Environmental Impact Assessment Report of the European Investment Bank-financed Sustainable Forest Management Project in Qiandongnan Prefecture, Guizhou Province

Forest Survey, Planning and Design Institute of

Qiandongnan Miao and Dong Autonomous Prefecture

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Project Name: Environmental Impact Assessment Report of the European Investment Bank-financed Sustainable Forest Management Project in Qiandongnan Prefecture, Guizhou Province

Construction Unit: Forestry Bureau of Qiandongnan Prefecture, Guizhou Province

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Chapter I General

1.1 Project Background

Qiandongnan Prefecture is located in southeastern Guizhou Province. Densely covered by mountains, it is very suitable for plant growth with a warm and humid climate and good soil conditions. Having long been known as “a mountinuous suitable land for forest”, it is a major collective forest area in south China with eight of the ten key forestry counties in Guizhou Province. Located at the upper reaches of the two water systems of the Yangtze River and the Pearl River, Qian Southease Prefecture has the Qingshui River and Douliu River which are important tributaries in the upstream of the two water systems, so that its forest ecological situation is directly related to the downstream ecological security and the forest here is an important ecological barrier. Previous Qiandongnan Prefecture party committees and governments have attached great importance to forestry development and made arrangements and deployments for the vigorous forestry development at the level of safeguarding the national ecological security and promoting the economic and social development across the Prefecture. Since 1980s, remarkable results have been achieved in forest cultivation and protection with funds raised through afforestation project loans and major forest projects.

Qiandongnan Prefecture has a land of 3,033,710.0 hectares, including 1,910,327.2 hectares of forest, with a forest coverage of 62.97% and forest stock of 119.243 million square meters, both being the best historical level since the founding of new China. However, due to historical, natural and socio-economic conditions, problems such as the not high forest resource quality, low forest productivity, single structure of tree species, fragile ecology in some areas, lack of funds for forest resource cultivation, and low proportion of forestry of forestry farmers’ income still exist currently in the ecological construction of the Prefecture. How to properly handle the relationship between the protection, use and cultivation of forest resources and to promote coordinated economic and social development across the Prefecture is a new major issue facing the Prefecture’s ecological construction now.

Since 2008, Guizhou Province has been listed as a national advance demonstration area of ecological cultivation and the Prefecture has been listed as national demonstration area of ecological compensation, and the Prefecture party committee and government has actively accelerated the construction of the three systems of “a complete forest ecological system, a developed forestry industry system and a prosperous eco-cultural system” based on the Prefecture’s conditions. In 2012, to support the economic and social development in Guizhou, the Central Party Committee and the State Council issued the Several Opinions on Further Promoting Sound and Rapid Economic and Social Development in Guizhou (Guo Fa (2012) No. 2) (hereinafter referred to as “Guo Fa No. 2” document) which clearly proposed the strategic position of an important ecological security barrier in the upper reaches of the Yangtze River and Pearl River for Guizhou. Qiandongnan Prefecture, as an important ecological area in the upper reaches of the two rivers, received further attention of various levels of party and government leaders in forest ecological construction. The Comprehensive Plan for the Treatment of Stony Desertification in the Water Conservancy Construction and

Ecological Construction in Guizhou (hereinafter referred to as the “Trinity” comprehensive plan) and the Tackling Plan for the Regional Development and Poverty Alleviation in Stony Desertification Areas in Yunnan Province, Guizhou Province and Guangxi Autonomous Region prepared by the state ministries and commissions led by the National Development and Reform Commission, both incuded Qiandongnan Prefecture in the scope of planning and provided a rare opportunity for development for the ecological cultivation in Qiandongnan Prefecture. Recently, the Party’s 18th Natinal Congress further proposed that ecological cultivation should cover all aspects and the whole process of economic, political, cultural and social development and it is a long-term plan related to the prople’s well-being and the nation’s future, further enhancing the confidence and determination of Qiandongnan Prefecture to accelerate the promotion of the ecological compensation demonstration area construction and to actively create the national advance demonstration area of ecologicl cultivation.

1.2 Project Overview

1.2.1 Basic Profile

1) Project Name

Sustainable forest management project financed by European Investment Bank loans in Qiandongnan Prefecture, Guizhou Province

2) Construction Unit

Forest Bureau of Quan Southeast Prefecture, Guizhou Province

3) Legal Representative

Li Jike

4) Project Organization Unit

Office of Qiandongnan Prefecture, Guizhou Province of Forestry Projects Financed by World Bank Loans

5) Technical Guidance Unit of the Project

Chinese Academy of Forestry Sciences, Guizhou University Forestry College, Guizhou Academy of Forestry Sciences, and Qiandongnan Prefecture Institute of Forestry Sciences

6) Type of Construction

New construction

7) Project Layout and Scope

According to the principles of project layout, the project involves six counties (cities) in Qiandongnan Prefecture, specifically, Liping County, Jinping County, Jianhe County, Danzhai County, Majiang County, and Kaili City.

1.2.2 Main Contents and Size of the Project

The project has a total area of afforestation engineering of 14,389.76 hm², including 4,809.35 hm² of the existing forest under management and 9,580.41 hm² of afforestation.

（1） Existing Forest Management

The existing forest under management of 4,809.35 hm² includes:

A. Transformation of pure Cunninghamia Lanceolata forest: the existing inefficient pure Cunninghamia Lanceolata forest will be divided into bands or blocks mixed with phyllostachys pubescens or local broadleaf tree species after cultivation and thinning.

a. 1,774.12 hm² of mixture of Phyllostachys pubescens and Cunninghamia Lanceolata; and

b. 1,458.41 hm² of mixture of Cunninghamia Lanceolata and broadleaf trees.

B. Forest-herbs multiple layered forest management: the existing young and middle aged forest of Cunninghamia Lanceolata and Pinus massoniana will be transformed, and suitable herbs such as Uncaria will be planted in the forest after thinning. The total area is 1,243.42 hm².

C. Cultivation of large-diameter wood of Cunninghamia Lanceolata and Pinus massoniana: 333.4 hm².

(2) Afforestation

9,580.41 hm², including:

A. Local rare species: 2,125.91 hm²;

B. Mixture of Cunninghamia Lanceolata and herbs: 2,005.05 hm²;

C. Woody oil featured economic forest: 1,051.5 hm²;

D. Blueberry featured economic forest: 2,350.33 hm²; and

E. Mixture of Cunninghamia Lanceolata and phyllostachys pubescens: 2,047.62 hm².

1.2.3 Project Objectives

1. Overall Objective

Based on ecological protection, through active cultivation of multifunctional and complex ecological forest and featured economic forest, transform coniferous plantations, carry out cultivation of large-diameter commercial forest, build a high-efficiency and high-quality forest ecosystem, increase forest carbon sinks, improve the stability and sustainability of the forest ecosystem, actively build an ecological barrier in the upper reaches of the Yangtze River and Pearl River. While giving play to ecological benefits of the forest, provide timber, fuelwood, fruit and other forest products and advocate the increase of income of farmers through the improvement of forest resource quality, laying a good foundation for the creation of the Qiandongnan Preafecture National Ecological cultivation demonstration area.

2. Specific Objectives

(1) Create multifunctional and complex ecological forest and featured economic forest to increase forest area of 9,580.41 hm² and prefecture forest coverage of 0.32%;

(2) Build high-efficiency multifunctional ecological forest of 4,809.35 hm² through transformation of the existing low-efficiency forest and cultivation of large-diameter timber;

(3) Increase forest stock by 0.74 million m3 and increase forest carbon sinks by more than 1.25 tons through project implementation (by 25 years);

(4) Finally increase the annual output of tea-oil camellia (dry seeds), blueberries (fresh fruit) and uncaria (fresh) to more than 26,000 tons, 1,500 tons and 9,000 tons respectively through featured economic forest construction;

(5) Strengthen international and domestic exchanges and cooperation and actively introduce advanced international and domestic forest management concepts and techniques. Strengthen scientific and technological support and training to provide technical support for the construction of a high-quality high-standard forest ecological system and the improvement of the level of sustainable forest management; and

(6) Actively solve the problem of employment of rural labor by providing 2.3 million labor man-days during the construction to arrange for long-term employment of 3,000 people.

1.2.4 Project Construction Priod and Progress

1. Construction Period

The construction period is 3 years from 2015 to 2017.

2. Construction Progress

In consideration of the needs of the project construction, the priority is given to the equipment of office equipment such as PDA, cameras, computers, etc. in the first year, and afforestation tasks and other facilities and equipment are equipped in the years in balance. For the afforestation tasks, 5,501.99 hm² will be completed in the first year, including the management of existing forest of 618.04 hm² and plantation of 4,883.95 hm²; 5,857.20 hm² will be completed in the second year, including the management of existing forest of 2,402.37 hm² and plantation of 3,454.83 hm²; 3,030.57 hm² will be completed in the third year, including the management of 1,788.94 hm² and plantation of 1,241.63 hm².

1.2.5 Main Technical Measures for Afforestation

1. Management Techniques for the Existing Forest

Management models for the existing forest: By improving conditions for tree growth, improve woodland productivity, enhance forest's ecological protection functions, design according to the close-to-nature multifunctional forest cultivation model, focusing on the cultivation of large-diameter timber and the misture transformation of pure plantations, and determine the targeted tree species and the management model according to the combined long and short term cultivation. There are four management models designed for the management of the existing forest and they are Model 1 – management of the mixture of Phyllostachys pubescens and Cunninghamia Lanceolata, Model 2 – management of the mixture of Cunninghamia Lanceolata and broadleaf trees, Model 3 – management of the multiple layered forest of forest and herbs, and Model 4 – cultivation of large-diameter timber.

Model 1 -- management of the mixture of Phyllostachys pubescens and Cunninghamia Lanceolata: By thinning and selective cutting of the pure Cunninghamia Lanceolata forest with poor ecological protection efficacy and low ecological efficiency on the coasts of the Qingshui River in Qiandongnan Prefecture, retain 50-70 selected trees per mu, plant the mixture of Phoebe and zhuzi in understory bands, use short-term forest to support long-term forest, harvest zhuzi and process for multiple purposes in the short term, and harvest large-diameter high-quality timber in the long term, improve the forest yield, and enhance forest ecological protection through multi-layer management.

Model 2 – management of the mixture of Cunninghamia Lanceolata and broadleaf trees: By thinning and selective cutting of the pure Cunninghamia Lanceolata forest with poor ecological protection efficacy and low ecological efficiency on the coasts of the Qingshui River in Qiandongnan Prefecture, retain 50-70 selected trees per mu, plant the mixture of suitable broadleaf trees in understory bands, and actively plant mixed forest, enhancing stability and ecological protection of forest ecosystems.

Model 3 – management of the multiple layered forest of forest and herbs: Transform the existing Cunninghamia Lanceolata, Pinus massoniana or Camellia oleiferaAbel forest, retain 50-70 selected trees per mu by thinning or selected cutting, plant scattered Uncaria, yinyanghuo, tianma and other suitable brush vines or herbs in understory bands to improve understory space utilization and develop understory economy on the one hand, and to support long-term forest with short-term forest in the long term, harvesting high-quality ingredients and processing for multiple purposes in the short term and harvesting large-diameter high-quality timber in the long term, increasing timber yields and enhancing ecological protection of forest

through multi-layer management.

Model 4 – cultivation of large-diameter Cunninghamia Lanceolata and Pinus massoniana timber: Choose existing well-growing Cunninghamia Lanceolata and Pinus massoniana forest at good locations, cultivate large-diameter timber in according to the industry standards in the Guidelines for Cultivation of Large-diameter timber forest (LY/T2118-2013), to improve forest quality and increase the overall efficiency of the forest. The final felling years is more than 30 years for large-diameter Cunninghamia Lanceolata timber cultivation and more than 40 years for Pinus massoniana.

2. Afforestation

(1) Afforestation Model Design

To increase biodiversity, increase forest coverage and expand the total amount and quality of forest resources through regional ecological construction, focusing on the strengthening of ecological protection in the Yangtze River basin. Meanwhile, the project fully takes into account that the project is located in the poor mountainous areas and certain economic benefits should be taken care of while adhering to eco-efficiency orientation, so the project chooses the forest category of the combination of ecological forest (shelter forest) and economic forest to achieve both ecological and economic benefits.

In the selection of afforestation method, multiple tree species are chosen to actively build mixed forest to improve stability and ecological benefits of forest ecosystems. In the use of ground space, try to combine trees, shrubs and grass to implement complex woodland management to improve forest yield.

Meanwhile, the project design fully respects the wishes of farmers and afforestation subjects and based on the afforestation characteristics in different regions and the foresty industry development direction, explore revenue growth to the masses driven by forest resource increase and promote the building of a moderately prosperous society in the eco-poor areas synchronously. To this end, the project design includes five afforestation models: Model 5 – afforestation of local rare species; Model 6 – afforestation of the mixture of forest and herbs; Model 7 -- woody oil featured economic forest; Model 8 – blueberry featured economic forest; and Model 9 – afforestation of the mixture of Cunninghamia Lanceolata and phyllostachys pubescens.

（2） Selection of Tree Species for Afforestation

Based on the basic principle of suiting the land and trees, tree species are selected in accordance with the standard of ecological forest domination giving consideration to economic forest, conventional afforestation trees combined with local rare species, and the combination of multiple trees, shrubs and grass to actively create multifunctional mixed forest, and afforestation species (grass) are selected as follows, fully respecting the conditions of the wishes of forest farmers and of the local forestry industry development direction: Cunninghamia Lanceolata, nanzhu, Taxus chiinensis, osmanthus, Ormosia henryi, Phoebe, Photinia, Beech, Paliurus, Manglietia, Chapensis, Liriodendron, Privet, Arborvitae, Dendrobenthamia, Cinnamomum camphora, Camellia oleiferaAbel, Blueberry and Uncaria. Grasses under mixed management in the featured economy are selected as Alfalfa, Clover and other forage legumes or other herbaceous herbs such as Radix, Chinese herbaceous peony, etc.

(3) Main Technical Points for Afforestation

A. Woodland Clearance

Woodland will be cleared about three months before afforestation, mainly clearing residul wood, shrubs and tree stumps to facilitate future construction. Controlled burning is prohibited during the woodland clearance in order to avoid soil erosion and compaction. For steep ecology-sensitive areas, woodland is cleared in strips along the contours with appropriate vegetation zones retained.

B. Woodland Preparation Specifications

Model 5 – afforestation of local rare species: 0.5×0.5×0.4m.

Model 6 – afforestation of the mixture of forest and herbs: 0.5×0.5×0.4m.

Model 7 -- woody oil featured economic forest: 1.0-1.5m strips and 0.6×0.5×0.4m holes.

Model 8 – blueberry featured economic forest: 1.0-1.5m strips, and preparation specifications of 0.5×0.5×0.4m.

Model 9 – afforestation of the mixture of Cunninghamia Lanceolata and phyllostachys pubescens: 0.5×0.5×0.4m for Cunninghamia Lanceolata and 0.8×0.5×0.5m for Phoebe.

C. Planting

Planting time: December to March of the following year, planting in rainy or cloudy days. Fully fertilize before planting.

Planting density: The planting spacing and density is determined according to the site conditions of woodland, specie characteristics, cultivation purposes and construction methods. The planting density and spacing is 110 trees/mu and 2.0 X 3.0 m for Model 5, 110 trees/mu and 2.0 X 3.0 m for Model 6, mixed by single trees, 110 trees/mu and 2.0 X 3.0 m for Model 7 with grass seeds sowed in the strips, 200 trees/mu and 1.5 X 2.0 m for Model 8 with grass seeds sowed in the strips, and 74 trees/mu and 3.0 X 3.0 m for Cunninghamia Lanceolata and 19 stems/mu and 6.0 X 6.0 m for nanzhu for Model 9.

Planting methods: a. Seedling planting. To prevent moisture loss of seedlings, root dip treatment should be done and seedlings should be placed in the heel if not planted in the same day after lifted. The hole planting is adopted; mix mud with phosphatic fertilizer before planting; planting depth should be 1-2 cm higher than the rhizosphere of seedlings. Carry out “three fillings, two steppings and one lifting” and meet the “seedling upright, roots relaxed, deep-rooted, and soil filled and pressed by layers” requirements when planting, and earthing should be higher than the hole sides, and pour enough water to fix the roots after planting. b. Planting of mother bamboos of nanzhu. Bottom the hole with surface soil in the cleared land, pick grass roots, step the bottom, place the mother bamboo in the hole, parallel the long side to the contour lines, bury the rhizome at an appropriate depth, 3-5 cm deeper than where it had grown, place moist topsoil under the rhizome, fill soil around the root stump and step hard by layers to make the rhizome and shoots in close contact with the soil, pour adequate water and re-case soil, not to hurt shoots or rhizome. Set up stands in the windward direction or where the wind is strong, to prevent swings or collapse.

D. Replanting

Replanting should be organized timely in the autumn of the same year of planting or the spring of the second and third years according to the survival of seedlings to ensure the effectiveness of afforestation.

E. Tending

Implement tending once in the summer of the same year after planting and once in each

spring of the second and third years. Clear grasses that affect seedling growth and loosen the soil and nurture stumps during the tending. Fertilize once in each of the second and the third year in combination with the tending.

1.3 Purpose of Assessment

According to information provided by the Feasibility Study Report of the Sustainable Forest Management Project Financed by European Investment Bank Loans in Qiandongnan Prefecture, Guizhou Province, this assessment will demonstrate the reasonableness, feasibility and coordination with the social and economic development and ecological environmental protection of the project through the whole-process analysis of project size, layout, forest management methods and related activities based on the sustainable use of resources in the project area, analysis of regional environmental carrying capacity and ensuring a virtuous cycle of ecological environmental protection, and gives corresponding countermeasures and recommendations based on the conclusions of the assessment.

The assessment discusses the possible target of the project in the premise of striving for sustainable use of resources in the project area and the ecological environmental quality not lower than the current level, providing a scientific basis for the coordinated development of regional resources, environment, society and economy.

Collect information to grasp the ecological environmental conditions, resource environmental bearing capacity and main existing environmental problems in the project area; analyzes the reasonableness and legality and environmental feasibility of the project and predict and assess the impact of the project on the ecological environment according to the size, layout and forest management methods of the project as well as the whole process of related activities; and proposes specific practical ecological protection measures and ecological managemet and minitoring plans for the project so as to minimize the impact on the resources and environment in the assessment area and effectively protect sensitive areas and sensitive objects.

1.4 Basis of Preparation

1.4.1 State and Local Laws and Regulations

(1) PRC Environmental Protection Law (December 26, 1989)

(2) PRC Environmental Impact Assessment Law (September 1, 2003)

(3) PRC Land Management Law (August 28, 2004)

(4) PRC Rural Land Contracting Law (March 1, 2003)

(5) PRC Water and Soil Conservation Law (June 29, 1991)

(6) PRC Forest Law (April 29, 1998)

(7) PRC Flood Control Law (January 1, 1998)

(8) PRC Water Polution Prevention Law (February 28, 2008)

(9) PRC Solid Waste Pollution Prevention Law (April 1, 2005)

(10) PRC Forest Law Enforcement Regulations (State Council Decree No. 278, January 29, 2000)

(11) Classification Catalogue for Enviromental Impact Assessment of Projects (October 1, 2008)

(12) Basic Farmland Protection Regulations (January 1, 1999)

(13) PRC Natural Reserves Regulations (December 1, 1994)

(14) PRC Wild Plants Regulations (January 1, 1997)

(15) Classification Catalogur for Environmental Protection of Projects (November 26, 2002)

(16) National Ecological Environment Protection Program (State Council, November 26, 2000)

(17) Notice of the State Council on the Issuance of the National Ecological Environment Construction Plan (Guo Fa [1998] No. 36)

(18) Decision of the CPC Central Committee and State Council on Accelerating the Development of Forestry (June 5, 2003)

(19) Decision of the CPC Central Committee and State Council on Accelerating the Development of Forestry (Zhong Fa [2003] No. 9)

(20) Notice of the State Forestry Administration on Issuing the Standards for Ecological Forest and Economic Forest Created in the Grain for Green Project (Lin Tui Fa [2001] No. 550)

(21) Guizhou Provincial Forest Regulations (March 24, 2000)

(22) Guizhou Provincial Environmental Protection Regulations (May 28, 2004)

(23) Guizhou Provincial Afforestation Regulations (2002)

(24) Guizhou provincial Forest Fire Prevention Regulations (2002)

(25) Guizhou provincial Fire Regulations (May 28, 2004)

(26) Guizhou Provincial Tree Seedling Management Regulations (January 1, 2005)

1.4.2 State Technical Regulations

(1) Technical Guidance for Environmental Impact Assessment (1-IJ/T2.1-2.3-93)

(2) Technical Guidance for Environmental Impact Assessment (Non-pollution Ecological Impact) (HJ/T19-1997)

(3) Technical Guidance for Environmental Impact Assessment (Acoustic Environment) (HJ/T2.4-1995)

(4) Techncial Regulations for Afforestation (GB/T15776-2006)

(5) Seedling Quality Grading for Main Afforestation Tree Species GB6000-85 (GB6000-1999)

(6) Fast-growing and High-yield Pinus massoniana Plantations ZBB64007-88 (LY/T1496-1999)

(7) Forest Harvesting Regulations (LY/T1646-2005)

(8) Forest Tending Regulations (GB/T15781-2009)

(9) Forest Tending Operation Design Requirements (GB/T26424-2011)

(10) Breeding Procedures and Requirements for Main Afforestation Broadleaf Species (GB/T14074-1993)

(11) Large-diameter Timber Forest Cultivation Guidelines (LY/T2118-2013)

(12) China Forest Certification Forest Management (GB/T28951-2012)

(13) China Forest Certification Production, Sales and Supervision Chain (GB/T28952-2012)

(14) Technical Standards for Forest Fire Prevention (LY-1991)

1.4.3 Direct Basis

(1) Feasibility Study Report of the Sustainable Forest Management Project Financed by

European Investment Bank Loans in Qiandongnan Prefecture, Guizhou province

(2) The county-level woodland protection and use plans of Guizhou Province and the database of public welfare forest division results of counties and cities in 2011, and statistics of county-level woodland update survey of Guizhou Province in 2013.

1.5 Biodiversity and Ecological Conversation Goals

The project investment and construction plan involves Kaili City, Liping County, Jinping County, Majiang County, Danzhai County and Jianhe County. According to the topography, geomorphology, climate, wildlife, regional ecological system and other features of the areas involved in the project, this assessment determines the biodiversity and ecological protection goals of the project as the following two aspects.

1.5.1 Main Ecologically Sensitive Areas in the Project Area

According to the state regulations related to ecological protection, combined with the ecological conditions in the project area, together with on-site fieldwork and data collection and analysis, the importation ecologically sensitive areas in the project area can be divided into three categoties: nature reserves, scenic spots and forest parks.

1.5.2 Ecological Damage Control and Ecological Protection Goals

According to the analysis of the ways of the project affecting the ecological environment, from a macro point of view, the project size and layout may affect the integrity and stability of the original ecosystems in the project area, and will also change local surface morphology, water and land erosion and forest ecosystems. From a micro point of view, the large-scale monoculture planting may cause a reduction in biodiversity; afforestation land clearance, land preparations for afforestation, management and protection, tending and harvesting process in the project area will cause different impacts on the ecological environment in a given period and lead to destruction of vegetation, water and soil loss, wildlife habitat changes and other consequences.

Therefore, the project's goals to control damage and protect ecological environment are as follows:

（1）maintain the consistency between the project blocks and the local planning objectives;

（2）maintain the stability of the regional ecosystem;

（3）protect biodiversity in the project area;

（4）maintain the balance of land carrying capacity and prevent the degradation of land productivity;

（5）prevent interference with and damage to nature reserves and other important sensitive areas;

（6）prevent interference with and damage to habitats and breeding grounds of rare and protected animals;

（7）prevent or reduce the impact on wildlife;

（8）prevent or reduce the amount of new soil erosion in the project area;

（9）protect natural vegetation and understory and forest-edge vegetation.

1.6 Level and Scope of Assessment

1.6.1 Level of Assessment

The project ranges 1,166,217 hm². According to the scope and degree of the project's impact on ecological environment and the environmental characteristics in the project plots and surrounding areas, in accordance with the Technical Guidance for Environmental Impact Assessment (Non-pollution Ecological Impact) (HJ/T19-1997), the ecological impact assessment of the project is identified as Grade B.

1.6.2 Scope of Assessment

The total size of the project is 14,389.76 hm² (215,846.4 mu) and includes 1,491 plots scattered in Kaili City, Liping County, Jinping County, Majiang County, Danzhai County and Hejian County and 57 townships (towns, forest farms).

Due to the large size and coverage of the project, the scope of the assessment area is identified as the administrative boundaries of the six counties (cities), covering an area of 1,166,277 hm².

Chapter II Overview of Natural, Economic, Social and Construction Conditions

2.1 Location

The project area is located in Qiandongnan Prefecture in the southeastern Guizhou and involves six counties (cities) (Kaili, Jinping, Majiang, Danzhai, Jianhe, and Liping) and borders Hunan Province in the east and adjoins Qian South Prefecture of Guizhou in the west.

2.2 Geology and Geomorphology

The project area is located in the transitional slope between the Yunnan-Guizhou Plateau and the hills in Hunan and Guangxi and its main topography is low mountains and hills. The topography is characterized by the low altitude, deep river cutting and large relative height difference. Most of the area has an average altitude of 500-800 m and a relative height difference of 300-500 m, and the valley of a tributary of the Duliu River that has the lowest altitude (137 m) is located in Diping, Liping County. The project area is rich in water resources and the Qingshui River flowing into the Yangtze River and the Douliu River flowing into the Pearl River transverse the entire project area from west to east.

Quan Southeast Prefecture's geomorphology includes normal landforms and karst landforms. Normal landforms are mostly located in Tianzhu, Jinping, Liping, Congjiang, Rongjiang, Leishan, Taijiang, Jianhe and Sansui counties and from central Cengong County to southeast Danzhai County. Karst landforms are mostly located in Kaili City and Majiang, Guangping, Shibing, Zhenyuan and Cengong counties and west and north Danzhai County. The terrain is high in the northwest and low in the southeast, sloping form the northwest to southeast. There are 38 peaks in the prefecture that are more than 1,000 m high and the 2,179 m high peak of the Leigong Mountains is the highest. The 137 m-high outlet of the Shuikou River in Diping Township, Liping County is the lowest in altitude in the prefecture. The prefecture's landforms include middle mountains, low mountains, hills and basins. Middle mountains include some high mountains and low mountains. There are low mountains and hills in the east, mingled with large river basins. Low mountains are dominant in the south, followed by low-middle mountains, with many valleys and less basins. Karst landforms are widespread in the west with well-preserved plateau surface and are dominated by hills and middle-low mountains which are followed by basins and valleys. The northe is dominated by low-middle mountains that are followed by basins and hills. In the centre, due to the uplift of Leigong Mountains and the two mainstreams of Qingshui River and Douliu River, landforms are dominated by middle mountans nd high-middle mountains.

Hills: Hills are mainly distributed in Tianzhu, Jinping, Liping, Rongjiang, Shibing, Zhenyuan and Cengong counties and cover an area of 427.96 square kilometers, accounting for 1.41% of the prefecture, the altitude ranging from 400 m to 900 m. Soil includes metamorphic rocks, limestone, yellow soil developed in old crust of weathering, and lime soil developed on limestone. The soil is suitable for Cunninghamia Lanceolata, Pinus massoniana, youtong,

Camellia oleiferaAbel and a number of other species to grow.

Low mountains: mainly distributed in the southeast of the prefecture, including Sansui, Tianzhu, Jinping, Liping, Congjiang, and Rongjiang counties. Some are distributed in the south Shibing County and north Cengong County and along the valley of the Qingshui River in Kaili City. A small amount of low mountains are distributed in all other countains. Low mountains have a total area of 5,792.96 square kilometers, accounting for 19.11% of the total area of the prefecture, mostly 500-1,000 m high in altitude. Soil is red and yellow soil and is thick. The soil is rich in nutrients and is loose, suitable for Cunninghamia Lanceolata, Pinus massoniana and other species to grow.

Middle mountains: Regions distributed with more low-middle mountains include Liping, Rongjiang, Jianhe, Taijiang, Danzhai, Zhenyuan and Cengong counties and the Chong'an River area in Huangping County and east Majiang County and south Kaili City. Low-middle mountains have an area of 11,682.40 square kilometers, accounting for 38.55% of the total land of the prefecture, the altitude being generally 1,000-1,500 m, the slope being 15-30 degrees. The undulating topography of low-middle mountains result in great differences between microclimates and different degrees of suitability for tree growth. From the middle of the mountain to the valley, soil is thick with high temperatures and rich heat and has a distribution of evergreen broadleaf forest, Pinus massoniana forest and Cunninghamia Lanceolata forest. Soil is thin and temperature low on the upper part of the mountain and vegetation is mostly shrubs and grass. Middle mountains are distributed around Leigong Mountains and in the mountains in south Congjiang County, east Jianhe County, north Shibing County, southeast and southwest Danzhai County. Middle mountains cover a total area of 5,137.17 square kilometers, accounting for 16.95% of the total land of the prefecture, with an altitude mostly between 1,000-1,800 m and a slope of 30-45 degree. The distribution of vegetation in middle mountains has significant vertical variation and is evergreen broadleaf forest at an altitude between 800-1,300 m, evergreen broadleaf forest and deciduous broadleaf forest. The Leigong Mountains are high-middle mountains above 1,800 m that cover an area of 353.55 square kilometers, accounting for 1.17% of the prefecture land. Soil is mountain yellow-brown soil, mountain shrub meadow soil and mountain swamp soil. Vegetation distribution includes moss coppice, alpine shrub and grasslands.

Basins: cover an area of 397.6 square kilometers, accounting for 1.3% of the prefecture land. Large basins are distributed in Liping, Huangping, Rongjiang and Shibing counties, mostly for agricultural use. Basin peripheries are suitable for Cunninghamia Lanceolata, Pinus massoniana, Camellia oleiferaAbel, wubai and various fruit trees to grow.

2.3 Clamatic Characteristics

The climate in the project area is a mid-subtropical type. Due to topography and latitude, vertical climate changes are greater than horizontal changes. Therefore, the clear vertical climate characteristics showed with different mountain altitudes create a multi-level multi-type forest ecology. The annual average temperature in most parts of the project area is about 17℃, with an annual accumulated temperature above 10℃ of 5,000-6,500℃, a frost-free period of 240-300 days, 1,200-1,600 hours of sunshine, and an annual rainfall of 1,000-1,400 mm, and therefore is characterized by summers without intense heat, winters without severe cold, high calorie, and enough rain with the same season as heat.

Qiandongnan Prefecture has a moist subtropical monsoon climate. The terriain is complex and the climate diverses in the prefecture. Microclimates are significantly different and are generally characterized by distinct four seasons, abundant rainfall, great humidity, rich heat in the same season as rain, and less sunshine. The prefecture is divided into two climatic zones: north Liping and Rongjiang counties and Jinping, Tianzhu, Jianhe, Sansui, Taijiang, Leishan, Danzhai, Majiang, Kaili, Huangping, Shibing, Zhenyuan, and Cengong counties (city) belong to the Qian east subtropical hot-summer cool-spring humid climate zone; south edges of Liping and Rongjiang counties and Congjiang County belong to the Qian south subtropical humid-summer dry-spring hot climate zone.

2.4 River Hydrology

2.4.1 Hydrology and Water Resources

Qiandongnan Prefecture has a developed water system. With Miaoling as the watershed, all rivers in the prefecture belong to the Yangtze River area and the Pearl River area. There are more than one thousand rivers in the project area and main rivers include the Qingshui River, which is the upstream of the Yuanjian River that belongs to the Yangtze River, and its first-class tributaries including Chong'an River, Bala River, Nanshao River, Wuxia River, Liudong River, Liangjiang River, Jianjiang River, Hongzhou River and Duijiang River.

2.4.2 Status Quo of Water Environment Quality in the Project Area

Based on the water environment minitoring data from Guizhou water resources bulletin.

1. Water quality conditions of main rivers are as follows:

(1) Qingshui River: 25.5% of monitored reaches is Grade II water quality throughout the year, and 74.5% of reaches is poor Grade V water quality. The main pollution indicators are total phosphorus and fluoride.

(2) Douliu River: Grade II water quality throughout the year.

2. Water environment quality in three partitions of water resoruces

(1) Qingshui River: 25.5% of monitored reaches is Grade II water quality throughout the year, and 74.5% of reaches is poor Grade V water quality. The main pollution indicators are total phosphorus and fluoride.

(2) Douliu River: Grade II water quality throughout the year.

2.5 Soil

Soil in the project is mainly yellow soil, red soil, yellow-brown soil, mountain shrub meadow soil, limestone soil, purple soil, and moisture soil. Zonal soil, yellow soil is mainly distributed in the mountains of 700-1,400 m in altitude. It is yellow with gray-brown surface, loam texture, high organic matter content, acidic reaction, and 4.5-5.5 PH, and with the highest value of use. Red soil is also zonal soil with a distribution area second only to yellow soil, mainly distributed in low mountains, hills, shallow or middle valley cutting areas. Yellow soil is mainly distributed in mountains of 1,400-2,000 m in altitude. Shrub meadow soil is mainly distributed in mountains over 2,000 m in altitude, mostly on the top. Limestone soil is non-zonal soil and is mainly distributed in the karst hill shallow cutting areas in karst broadvalley areas. Purple soil and moisture soil is distributed in very small areas, mainly in riversides.

2.6 Social and Economic Development Situation

2.6.1 Social Situation

The project area covers five counties and one county-level city, including 45 towns, 30 townships (including three nationality townships), 7 subdistrict offices, 28 resident committees, and 1,468 village committees.

As of the end of 2013, the total registered population in the project area is 1.9248 million, including 315,900 non-agricultural people, accounting for 16.41% of the total, and 1.6089 million agricultural people, accounting for 83.59% of the total. There are residents of a number of nationalities, including Miao, Dong, Han, Buyi, Shui, Yao, Zhuang, and Tujia, and the minority population accounts for 85.13% of the total population in the project area.

2.6.2 Economic Situation

According to the Statistical Yearbook 2013 of Qiandongnan Prefecture, the GDP of counties (city) in the project are in 2013 is RMB 29.046 billion, including RMB 3.958 billion from the primary industry, accounting for 13.6% of the total; RMB 9,300 billion from the secondary industry, accounting for 32.0% of the total; RMB 15.788 billion from the tertiary industry, accounting for 54.4% of the total; and the per capita GDP is RMB 15,090.4, an increase of 13.7% over 2012. The rural per capita net income is RMB 5,345.0, an increase of 15.6% over RMB 4,625.3 in 2012.

Qiandongnan Prefecture has the largest population among 30 autonomous minority prefectures nationwide and also a minority region with the most concentrated poor people. Of the 4.60 million people in the prefecture, 1.70 million are poor, accounting for nearly 40% of the total. Of the 16 counties and cities in the prefecture, 14 are poor counties supported by the state. The six counties and city are all the national poverty alleviation and development focus except Kaili City and cover an area of 1,035,627 hectares, accounting for 34.14% of the total area of Qiandongnan Prefecture.

The social and economic situation in the project area is as follows:

Statistics of socio-economic situation in the projet area

No.	County (city)	Total land area (hm^2)	Number of townships (towns)	Number of village households	Total population (10,000 people)	Minorities (10,000 people)	Agricultural population (10,000 people)	Number of rural workers			Grain output	Per capital net income of farmers	GDP (100,000 million RMB)	Agricultural output vale (10,000 RMB)	Forestry output value (10,000 RMB)
								Total	Where, female	Where, agriculture, forestry, animal husbandry and fishery					
Total		1166217	75	386971	192.48	163.85	160.89	954009	443156	488181	414981	32343	290	293114	109114
1	Danzhai County	93770	6	39305	17.16	15.15	15.3	97207	45987	41448	40927	5070	18	30591	9605
2	Jianhe County	216027	12	60286	26.04	24.24	23.83	146114	65011	79445	59295	5071	26	36870	20794
3	Jinping Countyy	159690	15	50280	22.83	20.24	20.22	123023	57217	58502	52575	4944	25	22311	16300
4	Kaili City	130590	9	72832	50.31	40.34	31.59	176248	87747	82557	82439	6945	148	92512	7589
5	Liping County	443920	25	113257	53.52	46.09	49.45	284544	130073	148652	119933	5201	47	58427	50179
6	Majiang County	122220	8	51011	22.62	17.79	20.5	126873	57121	77577	59812	5112	26	52403	4647

Note: The total land area from the data published by the forestry department and other data come from Statistical Yearbook of Qiandongnan Prefecture (2013).

2.6.3 Transportation Situation

The project area has convenient transportation with the 320 and 321 National Roads through the territory. Of the six counties and city, Jinping County will have a highway in June next year and the other five counties and city have had highways. As of the end of 2016, all counties in the prefecture will have highways and all townships will have asphalt roads. Roads to natural villages of more than 50 households are being planned and constructed. Railway construction is developing rapidly with Hu'nan-Guizhou Railway and Guizhou-Guangxi Railway through the territory, the Hu'nan-Guizhou Railway double-track construction has been completed and opened to traffic, Guizhou-Guangdong Fast Railway has been completed and will be open to traffic, and Shanghai-Kunming Fast Railway is under construction. Kaili, the capital of the prefecture, is less than a two-hour travel from Guiyang Longdongbo Airport, and Liping Airport has been officially opened to traffic.

2.7 Forestry Production and Management Conditions

2.7.1 Complete Forestry Production and Management Organizations, Personnel and Technology

Qiandongnan Prefecture is a major forest zone in Guizhou Province and a complete forest resource protection and management system has been formed from top to bottom over the years. All levels of forestry management organizations are complete and grassroots foresty organizations have a certain size. The prefecture and all counties (city) have their bureaus of forestry as an industry management organization to carry out industry management of forestry development and ecological construction in their territories, with nearly 4,000 foresty administrative management staff. All townships have forestry stations responsible for management and technical guidance of forestry construction in their territories. There are currently 209 forestry stations in the prefecture with 927 offical management staff, an average 4 staff per station. The prefecture has a complete system of 57 timber inspection and supervision stations, including 20 Grade I stations, 19 Grade II stations and 18 Grade III and roving stations, and there are also 39 forestry law enforcement units and other functional units of law enforcement with nearly 700 people. 17 forestry science and technology promotion stations cover the entire prefecture with 148 forestry technical personnel.

2.7.2 Rich Forestry Engineering Management Experience

Qiandongnan Prefecture has begun to implement fast-growing high-yield timber base afforestation and forestry loan afforestation projects since the mid-1980s and implemented Phase I, Phase II and Phase III afforestation projects financed by World Bank loans in early 1990s. In particular, since the implementation of the Tianbao Project, Grain for Green Project and other key forest ecological projects successively in 1998, afforestation tasks have been increased by the projects. A total afforestation area of 256,500 hectares (including 147,900 hectares of plantation and 108,600 hectares of closing-off afforestation) is completed in the Eleventh Five-Year period alone. Remarkable achievements have been made in forest ecological construction and industry construction of the prefecture, basically forming a complete ecological system and a good forestry industry resource system. Through recent decades of construction of key forestry projects, various levels of forestry departments have accumulated a wealth of project management experience in organization management, plan

management, engineering management, fund management, information and technical management.

2.7.3 Strong Seedling Supply Support Capabilities

(1) Seedling management agencies: The prefecture and all counties (cities) have established their tree seedling management agencies – tree seedling stations.

(2) Qiandongnan Prefecture has always attached importance to seedling production and construction and has initially built a tree breeding system. The prefecture has 173.3 heactares of primary Cunninghamia Lanceolata seed orchards and 166.7 hectares of secondary seed orchards, 78.3 heactares of Pinus massoniana seed orchards, 3,086.76 hectares of Cunninghamia Lanceolata seed bases and 13,333 hectares of Pinus massoniana seed bases. Huangping County Hengpo Forestry Farm and Liping County Dongpo Forestry Farm have been identified as national Pinus massoniana and Cunninghamia Lanceolata seed bases by the State Forestry Administration. In recent years, relying on the implementation of natural forest resource protection, grain for green and other key forest ecological projects, Qiandongnan Prefecture has achieved great development in the construction of seed bases. The prefecture now has 305 forestry nurseries and 616.25 hectares of nursery area, including 20 nursery bases under the management of the forestry system with a breeding base area of 179.9 hectares, and 285 social breeding units with an area of nearly 436.35 hectares. The prefecture has an annual seedling production of 134 million seedlings. These seedling bases provide fine breeds and strong seedlings for forestry production of the prefecture, ensuring the smooth implementation of various projects and the supply of seedings for the project.

For the supply of seedlings for the project, Qiandongnan Prefecture has 13 provincial and prefecture-level designated Camellia oleiferaAbel and Blueberry seedling production bases, with 14.06 hectares of Camellia oleiferaAbel Camellia oleiferaAbel nursery area and a production of 9.427 million seedling, and 42.59 hectares of Blueberry nursery area and a production of 10.2868 million seedlings. Jianhe County has planned to increase Uncaria production to 150,000 mu in the Twelfth-Year period. It has now built specialized Uncaria breeding bases with an annual production of more than 3 million seedlings. The prefecture is a Cunninghamia Lanceolata production area and all counties and cities in the project area have some Cunninghamia Lanceolata seedling production bases. Liping County Dongpo Forestry Farm has been identified as a national Cunninghamia Lanceolata breeding base by the State Forestry Administration. The supply of shamu seedlings is adequate and the project has a limited demand for local rare species which can be provided by the nurseries in the prefecture.

2.7.4 Good Scientific and Technological Support

Qiandongnan Prefecture Bureau of Forestry has the Personnel and Education Division and its secondary agencies include Institute of Forestry, Forestry Seedlings and Technology Promotion Station and Forest Survey, Planning and Design Institute (Grade B). The Bureau has established a research collaboration with Guizhou University Forestry Institute, Guizhou Academy of Forestry Sciences, Nanjing Forestry Universty and other units. In addition, the prefecture has set up 17 forestry science and technology promotion stations that cover 16 counties and cities of the prefecture with 148 forestry science and technology personnel currently.

Established in 1958, Qiandongnan Pefecture Institute of Forestry is a major forestry research organization in the prefecture with 38 serving workers, incuding 27 professional and

technical personnel, including 6 with senior technical titles and 13 with intermediate titles. In its 50 years of scientific research, the institute has formed strong scientific and technogical support to forestry production in the prefecture, and has achieved fruitful results in the introduction and transformation of scientific research results, in the promotion of practical technology, and in the provenance and breeding and other basic research. The institute has collaboratively assumed more than 60 ministerial, provincial and prefecture-level research projects and won 28 ministerial, provincial and prefecture-level scientific and technological progress awards, including 2 ministerial and provincial second prises, 7 provincial third prizes, 3 provincial fourth prizes, 4 prefecture and department second prize, 9 prefecture and department third prizes, and 3 prefecture fourth prizes. It currently assumes 16 research projects.

The prefecture has always attached importance to the application and promotion of scientific and technological achievements in forestry production practices. In order to accelerate the application of practical forestry technology in forestry production, the prefecture has actively built the information platform for forestry technology to serve “agriculture, rural areas and peasants” and streamlined the channels to serve “agriculture, rural areas and peasants” on the one hand, and strengthen the construction of forestry scientific and technological promotion system to accelerate the promotion and application of forestry scientific and technological achivements in in quality and quantity on the other hand. In recent years, the prefecture has successively held a lot of grassroots-oriented forest ecology and fast-growing high-yield forest cultivation training, fruit tree cultivation training, nanzhu cultivation training, Camellia oleiferaAbel cultivation training, Blueberry cultivation training, nutrition bag nursery training, forestry station head training and forest pest control training. All these training is very good technical preparations for the implementation of the project.

2.7.5 Complete Infrastructure

Forest fire prevention: The prefecture, cities and counties in the project area have established forest fire prevention organizations. Since 1997, the prefecture has had program-controlled telephone and extended to rural areas and has installed mobile communications stations to remote mountainous areas; by combining the program-controlled telephone and mobile telephone, the forest fire prevention information network has gradually built. In 2007, the prefecture’s forest fire prevention communications entered the Ministry of Public Security’s Shield Network. The prefecture now has 84 forest fire lookout stations, 4 forest fire meteorological stations, 976.5 kilometers of fire barriers, 5,495.5 kilometers of fire roads, 22 command vehicles, 4 publicity vehicles, 22 troop vehicles, 83 motorcycles, 3 other vehicles, 21 fire reserve libraries with an area of 950 square meters, 28,500 units (sets) various fire fighting equipment, 136 sets of binoculars, 2.98 kilometers of dedicated telephone line, and 594 radio stations.

Forest pest management: The prefecture and county-level forest control and quarantine agencies have all been established in the project area. The average annual control area is 47000 mu with a pest control rate of more than 90%. A national monitoring and reporting point was approved for Qiandongnan Prefecture in 2005, and after 7 years of construction, the prefecture’s ability to forecast pest has been significantly enhanced.

Other infrastructure: Villages in the project area have had basically accesss to roads, electricity, telephone and postal services, conducive to the construction, management and product transport of the base.

2.8 Basic Information of the Project Construction and Organization Unit

2.8.1 Overview of the Project Organizational Unit

The prefecture-level organizational unit of the project is Qiandongnan Prefecture Office of Forestry Projects Financed by World Bank Loans ("WB Office"). Established in September 1990, the WB Office is a deputy county institution responsible for the organization of the planning, reporting and audit of the three phases of the World Bank loans-financed project implemented in the prefecture from 1990 to the end of 2002; the supervision of project implementation, the technical guidance, material procurement, afforestation quality supervision, inspection and acceptance, project monitoring, information management, financial supervision and other work; the organization of the repayment of the loans by the project-implementing counties (cities). The WB Office has 9 serving staff, including 3 managers, 5 professional and technical personnel, 1 worker; and according to educational background, 6 of them are university graduates, 2 are college graduates and 1 is high school gradeate. Because the World Bank afforestion project has been completed and passed the inspection, the WB Office is currently mainly responsible for the organization of the relevant counties and cities to repay the loans as well as the afforestation forest management and natural forest protection engineering management which is added in accordance with the arrangement of the prefecture government and the prefecture bureau of forest.

After the project is approved, the counties and cities implementing the project will establish the Eurpean Investment Bank loans-financed forest project office that is responsibe for the implementation of the works of the project in counties and cities.

2.8.2 Overview and Experience of Using Foreign Preferential Loans

Qiandongnan Prefecture had implemented three-phase World Bank projects from 1990 to the end of 2002, i.e. the National Afforestation Project (1991-1994), Forest Resource Development and Protection Project (1995-1998), and Forest Development Project in Poor Areas (1999-2002). The project was implemented in 12 counties (cities) in the prefecture and accumulatively RMB 223.60 million was invested in the three projects, including World Bank loans equivalent to RMB 130.8198 million, and RMB 92.7802 million of domestic matching funds. From 1991 to the end of 2002, a total of 72,714.0 hectares of afforestation was complted, accounting for 104.67% of the planned number, including 43,689.3 hectares of Cunninghamia Lanceolata, 23,526.5 hectares, 970.5 hectares of pinus elliottii, 1,952.6 hectares of economic fruit forest, and 2,575 hectares of bamboo.

The third phase of the World Bank loan-financed forestry project is an afforestation project with the largest amount of foreign capital, the largest scale of afforestation, the rapidest construction, the highest technological content, and the best afforestation quality. The successful implementation the three phases of World Bank loan afforestation project has produced valuable experience for the prefecture in ecological forest construction by using foreign capital.

(1) Leadership attention, department coordination and farmer participation: Qian Southease Prefecture's World Bank loans-finaced afforestation project has been high valued at all levels of government and been strongly supported by the development and reform and financial and other departments; the project areas take the World Bank loans-financed afforestation project as an important carrier to development economy, reduce poverty and improve the environment; all leves of government department strengthen organizational leadership, sign liability forms from level to level, actively raise matching funds, improve department coordination, carry out extensive propaganda, effectively mobilize the farmers' enthusiasm to participate the project, ensuring the smooth implementation of the project.

(2) Establish rules and systems, standardize management and strengthen supervision: World Bank loan afforestation project implementation rules, seedling management practices, afforestation construction work deisgn methods, inspection and acceptance rules, project withdrawal and reimbursement methods, accounting methods and a series of other regulatory documents are developed based on project characteristics and requirments to strengthen project management. In project implementation, the principle of acceptance first and reimbursement second is adhered to, the project supervision system is introduced, and inspection and supervision is strengthened, to ensure project quality.

(3) Scientific design, strict construction and breeding: In project construction, suit the site and the tree, design first and construction second, attach importance to the selection of fine varieties and the promotion of new technologies, strengthen breeding and introduction of fine varieties as well as the directional breeding of superior clonal seedlings, to ensure fine varieties and strong seedlings are used for the afforestation of the project.

(4) Strengthen training, enhance services and carry out demonstration: In project implementation, strengthen the construction of the prefecture, county and city level project technology promotion training system, carry out all levels of technology promotion and project training from level to level, enhance technical guidance and services for all links of the project afforestation; meanwhile, establish a number of testing and demonstration bases of new varieties, new technologies and new models, making good models for households to improve project management level, and playing an important model role for the promotion and application of advanced management concepts and models of foreign-financed afforestation projects.

2.9 Information of Forestry Production Entities

Ecological cultivation not only requires a sound forest ecological system, but also requires the building a well-developed system of forestry industry. To meet the needs of a large-scale forestry industry base to support the construction of a well-developed system of forestry industry, actively expore to attract more social capital, manpower and material resources to participate in forestry production and construction. The prefecture has from 1980s begun to expore outward the introduction of enterprises to participate in afforestation, and inward the development of the management model of major afforestation households and collective economic organizations. After decades of groping and efforts, rich experience has been accumulated and fruitful results have been achieved. So far, the prefecture has a total of 81 state-owned forest farms and forestry enterprises with afforestation of about 2 million mu, more than 100 private enterprises participating in afforestation with afforestation of about 1.8

million mu, 501 collective economic organizations and specialized cooperative organizations with afforestation of 1.2 million mu, 40 households that have a area of afforestation of more than 10,000 mu with afforestation of more than 60,000 mu. The various forms of forestry production and manangement subjects and a number of inputs of social capital has played a huge role in promoting the acceleration of forestry production in Qiandongnan Prefecture.

Chapter III Investigation and Assessment of Ecological Status Quo

3.1 Status Assessment of Forest Resources

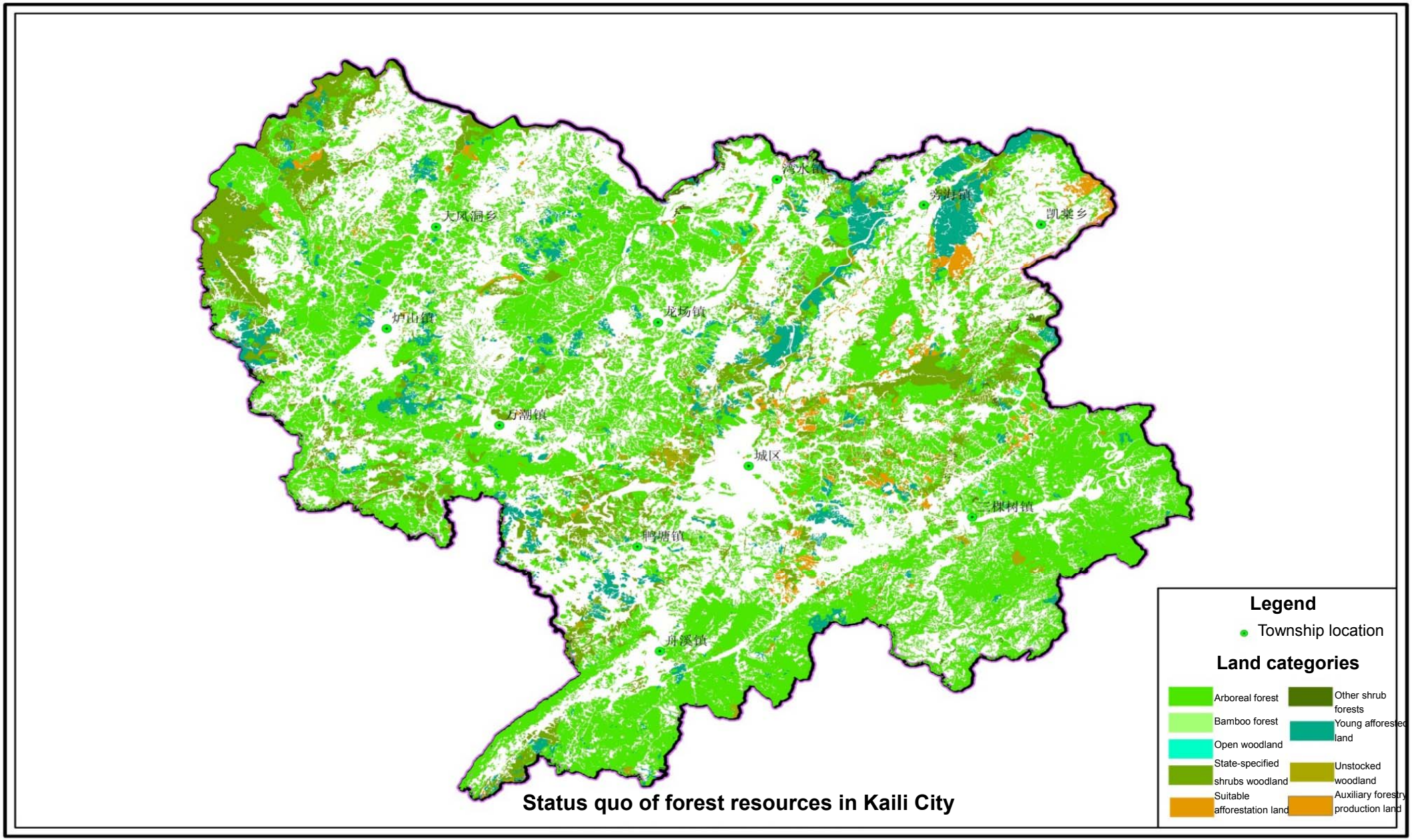
3.1.1 Woodland Composition

According to statistics of the woodland change results prepared by counties and cities in the project area in 2013, the project area has a total land area of 1,166,217.00 hectares, including 842,175.79 hectares of woodland, accounting for 72.21% of the total, and 324,041.21 hectares of non-woodland, accounting for 27.79% of the total.

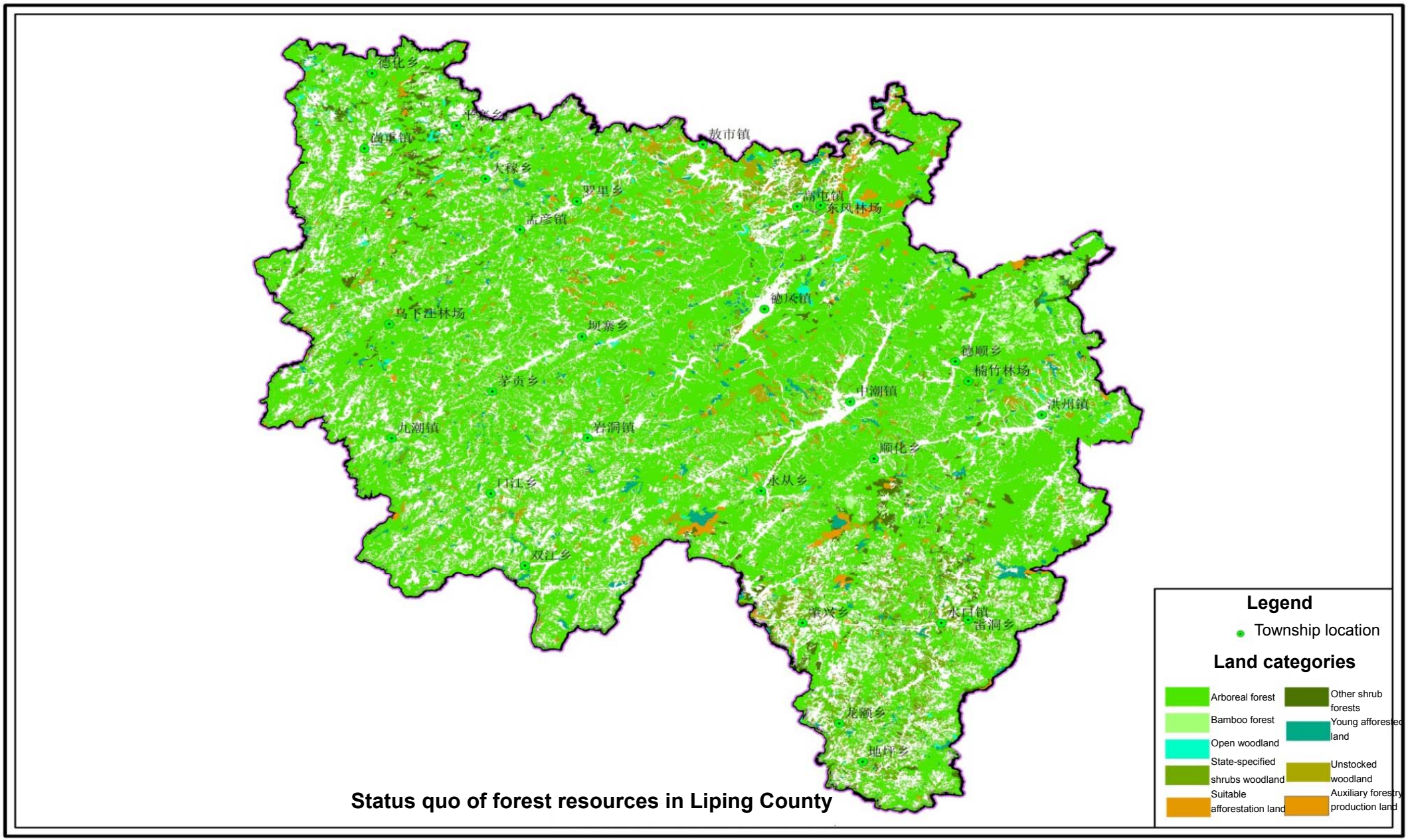
In the forestry land, there is woodland of 718,732.68 hm² (including 709,843.43 hm² of arbores and 29,547.72 hm² of bamboo), open woodland of 8,042.70 hm², shrub land of 57,116.4 hm² (including 27,568.68 hm² specified by the state, and 29,547.72 hm² of other shrub land), young afforested land of 26,665.16 hm², nursery land of 26.06 hm², unstocked woodland of 19,776.45 hm², barren hills and wastesuitable land for forest of 11,769.72 hm², auxiliary forestry production land of 47.62 hm², as detailed in Table 3.1 below and the resource status quo of each county.

Woodland resources in the project area

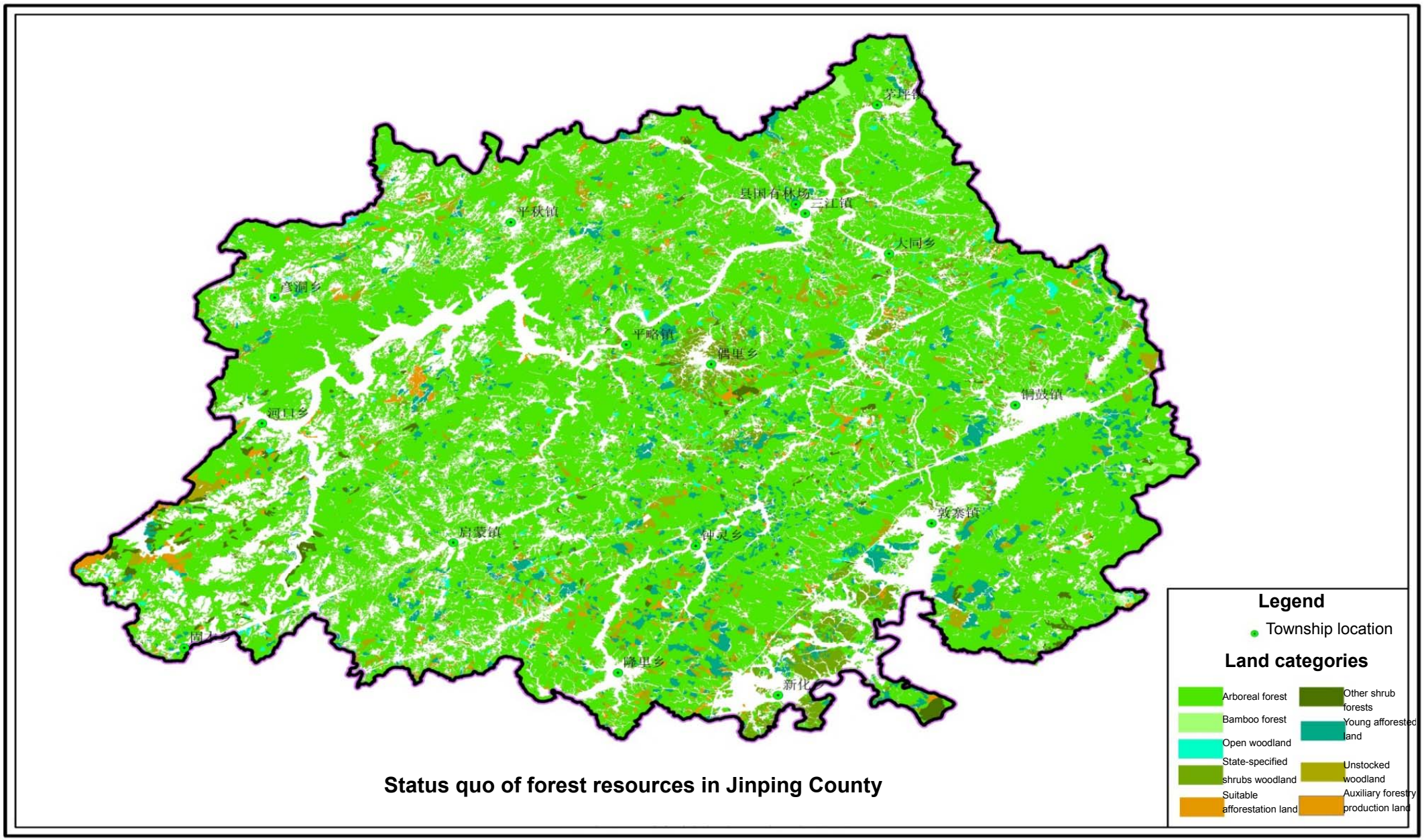
Table 3.1													hm^2
County (city)	Public welfare forests												
	total	Afforested land			Open woodland	Shrub woodland			Young afforested land	Nursery land	Unstocked woodland	Barren hills and wasteland suitable for afforestation	Auxiliary forestry production land
		Subtotal	Arboreal forest	Bamboo forest		Subtotal	Shrub woodland specified by the state	Other shrub forests					
Total	842175.79	718732.68	709843.43	8889.25	8042.70	57116.40	27568.68	29547.72	26665.16	25.06	19776.45	11769.72	47.62
Kaili City	73510.91	54128.32	53981.33	146.99	43.30	10780.72	10538.77	241.95	5980.96	1.95	786.28	1789.38	
Liping County	340482.49	298809.05	291879.68	6929.37	2085.31	17849.31	10848.69	7000.62	7051.82	13.95	8864.98	5777.29	30.78
Jinping County	12456.02	105137.10	103957.49	1179.61	1314.19	5184.08	3906.26	1277.82	7088.61	6.02	3669.67	2163.24	4.11
Majiang County	70815.24	59503.94	59331.33	172.61	149.43	9484.05	458.39	9025.66	513.16	2.69	571.62	578.16	12.19
Danzhai County	66236.37	55810.32	55702.71	107.61	834.39	3916.11	1612.05	2304.06	1666.52		3834.00	174.47	0.12
Jianhe County	166563.76	145343.95	144990.89	353.06	3616.08	9902.13	204.52	9697.61	4364.09	0.45	2049.46	1287.18	0.42



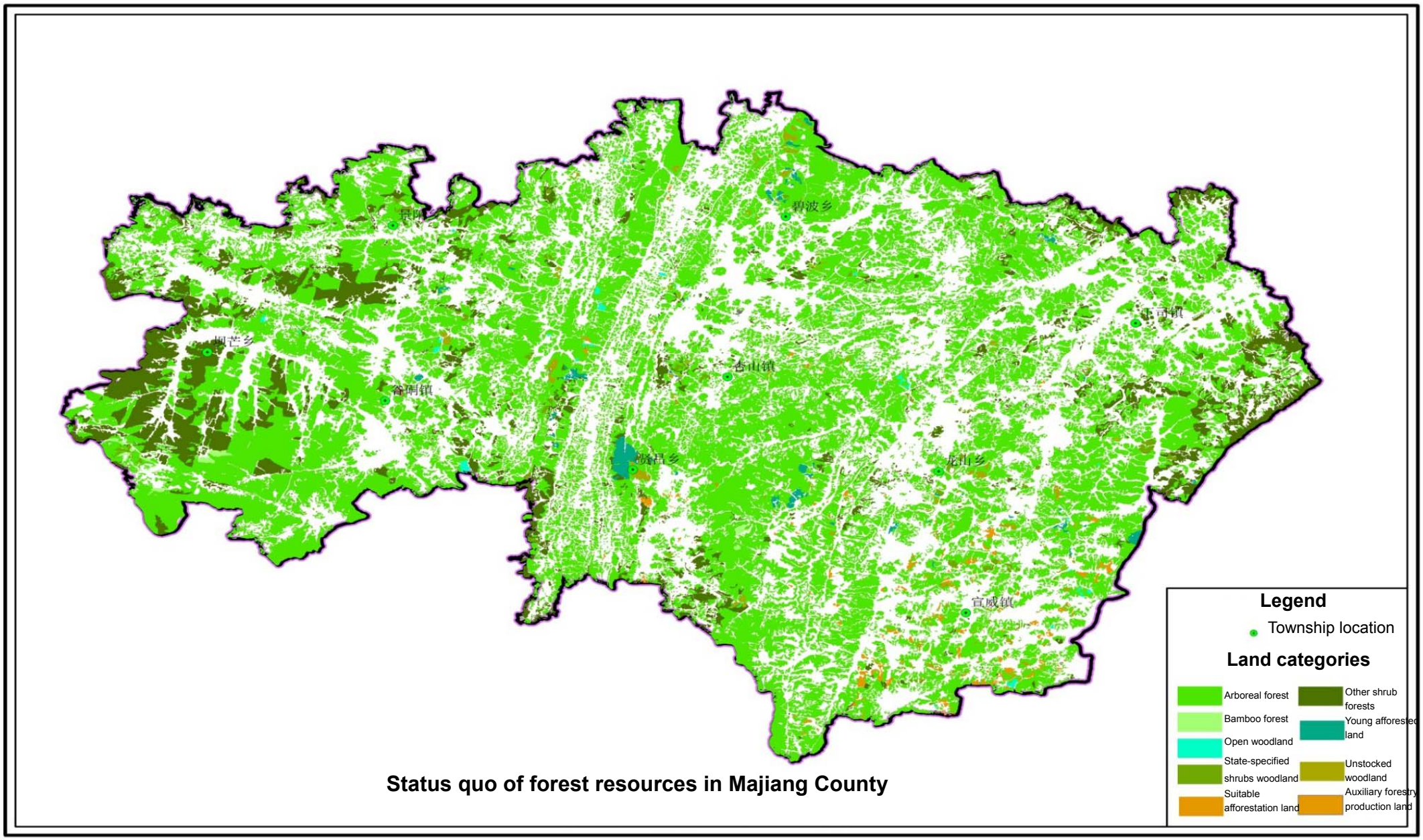
Status quo of forest resources in Kaili City



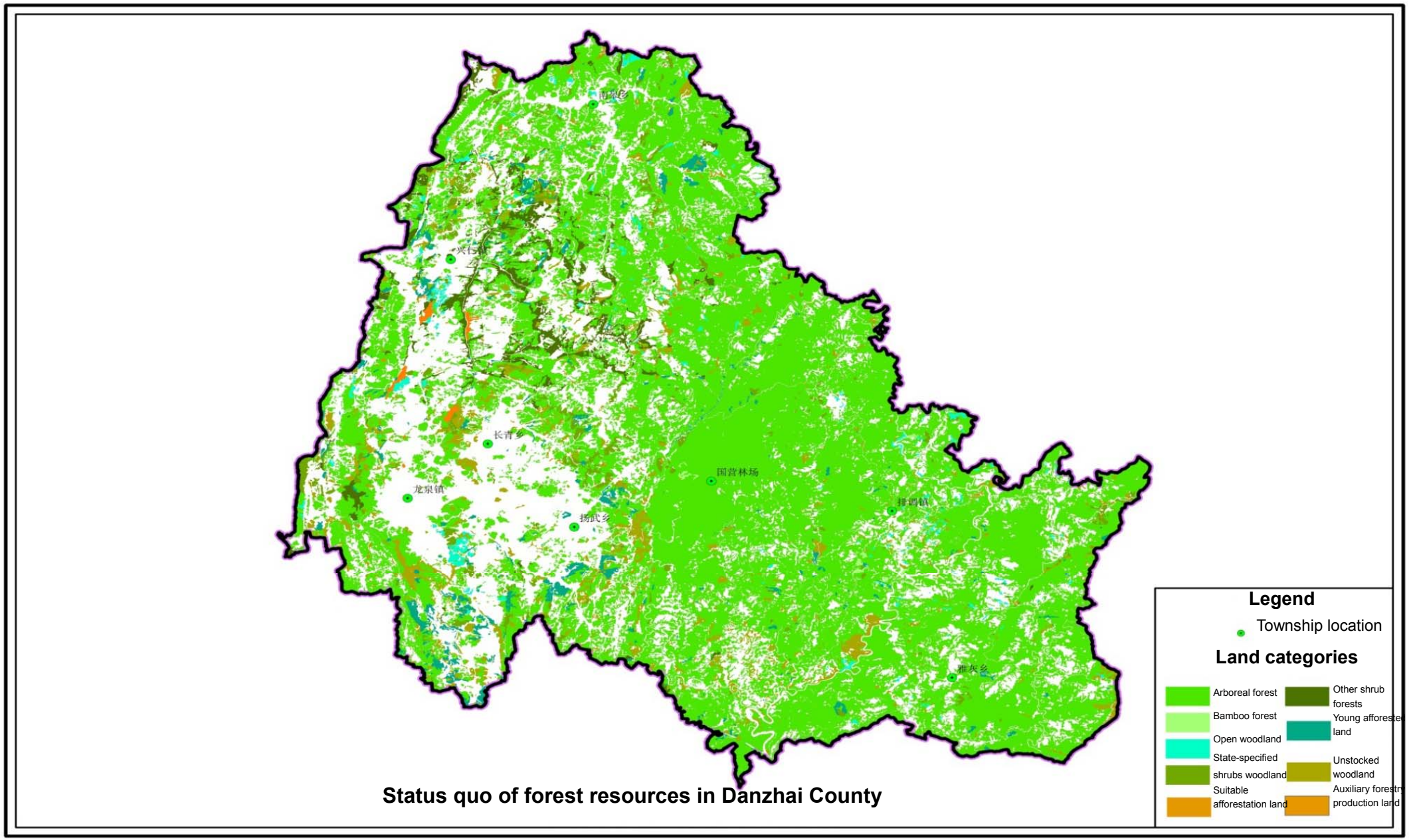
Status quo of forest resources in Liping County



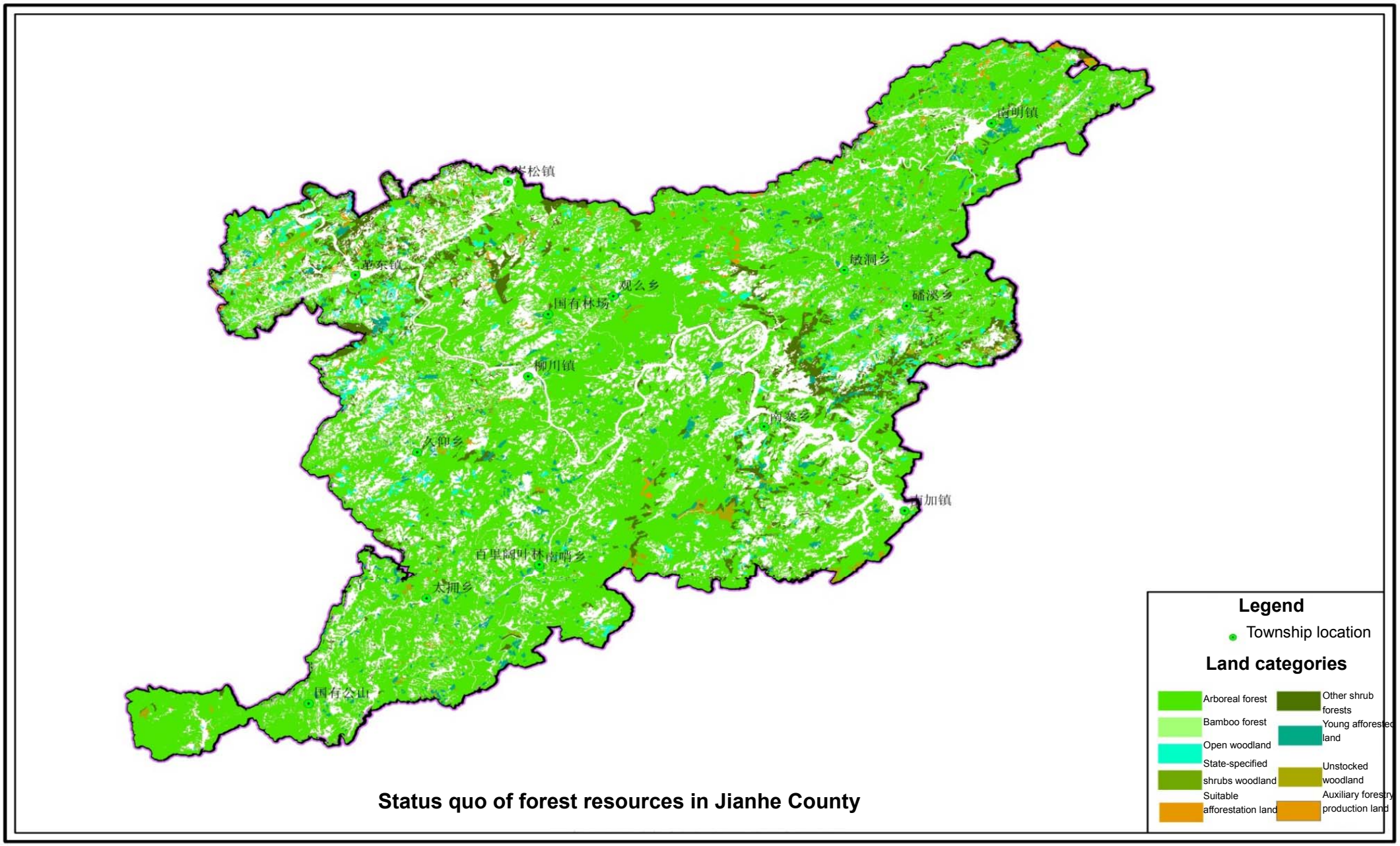
Status quo of forest resources in Jinping County



Status quo of forest resources in Majiang County



Status quo of forest resources in Danzhai County



Status quo of forest resources in Jianhe County

3.1.2 Forest Classification

1. Commercial Forest

According to the forest classification of the project area, the project area has 518,874,91 hm² of commercial forest, accounting for 61.61% of the forestry land area in the project area, including 452,572.82 hm² of woodland (including 451,448.93 hm² of arbores and 1,123.89 hm² of bamboo), 5,605.21 hm² of open woodland, 23,386.02 hm² of shrub land (including 13,795.45 hm² specified by the state and 9,590.57 hm² of other shrub land), 13,316.64 hm² of young afforested land, 16.83 hm² of nursery land, 14,197.05 hm² of unstocked woodland, 9,744.05 hm² of barren hills and wastesuitable land for forest, and 36.29 hm² of auxiliary forestry production land, as detailed in Table 3.2 below.

Woodland resources of commercial forests in the project area

Table 3.2										Hm^2			Unit: hm^2
County (city)	Commercial forests												
	Total	Afforested land			Open woodland	Shrub woodland			Young afforested land	Nursery land	Unstocked woodland	Barren hills and wasteland suitable for afforestation	Auxiliary forestry production land
		Subtotal	Arboreal forest	Bamboo forest		Subtotal	Shrub woodland specified by the state	Other shrub forests					
Total	518874.91	452572.82	451448.93	1123.89	5605.21	23386.02	13795.45	9590.57	13316.64	16.83	14197.05	9744.05	36.29
Kaili City	47800.43	37949.39	37865.34	84.05	42.41	4723.24	4612.71	110.53	2600.87	1.95	762.84	1719.73	0.00
Liping County	260820.16	196514.34	196318.17	196.17	1651.80	51669.54	49414.59	2254.95	3036.58	5.72	3930.79	3991.94	19.45
Jinping County	82002.11	68890.85	68444.19	446.66	1028.27	3137.10	2676.28	460.82	3436.61	6.02	3335.91	2163.24	4.11
Majiang County	29177.68	25220.47	25183.26	37.21	75.07	2658.46	288.16	2370.30	294.43	2.69	479.13	435.24	12.19
Danzhai County	51676.37	44162.02	44054.41	107.61	805.95	1961.64	1081.87	879.77	844.44	0.00	3729.00	173.20	0.12
Jianhe County	91781.16	79835.75	79583.56	252.19	2001.71	3709.04	194.84	3514.20	3013.71	0.45	1959.38	1260.70	0.42

2. Public Welfare Forest

The project area includes public welfare forest of 323,300.88 hm², accounting for 38.39% of the woodland area in the project area, including 266,159.86 hm² of woodland (including 258,394.5 hm² of arbores and 7,765.36 hm² of bamboo), 2,437.49 hm² of open woodland, 33,730.38 hm² of shrub land (including 13,773.23 hm² specified by the state and 19,957.15 hm² of other shrub land), 13,348.52 hm² of young afforested land, 8.23 hm² of nursery land, 5,579.4 hm² of unstocked woodland, 2,025.67 hm² of barren hills and wastesuitable land for forest, and 11.33 hm² of auxiliary forestry production land, as detailed in Table 3.3 below.

Public welfare forest resources of commercial forests in the project area

Table 3.2										Hm^2			Unit: hm^2
County (city)	Public welfare forest												
	Total	Afforested land			Open woodland	Shrub woodland			Young afforested land	Nursery land	Unstocked woodland	Barren hills and wasteland suitable for afforestation	Auxiliary forestry production land
		Subtotal	Arboreal forest	Bamboo forest		Subtotal	Shrub woodland specified by the state	Other shrub forests					
Total	323300.88	266159.86	258394.50	7765.36	2437.49	33730.38	13773.23	19957.15	13348.52	8.23	5579.40	2025.67	11.33
Kaili City	25710.48	16178.93	16115.99	62.94	0.89	6057.48	5926.06	131.42	3380.09		23.44	69.65	
Liping County	124135.33	102294.71	95561.51	6733.20	433.51	10652.77	5907.10	4745.67	4015.24	8.23	4934.19	1785.35	11.33
Jinping County	42564.91	36246.25	35513.30	732.95	285.92	2046.98	1229.98	817.00	3652.00		333.76		
Majiang County	41637.56	34283.47	34148.07	135.40	74.36	6825.59	170.23	6655.36	218.73		92.49	142.92	
Danzhai County	14560.00	11648.30	11648.30		28.44	1954.47	530.18	1424.29	822.08		105.44	1.27	
Jianhe County	74692.60	65508.20	65407.33	100.87	1614.37	6193.09	9.68	6183.41	1260.38		90.08	26.48	

3.1.3 Assessment of Exesting Woodland Resources

It can be seen from Table 3.1 that woodland accounts for a large proportion of the project area and is 842,175.79 hm², accounting for 72.21% of the total land, including 709,843.43 hm² of the existing arbores, the largest area, accounting for 60.87%; 266,65.16 709,843.43 hm² of young afforested land, accounting for 2.29%; 39,588.87 709,843.43 hm² of open woodland, no tree woodland and barren hills and wasteland, accounting for 3.39%. therefore, the project has adequate woodland resources.

3.2 Investigation and Assessment of Vegetation Status Quo

3.2.1 Flora Distribution

Forest plants in the project area have both subtropical and warm-temperature zone and temperature zone's ingredients, and the project area brings together a number of floras and ingredients. There are some unique tree species here, such as Leishan oak, small green-leaf small ficus, small-flower heather, camellia yungkiangensis, long-handle woody ginger, Guizhou buckthorn, Quercus Machilus, etc. There are also ancient species, such as rhoiptelea, Tetracentron, Paliurus, Eurycorymbus cavaleriei, Pteroceltis, etc. originating from the ancient tropical flora in the tertiary.

3.2.2 Vegetation Overview

Vegetation in the assessment area is mid-subtropical evergreen broad-leaved forest. Due to the long-term impact of human activities and natural forces, some forest has evolved into evergreen mixed coniferous-broadleaf forest, mixed coniferous-broadleaf forest and coniferous forest, and some areas become shrubs and grass.

Coniferous forest: mainly Cunninghamia Lanceolata forest and Pinus massoniana forest, followed by baimu forest, and a little huashansong forest and toushan forest. The largest coniferous forest is Cunninghamia Lanceolata forest.

Evergreen broad-leaved forest: mainly distributed in Jianhe and Liping counties in the project area. Edificators constituting evergreen broad-leaved forest are mainly Castanopsis, Lithocarpus and Quercus glauca of the Fagaceae; Cinnamom, Machilus, mountain pepper and Litsea of the Lauraceae; Magnolia and banana shrub of the Magnoliaceae; superba of the Theaceae; Sylvestrial, Japonicus and Sloanea of the Elaeocarpaceae, and Daphniphyllum.

Evergreen mixed coniferous-broadleaf forest: evergreen species of the edificators include Castanopsis, Lithocarpus and Quercus glauca of the Fagaceae; Superba of the Theaceae; Manglietia of the Magnoliaceae; deciduous trees include Fagus and Castanea of the Fagaceae; Liquidambar of Witch Hazel; P.adenopoda of the Salicaceae; Maple of the Aceraceae; weld jasmine, red leaf poplar and baixinyang of the Styracaceae; Cherry and rowan of the Rosaceae; and Pistache of the Anacardiaceae.

Broadleaved deciduous forest: main species include oak and chestnut of the Fagaceae; Liquidambar of the Witch Hazel; Maple of the Aceraceae; birch of the Betulaceae; and P.adenopoda of the willow.

mixed coniferous-broadleaf forest: conifer species include Cunninghamia Lanceolata, Pinus massoniana and baimu. Broad-leaved species are more, including evergreen species and deciduous species. The former includes glauce and Castanopsis of the Fagaceae; superba of the Theaceae; Camphor and sassafras of the Lauraceae; and Magnolia of the Magnoliaceae. Deciduous species include Quercus and chestnut of the Fagaceae. Understory

species include Eurya of the Theaceae.

Shrubs: main species include Rhus, Pyacantha, azalea, kangzhishaoma, coriaria, yuanguohuaxiang, etc.

3.2.3 Vegetation Survey Resouts

(1) Kaili City

According to the 2013 woodland change survey results, Kaili City has forest vegetation area of 73,510.91 hm², accounting for 56.29% of the total area of Kaili City. The majority is cultivated vegetation, especially Pinus massoniana forest with an area of 28,109.24 hm²，accounting for 21.52% of the land area of the city; followed by broad-leaved shrubs with an area of 10,497.00 hm²， accounting for 8.04% of the total land of Kaili. Statistics of vegetation types in Kaili are shown in Table 3.4.

(2) Liping County

According to the 2013 woodland change survey results, Liping County has forest vegetation area of 340,482.49 hm², accounting for 76.70 % of the total area of the county. The majority is cultivated vegetation, especially Cunninghamia Lanceolata forest with an area of 163,328.74 hm²， accounting for 36.79% of the land area of the county; followed by Pinus massoniana forest with an area of 50,995.08 hm²， accounting for 11.49% of the total land of the county. Statistics of vegetation types in Liping are shown in Table 3.4.

(3) Jinping County

According to the 2013 woodland change survey results, Jinping County has forest vegetation area of 124,567.02 hm², accounting for 78.01% of the total area of the county. The majority is cultivated vegetation, especially Cunninghamia Lanceolata forest with an area of 77,517.51 hm²， accounting for 48.54% of the land area of the county; followed by broad-leaved mixed forest with an area of 11,566.21 hm², accounting for 7.24% of the total land of the county. Statistics of vegetation types in Jinping are shown in Table 3.4.

(4) Majiang County

According to the 2013 woodland change survey results, Majiang County has forest vegetation area of 70,815.24 hm², accounting for 57.94% of the total area of the county. The majority is cultivated vegetation. Pinus massoniana forest covers an area of 26,986.26 hm², accounting for 22.08% of the land area of the county. Statistics of vegetation types in Majiang are shown in Table 3.4.

(5) Danzhai County

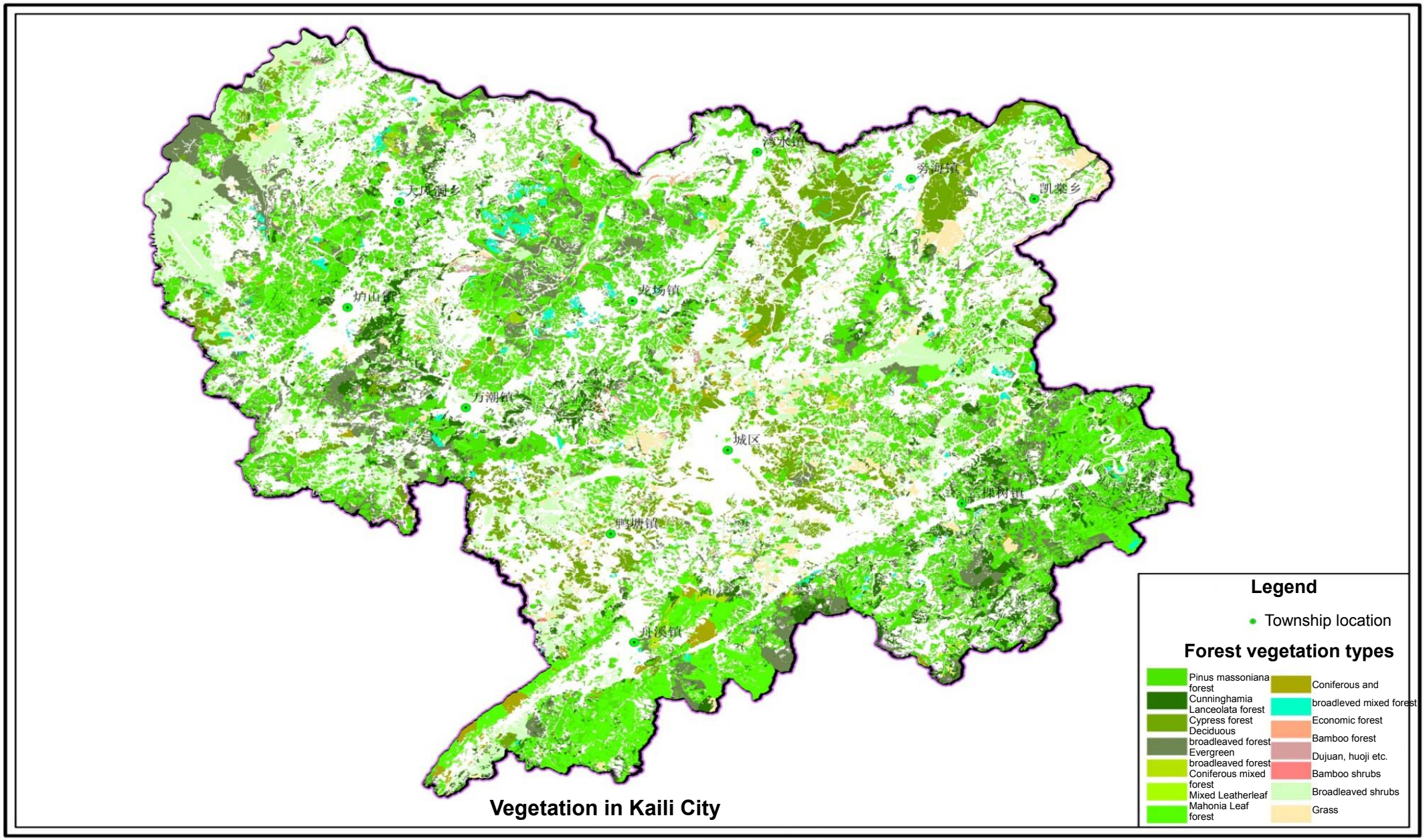
According to the 2013 woodland change survey results, Danzhai County has forest vegetation area of 66,236.37 hm², accounting for 70.64% of the total area of the county. The majority is cultivated vegetation, especially Pinus massoniana forest with an area of 22,236.41 hm², accounting for 23.71% of the land area of the county. Statistics of vegetation types in Danzhai are shown in Table 3.4.

(5) Jiahe County

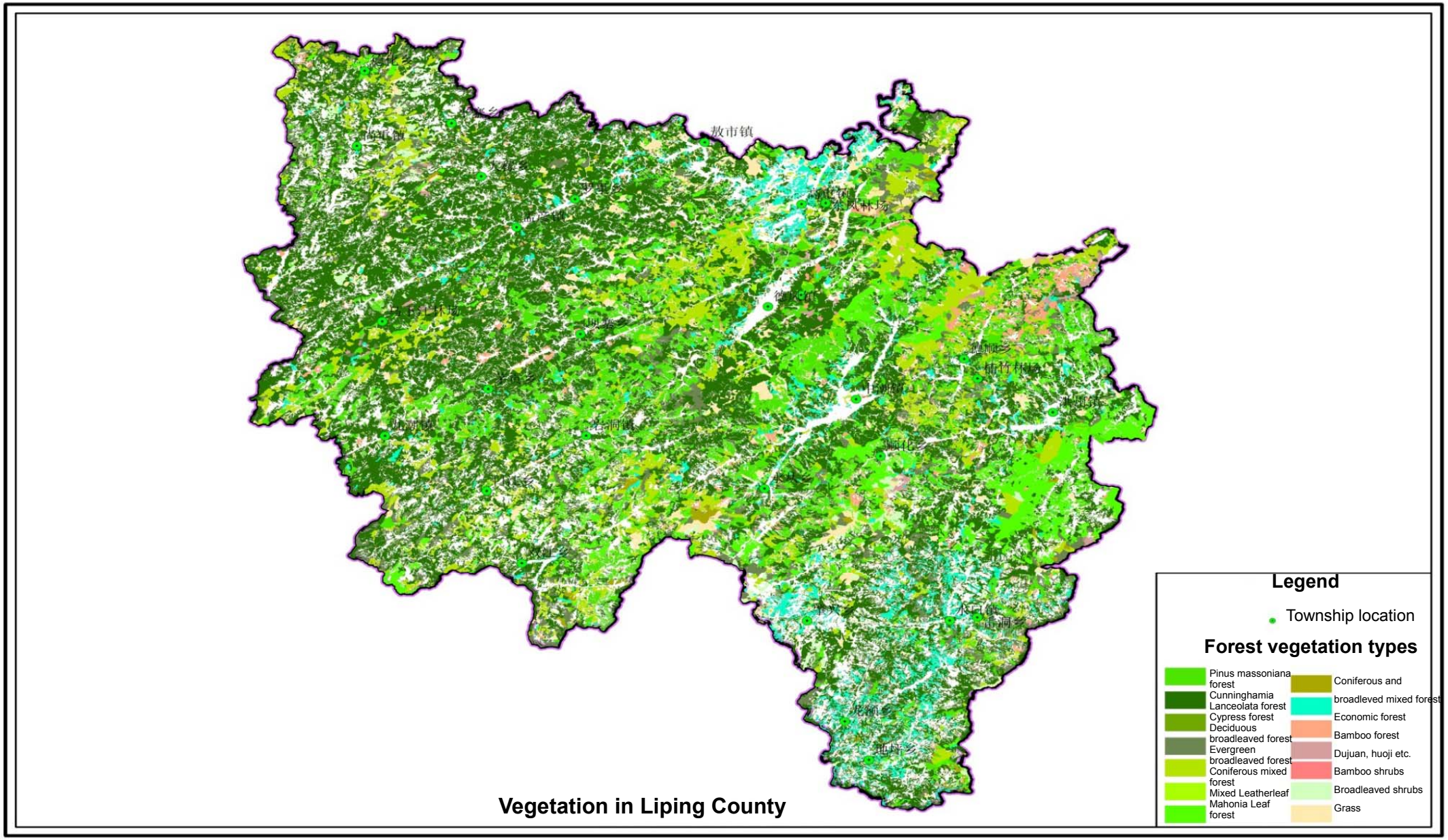
According to the 2013 woodland change survey results, Jianhe County has forest vegetation area of 166,563.76 hm², accounting for 77.13% of the total area of the county. The majority is cultivated vegetation, especially Cunninghamia Lanceolata forest and broad-leaved deciduous forest with an area of 68,405.14 hm² and 33,072.29 hm² respectively, accounting for 31.66% and 15.31 of the land area of the county. Statistics of vegetation types in Jianhe are shown in Table 3.4.

Forest vegetation types in the project area																
Table 3.4															Unit: hm²	
County (city)	Land area	Total	Cunninghamia Lanceolata forest	Pinus massoniana forest	Cypress forest	Evergreen broadleaved forest	Deciduous forest	Coniferous mixed forest	mixed coniferous-broadleaf forest	Mixed Leatherleaf Mahonia Leaf forest	Bamboo	Bamboo shrubs	Dujuan, huoji, oaks, xiaoguonanzhu	Broadleaved shrubs	Economic forest	Grass
Total	1166150	842175.79	333639.83	172944.45	13617.50	61419.56	85284.66	403.30	3345.74	58936.22	9090.09	746.63	4198.23	35843.80	31086.93	31618.85
Kaili City	130590	73510.91	5841.21	28109.24	7099.00	342.89	8806.83	61.92	908.40	7821.17	146.99	18.94	135.00	10497.00	1144.71	2577.61
Liping County	443920	340482.49	163328.74	50995.08	21.60	36414.83	22920.61	256.72	1906.96	19070.50	7055.04	78.22	1650.24	5275.87	16821.08	14687.00
Jinping County	159690	124567.02	77517.51	15142.38		1963.91	3227.81	47.74	297.30	11566.21	1251.54	29.11	30.75	1217.96	6431.76	5843.04
Majiang	122220	70815.24	4550.11	26986.26	6170.44	2558.63	11324.77	2.09	48.83	7191.06	172.85	548.57	1221.12	7277.19	1598.66	1164.66

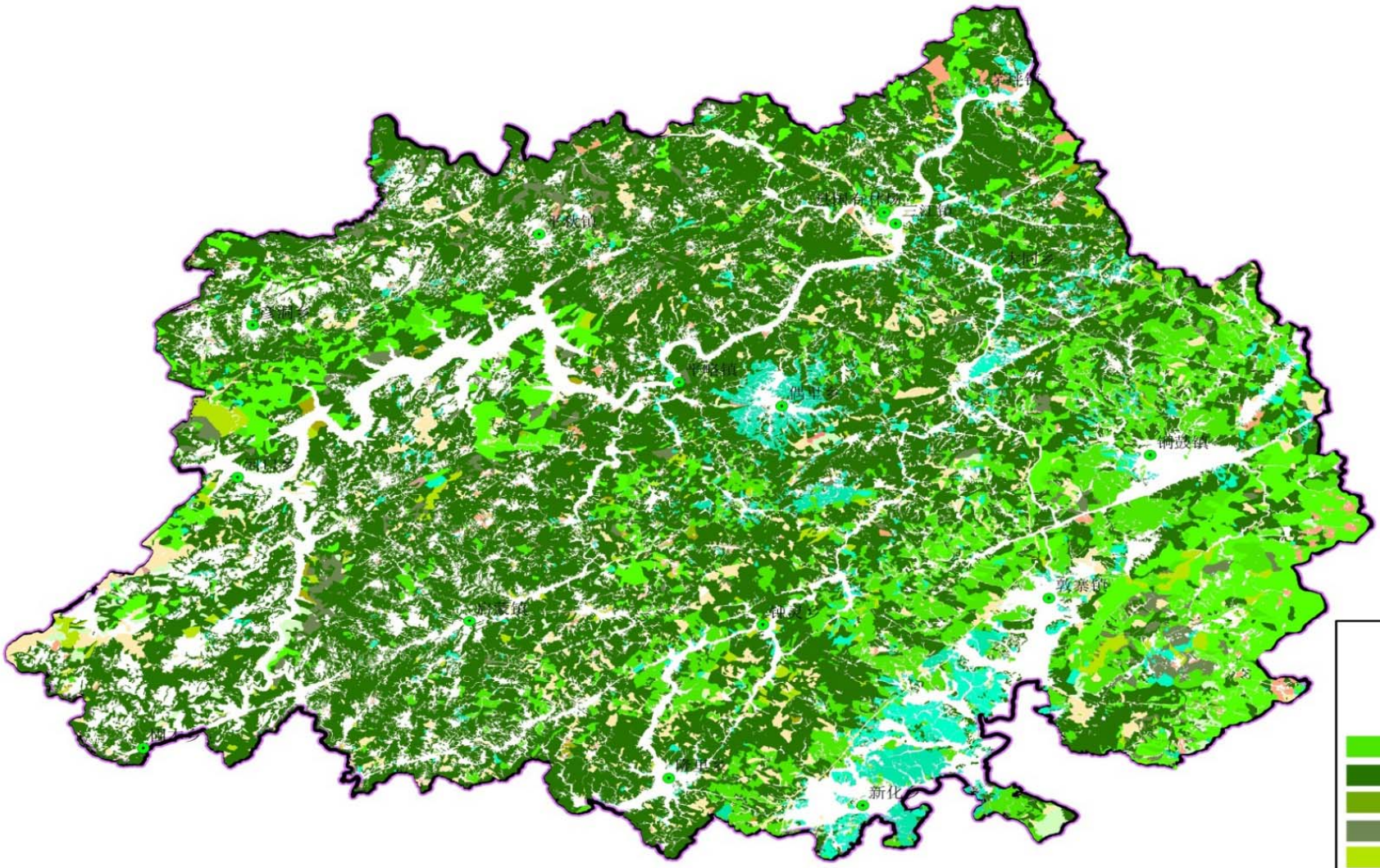
County																
Danzhai County	93770	66236.37	13997.12	22236.41	300.44	1543.17	5932.35	9.95	114.62	13287.28	107.61	66.03	67.37	2647.32	1917.67	4009.03
Jianhe County	215960	166563.76	68405.14	29475.08	26.02	18596.13	33072.29	24.88	69.63		356.06	5.76	1093.75	8928.46	3173.05	3337.51



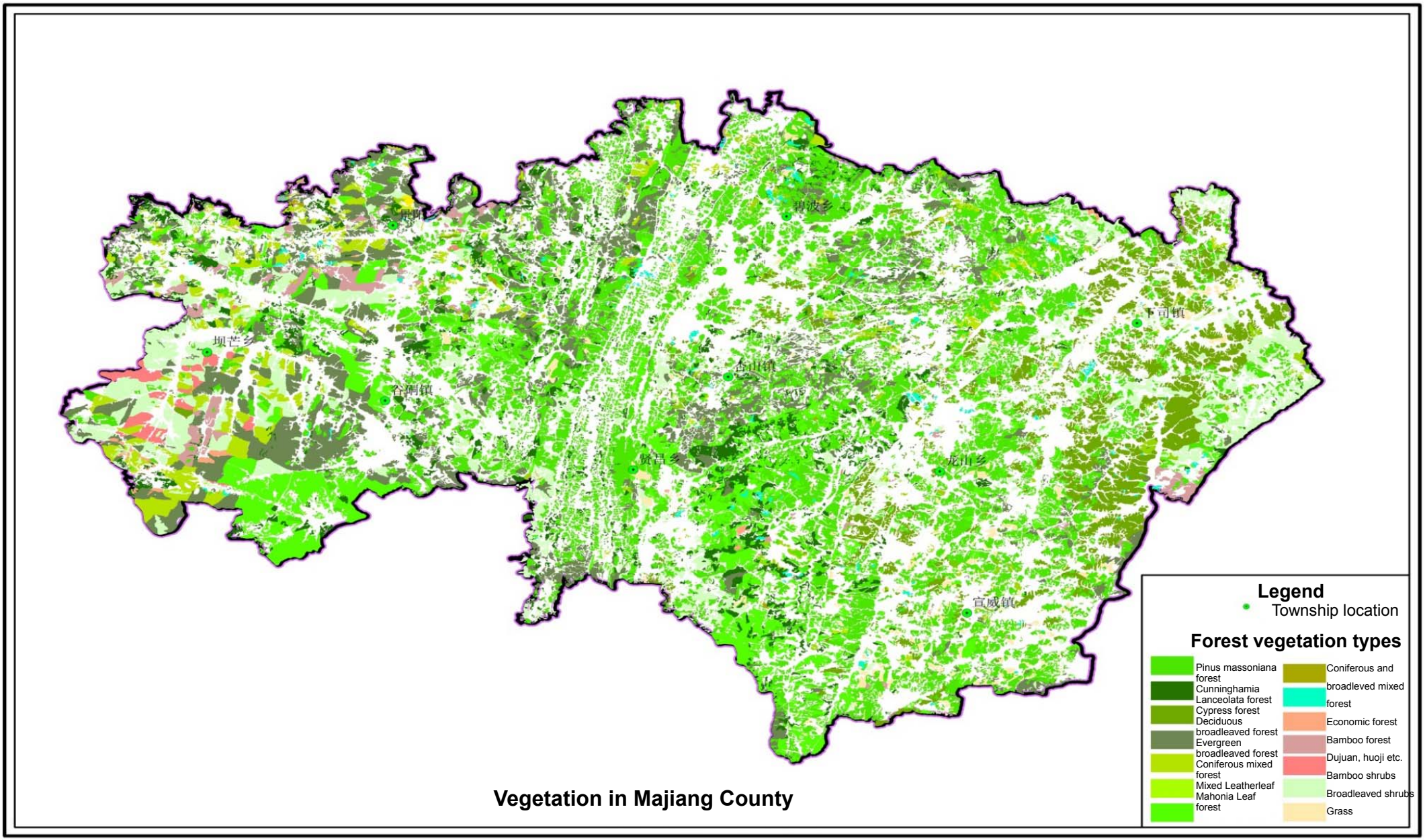
Vegetation in Kaili City



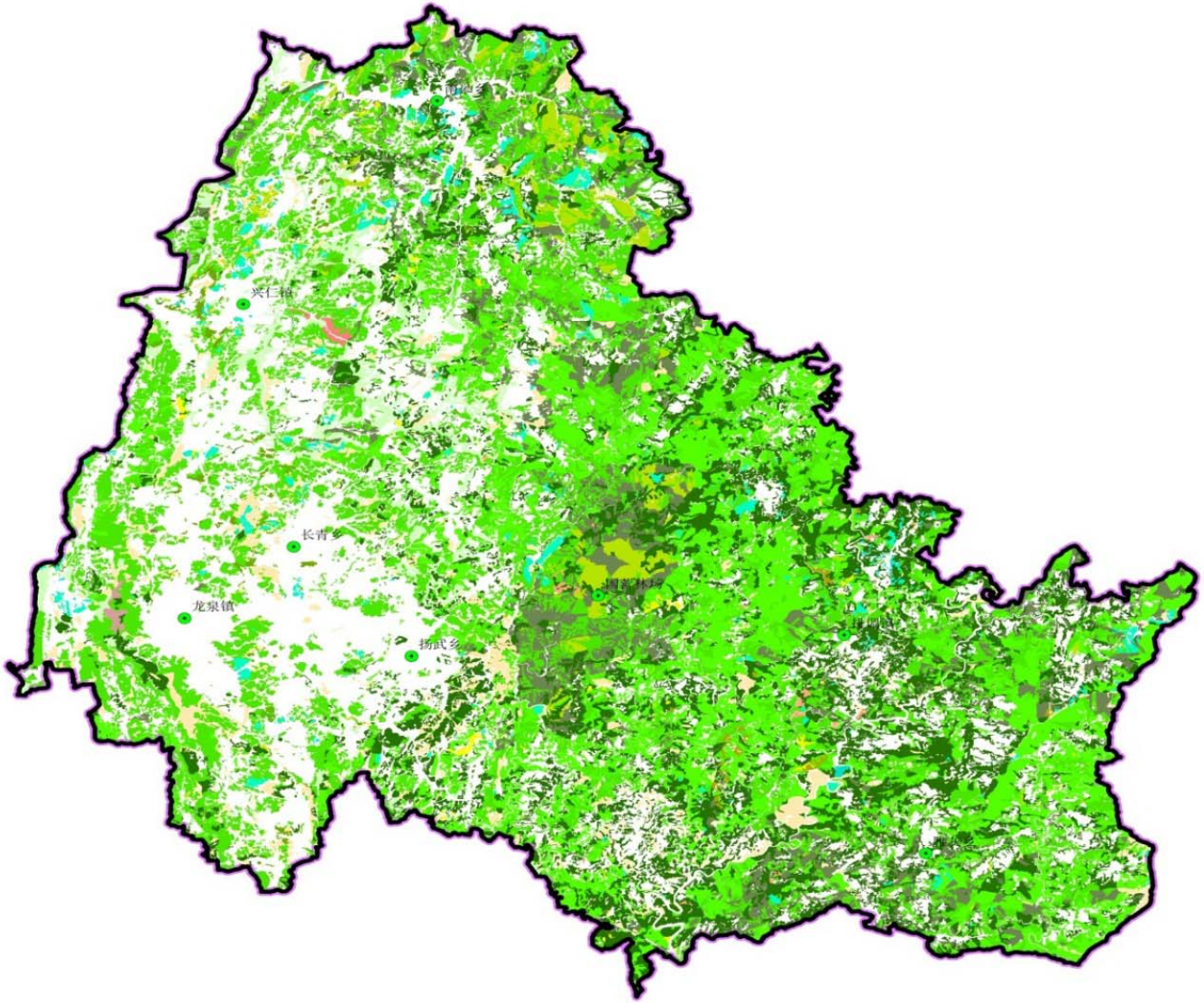
Vegetation in Liping County



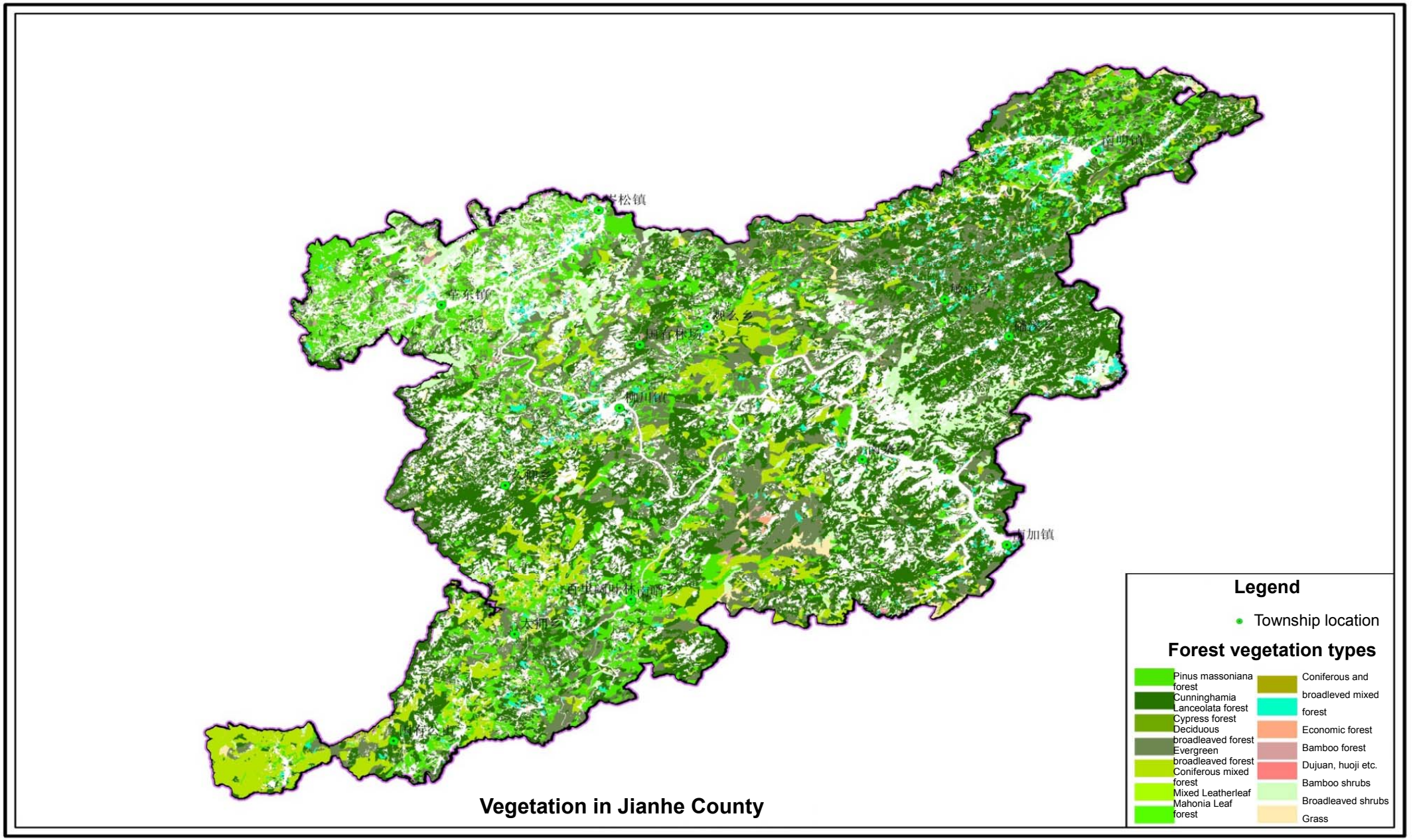
Vegetation in Jinping County



Vegetation in Majiang County



Vegetation in Danzhai County



Vegetation in Jianhe County

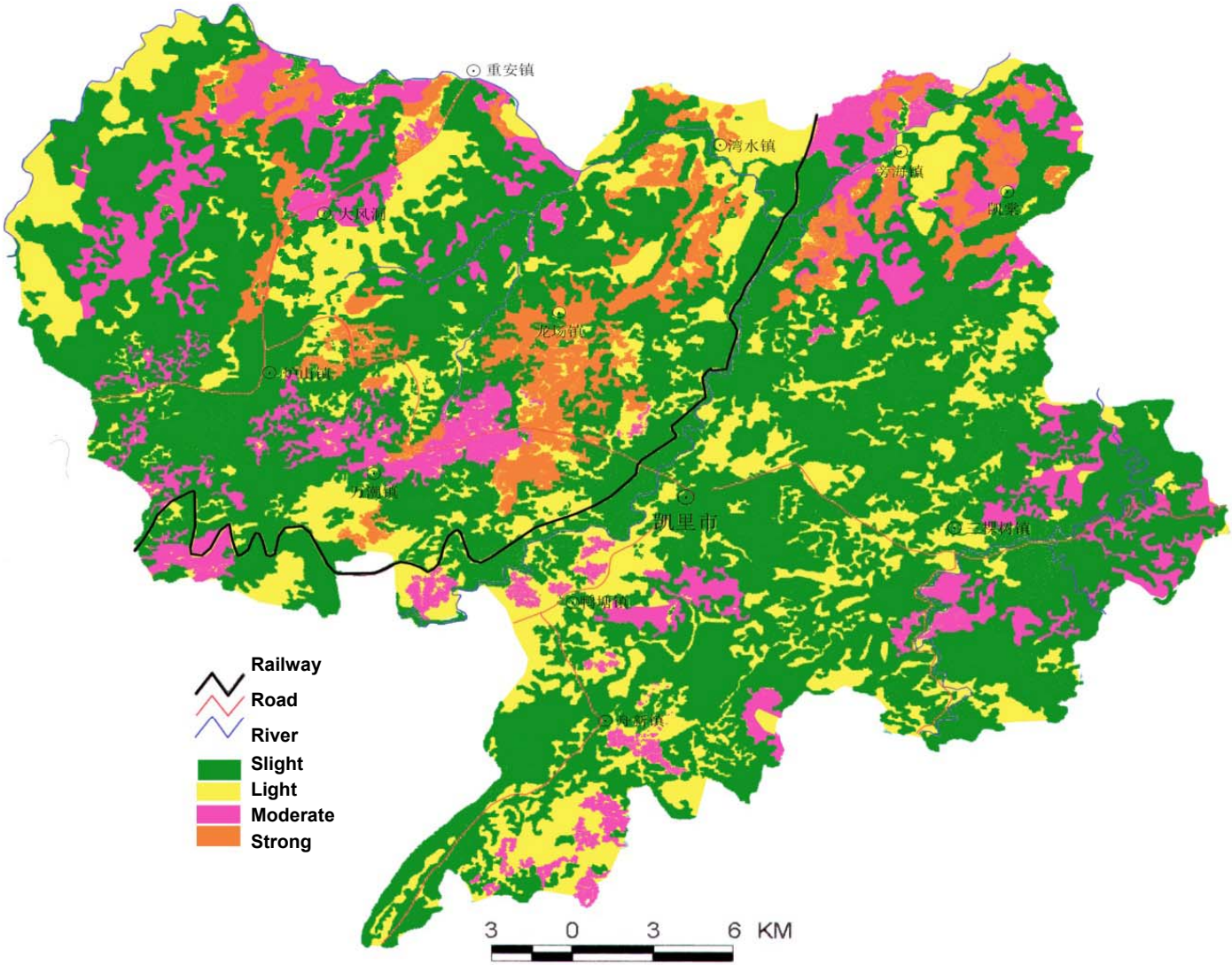
3.3 Investigation and Assessment of Soil Erosion Status Quo

3.3.1 Soil Erosion Survey

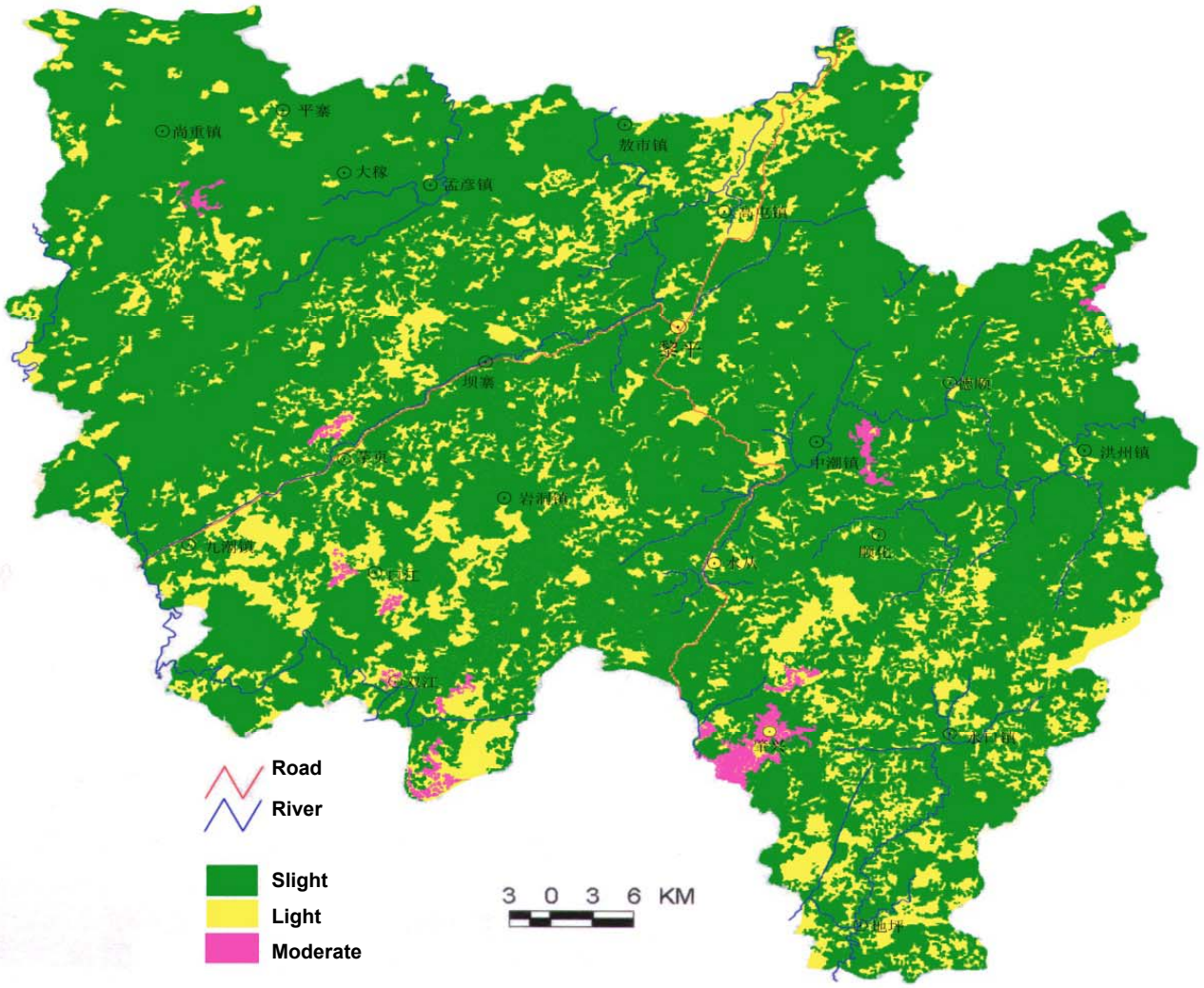
The soil erosion survey and assessment uses the data of water and soil loss survey in the Special Report of Ecological Impact of the Material Forest Base for MCC Paper Qiandongnan Prefecture Pulp Paper Integration Project by China Environmental Science Research Institute in 2008.

3.3.2 Soil Erosion Assessment Results

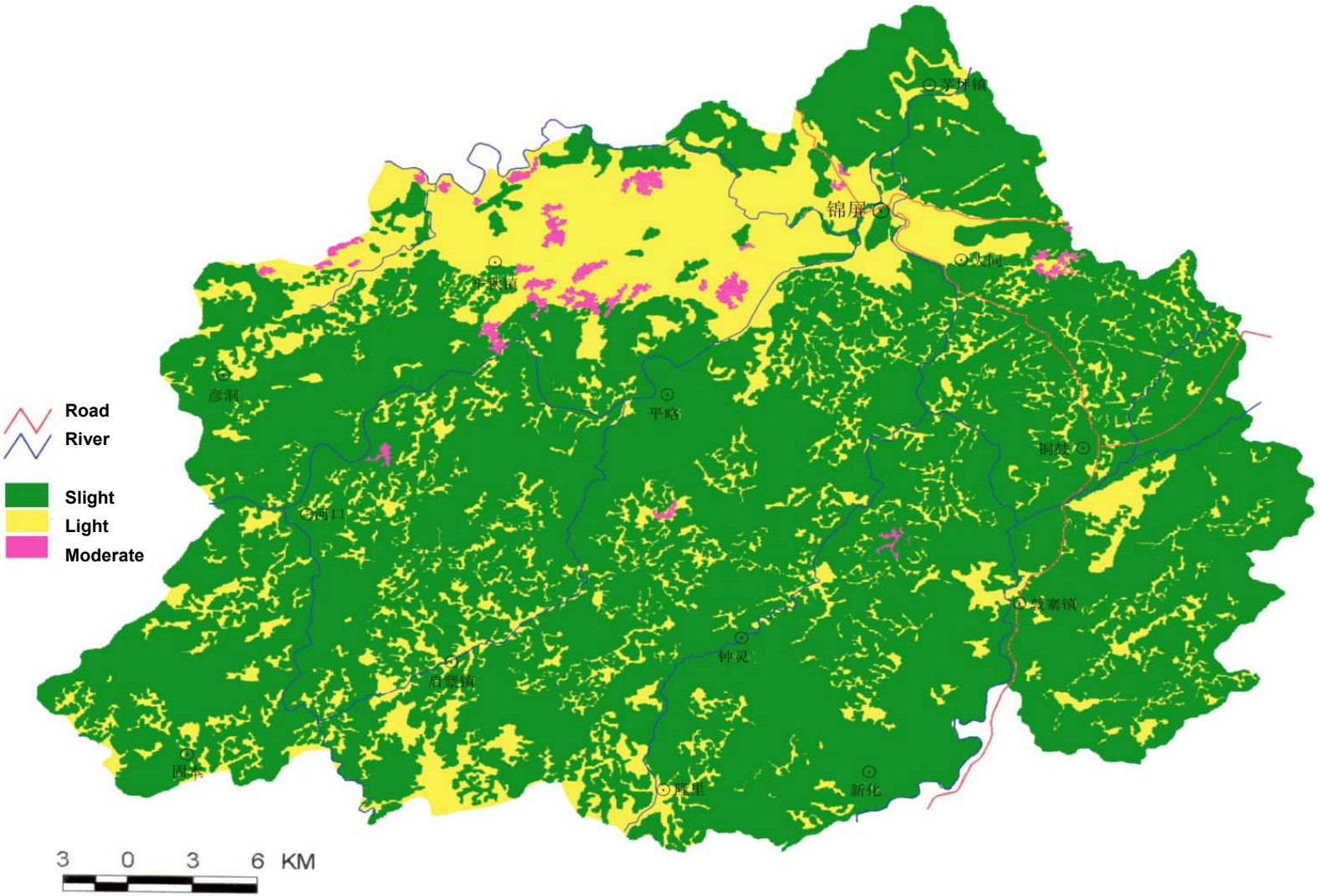
By analyzing the data of water and soil loss in the project area, it can be seen that 829,509 hm² in the project area does not have clear water and soil loss, accounting fro 71.13% of the total land. Water and soil loss area in the project area is 336,641 hm², accounting for 28.87% of the total land. The soil erosion is mainly mild erosion, followed by moderate erosion, accounting for 24.09% and 4.02% of the total land respectively. See Table 3.5 and figures of water and soil loss of each county and city for details.



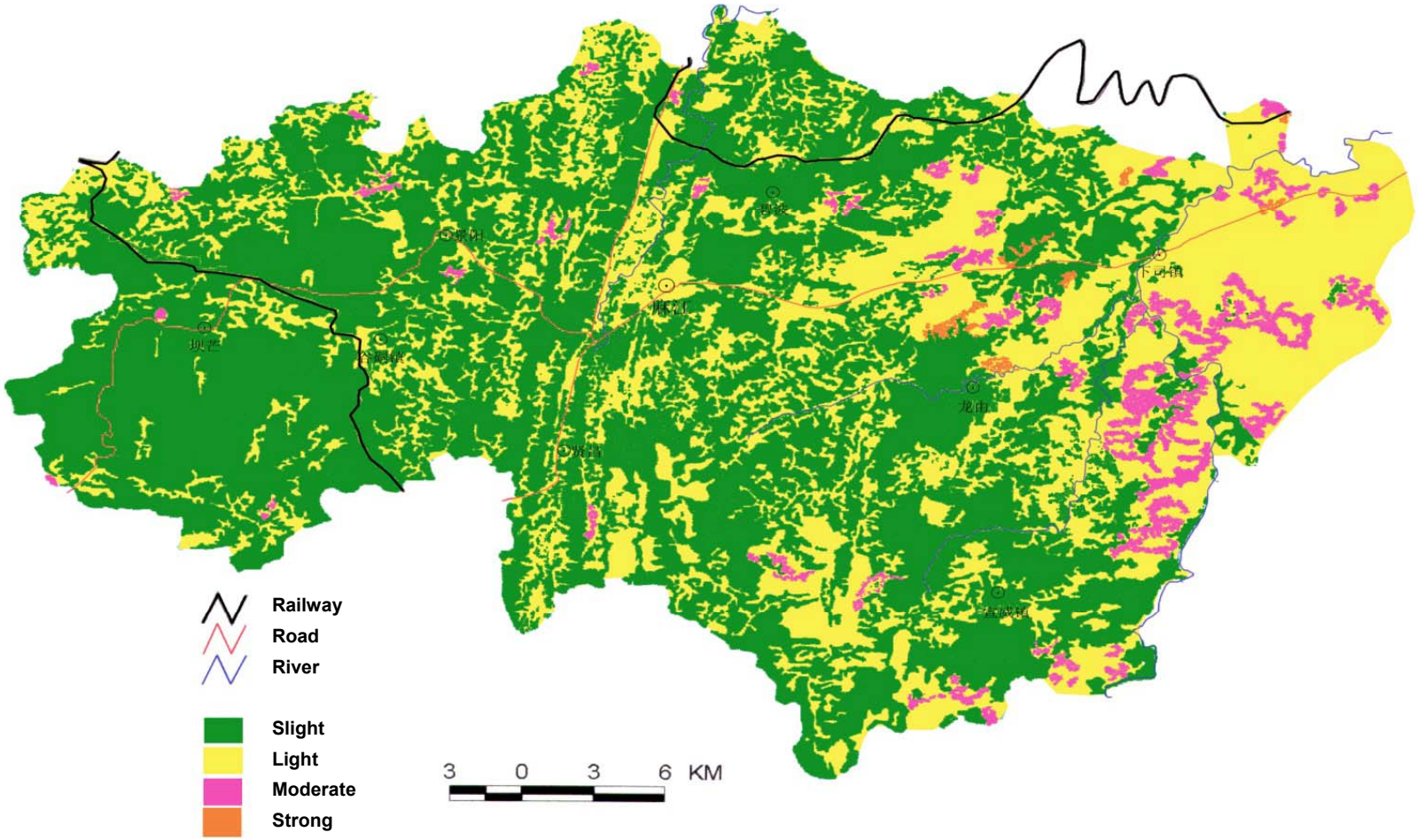
Status quo of water and soil loss in Kaili City



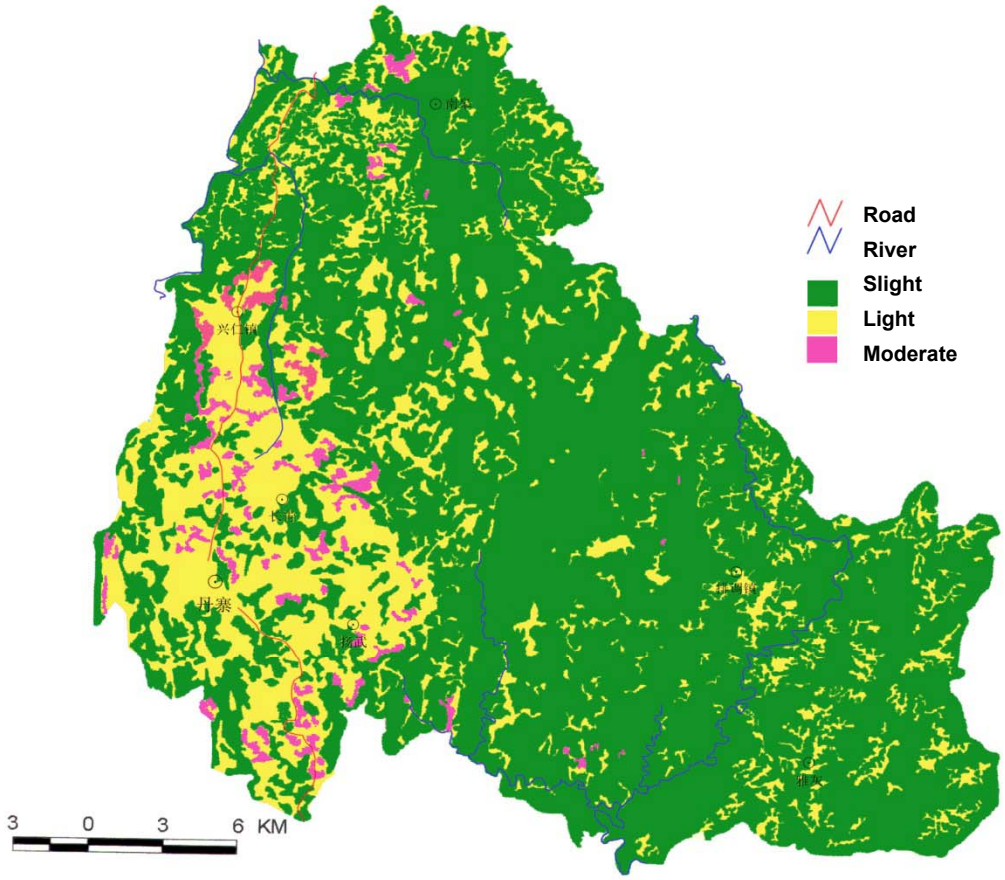
Status quo of water and soil loss in Liping County



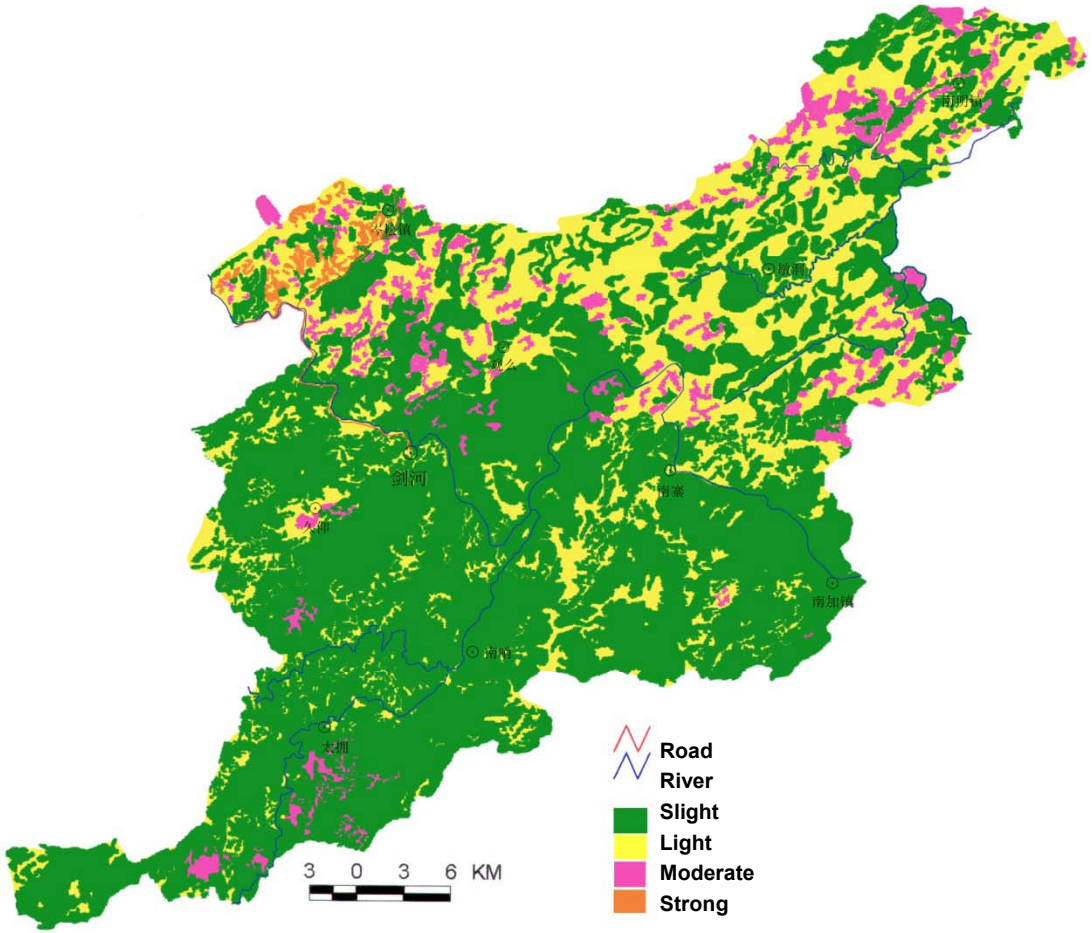
Status quo of water and soil loss in Jinping County



Status quo of water and soil loss in Majiang County



Status quo of water and soil loss in Danzhai County



Status quo of water and soil loss in Jianhe County

The status quo of soil erosion in the project area is that the area with not clear water and soil loss and that with light water and soil loss account for a large area, 1,110,478 hm², accounting for 95.23% of the total land in the project area. The area with moderate water and soil loss accounts for 4.77% of the total land. This indicates that after years of ecological construction and protection, the project area has currently a stable ecological system and the water and soil loss is not serious.

Among all counties and cities, Majiang County has the largest proportion of water and soil loss area of its total land, which is 51,464 hm², accounting for 42.11% of the total land of Majia, mainly mild and moderate erosion. Kaili follows, with an area of water and soil loss of 53,248 hm², accounting for 40.77% of its total land, also mainly mild and moderate erosion. Liping County has a smallest proportion of water and soil loss area, only 18.46%.

Jinping, Danzhai and Jiahe counties on which the project concentrates have relatively small water and soil loss areas. The area without clear water and soil loss accounts for 72.08%, 68.82% and 64.73% of the total land respectively. The area with moderate to severe water and soil loss accounts for 0.14%, 3.14% and 7.19% of the total land respectively.

The situation of water and soil loss in all counties and cities is shown in Table 3.5 below.

Statistics of water and soil loss														
Table 3.5														Unit: hm^2, %
County (city)	Total land area	Area without significant loss		Water and soil loss area										
				Total		Light			Moderate			Intensity		
		Area	Proportion of the total area	Area	Proportion of the total area	Area	Proporion of total area	Proportion of loss area	Area	Proporion of total area	Proportion of loss area	Area	Proporion of total area	Proportion of loss area
Total	1166150	829509	71.13	336641	28.87	280969	24.09	83.46	46887	4.02	13.39	8785	0.75	2.61
Kaili City	130590	77342	59.23	53248	40.77	27518	21.07	51.68	18905	14.48	35.50	6825	5.23	12.82
Liping County	443920	361979	81.54	81941	18.46	75637	17.04	92.31	6304	1.42	7.69		0.00	0.00
Jinping County	159690	115108	72.08	44582	27.92	44358	27.78	99.50	224	0.14	0.50		0.34	0.00
Majiang County	122220	70756	57.89	51464	42.11	46517	38.06	90.39	4535	3.71	8.81	412	0.00	0.80
Danzhai County	93770	64528	68.82	29242	31.18	26300	28.05	89.94	2942	3.14	10.06		0.72	0.00
Jianhe County	215960	139796	64.73	76164	35.27	60639	28.08	79.62	13977	6.47	18.35	1548	2.61	2.03

Note: From the Special Report of Ecological Impact of the Material Forest Base for MCC Paper Qiandongnan Prefecture Pulp Paper Integration Project by China Environmental Science Research Institute in 2008.

3.4 Investigation and Assessment of Key Species under Protection and Important Sensitive Areas

3.4.1 Overview of Biological Resources

Although natural native vegetation is long gone due to the long-term effects of human activities in the project area, there is still some distribution of evergreen broad-leaved forests, coniferous forests, mixed coniferous-broadleaf forests and sparse-tree and short-grass shrubs and other natural vegetation in some areas, so biological resources are abundant and biodiversity is still strong. Natura reserves, scenic spots or forest parks have established in these areas.

1. Plant Resources

The project area is located in the subtropical humid monsoon climate zone and the warm and humid climate and complex and diverse topolgraphy conditions provide a good growth environment for many plants so that there are a lot of plant varieties and abundant species in the project area. According to statistics, there are in the project area and the surrounding area forest plants of 290 families, 696 genera and 2009 kinds, including 1,444 kinds and 19 varieties of seed plants that are divided into 163 families and 492 genera. The seed plants include 1,084 wood plants that are divided into 108 families and 284 genera, and 360 herbs that are divided into 55 families and 208 genera. In these plants thare are 3 monotype families and 34 monotypic genera and ancient nenera; 49 Chinese endemic genera, including 17 monotype endemic genera, 30 less-species (2-5 species) endemic genera and 2 multiple (more than 6 species) endemic genera. Wood plants include 566 kinds of trees and 518 shrubs.

The project area has 37 national protected specis. First-grade protected species include toushan, Taxus chiinensis, south Taxus chiinensis, Bretschneidera sinensis and Alien Mussaenda. Natural toushan forests are mainly distributed in the Leigong Mountains, including 35 concentrated pieces. Second-grade protected species include Calocedrus, Ginkgo biloba L., Fujian cypress, Pinus massoniana, Peck walnuts, Tetracentron, Tsoongiodendron, Bretschneidera wood, Liriodendron, Sinicus, Diplopanax stachyanthus, Emmenopterys, Eurycorymbus cavaleriei, Rehderodendron macrocarpum, Eucommia, and Grate Cephalotaxaceae. According to the survey, there is 60 hectares of concentrated pieces of Liriodendron in Wugachong, Jianhe County, and other species are distributed sporadically. Third-class protected species include Pubescence Keteleeria, Phoebe, Phoebe bournei, Pteroceltis, Sheep cathayensis, hongdoushu, Stewartia sinensis, Money peg, Pterostyrax psilophyllus, silver sparrow tree, Douglas fir, red-flower Manglietia, Emei single-sex Manglietia, and yellow-branch Keteleeria.

2. Animal Resources

In the project area and surrounding areas, mammalia include 6 orders, 17 families and 38 species; aves include 10 orders, 20 families and 116 species; reptilian include 2 orders and 62 species; amphibian include 1 order, 9 families and 37 species, and pisces include 4 orders and 36 species. There are a number of national protected animals here. National Grade II animals include forest deer, pangolin, leopard, giant salamander, macaque and mandarin duck. National Grade III protected animals include rasse, silver pheasant, golden pheasant, river

deer, tiger frog, and python.

3.4.2 Important Ecologicla Sensitive Areas

1. Overview

After field investigation and data collection, important ecological areas in the project area can be divided into natural reserves, scenic spots and forest parks.

According to statistics, as of 2013, there are 13 established natural reserves, 7 forest parks and 7 scenic spots in the project area.

2. Survey of sensitive areas

(1) Natural reserves

There are 13 established natural reserves of all levels and all types, including Leigong Mountains Natural Reserve is a national natural reserve (including part of Jianhe County). Jianhe and Danzhai counties have 4 natural reserves each, Liping and Jinping counties have 2 natural reserves each, and Majiang County has two natural reserves. Natural reserves in the project area are detailed in Table 3.6.

Statistics of various natural reserves in the project area								
Table 3.6								
No.	Name of natural reserves	County (city)	Reserves areas (hm^2)	Main protected objects	Category	Level	Construction time	Authorities
1	Leigong Mountains National natural reserves	Jianhe County	47300	Taiwania flousiana and forest ecological system	Forest ecological system	State level	June 1982	Qiandongnan Prefecture government
2	Jianhe Baili broadleaved forest natural reserves	Jianhe County	10000	Beech, Taiwania flousiana, Taxus chiinensis, Metasequoia glyptostroboides Hu et Cheng and other rare animals and plants	Forest ecological system	Prefecture-level	June 1982	County-level forestry department
3	Jianhe Wujiachong natural reserves	Jianhe County	50	Liriodendron and ecological system	Forest ecological system	County level	June 1982	County-level forestry department
4	Gedong fossils natural reserves	Jianhe County	4760	Fossils	Paleontology relic	Provincial level	June 1982	Qiandongnan Prefecture government
5	Liping Taiping Mountains natural reserves	Liping County	31551	Forest ecological system	Forest ecological system	Prefecture-level	June 1982	County-level forestry department
6	Dongfeng Forest	Liping County	2831	Fine Cunninghamia	Forest	County level	June 1982	County-level

	Farm natural reserves			Lanceolata seedling forest	ecological system			forestry department
7	Jinping Guiye natural reserves	Jinping County	2000	Forest ecological system	Forest ecological system	County level	June 1982	County-level forestry department
8	Jinping Bahe natural reserves	Jinping County	4200	Forest ecological system	Forest ecological system	County level	June 1982	County-level forestry department
9	Majiang Laoshechong natural reserves	Majiang County	8678	Forest ecological system	Forest ecological system	Prefecture-level	June 1982	County-level forestry department
10	Danzhai Shanyangjie natural reserves	Danzhai County	84	Dujuan, huashansong, Phoebe and other water source forest	Forest ecological system	County level	June 1982	County-level forestry department
11	Danzhai Niujiao Mountains natural reserves	Danzhai County	160	Taxus chiinensis, Taiwania flousiana, Phoebe, yellow kiwi fruit and other plants and animals	Forest ecological system	County level	June 1982	County-level forestry department
12	Danzhai Longxuan Mountains natural reserves	Danzhai County	330	Water source forest (dujuan)	Forest ecological system	County level	June 1982	County-level forestry department
13	Danzhai Laodongzhai natural reserves	Danzhai County	4513	Rare plants and animals and water conservation forest	Forest ecological system	County level	June 1982	County-level forestry department

(2) The project area involves 7 scenic spots. Liping Dong Village Scenic Spot in Liping County is a national scenic spot. Provincial and lower leves of scenic spots include one in Jianhe County, one in Majiang County, two in Jinping County, one in Danzhai County, and one in Kaili City. Scenic spots in the project area are detailed in Table 3.7.

Various scenic spots in the project area

Table 3.7

No.	County (city)	Name of scenic spot	Areas (hm^2)	Main scenic spots	Level	Construction time	Authorities Qiandongnan Prefecture Bureau of Construction
1	Liping	Liping dong village scenic spot	12000	Bazhouhe scenic spot, Dong nationality scenic spot, Nanquanshan historical relic area, Maogong Dong nationality cultural area	State level	January 2004	Qiandongnan Prefecture Bureau of Construction
2	Jianhe	Jianhe scenic spot	15600	Weiquan minority village area, Baili original broadleaved forest area	Provincial level	February 2000	Qiandongnan Prefecture Bureau of Construction
3	Majiang	Xiasi scenic spot	6700	Qingshui River scenery ship tourism spot, Laoshanhe Valley scenery, Zhang Xianpei hometown, Xiansi ancient town scenic spot, Tonggu, Baiyang, and Heba national customs	Provincial level	February 2000	Qiandongnan Prefecture Bureau of Construction

4	Jinping	Jinping Sanbanxi-Longli ancient city scenic spot	18000	Sanbaixi lake area, Wuxia River area, Beidongjiuzhai area,and Longli ancient city area	Provincial level	November 2003	Qiandongnan Prefecture Bureau of Construction
5	Danzhai	Danzhai Longquan Mountains-Chahe River scenic spot	7510	Longquang Mountains area, Diaodong Valley area, Nangao area, Chahe area, and Paiting	Provincial level	November 2003	Qiandongnan Prefecture Bureau of Construction
6	Kaili	Xianglu Mountains scenic spot	600	Xianglu Mountains	County or city level	November 2002	Kaili City Bureau of Construction
7	Jinping	Jinping Bahe scenic spot	4200	Bahe hydropower station area	County or city level	December 1997	Jinping County Bureau of Construction

(3) Forest Parks

The project area includes 7 forest parks. Liping National Forest Park in Liping County is a national forest park. Provincial and lower levels of forest parks include one in Majiang County, one in Jinping County, one in Danzhai County, three in Kaili City. Forest parks in the project area are detailed in Table 3.8.

Various forest parks in the project area

Table 3.8

No.	County (city)	Name of forest park	Area (hm^2)	Main protected objects	Level	Construction time	Authorities
1	Liping County	Lipng national forest park	5475	Virgin forest	State level	December 2003	Liping County Bureau of Forestry
2	Danzhai County	Danzhai Longquanshan forest park	1884	Virgin forest	Provincial level	July 2001	Danzhai County Bureau of Forestry

3	Jinping County	Jinping Chunlei forest park	10250	Virgin forest	Provincial level	May 2002	Jinping County Bureau of Forestry
4	Kaili City	Kaili Luohanshan forest park	78.9	Virgin forest	Provincial level	December 2003	Kaili City Bureau of Forestry
5	Majiang County	Majiang Xianrenqiao forest park	5763	Virgin forest	Provincial level	November 2004	Majiang County Bureau of Forestry
6	Kaili City	Kaili Shixianshan forest park	628.7	Virgin forest	Provincial level	June 2005	Kaili City Bureau of Forestry
7	Kaili City	Kaili Pingguoshan forest park	8.5	Virgin forest	County level	March 2002	Kaili City Bureau of Forestry

Chapter IV Environmental Feasibility Analysis for Project Construction

4.1 Analysis of Forest Resource Consitions in Project Area

According to the data of 2013 forest change results in various counties and cities, the 6 counties (cities) have a total land area of 1,166,217.11 hm², including 842,175.79 hm² of forest land, accounting for 72.21% of the total of the project area; and 323,974.21 hm² of non-forest land, accounting for 27.78% of the total. The forst land includes 718,732.68 hm² of woodland (including 709,843.43 hm² of arbores and 8,889.25 hm² of bamboo), 8,042.70 hm² of open woodland, 57,116.4 hm² of shrub woodland (27,568.68 hm² specified by the state and 29,547.72 hm² of others), 26,665.16 hm² of young afforested land, 25.06 hm² of nursery land, 19,776.45 hm² of unstocked woodland, 11,769.72 hm² of hills and wastesuitable land for forest, and 47.62 hm² of auxiliary forest production land.

By comparing the above data with the 2011 County-level Woodland Protection and Utilization Planning Results (2010-2020) of the counties and cities, from the total forest land in the project area, the restults of forest protection and utilization are 842,226.02 hm², the woodland area increased by 9,623.91 hm² in 2013 compared with the data of 2013 woodland change results, where Kaili has the largest woodland area increase of 5,347.51 hm², followed by Jinping County with an increase of 3,275.31 hm². In addition, except Liping whose woodland increases by 600.22 hm², and three other counties have varying degrees of increase, Majiang by 1,262.03 hm², Danzhai by 328.17 hm², and Jianhe by 11.11 hm².

Throught the analysis of the data of forest land changes above, combined with the analysis of the 2013 forest land change survey and related information, in the Twelfth Five-Year period, Guizhou Province continues to implement natural forest resource protection project and the project of returning farmland to forests or grassland and other key projects, which is also the case in the project in recent years, speeding up the pace of afforestation, mainly regional afforestion in barren hills, low-yield forests, sparse and residue forests, deforested land and burned land, so that the frest land area is increased to a certain extent. Meanwhile, with the continued planning and implementation of Phase II natural forest resource protection and the successive implementation of a new round project of returning farmland to forests or grassland and other key projects in 2013, the woodland area will be further increased and forest coverage be improved in the project area.

Overall, the woodland area proposed in the project feasibility report can support the woodland resources required fore the project.

4.2 Analysis of Public Welfare and Commercial Forest in Project Area

4.2.1 Status Quo of Public Welfare Forests and Commercial Forests

According to the public welfare forest division results of the counties and cities, there are

518,874.91 hm² of commercial forests in the project area, accounting for 61.61% of the woodland in the project area, and 323,300.88 hm², accounting for 38.39% of the woodland area of the project area.

From the woodland distribution in various counties and cities, Liping has the largest area of commercial forests, 216,347.16 hm², accounting for 41.7% of the total commercial forests in the project area and accounting for 48.74% of Liping's land; followed by Jianhe whose area of commercial forests is 166,563.76 hm², accounting for 17.70% of the total of commercial forests, accounting for 42.54% of the county's land; the conditions of public welfare forests and commercial forests of other counties are detailed in Table 3.1 "assessment of the situation of forest resources".

4.2.2 Comparative Analysis of Project Plots and the Distribution of Commercial Forests and Public Welfare Forests

The main aspect of the project is the selection of suitable barren hills and unstocked woodland (deforested land and burned land) in the project area for afforestation and the transformation and cultivation of existing inefficient young and middle-aged forests. In order to avoid and reduce as much as possible adverse effects of the project on ecological environment and socio-economic environment, the classified forest management must be followed strictly and timber forests (cultivating large-diameter Cunninghamia Lanceolata and Pinus massoniana timber), oilseeds forests (featured economic woody oil forests) and fruit forests (featured blueberry forests) must be arranged in the commercial forests approved by the local government. Ecological and economic forests and ecological forests can be built eigher in commercial forests or in public welfare forests, but it is the most ideal that they are built in public welfare forests to increase the number of public welfare forests so that public welfare forests can better increase the connectivity of their plaque space and the stability of forest stand space while playing ecological effects. The primary principle of the plot layout of the project is to protect the ecological construction and stick to the principle of not selecting plots in the public welfare forests to built non-ecological forests.

It can be clearly seen from the project layout of the six counties and cities, the layout of plots of the project is adapted to the different management objectives, with non-ecological forests not distributed in public welfare forests.

According to the project plan, a new afforestation area of 9,580.41 hm² (143,706.15 mu) is planned for 2015 to 2017, accounting for 1.14% of commercial forests and 2.96% of public welfare forests, where, from counties and cities, Jianhe has the largest new afforestation area of 3,338.38 hm² (50,075.7 mu). The existing forest management area is 4,809.35 hm² (72,139.5 mu), accounting for 0.57% of commercial forests and 1.49% of public welfare forests, where Liping has the largest area of 2,000.16 hm² (30,001.5 mu) and Jianhe and Kaili do not have existing forest management.

From that perspective, the project has large space in the selection of commercial forests and public welfare forests, enough to meet the project size.

4.3 Analysis of Afforestation-sensitive Areas

To ensure ecological security in the project area and adjacent areas and avoid a serious impact of the project on the integrity, stability and biodiversity in the project area.

According to the relevant laws and regulations of the State, the plots of the project cannot

be laid to overlap natural reserves, scenic spots, forest parks and other ecologically sensitive areas. To analyze the areas allowed for construction and the specific distribution, the assessment mainly uses the GIS overlap analysis by superposing sensitive areas listed in Table 3.6, Table 3.7 and Table 3.8 in the counties' and cities' digitalized figures of vegetation types and woodland resources of the project area, and mark off areas that require special protection and are allowed for non-ecological forest construction.

Through the overlap analysis of the data above, the specific project plots of the project are not affecting all levels of natural reserves, scenic spots and forest parks in the project area.

4.4 Analysis of Woodland to Be Constructed by the Project

4.4.1 Analysis of Conditions Suitable for Afforestation Land

The project area is located in the transitional slope between the Yunnan-Guizhou Plateau and the hills in Hunan and Guangxi and its main topography is low mountains and hills. The topography is characterized by the low altitude, deep river cutting and large relative height difference. Most of the area has an average altitude of 500-800 m and a relative height difference of 300-500 m, and the valley of a tributary of the Duliu River that has the lowest altitude (137 m) is located in Diping, Liping County. The project area is rich in water resources and the Qingshui River flowing into the Yangtze River and the Douliu River flowing into the Pearl River transverse the entire project area from west to east.

The geological conditions are complex and diverse in the project area and the major outcropping rocks include carbonate rocks, quartz sandstone, slate and blastopsammitic rocks, basalt, sandshale and old weathered residual materiasl. The terrain is complex in the project area with a wide range of soil parent materials forming a wide variety of soils with a complex distribution under the impact of natural vegetation, climate and human activities, mainly including yellow soil, red-yellow soil, limestone soil and purple soil, all with good permeability and high fertility.

The climate in the project area is a mid-subtropical type. Due to topography and latitude, vertical climate changes are greater than horizontal changes. Therefore, the clear vertical climate characteristics showed with different mountain altitudes create a multi-level multi-type forest ecology. The annual average temperature in most parts of the project area is about 17℃, with an annual accumulated temperature above 10℃ of 5,000-6,500℃, a frost-free period of 240-300 days, 1,200-1,600 hours of sunshine, and an annual rainfall of 1,000-1,400 mm, and the project area is characterized by summers without intense heat, winters without severe cold, high calorie, and enough rain with the same season as heat.

Pinus massoniana, Cunninghamia Lanceolata, nanzhu and other native species are dominant in the project area that is a famouse commercial forest area in China and is a central area of production of Pinus massoniana and Cunninghamia Lanceolata in Guizhou.

From the water, soil, climiate, topography and other ecologically suitable conditions above, the project area is one of the most suitable areas in China for planting Pinus massoniana and Cunninghamia Lanceolata.

4.4.2 Analysis of Afforestation Site Conditions

The site conditions requirements of the afforestation land layout in the project feasibility report are as follows: The site indext of native rare species (Taxus chiinensis, osmanthus, Ormosia henryi, Phoebe, Photinia, Beech, Paliurus, Manglietia, Chapensis, Liriodendron,

Privet, Arborvitae, Dendrobenthamia, and Cinnamomum camphora) is generally required to reach 14, and the site index for other species is more than 16.

From the conditions ecologically suitable for each species, the woodland layout of the project is feasible. However, the project has great rainfall intensity and amount, and the land surface is vulnerable to water and soil loss after disturbed. Afforestation and replanting on slopes above 25 degrees may cause strong soil erosion and it is difficult to ensure overall ecological benefits. Therefore, the site slope is an important factor to consider in the site selection in addition to the site quality conditions above.

According to the Forest Harvesting Practice (LY/T1646-2005), combined with the ecological characteristics in the project area, the environmental assessment holds that, to prevent water and soil loss, the site selection of the project should limit the site slope under 25 degrees. Where afforestion is carried out on slopes above 25 degrees, woodland clearance and land preparation and the threshold expansion, scarification and other activites disturbing land surface in the management and tending should be strictly prohibited.

4.4.3 Analysis of Woodland Resoruces Available

1. Afforestation

According to the analysis for the project feasibility report, the project has a new afforestation plan of 9,580.41 hm² by using the existing land suitable for afforestaion, unstocked woodland (burned land and deforested land) above intermediate site quality in the project area. The afforestation includes five types: the afforestation of local rare species, afforestation of the mixture of forest and herbs, woody oil featured economic forest, featured economic blueberry forest and afforestation of the mixture of Cunninghamia Lanceolata and phyllostachys pubescens.

To analyze whether the project area can provide the woodland resources require for the new afforestation, the assessment analyses the project feasibility report and the small spot factor table of the new afforestation land of the project.

Of 39,588.87 hm² of open woodland, unstocked woodland and suitable afforestaion land in the project area, 31,546.17 hm² meet the afforestation conditions required by the project and the slope of the new afforestation land is less than 25 degrees.

In addition, according to the annual forest cutting quota of 3.7342 million square meters and main (secondary) cutting quota of 1.89.01 million square meters approved for Qiandongnan Prefecture by the State Council and Guizhou Provincial People's Government in the Twelfth Five-Year period referenced in the feasibility report, by estimate, 13,000 hm² deforested land will be formed annually and will be provided for the afforestation project.

2. Management of Existing Forests

According to the existing forest management objective of the project, and the woodland resources available for the project within the range of distribution of woodland resrouces in the project area.

The project will cultivate existing forest of 4,809.35 hm², including 1,774.12 hm² of mixed Cunninghamia Lanceolata and nanzhu forest, 1,458.41 hm² of broad-leaved and coniferous mixed forest, 1,243.42 hm² of multi-layered forest and herb forest, and 333.4 hm² of large-diameter Cunninghamia Lanceolata and Pinus massoniana timber forest. According to 2013 forest change data, the project now has 333,639.83 hm² of Cunninghamia Lanceolata forest, 403.3 hm² of broadleaved mixed forest, and 3,345.74 hm² of broadleaved and

coniferous mixed forest. The three resources amount to 337,388.87 hm². The existing resource area is far larger than that planned by the project for management, and thereore can meet the project's need for existing forest management.

4.5 Afforestation Land Layout Reasonability Analysis

The environmental assessment analyzes the reasonableness of the layout of afforestation land in counties and cities by superposing the layout of project afforestation plots and the data of 2013 forest change survey.

The scope of woodland planned for afforestation is worked out by superposing the the GIS database (Beijing 54 coordinate system) of the small afforestation class and the small existing forest management class provided by the project feasibility report and the classified forest management zooming map and satellite images of counties an cities in the project area.

The results show that currently all plots selelcted for the project based on the the forest resource survey are all distributed in the area allowed for construction.

4.6 Feasibiity Analysis of Environmental Protection Measures of the Project

In order to reduce the ecological damage and pollution during the project, a series of measures to prevent and mitigate environmental impacts have been developed from the perspective of prevention, including water and soil conservation, biodiversity conservation, woodland fertility maintenance, woodland sanitation and other aspects as well as environmental monitoring.

4.6.1 Water and Soil Conservation Measures

To prevent water and soil loss during the project construction, the project feasibility report proposes the corresponding water and soil conservation measures according to the project characteristics. Controlled burning is prohibited in woodland clearance. All afforestation activities should be carried out along the contours; the block form and triangle arrangement should be used in land preparation; the original vegetation should be retained between blocks; grass and shrubs cut in woodland clearance after the planting will used to cover the planting holes and around them to avoid direct rain erosion of soil. The land surface should be covered with deadwood and fallen leaves after tending and reclamation to keep the soil and water.

In the timber harvesting, if there are small streams, wetlands and lakes in the cutting area, or if the cutting area is close to natural reserves, cultural reserves, natural beauties, wildlife habitats and scientific experiments, a certain buffer width belt should be set aside.

Light water and soil loss exists in the project construction but can be effectively prevented in the project construction by using the measures above to strenghthen site construction supervision and supervise construction and technical personnel for construction in accordance with the design

Therefore, the water and soild conservation measures proposed in the feasibility report is feasible.

4.6.2 Woodland Environment Protection Measures

To prevent environmental pollution during the project construction, the feasibility report

proposes the following woodland environment protection measures:

Use fertilizer rationally. Use none or little pesticides; in the event of pests and diseases that requires the use of pesticides, efficient low-residue pesticides should be chosen. Use fertilizers and pesticides rationally; avoid surface scattering to pollut water resources;

Use easily degradable paper containers in the culture of seedlings; not use refractory plastic containers;

Recycle fertilizer bags, pesticide bottles and other reusable packagings as well as bags, pesticide bottles and simple tools that cannot be resused; not abandon them in the forest;

Billboards usef for forest fire prevetion should be made with wood materials and use as little as possible or no concrete and plastics.

The above measures are feasible for the maintenance of woodland environment, prevention of environmental pollution caused by fertilizer use and reduction of pesticide pollution.

4.6.3 Biodiversity Conservation Measures

In order to avoid the simplification trend of biodiversity caused by project construction, the feasibility report proposes the following biodiversity conservation measures:

In the woodland selection, afforestion and tending management, pay attention to the protection of the native forest and secondary forest around the woodland, and prohibit felling of valuable natural forests to make them become blocks of mixed forests;

Improve biodiversity of forests by purifying existing forests or select a number of species to create mixed forests in order to form a complete ecological sytem with strong self-control ability and increase the forest's ability to resist pests and diseases;

While creating economic forests, advocate planting economically valuable trees, shrubs and herbaceous plants to form a multi-level complex plantation community.

Overall, the measures above will play a positive role in maintaining biodiversity and reducing the extent of damage to biodiversity in the project area and maximizing the protection of important biological communities and key protected species and habitats. Although they have certain limitations, they are feasible to reduce damage to biodiversity during project implementation.

4.6.4 Woodland Fertility Conservation Measures

In order to meet the need of new forests for fertilizers and avoid damage to soil environment in the project area, the project feasibility report proposes the following forest fertility conservation measures.

To meet the need for the fast growth of Cunninghamia Lanceolata, Liriodendron, Taxus chiinensis and other native broad-leaf species, the amount of fertilizer must be increased. Ferlisers should be compound fertilizer-based, and organic fertilizer should be used as much as possible if conditions permit, to reduce the output of land fertility;

Protect the litter and ground cover plants, do not allow the collection of litter and turf as in woodland; residues of leaves, skins and roots in the heavesting should be retained in woodland;

Scientific management and reasonable logging. In clear cutting, retention bands or blocks should be retained to play the forest's protective role.

Timely update the clear cut land, at best at the year of harvesting, at least in the second year, with minor slash environmental changes, less update labor and a high survival rate, to recover forest cover as early as possible and improve land utilization.

The above measures maintaining woodland fertility come from the relevant research results and have been used locally with very good effects. They are effective in preventing soil degradation.

4.6.5 Environmental Monitoring Measures

Strengthen technical cooperation with environmental monitoring departments. Set up a certain number of monitoring sites in the project base to establish a complete system of monitoring forest and surrounding environment to strictly monitor the indicators of the forest and surrounding environment; once the standards are exceeded, the cause should be found out with appropriate countermeasures be developed.

Overall, although the environmental protection measures to be used for the protect are not comprehensive, most of them are feasible and will play a positive role in prevent and mitigate damage to and impact on ecological environment.

4.7 Feasibility Conclusions

The project area is suitable for the development of mixed Pinus massoniana and Cunninghamia Lanceolata plantation, coniferous and broadleaved mixed plantation and other mixed forests. The project is in line with the relevant planning of Qiandongnan Prefecture and has a basically reasonable manner of construction.

The forest land area in the project area can meet the needs of the project. The layout of new forests created by using the suitable land for forest and unstocked woodland is reasonable generally; however, future afforestaion activities should take into account the impact of slope afforestation and cutting on water and soil loss.

The project’s layout of afforestation land and existing forest land under management is reasonable, and the land is all distributed in the area allowed for the project.

Environmental protection measures to be taken during project construction are feasible.

Overall, the project has little impact on the environment and the project environment is feasibility.

Chapter V Analysis and Assessment of Ecological Impact

5.1 Macro Impact of the Project on the Ecological Environment

5.1.1 Impact on Land Utilization

According to the data in the project feasibility report, mainly the data of transformation of suitable afforestation land, unstocked woodland (deforested land and burned land) and inefficient middle-aged and young forests. Plantation of Cunninghamia Lanceolata, nanzhu, Beech, Blueberry, Liriodendron and other coniferous and broadleaf species on the original suitable afforestation land, unstocked woodland (deforested land and burned land); and management of inefficient young and middle-aged forests, implementation of commercial timber harvesting or public welfare forest update harvesting after cultivation to the harvesting period, and reforestation after harvesting. This is a change in the forest structure and the nature of forest land remains unchanged.

The biological firebreaks built to cater for the project block the fire primarily through planting local native vegetation, and they will not change the nature of the existing woodland, and this is a change in the woodland structure.

In the environmental feasibility analysis for the project, the feasibility report plans to plant new forest of 9,580.41 hm² on suitable land for forest and unstocked woodland (deforested land and burned land). Therefore, after the implementation of the project, the land involved in the project area will have 9,580.41 hm² of new woodland, and a corresponding area of suitable land for forest and unstocked land (deforested land and burned land) will be reduced.

Therefore, the impact on the land in the project area is mainly controlled in the scope of forest land. Through project implementation, the area of suitable land for forest and unstocked woodland (deforested land and burned land) in the forest land will be reduced to some extent and the woodland area will increase correspondingly. Other land in the project will not be changed.

5.1.2 Impact on Vegetation

(1) Impact on the Type and Spatial Distribution of Vegetation

Counties and cities involved in the project currently have a high proportion of cultivated vegetation and a low proportion of natural vegetation. In the selection of areas for construction in the environmental assessment, all pieces of natural vegetation in the project area have been designated as sensitive areas. According to the layout of woodland for the project, all plots are in the permitted area, so the project basically will not affect the pieces of natural vegetation in the project area and those affected may be small pieces of secondary shrub and grass vegetation in the forest edge, inside and understory as well as the grass and shrub vegetation in suitable land for forest.

New afforestation land and the exsiting forests identified for management are distributed in the forest land in the project area, so farmland vegetation and fruit forests and other crops and cash crops will not be severely affected by the project. Therefore, the project will only change the composition and growth of vegetation of the forest land available for project construction and as long as the biodiversity conservation countermeasures proposed in the project feasibility report and the environment assessment are strictly followed and the planned management methods and layout is strictly complied with, the majority of the original forest

composition will remain unchanged. In the management of existing forests, the main composition of vegetation will not be change significantly compared to the original plantation, but specific species and levels of distribution of vegetation will be changed due to management objectives.

The project is based on the creation of ecological forest with fewer restrictions on the project land. From the existing forest plots and the environmental conditions of the afforestation areas, Cunninghamia Lanceolata and Pinus massoniana dominated coniferous plantations and the plots proposed for afforestation will scatter in the project area in varying areas, forming a coniferous and evergreen broadleaved mixed forest landscape with Pinus massoniana, Cunninghamia Lanceolata, Phoebe and Uncaria as the main body and other types of plant communities in mosaic distribution, increasing vegetation diversity in the landscape level.

(2) Analysis of Impact on Understory Vegetation

On whether understory vegetation is sparse and biodiversity is reduced in plantations and other questions, this assessment investigates and analyses the afforestation land and other adjacent types in different years in the project area, focusing on the Cunninghamia Lanceolata forest, Pinus massoniana forest created in the project in recent years and their understory vegetation.

From the findings, the understory vegetation of the Cunninghamia Lanceolata forest and Pinus massoniana forest planted in the project area is not significantly different from forest edge and outside vegetation compared to barren vegetation, all showing an increase in height and amount in terms of vegetation coverage, plant species and heights.

It can be determned that as long as the technical solutions for afforestaion adopted in the project feasibility report are strictly followed in the project implementation and the ecological environment protection measures proposed in the environmental assessment is implemented, the afforestation of forests for different management objectives in the project area can certainly avoid sparse understory vegetation, increased soil erosion, great loss of biodiversity and other adverse effects.

5.1.3 Impact on Soil Erosion and Assessment

(1) Impact of Plantation and Replantation on Soil Erosion

The project's impact on soil erosion is mainly reflected in soil erosion caused by plantation, replantion of existing forests and other construction activities.

The project plans 9,580.41 hm² of new afforestation forest and the afforestation has significant surface disturbance. During construction, land preparation, woodland clearance and other activities will inevitably destroy part of surface vegetation and the original stable surface, make soil loose, produce a certain area of bare ground, and cause a certain degree of soil erosion, but this effect will be gradually eliminated in a short term with the restoration of understory vegetation.

Soil erosion increased by the project is mainly produced in the woodland clearance and land preparation. Due to the fast vegenation recovery, erosion mainly occurs in the first year when the increase of soil erosion is total of that in the future 4 to 5 years. When the project (including afforestation and management of existing forest) enters normal operations, the erosion to be caused in the future 4 to 5 years can be deemed as the amount of a year for assessment. The soil erosion is great in the first year, but from the annual share and the

dispersed areas, hazards and effects of erosion are small. The erosion is acceptable from the overall ecological environment.

(2) Impact of Forest Management on Soil Erosion

In the thinning of the existing forests and replanting nanzhu, Leatherleaf Mahonia Leaf and Uncaria, water and soil loss will be changed due to the change in vegetation composition. The main factors influencing water and soil loss are canopy closure, understory vegetation, understory litter coverage and harvesting periods. After the completion of afforestation of the project, some of existing unstocked woodland, deforested land and low-yield and inefficient woodland will become forests with high vegetation coverage. The survey of understory vegetation of the existing Cunninghamia Lanceolata forest shows that the existing plantations in the project area have lush understory vegetation with high vegetation coverage.

The construction plots are mainly distributed in the areas with no or light soil erosion. The light soil erosion is mainly changes in the species composition. Therefore, there is little change in the soil erosion modulus.

As long as the various ecological protection measures are strictly executed in the project, the original unstocked woodland, barren hills and wastesuitable land for forest and other woodland will have reduced soil erosion with the completion of the project due to the increase in vegetation coverage and the blocked runoff, playing the role of regional water and soil conservation.

5.1.4 Analysis of the Impact on Key Protected Species and Sensitive Areas

1) Impact on Key Protected Species

The impact of the project on key pretocted species depends mainly on:

a. whether the proposed afforestation plots are habitats or main activity areas of key protected animals;

b. whether the spatial layout of the project plots block the migration route of protected animals;

c. whether key protected plants are distributed in the proposed afforestation plots; and

d. whether the impact of the project spreads to habitats and growing areas of key protected species.

According to the environmental feasibility analysis of the project, the project area is in the allowed range of forest. Meanwhile, the scene investigation of the project area in the environmental assessment shows that the project plots are mainly in the areas at a lower elevation with frequent human activities. These areas have been strongly distured by human activities over the years, the native natural vegetation has long been replaced by artificial vegetation, habitats of key protected animals have been changed, and the environment suitable for their reproduction and habitation has been split.

Currently, key protected animals are mainly distributed in natural reserves in the project area and in secondary forests with a relatively large contiguous area and less human disturbance because these areas have been separated in the project feasibility report. Therefore, the afforestation areas selected for the project are not in habitats of key protected animals or in main activity areas of key protected animals and therefore will not cut or obstruct the migration route of animals.

Key protected plants in the project area are mainly distributed in natural reserves, forest parks, scenic spots and other important sensitive areas in the project. In addition, they also

scatter along rivers and valleys in the project area. These areas are prohibited from arrangement of afforestation in the project feasibility report.

The project will have some impact on common wildlife, but due to the small contiguous areas and the mosaic distribution with other types of vegetatation, will not significantly change the entire wildlife populations in the project area.

Overall, the project has a small impact on key protected species in the project area.

2) Impact on Important Sensitive Areas

Important sensitive areas in the assessment area are some important areas subject to the impact of the project and those specified by the state. The assessment divides important ecologically sensitive areas into natural reserves, scenic spots and forest parks.

The assement has taken into account in the project feasibility analysis that the project may intersect with natural reserves, scenic spots and forest parks leading to the occurrence of construction plots invading natural reserves, scenic spots and forest parks, so it is recommended to arrange a certain area of buffer outside these sensitive areas to try to avoid the adverse effects and minimize the impact of the project on the important sensitive areas.

Overall, as long as the project follows the measures and requirements proposed in the environmental assessment, it will not have a big impact on the ecologically sensitive areas in the project area and surrounding areas.

5.2 Impact of Project Activities on the Ecological Environment

5.2.1 Impact of Woodland Selection on Ecological Environment

(1) Restriction Analysis

According to the project feasibility report, the afforestation land selection should follow the overall layout of forest subdivision and the afforestation layout should be controlled within the scope of forestation land approved by the government. The existing forests under management are selected in the lower (middle lower and middle) slopes of low mountains (hills), slate (sandshale and sandstone), and the site index of Pinus massoniana and Cunninghamia Lanceolata is required to reach 16 generally and the site index of Liriodendron and other local species above 14. the order of selection is barren hills and wastlands suitable for afforestation, deforested land and burned land.

For the site restrictions proposed in the feasibility report, the environmental assessment holds that they should be further improved from the perspective of ecological protection. Practice shows that plantation of featured economic forests on slopes over 25 degrees, even if hole land preparation is used, will cause severe water and soil loss and it is not in line with the state regulations and policies. According to the relevant regulations and documents of the State Council regarding grain for green, “slopes over 25 degrees and river sources and other ecologically important areas should all be returned to ecological forest and grass and should be closed for protection after grain for green after return to forest and be fenced for cultivation after return to grass. In areas with suitable site conditions and inappropriate for water and soil loss, economic forests, timber forests and firewood forests should be developed in the premise of ensureing the overall eco-efficiency. In short, grain for green should also ensure the dominance of ecological forest and grass.” Therefore, slopes over 25 degrees should be avoided as far as possible in the selection of afforestation land and the management of existing forests.

According to the clearcutting regulations in the Forest Harvesting Practice (LY/T1646-2005), the slope of afforestation plots of the project may be less than 35 degrees. Due to the large rainfall intensity and amount in the project area easily causing water and soil loss after surface disturbance, plantation of featured economic forests on slopes over 30 degrees is difficult to ensure the overall ecological benefits. Therefore, the slope should be less than 30 degrees. The project has taken into account the site conditions in the planning of the section of aforestation land and existing forest land and selects all forest patches less than 30 degrees, complying with the ecological restrictions on forest construction.

(2) Ecological Impact Analysis

According to the project feasibility analysis in the environmental assessment, the afforestation areas of the project should be strictly controlled within the allowed area. The allowed area is the forest land after the removal of ecologically important sensitive areas in the project area, so the project woodland does not involve natural secondary forest woodland, shrub woodland and other naturally good areas.

Therefore, as long as the feasibility report and the requirements proposed therein in the project, arranging afforestaionland far away from ecologically important sensitive areas in the project area in the preliminary stage and early stage of the project, i.e. the woodland selection stage, the impact on regional ecological environment will be avoided or reduced.

From the spatial distribution alone, the planned afforestation land layout makes full consideration to the effective fitting with natural reserves and the actual woodland layout is dispersed, forming a natural connection to other surrounding woodland (or farmland). Morever, the buffer between the afforestation land and the sensitive areas effectively prevents disturbance to the edge of sensitive areas. Therefore, the afforestation land of the project will not basically have a direct impact on the local natural ecological system, nor will it affect the long-term effective play of the functions of the natural ecological system in the project area, and the integrity and stability of the original system structure will not be affected significantly.

5.2.2 Impact of Woodland Clearance, Land preparation, Planting and Tending on Ecological Environment

The technical methods used in the woodland clearance, land preparation, planting and tending in the project are feasible mostly. They are techniques and methods summed up in the afforestation pratice of the forestry system and have small adverse effects on ecoligcal environment.

In the project from the environmental protection, woodland is cleared for afforestation and replanting in strips along contours and land preparation is carried out in blocks or holes. The thinning and nanzhu-replanting land preparation specifications are 0.8 X 0.5 X 0.4 m, thinning and Leatherleaf Mahonia Leaf-replanting land preparation specifications are 0.5 X 0.5 X 0.4 m, and thinning and Uncaria-replanting land preparation specifications are 0.4 X 0.4 X 0.4 m; the land preparation specificatios for local rare species afforestation and mixed forest and herbs afforestation are 0.5 X 0.5 X 0.4 m, and the planting density is 110 seedlings/mu. The land preparation specifications for featured economic woody oil forest and featured economic Blueberry forest are strips of 1.0-1.5 m wide and holes of 0.6 X 0.5 X 0.4 m, and the planting density is 110 plants/mu and 220 seedlings/mu, and based on 110 seedlings/mu, the area of destroyed vegetation/mu is 27.5-137.26 square meters, equivalent to only 4.1-20.5% of afforestation area/mu. The project plans a new afforestation area of 9,580.41 hm² (143,706.15

mu), including 2,350.33 hm² of Blueberry (35,254.5 mu) and 4,446.5-7,227.1 mu of vegetation will be destroyed in the assessment area, accounting for 3.09-5.03% of the total assessment area. From the total area of destroyed vegetation, the impact is serious, but due to the different spatial distribution of afforestation plots and fast recovery of understory grass vegetation,other adverse effects caused after vegetation is destroyed can be effectively mitigated. Therefore, this is acceptable from the perspective of the overall ecological environment.

5.2.3 Impact of Fertilizers and Pesticides on Ecological Environment

(1) Impact of Fertilizers on Ecological Environment

Non-point source pollution caused by fertilizer use has become one of prominent environmental problems. It is an important question in the environment assessment whether in the original natural or semi-natural ecological system, application of a lot of fertilizer will increase non-point source pollution in the project and lead to decline of water quality.

By using effective methods, the project can avoid fertilizer exposed on bare surface and washed by rain into the water and can effectively prevent pollution to the environment by application of fertilizer. If construction is regulated strictly without serious water and soil loss, fertilizer use in the project will not cause pollution to regional environment and will not have a great impact on the water environment. Long-term application of fertilizer can easily cause soil compaction and soil deterioration and reduced soil fertilizer. Fertilizers used in the projce are mainly compound fertilizers and organic fertilizers that will not have a great impact on the soil environment.

(2) Impact of Pesticides on Ecological Environment

Plantation pest control is an important part of forest management.

The part is targeted at the following species selected for the project: Cunninghamia Lanceolata, Blueberry, Camellia oleiferaAbel, Hickory, Taxus chiinensis, osmanthus, Ormosia henryi, Phoebe, Photinia, Beech, Paliurus, Manglietia, Chapensis, Liriodendron, Privet, Arborvitae, Dendrobenthamia and Cinnamomum camphora. In accordance with the “prevention dominance and comprehensive treatment” requirements and starting from seedlings and other reproduction materials, the project uses fine seeds and strong seedlings and strengthen tending and fertilization of young forest to enhance forest immunity, and takes advantage of the broken terrain in the project area to block the pest transfer channel by small spot. Strengthen forecasting work; while planting, arrange about 30 fixed standard areas, each not less than 3 mu, in the planting small spot for each type of forest to regularly observe pest occurrence in the standard areas to understand the rule of pest occurrence and development and forecast the pest occurrence trend in order to facilitate preventive measures.

The implementation of the measures above can effectively avoid fertilizer broadcasted on land surface, polluting water and environment, killing beneficial organisms and affecting human and animal safety. Therefore, pollution to water and environment caused by the project is relative low. If fertilizer application is required, the practices must be strictly observed and the doses of pesticides be controlled, and this will mitigate the harm to beneficial organisms and ensure human and animal safety.

List of pesticides to be used for various models in the project is detailed in Table 5.1.

List of pesticides to be used in the project

Table 5.1

Management type	Management model		Main target species	Pesticide name
	Model No.	Model name		
Management of existing forests (young forests)	M1	Management of mixed Cunninghamia Lanceolata and nanzhu forest	Cunninghamia Lanceolata and nanzhu	Dimethoate
	M2	Management of mixed Cunninghamia Lanceolata and Leatherleaf Mahonia Leaf forest	mixed coniferous-broadleaf forest(Cunninghamia Lanceolata and Leatherleaf Mahonia Leaf)	Bt or dimethoate
	M3	Management of mixed forest and herbs forest	Cunninghamia Lanceolata, Pinus massoniana and Uncaria	Dimethoate
	M4	Large-diameter Cunninghamia Lanceolata and Pinus massoniana timber cultivation	Cunninghamia Lanceolata and Pinus massoniana	Dimethoate
Afforestation	M5	Afforestation of local rare species	Mixed Leatherleaf Mahonia Leaf forest	Bt or dimethoate
	M6	Mixed forest and herbs afforestation	Cunninghamia Lanceolata and Uncaria	Dimethoate carbendazim
	M7	Featured economic woody and oil forest	Hickory and Camellia oleiferaAbel	Bassiana
	M8	Featured economic Blueberry forest	Blueberry	Bassiana
	M9	Mixed Cunninghamia Lanceolata and nanzhu afforestation	Cunninghamia Lanceolata and nanzhu	Dimethoate

5.2.4 Thinning Impact on Ecological Environment

The management of existing forests in the project is the thinning of existing Cunninghamia Lanceolata forests to replant nanzhu, Leatherleaf Mahonia Leaf and Uncaria and the thinning of mixed Cunninghamia Lanceolata and Pinus massoniana forests to cultivate large-diameter timber.

Destruction of forest thinning of understory vegetation is different from woodland clearance but is also serious, especially in case of skid trails for rolling logs from the hillside, where surface vegetation is almost destroyed completely, easily causing serious water and soil loss. In addition, forest roads built for shipping timber destroy vegetation seriously. If there are no water and soil conservation measures, bare vertical hilltop sections can easily cause collapse and landslide. Concrete practices must be developed for the project to prevent formation of skid trails and regulate construction of forest roads.

To avoid damage to vegetation during thinning, the project has a human-based operating type. Cable skidding may be used in special areas of high mountains and steep slopes where it is difficult for hand skidding. Small tractor skidding may be used where the terrain conditions

are good. In addition, forest roads have been built in the project area, providing the necessary guarantees for timber transport.

5.3 Analysis of the Social Impact of the Project

5.3.1 Impact of the Project on Local Rural Economy

The project involves a number of interest groups and foresters, forest farms, local governments, forestry authorities, planning and design units and project supervision units will benefit in addition to related enterprises. The labor in the project construction and operation is not intense, giving equal employment opportunities to women and providing a platform for the popularization of scientific knowledge of forestry. Overall, the project has no negative impact on the production and life of people in the project area and does not affect the normal activities of any organization.

The project will have some positive impact on the rural economy in the project area, which is specifically reflected in the following aspects:

(1) The project uses the shareholding management, individual management and a number of other forms of management and can revitalize rural land resources so that farmers get income from land; the project can also provide employment opportunities for the people in the project area so that farmers get labor income.

(2) After the completion of the project, except ecological forests, fresh fruits and forest herbs products, after processing, can be used to extend the industry chain to improve added value of products and increase local fiscal revenue and promote economic development in the project area.

(3) The project can be used as a link between the primary industry and the secondary industry. The application of advanced technology, introduction of advanced management models and construction of forest roads, will all promote rural economic development in the project area.

5.3.2 Social Risks of the Project

(1) Social Risks in the Selection of Afforestation Plots

Currently, most of the woodland for afforestation of the project is collectively owned and the right to operate is mostly owned by foresters. The project involves a wide range and many households and it is difficult for the project owner to implement land selection by putting together woodland of a lot of households. If the land is not selected timely, the progress and investment of the project will be affected.

(2) Disruption Risk of the Project

This risk depends on the assessment and demonstration of the project by the subject providing loans, i.e. European Investment Bank, whether it can provide loans to support investment in the project.

According to the project feasibility report, project size and project implementation effects, the probability of risks caused by the implementation subject is very small.

5.4 Econometric Analysis of Carbon Sequestration of the Project

5.4.1 Carbon Stocks

According to the Guide for Econometric Monitoring of Carbon Sequestration of

Afforestation Projects prepared by the State Administration of Forestry, ground and underground biomass carbon pools must be chosen. According to the conservative and cost-effective principles, the project can ignore dead wood, litter, soil organic carbon and wood product carbon pools.

Carbon stocks are calculated for the project based on stumpage, relationship between biomass and stock volume of different dominant species (groups) and carbon content rate of different species (groups) according to the National Technical Guide for the Econometric Monitoring of Forestry Carbon Sequestation.

The model of relationship between biomass and stock volume of different dominant species (groups) is as follows:

Mi＝aXi＋b.

Note: Mi is the biomass per unit area of the i-th species (group); Xi is the stock volume per unit area of the i-th species (group); a and b are parameters.

Regression equation parameters of biomass and stock volume of main species are detailed in Table 5.2.

Total value of biomass and stock volume relationship parameters

Table 5.2

No.	Species	a	b
1	Cunninghamia Lanceolata	0.46520	19.14100
2	mixed coniferous-broadleaf forest	0.81360	18.46600
3	Pinus massoniana	0.50340	20.54700
4	Mixed Leatherleaf Mahonia Leaf forest	0.97880	5.37640
5	Hickory	0.85205	13.48525

Note: From the National Technical Guide for the Econometric Monitoring of Forestry Carbon Sequestation.

Calculation formula for carbon stocks:

Ci＝∑（Mi×Ai×CFi）

C=∑Ci

Note: C is total carbon stock; Ci is carbon stock of the i-th species (group); Mi is biomass per unit area of the i-th speies (group); Ai is area of the i-th species (group), and CF is carbon content rate of the i-th species.

The carbon content rates of various species (groups) are detailed in Table 5.3.

Carbon content rates of various speices (groups)

Table 5.3

Species (group)	Tree carbon content rate	Species (group)	Tree carbon content rate	Species (group)	Tree carbon content rate
Cunninghamia Lanceolata	0.5127	mixed coniferous-broadleaf forest	0.4893	Economic forest (Hickory)	0.4700
Pinus massoniana	0.5271	Mixed Leatherleaf Mahonia Leaf forest	0.4796	Uncaria, etc. (shrubs)	0.4672
Nanzhu	0.4705	Camellia oleiferaAbel (shrub)	0.4672	Blueberry (shrub)	0.4672

Note: From the National Technical Guide for the Econometric Monitoring of Forestry Carbon Sequestation.

In the 25 years of calculation, the project will increase 1261.266688-1.3440306 million tons of carbon stock. Carbon stock increases of various types of afforestation are detailed in Table 5.4.

Table of calculation of term-end carbon stocks of various major afforestation models

Table 5.4

Management type	**Management model**		Main target species	Total area under management (ha)	Construction period (1st-5th years)				Operation period (6th-25th year)			
	Model No.	**Model name**			Calculation of term-end stocks per unit area (m^3)	Calculation of term-end biomass per unit area (t)	Tree carbon content rate	New carbon stocks (10,000 t)	Calculation of term-end stocks per unit area (m^3)	Calculation of term-end biomass per unit area (t)	Tree carbon content rate	New carbon stocks (10,000 t)
Total				**14190.76**	-	-	-	**23.86585-24.98898**	-	-	-	**102.80295-109.41408**
Management of existing forests (young forests)	Subtotal			**4609.35**	-	-	-	**13.87844-14.96142**	-	-	-	**53.37078-59.78118**
	M1	Management of mixed Cunninghamia Lanceolata and nanzhu forest	Cunninghamia Lanceolata	1774.12	66.66825	50.15507	0.51270	7.61109	381.14550	196.44989	0.51270	22.65179
			Nanzhu		-	36.52743	0.47050		-	57.29898	0.47050	
	M2	Management of mixed Cunninghamia Lanceolata	mixed coniferous-broadleaf forest (Cunninghamia Lanceolata and	1258.41	38.50688	49.79519	0.48930	3.06609	250.56225	222.32345	0.48930	13.68934

		and Leatherleaf Mahonia Leaf forest	Leatherleaf Mahonia Leaf)									
	M3	Management of mixed forest and herbs forest	Cunninghamia Lanceolata	1243.42	66.66825	50.15507	0.51270	2.57293-3.42693	381.14550	196.44989	0.51270	13.67164-18.72664
			Pinus massoniana		30.21150	35.75547	0.52710		491.98500	268.21225	0.52710	
			Uncaria, etc. (shrubs)		-	3.95200	0.46720		-	19.76000	0.46720	
	M4	Cultivation of large-diameter Cunninghamia Lanceolata and Pinus massoniana	Cunninghamia Lanceolata	333.4	66.66825	50.15507	0.51270	0.62833-0.85731	381.14550	196.44989	0.51270	3.35801-4.71341
			Pinus massoniana		30.21150	35.75547	0.52710		491.98500	268.21225	0.52710	
Afforestation	Subtotal			**9581.41**	-	-	-	**9.98741-10.02756**	-	-	-	**49.43217-49.63290**
	M5	afforestation of local rare species	Mixed Leatherleaf Mahonia Leaf forest	2125.91	3.36600	8.67104	0.47960	0.88409	101.12850	104.36098	0.47960	10.64050
	M6	Afforestation of mixed forest and herbs	Cunninghamia Lanceolata	2005.05	7.67250	22.71025	0.52710	2.77037	259.90200	140.04741	0.52710	16.65211
			Uncaria, etc. (shrubs)		-	3.95200	0.46720		-	19.76000	0.46720	

	M7	Featured economic woody oil forest	Hickory	1052.5	-	4.74000	0.47000	0.19433-0.23448	-	23.70000	0.47000	0.97165-1.17238
			Camellia oleiferaAbel (shrub)			3.95200	0.46720			19.76000	0.46720	
	M8	Featured economic Blueberry forest	Blueberry (shrub)	2350.33	-	3.95200	0.46720	0.43396	-	19.76000	0.46720	2.16979
	M9	Afforestation of mixed Cunninghamia Lanceolata and nanzhu forest	Cunninghamia Lanceolata	2047.62	7.67250	22.71025	0.47000	5.70466	259.90200	140.04741	0.47000	18.99812
			Nanzhu		-	36.52743	0.47050		-	57.29898	0.47050	

5.4.2 Greenhouse Gas Emissions

The relevant formulas and parameters come from the 2011 Guide for Econometric Monitoring of Carbon Sequestration of Afforestation Projects.

1. Fertilization

Direct N_2O emissions are calculated based on the project design, the varities, area, amount and N content of fertilizers applied annually.

$E_{N\_Fertilizer,t}=[(F_{SN,t}+F_{ON,t})*EF_I]*MW_{N2O}*GWP_{N2O}$

Where: $F_{SN,t}$ – amount of nitrogenous fertilizers applied in the 5-th year after volatization of NH_3 and NO_X: ($tN.a^{-1}$);

$F_{ON,t}$ – amount of organic fertilizers applied in the 5-th year after volatization of NH_3 and NO_X: ($tN.a^{-1}$);

EF_I – NO_2 emission factor of nitrogenous fertilizer application (IPCC reference value = 0.01 t N_2O-N.$(tN)^{-1}$);

MW_{N2O} – molecular weights of NO_2 and N (44/28) (t N_2O-N.$(tN)^{-1}$);

GWP_{N2O} – N_2O global warming potential (IPCC reference value = 310 t CO_2-e.$(tN_2O)^{-1}$).

Only emissions of compound fertilizers are calculated. 1 t of compound fertilizer is equivalent to 0.52 ton of urea (urea's N content is 46% and compound fertilizer's is 24%), and rea volatizes by 20% (from the 2011 master's thesis entitled Analysis of Farmland Nitrogen Loss Pathways and Water and Nitrogen Use Efficiency under Different Fertilization Patterns in High-yield Grain Areas by Li Li, master degree candidate from Shandong Agricultureal University). It is estimated that 12,585 t of compound fertilizers will be applied in the project with 11,770.9 t of greenhouse gas emissions. The amount of application of compound fertilizers and greenhouse gas emissions in various major afforestation models are detailed in Table 5-4.

2. Fuel

Main considerations are given to CO_2 emissions caused by fossil fuel combustion of the means of transport used (vehicles consuming fuel). The calculation is based on the means of transport used for transport of fertilizers, seedlings and wood, fuel category, average transport distance and fuel consumption per kilometer in different models of afforestation. The following formula is used:

$$LK_{vehicle,t}=\sum_{f=1}^{n} EF_{CO_2,f}\times NCV_f\times FC_{f,t}$$

Where: $LK_{vehicle,t}$ -- CO_2 emissions caused by external transport of the project in the t-th year: (tCO_2-e.a^{-1});

$EF_{CO2,f}$ -- CO_2 emission factor of Class f fuel: (tCO_2-e.GJ^{-1});

NCV_f – heating value of Class f fuel: ($GJ.L^{-1}$);

$FC_{f,t}$ – consumption of Class f fuel in the t-th year: (L).

Fuel mainly used by the project is diesel and the greenhouse gas emission factor is 2.778 kg.CO_2/L (IPCC data). The project is expected to use 5 L fuel per hectare in the construction period and 10 L in the management period. The project is expected to use a total of 1,828 t diesel with 507.8 t greenhouse gas emissions. The amount of diesel use and the greenhouse emissions in various models of afforestation are detailed in Table 5.5.

Table of calculation of term-end greenhouse emissions in various major models of afforestation

Table 5.5

Type of management	Management model		Main target species	Total area under management (ha)	Construction period (1st-5th year)					Operation period (6th-25th year)				
	Model No.	Model name			Total (t)	Amount of fertilization (t)	Greenhouse gas emissions (t)	Fuel use (t)	Greenhouse gas emissions (t)	Total (t)	Amount of fertilization (t)	Greenhouse gas emissions (t)	Fuel use (t)	Greenhouse gas emissions (t)
Total				14190.76	11939.8	12585.0	11770.9	60.8	168.9	338.9			122.0	338.9
Management of existing forests (young forests)	subtotal			4609.35	1986.7	2069.8	1935.9	19.7	54.7	110.3			39.7	110.3
	M1	Management of mixed Cunninghamia Lanceolata and nanzhu forest	Cunninghamia Lanceolata and nanzhu	1774.12	643.4	665.3	622.3	7.6	21.1	42.5			15.3	42.5
	M2	Management of mixed Cunninghamia Lanceolata and Leatherleaf Mahonia Leaf forest	mixed coniferous-broadleaf forest	1258.41	456.4	471.9	441.4	5.4	15.0	30.0			10.8	30.0
	M3	Management of mixed forest and	Cunninghamia Lanceolata and	1243.42	886.9	932.6	872.2	5.3	14.7	29.7			10.7	29.7

		herbs forest	Pinus massoniana											
	M4	Cultivation of large-diameter Cunninghamia Lanceolata and Pinus massoniana	Cunninghamia Lanceolata and Pinus massoniana	333.40	-	-	-	1.4	3.9	8.1			2.9	8.1
Afforestation	Subtotal			9581.41	9949.2	10515.2	9835.0	41.1	114.2	228.6			82.3	228.6
	M5	afforestation of local rare species	Mixed Leatherleaf Mahonia Leaf forest	2125.91	771.0	797.2	745.7	9.1	25.3	50.8			18.3	50.8
	M6	Afforestation of mixed forest and herbs	Cunninghamia Lanceolata and shrubs	2005.05	1430.4	1503.8	1406.5	8.6	23.9	47.8			17.2	47.8
	M7	Featured economic woody oil forest	Camellia oleiferaAbel and Hickory	1052.50	5328.4	5683.5	5315.9	4.5	12.5	25.0			9.0	25.0
	M8	Featured economic Blueberry forest	Blueberry	2350.33	1676.8	1762.8	1648.7	10.1	28.1	56.1			20.2	56.1
	M9	Afforestation of mixed Cunninghamia Lanceolata and nanzhu forest	Cunninghamia Lanceolata and nanzhu	2047.62	742.6	767.9	718.2	8.8	24.4	48.9			17.6	48.9

5.4.3 Net Carbon Sequestration of the Project

In the 25-year calculation period, the project will produce net carbon sequestration of 1,254,409.3 5-1,331,751.9 t of net carbon sequestration. Net carbon sequestration of major models of afforestration is detailed in Table 5.6.

Table of net carbon sequestration of the project

Table 5.6

Management type	Management model		Period	Changes in project carbon stocks (A)		Project greenhouse gas emissions (B)		Project net carbon sequestration (C=A-B)	
				Average annual change	Total	Average annual emissions	Total	Average annual change	Total
	Model No.	Model name		(tCO_2-e.a^{-1})	(tCO_2-e)	(tCO_2-e.a^{-1})	(tCO_2-e)	(tCO_2-e.a^{-1})	(tCO_2-e)
Total of six counties	Construction period (1st-5th year)			47731.7-49978.0	238658.5-249889.8	2387.3	11939.8	45344.4-47590.7	226718.7-237950.0
	Operation period (6th-25th year)			51401.5-54707.0	1028029.5-1094140.8	16.9	338.9	51384.6-54690.1	1027690.6-1093801.9
Management of existing forests (young forests)	M1	Management of mixed Cunninghamia Lanceolata and nanzhu forest	Construction period (1st-5th year)	15222.2	76110.9	128.7	643.4	15093.5	75467.5
			Operation period (6th-25th year)	11325.9	226517.9	2.1	42.5	11323.8	226475.4
	M2	Management of mixed Cunninghamia Lanceolata and Leatherleaf	Construction period (1st-5th year)	6132.2	30660.9	91.3	456.4	6040.9	30204.5
			Operation period (6th-25th year)	6844.7	136893.4	1.5	30.0	6843.2	136863.4

		Mahonia Leaf forest							
	M3	Management of mixed forest and herbs forest	Construction period (1st-5th year)	5145.9-6853.9	25729.3-34269.3	177.4	886.9	4968.5-6676.5	24842.2-33382.2
			Operation period (6th-25th year)	6835.8-9363.3	136716.4-187266.4	1.5	29.7	6834.3-9361.8	136686.7-187236.7
	M4	Cultivation of large-diameter Cunninghamia Lanceolata and Pinus massoniana	Construction period (1st-5th year)	1256.7-1714.6	6283.3-8573.1	-	-	1256.7-1714.6	6283.3-8573.1
			Operation period (6th-25th year)	1679.0-2356.7	33580.1-47134.1	0.4	8.1	1678.6-2356.3	33572.1-47126.1
Afforestation	M5	afforestation of local rare species	Construction period (1st-5th year)	1768.2	8840.9	154.2	771.0	1614.0	8069.9
			Operation period (6th-25th year)	5320.3	106405.0	2.5	50.8	5317.7	106354.2
	M6	Afforestation of mixed forest and herbs	Construction period (1st-5th year)	5540.7	27703.7	286.1	1430.4	5254.7	26273.3
			Operation period (6th-25th year)	8326.1	166521.1	2.4	47.8	8323.7	166473.3
	M7	Featured economic woody oil forest	Construction period (1st-5th year)	388.7-469.0	1943.3-2344.8	1065.7	5328.4	-677.0--596.7	-3385.1--2983.6
			Operation period	485.8-586.2	9716.5-11723.8	1.3	25.0	484.5-584.9	9691.4-11698.7

			(6th-25th year)						
	M8	Featured economic Blueberry forest	Construction period (1st-5th year)	867.9	4339.6	335.4	1676.8	532.6	2662.8
			Operation period (6th-25th year)	1084.9	21697.9	2.8	56.1	1082.1	21641.8
	M9	Afforestation of mixed Cunninghamia Lanceolata and nanzhu forest	Construction period (1st-5th year)	11409.3	57046.6	148.5	742.6	11260.8	56304.0
			Operation period (6th-25th year)	9499.1	189981.2	2.4	48.9	9496.6	189932.3

Note: the factor of converting carbon (C) to CO_2 is 44/12.

Chapter VI Ecological Impact Protection Measures and Restoration Strategies

6.1 Ecological Impact Avoidance Measures

Ecological impact avoidance measures means adjusting some aspects in the premise of ensure the basic conditions required for the project, prohibiting and restricting some activities to avoid adverse effects on the ecological environment.

6.1.1 Measures to Avoid the Impact of the Project Layout on Ecological Envrionment

According to the scale of construction proposed in the feasibility report, the six counties and cities involved in Qiandongnan Prefecture, Guizhou Province have a planned area of construction of 14,389.76 hm² (215,846.4 mu), including 9,580.41 hm² (143,706.15 mu) of new afforestation and 4,809.35 hm² (72,139.5 mu) of existing forest under management.

According to the environment survey analysis, the total woodland resources available in the project area are sufficient currently and can meet the project needs for afforestation and existing forest resources. According to the detailed distribution of afforestation land provided in the feasibility report, the planned management plots are all distributed within the scope of forest land allowed for construction.

To ensure reasonableness of the layout of afforestation plots, avoid impact on important ecologically sensitive areas (natural reserves, scenic spots and forest parks), avoid increased patchy connection of construction plots in the spatial landscape layout, leading to changes in ecological functions of the landscape, the project should take the following measures:

1) Prohibit arrangements of plots in natural reserves, scenic spots, forest parks and other ecologically sensitive areas or change randomly or in disguise the woodland nature for the purpose of afforestation.

2) To avoid too large areas of pure forests in the project and the impact of human disturbance on ecology and biodiversity during construction and protect natural reserves against disturbance and impact, construction plots are prohibited within 500 m outside natural reserves.

3) To protect natural vegetation on both sides of rivers and promote recovery and healthy development of natural vegetation, plots are prohibited within 50 m from both sides of main rivers and 20 m from tributaries. Plots are prohibited within 500 m from outside the scope of protection surface water sources.

4) Reasonably allocate the construction sizes in counties and cities and effectively use the existing resources to fully gurantee the sizes and layouts in various counties.

5) To ensure the reasonableness of the layout of woodland plots and ease of supervision and management, plots for different species under different management models must be indicated in figures before contracting. Figures must contain geographic information, plot status quo, types of resource types and relationship with sensitive areas, and should be reported to the local environmental protection and management department for record.

6.1.2 Measures to Avoid Impact of Woodland Selection on Ecology

To avoid adverse effects of afforestation land selection on the ecological environment,

maximize the maintenance of regional biodiversity and ecological system stability and ecological integrity, and prevent serious water and soil loss, the project takes the following measures in the woodland selection:

1) Strictly control the woodland range. Land selection should be firstly implemented on the basic figures of woodland resources in the project area and construction plots should not be arranged in areas where construction is prohibited.

2) Comprehensively consider the forest reources in the project area counties and try to avoid afforestation within the scope of natural reserves, scenic spots, agricultural land and urban development land.

3) The woodland selection for existing forests should be strictly required to be far away from special protected areas and owners of the selected plots should be recorded and the specific location, plot area and site situation should be recorded.

4) The overall ecological benefits of economic forests built on slopes over 30 degrees is difficult to ensure and is easily to cause water and soil loss. Therefore, afforestation of economic forests should be prohibited on slopes over 30 degrees.

6.2 Ecological Impact Mitigation Measures

The project will inevitably have certain impact on the regional ecological environment. Some impact is unavoidable and can only be minimized by taking some practical measures to mitigate.

6.2.1 Soil Erosion Mitigation Measures

1) Strictly implement the woodland clearance along contours proposed in the feasibility report.

2) Strictly implement the land preparation by blocks or holes proposed in the feasibility report.

3) Water and soil conservation measures should be taken before land preparation and afforestation in some slopes with serious water and soil loss.

4) A 10 m-wide secondary vegetation protection band must be kept between the afforestation land edge and agricultural land.

5) The land surface should be timely covered with litter after land preparation and topsoil should not be exposed to air.

6) Strictly implement the following measures proposed in the feasibility report: tend once in summer in the same year after planting and once in each spring and summer in the second and third years; clear grass affecting growth of seedling and loosen the soil; when tending, apply fertilizers in the second and third years; replanting should be timely organized in autumn and winter in the same year of afforestation and in springs of the second and third year according to the survival of seedlings to ensure effectiveness of afforestatio.

7) Develop and strictly implement harvesting practices, control rolling logs from the hillside, and prohibit the formation of skid trails.

8) Develop practices for construction of forest roads, use natural roads as far as possible, and develop water and soil conservation measures for new forest roads.

9) Maximize the retaining of understory vegetation and litter.

6.2.2 Biodiversity Impact Mitigation Measures

1) Afforestation land should be strictly controlled within the allowed area designated in the

feasibility report.

2) In the woodland selection, priority should be given to deforested land, suitable land for forest and unstocked woodland.

3) Try to lay aside some wildlife pathways in the arrangement of afforestation plots to protect connectivity between regions for animal activities.

4) Natural broadleaf trees and shrubs in gullies and ridges should be protected in land preparation to protect natural wetlands.

5) Ensure the proportion of mixed forests of various species in afforestation and try to make a dispersed and even layout.

6) Protect understory vegetation, protect the original vegetation between land preparation bands, and protect forest edge vegetation.

6.2.3 Fertility Degradation Mitigation Measures

1) Implement soil-based balanced fertilizer techniques

2) Fertilizers are mainly compound fertilizers, organic fertilizers used as much as possible, to maintain forest fertility and protect the environment.

3) Restore and maintain land cover as much as possible in the premise of protecting normal growth of seedlings.

4) Retain leaf, skin and root residues in the woodland during thinning.

6.2.4 Environmental Pollution Mitigation Measures

1) Minimize the use of fertilizers and pesticides and if they must be used, use timely and appropriately.

2) Increase the proportion of organic and green fertilizers in the fertilizer selection.

3) Prohibit application of fertilizer on land surface. Use the trench and pit fertilizer application and cover fertilizer with soil and litters.

4) Prohibit the use of highly toxic and long residual pesticides, and give priority to the selection of pollution-free pesticides.

5) Do not spray excessive pesticides.

6) Use recyclable containers or easily degradable paper containers in breeding, and do not use refractory containers or those of other textures.

7) Recycle fertilizer bags, pesticide bottles and other reusable packagings and treat bags, pesticide bottles and simple tools that cannot be reused and do not leave them in the woodland.

8) Forest fire prevention billboards should be made with wood materials and minimize the use of do not use concrete and plastic.

6.3 Ecological Restoration

The impact of the project on the ecological environment is a gradual ongoing process; some impact is difficult to see in the short term and some impact accumulated and overlaid may cause serious consequences. The necessary biological or engineering measures should be taken to recover losses appearing or expected to appear that are caused by ecological impact. Measures should be timely taken to recover vegetation damage caused by project activities, biomass loss, water and soil loss, and ecological damage caused by failure to implement the planning and design, failure to operate in accordance with the practice, failure to implement ecological protection measures, etc.

The content of ecological recover should be implemented in the preliminary design document, listing the specific ecological recovery measures, undertaking units and proposed budget. Business entities should develop ecological recovery plans and timely understand ecological environment changes and damages and timely recover the damaged ecological environment.

6.4 Ecological Impact Risk Prevention Measures

In the implementation of the project, there may be forest pests and diseases that result in damage to large areas of forests and alien species that destroy regional biodiversity, so effective preventive measures must be developed and implemented.

6.4.1 Forest Pest Prevention Measures

(1) Mixed forests and mixed species

Given the fact of large-scale single-species plantations causing pests and diseases, the project is dominated by mixed forests so as to improve the stability of the forest ecological system and avoid occurrence of large-scale pests and diseases while protecting biodiversity. Meanwhile, due to the simple structure of pure forests, the community system is not stable and the self-feedback capability is poor, easily causing occurrence of pests and diseases. Therefore, the project makes full use of Cunninghamia Lanceolata, nanzhu, Uncaria and other species to actively create mixed forests, protect biodiversity, improve the stability of the forest ecological system, and avoid occurrence of large-scale pests and diseases. To take full advantage of woodland and taking into account the characteristics of sustainable intensive management of the project and by using the patch–corridor–background and stability theory, the project should use the mixture of patches, i.e. mixing Cunninghamia Lanceolata, nanzhu, Uncaria and other species between afforestation patches to produce mixed forests.

(2) Prevention Dominance and Comprehensive Treatment

Pest prevention should start from seedlings and other reproduction materials. Strengthen plant quarantine to prevent the invasion of quarantine objects. Use fine seeds and strong seedlings, strengthen tending and fertilization of young forests, enhance tree immunity. Take advantage of the characteristics of broken terrain in the project area to create mixed forests by small classes, and block pest transfer channels. Strengthen forecasting. While creating forests, arrange about 30 fixed standard areas in the small afforestation patch with an area not less than 3 mu in each type of afforestation to regularly observe occurrence of pests and diseases in the standard land, grasp the law of development of pests and diseases and forecast pest occurrence trends to facilitate preventive measures.

(3) Prevention mechanisms and plans: Forest pest prevention and control should be the responsibility of the afforestation subjects themselves. Each afforestation subject should deliver targeted biological predators or chemicals according to pest forecasting to prevent large-scale pests and diseases. In the event of forest pest disasters, afforestation subjects must actively invite forest pest prevention experts to give advice on pest trends and timely report to the local forestry authorities and take appropriate prevention methods based on expert opinion.

6.4.2 Alien Species Invasion Preventive Measures

Species selected for the project are Cunninghamia Lanceolata, nanzhu, Uncaria, Camellia oleiferaAbel, Hickory, Taxus chiinensis, osmanthus, Ormosia henryi, Phoebe,

Photinia, Beech, Paliurus, Manglietia, Chapensis, Liriodendron, Privet, Arborvitae, Dendrobenthamia, and Cinnamomum camphora, which are native species in the project area and have been planted for many years there, thus preventing invasion of alien species.

Chapter VII Ecological Environment Management and Monitoring Plan

Ecological environment and monitoring is an important part of the project and also one of the important responsibilties of various business entities. It is an important measure to effectively implement the national and local environmental supervision and management regulations, minimize the impact of the project on the ecological environment and implement coordinated environmental, production and economic development of enterprises. Therefore, ecological environment management and monitoring must be included in the project construction and management.

7.1 Ecological Environment Management

7.1.1 Institutional Settings

The business entities of the project are diverse so special ecological management departments are set up in the operating enterprises or companies that have the conditions according to the project characteristics that are responsible for the management of internal ecological environment of enterprises. Ecological environment management departments are set in afforestation companies and cological environment managers are set in forest farms, establishing a hierarchical management system.

7.1.2 Management Plans

Whole-process ecological environment management is implement for the project to prevent and mitigate the loss of biodiversity, protect regional biodiversity and ecological system stability, prevent disturbance and destruction of important sensitive areas by the project, protect natural vegetation and understory and forest edge vegetation, prevent and mitigate regional soil erosion, prevent and mitigate regional non-point source pollution, and ensure effective implementation of various ecological environmental protection measures.

The environment management and implementation plans are developed based on the project's characteristics according to state and local environmental management regulations.

Various implementation plans of ecological environmental protection measures are developed to effectively implement various ecological environmental protection measures.

A resource, environment and management information system should be established as soon as possible to smoothly implement the project, ensure the reasonableness of the project layout and prevent and mitigate impact on the ecological environment.

Specific practices should be developed to implement ecological environment management in various links of the project. An environmental management system should be established according to the ISO 14000 envrionmental management system standards. Establish the ecological environment management and operation supervision mechanism.

7.2 Ecological Environment Monitoring

Environmental monitoring is an important part of project implementation and the most important task of environmental monitoring is to provide scientific and timely data for

supervision and management. Therefore, it is particularly important to strengthen environmental monitoring for the project, i.e. provide timely and effectively services for environmental monitoring management and meanwhile provide scientific data for many undetermined environmental issues and phenomina.

Ecological environment monitoring content and methods: ecological environment monitoring includes two aspects, i.e. macro monitoring and location monitoring.

Macro monitoring is to use the 3S technology to carry out dynamic monitoring of landscape, vegetation, hydrology and soils in the project area and to carry out regular assessment of the ecological environment in the project area. The focues of macro monitoring is to understand the layout, dynamic changes, and spatial layout of regional landscape in construction plots.

Location monitoring is to observe the population and distribution of animals and plants in the project area and observe soil erosion, especially regular observation of understaory vegetation. Conventional methods are used.

(1) Monitoring Frequency and Sample Plot Arrangement

Ecological monitoring should be synthronized with the project investment and construction.

All monitoring content of macro monitoring should be carried out every five years and the monitoring of construction plots should be carried out once a year. Macro monitoring should start from 2015 and be carried out every five years thereafter.

Location monitoring should be carried out twice a year from 2015 and monitoring points should be arranged according to different afforestation years and sensitive areas. Sample plots should be set by 1-3% of annual afforestation plots and should not be less than 3 in principle for important sensitive areas.

(2) Reporting System

The reporting system, data review, reporting implementation annual report system and special reporting of special events are strictly implemented for ecological monitoring. Enterprises have a responsibility to report monitoring data to local environment authorities.

(3) Strengthen Collaboration and Staff Training

Strengthen technical collaboration with the local environmental monitoring authorities, set up a number of monitoring points in the project base, establish a complete woodland and surrounding environment monitoring system, closely supervise indicators of woodland and surrounding environment; once the standards are exceeded, causes should be found out timely and appropriate countermeasures should be developed.

Ecological monitoring is completely new work that involves ecology, earth science, environemtal science, remote sensing, GIS and a number of other disciplines and professions with techniques and methods constantly updated, so technical training should be strengthened for the monitoring staff so that they can be adapted to the work needs. Staff training should carried out in the two forms of training in ecological monitoring practice and training by sending; priority should be given to the former.

Chapter VIII Conclusions and Recommendations

8.1 General Conclusions

8.1.1 Project Overview

The Environmental Impact Assessment Report of the Sustainable Forest Management Project Financed by European Investment Bank Loans in Qiandongnan Prefecture, Guizhou Province is a new project. It is planned to be implemented in Kaili City and Majiang, Danzai, Jianhe, Jingping and Liping counties, a total of six counties (cities).

Construction content: The total size is 14,389.76 hm², including 4,809.35 hm² of existing forest under management and 9,580.41 hm² of afforestation.

(1) Management of Existing Forests

On the basis of comprehensive management and protection of existing forests, according to their characterstics, take tending, replanting, reclamation and other transformation measures to improve forest tree species, age and spatial structures, actively cultivate large-diameter timber and multi-purpose compound mixed forests, and maximize the overall efficiency. Four models are designed:

Model 1 – mixed Cunninghamia Lanceolata and nanzhu forest: the operating area is 1,774.12 hectares.

Model 2 – mixed Cunninghamia Lanceolata and Leatherleaf Mahonia Leaf forest: the operating area is 1,258.41 hectares.

Model 3 – multi-layer forest and herbs forest: the transformation area is 1,243.42 hectares.

Model 4 – large-diameter timber cultivation: the cultivation area is 333.4 hectares.

(2) Afforestation

To develop and cultivae multi-purpose complex plantations on unstocked woodland, suitable land for forest and other suitable land for afforestation. Five models are designed:

Model 5 – afforestation of local rare species: Suitable for afforestation land with not important ecological niche and good site conditions. Carry out afforestation selecting Taxus chiinensis, Cinnamomum camphora, Liriodendron, Ormosia henryi, Phoebe and other local rare species; multiple species should be selected to create mixed forests in areas with good conditions. The planned area of afforestation is 2,125.91 hectares.

Model 6 – afforestation of the mixture of forest and herbs: choose afforestation land with good site conditions, convenient transportation and light water and soil loss to create compound forests of arbor species and Uncaria and other herbs suitable for understory growth to shorten the woodland output cycle while maintaining forest ecological benefits. The planned afforestation land area is 2,005.05 hectares.

Model 7 -- woody oil featured economic forest: According to Qiandongnan Prefecture's Camellia oleiferaAbel development plan, creat Camellia oleiferaAbel forests on deforested land, barren hills and wasteland suitable for afforestation with good site conditions, an elevation below 800 m and a slope less than 25 degrees and plant Alfalfa, Clover and other forage legumes for animal husbandy to develop three-dimensional circular economy. The planned afforestation area is 1,052.5 hectares.

Model 8 – blueberry featured economic forest: select barren hills and wasteland and

deforested land suitable for afforestation with a slope less than 20 degrees, soil Ph of 4.2-5.5, loose soil, good ventilation, moisture without water to plant Blueberry and sow Alfalfa, Clover and other florage legumes or herbs, to improve the overall efficiency on the one hand, and promote organic Blueberry cultivation through returning organic fertilizer to woodland from animal husbandy, forming a circular economy. The planned afforestation area is 2,350.33 hectares.

Model 9 – afforestation of the mixture of Cunninghamia Lanceolata and phyllostachys pubescens: select afforestation land with gentle slope and good site conditions to create mixed ecological Cunninghamia Lanceolata and nanzhu forests of 2,047.62 hectares.

The construction period of the project is three years. Thining and replanting and afforestation will be completed in three years from 2015.

The project affects the ecological environment mainly in the following ways:

a. The impact of the project's total land demand of 14,389.76 hm² and the layout on the carrying capacity of regional woodland resources, the integrity and stability of regional ecological system and the land use structure.

b. The impact of the plot selection and determination on important sensitive areas and key protected species.

c. The impact of the selection of different mixed plantation species on the forest composition, ecosystem diversity, species diversity and other aspects.

d. The impact of woodland clearance, land preparation, planting and fertilizer application on vegetation, soil wildlife and water and soil loss in the construction period.

f. The impact of ridge expansion, tillage, weeding, fertilization and other activities on local vegetation, water and soil loss, non-point source pollution and other aspects in the operation period.

g. The impact of the project on regional socio-economic environment.

8.1.2 Ecological Environment Status Quo

According to the data provided by the feasibility report, the project are has forest land of 842,175.79 hm², accounting for 72.21% of the total project area; non-forest land of 323,974.21 hm², accounting for 27.78% of the total. The forst land includes 718,732.68 hm² of woodland (including 709,843.43 hm² of arbores and 8,889.25 hm² of bamboo), 8,042.70 hm² of open woodland, 57,116.4 hm² of shrub woodland (27,568.68 hm² specified by the state and 29,547.72 hm² of others), 26,665.16 hm² of young afforested land, 25.06 hm² of nursery land, 19,776.45 hm² of unstocked woodland, 11,769.72 hm² of hills and wastesuitable land for forest, and 47.62 hm² of auxiliary forest production land.

According to the forest classification of the project area, the project area has 518,874,91 hm² of commercial forest, accounting for 61.61% of the forestry land area in the project area, including 452,572.82 hm² of woodland (including 451,448.93 hm² of arbores and 1,123.89 hm² of bamboo), 5,605.21 hm² of open woodland, 23,386.02 hm² of shrub land (including 13,795.45 hm² specified by the state and 9,590.57 hm² of other shrub land), 13,316.64 hm² of young afforested land, 16.83 hm² of nursery land, 14,197.05 hm² of unstocked woodland, 9,744.05 hm² of barren hills and wastesuitable land for forest, and 36.29 hm² of auxiliary forestry production land.

The project area includes public welfare forest of 323,300.88 hm², accounting for 38.39%

of the woodland area in the project area, including 266,159.86 hm² of woodland (including 258,394.5 hm² of arbores and 7,765.36 hm² of bamboo), 2,437.49 hm² of open woodland, 33,730.38 hm² of shrub land (including 13,773.23 hm² specified by the state and 19,957.15 hm² of other shrub land), 13,348.52 hm² of young afforested land, 8.23 hm² of nursery land, 5,579.4 hm² of unstocked woodland, 2,025.67 hm² of barren hills and wastesuitable land for forest, and 11.33 hm² of auxiliary forestry production land.

Vegetation in the assessment area is mid-subtropical evergreen broad-leaved forest. Due to the long-term impact of human activities and natural forces, some forest has evolved into evergreen mixed coniferous-broadleaf forest, mixed coniferous-broadleaf forest and coniferous forest, and some areas become shrubs and grass.

The status quo of soil erosion in the project area is that the area with not clear water and soil loss and that with light water and soil loss account for a large area, 1,110,478 hm², accounting for 95.23% of the total land in the project area. The occurrence of water and soil loss is mainly caused by man-made unreasonable development, construction and production activities in addition to geological, geomorphological and climatic factors.

Although natural native vegetation has gone in the project area due to long-term human activities, some regional evergreen broadleaved forests, coniferous forests, mixed coniferous-broadleaf forests and sparse-tree and short-grass shrubs and other natural vegetation are still distributed with abundant biological resources and high biodiversity. Now natural reserves or scenic spots and forest parks have been established in these areas.

8.1.3 Environment Feasibility of the Project

1. Feasibility of Construction Scale

The feasibility report arranges the project within the scope of forest land, in line with the status quo of project area land resources. From the forest land area only, the woodland area proposed in the feasibility report can support the woodland resources required for the project.

The project construcation size is 14,389.76 hm², accounting for 1.71% of the total woodland in the project area. From the woodland quality and quantity, the afforestation land resources required for the project can be met and the construction size is basically feasible.

2. Woodland Resources for the Project and Compliance of Woodland Resources Available

(1) Afforestation

According to the analysis for the project feasibility report, the project has a new afforestation plan of 9,580.41 hm² by using the existing land suitable for afforestaion, unstocked woodland (burned land and deforested land) above intermediate site quality in the project area. The afforestation includes five types: the afforestation of local rare species, afforestation of the mixture of forest and herbs, woody oil featured economic forest, featured economic blueberry forest and afforestation of the mixture of Cunninghamia Lanceolata and phyllostachys pubescens.

To analyze whether the project area can provide the woodland resources require for the new afforestation, the assessment analyses the project feasibility report and the small spot factor table of the new afforestation land of the project.

Of 39,588.87 hm² of open woodland, unstocked woodland and suitable afforestaion land in the project area, 31,546.17 hm² meet the afforestation conditions required by the project and the slope of the new afforestation land is less than 25 degrees.

(2) Management of Existing Forests

According to the existing forest management objective of the project, and the woodland resources available for the project within the range of distribution of woodland resrouces in the project area.

The project will cultivate existing forest of 4,809.35 hm², including 1,774.12 hm² of mixed Cunninghamia Lanceolata and nanzhu forest, 1,458.41 hm² of broad-leaved and coniferous mixed forest, 1,243.42 hm² of multi-layered forest and herb forest, and 333.4 hm² of large-diameter Cunninghamia Lanceolata and Pinus massoniana timber forest. According to 2013 forest change data, the project now has 333,639.83 hm² of Cunninghamia Lanceolata forest, 403.3 hm² of broadleaved mixed forest, and 3,345.74 hm² of broadleaved and coniferous mixed forest. The three resources amount to 337,388.87 hm². The existing resource area is far larger than that planned by the project for management, and thereore can meet the project's need for existing forest management.

3. Feasibility of Environmental Protection Measures

To prevent and reduce water and soil loss caused by woodland clearance, land preparation and other activities, effective measures are taken to control and mitigate water and soil loss that are summed up in afforestation practices over years. The practical implementation of these measures in the project will effectively mitigate and control water and soil loss caused by the project.

Overall, the measures taken to protect biodiversity in the project area during project implementation will play a positive role in maintaining biodiversity and reducing the extent of damage to biodiversity in the project area and maximizing the protection of important biological communities and key protected species and habitats. Although they have certain limitations, they are feasible to reduce damage to biodiversity during project implementation.

Woodland fertility maintenance measures taken in the project to maintain soil fertility and prevent soil degradation are developed based on the relevant research results and have been applied locally with good effects. These measures are effective currently in prevent soil degradation.

The measures taken to protect woodland environment and prevent pollution are feasible in maintaining good woodland environment, preventing non-point pollution caused by fertilizer use and reducing pesticide pollution.

Overall, although the environmental protection measures are not very comprehensive, most of them are feasible and will play a positive role in preventing and mitigating damage and impact on the ecological environment.

8.1.4 Environmental Impact

(1) Macro Impact

In the environmental feasibility analysis for the project, the feasibility report plans to plant new forest of 9,580.41 hm² on suitable land for forest and unstocked woodland (deforested land and burned land). Therefore, after the implementation of the project, the land involved in the project area will have 9,580.41 hm² of new woodland, and a corresponding area of suitable land for forest and unstocked land (deforested land and burned land) will be reduced.

Therefore, the impact on the land in the project area is mainly controlled in the scope of forest land. Through project implementation, the area of suitable land for forest and unstocked woodland (deforested land and burned land) in the forest land will be reduced to some extent

and the woodland area will increase correspondingly. Other land in the project will not be changed.

(2) Impact of Construction on Ecological Environment

The techniques and methods used in the woodland clearance, land preparation, planting and tending in the project are feasible mostly. They have small adverse effects on ecoligcal environment.

By using effective methods, the project can avoid fertilizer exposed on bare surface and washed by rain into the water and can effectively prevent pollution to the environment by application of fertilizer. If construction is regulated strictly without serious water and soil loss, fertilizer use in the project will not cause pollution to regional environment and will not have a great impact on the water environment. Long-term application of fertilizer can easily cause soil compaction and soil deterioration and reduced soil fertilizer. Fertilizers used in the projce are mainly compound fertilizers and organic fertilizers that will not have a great impact on the soil environment.

In accordance with the “prevention dominance and comprehensive treatment” requirements and starting from seedlings and other reproduction materials, the project uses fine seeds and strong seedlings and strengthen tending and fertilization of young forest to enhance forest immunity, and takes advantage of the broken terrain in the project area to block the pest transfer channel by small spot. Strengthen forecasting work; while planting, arrange about 30 fixed standard areas, each not less than 3 mu, in the planting small spot for each type of forest to regularly observe pest occurrence in the standard areas to understand the rule of pest occurrence and development and forecast the pest occurrence trend in order to facilitate preventive measures. The implementation of these measures can effectively avoid fertilizer broadcasted on land surface, polluting water and environment, killing beneficial organisms and affecting human and animal safety. The implementation of the measures above can effectively avoid fertilizer broadcasted on land surface, polluting water and environment, killing beneficial organisms and affecting human and animal safety. Therefore, pollution to water and environment caused by the project is relative low. If fertilizer application is required, the practices must be strictly observed and the doses of pesticides be controlled, and this will mitigate the harm to beneficial organisms and ensure human and animal safety.

The management of existing forests in the project is the thinning of existing Cunninghamia Lanceolata forests to replant nanzhu, Leatherleaf Mahonia Leaf and Uncaria and the thinning of mixed Cunninghamia Lanceolata and Pinus massoniana forests to cultivate large-diameter timber.

Destruction of forest thinning of understory vegetation is different from woodland clearance but is also serious, especially in case of skid trails for rolling logs from the hillside, where surface vegetation is almost destroyed completely, easily causing serious water and soil loss. In addition, forest roads built for shipping timber destroy vegetation seriously. If there are no water and soil conservation measures, bare vertical hilltop sections can easily cause collapse and landslide. Concrete practices must be developed for the project to prevent formation of skid trails and regulate construction of forest roads.

To avoid damage to vegetation during thinning, the project has a human-based operating type. Cable skidding may be used in special areas of high mountains and steep slopes where it is difficult for hand skidding. Small tractor skidding may be used where the terrain conditions

are good. In addition, forest roads have been built in the project area, providing the necessary guarantees for timber transport.

Changes in local ecological environment caused by forest harvesting are what the project must face, and they are acceptable from the ecological environment as a whole.

(3) Effects of the Project on the Social Environment

a. The project uses the shareholding management, individual management and a number of other forms of management and can revitalize rural land resources so that farmers get income from land; the project can also provide employment opportunities for the people in the project area so that farmers get labor income.

b. After the completion of the project, except ecological forests, fresh fruits and forest herbs products, after processing, can be used to extend the industry chain to improve added value of products and increase local fiscal revenue and promote economic development in the project area.

c. The project can be used as a link between the primary industry and the secondary industry. The application of advanced technology, introduction of advanced management models and construction of forest roads, will all promote rural economic development in the project area.

8.1.5 Preventive Measures and Recover Strategies

1) Avoidance Measures

To ensure the reasonableness of the layout of afforestation plots, avoid impact on important ecologically sensitive areas (natural reserves, scenic spots and forest parks), and avoid increased patchy connection of the construction plots in the spatial pattern of landscape, leading to changes in ecological functions of landscape, the project should use take the following measures:

a. Prohibit arrangements of plots in natural reserves, scenic spots, forest parks and other ecologically sensitive areas or change randomly or in disguise the woodland nature for the purpose of afforestation.

b. To avoid too large areas of pure forests in the project and the impact of human disturbance on ecology and biodiversity during construction and protect natural reserves against disturbance and impact, construction plots are prohibited within 500 m outside natural reserves.

c. To protect natural vegetation on both sides of rivers and promote recovery and healthy development of natural vegetation, plots are prohibited within 50 m from both sides of main rivers and 20 m from tributaries. Plots are prohibited within 500 m from outside the scope of protection surface water sources.

d. Reasonably allocate the construction sizes in counties and cities and effectively use the existing resources to fully gurantee the sizes and layouts in various counties.

e. To ensure the reasonableness of the layout of woodland plots and ease of supervision and management, plots for different species under different management models must be indicated in figures before contracting. Figures must contain geographic information, plot status quo, types of resource types and relationship with sensitive areas, and should be reported to the local environmental protection and management department for record.

为避免由于造林地选择对生态环境的不利影响：

To avoid the adverse effects of afforestation land selection on the ecological environment:

a. Strictly control the woodland range. Land selection should be firstly implemented on the basic figures of woodland resources in the project area and construction plots should not be arranged in areas where construction is prohibited.

b. Comprehensively consider the forest reources in the project area counties and try to avoid afforestation within the scope of natural reserves, scenic spots, agricultural land and urban development land.

c. The woodland selection for existing forests should be strictly required to be far away from special protected areas and owners of the selected plots should be recorded and the specific location, plot area and site situation should be recorded.

d. The overall ecological benefits of economic forests built on slopes over 30 degrees is difficult to ensure and is easily to cause water and soil loss. Therefore, afforestation of economic forests should be prohibited on slopes over 30 degrees.

2) Mitigation Measures

a. Strictly implement the woodland clearance along contours proposed in the feasibility report.

b. Strictly implement the land preparation by blocks or holes proposed in the feasibility report.

c. Water and soil conservation measures should be taken before land preparation and afforestation in some slopes with serious water and soil loss.

d. A 10 m-wide secondary vegetation protection band must be kept between the afforestation land edge and agricultural land.

e. The land surface should be timely covered with litter after land preparation and topsoil should not be exposed to air.

f. Strictly implement the following measures proposed in the feasibility report: tend once in summer in the same year after planting and once in each spring and summer in the second and third years; clear grass affecting growth of seedling and loosen the soil; when tending, apply fertilizers in the second and third years; replanting should be timely organized in autumn and winter in the same year of afforestation and in springs of the second and third year according to the survival of seedlings to ensure effectiveness of afforestatio.

g. Develop and strictly implement harvesting practices, control rolling logs from the hillside, and prohibit the formation of skid trails.

h. Develop practices for construction of forest roads, use natural roads as far as possible, and develop water and soil conservation measures for new forest roads.

i. Maximize the retaining of understory vegetation and litter.

To mitigate impact on biodiversity:

a. Afforestation land should be strictly controlled within the allowed area designated in the feasibility report.

b. In the woodland selection, priority should be given to deforested land, suitable land for forest and unstocked woodland.

c. Try to lay aside some wildlife pathways in the arrangement of afforestation plots to protect connectivity between regions for animal activities.

d. Natural broadleaf trees and shrubs in gullies and ridges should be protected in land preparation to protect natural wetlands.

e. Ensure the proportion of mixed forests of various species in afforestation and try to

make a dispersed and even layout.

f. Protect understory vegetation, protect the original vegetation between land preparation bands, and protect forest edge vegetation.

To mitigate soil degradation:

a. Implement soil-based balanced fertilizer techniques

b. Fertilizers are mainly compound fertilizers, organic fertilizers used as much as possible, to maintain forest fertility and protect the environment.

c. Restore and maintain land cover as much as possible in the premise of protecting normal growth of seedlings.

d. Retain leaf, skin and root residues in the woodland during thinning.

To mitigate environmental pollution:

a. Minimize the use of fertilizers and pesticides and if they must be used, use timely and appropriately.

b. Increase the proportion of organic and green fertilizers in the fertilizer selection.

c. Prohibit application of fertilizer on land surface. Use the trench and pit fertilizer application and cover fertilizer with soil and litters.

d. Prohibit the use of highly toxic and long residual pesticides, and give priority to the selection of pollution-free pesticides.

e. Do not spray excessive pesticides.

f. Use recyclable containers or easily degradable paper containers in breeding, and do not use refractory containers or those of other textures.

g. Recycle fertilizer bags, pesticide bottles and other reusable packagings and treat bags, pesticide bottles and simple tools that cannot be reused and do not leave them in the woodland.

h. Forest fire prevention billboards should be made with wood materials and minimize the use of do not use concrete and plastic.

3) Ecological Restoration

For ecological impacts that cannot be avoided and mitigated in the project, the principle that those who destroy shall compensate and restore, and compensation should be based on the extent of impact and destruction. Ecological compensation should be charged to the project costs.

The impact of the project on the ecological environment is a gradual ongoing process; some impact is difficult to see in the short term and some impact accumulated and overlaid may cause serious consequences. The necessary biological or engineering measures should be taken to recover losses appearing or expected to appear that are caused by ecological impact. Measures should be timely taken to recover vegetation damage caused by project activities, biomass loss, water and soil loss, and ecological damage caused by failure to implement the planning and design, failure to operate in accordance with the practice, failure to implement ecological protection measures, etc.

The content of ecological recover should be implemented in the preliminary design document, listing the specific ecological recovery measures, undertaking units and proposed budget. Business entities should develop ecological recovery plans and timely understand ecological environment changes and damages and timely recover the damaged ecological environment.

8.2 Overall Conclusions

The Sustainable Forest Management Project Financed by European Investment Bank Loans in Qiandongnan Prefecture, Guizhou Province selects Kaili City and Majiang, Danzhai, Jianhe, Jinping and Liping counties for construction, which is in line with the local economic and social development, land use and forestry planning. The project is beneficial to the adjustment of local rural economic structure, promotion of local economic development, increase of farmers' income, optimization of the industrial structure of forestry, and increase of forest coverage. The project has significant economic and socal benefits and certain ecological benefits.

1) The total project size is 14,389.76 hm², including 4,809.35 hm² of exisiting forest under management and 9,580.41 hm² of afforestation. The base construction period is 3 years and entire project will be completed in three years form 2015. According to the project area forest resources survey results, the woodland area proposed in the feasibility report can support the woodland resources required for the project.

2) Kaili, Majiang, Danzhai, Jianhe, Jinping and Liping selected for the project are located in the subtropical climate zone with a warm climate, abundant sunwhine and adequate rainfall are suitable for cultivation of Pinus massoniana, Cunninghamia Lanceolata and other species and have the natural conditions for the project construction.

3) According to the environmental impact assessment, from the woodland quality and quantity, the afforestation land resources meet the needs of the project and the project is basically feasible from the point of view of the construction scale.

4) The project does not change the use nature of land in the project area and the afforestation technology solutions and environmental protection measures are mostly feasible. The impact of the project on the ecological environment is generally acceptable; as long as the ecological protection measures proposed in the feasibility report and assessment report are strictly implemented, the project will not threaten the stability of regional ecological system, important sensitive areas and key proteted species, will not have a significant impact on the regional biodiversity and will not cause soil degradation, sparse understory vegetation, water and soil loss and increased non-point pollution. The effective implementation of various environmental protection measures will promote the improvement of the local regional ecological environment in the project area.

5) The project has a pivotal role in the local social and economic development. The project is in a sense within the scope of ecological environment construction and the environmental and economic benefits will far weight the environmental and economic loss caused by the project.

Overall, the project is feasible from the viewpoint of environmental protection as long as the ecological protection measures proposed in the report are strictly implemented and the whole processof environmental management is strengthened for the project.

osmanthus, Ormosia henryi, Phoebe, Photinia, Beech, Paliurus, Manglietia, Chapensis, Liriodendron, Privet, Arborvitae, Dendrobenthamia, Cinnamomum camphora, Camellia

oleiferaAbel, Blueberry, Uncaria
Alfalfa, Clover, Radix, Chinese herbaceous peony