry policies.

7.3.1 Employment in the forest sector

Rational and significance

This indicator provides information on the direct or indirect employment in forestry. It has widely acknowledged that employment is a measurement in deciding the health condition of the economy, society and community. On the state level, the statistic range for forestry employment only covers the formal forestry employment within the state-owned economic sector instead of the overall forestry employment in the whole country, which also includes formal forestry employment in other sectors and non-formal forestry employment in rural areas. The categories of forestry employment consist of cultivation and management of forest (including farming, forestry, husbandry and fishery, as well as logging); timber processing and manufacturing (including timber processing, bamboo and rattan products, furniture, pulp and other forest products); research and education on forestry; tourism and so on.

Source of data

China Forestry Statistical Yearbook (2000-2011)

Current situation and trend analysis

The overall number of employees in forestry and employees in forest cultivation has undergone a decline since 2000, owing to the implementation of projects to protect natural forests, industrial reconstruction of forestry as well as the transfer of employment from formal to non-formal forestry sectors. The number of employees in forestry has decreased by 0.63 from 1.98 million in 2000 to 1.35 million in 2011, a drop of 31.56%. Meantime, employees in forest cultivation (state-owned forest farms, seedling nurseries, planting stations, stations of controlling decease and pest infestation and combating desertification) have increased by 341,931 from 779,100 in 2000 to 112,100 in 2011, a rise of 43.89 %, which is mainly attributed to the fact that forest cultivation has been highlighted since 2000. In addition, the share of employees in forest cultivation in the overall forest employment has increased from 26.07 % in 2000 to 31.77 % in 2011 (Figure 7-26).

With the marketization deepening in China's industrial economy as well as the implementation of projects to

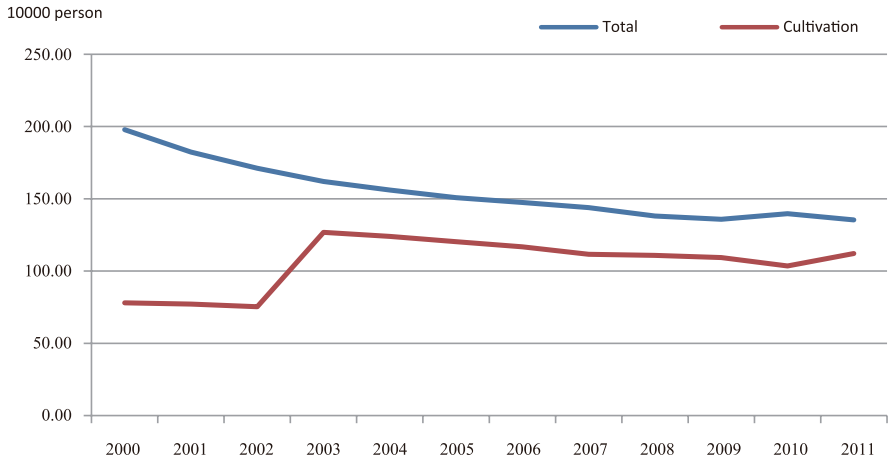


Figure 7-26. Number of overall forestry employment and employment in forest cultivation from 2000-2011

protect natural forests, more and more timber processing work and the manufacture of related products are transferred to private sectors, causing the decline in forestry employment. In 2000, the number of employees engaged in timber processing and manufacture of bamboo, rattan, hemp and straw products was 68,192. In 2011, however, the number decreased by 43,022 to 25,170, a drop of 63.09 %.

7.3.2 Average wage rates, annual average income and annual injury rates in major forest employment categories

Rational and significance

This indicator provides information on the wage level, average income and work-related injury rate so as to reflect the quality of forestry employment, the economic value of forests and the importance of forest employment to the society. Due to the limit of data, this report only focuses on the formal forestry employment in state-owned sectors. As for the state-level statistics, there is no access to the data of average monthly wage, but those of average annual income are available. The annual work-related injury rate calculates the number of minor injury, serious injury and death in state-owned forest farms and in timber transportation and processing as well as in the manufacturing of timber, bamboo, rattan, hemp and reed products.

Source of data

China Forestry Statistical Yearbook (2000-2011)

Current situation and trend analysis

(1) Average annual income of employees in forestry

From 2000-2011, the average annual income of employees in forestry rose steadily with the managerial staff enjoying a higher income increase than the frontline staff. After adjusted from the impact of inflation (deducted inflationfactor and taken 2000 as 100 and deducting the discrepancy in CPI of the following years), the average annual income of employees in forestry

was 19,114 yuan in 2011, an increase of 256.21% from 5,366 yuan in 2000. Meantime, the average annual income of employees in forest cultivation increased by 189.42%, while that of employees in timber processing increased by 226.61% , both are lower than the average increase rate, signifying that managerial staff have a higher income increase. In terms of absolute wages, the average annual income of employees in forest cultivation was 5542 yuan in 2000, 531 yuan more than the overall average income in forestry. This situation continued to 2002. Since then, the income of employees in forest cultivation began to fell short of the overall average income. In 2011, this discrepancy reached 2,047 yuan. (Figure7-27, 7-28)

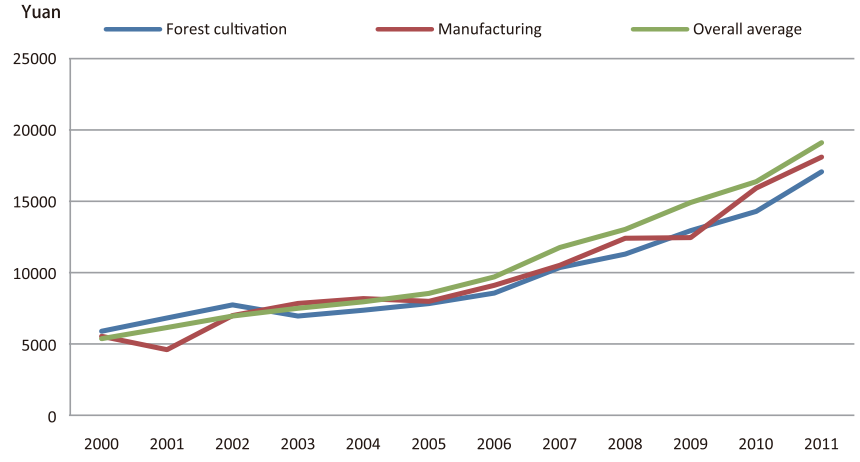


Figure 7-27. Average annual income of employees in forestry from 2000 to 2011

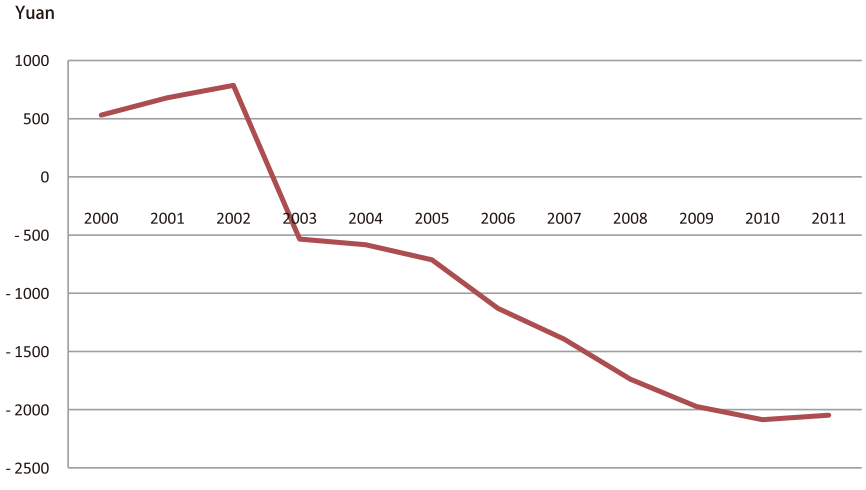


Figure 7-28. Discrepancy between income of employees in forest cultivation and overall average income of forestry from 2000 to 2011

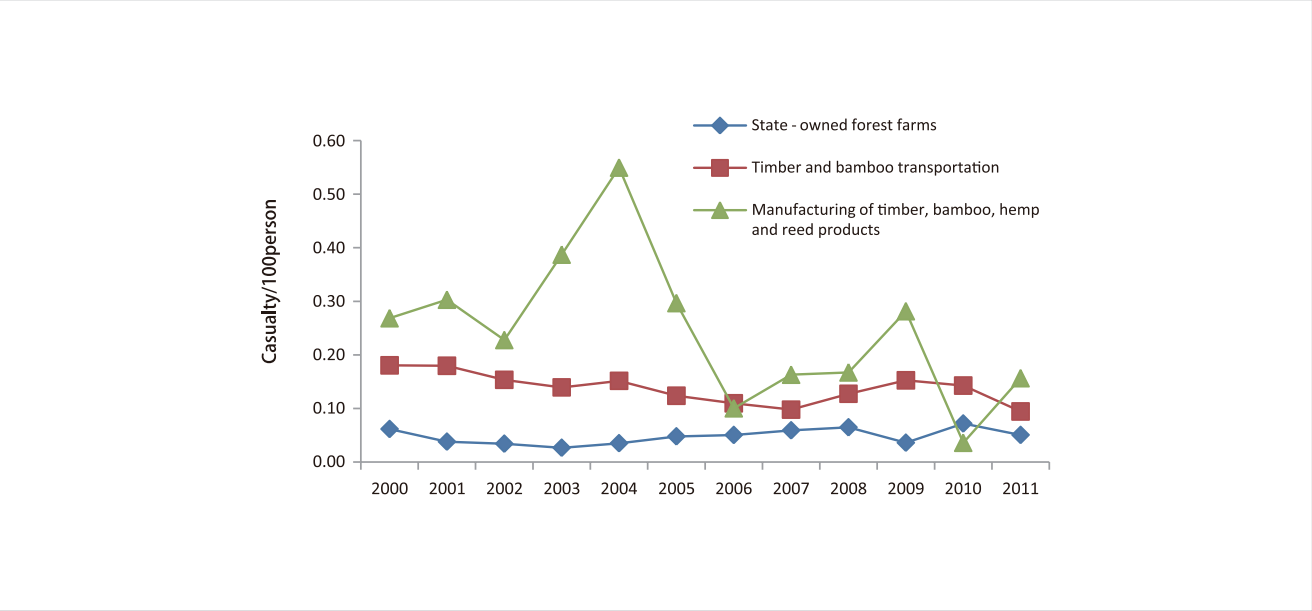


Figure 7-29. Casualty rate in 100 people in the main categories of forestry from 2000-2011

(2) Annual work-related injury rate in the main categories of forestry

Since 2000, the number of the injured and dead in the main workplace of forestry (state-owned forest farms, timber transportation and processing, and the manufacturing of timber, bamboo, rattan, hemp and reed products) has undergone a decline steadily, and the casualty rate is stable with a declining tendency. The death toll has decreased from 1689 in 2000 to 627 in 2011, a drop of 62.88 %. The average casualty rate for state-owned forest farms is 0.06 among 100 people. The rate for timber transportation and processing, manufacturing of timber, bamboo, rattan, hemp, reed products is 0.14 and 0.24, respectively.(Figure 7-29)

7.3.3 Resilience of forest-dependent communities

Rational and significance

This indicator provides information on the reaction and adaptation capability of communities dependent on forests to make a living, acquire benefits, improve their living standards and gain a sense of community identity. In China, there does not have an unified definition of community dependency on forestry. This report defines forest-dependent townships by the standard that forest accounts for over 80% of the total land area and over 50% of farmers' income comes from forestry. However, at present, there is no such statistical data.

Source of data

Related case studies

Current situation and trend analysis

Up till now, researches on forest-dependent communities have not been carried out in China. As a result, relevant data is out of reach. Generally speaking, forest-dependent communities' capability on reacting to social and economic changes has improved a lot thanks to the broad implementation of policies aimed to benefit farmers and projects to protect and restore forests. However, in some places, this capability is degenerated, resulting from turning the natural forests into plantation of single economic tree species. In this report, we will illustrate the reaction capability of communities with two conversing cases.

Case: Jiazi Village--improving the reaction capability of forest-dependent communities through ecological tourism and income restructuring

Jiazi Village is located in the center of Mount Yulong Tourist Site, with an elevation of 2,785 m. It belongs to Daju Township in Yulong Naxi Autonomous County, 43 km away from Lijiang City. Surrounded by mountains, Jiazi Village is mainly inhabited by Naxi people. It has a population of 2,325 in 665 households, among which 2,056 people are engaged in agriculture, and the labor force constitutes 1,135 people. The total area of the village is 96.61 square kilometers with arable land taking up 3,863.70 mu and forest covering 77,620.00 mu.

In former days, residents in Jiazi Village made a living on logging. They used to roundwood 5 m^3 economic trees and 5 tons fuel wood on average per household per year, with an annual income of 1,500 yuan. In 1998, in carrying out the "NFPP", Yulong County closed down over 100 timber processing plants and 18 markets for timber trade. Villagers who lived on these revenues fell into a plight. In order to solve this problem, the local government set up a tourist service corporation to guide villagers in the development of forest tourism. Through corporation management and the policy of feeding agriculture on tourism as well as direct subsidy, residents in Jiazi Village manage to participate in tourism in an orderly way. Every year, 2,388 people in 626 households receive a total subsidy of over 10 million yuan from government ticket fund, tourist companies and companies managing community projects. Many of the young villagers are hired in the stage drama of "Impression of Lijiang" directed by Zhang Yimou , with a monthly income of 3,500 yuan. Besides, villagers are making full use of forest recourses such as raising yaks and lambs in forests and gathering wild mushrooms. It is estimated that about 85 % of their income comes from forestry. Through developing tourism, husbandry and gathering, farmers in Jiazi Village succeed in the transformation from living on logging to enjoying diversified income sources. Their reaction capability is therefore enhanced. There are many similar cases in China.

Case: Manwan Village–vulnerability increased by turning natural forests into rubber plantations

Manwan Village is a Dai Village belonging to Xishuangbanna Dai Autonomous Region. It has a population of 749 in 147 households with 354 males and 395 females. The labor force constitutes 478 people with no one working outside. The education level of the villagers are quite low, the majority of villagers born in the 1960s or before only received elementary education, and others only have a middle school diploma and in recent years, only 5 people are going to college.

Manwan Village has a land area of 4.36 square km. Arable land takes up 780 mu, with rice as its main grain crop. In recent years, over 300 mu of it are leased to outsiders to plant vegetables. Forests take up 5,000 mu, covering 80 % of the total land area. Among it, the ecological forest is over 2,000 mu, with bamboos and wide chestnut trees as its main species. The economic forest is over 3,000 mu and is made up of rubber trees. The rest of land is used by houses, temples, pavilions, roads and reservoirs, taking up 700 mu.

Since the early 1950s, Xishuangbanna has become an important base for rubber trees and plantation was carried out on a large scale. It was majorly conducted by state-owned farms. Villagers began to plant rubber trees in the 1960s but on a small scale. After applying the system of land contract, more and more people were engaged in this business. As the economic benefits of planting rubber trees became notable in the 1990s, residents in Manwan Village began to plant rubber trees on a large scale, even employing the arid land in the valley. According to a statistics on the reform of collective forest tenure system in Manwan Village in 1983, private rubber plantations take up 3,362.3 mu, accounting for 51.4 % of total land area. Besides, villagers have been usurping the state-owned forests to plant rubber tress since 1983. At present, farming households in Manwan Village have rubber plantation areas varied from 7 mu to 100 mu.

Nowadays, over 90 % of villagers' income comes from rubber plantations, which enables them to shake off poverty quickly and improve their living standards. About 80 % of families have bought cars for the convenience in transportation and rubber harvest. Motorbikes are available to every household. In 2011, the broadband network was introduced to Manwan Village, many young men bought computers to play games online.

As a mainstay of local economy, however, rubber plantation has caused Manwan Village to become more and more dependent on it. It also damages the local eco-environment. The fluctuation on the price of rubber has a direct impact on the people's income, resulting in their weakening capability in reacting to social, economic and environmental changes.

If the price of rubber decreased from 25,000 yuan/t in 2011 to 16,000 yuan/t, planters could do nothing but complaining. In Manwan Village, many young people choose to return to plant rubber trees for its high profits after graduating from the middle school. Many people here prefer laboring in the village to working or studying outside. Since the 1990s, the large-scale rubber plantation has been conducted in natural forests or secondary woodlands. The single species plantation has damaged its biological diversity. The long-term tapping of rubber trees needs to consume a great deal of moisture. As a result, the rubber plantation could not be used to restore water. On the contrary, it has absorbed a lot of water. In conclusion, the large-scale rubber plantations, at the cost of natural forests, have shortened the water supply in Manwan Village and affected the water quality as well.

7.3.4 Distribution of revenues derived from forest management

Rational and significance

This indicator imparts information on revenue and its distribution resulted from forest services, management and exploitation to forestry producers, local authorities and forestry departments and aims to reflect how the revenue of forest management is distributed among those stakeholders. Since 1978, the most determinant policies in China on forestry income distribution are the taxes and fees on wood producers, including national taxation and fees charged by local forestry bureaus, some of which are not reasonable enough. Thosetaxes and fees affect forest producersforest management behavior. This report focuses on income distribution within the timber production industry. Since the beginning of 21st century, China has been increasing its public finance on forestry development. Subsidies to encourage conversion of cropland to forests and forest tending have become a major income source for forestry producers, especially those impoverished. China's financing on forestry is playing a dual role in eco-system improvement and poverty alleviation..

Source of data

National Forestry Authority

Current situation and trend analysis

(1) Timber Income Distribution

At the initial stage of China's economic development from the 1980s to the 1990s, agricultural products, including forest products, are heavily taxed to accumulate capital for economic growth. Although since the mid 1980s, the tax burden has become a hot spot in China's forestry development, it is not well handled. Taxes and fees in 1990s cost over 50% of the forest farmers' income on timber. At present, all taxes on agricultural and forestry specialties have been exempted. With only fees left, the charges in timber production is reduced to 15% of its income.

(2) Policies on conversion of cropland to forests effectively eased poverty in rural areas

To effectively curb the aggravating water loss and soil erosion, since 1999, the Chinese government has begun the Converting Cropland to Forests Programs (CCFP).

By 2011, China has converted 9.06 million ha of cropland into forests, reforested 15.34 million ha and closed 2.47 million of ha of areas for reforestation, with

Special column: Changes in timber income distribution

This report is based on a cash flow tableof masson pines and firs cultivation provided by the World Bank's fast-growing plantation projects and analyses income distribution changes in China. In 2000, the World Bank launched projects in China and established detailed operation information base on major fast-growing tree species in south China, i.e. masson pines and firs. Included in it is a cash flow table, logging taxes and fees levied then on the tree plantation. Based on the table, the report analyses distribution changes in the income from the production of south China's major fast-growing tree species.

In 2000, 1 ha of masson pines offered 154 m^3 of timber, bringing about an income of 81,443 yuan. According to tax policies at that time, forest farmers had to pay 6,809 yuan of tax on agricultural and forestry specialtiesand 16,981 forestry fees, accounting for 8.36% and 20.85% respectively of final logging returns of masson pines. The rate of return for forest producers was 70.79%. Therefore, without consideration of transaction costs or unreasonable charges, the layout of the return of per unit masson pine in 2000 was 8.36% for the state, 20.85% for local forestry sector and 70.79% for timber producers.

Suppose that commodity prices and wood productivity and other factors remain unchanged, 1 ha of masson pines offers 154 m^3 of timber, bringing about 81,443 yuan of final logging return. As the tax on agricultural and forestry specialties was exempted, producers of masson pines only had to pay 13,577 yuan of public funds – 16.67% of final logging income – leaving producers up to 83.33% of it. With transaction costs and unreasonable charges ignored, the current profit distribution of China's timber industry is roughly 16.67% for local forestry sector and 83.33% for timber producers. The proportion for producers herein rose by 12.54 percentage points compared with 2000. In the same period, the rate of return for fir producers increased from 71.91% to 79.95%, up by 8.04%. This shows an improvement of China's timber business environment and an increase in producers' income, which will encourage producers to invest more and strive for sustainable forest management.

Income Distribution Based on World Bank's Cash Flow of Timber Production

		Tax (yuan)	Ratio of taxation (%)	Forestry fees (yuan)	Ratio of fees (%)	Final logging return (yuan)	Ratio of all charges (%)	Rate of return for timber producers (%)
Masson pines	Year 2000	68090	8.36	16981	20.85	81443	29.21	70.79
	No tax only fees			13577	16.67	81443	16.67	83.33
Firs	Year 2000	76970	8	19195	20	95739	28.09	71.91
	No tax only fees			15960	16.67	95739	16.67	79.95

wider vegetation coverage in operating area and lower threat from water loss and soil erosion and sand storm; the government has granted 219.92 billion yuan of subsidies to over 37 million rural households involved. These food and living subsidies have constituted a major part of their income and contributed a lot to improve their living standard.

According to the Report for Monitoring and Assessment of the Socio-economic Impacts of China's Key Forestry Programs 2012, since the execution of CCFP, a group of 1,165 sampled households received 19,406.8 yuan of subsidies per households from CCFP subsidy. The subsidies accounted for 15.67% of their net income. Among impoverished peasants, the rate may exceed 50%. The poverty incidence among sampled households dropped from 36.14% before the program to 6.56% in 2011. The land conservation policy has achieved dual tasks of improving the ecosystem and alleviating poverty (Figure 7-30).

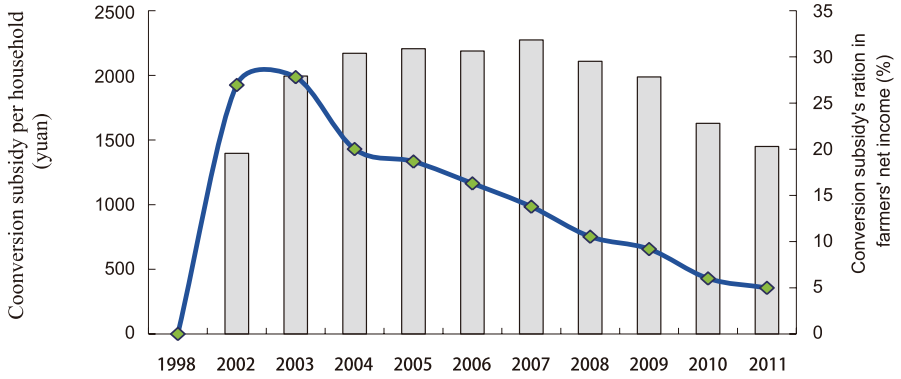


Figure 7-30. Changes in the proportion of subsidies for conservation of cropland to forest in sampled households' annual net income

7.4 Recreation and tourism

7.4.1 Area and percent of forests available and/or managed for public recreation and tourism

Rational and significance

A forest park is a forest for vacation or, after renovation, a system of scenic spots. It is an operation and management complex that utilizes the multiple functions of a forest to provide tourist services and improve scientific and cultural activities.

China Forest Park Landscape Resources Grade Evaluation, published in 1999, defines a forest park as "a lawfully applied and approved forest area with forest landscape resources and environmental conditions of a certain size and quality to develop forest tourism". A forest park: 1) shall be a land with certain area and boundaries; 2) shall have forests as its landscape; 3) shall be commercially exploitable, with certain amount and quality of natural and cultural landscape for recreation, fitness, scientific research, cultural education and so on; 4) shall be applied and approved through legal procedures. All these demands shall be met; otherwise it cannot be called a forest park. The area of a certain forest park, in this report, is defined as the area available for recreation and tourism.

Source of data

National Forestry Authority

Current situation and trend analysis

(1) Area and proportion of forests for public recreation and tourism

The Recreation Area in forests provides quality recreational experience for tourists. By 2011, China has established 4,561 entities for public recreation and tourism, the majority of which is nature reserves and forest parks, with a total area of 59.73 million ha (Figure 7-31). Among them, national forest parks amount to 747, covering an area of 11.76 million ha. National nature reserves amount to 223, with an area of 17.45 million ha. Local forest parks amount to 2000, covering an area

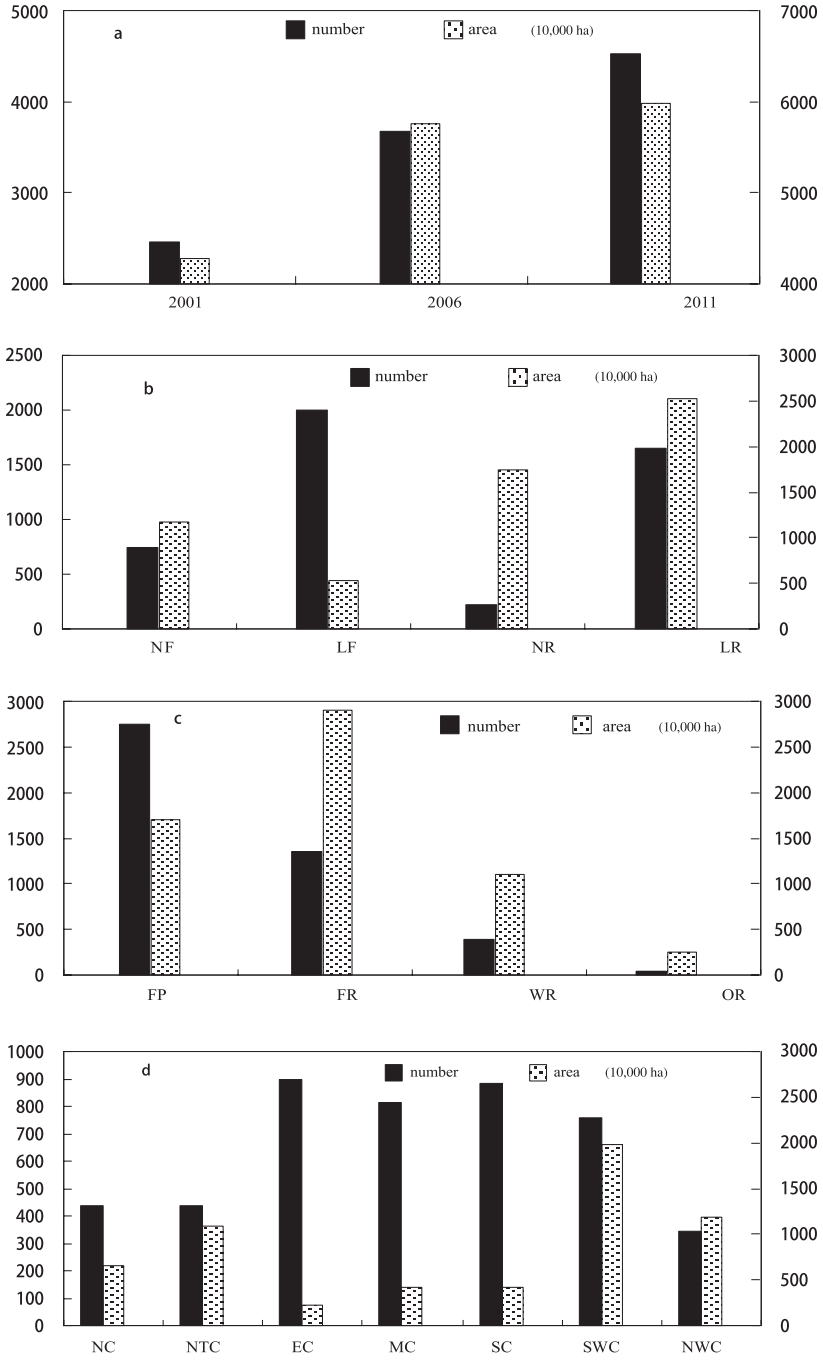


Figure 7-31. Number and proportion of parks used for public recreation and tourism

(Note: figure b, NF-national forest park, LF-local forest park, NR- national reserve, LR- local reserve; figure c, FP-forest park, FR- forest reserve, WR-wildlife reserve, OR- other reserve; figure d, NC-North China, NTC-Northeast China, EC-East China, MC-Middle China, SC-South China, SWC-Southwest China, NWC-Northwest China)

of 5.27 million ha. Local-level nature reserves amount to 1,563, including those of provincial, municipal and county levels, covering 25.24 million ha. Starting from 2000, the government has stepped up their efforts in building forestry reserves and forest parks for public recreation and tourism. From 2001 to 2011, the state has approved the establishment of 2,364 forestry reserves or forest parks of all kinds, a 109% increase in comparison with 2000. Over 40% of them are located in the provinces of Tibet, Sichuan, Heilongjiang, Gansu and so on.

Among those entities available for forestry recreation, 2,747 are forest parks, accounting for 60.2% of the total amount and 28.6% of the total area; 1357 are forestry reserves, accounting for 29.8% of the total amount and 48.6% of the total area; 384 are wildlife reserves, account for 8.4% of the total amount and 18.5% of the total area; 46 are coastal mangrove forests or forests of other types, accounting for 4.2% of the total area.

The northwest and southwest parts of China together have 31.60 million ha of forestry reserves and forest parks, accounting for 52.9% of the total; northeast China has 10.91 million ha of forestry reserves and forest parks, accounting for 18.3% of the total; North China has 6.51 million ha of forestry reserves and forest parks, accounting for 10.8% of the total; Middle, South and East China merely account for 7.1%, 7.0%, 3.8% respectively of the total. Each of such provinces as Guangdong, Jiangxi, Shandong, Sichuan, Fujian and Hunan has more than 200 reserves and parks. Together the six have 1980 entities, accounting for 43.4% of the total amount, but merely 21% of the total area.

(2) Area and proportion of forests for public recreation and tourism

Forest parks are a stronghold in China's natural heritage protection effort. They are also important tourist destinations. For more than 20 years since the opening of China's first national forest park in September 1982, China's forest parks have continually been developing. The area of forests exclusively for public recreation and tourism is booming, representing a new pattern of the nation's tourism. The recent development pattern of China's forest parks is shown in Table 7-5.

In 1997, China had over 800 forest parks. Then the figure increased to 1078 in 2000 and rose to 2067 in 2006. By 2011, China has 2747 forest parks, with an annual increase rate of 8.9%. The total area of forest parks has climbed from 9.83 million ha in 2000 to 17.03 million ha in 2011, accounting for 9.0% of the nation's total forest area, with an annual average increase of 5.6-2%. Nine provinces have more than 100 forest parks for each. (Figure 7-30). Compared with the data by the end of 2000, there have been 1,669 new forest parks, contributing another 7.23 million ha to the total area. Among them, there are 403 new national parks, with a newly added area of 5.22 million ha. A system of forest landscape reservation and management that takes national forest parks as a core and comprehensively develops national, provincial and county parks has taken shape and is improving day by day. At present, 15 out of 42 world

Table 7-5. Development situation of China's forest parks since 2000

Year	number	Total Area (10,000 ha)	Area Per Capita (m^2)
2000	1078	983.7	75.8
2001	1217	1138.3	87.1
2002	1476	1268.95	96.5
2003	1658	1390.0	105.1
2004	1771	1460.2	109.7
2005	1928	1513.4	113.1
2006	2067	1569.3	116.7
2007	2151	1597.5	118.2
2008	2277	1630.2	120.4
2009	2458	1652.5	121.0
2010	2583	1677.7	122.4
2011	2747	1706.3	123.9

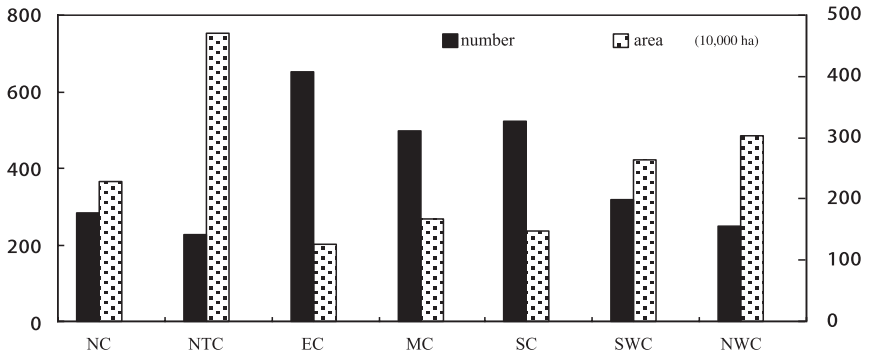


Figure 7-32. Amount of Forest Parks in Different Regions

(Note: figure 7-32, NC-North China, NTC-Northeast China, EC-East China, MC-Middle China, SC-South China, SWC-Southwest China, NWC-Northwest China)

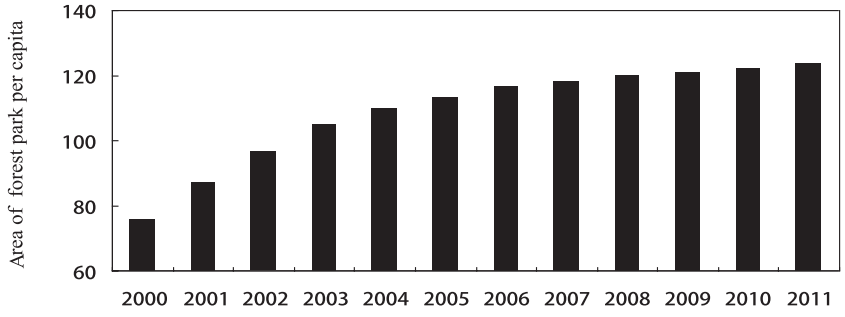


Figure 7-33. Changes of Per Capita Area of Forest Parks

cultural or natural heritages in China have forest parks. Among 24 geological parks, 15 are forest parks.

By 2011, among all provinces, Jilin has the biggest forest park area, covering 2.37 million ha. The area of forest parks in Guangdong, Xinjiang, Tibet and of Longjiang Forest Industry Group also exceeds one million ha respectively. The total forest park area in these provinces is 7.37 million ha, accounting for 43% of all parks in the country (Figure 7-32).

From 2000 to 2011, the per capita forest park area has increased from 76 m^2 to 124 m^2, a 63 % increase (See Figure 7-33). The growth rate from 2001 to 2003 was 14.9%, 10.7% and 8.9% respectively. From 2004 to 2007, the rate has decreased from 4.4% to 1.3%. Since 2007 the annual per capita growth stood between 0.8% and 1.9%.

7.4.2 Number, type and geographic distribution of visits attributed to recreation and tourism and related to facilities available.

Rational and significance

Forest tourism, also named green tourism, is a new form of tourist industry and the definition of forest tourism is the sum of all the activities that people choose freely to conduct in forest surroundings during their leisure

time for refreshment and pleasure (Chen Xinfeng, 2000). Forest tourism has many features including being natural, diversified, localized, intersectional, sustainable, fragile and intelligence increasing. The major functions of forest tourism consist of providing beautiful scenery and recreational spots, helping people to improve their health, and facilitating people taking exercise, etc.

Forest tourism makes use of a region's forest resources, opens to the external under certain control and holds some tourist projects specialized in forest regions to put tourists into the fantastic scenery of nature, extraordinarily fresh air as well as extremely quiet environment so that tourists will be able to enjoy the beauty of nature, improve their physical and mental health, cultivate their taste and increase their knowledge of nature; meanwhile, forest tourism can also gain large sums of foreign exchange and increase tourist revenue for regions or countries (Xiao Xing & Yan Jiangping, 2000). The major carriers of forest tourism are forest parks and natural reserves (Song Xiuhu, 2007).

Sources of data

National Forestry Authority

Zhejiang Province Tourism Statistics Yearbook

Current situation and trend analysis

(1) Overview

The development of China's forest tourism market in recent years is shown in Table 7-6. China's forest tourism market enjoys a fast speed of growth during the past 20 years or so. Direct revenue of forest tourism surpassed 100 million yuan in 1992. In 2000, it was over 1 billion yuan and in 2006, it went beyond 10 billion yuan. In 2011, direct revenue of forest tourism was 37.64 billion yuan, and the average increase rate of direct revenue of forest tourism reached 34.5% over the past 20 years, enhancing social comprehensive production by about 10 times. In 2000, visitors to China's forest tourism market were 72 million person-times; in 2002, it was over 100 million person-times for the first time and in 2011, it totaled 468 million person-times, among which 12.07 million were foreign visitors. The average annual increase rate was 21%. The infrastructure construction of China's forest tourism grows at a very fast speed. In 2000, the length of tourist roads totaled 20,700 km and the number of reception beds for tourists was 117,000; in 2011, the number increased to 60,400 and 728,000 respectively with the average growth rate being 20% for both.

According to the statistics of 2191 forest parks in 31 provinces, autonomous regions and municipalities as well as forestry group companies of Inner Mongolia autonomous region, Jilin province, Heilongjiang province and Greater Khingan Mountains, China's construction funds for forest parks were 31.31 billion yuan in 2011, increasing by 8.815 billion yuan compared with the 22.50 billion yuan of 2010, up by 39.18%. Among the construction funds of 2011, 4.33 billion yuan was invested in environmental protection construction, increased by 1.79 billion yuan compared with 2.53 billion yuan of 2010, up by 70.79%. In 2011, 102,500 ha scenic beauty forests were developed and 158,200 ha forests were transformed in China's forest parks. By the end of 2011, there were 60,400 km of tourist roads, 31,000 tourist vehicles, 728,000 reception beds for tourists and 1.28 million reception seats in restaurants. And about 150,000 staff worked in tourism management and service. The number of tourist guides and social workers were 16,000 and 640,000 respectively.

In 2011, China's forest parks (including Baishan National Forest Tourist District) attracted visitors of 468 million person-times, among which 12.07 million are foreign visitors. Compared with the total number of 396 million person-times of 2010, the number increased by 18.18% in 2011. In 2011, 79 forest parks (54 of which being at the national level) were visited by over 1 million person-times, and 207 ones (127 of which being at the national level) were visited by over 500,000 person-times.

In 2011, the direct tourist revenue was 37.64 billion yuan. Compared with the 29.49 billion yuan of 2010, the number increased by 27.63% in 2011. It was estimated that in 2011, the social comprehensive production of China's forest parks was 300 billion yuan. Tourist revenue of 344 forest parks (235 of which being national level) was over 10 million yuan.

746 national forest parks received 260 million person-times of tourists with the tourist revenue of 29.12 billion yuan. Each park received 348,500 person-times on average and the average tourist revenue was 39.04 million yuan. According to incomplete statistics of 18

Table 7-6. Development of China's forest tourism market since 2000

Year	Direct tourist revenue (100 million yuan)	Number of tourists (100 million person-times)	Length of tourist roads (10 thousand km)	Number of beds (10 thousand)
2000	12.9	0.72	2.07	11.7
2001	28.2	0.86	2.29	15.8
2002	37.0	1.10	2.67	17.1
2003	41.9	1.16	2.49	20.8
2004	69.1	1.43	3.92	27.3
2005	83.98	1.74	6.04	36.3
2006	118.3	2.13	3.12	40.3
2007	157.98	2.47	4.49	49.9
2008	187.1	2.74	4.54	53.6
2009	226.1	3.33	5.14	58.0
2010	294.9	3.96	5.47	62.6
2011	376.4	4.68	6.04	72.8

provinces, autonomous regions and municipalities, 228 forest parks (41 of which being at the national level) were free to public. 71.87 million person-times of visitors enjoyed free entry, among which 36.10 million person-times were visitors to national forest parks, accounting for 15.4% and 13.8% of the total number of tourists every year respectively.

Case: Forest Parks Construction in Zhejiang Province

Zhejiang province is located in southern part of the Yangtze River Delta in China. Its land area is 101,800 km^2, accounting for 1.06% of the country's total. It enjoys rich forest tourism resources and its greening coverage ratio is as high as 92.4%. The province is full of diversified landforms, including high mountains, canyons, hills, islands, caves, rivers, lakes, etc. It is abundant with wild fauna and flora resources with over 4,550 species of higher plants, among which 3,379 are spermatophyte species. Of the 3,379 spermatophyte species, 60 are gymnosperms and 3,319 are angiosperms. According to experts, as high as 70% of the 100 plus state-owned forest farms in the province has good value of tourism development. In general, forest resources are diversified, forest landscapes are colorful, landform scenery magnificent and forest tourism resources well-distributed in Zhejiang province.

In August, 1982, Zhejiang built the first forest park—Ningbo Tiantong Forest Park. With over 30 years of development, forest tourism has now become a new strength of tourist industry. By 2011, the province has built 95 provincial or national forest parks, among which 34 are national forest parks, 9 are national natural reserves and 9 are provincial natural reserves. The total area of forest parks was 345,000 ha, accounting for more than 6% of the province's total forest area.

Qiandao Lake Forest Park is situated in Chun'an county, Zhejiang province. It is an artificial lake formed because of the impoundment of Xin anjiang Reservoir after its establishment in 1959. Made up with 19 state-owned forest farms, Qiandao Lake Forest Park is one of the largest forest parks in China. Its area totals 95,000 ha with the lake area being 53,000 ha. There were 1,078 islands of various views and sizes in the Qiandao Lake Forest Park. In 2011, the park attracted 4.06 million person-times of tourists from home and abroad, totally gaining 5.31 billion yuan of tourist revenue, ranking No. 10 and No. 1 respectively among all forest parks in China.

According to the 2009 Annual Monitoring Statistics Report of Current Situation of Forest Resources of Zhejiang Province, about 6.68 million ha of forest land was used for tourist services in Zhejiang, accounting for 63.64% of the province's total land area. Among it, the area of forests was 5.94 million ha; that of open forests was 33,100 ha; that of other shrub forests was 266,000 ha; that of under-aged forest land was 82,700 ha; that of nursery garden was 23,100 ha; that of no standing trees was 105,800 ha; and that of land suitable for forests was 198,400 ha. Forest coverage ratio was 60.5% in Zhejiang province which was among the top of the country. The coverage ratio of economic forests was 18.45% and that of the bamboo forests was 13.80%.

The total stand stock volume of Zhejiang province was 229 million m^3, among which forests stock volume was 204 million m^3. The area of coniferous forest was 2.39 million ha, accounting for 55.64%, and its stock volume was 127.44 million m^3, accounting for 62.43%. The area of broad-leaved forests was 1.41 million ha, accounting for 32.78%, and its stock volume was 46.12 million m^3, accounting for 22.60%. The area of broad-leaved and conifer mixed forests was 497,200 ha, accounting for 11.58%, and its stock volume was 30.55 million m^3, accounting for 14.97%. The land area of broad-leaved forests and broad-leaved and conifer mixed forests shows a tendency of going up each year, but the major component was still coniferous forests.

In 2011, Zhejiang's forest parks attracted over 100 million person-times of tourists from home and abroad and the forest tourism revenue was 28.87 billion yuan. It grew by 13.7 times within 10 years with an average growth rate of 30.9% each year. In terms of tourism revenue, the top 3 are Qiandao Lake National Forest Park (5.31 billion yuan), Zhuxiang National Forest Park (2.00 billion yuan) and Putuoshan Provincial Forest Park (1.82 billion yuan). Those three parks were also top 3 among China's forest parks in this aspect in 2011.

In recent years, many regions in Zhejiang province combine the construction projects of developing forest recreational tourism, roads of forest regions, modern forest farms with reconstruction of old and dilapidated buildings together, and continue to improve forest tourism infrastructure construction. The accumulative investment in forest tourist area alone has already surpassed 20 billion yuan in Zhejiang province. Due to those work, relevant infrastructure, tourist services and reception facilities have all been enhanced greatly. The development of forest tourism has also driven the growth of a series of related industries such as forest specialties production, catering and accommodation, crop production as well as livestock breeding, which has expanded channels to increase the income of farmers in forest regions.

7.5 Cultural, social and spiritual needs and values

7.5.1 Area and percent of forests managed primarily to protect the range of cultural, social and spiritual needs and values

Rational and significance

The forests referred to under this indicator include forests owned and managed by village collectives to protect local *Fengshui*, religious faiths as well as other spiritual and cultural values. That kind of forests consists of community forests, *Fengshui* forests, forests in temples, sacred mountains and trees, etc. The forests referred to under this indicator also include forests to promote national education, ecological culture, aesthetics, scientific research and people's recreation which has been managed by government at all levels and

their subordinate units. This kind of forests consist of natural reserves of forest ecological types, forest parks, forest cities and forests awarded "National Education Base of Ecological Civilization".

Forests managed to meet social, cultural and spiritual demands and values are managed by different parties such as national forestry, cultural, educational or religious departments as well as village collectives. Meanwhile, the kind of forests is usually of both ecological and economic values. Therefore, China has not conducted specialized projects to calculate the land area of these forests yet.

The long established civilization, diversified culture and abundant natural characteristics of China have bred a colorful forest culture and endowed forests with various spiritual as well as emotional sustenance. Nowadays, advanced science and technology have been introduced into and developed in China; people's life has been improved significantly and urbanization ratio has become higher and higher. The cultural, educational, recreational and scientific research values of forests have obtained more and more attention. Therefore, it is also an important task to do for sustainable forest management to monitor this indicator, and to sustain or even increase the land area of the kind of forests under this indicator to meet the growing cultural and spiritual demands.

Source of data

Typical survey data

Current situation and trend analysis

(1) Forests with social, cultural and spiritual values that are collectively owned and managed

In the long history, people, be they lived on plains or in secluded mountains, all believed that their ancestors and gods lived in all kinds of forests, holy mountains or holy trees. The forests were those that are surrounded a temple for worshiping gods, a buddhist temple, a monastery or that were conserved for good *Fengshui* (literally wind-water in English). Such forests, mountains and trees were the villagers' mental and emotional sustenance and were usually collectively managed by them through local regulations and agreement. Any sort of deforestation, cultivation and hunting was forbidden. Many plants and animals were considered "divine" or with other cultural connotations. Some tree species were used as religious or ritual tools.

Since 1949, a series of movements and reforms like the Land Reform, the Cultural Revolution, the Reform on Woodland Ownership and the market-oriented reform have greatly collided with and harmed villages' traditional culture and seriously damaged some forests that were of social, cultural and spiritual values. Their area was drastically reduced and the management on them fell gradually into a vacuum state. According to the statistics in 2012, after a new round of reforms on the collective ownership on forest, the area of the collectively managed forest was 51.77 million ha, accounting for 30.98% of the total collectively owned forest area. Among the collectively managed forests, especially among the forests with spiritual and cultural values (all types of forests mentioned above) in the ethnic minority areas in southwest China, were protected again by local villages, who, in addition to complying with national laws and regulations, adopt traditional practices, local regulations and folk agreements to manage the forests (Case). These kinds of forests not only are an important part of community culture, but also contain a wealth of China's traditional knowledge on forestry and species resources, thus playing a vital role in biodiversity conservation.

The traditional knowledge on forestry and species resources, carrying potential and actual commercial and ecological values, have become a focus of international debates on biodiversity conservation, desertification control, international patents, trade, climate change, etc. (Liu Jinlong, 2007). With the Chinese government paying more and more attention on ecological civilization, these kinds of forests have been attached with increasing attention and under improved protection; some of them have even been protected in the form of village eco-tourism. What follows is the coordination between community development and forest conservation.

(2) Nature reserves with forest ecosystem

Nature reserves are not only of high ecological, economic and social values, but also important bases for scientific research in biodiversity, natural landscapes and ecosystems. China has begun to establish nature reserves since 1956 and there were altogether 1,254 nature reserves with forest ecosystem by the end of 2010

Table 7-7. List ofNational Ecological Civilization Educational Bases

Provinces	Bases	Quantity
Guangdong	Maofeng Mountain Forest Park of Guangzhou, Guangdong	1
Guizhou	Longjia Mountain National Forest Park; Qianling Mountain Park of Guiyang, Guizhou	2
Henan	Yuntai Mountain National Forest Park; Wild Animals Rescue Center, Henan	2
Hubei	Wuhan University, Dakou National Forest Park of Zhongxiang, Dalaoling National Forest Park of Yichang, Hubei	3
Hunan	Hunan Forest Botanic Garden, Wujian Mountain National Forest Park, Zhangjiajie National Forest Park, Hunan Pocytechnic of Environment and Biology Vocational School	4
Beijing	Beijing Forestry University, Peking University, Affiliated High School of China Building Materials Academy	3
JJiangxi	Boyang Lake National Natural Reserve, Jinggang Mountain National Natural Reserve, Jiangxi	3
Liaoning	Guanmen Mountain National Forest Park of Benxi, Laotudingzi National Natural Reserve	2
Inner Mongolia	Youth Green Homeland, Desertification Comprehensive Demonstration Zone of Keshiketeng	2
Shaanxi	Shi Guangyin Hero Park of Dingbian County, Niubeiliang National Natural Reserve	2
Shandong	Bin Lake National Wetland Park of Tengzhou	1
Anhui	Shangyao National Forest Park	1
Yunnan	Haikou Wood Farm of Kunming, Shanzhou Wood Farm of Shimian County	2
Gansu	Yilian Mountain National Natural Reserve	1
Sichuan	Wolong Panda Protection Research Center	1
Xinjiang	Wild Horse Breeding Research Center of Xinjiang Uyghur Autonomous Region	1
Fujian	Jiulonggu National Forest Park, Gutian Town of Shanghang County, Hongtian Village Forest Tenure Reform Memorial Hall of Yongan, Tianzhu Mountain National Forest Park	4
Zhejiang	China Root Carving Art Exposition of Kaihua County, Xixi National Wetland Park of Hangzhou, Zhejiang Forestry University	3
Heilongjiang	Arctic National Forest Park, Northeast Forestry University, Fujin National Wetland Park	3
Total		41

Table 7-8. List of National Forest Cities

Province	City	City Quantity
Guangdong	Guangzhou	1
Guangxi	Wuzhou, Naning, Liuzhou	3
Guizhou	Guiyang, Zunyi	2
Henan	Xuchang, Xinxiang, Luoyang, Luohe, Sanmenxia	5
Hubei	Wuhan, Yichang	2
Hunan	Changsha, Yiyang	2
Jilin	Huichun	1
Jiangsu	Wuxi, Yangzhou, Xuzhou	3
Jiangxi	Xinyu	1
Liaoning	Shenyang, Dalian, Benxi, Anshan	4
Inner Mongolia	Baotou, Hohhot, Hulun Buir	3
Shandong	Weihai	1
Shaanxi	Baoji	1
Sichuan	Chengdu, Xichang, Luzhou	3
Xinjiang	Aksu, Shihezi	2
Zhejiang	Linan, Hangzhou, Longquan, Ningbo, Quzhou, Lishui	6
Chongqing	Yongchuan District	1
Total		41

Case: Values and Management of the Fengshui Forest—Houlong Mountain of Shangxiang Village, Boyang Town, Tongdao County, Hunan Province

Fengshui forest of Shangxiang Village is located in Boyang Town of Tongdao County, Hunan Province, a well-reserved village with strong Dong culture in Hunan, Guangxi and Guizhou Areas. This forest has an area of 130 mu and is called "Houlong Mountain" by local people. At the beginning of liberation, the village was surrounded by Houlong Mountain, whose area was five times larger than it is now. During the Iron-and-Steel-Making period of 1958, most of the Fengshui forest was seriously damaged, leaving only Shangxiang Village with its natural forests of over 100 mu. Besides, old trees are thriving and steles still have clear writings in Shangxiang, which are quite rare. Houlong Mountain has rich species resources, with about 55 arbor species and 2,200 trees over 100 years old.

Houlong Mountain belongs to the "Fengshui Array" of Shangxiang Village.

Shangxiang Village is like a raft anchoring at the Shangxiang River, and the stony road stretching out of the village is like an anchor fixing on a big pine, with several white rocks pressing on the anchor. This means the village can float on the water safely and steadily without suffering from floods. Houlong Mountains not only acts as a supporting role, but also is specially "designed" to prevent fire of the hillside behind Houlong from burning the village.

In 1808 of the Qing Dynasty, villagers swore to heaven and reached an agreement to forbid logging in Houlong Mountain in order to protect the mountain. Even those picked branches could only be used in public spaces such as bridges, the drum tower and schools. Otherwise people would be punished by the heaven. There are also old sayings about forbidding logging. Therefore, villagers here have had known that it is not allowed to climb trees in Houlong Mountain or else he/she would fall or suffer from a stomach pain.

Though hit by the Cultural Revolution, the forest tenure reform and the invasive alien tree species, Houlong Mountain still has lush vegetations. The forest culture which people and nature coexist harmoniously inHoulong Mountain has become an inseparable part of the social and economic culture system of Shangxiang Village and boosted the sustainable development of forests and sound characteristics of the community.

in China, with a total area of 30.86 million ha.

(3) Forest parks

Forest parks are forest areas where forest landscape is based on and where recreation, entertainment, education, researches and cultural activities can be carried out. China's widely distributed forests are of rich species, historical and cultural resources, which are able to provide a good foundation for the construction of forest parks. China's forest parks can be found in all the 31 provinces, autonomous regions and municipalities except for Hong Kong, Macao and Taiwan, covering the most representative forest resources of China and different types of forest landscapes and numerous historical sites and cultural landscapes. Fifteen landscapes on China's World Natural and Cultural Heritage List have forest parks in them, and fifteen landscapes on China's Geo-park List have forest parks in them. Forest parks are essential in the protection of natural and cultural heritage. Now the cultural publicity and education functions of forest parks all cross China have been strengthened and the forest park have become an important carrier to disseminate ecological culture, and promote ecological civilization construction. For the detailed description of the social values of forest parks, please see 6.4a.

(4) Ecological civilization educational base and national forest cities

The Chinese government has attached great importance to ecological civilization construction. It has quickened its speed to proceed with the basic building of ecological

civilization and set up ecological civilization educational bases supported by nature reserves, forest parks, wetland parks and museums. It also started to build national and provincial forest cities. Since 2008, the state has named 41 forest parks, nature reserves, wetland parks, schools and museums as "National Ecological Civilization Educational Bases" in succession (table 7-7). According to rough estimates, the public receiving education at these bases has reached over 20 million, which greatly publicizes the ecological civilization concept and improve ecological civilization awareness of the public.

Starting from 2004, there are 41 cities being named "National Forest City" (table 7-8). These cities have initially built a sound and stable forest ecological system integrating urban and rural areas and dominated by forest vegetations. They have blazed a successful way to build forest cities that are in line with local economic and social development and meet the ecological demands of the people. Such way has a strong regional representation and demonstration effect.

7.5.2The importance of forest to people

Rational and significance

Forests provide various ecological, economic, social and cultural products for humans. This indicator will measure the evaluation of governments and farmers about forests' ecological, economic, social and cultural values. Their evaluation creates the society's attitude to forests and actions to manage forests and plays an important role in the sustainable forest management and applying their various functions.

This data analysis is based on data collected by the Forestry Center and Resource Policy Center of Renmin University of China about the evaluation on the importance of forests of the Dong farmers in Guizhou, Hunan and Guangxi in 2012. The center got 279 valid data in all.

With the economic development and the improvement of the society and people's living standards, great transformation has taken place in the understanding of forests' various values of governments and famers. Forestry development has turned from single timber production to meeting the demands of the society on forestry products, ecological services and social culture, and paid more attention on communities and their residents relying on forests to survive. By showing evaluations of governments and farmers on forests' various values, this indicator is conducive for the state, local governments and communities to specify the goal of sustainable forest management and force forestry development policies and implementation process hear the voices of the public, especially willingness of farmers.

Source of data

Typical cases survey data

Current situation and trend analysis

(1) Governments' understanding on the importance of forests

From 1949 to 1978, it took the Chinese government a long time to understand forests' ecological, economic, social and cultural values. From the 1950s to the end of 1970s, China's forestry industry was featured with timber development and application, with timber production as its priority. Therefore, the state government set up a large batch of state-owned forestry enterprises in the northeastern, southwestern and northwestern virgin forests to meet the demand of industrialized building. During this period, forest was regarded as pure material means of production, while its ecological, social and cultural benefits were ignored. This created serious forest devastation and ecological environment degradation.

From 1978 to 2000, China's forestry policies started to pay attention to forest cultivation and forests' ecological function has been understood and taken in account gradually. More policies began to strike a balance between forests' economic and ecological benefits. Take the official launch of the "Three North" Shelterbelt System of 1978 as a symbol, China's forestry industry started to transform from single timber production to the combination of timber production and ecological building. During this period, the Chinese government began to launch major forestry ecological programs such

as the "Three North" Shelterbelt System Programand the major rivers shelterbelt system building Programs. The government also developed large-scale forest planting and barren hills elimination movements in collective forest zones. Through large-scale reforestation, China gradually reversed the trend of the decreasing forest resources.

Since 2000, the entire country started to reflect on and adjust the relationship between forestry ecological improvement and economic development especially since floods of the Yangtze River, Songhua River and Nen River which brought devastating damages to economy and society in 1998. In 2003, the Central Committee of CPC and the State Council issued the *Decision on Speeding Up Forestry Development*, which put forward that "ecological demand has become the prior demand of the society on forestry industry". This signified that China's forestry policies had achieved historical transformation from attaching importance to timber production to giving the first priority to ecological building. From the late 1990s to the beginning of the 21st century, the central government had integrated the previous forestry ecological programs systematically and launched The Six Key National Forest Programs which include NFPP, CCFP, et.al. These six major forestry progroams cost several hundred billion RMB, and covered 97% of counties across the country, showing the holistic spreading of forestry ecological improvement strategy.

China's forestry industry put priority to both improving ecology and people's livelihood. In 2008, the Chinese Government comprehensively launched a new round of collective forest tenure reform. Through clarifying property rights, household contracts, flexible management rights, practical deposition rights and safeguarding rights to use, over 87 million households of farmers obtained the right to use 2.6 billion mu forestland and forest ownership which worth several trillion RMB. The newround of collective forest tenure reform actively developed under-forest economy, forest tourism, forest tenure mortgage loans and tenure transfer and tried hard to combine forest resource protection with farmers' livelihood improvement so as to realize a win-win of the two.

The Chinese government fully realized the unique role of forests in climate change and has treated forestry as an important part in the international cooperation and domestic action to address climate change. In June 2007, the *China's National Plan to Address Climate Change* was issued and implemented, which included forestry into the important fields of mitigating and adapting climate change. In 2009, the Central Forestry Conference had for the first time stated that "forestry has a special status in addressing climate change" and emphasized that "forestry must be regarded as a strategic choice to address climate change". In September 2009, Hu Jintao, President of China, announced at the UN Climate Change Summit that by 2020, China would increase forests area by 40 million ha and forest stock volume by 1.3 billion m^3 on the 2005 basis. This promise was officially ratified by China's legislation and was included into the *Copenhagen Accord* after the 2009 Copenhagen Climate Change Conference in Denmark in 2009 as an autonomous action of China to mitigate climate change. To achieve the above-mentioned goals, China's State Forestry Administration issued the *Action Plan to Address Climate Change*, which specified a series of concrete actions to fight climate change.

Since 2003, the Chinese government has lifted the status and role of forestry to a unprecedented height by making historical adjustment in forestry development strategy, which is putting forestry in an important status in implementing the sustainable development strategy, putting forestry in a prior status in ecological improvement, putting forestry in a fundamental status in Western Development and putting forestry in a special status in addressing climate change. The five functions of forestry, namely ecological, economic, social, carbon sink and cultural functions, have become the policy goal of China's sustainable forest development.

(2) Farmers' understanding on the importance of forests

In China's rural areas, especially villages in mountain areas, forests provide various products and services, including: first, firewood, wild edible plants, herbal medicines, building materials and other products for self-use; second, economic benefits by selling forest products; third, providing social security such as risk prevention, old-age pension and migrant workers protection; five, spiritual and cultural value of maintaining community *fengshui* and religious faith.

The importance of forests' various values to farmers is ranked as follows: economic income, household self-

used forest products, social security and ecological protection (Figure 7-34). 49.82% of interviewed farmers put providing income as the No.1 function, 40.86% farmers thought that forests' function is mainly providing firewood, herbal materials and building materials.
The reducing degree of relying on forests in farmers' everyday lives is closely linked to the increasing income and increasing prices of forest products. If we add up the ratio of providing incomes and products for self-use, we can know that as many as 91.86% of farmers think the economic function is the most important function of their forests. On the contrary, only a small part of interviewed farmers, namely 7.17% and 2.15% respectively, believe social security and ecological protection are the major functions of their forests.

Before modern medical treatment entered the Dong society, traditional forest herbal materials were the major prescriptions for them to treat diseases. Currently, over a half (56.27%) of interviewed farmers don't know nor distinguish traditional herbal materials (Figure 7-35), while only 43.73% of interviewed farmers know and can distinguish these traditional herbal materials. This 43.73% group is dominated by old people. Middle-aged men or young men seldom know or distinguish herbal materials. This tradition is facing the risk of extinction.

For a long time, She Forests, Chan Forests, *Fengshui* Forests, Holy Mountain and Holy Trees are regarded as living places for ancestors or supernatural beings, maintaining community *fengshui*and religious faith. Figure 7-36 shows that 70.97% of farmers know the existence of Holy Mountains, Holy Trees, *Fengshui* Forests and Landscape Forests, while 29.03% of farmers

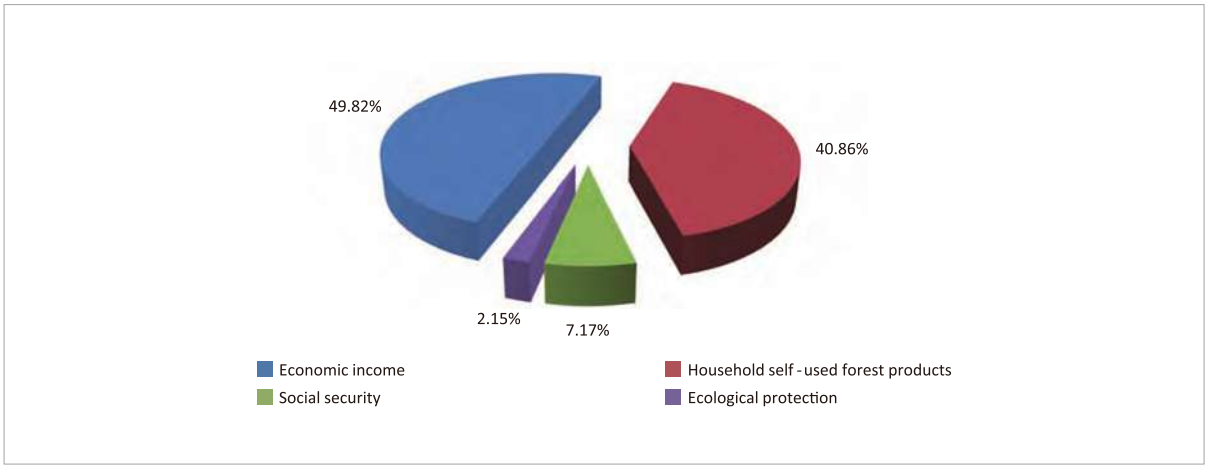


Figure 7-34. Farmers' evaluation on forests' values

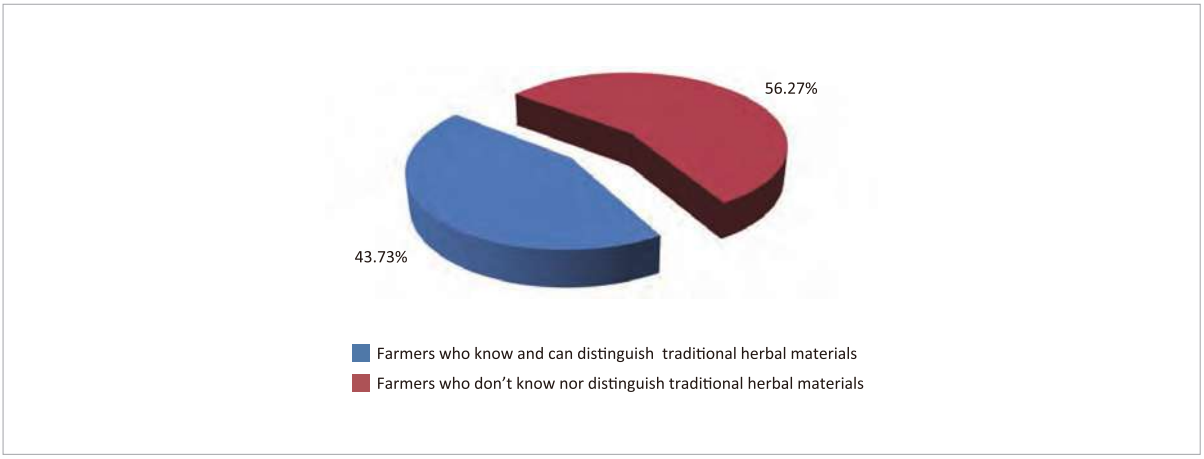


Figure 7-35. Farmers' understanding on forests' traditional herbal materials

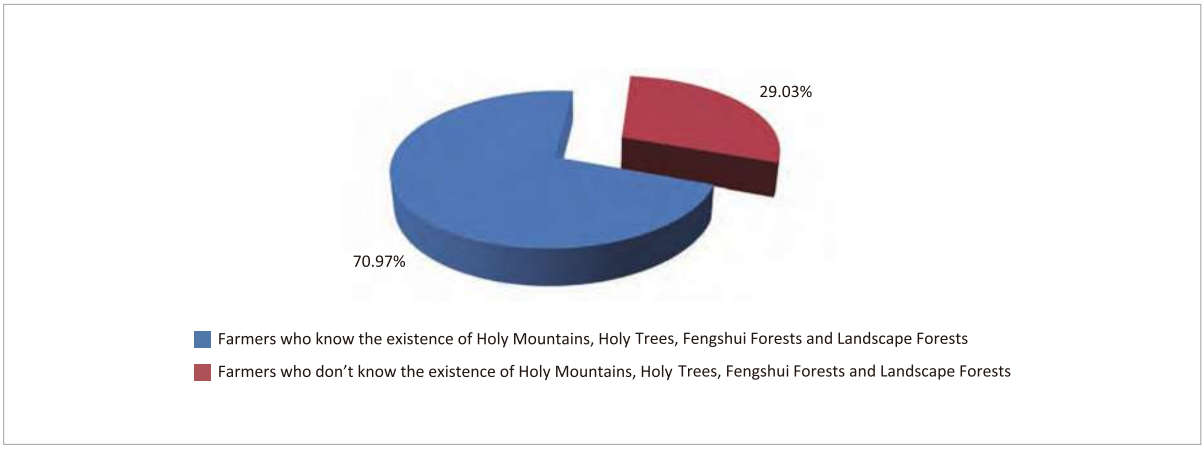


Figure 7-36. Farmers' Understanding on Forest Cultural Value

have no idea about these, dominated by young men. Economic development has greatly reduced forests with spiritual and cultural values in rural areas. It is extremely urgent to protect forest traditional culture.

As China's marketization and industrialization accelerate, forests economic values are becoming prominent to farmers. However, forests' spiritual and cultural values are decreasing day by day. Different from governments who put priority to forests' ecological values, farmers pay more attention to economic values, which inevitably brings conflicts on forest management between governments and farmers. How to combine improving ecology and people's livelihood still remains a long-term and arduous task of the sustainable development of China's forestry.

National Report
on Sustainable Forest Management

8

Legal, Institutional and Economic Framework for

Forest Conservation and Sustainable Management

8.1 Laws and policies supporting sustainable forest management

This chapter elaborates on economics, laws, mechanisms and policies related to sustainable forest management. It is closely related to Chapter Two to Chapter Seven. The combination of legislation, institutional capacity, economic arrangement, policies and measures provides sound policy and institutional environment for sustainable forest management. Report on these issues helps raise the general public and policy-makers' awareness about forest issues and support the fast development of sustainable forest management.

8.1.1 Legislation and policies supporting the sustainablemanagementof forests

Rational and significance

This indicator addresses laws and policies related to sustainable forest management. Through legislation and planning, these laws and policies manage and guide forest management and utilization. Laws, policies and plans aiming at protecting and improving forest functions and values are the preconditions of achieving sustainable forest management.

Source of data

National Forestry Authority

Current situation and trend analysis

(1) Laws and legislation that support sustainable forest management

The Law of Land Administration of the People's Republic of China and *Forest Law of the People's Republic of China* make related stipulations about the protection, exploitation and rational utilization of forestland. *Forest Law of the People's Republic of China* and *Regulations for the Implementation of Forest Law of the People's Republic of China* make more detailed stipulations about protection, cultivation and rational utilization of forest resources. Laws and regulations including *Seed Law of the People's Republic of China, Regulations of the People's Republic of China on Nature Reserves, Regulations of the People's Republic of China on Wild Plants Protection, Regulations on Scenic Area and Regulation on Forest Fire Prevention* also make specific stipulations about seedling management, protection of forestland and forests, forest logging and regeneration, public benefit forests protection, wild animals and plants protection, plant quarantine, forest disease and pest prevention and control and forest fire prevention. These stipulations provide strong institutional guarantee for the sustainable management of forest resources (Table 8-1).

(2) Forestry policies that support sustainable forest management

In addition to laws and regulations set up by forestry and other related departments, the Chinese government formulated a series of important principles and policies in relation to afforestation, forest resources management, public finance and financial support and forest ownership reform. These important principles andpolicies facilitate sustainable forest management in China.

① **Afforestation Policies** In 1981, advocated by Mr. Deng Xiaoping, the Fourth Session of the Eleventh National People's Congress adopted *the Resolution on the Voluntary Tree-Planting Campaign among the*

Table 8-1. Major national laws, regulations and rules that support sustainable forest management

Category	Major laws and regulations	Implementation Date (year)
General laws and regulations	*Forest Law of the People's Republic of China*	1985
	Regulations for the Implementation of Forest Law of the People's Republic of China	2000
Seedling Management	*Seed Law of the People's Republic of China*	2000
	Measures for Managing Forest Wood Seedling Quality	2007
	Measures for Managing Forest Wood Germplasm Resources	2007
	Specifications of Implementing Regulations for Protecting New Plant Species of the People's Republic of China (For Forestry)	1999
	Specifications of Implementing Regulations for Plant Quarantine	1994
	Catalogue of Major Forests Woods in the People's Republic of China (First and Second Batch)	2001
	Measures for Managing the Promotion of Fine Tree Species	1997
Forest Wood and Forestland Protection	*Measures of Handling Disputes of Forest Wood and Forestland Ownership*	1996
	Measures for the Administration of Forest Wood and Forestland Ownership Registration	2000
	Measures for the Administration of Examination and Approval of Forestland Occupation and Requisition	2001
Forest felling regeneration	*Measures for Managing Forest Felling Regeneration*	1987
Non-commercial Forests Protection	*Measures for Managing Central Government's Compensation Fund for Ecological Benefits (regulatory documents)*	2004
Biodiversity	*Law of the People's Republic of China on the Protection of Wild Animals*	1989
	Regulations of the People's Republic of China on the Protection of Wild Animals	1997
	List of National Key Protected Wildlife (First Batch)	1999
	Regulations of the People's Republic of China on Nature Reserves	1994
Plant quarantine	*Law of the People's Republic of China on Entry and Exit Animal and Plant Quarantine*	1992
Forest disease and pest prevention	*Rules of Forest Disease and Pest Prevention*	1989
Forest fire prevention	*Rules of Forest Fire Prevention*	1988

People which established the voluntary afforestation campaign with public participation and social support. Since the reform and opening up, key forestprograms including Three-North Shelterbelt program, the NFPr P, the CCFP and key shelterbelt programs concerning the Yangtze River, Yellow River, Huai River and Tai Lake. In addition, some key ecologically fragile and ecologically important areas has been protected, forestry ecological improvement strategy gradually established. In 2004, Chinese government officially set up the compensation fund for forest ecological benefits. After the unveiling of *The Opinions of the Central Committee of the Communist Party of China and the State Council on Boosting the Reform of Collective Forest Tenure System in an All-round Way* , the Chinese government formulated a series of fiscal, financial and insurance policies to support collective forest tenurereform and sustainable forest management. In 2011, in order to meet the demands posed by social and economic development to afforestation, to implement central government's policy arrangements for accelerating forestry development and to honor the national commitment on climate change, the Chinese government formulated *the Outline of National Afforestation Plan (2011-2020)*. The Outline made arrangements about the goals, tasks and ways to meet the goals and policy guarantee for China's afforestation for the next 10 years.

② **Forest resources management policies and mechanisms** During long-time practices and explorations, forest resources managementsystems have been establishedin China's, including forestland and forest ownership management system, forest resources monitoring system, forest resources utilization management system and forest resources supervision and inspection system.

Forestland Management In 1998, *Circular of the State Council on Protecting Forest Resources, Stopping Deforestation for Agricultural Purposes and*

Illegal Occupation of Forestland demanded that local governments at all levels should attach equal importance to forestland and farmland and pay great attention to forest protection. Since 2000, the State Forestry Administration has implemented rules and regulatory documents including *Measures for the Administration of Examination and Approval of Forestland Occupation, Expropriation and Requisition* and *Rules for the Administration of Examination and Approval of Forestland Occupation and Requisition.* These rules and regulatory documents have improved administrative system of examination and approval of forestland occupation and requisition. In July 2010, *National Plan for the Use and Protection of Forestland (2010-2020)* was issued. To deal with the pressure of rigid demand brought by urbanization and industrialization, the Plan established a system to protecting and utilizing forestland at national, provincial and county levels, construct a forest land dynamic management system which was "regulated according to plans and maps", and a quota system for forestland occupation and expropriation. The Plan also set up a new forestland utilization mechanism that "controls total use, manages use quota, saves more land, offers land rationally and balances occupation and compensation".

Forestland tenure management In 1981, the central committee of CPC and the State Council issued *Decision on some Issues about Forest Protection and Forest Development*. The Decision required that collective forest areas should "stabilize mountain and forest rights, mark off privately-farmed mountains and carry out forestry production responsibility system" and ownership and managing rights of collective forestland should be separated. A relatively complete regulations and policies about administration of forest ownership

Case: Digital National Forestland Map Building

National forestland map is a collection of multi-source data set based on high-resolution remote sensing image, forest resources researching data and basic geographic information, and its core content is forestland boundary. It is the basic work of forestland protection management launched in October 2010, with the aim of implementing *Guidelines of National Forestland Protection and Utilization Plan* and building national forestland protection and utilization plan systems at national, provincial and county levels. The map took more than 50,000 people for two years with input of nearly 1 billion yuan and was completed in 2012.

This map helps establish a roving forestry geographic space digital platform covering the whole country based on high-resolution remote sensing image and three-dimensional geographic space data. On the basis of unified technical standards and time node, the map can locate even a hill on the 4.56 billion mu of forestland in China forming a map with accurately-defined forestland location and boundary and a seamless map that reflects national forestland scope and forest resources distribution. The map offers information used by national and local governments on land type, ownership, category, origin and engineering category.

With the help of the map, we can know the forestland resources distribution, examine forestland information. And it plays an important role in achieving using maps to manage land, strengthening forestry supervision, formulating ecological space planning, promoting innovative supervision system and supervising the protection of public benefit forests at the national level. It brings transformation to forestry management approaches and enhances macro decision-making and managing capacity.

has been set up. Since China issued its first *Forest Law* in 1985, especially after issuing the *Forest Law of the People's Republic of China (1998 Amendment)* and the *Regulations for the Implementation of the Forest Law*, a legal system dealing with forestland tenure, registration and certificates issuance and forestland tenure dispute mediation has been set up. The content and extent of forestland tenure management and forestry authorities' management functions of forestland tenure registration, certificates issuance and registration archives have been identified. Sector rules including *Measures on Mediation of Forest, Tree and Woodland Right Disputes* and *Measures on the Administration of Forest*, and *Tree and Woodland Right Registration have been formulated*. Policy documents regulating forestland tenure administration of key state owned forestland, administration of contracted managerial right change for collective forestland and administration of forestland right of foreign investors using Chinese forestland have been established. The establishment of a complete forestland tenure administration law system provides forestry authorities with laws to abide by, when dealing with administration of forestland tenure. These laws, regulations and rules provide legal basis and important references for government and court at all levels to determine forestland tenure and to hear related administrative cases.

Supervision of forest resources utilization China adopts forest logging quota management system. To solve the conflicts between forest resources shortage and the increasing demand brought by economic development and to promote sustainable forest management, since the 1980s, China started to adopt forest logging quota management system based on the principle that forest resources consumption should be less than its growth. Forest logging quota is the maximum limit for forest consumption and forest wood stock. Adopting the quota management is an important legal system decided by the *Forest Law*, a core measure to control excessive forest resources consumption and a key method to enhance sustainable forest management. To adapt to new situations and new demand brought by collective forest tenure reform, promote sustainable forest management and protect the legitimate rights of forest producers, China has made a series of reforms and innovation in forest logging management system since 2003. *Work Plan for Forest Felling Management Pilot Reform* was issued to carry out systematic reform on forest wood logging management. The

legislations include *Notice on Adjusting Commercial Forests Felling Management Policies, Opinions on Strengthening Natural Forest Management, Opinions on Improving Commercial Forest Felling Management, Notice on Improving Farmland Shelter-belt Felling and Regeneration Management* and *Notice on Improving Industrial Forests Felling Management were issued*. A series of measures of logging management reform were issued as well. In 2007, Fujian Province was approved to be the pilot place for forest logging management system reform. After CPC Central Committee and the State Council had issued *Opinions on Boosting the Reform of Collective Forest Right System in an All-round way*, the State Forestry Administration issued *Notice on Launching the Pilot Reform of Forest Felling Management* based on the pilot reform in Fujian Province. Since 2009, pilot reform has been carried out in 193 counties (forest farms) of 24 provinces, autonomous regions and cities in 2 years. *Opinions of the State Forestry Administration on Reforming and Improving Collective Forest Felling Management* was formulated. It has reformed and made innovation in principles and scope of logging quota management, simplifying logging management links and logging examination and approval procedures, initiating online certificates handling on a trial basis, promoting a logging public notification system, adopting single indicator controlling in logging areas, transferring the use of unused logging quota and keeping record of timber production and planning. It has made clear that forest wood from non-forestry land is not included in the quota management and it is independently managed and logged by the forest managers. An open, transparent and simple logging management mechanism has been gradually set up. The mechanism has promoted functional changes of

Special column: National framework for adjusting timber forests policies

Since the 1990s, China has been better aware of forests' ecological benefits, and since the late 1990s, China has classified and defined forest zones for 4 times. The first was in NFPPPhase I in which original forest zones was classifed and defined. According to *Notice of State Forestry Administration on Launching Classification of National Forest Zone* and *Notice of State Forestry Administration on Issuing Technical Instruction on Classification of Forest Zone of Natural Forest Preservation Zone in Key Areas*, forest resources in NFPP I have been categorized into key ecological preservation area (prohibited logging area), ecological preservation area (limited logging zone) and commercial forest management area. The second was in 2001, according to *Measures for the Determination of National Non-commercial Forests (for trial implementation)*, national public benefit forests have been defined. The third was in 2004, according to *Notice of State Forestry Administration and Ministry of Finance on Issuing Measures for the Determination of Key Non-commercial Forests*, key public benefit forests were classified and defined again. The fourth was in 2009, according to *Notice of State Forestry Administration and Ministry of Finance on Issuing Measures for the Determination of Non-commercial Forests at the National Level*, public benefit forests at the national level were classified and defined.

forestry authorities, innovated managing approaches and protected legitimate rights of forest managers. In 2010, *Notice on Deepening Forest Felling Management Pilot Reform* was issued, which arranged the deepening of the pilot reform and summarizing reform achievements. Since 2011,China has adopted policies of commercial forests logging quota transfer management.

After years of practice and reform, forest logging quota system has achieved the following results: turning mainly logging natural forests into plantation forests, changing unified management mode into different policies for different regions, turning solely controlled forest consumption into focusing equally on eco-protection and forestry development, and turning low-value consumption to high-value utilization. During the 7th, 8th, 9th, 10th and 11th five-year plan period, yearly forest logging quota accounted for 45.7%, 73.3%, 63.6%, 48.8% and 49.9% of yearly forest growth respectively. Logging quota is far less than growth. It has played an irreplaceable role in controlling excessive consumption of forest resources, promoting the double digit growth for 20 consecutive years, safeguarding national territorial and ecological security and promoting social and economic sustainable development.

Forest Resources Supervision Forest resources supervision is an important element of China's forest resources protection and management. Establishing special supervisory agencies is a major measure to strengthen forest resources protection and management. Since 1998, supervisory agencies were set up in key forest areas. In November 2003, China established Forest Resources Supervision and Management Office in State Forestry Administration. In 2011, those agencies were integrated and a full coverage of supervision was realized. except Hong Kong, Macao and Taiwan The agencies focus equally on supervision and services, strengthen communication and coordination and promote administration according to law. They play an important role in fully supervising the protection and management, safeguarding the enforcement of related laws and regulations, controlling illegal loss of forestland and excessive consumption of forest resources and standardizing related actions.

8.1.2 Cross-sectoral policies and programme coordination

Rational and significance

This indicator provides information on cross-sectoral sustainable forest management policies and coordinated planning. Non-forestry departments' land-use and development policies can greatly influence forestry.

Through reducing negative impacts on forests, cross-sectoral coordination in related forestry and non-forestry policies and plans improves sustainable forest management and increases our capacity to respond to national and global issues.

Sourceof data

National Forestry Authority

Current situation and trend analysis

Forestry is an industry related to agricultural, water conservation and environmental departments. Forestry policies, therefore, need cross-sectoral coordination. According to *Law of the People's Republic of China on Legislation*, departments of the State Council should perform their own functions and coordinate with each other. Currently, There arevarious forms of government departments' cooperation. In terms of cross-sectoral cooperation on sustainable forest management, there are three forms:

(1) Establishment of national forestry cross-sectoral coordination mechanism

For example, the National Afforestation Commission and Forest Fire Management Office formed by related departments of the State Council in State Forestry Administration to coordinate national afforestation and forest fire prevention.

(2) Forestry legislation

According to demands of *Law of the People's Republic of China on Legislation*, during legislation process of departments of the State Council, the State Forestry Administration's opinions on issues related to forestry responsibilities should be highlight. In terms of forestry laws, administrative regulations drafted by forestry authorities that are related to functions of other departments of the State Council or are close to other departments of the State Council, the draft of departments should consult related departments, including agricultural, water conservation, environmental and land administrative departments.

(3) Important national forestry policies

The coordination mechanisms between related departments of the State Council and local governments to coordinate major issues also set up. For example, the establishment of Provincial and Ministerial Joint Conference Mechanism on Consolidating Results of CCFP and the establishment of Provincial and Ministerial Joint Conference Mechanism on Combating Desertification Program around Beijing and Tianjin were approved by the State Council. Departments involved in the mechanisms include National Development and Reform Commission, Ministry of Finance and related provincial governments. These mechanisms coordinate related departments to promote conversion of farmland to forests and control of desertification.

8.2 Economic policies that support sustainable forest management

8.2.1Taxation and other economic strategies that affect the sustainable managementof forests

Rational and significance

This indicator provides information on the economic environment that affects sustainable forest management. Economic measures affect forest management, and governments' policies and strategies related to

investment, taxation and trade affect long-term forestry investment. Fiscal and financial policies are important tools for the macro-control of forest management. The Chinese government attaches great importance to the use of these policies to promote sustainable forest management. Fiscal policies of forestry in China consist of taxation policies and government subsidy policies related to forests. Our financial policies consist of loan discounts and insurance subsidies. These are important non-market mechanisms that support sustainable forest management and important supplements of market mechanisms, such as forest authentication.

Source of data

Measures on Administration of Central Government Discount on Forestry Loan

China Forestry Development Report (2012)

Current situation and trend analysis

Since the reform and opening up, public finance system in China has been improved constantly. A public finance system for forestry has been gradually established with tools like forestry taxation, subsidy and special fiscal fund; and the system aims at providing public forest products. This system became an economic tool for sustainable forest management.

(1) Forestry taxation policies

Since 1983, forest tax forms and tax rates have been reduced and preferential policies have been put out. Currently, all forms of forest tax have been eliminated. The government has put out a series of preferential tax policies, including reducing income tax, export tax rebate on forest products, VAT favorable policy of the comprehensively-used product produced and processed with the "three residues" and "small firewood materials" as raw materials, exemption of VAT on imports of seeds (seedlings) and non-profit wildlife sources and tax incentives given to enterprises and other institutes implementing the Natural Forest Protection Program.

(2) Compensation policies for forest ecological benefits

In November 2001, the Chinese government decided to carry out pilot projects of compensation for forest ecological benefits in 11 provinces. The fund was officially established in 2005. Since 2006, the central government has increased its financial input, area receiving compensation and compensation fund scale. The area has increased from 13.33 million hain 2001 to 83.95 million ha in 2011, an increase of 529.64%. Compensation fund has increased from 1 billion yuan in 2001 to 9.68 billion yuan in 2011, an increase of 867.93%. By the end of 2011, the central government has put a total of 39.34 billion yuan into the compensation fund for forest ecological benefits.

(3) Forest insurance policies

To support collective forest tenure reform, in 2009, the Chinese government launched a pilot project of forest insurance premium subsidization in Fujian Province, Jiangxi Province and Hunan Province. By the end of 2011, 9 provinces had been included into the pilot project, including Liaoning, Zhejiang, Jiangxi, Fujian, Hunan, Yunnan, Guangdong, Guangxi and Sichuan. Area covered in the forest insurance reached 49 million ha and the premium subsidy given by the central government 502 million yuan.

(4) Discount loan policies

The Chinese government constantly strengthens policy support for financial services aimed at developing forestry, putting out various forms of discount loan policies for forestry. In 2002, the Ministry of Finance formulated *Administrative Measures of the Fund for Loan Interest Subsidy for Desertification Prevention in Forestry*, making clear that from 2003 loan interest would be given to fast-growing and high-yielding forests program, programs of forests for non-wood products, programs of forests for controlling sandstorms and comprehensive forests utilization projects. In 2005, the Ministry of Finance and the State Forestry Administration jointly issued *Administrative Regulations of the Central Government's Interest Subsidy on Forestry Loans*. The Regulations changed the fact that the Central government only gave interest subsidy to loans given by the Agricultural Bank of China. The Measures removed the limitations that non-public enterprises cannot get loan interest subsidy. The Measures also stipulate that loan interest subsidy given to loans made by various banks including rural credit cooperatives, loans made to leading non-public enterprises in forestry and follow-up industrial projects of key ecological natural forests

protection projects and the conversion of farmland into forestland projects. In 2009, the Ministry of Finance and the State Forestry Administration jointly revised and issued *Administrative Measures of the Central Government's Interest Subsidy on Forestry Loans*. The Measures provided that except loan interests given to banks and rural credit cooperatives, forestry loans given by non-bank financial institutions, i.e. small loan companies were included for the first time into the ones that can get interest loan. Period of interest loan for small afforestation loans was extended to 5 years. Discount interest was raised from 2% to 3%. In addition, loan interests were granted to more kinds of loans including crop farming loans of woody oil forests planted by economic entities, of desert areas and eco-tourism projects of nature reserves and forest parks.

(5) Other subsidy policies

From 2009, the Central Government has carried out pilot project of forest tending subsidy, afforestation subsidy and fine tree species subsidy. In 2011, forest tending subsidy was extended to 34 provinces and forest industry groups, covering 46.04 million mu with subsidies of 5.13 billion yuan. 500 million fine tree species were subsidized. Oil-bearing tree species like oil-tea camellia and olives got 0.5 yuan of subsidy per strain and other species got 0.2 yuan per strain. Afforestation subsidy was extended to 29 provinces (autonomous regions and municipalities) except Shanghai and Beijing and two cities especially designated in the state plan—Ningbo and Qingdao. Subsidy for woody oil forests was raised from 160 yuan to 200 yuan with the central Government granting 544 million yuan.

8.3 Policies that support sustainable forest management

8.3.1 Clartiy and security of land and resource tenure and property rights

Rational and significance

This indicator provides information on land, right to use forest resources and legal rights. Clear ownership identifies owner of rights and obligations related to the land and its resources; and proper procedures ensure that the rights are protected or questioned. Lack of clear ownership or appropriate procedures hinders stakeholders from participating in sustainable forest management or threatens legal or sustainable forests utilization. According to *Regulations for the Implementation of Forest Law of the People's Republic of China*, forest resources include forest, forest wood and forestland, as well as wild animals, plants and microorganisms whose survival depend on forest, forest wood and forestland. Forest resources include forestland and all the forest organisms that grow on it. Forest resources ownership is categorized into state-owned and collectively- owned.

Sourcesof data

National Forestry Authority

7th National forest inventory

Current situation and trend analysis

Since the founding of the PRC, forest resources ownership in China has changed for 4 times:

(1) First stage (1949-1956), China established state ownership and farmer's individual ownership of forest resources.

In 1950, according to related provisions of *Land Reform Law of the People's Republic of China*, related local departments formulated related measures. State ownership and individual farmer's ownership of forest resources (forestland and forest wood included) were established nationwide.

(2) Second stage (1957-1976), former individual farmer-owned forestland was turned into collectively-owned forestland. Individual ownership of forestland was abandoned.

In 1958, after "Great Leap-forward" was carried out and people's communes adopted, forestland and forest wood ownership underwent great changes. The changes could be summed up as "state-owned parts remain unchanged, collective ownership start to appear, and farmer-owned parts are greatly reduced". It meant that state-owned forestland and forest wood ownership remained unchanged, farmer-owned forestland was turned into collectively-owned forestland, forestland resources were collectively-owned, forest wood and other forest resources on collectively-owned forestland started to be collectively-owned or farmer-owned.

(3) Third stage (1977-2008), mountain and forestland rights of collective forest resources were stabilized, and forestry production responsibility system was decided and productive forces liberated.

Forest Law of the People's Republic of China issued in 1984 and Forest Law of the People's Republic of China amended in 1998 both provide that forest resources of the PRC belong to the country except the resources decided by law that belong to collective groups. For collectively-owned forest resources, in March 1981 the CPC Central Committee and the State Council issued *Decision on some Issues about Forest Protection and Forest Development*. The Decision started to carry out the "stabilize mountain and forest rights, mark off privately-farmed mountains and decide forestry

Table 8-2. Major national laws, regulations and rules related to forest resources ownership in China

Law			
Name of the Laws	II Issuing Departments	Implementation Time (year)	Area
Forest Law of the People's Republic of China	National People's Congress	1985	Nationwide
Law of the People's Republic of China on the Protection of Wild Animals	National People's Congress	1989	Nationwide
Rural Land Contracting Law of the People's Republic of China	National People's Congress	2003	Nationwide
Land Administration Law of the People's Republic of China	National People's Congress	1999	Nationwide
Administrative Regulations			
Name of the Regulations	Issuing Departments	Implementation Time (year)	Area
Regulations for the Implementations of Forest Law of the People's Republic of China	State Council	2000	Nationwide
Measures for Managing Forest Felling and Regeneration	State Council	1987	Nationwide
Departmental Rules			
Name	Issuing Departments	Implementation Time (year)	Area
Measures of Handling Disputes of Forest Wood and Forestland Ownership	Ministry of Forestry	1996	Nationwide
Measures for the Administration of Forest Wood and Forestland Ownership Registration	State Forestry Administration	2000	Nationwide
Measures for the Administration of Examination and Approval of Forestland Occupation and Requisition	State Forestry Administration	2001	Nationwide

production responsibility system". It also stipulates that forestland is collectively-owned and many forms of forestry production responsibility systems are promoted in forest resources management.

(4) Fourth stage (2008-now), the ownership of collectively-owned forest resources is furthered identified and productive forces enhanced.

On June 8th 2008, the Chinese government promulgated *Opinions on Boosting the Reform of Collective Forest Right System in an All-round Way*. The Opinions spell out the content of collective forest right system reform, including clarifying property rights, settling boundary and issuing certificates, easing control on management right, implementing disposable right, safeguarding income right and fulfilling due responsibilities. The reform has been carried out intensively and extensively in the country. While remaining the ownership of collectively-owned forestland, the reform, through household contracting, lawfully gives contracted management right and forest wood ownership to farmers belonging to collective economic organizations. It identifies farmers as contracted managers of forest wood. Contract period of forest wood is 70 years. Upon expiration, contracts can be renewed on the basis of related national rules. By the end of 2011, China has 178 million ha of collectively-owned forestland with clear ownership, accounting for 97.8% of all the collectively-owned forestland. China has forestland with certificates of 158 million ha, accounting for 88.5% of forestland with clear ownership. 100 million forest right certificates were granted. 87.84 million farm households received the certificates.

Major laws and regulations related to forest resources ownership in China are shown above (Table 8-2). Currently, except Hong Kong, Macao and Taiwan, Chinese mainland has forestland of 181.38 million ha. Categorized by land ownership, 72.47 million ha are state-owned, which is 39.95% of the total. 108.91 million ha are collectively-owned, 60.05% of the total. Categorized by forest wood ownership, 71.43 million ha are state-managed, 51.77 million ha collectively-managed and 58.18 million ha individually-managed, which account for 39.38%, 28.54% and 32.08% respectively.

8.3.2 Enforcement of laws related to forests

Rational and significance

Illegal and criminal activities including illegal logging and illegal occupation and expropriation of forestland severely affect forest security and its sustainable management. Administrative law enforcement in forestry is what national administrative organs and related judicial departments do to lawfully exercise administrative authority, fulfill responsibilities, implement forest laws and crack down on illegal and criminal activities, with the aim of maintaining forest management orders, and protecting forests, wild animals and plants. Administrative law enforcement in forestry covers many areas, including forest logging, forestland right, timber transportation and selling, wild animals and plants protection, fire prevention, pest control, seedling and plant quarantine. Administrative law enforcement in forestry is wide-ranging and highly professional and is an important part of national administrative law enforcement system. Summarizing and analyzing law enforcement in forestry plays an irreplaceable role in strengthening administrative law enforcement, cracking down on illegal and criminal activities, encouraging the whole society for afforestation, promoting the scientific management and rational utilization of forest resources and safeguarding the orderly operation of forest economy.

Source of data

National Forestry Authority

Current situation and trend analysis

(1) Establishment of administrative law enforcement system in forestry

① **Departmental Rules** The Forestry Authority of the State Council formulated and issued more than 80 departmental rules including *Measures for the Administration of Forest Parks, Measures on Mediation of Forest, Tree and Woodland Right Disputes, Measures for the Administration of Examination and Approval of Forestland Occupation and Requisition, Measures for*

the Management of Profit-making Transformation of Desertification Land, Measures for the Management of Forest Seed Quality and *Measures for the Supervision over and Administration of Forest Resources*, strengthening the institutional building of administrative licensing, administrative reconsideration and administrative litigation response system. Local people's congress and local governments at all levels formulated more than 400 forestry-related local regulations and local government rules, which are complementary to related administrative regulations and regulatory documents. These documents made laws and regulations in forestry more detailed and operational.

② **Law enforcement institutions in forestry** A relatively comprehensive administrative law enforcement system has been formed, covering forestry authorities at all levels and law enforcement departments including policy administration departments, public security departments, plant quarantine institutions, timber checkpoints, forestry stations, seedling stations with more than 200,000 law enforcement personnel.

③ **Forestry authorities of the State Council** The Ministry of Forestry and Land Reclamation was founded in 1949. In 1951, it was turned into the Ministry of Forestry, responsible for forest management and forest industry. After the State Council carried out institutional reforms for four times in 1998, the Ministry of Forestry was turned into State Forestry Administration, which is directly under the administration of the State Council. It is responsible for supervising and managing national forestry and ecological construction; promoting forestry reform; protecting and developing forest resources; supervising and managing forest nature reserves; organizing, coordinating, guiding and supervising afforestation, wetland protection, desertification control, terrestrial and wild animals and plants protection and fire prevention; supervising and examining different industries' development and utilization of forest, wetland, desert and terrestrial and wild animal and plant resources; participating in forest-related and ecology-related policy-making; organizing and guiding forestry-related work in science, education and foreign affairs, and guiding the building of national forestry team. State Forestry Administration consists of 11 divisions, including Department of Policies, Laws and Regulations, Department of Afforestation and Greening Management, Department of Wildlife Conservation and Nature Reserve Management and Forest Police Bureau. It also has related divisions including General Station for State-owned Forest Farms and Seedlings, General Forestry Management Station and Forest Resources Supervision and Management Office which are responsible for administrative management and law enforcement supervision of their own domain.

④ **Forest armed police force**

The forest armed police force was founded in the 1950s. Its predecessor was People's Police for Protecting Forests in China in Heilongjiang and Jilin provinces. In 1978, Unit of Forest Armed Police Force was officially founded. Its military service was compulsory. In 1988, it was integrated into Chinese People's Armed Police Force and given the current name; and adoped active duty system. In 1999, Forest Armed Police Force Headquarters was founded. It is under the dual leadership of General Headquarters of People's Armed Police and national forestry authorities. By the end of 2012, Forest Armed Police Force has stationed in 13 provinces. It is in charge of protecting mountains and forests, fire prevention and ecological protection. It works with local forestry police to carry out special efforts to protect national forests security.

⑤ **Forest public security**

In 1979, forest public security institutions were set up in key forest areas. In 1984, the former Ministry of Forestry set up forest police bureau (Office Of Forest Fire Prevention), which was a functional department of the Ministry of Forestry and an operational department of the Ministry of Public Security (the 16th bureau of Ministry of Public Security). Forest public security institutions were also set up at local levels. Now, 30 provinces (autonomous regions, municipalities) except Shanghai and key state-owned forest areas have forest public security institutions, which are at national, provincial, city or county levels. They have functions of criminal law enforcement and administrative law enforcement, implementing related forest laws and regulations, protecting forest and wildlife resources, safeguarding social, political and public orders of forest areas and protecting regional ecological security.

⑥ **Supervisory institutions for forest resources**

In 1989, to strengthen forest resources management of key state-owned forest areas, China started to build

supervisory institutions in those areas. Forest resources supervisory system has been improved according to the changing situation and tasks. Now, there are 16 supervisory institutions directly under the administration of the State Forestry Administration, covering all the areas except Hong Kong, Macao and Taiwan. Some provincial forestry authorities have established supervisory institutions in key forest areas in districts and counties.

⑦ **Establishing forestry institutions**

Provincial people's governments establish provincial forestry departments (bureaus) and establish forestry bureau in cities (autonomous prefectures, counties, districts, or autonomous counties). About 80% of towns have forestry work stations and law enforcement departments and divisions for law enforcement in forestry and law enforcement supervision.

(2) Legal-awareness education in forestry

Legal-awareness education popularizes general legal knowledge, constitution and laws and regulations closely linked to economic and social development and people's lives and work. National legal-awareness education in forestry started from 1986. It is carried out every 5 years. It popularizes forest-related laws and regulations, including *Forest Law of the People's Republic of China, Law of the People's Republic of China on the Protection of Wildlife, Seed Law of the People's Republic of China* and *Law of the People's Republic of China on Prevention and Control of Desertification*. The education also aims at enhancing leader's decision-making capacity, regulating administrative actions of forestry authorities at all levels, promoting the building of administrative law enforcement team and enhancing the general public's legal knowledge about forestry.

(3) Forestry law enforcement and supervision

To enhance sustainable forest management, China not only enforces laws, regulations and departmental rules in forestry, but also enforces laws related to forest resources management, including *Law of the People's Republic of China on Soil and Water Conservation, Law of the People's Republic of China on Contracting of Rural Land, Law of the People's Republic of China on Land Administration* and *Water Law of the People's Republic of China*. For a long time, China increases its input into forestry construction, cultivates back-up resources, strengthens management and protection of forests and wildlife resources, promotes lawful administration and lawful management, accepts and supervises major forest resources cases and carries out examinations of seedlings. China has carried out special combat efforts to deal with a series of illegal forestland occupying and expropriating cases and forest and wildlife resources damaging cases. These efforts included *Hoh Xil No.1 Operation* (1999), *Protect Tibetan Antelope No.1 Operation* (2002), *Administrative Law Enforcement and Quality Supervision Year for Seedlings* (2003), *Seedling Quality Year* (2004), *Plateau No.2 Operation* (2004), *Banna Rainforest No.2 Operation* (from 2005), *Green Shield Operation* (2006), *Green Shield No.2 Operation* (2007), *Eagle Operation* (from 2008), *Green Shield No.3 Operation* (2009), *Spring Operation* (from 2010), *Winter Operation* (2010), *Sword Operation* (2011) and *Clear Net Operation* (2011). These efforts have cracked down on illegal and criminal cases in forestry, achieved great law enforcement results and protected results achieved from forestry reform and development.

In terms of administrative cases in forestry, after entering the 21st century, China has had 4.21 million such cases including unlawful and excessive logging, damaging forest seedlings, illegally occupying and expropriating forestland, illegally transporting timber and illegally buying, managing and processing timber, of which

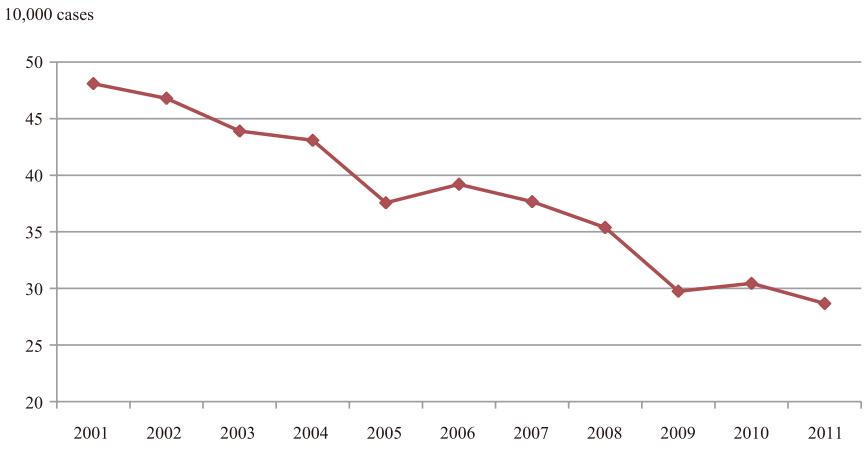


Figure 8-1. National forestry administrative cases since 2001

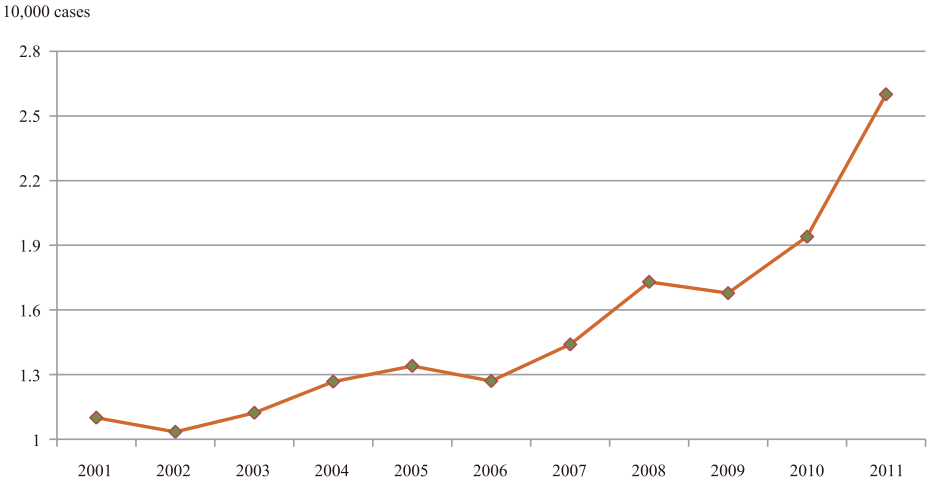


Figure 8-2. Criminal cases related to national forest and wildlife since 2001

4.15 million cases have been dealt with, and more than 12 billion yuan of economic losses were recovered. In the recent decade (Figure 8-1), administrative cases in forestry have been reduced from 481,000 in 2001 to 286,700 in 2011, a lowering of 194,300 cases equal to a 40% reduction. Forestry reforms like the reform of collective forest right system has been deepened. Pro-farmers and pro-forestry policies have been implemented. Ability to carry out lawful administration has been increased. Because of all the improvement, administrative cases in forestry have been reduced, major cases have been reduced significantly and forest

resources have been protected.

In terms of criminal cases in forestry, after entering the 21st century, China's public security authorities in forestry investigated over 16,500 criminal cases damaging forest and wildlife resources and dealt with over 14,000 such cases. They also dealt with more than 16,000 related criminals, recovered over 1.1 million m^3 of forest wood and 1.3 million heads of wildlife. Money related to these cases reached as high as more than 26 billion yuan. In the recent decade (Figure 8-2), criminal cases in forestry have increased from 11,000 in 2001 to 26,000 in 2011, an increase of 15,000 cases equal to 136.36%. Except for 2006 and 2009 when the number of cases was lowered, criminal cases that have been dealt with have increased continuously.

Case: Introduction of the new mechanism of forest logging management in Yong'an

For the past few years, the city of Yong'an followed the idea of "managing public benefit forests and easing commercial forests", explored, innovated and improved the new mechanism of forest logging management of the "two types of forests", and encouraged forest managers to make related forest management plans guided by the *Forest Management Plan*. While sticking to the logging quota, forest resources are classified into public benefit forests and commercial forests. Different logging quota systems are adopted, compensation mechanisms for forest ecological benefits are established, and efforts are made to achieve scientific protection and intensive management of forests with the aim of promoting sound and fast forestry development. The specific methods are as follows:

(1) Promote small group management. A small group is the smallest unit for logging management. Logging area is controlled by the group's obvious land boundary. Logging output that exceeds the permissible error will be deducted from the logging quota.

(2) Encourage farmers to afforest on unplanned forestland. Farmers afforesting timber forests on unplanned forestland will get free seedlings and their logging consumption will not be included in the logging quota management. Farmers can decide on their own logging age and approaches. They do not need forest wood logging licenses, and can transport the timber with certificates given by local county forestry stations.

(3) Adopt favorable policies to encourage tending of young and middle-aged forests. For the logging of those trees, only half the forestry expenses and taxations are levied. Trees with diameter breast height less than 10 cm are not included in logging quota. The principle of "cutting three and keeping three" is adopted to keep proper number of trees and decide thinning intensity based on different tending purposes so as to guide farmers for better management and enhance forest stands quality management.

(4) Adopt management mode that is conducive to positive succession of natural forests. Approaches like selected logging of natural broad-leaved timber forests, "protecting broad-leaved forests and planting coniferous forests", artificial regeneration and no slash burning for afforestation are used to ensure the protection and sustainable management of natural forests and to achieve the maximum economic, ecological and social benefits of the natural forests. For natural commercial forests with regional broad-leaved trees as advantageous trees, in principle, clear cutting is not adopted so as to prevent natural forest stands from turning into artificial forest stands. For natural commercial forests with coniferous and broad-leaved mixed trees, mass clear cutting should be controlled. Logging area should be properly laid out for regeneration without affecting the ecological structure and functions.

(5) Innovative public benefit forests management mechanism. Tiered management and limited utilization are conducted according to different positions of

ecological public benefit forests. Forests that need to be strictly protected are ones which are extremely important to ecological positions, whose ecological environment is very fragile and whose regeneration is difficult after logging. These forests should not be logged for utilization, including Tianbaoyan National Nature Reserve. Ecological forests that need to be specially protected are the ones situated on the sources and banks of the main streams of Min River, the ones surrounding Ansha Reservoir, forests with special purposes like environmental protection forests and landscape forests. They can be logged for tending and regeneration purposes. Forests that need to be commonly protected are the ones that are first-generation forest stands of privately-farmed hills and artificial commercial forests. For regions with good land occupation conditions, mild slope and less soil erosions, logging and utilization is allowed on the condition of protection. Single tree species and single-story standing forests should be gradually alternated for stratified mixed forests so as to restore their ecological system functions and enhance their ecological benefits.

8.4 Enhancing the management and application capacity of forests management and offering various forest products and services

8.4.1 Programmes, services and other resources supportingthe sustainable management of forests

Rational and significance

This indicator provides information on government departments' and private organizations' programs and services that aim at maintaining and developing infrastructure and putting financial and human resources input to support the capacity of achieving sustainable forest management. Capacity, trained staff and ample infrastructure of forestry institutions are important for sustainable forest management. The analysis of this indicator reflects an objective way what China adopts to support implementing sustainable forest management including its financial and human resources input and China's process and progress in achieving such management.

Sources of data

China Forestry Statistical Yearbook (2000-2011)

2012 Report on Monitoring Socio-economic Impacts of Key National Forestry Programs

National Forestry Authority

Current situation and trend analysis

(1) Basic capacity building for sustainable forest management

In recent years, China has enhanced basic capacity

building for nature reserves, increased related investment, strengthened protection and recovery of facilities and scientific research and monitoring and related education. According to the results of 2012 monitoring socio-economic impacts of key national forestry programs, from 2000 to 2011, China has founded 253 protection stations in 40 national nature reserves, covering 65,177.4 m^2; 36 aid stations for wildlife, covering 61,412.4 m^2; 55 ecological observation stations, covering 9,863.5 m^2; 6 soil monitoring stations, covering 3,260.0 m^2; 64 monitoring posts of key species, covering 5,868.0 m^2; 39 monitoring stations of wildlife epidemic disease and its source, covering 2,711.0 m^2; nursery for rare plants, covering 377.6 ha; patrol path covering 2,341.1 km; improved habitat, covering 32,019.2 m^2 and room for scientific research, covering 32,766.4 m^2.

(2) Pilot projects on sustainable forest management

To explore forest management path with Chinese characteristics and to improve China's forest management, State Forestry Administration (SFA) has carried out a series of nationwide pilot projects. In 2002, SFA formulated and issued *Standards and Indicators for Sustainable forest management in China*; in 2004, 7 organizations, including Wangqing Forestry Bureau in Jilin Province, carried out experimental demonstration for sustainable forest management; in 2006, to enhance macro guidance, promote ideas of sustainable forest management and adjust related policies and measures of forest management, SFA formulated *Guide to Sustainable forest management in China* and issued *Outlines for Formulating and Implementing Forest Management Plans (For Trial Implementation)* with the aim of guiding the drawing up and implementation of forest management plans nationwide; in 2007, SFA issued *Notice of Scientifically Formulating Forest Management Plan and Promoting Sustainable forest management*; in 2009, in provinces, autonomous regions and municipalities where major tasks of collective forest right system reform have been completed and management has been put in place, pilot projects of forest logging management reform were carried out with counties (county-level cities) as units; SFA has carried out such projects in 193 county-level units in 24 provinces, and has made explorations in simplifying logging management, promoting logging public notification system, improving logging quota distribution mechanism and logging of unplanned forestland and forest wood; SFA has carried out pilot projects of forest management in 128 units (counties, forest farms and forest industry bureaus), launched pilot projects of subsidy for forest tending with the government granting subsidy for forest tending (column). In 2011, SFA carried out pilot projects of forest resources sustainable management with forest resources management reform as the core in 200 units nationwide. It is estimated that province-level and county-level plans for sustainable forest management will be completed during the 12th five year plan period. 100% of state-owned forest management units will formulate their plans. 80% of collectively-owned forest management units will formulate their plans so that forest logging quota management system with forest management plan as the core will be established. In 2012, SFA chose 15 units to carry out the building of demonstrative base for national forest management and issued *Guidelines of State Forestry Administration on Building Demonstrative Base for Forest Management* which identified construction goals, major tasks and guarantee measures. Through the above-mentioned pilot projects, related units initially established sustainable forest management mechanism, management modes for sustainable forest management of different types of forests and communication platform with international standards. All of these provide typical modes and successful experience for China's forest management. From the perspective of forest tending of the past decade, national forest tending and management area have increased, which helps meet the goals of China's sustainable forest management (Figure 8-3).

(3) Standardization in sustainable forest management

As the pilot projects in forest management are carried out, sustainable forest management is developing in a standardized direction. In addition to industrial guidelines including *Guidelines for Sustainable forest management* (2006) and *Outlines for formulating and implementing forest management plans (2006, for trial implementation)*, China has issued a series of national and industrial standards, especially ones aiming at sustainable forest management: *China Forest Certification—Forest Management (GB/T28951-2012), China Forest Certification—Supervisory Chain for Production and Marketing (GB/T 28952-2012), Regulations on Forest Tending (GB/T 15781-2009), Standards and Indicators for Sustainable forest management in China (LY/T 1594-2002), Standards*

and Indicators for Sustainable forest management of Northeastern Forest Area in China (LY/T 1874-2010), Standards and Indicators for Sustainable forest management of Tropical Area in China (LY/T 1875-2010), Standards and Indicators for Sustainable forest management of Northwestern Forest Area in China (LY/T 1876-2010), Standards and Indicators for Sustainable forest management of Southwestern Forest Area in China (LY/T 1877-2010), Technical Regulations of Formulating Concise Plan on Forest Management (LY/T 2008-2012) and *Guidelines for Forest Sustainability Evaluation (LY/T 1958-2011)*. Current national and industrial standards related to forest management (Table 8-3).

Moreover, provinces have formulated their own local standards. For example, Beijing local standards include *Regulations of Classifying Management Types of Non-commercial Forests* and *Regulations of Healthy Forest Management and Ecosystem Evaluation*. Local standards in Liaoning Province include *Technical Regulation of Forest Management*. Local standards in Heilongjiang Province include *Technical Regulation of Forest Felling and Regeneration*.

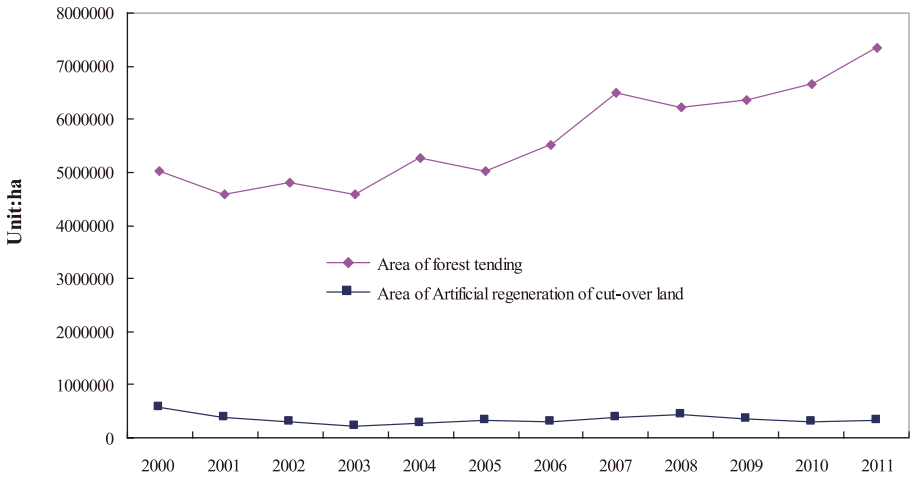


Figure 8-4. Changing trend of national forest tending area and artificially regeneration area of cut-over land

Special column: Pilot projects of subsidy for forest tending

To promote sustainable forest management and to enhance forest resources quality and quantity, the Chinese government subsidizes forest tending. The Ministry of Finance and the State Forestry Administration (SFA) launched pilot projects of subsidy for forest tending in 2009, and formulated management plans of forest tending and demonstrative policies and administrative measures. In 2009, SFA carried out pilot projects of forest management in 128 units including counties, forest farms and forest industry bureaus. By the end of 2009, 500 million yuan of subsidies has been granted, covering 5 million mu of forestland in 13 provinces. In 2010, the Ministry of Finance earmarked 2 billion yuan for subsidies, covering 20 million mu of forestland in 29 provinces, including 1,324 places. By the end of July 2011, the Ministry of Finance has all together granted 5.13 billion yuan of subsidies, covering 46.04 million mu of forestland in 2,418 places, which has greatly promoted national forest tending management.

Table 8-3. Current national and industrial standards related to forest management

Serial Number	Name of Standards	Implementation date
GB/T 28951-2012	China Forest Certification—Forest Management	2012-12-1
GB/T 28952-2012	China Forest Certification—Supervisory Chain for Production and Marketing	2012-12-1
GB/T 26424-2010	Technical Regulations of Forest Resources Planning and Investigation	2011-6-1
GB/T 15781-2009	Regulations for Forest Tending	2009-11-1
GB/T 15782-2009	Regulations for Planning Afforestation	2009-8-1
GB/T 18337.4-2008	Regulations for Evaluating and Inspecting Non-commercial Forest Construction	2009-3-1
GB/T 15776-2006	Technical Regulations for Afforestation	2006-12-1
GB/T 20399-2006	Technical Regulations for Overall Planning of Nature Reserves	2006-11-1
GB/T 20416-2006	Technical Regulations for Eco-tourism of Nature Reserves	2006-11-1
GB/T 15162-2005	Technical Regulations for Feibo Afforestation	2005-9-1
GB/T 15163-2004	Technical Regulations for Forest Conservation	2004-7-1
GB/T 18337.1-2001	Guiding Rules of Non-commercial Forest Construction	2001-5-1
GB/T 18337.2-2001	Notice on Planning Design of Non-commercial Forest Construction	2001-5-1
GB/T 18337.3-2001	Technical Regulations for Non-commercial Forest Construction	2001-5-1
LY/T 2008-2012	Technical Regulations for Formulating Concise Forest Management Plan	2012-7-1
LY/T 1957-2011	Statistical Specifications of Processing National Forest Resources Inspection Data	2011-7-1
LY/T 1958-2011	Guidelines for Forest Sustainability Evaluation	2011-7-1
LY/T 1872-2010	Specifications of Managing Forest Eco-system Positioning Research Station Data	2010-6-1
LY/T 1873-2010	Technical Standards of Digital Building of Forest Eco-station	2010-6-1
LY/T 1874-2010	Indicators of Sustainable Forest Management in Northeastern China	2010-6-1
LY/T 1875-2010	Indicators of Sustainable Forest Management in Tropical China	2010-6-1
LY/T 1876-2010	Indicators of Sustainable Forest Management in Northwestern China	2010-6-1
LY/T 1877-2010	Indicators of Sustainable Forest Management in Southwestern China	2010-6-1
LY/T 1882-2010	Technical Regulations for Tissue and Seedling Culture of Forest Wood	2010-6-1
LY/T 1898-2010	Technical Regulations for Changing Natural Secondary Low-yielding Forests	2010-6-1
LY/T 1813-2009	Technical Regulations for Ecological Quality Evaluation of Nature Reserves	2009-10-1
LY/T 1814-2009	Regulations for Researching Biodiversity of Nature Reserves	2009-10-1
LY/T 1836-2009	Regulations for Managing Eco-environment of Industrial Forests	2009-10-1
LY/T 1844-2009	Indicators for Evaluating the Quality of Reforestaion	2009-10-1
LY/T 1764-2008	Technical Regulations for Functional Zoning of Nature Reserves	2008-12-1
LY/T 1791-2008	Technical Regulations for Producing Pulp-producing Forests	2008-12-1
LY/T 1721-2008	Standards of Evaluating Forests Eco-system Service Function	2008-5-1
LY/T 1724-2008	Regulations for Felling Short Rotation and Fast-growing and High-yielding Forests	2008-5-1
LY/T 1726-2008	Technical Regulations for Managing and Evaluating Nature Reserves	2008-5-1
LY/T 1690-2007	Technical Regulations for Transforming Low-efficiency Forests	2007-10-1
LY/T 1706-2007	Technical Regulations for Cultivating Fast-growing and High-yielding Forests	2007-10-1
LY/T 1714-2007	China Forest Certification—Forest Management	2007-10-1
LY/T 1715-2007	China Forest Certification	2007-10-1

(Continue)

Serial Number	Name of Standards	Implementation date
LY/T 1646-2005	Regulations for Forest Felling Operations	2005-12-1
LY/T 1647-2005	Guiding Rules for Fast-growing and High-yielding Forests	2005-12-1
LY/T 1607-2003	Regulations for Designing Afforestation	2003-12-1
LY/T 1594-2002	Standards and Indicators for Forest Sustainable Management in China	2002-12-1
LY/T 1556-2000	Technical Indicators for Categorizing Commercial and Non-commercial Forests	2001-2-1
LY/T 1571-2000	Regulations for Examining State-owned Forest Areas	2000-7-1
LY/T 1572-2000	Technical Regulations for Managing Secondary Forests in Northeastern China and Inner Mongolia	2000-7-1
LY/T 1560-1999	Technical Regulations for Changing Low-production Forests	1999-12-1

Table 8-4. Institutions and staff categorized by industries in forestry system in 2010

	Number of institutions	Number of Staff
Total	46396	1347142
State-owned Economic Institutions	45950	1325267
Including: 1. Enterprises	2200	549304
2. Public Institutions	39952	682556
3. Authorities	3798	93407
Collective Economic institutions	191	5999
Other Economic institutions	255	15876
Institutions Directly Linked to Forest Sustainable Management in State-owned Economic institutions		
(1) Agriculture, forestry, husbandry and fishery	39454	1095242
Including: 1. Timber and bamboo lumbering companies	798	444281
2. State-owned forest farms	4557	350698
3. State-owned nurseries	1732	31218
4. Forestry stations	20670	123304
5. Timber checkpoints	2375	21650
6. Seedling stations	871	7070
7. Disease and pest prevention and control	1595	11554
8. Sand control stations	79	1191
9. Others	6777	104276
(2) Science research, technical services and geological	731	25893
Survey Including: 1. S&T communication and dissemination services	309	5910
2. Planning and management	159	7913
(3) Water conservation, environment and public facility management	693	36410
Management industry		
Including: 1. Nature reserves management	415	14925
2. Wildlife management	152	1321
(4) Education	69	9373
(5) Public management and social organizations	4051	101832

(4) Major service institutions and staff in sustainable forest management

State-owned economic institutions at all levels include forestry authorities, enterprises and public institutions, responsible for developing and implementing sustainable forest management projects and providing related services. Collective and other forms of economic institutions complement state-owned ones. In 2010, there were 46,396 institutions in national forestry system with 1.35 million staff. 94.2% of them directly involved in the implementation and service-providing of sustainable forest management in state-owned economic institutions (Table 8-4). In forest stations nationwide, staff with diploma above junior college accounted for 47.04% and those with diploma above vocational secondary school accounted for 26.0%. Most staff received special training, enhancing their service capacibilities in sustainable forest management.

8.5 Monitoring and evaluation capacity of forest protection and sustainable management

8.5.1 Partnerships to support the sustainable management of forests

Rational and significance

Forest partnership refers to increasingly close strategic partnership formed between China's forestry sector and various stakeholders, such as international organizations, foreign governments, related ministries, civil society organizations and the private sector, to address and resolve forest-related problems, such as deforestation and forest degradation, poverty reduction, biodiversity, climate change and desertification. By providing experience and capital, technologies, training, etc.,forest partnership can promote mutual cooperation and coordinationon forestry issues and activities betweenthe Chinese forestry sector and stakeholders to promote sustainable forest management.

To realize China's sustainable forest management, it is necessary to build partnership to connect the global processes with local activities, and toset up a platform conducive to the participation of all parties involved to share expertise and resources so as to contribute to the change of forest management methods, to combat climate change, and to build ecological civilization. Through describing this part, expanding and deepening partnership of China's sustainable forest management, promoting the solution for key common concerns of forestry, promoting multi-channel support for China's forestry construction with funding, practical policy advice, technical support and demonstration experience, sustainable forest management can be gradually achieved at the international, national and local levels.

Sourceof data

China Forestry Development Report (2001-2012)

Current situation and trend analysis

(1) Partnership with intergovernmental organizations

China's forestry agencies actively develop multilateral

cooperation and establish long-term cooperative relationship with international intergovernmental organizations. State Forestry Administration, on behalf of the Chinese government, joined the United Nations Forum on Forests (UNFF), the Montreal Process, Wetlands International, International Networkfor Bamboo and Rattan (INBAR), IUFRO, Northeast Asia and Europe Processes of Forest Law Enforcement and Good Governance, Asia Processes of Forest Law Enforcement and Good Governance and Asia Forest Partnership. It also established a good cooperation relationship with the UN Food and Agriculture Organization (FAO), the United Nations Development Program (UNDP), UNESCO, UNIDO, the World Food Program (WFP), the World Bank (WB), the Asian Development Bank (ADB), the International Tropical Timber Organization (ITTO), the Global Environment Facility (GEF), International Fund for Agricultural Development (IFAD), INBAR, the Asia-Pacific Economic Cooperation (APEC) and other international organizations. While actively carrying out cooperation with international organizations, SFAhas initiated the establishment of two international organizations with headquarters in China: INBAR and Asia-Pacific Forest Rehabilitation and Sustainable Management Network (APFNet). The exchanges and cooperation with multilateral organizations have promoted China's participation in international cooperation in solving global forestry issues and introduced funds, equipment, technology and management expertise and trained a large number of research and management personnel for China's forestry construction.

(2) Partnership with international non-governmental organizations

As the international community pays more attention to ecological and environmental protection, China's forestry sector hasregistered rapid cooperation and development with non-governmental international organizations in the field of natural resourcesprotection. More and more non-governmental international organizations set up offices in China to carry out forestry and nature conservation projects. Currently, SFA has established long-term, stable relations of cooperation with 12 internationally renowned non-governmental organizations, such as WWF, IUCN, the Nature Conservancy, Conservation International, Center for International Forestry Research, the International Union of Forestry Research Organizations, the Asia-Pacific Forestry Training Centre, the International Wildlife Conservation Society, the International Fund for Animal Welfare, the Forest Stewardship Council and the PEFC. The cooperation forms include friendly exchanges, academic exchanges, project cooperation, personnel training, co-hosting international conferences and others. The project cooperation area has been gradually expanded from panda conservation in the late 1990s to wetland conservation, biodiversity protection, climate change, forest certification and other fields. International non-governmental organizations came to assist the Chinese government in protecting China's natural resources and improving the ecological environment. This has created the conditions for promoting new technologies and new ideas. It has not only improved the ecological environment of the project area, but also brought good socio-economic benefits to the local.

(3) Bilateral partnership with governments

Chinese forestry agencies actively carry out the "north-south", "south-south" bilateral cooperation in forestry. They won assistance to China's forestry from Germany, Holland, Italy, Japan, Korea, Australia, the European Union and other developed countries. The cooperative projects cover forest management, ecological afforestation, pest control, wetlands biodiversity, sustainable utilization and other fields. Through the introduction of capital and technology, the new forestry management principles, new ideas and new methods in foreign countries are introduced to China. While combining the specific circumstances of China's forestry practice and exploration, they have gradually improved China's various forest management ways and effectively pushed forward the forestry development in the project areas. For example, the reforestation project funded by the German and Chinese finance is invested by the 2 countries to carry out ecological forestry construction in poor areas in China. Chinese-German cooperation not only is eco-efficient, but also provides advanced concepts and technical support for China's indigenous afforestation. "Payment and reimbursement according to afforestation results" are widely applied in China's afforestation projects.

(4) Partnership with domestic private sector and civil society organizations

China's forestry agencies have actively developed partnership with domestic private sector and civil

Case: Construction of Wuyuan Small Natural Reserve

Wuyuan County is in northeast of Jiangxi Province. In 1992, China's first small nature reserve was established in Wuyuan—Yutan Village Small Natural Reserve. In the protected area, there are nearly 50 kinds of birds, of which, egrets, the provincial key protected animals, reached as many as 200. In May 2000, garrulaxgalbanuscourtoisi breeding species, an endangered bird which had not been found for nearly a century was discovered in the small reserve. By 2004, 191 small reserves had been set up in Wuyuan. There are 172 ecological reserves, 6 reserves for rare animals and 3 for rare plants, 2 for water conservation and 8 for natural landscape. The area of the reserves cover 630,000 mu, accounting for 14% of the county's land area.

In south China, the mountain forest ownership is mainly owned by collectives or individuals. It is difficult to build large-scaled natural reserves in densely populated areas or in scattered villages. The small natural reserves in Wuyuan were set up according to the landscape and forest. There is no limit in the area. The main purpose is to maintain a natural ecological system and to consider the room for sustainable development.

Since ancient times, Wuyuan County has the tradition of protecting forest resources and ecological environment with the involvement of the public. The public are guided to build and manage small natural reserves with methods of "self-build, self-finance, self-manage and self benefit". It has mobilized the initiatives of local residents. The forestry agencies are responsible for assisting in the investigation and planning of natural reserves, establishing detailed filing system and providing proper funding support. The routine management is mainly carried out by townships, villages and production teams. Forestry competent departments assist in administration and technology management. There are 187 village committees in 20 towns in Wuyuan County. In every village, there is at least one reserve. Many village committees even issue the forest protection convention to every household and post a notice in marked areas. The small natural reserves are built by the towns, villages and production teams, who also share economic benefits.

Wuyuan small natural reserves have attracted attention from environment protection specialists and organizations from home and abroad, and won financial support from foreign environment protection agencies. Wuyuan small natural reserves are listed in the species protection small funding project of the WWF. In 2004, Wuyuan County Forestry Bureau renewed a three-year international cooperation treaty with German, French and the U.K. animal species and population associations to protect the endangered bird species garrulaxgalbanuscourtoisi. The associations of the three countries will provide special fund every year to support the protection. In 2004, Wuyuan County Forestry Bureau introduced over 20 million RMB loan from the Japanese government. All the money were used for closing hillsides to facilitate afforestation, middle-aged and young forest tending and improving forest reserves and other afforestation projects. The planned construction area of protection forest, timber forest and economic forest reaches 8230 ha. The continuous foreign capital and environment protection technology support has forcefully supported the construction of the Wuyuan small natural reserves and greatly improved the ecological construction level.

The model of Wuyuan small natural reserves is gradually recognized and accepted by the society and promoted across China as "Wuyuan Model" in forestry classified management. In 2001, in China, there are over 50,000 small reserves of various types with a total area of 1.35 million ha. The establishment and development of Wuyuan small natural reserve is also fully affirmed by the international conservation organizations. The research subject of Wuyuan small natural reserve was awarded World Science and Peace Contribution Prize by the IFIA in Vienna in 1994. In 2002, Wuyuan was awarded the first prize among the natural environment protection projects by the Ford Environment Protection Award.

society organizations. In recent years, more and more enterprises and civil society organizations are concerned about and actively participate in forest carbon sinks, afforestation, combating desertification, biodiversity conservation and other activities. In 2010, China Green Carbon Foundation, China's first nationwide publically-raised fund to combat climate change, to increase forest carbon sinks and to help businesses voluntary emission

reduction, was established in Beijing. It has served as a public-service platform, through which forestry measures "to save carbon sink credits, fulfill their social responsibilities, increase farmers' income, and improve the ecological environment" can be adopted. The partnershipwith the private sector and civil society organizations has strengthened the effectiveness of projects that protect the natural environmentand enhance forest development carried out by the Chinese government. With the help of the characteristics of civil society organizations, all walks of life are mobilized to participate in sustainable forest management. The public awareness of sustainable development has been enhanced. Complementary and win-win cooperation has been achieved betweenthe national forestry sector, the private sector and civil society organizations. Undeniably, the civil society organizations that establish friendly relations with China's forestry agencies are mainly international civil organizations and their branches. There is still room for deepening the cooperation between local non-governmental organizations and the forestry agencies.

8.5.2 Public participation and conflict resolution in forest-related decisionmaking

Rational and significance

Public participation in decision-making related to forests means that the public is entitled to acquiring forest-related information, participating in formulating, implementing and evaluating forest laws and regulations, policies and projects through various ways, and to influencing the public decision-making and forest governance through feedback. It consists of a continuous two-way exchange of views between the governments and the public, timely informing the public ofthe formulation and implementation of all the policies, programs and plans, and actively listening to the opinions of stakeholders. Forest-related conflict resolution aims at mitigating or resolving disputes or conflicts arising from the management and utilization of natural resources between various stakeholders. To this end, the government adopts political, legal, economic and other means to coordinate the interests of all parties so as to effectively deal with the relationship between forest conservation and community development.

Through the description of indicators, public participation level and conflict resolution ways of decision-making related to forests are straightened out. Experience of promoting the public participation and solving disputes related to natural resources in China is introduced. All of these are conducive to improving forestry decision-making and further reflecting the needs of different stakeholders. By so doing, the partnership between the forestry agencies and the public is established in managing and utilizing natural resources, so as to achieve a win-win situation of community development and conservation of natural resources.

Source of data

Investigation materials of related cases

Current situation and trend analysis

Forests have ecological, economic, social, cultural and other multiple benefits, and are shared and concerned by different stakeholders (Liu Jinlong, et al, 2011). In China, stakeholder participation mechanism of sustainable forest management is categorized into two levels: the first one is the national level. For major forestry policies influencing the whole the country, like the conversion of farmland to forests, the Chinese government sets up liaison offices to coordinate major issues by establishing coordination mechanisms between related departments of the State Council departments and local governments. Meanwhile, when there is work related to forestry in departments of the State Council, opinions are solicited from the forestry sector. At the national level, currently, there is no direct participation of the private sector, industries and the public in this stakeholder participation mechanism for sustainable forest management. However, their proposals can be reflected through the internet, letters, forums, seminars, public hearings and other forms. SFA has formulated regulations and rules, such as *Regulation of the Legislative Work of the State Forestry Administration*, *Measures for Government Information Disclosure Rules of the State Forestry Administration (Trial)*, and *Measures for Hearing of Forestry Administrative Licenses and Rules of Forestry Administrative Punishments*. These documents have defined ways, means and content for the public to participate in forestry decision-making.

Case: Application of the "Participatory Approach" of Forestry Policy in Formulating the Rules of Timber Logging Management in Sanming, Fujian Province

Sanming City, covering an area of 22,900 km^2, is a key collective forest zone in south China. Its forest coverage proportion is 76.8% and standing tree stock is 120 million m^3. With the further clarification of forest property rights, the forest management bodies are diversified and decentralized. To solve the conflict of forest logging quota distribution due to diversified management bodies, the Municipal Forestry Bureau and Supervisory bureau carried out an in-depth investigation with the "participatory approach". With this new method, new logging quota distribution system was set up, which laid the foundation for promoting scientific forestry management.

After the reform of collective forest rights, the majority of small-scale farmers did not agree with logging indicator distribution. In the competition with large forestry households and processing enterprises, state-owned forest management institutions for logging quota, they are totally in disadvantage. In Xiaqu Village, Taining County of Fujian Province, the Working Group adopted problem ranking method to understand the problems in quota distribution. They analyzed the problems put forward by the public, which mobilized the public to participation. In Taining County Forestry Bureau, the Working Group adopted aquarium debate method. They divided people into different groups—the managers, private forest farms, state-owned companies, timber processing enterprises, farmers and family forest farms. Each group discusses the issue and forms their views. Debates around the management of timber harvesting were held. Different viewpoints of various interest groups were heard adequately.

In order to ensure the public's right to know and the right to participate, Sanming Forestry Bureau held public hearings on forest logging quota distribution and management so as to collect views of the community more broadly. The hearings were released through television, newspapers, and the Internet, and the hearing announcement was posted in the market place. Representatives were generated by application and recommendation, and applied representatives accounted for 62%. The Forestry Department of Fujian Province, Sanming municipal government and related departments, universities outside Fujian, research institutes and media representatives were invited to observe the hearings. In the hearings, 25 opinions were put forward. 18 of them were related to timber logging quota distribution, 5 related to forest management, and 2 related to forestry taxes. According to the comments made in the hearing, Sanming Municipal People's Government issued the *Opinions on Standardizing Timber Cutting Quota Distribution and Use Management*. It was the first forest logging quota distribution mechanism in Fujian Province based on forest resources and forest types. Because of the high degree of transparency and strengthened supervision, operation loopholes can be prevented from the source. Therefore, it was widely welcomed by the community (Liu Jinlong, et al, 2010).

The second is at the grassroot level. The private sector, industry and farmers are directly involved in county, township and village forestry decision-making. Under the *Law of the People's Republic of China on Land Contract in Rural Areas*, land contracting plans can be adopted with the approval of over two thirds of the participants of village conference composed of the members of the collective economic organization or over two thirds of the villagers' representatives. Women and men enjoy equal rights. In a new round of collective forest rights reform, village-level reform program must be legally approved by over two thirds of the participants of village conference composed of the members of the collective economic organization or over two thirds of the villagers' representatives. The contents, procedures, methods and results must be publicized to guarantee the farmers' rights to know, to participate, and to make decisions. In addition, the suggestions and proposals of the farmers and forestry workers can be delivered to the state forestry departments by a variety of forestry policy

Case: Conflict Management of Daweishan Natural Reserve in Pingbian, Yunnan Province

Daweishan state-level reserve is situated in the south of Yunnan Province. It was set up to protect natural landscape of tropical mountain rain forests and evergreen broad-leaved forests, and various kinds of rare and endangered animal species. The animal and plant resources are abundant in the reserve. The plants there are featured by antiquity, rarity, diversity and integrity. It is one of the reserves with the most diversified rare and endangered plant species. In and around the reserve, there are 59 natural villages, 11 village offices in 6 towns directly connected with the reserve. The population there reaches 12,934, 1,461 households.

Due to the need of managing the reserve and protecting wildlife resources and ecological environment, there are conflicts and contradictions between the management agency of the reserve and the surrounding communities in the management and utilization of these resources. They mainly include land tenure conflicts, natural resources management and utilization conflicts (the ban on timber harvesting against stealing and illegal logging, collecting firewood, grazing in reserves, the land fight between farming and forestry protection, the disappearance of forest resources, over-exploitation of wild plant resources, cash crops planting and destruction of biodiversity), disputes caused by related policies and regulations on resource management and protection, and conflicts between local traditions and customs and resource regulations and management.

With the help from the government and social organizations, a series of measures have been adopted to solve or alleviate natural resource conflicts in Daweishan, Pingbian. First, to meet the demand of forest resources by the communities, such as mitigating community energy crisis by building biogas tank, using energy-saving cooking stoves, and providing free quality seedlings to meet their demand for timber. Second, to improve the community capacity building and economic development pathways, such as transforming existing resources of farmers' income. It mainly includes strengthening the management of existing cash crops in the community and improving methods for pig rearing and developing new sources of income according to the local climate and environment and resources advantages, in combination with the market demand. Third, to build the community-based forest management capacity. It includes establishing forest management organizations, developing community-based forest management regulations, citizenship education and regulatory advocacy, and establishing a flexible communication system. Fourth, to build the capacity and shift functions of the nature reserve management agency. It includes redefining the responsibilities and functions of the management agencies of the natural reserve, strengthening training of the staff management agencies of the natural reserve, and improving the management system. Through these efforts, the majority of farmers have recognized the importance of protecting forests and establishing protected areas. Meanwhile, the relationship between the community and reserves has been improved and development capacity of the protected area and the community has been enhanced. (Lai Qingkui et al, 2001)

monitoring systems, such as the monitoring system of returning farmland to forest policy, the monitoring system of social and economic benefits of key forestry projects of the State Forestry Administration, as well as monitoring systems of various rural policies by research institutions.

The "participatory approach" to encourage and to guarantee grassroots farmers to participate in forest-related decision-making is widely applied in the 1990s in rural development projects. In the early 1990s, the Ford Foundation, the World Wildlife Fund, the World Bank and other international organizations began to promote the "participatory approach"in projects developed in Yunnan, Sichuan and other places of China. The participation and decision-making process can ensure thatthe rights to speak, analyze and make decisions are returned to the local communities and farmers.

Meanwhile, the government sector and development agencies serve more as facilitators and service providers. The "participatory approach" in forestry has been widely used in many provinces of China in forestry policy formulation, community development and management, poverty alleviation, natural resources management, watershed management and other projects (case).

The "participatory approach" was introduced to resolve conflicts between natural resource management and utilization. The practice and exploration are combined with China's forestry actual situations. The conflict resolution and community development are linked. These have become important ways to address natural resource management and utilization conflicts (Lai Qingkui, Wang Liping, 2001a). In alleviating or resolving conflicts over natural resources, we should not only focus onmediating a conflict or dispute, but also link dispute mitigation process with the local community capacity building and comprehensive development. For example, addressing the needs of communities on forest resources, improving community capacity building and economic development, and community-based forest management capacity building can be linked together (refer to the case). Meanwhile, China has explored and practiced "community condominium" approach to manage natural reserves and motivate surrounding communities to participate in the management of natural reserves. These have effectively resolved the conflicts between management departments of protected areas and communities.

In China, *Law of the People's Republic of China on Land Contract in Rural Areas, Forest Law of the Peoples Republic of China, the Law of Land Administration of the People's Republic of China, Measures for Dealing with Disputes in Stand and Forest Land Tenure, Investigation Measures for Dealing with Disputes in Land Tenure, Measures for the Administration of Circulation of Rural Land Contracted Management Right, Law of the People's Republic of China on the Mediation and Arbitration of Rural Land Contract Disputes, the Law of Administration State-owned Forest Land* and other laws and regulations have clearly defined that there are 4 main ways to deal with forest tenure conflicts and disputes: administrative handling, litigation, consultation and mediation and arbitration. In practice, very few Chinese forest tenure disputes are resolved through judicial litigations. The majority of private forest ownership disputes are resolved through consultations (Zhou Bohuang, Fu Jingxin, 2010). According to the statistics from Monitoring Report of Reform of Collective Forest Right System in 2010 (2012), 49.23 % of forest ownership dispute are resolved by village committees mediation, 29.23 % through the mediation by the forestry station or township governments, 20.00 % through negotiation between farmers in private and 1.54 % through mediation by courts and other institutions.

8.5.3 Monitor, assessment and reporting on progress towards sustainable management of forests

Rational and significance

Monitoring and evaluation of sustainable forest management means the observation, measurement, analysis and evaluation of forest ecosystems and ecological, economic and social effects of the management activities by a variety of information collection, processing and analysis techniques and criteria and indicators of sustainable forest management in a certain range of time and space. It is a very important basic work. A sound, efficientand transparent monitoring system can timely generate accurate and reliable information about the forest, improve the public and government awareness of the forestry problems, and give full play to the government in supporting the formulation of sustainable forest management policies, major forest management plans and forest management.

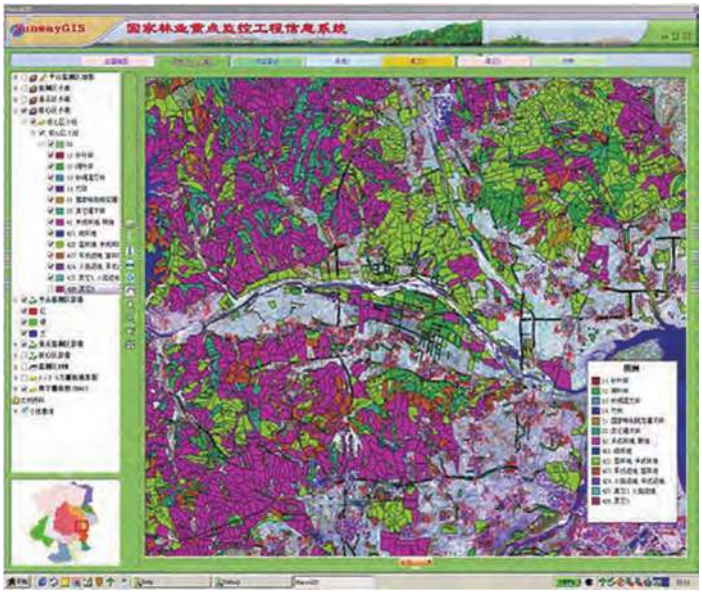
Source of data

National Forestry Authority

Current situation and trend analysis

China'sforest resources monitoring began in 1951 withDailing forest management pilot program. In 1953, forest management survey was carried out in the northeastern state-owned forest regions. Subsequently, in accordance with national forestry development and management needs, national forest inventory (NFI), forest management inventory (FMI), Forest Operating Investigation, Forest Fire Monitoring, Forest Pest Survey, and Special Survey of Forest Resources Management are carried out for different ecosystems. Desertification, sandification, and stony desertification

Forest ecological factors observation



Analysis of forest resource remote sensing zoning and space information

monitoringare carried out for desert ecosystems; wetland resource monitoring for wetland ecosystems; and wildlife diversity surveys for wildlife resourcesand so on. In typical ecological zones with "three systems, and one diversity", long-term continuous and dynamic observations are established. Annual forestry statistics are collected and *China Forestry Statistical Yearbook* is published. By so doing, a relatively complete forestry monitoring system has been basically established (Table 8-5).

(1) National Forest Inventory (NFI)

NFI is province-based and the cycle is five years. By using sampling technology systems, 415,000 terrestrial fixed plots and 2.84 million remote sensing interpretation plots are chosen. Through regular fixed plot measurement and interpretation of remote sensing plots, forest resources of provinces (autonomous regions and municipalities) and the nation will be monitored in a unified timeaccording to uniform requirements to identify the growth and decline. The inventory is deployed by the State Forestry Administration and implemented by provincial forestry authorities. Terrestrial fixed sample spacing is 2 * 2km-8 * 8km and the spot area is between 0.06-0.10ha (mostly 0.0667ha). Inventories cover land use and coverage, forest site and soil, stand characteristics, functions of forests, ecological conditions and other aspects of plot geospatial data totaling nearly 160 factors.

NFI was started in 1973 and the 1st inventory was completedat the end of 1976. In the 2nd inventory, NFI system was established with sampling technique as the theoretical basis and a province as the sampled population. In the 5th inventory, the remote sensing, geographic information and global positioning technology were first introduced to carry out remote sensing survey through arranging remote sensing interpretation plots. In the 6th inventory, application of remote sensing technology was expanded toTibet, Xinjiang, Gansu, Qinghai, Sichuan and other provinces for the first time to carry out a full range of check. Across China, 415,000 ground fixed sampling spots and 2.84 million remote sensing interpretation plots were set up for the first time, which enabled a full coverage of the mainland China. In the 7th inventory, technical requirements of National Forest Inventory issued in 2004 was executed to increase surveys with forest health, ecological function and biodiversity, and the first

Table 8-5. Components and development of China's forestry monitoring system

Monitoring Object	Monitoring Type	Monitoring Task	Monitoring Methods	Survey Factors	Progress
Forest ecosystem	National Forest Inventory	Periodic review of provincial and national forest resources and getting a macro understanding of the resource changes.	Measuring 415,000 permanent plots and interpreting 2,840,000 remote sensing plots	Over 160 items reflecting forest resources quantity, quality, structure, function, health and ecological conditions.	7 NFI finished, 8th inventory will be finished in 2013.
	Forest Management Inventory	Understanding of forest resources of the business units to meet the need for business management, plan preparation and so on.	Combined with data from high-resolution remote sensing to carry out zoning investigation	Over 70 items reflecting FMU forest, woodland and forest resources types, quantity, quality and distribution.	Normally every 10 years.
	Forest Operating Investigation	Meeting the requirements of final cutting, disengagement cutting, and afforestation and other operations.	Field survey and individual measurement	Designed according to the survey purpose including forest land, forest, forest resources, site quality, etc.	A year before the operation.
	Forest Fire Monitoring	Monitoring forest fires, spreading trends across China and early warning of fire.	Aerospace remote sensing, aerial inspection, deck observation and ground observation patrol combined.	Types of fire, the fire location, burning area, meteorological fire danger rating and so on.	Continuous and real-time observation
	Forest Pest Survey	Monitoring and forecasting occurrence and development of forest diseases and pests, invasive species.	Field observations and animal and plant quarantine inspection combined.	Disaster prevention, pest spreading and so on	Real time.
	Forest Resources Management Special Survey	Knowing the result of afforestation, implementing forest cutting quota and forestland occupancy.	County-level self-examination, provincial-level review, national–level spot check by combining social investigation and field survey.	Over 20 items covering afforestation effectiveness, implementation of annual forest cutting quota and forestland occupancy and so on.	Once a year.
Desert ecosystem	Nationwide Monitoring of Desertification and Sandification	Identifying land area, distribution and land degradation status and dynamics caused by desertification and sandification.	Macro surveillance, monitoring of key sensitive areas with fixed-spot observation combined.	Over 30 items reflecting the types and extent of desertification and sandification.	4 surveys finished, 5th ongoing.
	Nationwide Early Warning and Monitoring of Sandstorms	Nationwide monitoring of sandstorms happenings and spreading trend for early warning.	Satellite remote sensing, site tracking, loss of ground investigation	Sandstorms generation, extent, the scope of impact and losses.	Continuous tracking and monitoring
	Nationwide Monitoring of Stony Desertification	Periodic survey to identify the status of desertification and the dynamic change in South China	Survey of interpreting the remote sensing zoning	Rocky land distribution, extent, scope of impact and soil erosion. Conditions, dynamic changes and evolution, physical geographic and, socio-economic factors and so on	2 surveys finished
Wetland ecosystems	Monitoring of Wetland Resources	Regular monitoring of the national wetland resources and ecological environment conditions.	Typical survey as the main method, combined with macroscopic investigations and Special Surveys	over 50 items involving the wetland resources quantity, distribution, protection and utilization and other aspects of their environment more than a total of 50	1st survey finished, 2nd ongoing.
Biodiversity	Wildlife Resource Survey	Identify the quantity of major terrestrial wildlife resources and their distribution.	Using survey methods, such as line transect surveys	More than 50 items, reflecting wildlife quantity, distribution and habitat conditions and utilization	1st survey finished, 2nd ongoing.

(Continue)

Monitoring Object	Monitoring Type	Monitoring Task	Monitoring Methods	Survey Factors	Progress
Biodiversity	China's Forest Biodiversity Monitoring Network	Coniferous and broad-leaved mixed forest, deciduous forest, evergreen deciduous forest, broad-leaved forest, evergreen broadleaf forest and rainforest	Monitoring 12 large sample plots	Monitoring all woody plants with DBH>1CM, seeds, litter, seedlings, coarse wood debris and leaf area indicator	Mid-term evaluation finished.
Terrestrial Ecosystem Research Station Network: Ecosystem Site-specific Observation		Revealing the relationship between forest ecosystems and the environment, monitoring the impact of outside activities on the system and its self-regulating process.	site-specific observation, experiment and research	Reflecting the surrounding forests and other ecosystems and their environmental conditions and other factors.	Continuous and long-term monitoring
Monitoring and Evaluation of Key Forestry Ecological Projects		Knowing construction progress and effectiveness	Remote sensing, ground surveys and socio-economic survey	Designing according to the type of project and construction content	Annually and not periodically
Global Forest Resources Assessment—Country Report China		Submitting regularly data reflecting China forest resources volume, structure, function effectiveness and other aspects of to FAO	Building the model for statistical analysis and evaluation in accordance with the FAO definition set standards and regulatory requirements,	Covering seven standards of sustainable forest management, nearly 100 indicators involving changes in forest resources, management, biomass, carbon storage, forest disasters, forest products, forestry employment, forestry policy, forestry agencies, research and education, taxes and spending, etc.	Every 5 years.

national forest ecosystem services benefit assessment was carried out. The 8th inventory (Figure 8-4) will be completed by the end of 2013.

Tree measurement

For NFI, 1/5 of each province is reviewed every year and the nationwide inventory results summary of all the provinces is compiled every 5 years. By so doing, the national forest inventory results can be generated. Inventory results are rich in content, extensive in information, and reliable in data. It has been recognized by society as the most authoritative data reflecting the national and provincial forest resources. It is a reference for the preparation of a variety of forestry programs and scientific decision making. It is a window for the society to understand and care about forestry and also an important reference for scientific research.

(2) Forest Management Inventory (FMI)

Forest Management Inventory (FMI) is based on prefectures (state-owned forestry bureaus, forest, natural reserves, forest parks, etc.). The aim is to meet demands of forest management, forest management plan preparation, overall design, forestry zoning and planning and design and it is carried out according to hilltop plots. FMI is operational investigation and carried out usually once every 10 years. The provincial level is responsible

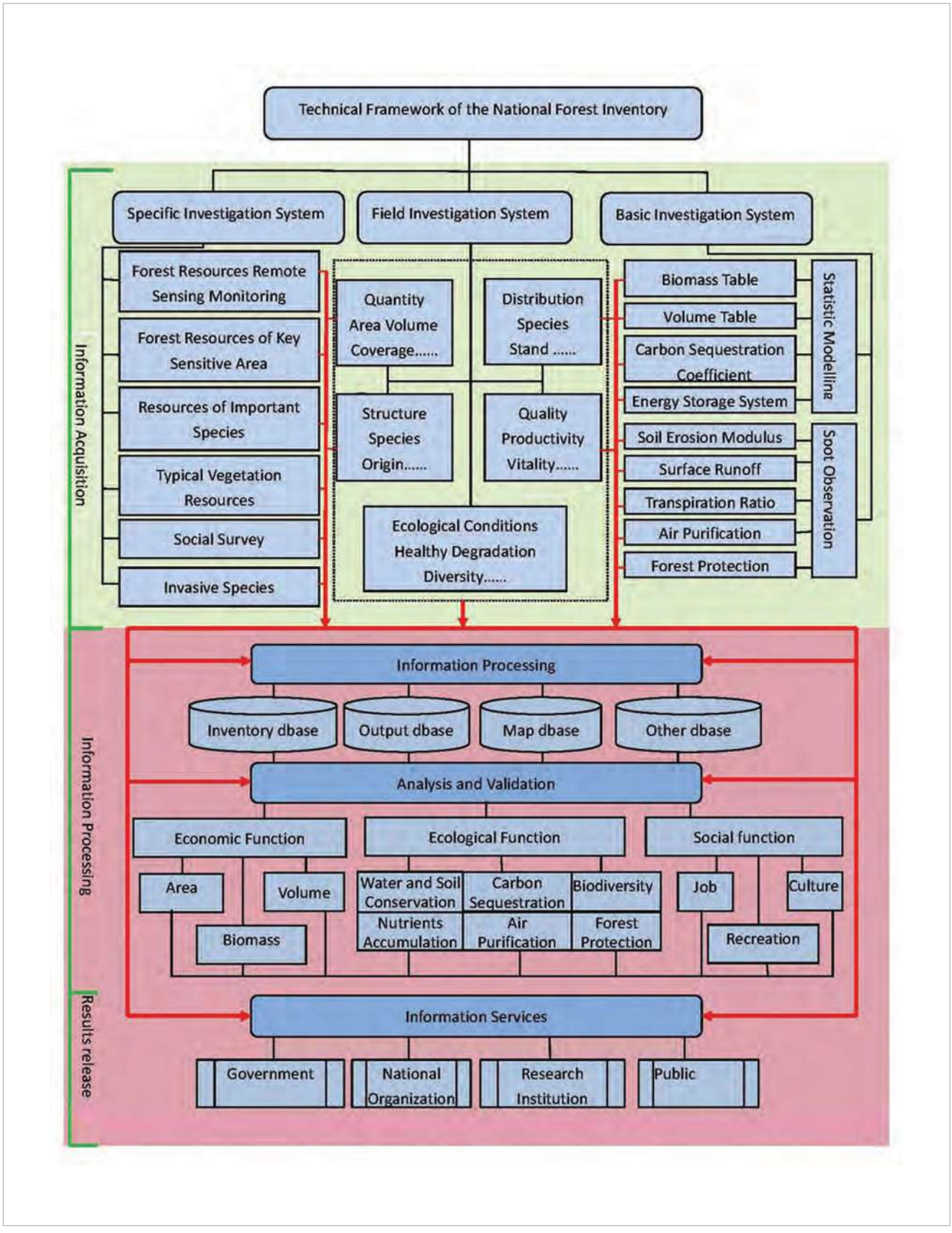


Figure 8-4. Technical framework of the NFI system

Case: China's NFI System, among the top of the world

Since the 1970s, China began to adopt the world recognized "continuous forest inventory" approach and established National Forest Inventory System. NFI takes provinces (or autonomous regions and municipalities) as a unit and the cycle is five years. By the end of 2008, 7 national forest inventories had been finished and the 8th will be completed by the end of 2013.

China's NFI takes mathematical statistics sampling survey as the theoretical basis and provinces (autonomous regions and municipalities) as the sampling population. Systematical setting up of fixed sample spots, integrated application of 3S technology, and investigations and periodic review are carried out to acquire national forest resources and dynamic information. Nationwide, 415,000 fixed plots and 2.84 million remote sensing plots were set up. The number of plots is even more than that of the United States and is the most in the same type across the world. These plots, like a checkerboard grid system, are distributed on China's territory except Hong Kong, Macao and Taiwan. These plots can objectively reflect forest resources of different climatic zones and various species. They are very representative, which can ensure that the inventory data are precise. The fixed sample plot takes an area of 1 mu and is square. It is set at fixed locations on the kilometer outlets of geographical coordinates. All the trees within the plot are numbered and positioned. The measuring part of each tree is fixed to ensure the accuracy and continuity of each measurement value. Every five years, professional investigators and technical personnel visit the fixed spot to carry out reduction investigation of the spots and trees and accurately measure investigation factors of the sampling spots and trees, such as land use and cover, soil and vegetation, site conditions, forest characteristics, forest health, and forest functions. The data are detailed, accurate and reliable.

China's NFI system lives up to the international level in methods and technologies. Its organization, administration and systemic operation are standardized and efficient. The quantity of the sampling spots and the review frequency outnumber other countries. The advanced checking methods and credible data are high appreciated and recognized by international organizations, such as FAO, and is promoted to other countries as an example to learn from. China's forest inventory system is among the top of the world. Forest inventory results have played an important role for many times in national construction and economic development. It also contributes to assuming international obligations and participating in evaluating global forest resources.

for organization and planning. Qualifiedinstitutions with forestry investigation, planning and designing carry out the investigation. The content covers various types of woodland forest areas, various forests, forest reserves, and natural geographical environment and ecological environmental factors related to forest resources, the main forest management conditions and operating performance of the forestry management units. Meanwhile, forest growth and consumption, forest soils, forest regeneration, pest and other data can be acquired through special surveys.

So far, 5 rounds of FMI have been completed. Survey results are based on surveys factor database of various investigations, statistical table of forest resources of operating institutions and drawing materials of forest maps, forest resource files and forest resources information management system results of small groups. Every year, forest management institutions update forest resources file according to operation design maps, inspection and acceptance of materials and supplementary remote sensing surveys and other measures. FMI results reflect a region's forest resource information of hills plots and provide basic data for forest management institutions to establish forest resource files, to develop forest cutting quota, to implement asset management of forest resources and to guide scientific management.

(3) Forest Operating Investigation (FOI)

FOI is based on a specific range or operating area. Methods like field survey and individual measurement are adopted to meet the demands of production and operation (such as felling, thinning, reforestation, etc.). Generally, it is carried out one year before production

and operation.

(4) Annual Special Survey of Forest Resource Management

Annual Special Survey of Forest Resource Management is to verify the implementation of the annual forest logging quota, annual afforestation, artificial regeneration, implementation and preservation of closing hillsides to facilitate afforestation, annual occupied forestland, farmland conversion to forest and other major forest ecological projects through on-site investigation. The content includes: comprehensive performance verification of afforestation, logging quota implementation checks, forestland occupancy checks and verification and protection of the state ecological forest zoning. The investigation and check results provide a scientific basis for monitoring and evaluating performance and effectiveness of national afforestation and key project construction, strengthening the management of forest logging quota, management of forestland occupancy, evaluating the effectiveness of national forest management and protection, and promoting forest ecological benefit compensation.

(5) Forest Fire Monitoring

Forest fire monitoring is carried outby adopting real-time observation methods, such as aerospace remote sensing, aerial inspection, deck (tower) observation and ground patrol observation, so as to monitor the occurrena and spreading trends of forest fires. Combined with local weather and objective conditions that may cause forest fires, it can forecast forest and warn forest fire. At present, China's forest fire monitoring system has been formed with an aerospace remote sensing, aerial inspection, deck (tower) observation, ground patrol observation. This quaternity forms a complete forest fire monitoring system. It is capable of timely detecting fire, tracking the fire and forecasting and early warning fires. Forest fire monitoring technology and equipment have developed rapidly in recent years. Thunder light Monitoring and Warning System in the Northern Forest of Daxingan Ling is China's first large-scale protection system against forest fires caused by lightning. China's 1stsatellite remote sensing data receiving system for forest fire monitoring has been put into use at Forest Fire Information Center of the State Forestry Administration. EOS, NOAA, FY series data from satellite remote sensing has played an important role in forest fire early warning, monitoring and damage assessment.

(6) Forestry Pest Survey

Forestry Pest Survey is aimed atmonitoring and forecasting the occurrence and development of forestry peststhrough field observation, and animal and plant quarantine checking methods. After more than 30 years' of development, China has formed five levels of monitoring and warning network with national central monitoring spots as the backbone, national, provincial, city- and county-level monitoring institutes as the mainstay, and grass-root monitoring spots as the basis. So far, 1,000 central monitoring spots, more than 1,000 provincial key monitoring spots, over 24,600 general monitoring spots, and 2,782prevention and treatment quarantine stations have been built. All levels of monitoring spotshave amounted to 22,807 and quarantine checkpoints 858. Specialized system of mainforestry pests prediction and pests and disease information has been set up and the "Chinese Forest Pest and Disease Indicator" and the "Forest Pests and Diseases Monitoring and Forecasting System" have been established. The information transmission of pest and disease has been basically realized through computer network, and capability of disaster early warning has been improved substantially.

(7) Wildlife Resources Survey

Wildlife Resources Survey is aimed at realizing

Wild elephant valley in Xishuangbanna

Special Column: Forest Fire Monitoring Methods

In China, the main monitoring methods of forest fire are ground observation, satellite detection and plane detection, among which the first two are the main means. Satellite detection is an important means at national and provincial levels.

National forestry authorities have adopted meteorological satellites for forest fire monitoring in 1994. Forest Fire Information Centers, Southwest, Northwest, Northeast forest fire monitoring sub-centers of the National Forestry Administration were set up in Beijing, Kunming, Urumqi and Harbin respectively. These four national satellite forest fire monitoring centers can achieve forest fire monitoringacross China. At present, forest fire monitoring satellites are Fengyun series (FY-3A, FY-3B), NOAA (16,18,and 19) and EOS series (TERRA, AQUA). These seven satellites scan the same area about 10 times in every day. Within 30 minutes of satellite scan, suspicious hotspots can be extracted through man-machine interaction. The latitude and longitude location, land type and administrative areas and other information of hotspots are posted on the Chinese Forest Fire Prevention Operation System and relevant provinces are notified for verification. After receiving the hotspot notice, related agencies conduct on-site verification and take appropriate measures. The feedback will be posted through the network. Forest fire recognition accuracy rate is over 90%.

With the support from the North Station of Forest Protectionwith Aviation Operations and the South Station of Forest Protectionwith Aviation Operations, there are already 17 provinces (autonomous regions and municipalities) that have carried outaviation operations against forest fire. Over 140 aircrafts have been rented and 28 terminals have been built. Throughobservation and monitoring system combining satellite, aircraft, and ground observatory and ground patrol, the fire can be discovered in time and monitoring coverage has reached 63.1%.

Forest Fire Monitoring Means in China

Means	Main Types
Satellite	FY-3A, FY-3B, NOAA (16,18,19) and EOS series (TERRA, AQUA)
Plane	Helicopters, fixed-wing aircraft
Observation tower	TV automatic fire detection, manual monitoring
Ground patrol	Motorcycle, automobile and on foot

effective protection, sustainable utilization and scientific management of China's wildlife resources and at providing services for national macro decision-making, implementation of international conventions or agreements, and carrying out international exchanges and scientific research. The main content of the survey is quantity, distribution and habitat conditions, utilization, management and research conditionsof wildlife and the main factors affecting resource changes. Survey results include wildlife resource database, status quo and the dynamic change table, survey reports, etc.

From the founding of the P.R.C. to the early 1990s, China conducted many regional or special wildlife resources surveys, such as pandasurvey. In 1995, 252 kinds of terrestrial wildlife which were overly consumed or relatively endangered (including 153 national key protected species) have been selected for a nationwide survey of wild animal resources. Since 1996, 189 wild plant resources which were overly consumed or relatively endangered have been selected for a nationwide survey of wild plant resources. The first national survey of wildlife resources was completed by the end of 2003. Currently, the second national wild animal and plant resources survey is ongoing.

(8) Location observation and research station of terrestrial ecosystem of SFA

In the late 1950s, taking natural conditions and actual needs of forestry construction into consideration, China carried out special semi-location observation and research in typical ecoregions, including western Sichuan, Lesser Khingan Mountains, and Jianfengling in Hainan Province and gradually established Forest Ecosystem Research Station, which has marked the beginning of China's location observation and research on ecosystem. In 1978, the draft Development Plan of National Forest Ecological Station was prepared for the first time. In 1992, the draft was revised and the idea of eco-station network observation was put forward. Since 1998, the State Forestry Administration has gradually accelerated the construction of an ecological station network. A number of new ecological stations have formed the basic overall distribution. In 2003, Chinese Forest Ecosystem Research Network (CFERN) was formally established, which defined the importance of ecological station network in forestry science and technology innovation system and indicated that the construction of the ecological station network has entered a critical period of rapid development and comprehensive promotion.

So far, 113 ecological stationshave been established (75 forest ecological stations, 21vwetland ecological stations and 17 desert ecological stations). CFERN has been developed into anationwide observation and research network crossing 30 latitudes. It is alsoan ecological gradient mesh, which is driven by heat from north to south and by water from east to west. Some of the ecological stations are recorded by GTOS or are in cooperation and exchange relations with ILTER, ECN, and Asia Flux. CWERN basically includes 4 natural wetlands (swamps, lakes, rivers, and coastal wetlands) andconstructed wetlands. Ascientificobservation and research network covering key ecoregions has been primarily formed. CDERN covers China's major deserts, sand and rocky desertification, dry and hot dry valleys and other special environments. Theecological observation system covering China's main desert types has been basically formed.

Antelope

(9) China's Forest Biodiversity Monitoring Network

China's Forest Biodiversity Monitoring Network (CForBio) is a biodiversity routine monitoring network in the charge of the Institute of Botany, the CAS. It has 8 sample spots, namely, the Changbai Mountain, Gutian Mountain, Dinghu Mountain, Banna, Dongling Mountain, Baotianman, Badagong Mountain. CForBio is responsible for routine monitoring content and data. CForBio's long-term development strategy is to conduct special research for different sample spots in China's forest biodiversity monitoring network. The research on CForBio sample spots attempts to break through the conventional ecological thinking, to introduce new technologies and apply transcript to large sample land to conduct research on the threat on species posed by drought and inter-specific interactions. It also carries out study on microorganisms by adopting high throughput sequencing with the reference of the large plot mapping method.

National Report
on Sustainable Forest Management

9

Promoting Sustainable Forest Management in China by Innovation

9.1 Major challenges of sustainable forest management in China

9.1.1Challenge of environment effects of forest resources brought by globalization

In the past two decades, forest has played an important role in climate change mitigation and adaptation. The international community generally believes that reducing deforestation and increasing forest carbon sink are the most economical and technically feasible mitigation measures in the future. And increasing forest resources should be the core contribution of forestry to combat climate change; and the adaptability of forest to climate change will further increase their mitigation capability. Therefore, many countries took concrete actions on improving forests' adaptation. Developed countries' actions include enhancing landscape connectedness, strengthening the stability and resilience of the eco-system and increasing forests' adaptability to extreme weathers. By contrast, for the developing countries, there is still a long way to go in mitigation and adaptation, because their adaptation action plans focus more on the recovery and utilization of forest resources than on the adaptation to climate change.

China's forestry ecological construction programs have obviously improved the forest quality, landscape connectedness, systematic stability, resilience and so on. It has brought forth growth both in forest area and quality for a long period of time, and has made China a country with the largest area of plantations. The plantations in China play an increasingly important role in meeting China's timber demand and safeguarding the regional ecological balance, especially in contributing to China's forestry biomass carbon storage. However, the current forest coverage in China is still only 2/3 of the global average level, ranking 139th in the world (FAO, 2010). The per capita forest area is still less than 1/4 of the world level; and the per capita forest stand volume is only 1/7 of the world level.

So far, acquisition and efficient distribution of resource through globalization has been formed in the areas of timber, pulp, new bio-energy, etc. With economic globalization accelerating, the influence of China's economy will widen on international trade and global environment. In 2011, China's imported roundwood and other wood products amounted to 223.75 million m^3 of wood, accounting for 44.75% of the total domestic consumption. The hardwood, which was used to make plywood, furniture and floorboard, also depends on import. The fiber materials came from China was in short supply, and the imported fiber wood products took up more than 80% of all imported wood on one year. China has become the second largest importer of wood products in the world, whose wood import quantity ranks the third only to that of petroleum and steel. The major importers are the United States, Canada, Russia and the Southeast Asia market, but Russia witnesses a decline of import share; the United States and Japan are major exporters of wood products, but the former one sees a decline of share in the export market; the first five export trading partners of China are the United States (21.73%), Japan (10.17%), Hong Kong of China (5.28%), the United Kingdom (4.08%) and Germany (3.16%); the first five import trading partners of China are the United States (12.93%), Thailand (11.34%), Indonesia (10.85%), Malaysia (10.42%) and Canada (8.45%)(SFA, 2012). It is obvious that China's forestry resources management and trade will exert more and more influence on global economic and ecological sustainability.

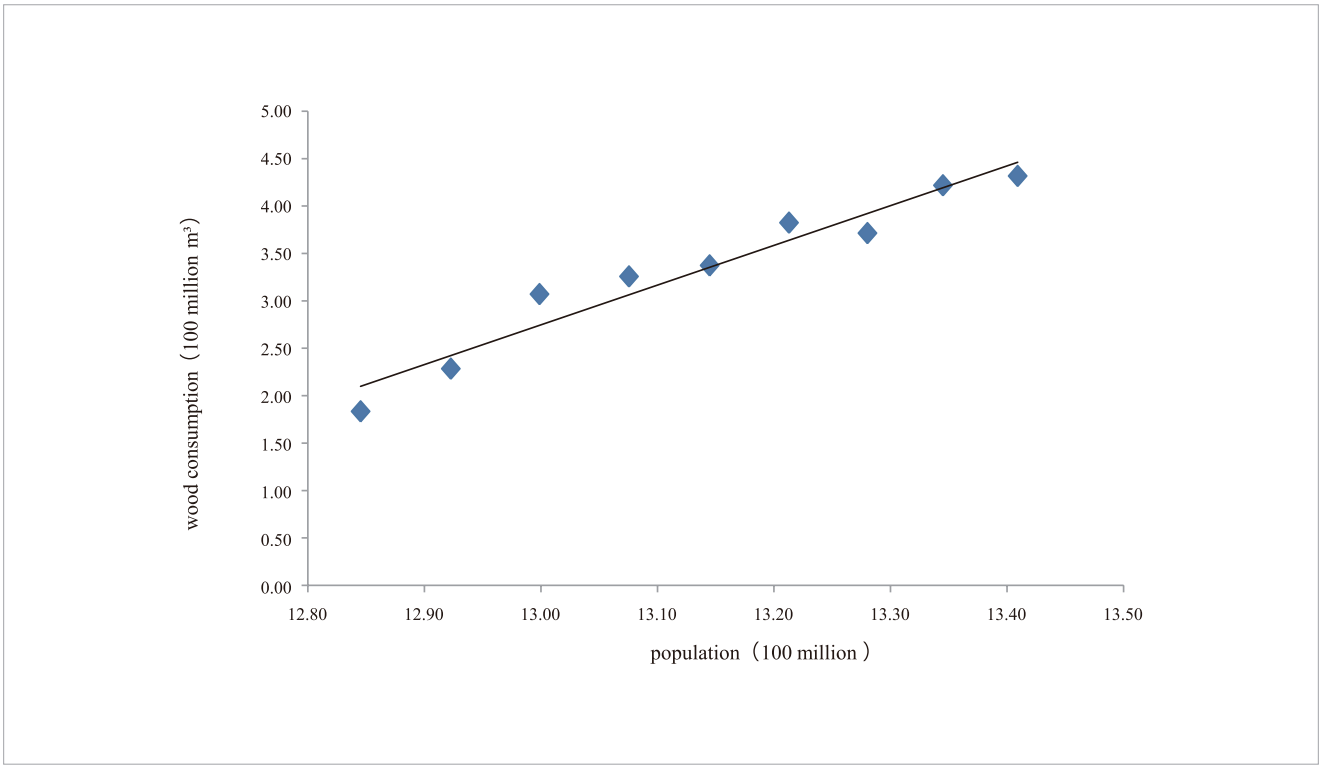


Figure 9-1. Wood consumption and China's population

9.1.2 Challenges of the increasing consumption of forestry resources caused by population growth and rapid socio-economic development

On the one hand, China is a country with a large population and still at the stage of population growth, which will inevitably lead to an increase of resource consumption. In 2011, the total consumption of wood products nationwide reached 500 million m³, up by 15.78% on the 2010 level (SFA, 2012). Wood consumption will also increase as the population and market demand increase.

On the other hand, the expansion of economy generally requires more resources. Since the reform and open-up policy, the economy of China has increased rapidly especially from 2003 to 2011, when it maintained an annual growth rate of 10.7%. This led to an increasing consumption of resources. In 2009, China's wood consumption reached 422 million m³; China's annual net consumption of forestry resources was 379 million m³ with a supply gap of 100 to 150 million m³ (SFA, 2010). In 2011, the nationwide supply of wood products was 500.04 million m³, up by 15.78% on the 2010 level; and the overall consumption of wood products was 199.92 million m³, up by 15.78% on the 2010 level. At the same time, industrialization, rapid urbanization and large-scale construction projects that are necessary to China's fast economic and social development require large amounts of resources, discharge more pollutions and occupy more lands including forestry lands.

Therefore, the policy of "wealth transfers between generations" should be adopted to balance supply and demand, seek sustainable utilization of forestry resources, generate economic and ecological benefits of forests, pursue sustainable development of forest communities and the national economy, and create fair opportunities for intergenerational equality. These are both an important mission and a huge challenge for China's sustainable forest management (SFM).

9.1.3 Challenge of constrains in forest production efficiency caused by imbalance natural resources endowment and backward technologies for forestry economy

China is a developing country with a vast mountainous area. But we have imbalanced natural resources endowment for forestry development. To be more specific, besides a serious shortage of forestry resources, China also has a small-scale forest industry, low production efficiency, backward technologies for forestry economy, imbalance of wood supply and demand, slow income increase of forestry workers and residents in the forest areas, a vulnerable forestry eco-system, and large social demand. For instance, first of all, the mountainous areas of China account for 69% of the national territory, and residents there take up 56% of the total; mountainous areas are the resource treasury and the source of many big rivers, because 90% of the country's forestry lands, 84% of the forest stock volume, 77% of the meadow, 76% of the lakes and 98% of the hydro-energy lie there[11]. But generally speaking, the social undertakings in mountainous areas so far are still backward, which directly determines the overall process of China's SFM. Second, under-endowed natural resources and backward forest technologies can directly lead to inefficient utilization rate of national and local forestry funds. There are backward technologies particularly in the grass-root level of the mountainous areas, low-level technology management, and an imbalance between forestry management capability of individual forest managers and increasing economic and ecological demands. Third, there are insufficient funds for forestry technologies, a lack of independent innovation capability and ineffective technology promotion measures, and an increase of diseases and insects in the forests, which can lower the technology efficiency.

The backwardness of forestry technologies is also reflected in development limits by technological approaches and policies. (1) One of the key transitions that China's forestry economy must go through is to make ecological and environmental problems a main issue for consumers and the market, instead of just a focal point of the country, so as to further convert the ecological and environmental benefits into competitiveness. That means we should make every effort to turn forest management into a way of utilizing the land that cultivate our competitiveness, no matter from the national, local or individual level, so as to comprehensively and systematically promote the technology, policy and management development for sustainability of forests, and to form a system of theories, technologies and institutions with Chinese characteristics as soon as possible. (2) Local forestry institutions, particularly the newly emerging forestry corporations, lack technological capability for improving forestry management and logging operation, as well as that for development. There is also a shortage of systems to support the proper distribution of technology upgrading cost, administrative cost and operational cost at the government, company and user level. Changing the above two conditions is important to increase economic benefits of the forestry economy. (3) Although the *Forest Law* has explicit provisions on forest management plans and schemes, they are yet hard to be implemented with the current enforcement and examination system. (4) The overall improvement of forestry productivity and scientific evaluation cannot be guaranteed because of the less standardized technologies and the less transparent, normalized and legalized enforcement of standards which cause a big difference of institutions and groups in demands and enforcement. (5) We should build information-based forest areas and forestry, and pursue professional forestry management. China has tens of millions of residents in the mountainous areas or forest areas. Most of the places have backward transportation and information conditions. The information gap has become an important feature of the dual structure of rural and urban areas. Accelerating the building of information-based forest areas is conducive to the proper distribution and two-way flow of production factors, economic factors and living factors of the forestry, as well as the development of modern forestry and the building of new countryside. Thus, we should rely on modern science and technologies to promote the professional management of forests. The experience of developed countries prove that the most direct and effective ways to upgrade traditional forestry and improve productivity are to improve workers' overall management quality through science and technology, cultivate a batch of modern forestry labor force working full-time or in multiple locations, and build a new-type

[11] *Hu Yingxue. Events of the Comprehensive Development of Mountainous Areas in China. Forestry Finance and Accounting. 1996, (12)*

service system for forestry technologies that combine technological innovation with forestry business.

In fact, "For a long period of time, we segmented the process of forestry management. Forestry production seemed to be the combination of afforestation on the one hand, and deforestation on the other hand. As a result, a wrong concept was formed that afforestation means protecting forests, while deforestation means damaging forests. Actually, forest management is a project requiring scientific planning and meticulous enforcement. Only by doing so, can we really improve the quality of forests and achieve SFM (Tang Shouzheng, 2011)". China highlighted both afforestation for greening the country and deforestation for using wood, which contributed to the expansion of forest areas and meeting wood demand. But this kind of practice that emphasized on only the two ends while ignoring the intermediate links will lower the productivity of forest resources. Meanwhile, the backward theories and technologies of China's forestry management have proved to be obstacles to establishing a system of theories, technologies, policies and institutions on forestry management with Chinese characteristics, not to mention sustainable management. This is the key reason why China cannot meet wood demand and address ecological problems. And this is also the gap between the forestry of China and of other countries.

The development and reform of forestry, especially the collective forest tenure reform, inject vigor into this industry in China. The model of green economy which adjusts measures to local conditions and gives equal attention to protection and development, such as "under-forest economy", focuses more on balancing and improving the productivity of forest eco-systems. This model is now promoting the healthy development of China's SFM. But generally speaking, how to advance forest management, maintain and take advantage of technological progress in order to motivate different managers in designing forest management plans and institutions and utilizing technologies, particularly forest farmers, and to make sustainable management profitable without sacrificing ecosystems at the same time, is a long term issue.

9.1.4 "Soft" Restraint of Law, Policy and Management Mode

1. Conflicts and restraints of relevant national laws and regulations and their implementations

The major legal system of China's forest protection, utilization and sustainable management consists of the *Forest Law of the People's Republic of China* and its implementing regulations, *Law of the People's Republic of China on Water and Soil Conservation, Water Law of the People's Republic of China, Land Administration Law of the People's Republic of China, Law of the People's Republic of China on the Contracting of Rural Land, Law of the People's Republic of China on the Protection of Wild Life* and its implementing regulations, and so on. However, the laws and regulations on the utilization and protection of forest resources are still not complete or rigorous, and cannot scientifically handle the relations between development and efficiency, efficiency and equity, leading to the conflicts between the utilization and the protection of forest resources. Although China's *Forest Law* includes requirements on forest ecological benefits compensation, it still lacks provisions on forest rights compensation fees, which makes forestry investors and protectors cannot receive relevant compensation or returns. The compensation fees in the current relevant compensation clauses or provisions are relatively low, which has severely impacted the implementation and practice of the protection policies of forest resources.

With the acceleration of economic globalization, the globalization of forest issues has become an inevitable trend of forest sustainable management and development. Rio+20 highlights again the position and role of forests in global sustainable development. As a big responsible developing country, China has acceded to many international conventions, such as the *Convention on Biological Diversity, United Nations Framework Convention on Climate Change* and *United Nations Convention to Combat Desertification*. China has built a good international image in shouldering responsibilities and fulfilling obligations, but China's forestry and forest legal environment is still in need of further improvement to adapt to the globalization of forest issues.

2. Restraint of inter-sectoral cooperative mechanisms

China's special historical culture and basic national conditions decide China's forest conditions and the particularity of China's laws, policies, institutions and systems related with forest resources protection and sustainable management. China's forest is not only one of the basis of national economy, but also a protective shield of China's ecological security and an important basis of dealing with climate change and enhancing green development. Therefore, the management and sustainable development of forest resources should not only be the work of forestry authorities, but also part of the core plans uniformly coordinated by the government. However, in the past decades, forest management still has not been included in the core content of national economic development plans and the capacity of authorities related with forest management cannot meet the demand of implementing SFM. At the same time, China's economic departments and departments of resources and environment still lack highly efficient cooperation and coordination. The setting and obligation defining of institutions related to resources and environment are not systematic or complete, and even conflict with each other. For example, the laws and regulations related to land, forest, biodiversity, and the conservation of water and land are managed by different departments, leading to decentralized and separated management, which is not beneficial for the protection of woodland and forest resources and the full play of their functions. The governmental authorities are too soft in the operations management and responsibility coordination of forest and the government's management over programs leads to the fight for programs and the ignorance of law enforcement, policy implementation, supervision and management. For example, the management planning and plans of forest is difficult to implement, and the construction of ecological projects and developing programs of forest resources can hardly obtain the expected performance.

3. Challenges on the transition of resource management mode

On the one hand, China's forest resources management mode originated from the planned economic system and has obvious characteristics of administrative systems, which is government-oriented and stresses the control of the government. Basically, it is a top-down management mode and decision mechanism. This system has played a huge role in securing economic development in the national construction period and protecting forest resources for a long period of time. But the policymaking, planning and environmental impact decision of ecological protection lacks efficiency, responsibility and equity. Although it seems that the reform of forest rights has impacted the management mode; stakeholders are diversified; and the environment, objects and range of forest policy implementation has changed. However, the effective balance mechanism in protecting forest resources between the central and local governments still has not been formed; many fields of the evaluation system related with resources protection and environmental impact involves multiple departments; and the dual command between the superior authorities and local governments are obvious. These, to a large extent, have impacted the execution and efficiency of policies, laws and regulations related with forest resources.

On the other hand, although China has made substantial progress in public participation field, because of the impact of factors like long-term planned economic system and traditional culture, China's public participation mechanism is still incomplete; public's overall sense of participating in resources and environmental protection is still rather low; the ways of participation are scarce; and the level of participation is low, which makes it difficult to conduct effective supervision and restraint over forest resources management behavior of governments at all levels. The policy-making is centralized in the central government, and in the setting of obligations, local governments lack mechanisms and ways to participate in policy-making.

9.2 Promoting China's sustainable forest management through innovation

9.2.1 Theory innovation

Innovation refers to developing new products or services, new markets, new sources of supply, advanced techniques or effective ways of organizing production, so as to improve productivity and create profits and wealth (Schumpeter, 1934). The innovation of theory and concept is the source of all technological innovation.

The first thing to promote SFM is theoretical innovation. In the global trend of welcoming green economy, low-carbon economy and circular economy, the innovation of forest management theory is the fundamental way out for promoting the SFM. At the national level, the essence of SFM is to connect the cultivation, utilization and protection of forest resources together organically, integrate the primary, secondary and tertiary industries together with modern science and technologies, and establish and improve the modern forestry system that "integrates ecology and people's livelihood together". "Forestry for ecology and people's livelihood" is the spirit of the strategic thoughts of China's SFM.

SFM is the key to realize and give full play to forest's ecological service function, offer more and better forest products, ecological products and eco-cultural products to the society. Therefore, in theoretical aspects, the SFM theory is an innovation of traditional forest management theory, whose cores are: 1) Inherit and utilize traditional technologies; add the theory of protecting and reasonably utilizing ecology, environment and bio-diversity to forest traditional management and forest utilization technologies; and at the same time, fully consider people as part of the ecosystem, consider the impact of people's policies and behaviors on the ecosystem and care about the impact of this kind of impact on the structure and functions of forest ecosystem. 2) Different ecosystems and eco-services should be managed effectively at the landscape level, instead of being limited to health and stability of a single ecosystem, and should maintain the sustainability of the overall structure and functions of the whole landscape so as to ensure forest offer diversified products, services and ecological functions at a broader landscape level, instead of just expanding the forest coverage in certain regions. 3) The concept of SFM considers the complexity of climate change's impact over forest and the impact of solutions under specific conditions, and offers a beneficial framework for forests to mitigation impacts of climate change. 4) To implement SFM, an incentive mechanism and public participation system must be established to improve the initiative of forest management institutions. There are many important restraining factors of SFM, such as traditional concepts, capital investment mechanism, income distribution system and changes of market demand. In practice, we must stick to the categorized guidance, establish and improve the wide participation mechanism of different interest groups related to forest, reasonably choose forest management mode and give full play to the initiative of forest management institutions, so as to realize the best effects of forest management.

At present, China's construction of testing and demonstrati*in situ* of SFM offers a good opportunity and platform for accelerating the transition from the traditional thought of forest permanent utilization to the modern thought of sustainable management. Firstly, it has improved people's understanding of forest's multiple functions, which not only stresses forest's timber production function but also highlights forest's eco-

service function; secondly, in the content of operation, it not only pays special attention to the growth of forest resources, but also specifically requires the maintenance and improvement of the overall functions of forest ecosystem; thirdly, instead of being limited to forest management institutions, it considers the residents' interests in the forest area to promote the participatory forest management.

All in all, the theoretical and technological innovation of SFM should be based on the sustainable development theory, aim at increasing forest resources, improving forest quality and playing its service functions, be guided by the methodology of comprehensive ecosystem management and landscape ecology, so as to scientifically make forest management plans and guide the practice of SFM.

9.2.2 Technology innovation

Global climate change is changing the environment of forest management. China's forestry is also facing many practical problems, such as the decreasing per capita area and low quality of woodland and forest resources, the frequent climate disasters, the huge and increasing forest health risks, the decreasing labor forces in forestry and the lag of people's livelihood construction in the mountainous areas. Under the double pressure of increasing rigid demand and severe restraint of resources and environmental factors, we must, according to China's practical conditions, implement the innovation-driven strategy, accelerate the transition of forest management and forestry development methods relying on science and technology innovation, improve the scientific quality of foresters and mass forest workers, accelerate the restoration, industrialized management and sustainable development of forest ecosystem and improve the woodland productivity, labor productivity and resource utilization ratio constantly.

At the national level, forestry technology research and development should be conducted around aspects like resource growth, ecological security, industry upgrade, serving forestry reform and dealing with climate change, mainly including forestry ecological construction, forest management and protection, the cultivation, processing and transformation of commercial forest, the high-efficient utilization of forestry resources, and the forestry facilities and information technologies. At the same time, important basic theoretical research should be conducted on aspects like forest eco-service function, forestry eco-disaster prevention and control, forestry's dealing with climate change, innovation of tree species and qualities, forest resources cultivation and the high-efficient utilization of resources.

At the level of management institutions, the key is to make scientific and practical forest management plans, through the national demonstration plans of SFM and with the current knowledge and technologies, so as to build a technological system which can ensure forest owners effectively prevent or reduce the potential

Best Management Practice Framework	Main Contents	Major Focuses
Forest Management Plans	Interest Group Participation	Vulnerable Group
Forest Management Technologies	Landscape Approach	Water and Soil Conservation
	Ecosystem Management	Biodiversity
	Close-to-Nature Forestry	Pollution Control
	Ecological Logging	…….
	Under-Forest Economy	
	Compound Forestry	
	Traditional Management Technology	
	Health Management	
	……	
Human Resources	Technological Training	Skilled Labors and Professional Workers
Best Technological System = Management Goals × Ecological Risks × Technological Costs = Optimization		

negative impact on environment in the process of forest management, while gaining maximum forest product harvest. Through changing the composition of tree seed, we can effectively utilize the forest genetic resources, increase gene diversity, improve forest's adaptability, utilize more timber as renewable resources, improve the carbon sequestration function of forests and reduce the impact of climate change on SFM. We should also strengthen forest protection measures and improve the capacity to defend wind damage, insect plague and forest fire, etc., so as to build a technological system of SFM gradually.

A matured best technological system needs the optimization of management goals, ecological risks and technology cost.

9.2.3 Institution Innovation

The key of SFM system innovation is to increase the quantity and quality of forest resources and to offer an incentive and protection mechanism for the green transition of forest utilization, through adjusting and improving the current forest system.

Currently, the major system design in China is afforestation system, forest classified management and management system, forest protection system and so on, running through which are forest property right system, forest logging quota system, forestry taxes and fees system and so on. These systems are related with a wide range of legal systems related with the business scope of forest management, the rights and obligations of forest management institutions, the long-term plan of forest management, forest management plans, incentive and constraining mechanisms, quality supervision, qualification management, technology standard and cultivation quota management.

Afforestation is the fundamental measure to cultivate and increase forest resources. The laws and regulations concerning afforestation in the *Forest Law* include six aspects: forestry construction principles, science and technology support, voluntary tree-planting system, afforestation planning, afforestation tasks and closing hillsides to facilitate afforestation. With the rapid transition and development of the economy and society, requirements on the protection and restoration of forest are higher and higher. Further system innovation is needed to scientifically fulfill the responsibilities and obligations of afforestation.

Property right is the most basic problem of China's forest management system. The obscure defining of forestry property rights not only affects the play and further improvement of its efficiency, but also makes property rights exist nominally only. Defining property rights clearly needs to define many rights including right to use, right to benefit and right to transfer; it not only needs to define the stakeholders, but also needs to define the behavioral subjects and responsibility subjects.

Classified management is the basic system of China's forest management. According to different management goals and major utilization of forest, the *Forest Law* classifies forest and conduct relevant management measures to realize different forest management goals. Though loose, the basic framework of regulations on forest classified operation and management in the *Forest Law* is clear. The *Forest Law* provides the basic classification regulations of forest and the corresponding forest logging management regulation; the current applied forest classified management is also conducted under the original framework of five major tree categories and other relevant systems are scattering in a series of laws, regulations, rules and documents issued based on the *Forest Law*. For example, the *Regulations for the Implementation of the Forest Law, Measures for Forest Harvest and Regeneration, Measures for Dispute Settlement on Timber and Forest Land Tenure, Interim Measures of Closing Hillsides for Afforestation, Supervision and Inspection Measures for Timber Transportation*, and so on. On the whole, there are no clear definitions and regulations on forest classified management. The highest effective document proposes classified management is the *Decision of the CPCCC and the State Council on Accelerating the Development of Forestry*, which are neither regulations nor rules. To a large extent, this does not meet the requirements and importance of forestry to China's economy, social development and ecological security. Therefore, further improvement must be made from the perspective of systems to the perspective of laws.

In the management of commercial forest, the forest

logging quota system must be innovated urgently. On the one hand, forestry authorities and governments at all levels need to further improve the reasonable utilization of logging quota, to let different forest managers fully utilize the logging quota according to market changes, so as to gain economic benefits in time and promote forest protection at the same time. On the other hand, forest resources are public resources with economic, ecological and social benefits; to conduct forest logging quota management is to arrange the utilization of forest resources from the perspective of time and space, so as not to minimize the economic benefits of forest products consumption in region and time; and its essence is to pursue the equity of benefits and responsibilities. China is a country of scarce forest resources with low quality, uneven distribution and unreasonable structure. The deterioration of ecology has not been curbed fundamentally; and the rigid demand of the rapid economic development on forest resources and timber is increasing. Only by sticking to the forest logging quota management system and controlling the excessive and unreasonable consumption of forest resources can the baseline of ecological construction be guarded and the task of protecting eco-security be finished. Since 2002, China has conducted gradual adjustment on artificial timber forests logging management policies and tried the controllable logging quota policy. But in general, managers' right of disposition over forest assets has been limited in many aspects with little initiative. Further improvement needs to be made to balance the effective utilization of controllable logging quota and to control the over-quota logging phenomenon from the perspective of systems. For the management institutions of commercial forest, the most important thing is to offer protection in systems to let them make decisions freely according to the market mechanism, so as to increase their expected returns, reduce management risks, encourage investment in this field and increase social welfare.

Ecological compensation is the core of public benefit forest management which needs desperately to establish a transparent public participation mechanism. When amending the *Forest Law* in 1998, forest ecological compensation fund system was established; in 2000, the *Regulations for the Implementation of the Forest Law* provided regulations on the planning of public benefit forest. Conducting the forest ecological compensation fund system is an important change with strategic significance in China's forest management and ecological construction process. It fundamentally changes the forestry management system which originally regarded wood production and utilization as the only goal. It also marks the establishment of forestry's dominance in ecological construction, which plays a vital role in land ecological security, biodiversity protection, and economic and social sustainable development. However, China's current asset assessment of forest resources has no unified standard yet and lacks independent and professional asset assessment institutional system, which makes the evaluation and audit of forest resources asset difficult to conduct and it severely impacts the scientific and reasonable operation and management decision of forest resources.

As an innovation mechanism, forest certification is actively promoting SFM and forest product's accession to the international market. Implementing forest certification system will help: forest resources change from government direct management to government-society supervision and management; forest operation from focusing on economic benefits to the balanced development of ecological, social and economic benefits; forest logging from quota management to the management of forest management plans; certified timber transportation from license management to certification mark management; forest products from excessive consumption to green consumption. After ten years' efforts, China's forest certification system has been established and the international mutual accreditation is about to be completed soon, which will lay a solid foundation for comprehensively implementing the forest certification system.

With the improvement of forestry's position in dealing with climate change and improving people's livelihood, the concept of SFM and relevant systems are in urgent need of improvement and, at the same time, new system innovation is needed. For example:

(1) Forest ownership—forest carbon right system

With the changes and improvement of forest's position in dealing with the global climate change, especially after REDD+ became an important part of forest carbon issue, the new concept of forest "carbon right" has become an important part of forest ownership, directly impacting the process of SFM of countries.

Currently, countries are trying to regulate forest carbon

right in the legal and voluntary carbon market through legal means. The establishment and protection of carbon right can encourage the public and private investors to invest more in forest programs (such as REDD+). However, as a legal issue about new property rights, forest carbon right still has many contents that require discussion and further definition. For example, who owns the carbon right, the government or the private sector? How to incorporate the carbon right into the national legal framework? How to define and protect the carbon right in the circulation of different operation rights, and manage it in a sustainable way? Is the carbon sequestration right a new asset separated from land or an asset connected with land?

China has made important progress in the forest ownership field, but China's relevant research, policies and laws in the "carbon right" field are still scarce. Based on the MRV (can be measured, reported and verified) principle and the development trend requirements of SFM in the context of global climate change, in the future, strengthening the research on forest carbon right and the design of relevant systems, policies and laws will be an important task.

(2) More effective laws and policies of non-wood forest products

Non-wood forest products can make a great monetary and non-monetary contribution to people's livelihood. China's non-wood forest product resources are rich, with nearly 1000 kinds of economic trees and nearly 60 kinds of mass-planted tree species, including eight categories: fruits, dried fruits, woody oil crops, crude drugs, industrial raw materials, drinks, forest food and spices. China's planting area of non-wood forest product has been growing rapidly since 2004, accounting for one third of the total forest planning area by 2011. Its gross output has accounted for 10% of the forestry output by 2011, playing an important role in increasing the income of forest farmers. The non-monetary contribution of non-wood forest products is usually larger than the monetary income from forests. In addition, non-wood forest products also have a strong carbon storage capacity. Therefore, as an important part of forest resources and forest ecosystem, the non-wood forest product is an important goal and direction of SFM and an important power for China to stick to "ecological forestry" and "forestry for livelihood" and realize green growth and green development.

The sound laws and policies of non-wood forest products can enhance the ecological sustainability to ensure the non-wood forest products not being developed excessively. It is also beneficial for incorporating non-wood product into the framework of policies and laws in a better way. It can fully demonstrate the extent of commercialization and the heterogeneity and diversity of non-wood forest product resources, markets and stakeholders, and ensure the trade equity and improve people's livelihood in the rural areas. At present, China still has no clear legal systems in the non-wood forest product field, and innovative research and system design is urgently needed in the field of laws, systems and policies to support and protect non-wood forest products.

(3) Establishing effective green accounting mechanism, improving taxation systems and innovating ecological compensation mechanism construction

As a renewable resource, forests have become an important part of green economy by offering various products and services. Establishing an effective green accounting mechanism and improving taxation systems is an important way to guide green consumption and environmental investment and enhance the sustainable utilization of forest resources.

On the one hand, social high-income class has occupied a large share of resources and disturbed or polluted the environment for high income, so high earners have to pay high taxes and high environmental compensation. From the perspective of resources management, we should clearly define the responsibilities of forestry administrative authorities at all levels and establish the forest resources classified management and coordination mechanism and the forest value system for the paid use of woodland and forest resource, so as to realize the capitalized management of forest.

On the other hand, we must further realize the two externalities in the forestry production process—the external economy of forest cultivation and the external diseconomy of development and utilization. Through establishing the economic incentive mechanism which can protect and effectively utilize environmental resources, and making forest, environmental and economic policies which can partly ensure the source of forest cultivation fund, we can compensate and internalize the two externalities to realize the dual goals

of protecting resources and environment and maximizing economic benefits, so as to realize the permanent and high efficient utilization of forest resources. External economy (the free utilization of ecological efficiency) is measured by shadow prices and the government can use means of macro control, such as charging consumers ecological construction fees, appropriation and subsidies, so as to realize the compensation of ecological efficiency values; for the external diseconomy (the loss of ecological efficiency), the government can charge forest producers ecological destruction taxes to internalize external cost and promote the sustainable management of forest.

All in all, China's forestry has developed from being dominated by "wood production" to "classification management", from being dominated by "ecological rehabilitation" to "ecological forestry and forestry for people's livelihood". The theoretical framework of China's forestry development is developing and improving, and embarked on the development road of "ecological civilization" construction. However, on the whole, China's forestry management is still a top-down management mode. Aiming at the defaults and disadvantages of this mode, according to the principles of combining centralization with decentralization, and matching rights, responsibilities and capacities, China's SFM needs to further establish and improve the legal system related with forests, effectively supervise and regulate various levels of protection and utilization of forest resources and innovate China's forestry systems and management methods, which means to improve forestry management tools in the national, private sectors and at the social public level.

① Evaluating and sorting out laws such as the Forest Law, and dealing with its conflicts with other relevant laws. Improving laws and regulations related with forestry and strengthening the coordination between different departments; strengthening law enforcement efforts and giving full play to the effectiveness of the current laws and regulations;

② Sorting out relevant policies, adjusting and improving inappropriate forestry policies and coordinating the relations between different forestry production links to improve the systematicness and compatibility of various policies. Strengthening the cost efficiency analysis of policy-making and the supervision and evaluation of policy execution, and improving policy execution effects and avoid policy malfunction.

③ Improving intergovernmental coordination of SFM policies and the wide participation mechanisms of the central, local governments and the public, to highlight the social characteristics of forestry;

④ Strengthening the protection, restoration and utilization of forest and the demonstration, research, monitoring, evaluation and report of sustainable management, and gradually developing the SFM theory and technological systems with Chinese characteristics;

⑤ Enhancing the forestry technology consciousness of governments at all levels, forestry authorities and forest managers, vigorously promoting the popularization of forestry technologies, and improving the transforming efficiency of forestry technologies;

⑥ Deepening forestry reforms and resolving the system and mechanism issues of forestry construction. Further improving forest management systems, defining and strengthening functions of the government in SFM and forestry sustainable development, boldly developing non-state-owned forestry, and promoting the public-run forestry.

Special column: Demonstration of China's SFM—Management System

At present, China is carrying out the SFM demonstration. One of its main purposes is to summarize and explore China's SFM system in a creative way, mainly shown in the practice and reform of logging management system, the compilation and implementation of forest management plan, the improvement of forest management planning system, the exploration of collective forest rights system, the formation and development of participatory forestry management mode, the issuance of varied supporting policies, the usage of new management means and monitoring technologies, and so on. This will vigorously support and promote the rapid development of China's SFM.

1. Logging management system

In 2009, China issued the Opinions on the Reform and Improvement of Collective Forest harvesting Management and carried out pilot reform of forest logging management in 193 counties of 24 provinces nationwide. Through the trial, reform has been conducted in adjusting the range of quota management, simplifying forest logging management links, promoting forest logging publicity system, implementing single control of "stand volume" in logging quota management, carry-over utilization of logging quota, timber production plan filing, and not incorporating unplanned woodland and timber logging into quota management. An open, transparent and simple new logging management mechanism has been established gradually. The concrete logging management policies and measures of the pilot units mainly include the following aspects:

(1) Conduct classified management system over ecological public benefit forest.

(2) Loosen commercial forest logging management.

(3) Establish forest logging contracting system. The way to complete this program is to gradually adjust the forest logging and regeneration management policies, to realize the decentralization of administration authority to correspond with the shouldered responsibilities and obligations.

(4) Regulate the distribution and utilization management of forest logging quota, properly loosen restrictions on factors like forest logging area, tree species, gradient and strength, and gradually improve forest farmer's legal right of disposition over forest.

(5) Further improve the distribution method of logging quota and change from the sum management and total control of logging quota to quota management and item control. Counties directly allocate various annual logging quotas to farmers and plots, to let forest farmers know the logging quota in five years ahead of time. Village-level quota allocation disclosure system should be conducted, the allocation list should be disclosed to ensure fairness, just and open, and supervision should be accepted consciously.

(6) Simplify forest logging management links and adopt measures of "one-stop" application, "one-card" design, "one approval", "zoning policy implementation" and "transparent management".

2. Compilation and implementation system of forest management plans

According to the national Compilation and Implementation Outline of Forest Management Plan, we carried out the testing and demonstration of SFM in seven institutions, organized 200 pilot compilation programs of forest management plans, and explored actively the policies, regulations, rules and modes of SFM in different regions.

(1) Stick to multi-coordination, which means the coordination of resources, environment and economic and social development, the coordination of responsibilities, rights and benefits of owners, operators and managers, the connection of plan compilation implementation and zoning policy implementation and classified management policies, paying equal attention to the protection, development and utilization of forest resources, and the coordination of ecological, economic and social benefits.

(2) Stick to multi-participation. The compilation authorities should dominate the compilation work, and forestry planning and design authorities, representatives of forest right owners, representatives of forestry authorities and representatives of communities should participate together, and fully respect the autonomous right of forest

managers. The forestry authorities should be in charge of the check and coordination of policies, and the planning and design authorities should be in charge of technological service.

(3) Stick to be prudent and normative, which means strictly following the requirements of plan compilation outlines to conduct compilation projects, including preparatory work, conducting resources system evaluation, making multi-plan decisions, encouraging public participation, soliciting public opinions, conducting operation decisions, planning and design, carrying out review and revision, and so on.

(4) Organize meticulously, which means selecting professional talents, hiring hi-tech talents for guidance, establishing professional compilation team, widely collecting related materials, proposing back-up plans based on systematic analysis, determining the best plan through experts' review and argument and carrying out forest operation zoning, layout and forest planning and design according to the best plans.

(5) In technology, we should comprehensively analyze the status quo of forest resources and management, learn the experience of secondary forest comprehensive cultivation, natural forest protection projects and the construction of testing and demonstratiin situs, apply modern forestry theories and new technologies, regard forest resources protection and development as the core, focus on improving the overall functions of forest ecological system and regard enhancing the economic, ecological and social sustainable development of forest district as the goal. We should analyze the multi-resources utilization model through combining the time and space, make clear the forest functions, operation and management types, management technology modes, reasonable annual logging volume, management task planning and arrangement, etc., and compile bureau-level SFM plan according to the demand of multi-goal operation.

(6) Adopt classified management method for forest management planning and plans. For example, we can incorporate SFM into local economic and social development plans; and according to different management institutions and cultivation goals, compile four kinds of plans respectively: collective forest management plan, village and town simplification plan, state-owned forest farm management plan and large forestry managers' management plan, to realize the full coverage of every aspect of forest management.

3. Forest Management Planning System

Sustainable forest management planning is the forest management required by forestry administrative authorities and be conducted in a certain time period, according to the theories and requirements of SFM. Its contents include factors like planned activities, location, time, reason and completers. The planning refers to a planned arrangement guiding the jurisdictional regions and management authorities to conduct SFM and it is also an important evidence of local administrative authorities or forest management authorities to protect and develop forest resources.

At present, after years' of efforts, China has basically formed an overall framework of SFM planning decision, which refers to the four systems formed under the guidance of the macro-strategic thoughts of forest classified management: the macro guidance system based on the national forestry development zoning and the policy implementation principles of forest resources operation and management zoning; the regional decision system based on regional SFM planning; the operation and management system based on forest management plan; and the technology mode system based on multiple forest management means and ways.

A complete forest management planning system includes five levels.

(1) National or mega regional forestry planning: it includes forestry development planning, the protection, utilization and planning of woodland and the contents related with forestry in the medium and long term development plan of national economy, and it is complied mainly by the country.

(2) Provincial forestry planning: it is the planning of provincial-level forest management and is compiled mainly by provincial authorities.

(3) County-level forestry construction and development planning: it is the planning of county-level forest management and is mainly compiled by county-level authorities.

(4) Forest management plan or simplified forest management plan of forest management authorities: in order to manage forest scientifically, economically and orderly, and give full play to the ecological, economical and social benefits of forest, according to the situation of forest resources and social, economic and natural conditions and under the guidance of SFM planning, forest operation authorities compile the implementation arrangement of forest cultivation, protection and utilization and the design of production order and management and utilization measures; according to current regulations, for the forest operation authorities with legal personality, including state-owned forestry bureaus (afforestation bureaus), state-owned forest farms (management institutes), state-owned forest operating companies, state-owned forest logging and cultivation farms, nature reserves, forest parks and other state-owned forest operation authorities; and forest operation plans are compiled and implemented independently; for the collective operation (management) organizations with a large area (above 200 ha) and non-public operation entities, simplified forest management plans are organized and compiled under the guidance of local forestry authorities.

(5) Annual operational plan and design: the measures and arrangements conducted before operation.

4**. Collective forest rights reform and participatory forestry management system**

(1) Collective forest rights reform policies. The central government uniformly deploys the reform of collective forest rights. Local governments comprehensively deepen the reform, mainly including the following aspects: ① Establishing modern forestry property rights system, conducting collective forest rights system reform with "identifying property rights, settling boundary and issuing certification, loosening management rights, protecting right to use and shouldering responsibilities" as its main contents. Establishing forest rights management and service centers, building forest rights circulation and transaction platform, strengthening the construction of forest resources asset assessment institutions and teams, improving forest rights circulation systems, orderly conducting forest rights circulation and vitalizing forest resources assets. ② Strengthening the financial support for forestry development, innovating financial products, improving forest rights mortgage system and expanding the coverage of forest rights mortgage. Guiding forestry management entities to actively participate in the policy-oriented forest comprehensive insurance to expand the insurance coverage. Implementing the policy of exempting forestry cultivation fund for light penetration tending and subsiding afforestation nursery stock and young growth, establishing financial supporting system for forest rights mortgage, strengthening the promotion of forest rights mortgage, expanding mortgage range and broadening the channels of forestry financing, so as to greatly motivate the enthusiasm of farmers to plant trees, strengthen the vitality of forestry development and manage forest scientifically and reasonably. ③ Reforming forest logging management, strictly implementing the forest logging quota system and improving the forest logging classified management. ④ Innovating forestry management mechanisms, cultivating new forestry operation entities, vigorously developing cooperative organizations like forestry professional cooperatives, cooperative forest farms and shareholding forest farms. Making leading enterprises bigger and stronger, guiding these enterprises to establish close interest connection mechanisms with farmers, vigorously promoting industrialized operation of forestry and improving operation benefits. ⑤ Strengthening the construction of program management systems, establishing various modes of systems, such as program management systems, financial systems, performance evaluation systems and filing management systems, and conducting regular and

irregular special examinations to ensure the fund being earmarked.

(2) Participatory operation and management system. Participatory forestry operation is not only a kind of technology and management measure; more importantly, it is a kind of concept which stresses adjusting, adapting and managing forest flexibly with the changes of social values, environmental conditions and political pressure. With the deepening of collective forest reform and learning from the participatory forestry operation and management methods, pilot institutions should actively explore and gradually form new modes and methods of forest management co-managed by communities.

5. Monitoring and Evaluation System

The monitoring and evaluation of China's SFM embodies the principle of combining systematicness with expandability, comprehensive management with comprehensive benefits. The system is as follows:

(1) Establishing a forest condition monitoring and evaluation system based on central-local forest resources monitoring and evaluation;

(2) Improving monitoring technology systems. 1) Establishing sustainable management, monitoring and evaluation standard systems. Through summarizing the experience of pilot forest and learning from the standards of international organizations, such as International Tropical Timber Organization (ITTO) and International Standard Organization (ISO), we should design an evaluation standard system for the SFM at the institution level, which fits the features of domestic forest management. 2) Establishing forest and ecological monitoring system. According to the evaluation requirements of SFM standard system, we should establish a monitoring system which can objectively reflect forest management dynamics and effects and conduct regular or real-time monitoring of the environmental, economic and social impact of its management activities. It mainly includes: (a) Operation-level monitoring. It mainly monitors whether proper management procedures have been implemented and whether management goals have been reached, with methods like tracking monitoring, operation examination and acceptance and operation performance examination; (b) Macro forest and environmental monitoring. It mainly monitors the long-term impact information of forestry activities, mainly through methods of establishing fixed sample plot (belt transect) systems, positioning observation stations (ecological, environmental, hydrological factors) and special investigation. The trial initially developed new forest resources monitoring technologies, such as strengthening continuous forest inventory and forest management inventory, which means timely reflecting forest management activities to strengthen the investigation and evaluation of forest health and biodiversity, realize the dynamic monitoring of forest resources and regularly publish forest ecological resources monitoring results. 3) Establishing and improving forest management and management information system. After the supplementary investigation of forest resources, we should establish a forest operation and management information system which can effectively manage forest resources and all management activities based on "3S" technology, to offer basic information evidence for timely making decisions of adjusting policies, planning and taking emergency measures.

6. Supporting policies and systems

(1) Laws and regulations. 1) The legal status of forest management plans. We should gradually establish a reward system of forest resources management plan design and execution which is guided by the government reward, dominated by departmental reward and combined with regular reward and timely reward; we have established the forest management plan publicity system, the democratic supervision system combining superior authorities with social opinions, and the accountability system for the management entities which violates forest management plans and the superior authorities which supervise inadequately. 2) The legitimate rights and interests of forest management institutions. We should gradually strengthen the

legitimate rights and interests of forest management institutions, including: ① defining property rights, ② loosening management rights, ③ implementing disposition rights, ④ protecting the right to use. Besides, the current laws do not explicitly stipulate the definition and ownership of the property rights of forest carbon sink. It is still at the stage of exploration. This will help encourage and restrain the operation behavior of forest managers. 3) The evaluation system of forest management and logging management. We are trying to gradually establish the forest management planning and target assessment systems, and improve policies of forest logging quota systems. According to the requirements of forest classified management, policies should be issued to conduct different logging management systems for ecological public benefit forest and commercial forests.

(2) Economic policies. According to the characteristics of forest resource management, we are trying to improve the following economic policies gradually: 1) making the policy of full amount appropriation for forest management departments; 2) improving ecological public benefit forest compensation policies; 3) improving forest management subsidy policies; 4) improving forest rights mortgage and forestry auxiliary financial products policies; 5) expanding the range of the preferential policies on forest management tax breaks; 6) formulating policy-oriented forest insurance policies and; 7) establishing new development fund for forest management.

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