European Investment Bank Loan-Financed Project

Woody Oil Development Project in Zhejiang Province

Environmental Impact Assessment Report

Zhejiang Academy of Forestry
Office of Zhejiang Afforestion Projects on World Bank Loans

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Content

Chapter 1 Foreword

1.1 Project Background

The project focuses on the development of *Torreya grandis* and the intensive management of the low-yield bamboo forest, an industry encouraged and supported by the government and conforming to the national industrial policy. The national "The Twelfth Five-Year Plan for Forestry Development" proposed to "vigorously develop woody oil and characteristic cash forest (called economic forest in China) sector" and "cultivate the bamboo sector". The state has started the woody oil development project. The Ministry of Finance issued the "Guideline on the integration and coordination of funds to support development of the woody oil industry" (Financing & Farming (2011) No. 19) as well as the "Guideline on the integration and coordination of funds to support development of the woody oil industry" (Financing & Farming (2012) No. 11) in 2011 and 2012 respectively. In 2012, the State Forestry Administration issued the "National enrich-people plan by developing special cash forestry sector in thousand counties (2011-2020)" and "National development plan of bamboo sector (2011-2020)", addressing specific plan on special cash forestry sector and bamboo sector.

Zhejiang Province highly values the development of *Torreya grandis* and the transformation of low-yield bamboo forest. "The Twelfth Five-Year Plan for Forestry Development of Zhejiang Province" proposed to implement promotion project of bamboo sector, base construction project of special dry fruit and fresh fruit, fine- processing industry project and forest road construction project, simultaneously and powerfully supported the development of *Torreya grandis* and intensive management of the low-yield bamboo forest. Zhejiang province has

issued “Views on Accelerating the Development of Agricultural Leading Industry and Promoting Modern Agriculture Construction”, in which it clearly put forward that development and production funds should be mainly used to support major area and key links of leading industry. In 2011, Zhejiang Provincial Department of Finance and Zhejiang Provincial Department of Forestry issued "The guideline on integration and coordination of local funds to support the development of the woody oil industry" (Zhejiang Financing & Farming (2011) No. 288), focusing on the support of development of the *Torreya grandis* and other industry.

Zhejiang is the birthplace and the main production areas of *Torreya grandis*, boasting more than 1000 years of cultivation history in Zhejiang province. Zhejiang has promulgated and implemented the "Product of geographical indication-Fengqiao Torreya" (DB33/T 838-2011), "Non-environmental pollution Torreya: Environment of production area" (DB33/T 340.2-2006), "Non-environmental pollution Torreya: Regulation of production technique" (DB33/T 340.2-2006), "Technical regulations for *Torreya grandis* cultivation" (DB33/T 340-2012) and other local standards. Zhejiang is the main production area of bamboo, with a long standing history and high technology level for bamboo cultivation and utilization. Zhejiang is known for its bamboo, with a sayings such as "China is world-famous for its bamboo; Zhejiang is famous for bamboo within China". Bamboo cultivation technology standardization in Zhejiang province has successively promulgated and implemented, such as “Regulation for cultivation technology of high-yield bamboo forest” (DB33/T 391-2003), "Mao (Moso) bamboo forest for both shoots and bamboos " (DB33/T 261-2005), "Non-environmental pollution bamboo shoot" (DB33/T 333-2006), and “Technical specification for cultivation of both shoot and culm-producing stands of *phyllostachys heterocycla* var. *pubescens*” (DB33/T 261-2012).

Zhejiang Province has entered a new stage of building its material and spirit prosperity. In this circumstance, status and responsibility of forestry in the economy and society has been prominent: firstly, a series of environmental problems caused by accelerating urbanization and industrialization and the frequent natural disasters has become an important factor to restrict the sustainable development of economy and society in our province, forestry as the main body of ecological construction shoulders the important mission of safeguarding ecological balance, protecting species resource, reducing natural disasters, coping with climate change and a series of ecological problems; secondly, with upgrading of urban and rural residents' consumption level and consumption structure, demand on wood, bamboo, and other renewable raw materials and biomass energy has been increasing obviously, demand on organic food, medicines and health products, forest ecological tourism has been growing .according to the market demand, development and production of more better and diversified forest products is an important task of current forestry development; again, based on the current situation of Zhejiang Province, " seventy percent of hills, ten percent of water and twenty percent of cropland" has determined that difficulty in the building material and spirit prosperity and the modernization process of Zhejiang Province is the mountains, the urgent need of the province is to speed up the development of forestry industry and give full play to the economic functions of forestry. Forestry should undertake the important responsibility of the prosperity of the rural economy, especially the economy in mountain area, increasing farmer income and alleviating "three rural issues".

Torreya grandis is one of the precious and rare tree species of fruit trees and woody oil plants. *Torreya grandis* area and output in Zhejiang Province occupies 95% or above national area and volume of production

and Kuaiji mountain *Torreya grandis* industrial belt has been formed, which is expanding and extending gradually from Kuaiji mountain to Lanxi, Pujiang and other surrounding areas as well as Longquan, Songyang and the southern region of Zhejiang. Because of farmers have benefited from planting *Torreya grandis* greatly, they are of high enthusiasm in it and it has become an important way to increase the income of them. Therefore, the development of woody oil industry is the strategic decision of ecological, economic and social benefits, not only helping increase the edible oil supply, improving self-sufficiency level and meeting consumer demand for the people, but also helping increase the income of the farmers and promote economic development in mountainous areas.

In May 2012, to vigorously promote the transformation of scientific and technological achievements in forestry, and boost the transformation of forestry development, in accordance with the consideration of serving large industry, organizing large projects and promoting large achievement, based on in-depth research and analysis in the present situation, technical needs and extensive solicitation of bamboo industry development in Zhejiang Province, Provincial Science and Technology Department and Forestry Department jointly studied and formulated “implementation plan of benefit improvement project of million mu bamboo forest in ten counties in Zhejiang Province ”, put forward the implementation of key achievement transformation in 14 counties (cities and areas), including Anji County, Longyou County, Longquan City, Lin’an City, Deqing County, Changxing County, Qingyuan County, Suichang County, Fuyang City, Pingyang County, Qujiang District, Wuxing District, Shaoxing County and Yuyao City, so as to significantly promote the modernization level of the province’s bamboo seedling industry, bamboo cultivation and bamboo shoot and bamboo processing, achieve industrial efficiency and

increase of bamboo farmers' income .

Zhejiang province highly values the construction of industry associations of *Torreya grandis* and bamboo, and sets up industry associations of *Torreya grandis* and bamboo respectively in 2002 and 2003, which play an important role in strengthening industry self-discipline, standardizing industrial management, and promoting healthy and orderly development of *Torreya grandis* and bamboo industries.

1.2 Background of the Project

Founded in 1958, European Investment Bank (hereinafter referred to as "EIB") is owned by all EU Member States. It is a non-profit and the largest multilateral financial institution in the world, with its headquarter in Luxemburg. Its main mission is to provide long-term financing support to investment projects with conform to EU policy objectives and promote the economic, social and political interests. Cooperation between China and the EIB is part of the China-EU comprehensive strategic partnership, since both sides signed "Framework Agreement on Financial Cooperation between the People's Republic of China and European Investment Bank" in 1995, EIB has provided financing for specific projects in China. Up to now, the EIB's total loan commitment amounted to about Euro 1,730 million and total amount of signed load agreements has reached Euro 1,145 million, cooperation between both sides is smooth and fruitful. In June 2010, NDRC and Ministry of Finance has reached intention with EIB during its visit in China, EIB will provide preferential loans to support the development of our country forestry. In September 2011, Chinese Forestry Special Framework Loan Planning of EIB was approved by State Council. In February 2012, the Ministry of Finance signed "Chinese Forestry Special Framework Loan Agreement between

the People's Republic of China and the European Investment Bank" with EIB on behalf of China government. The framework loan project aimed to support the development of forestry project, increase forestry carbon sequestration in China and play a positive role in mitigating global climate change. Loan funds would be used to support the new protective forest, timber forest, economic forest, forest cultivation and low-yield forest reform, sustainable development of forest ecosystem and biomass energy forest base construction project.

In order to further promote the economic development in mountain area in Zhejiang, increase farmer' income, improve the ecological environment and speed up the construction of "Beautiful Zhejiang" and "Forestry Zhejiang", according to the loan requirements, Zhejiang Province decided to implement *Torreya grandis* development and low-yield bamboo forest transformation project in 5 counties, including Lin'an, Fuyang, Zhuji, Lanxi and Longquan.

1.3 Experiences and References of Forestry Project Environmental Management for Loan from World Bank

Zhejiang Province has successively implemented three phase of forestry projects on World Bank loans. We have implemented World Bank loan National Afforestation Project, the World Bank Loan Forest Resources Development and Conservation Project and the World Bank Loan Integrated Forestry Development Project. These three World Bank Loan forestry projects were well implemented, and played positive roles in increasing the quantity and quality of forest resources, increasing the effective supply of timber, easing contradictions between timber supply and demand, improving forestry farmers' income and enhancing ecological functions of forests. During the project implementation, the province has established provincial and county level management and

organizing units, developed sound technical and financial management systems, trained a group of management personnel of foreign funded projects, accumulated rich experience in project management, and laid solid foundation of the project implementation. See table 1-1.

Table 1-1 Forestry foreign investment projects implemented in Zhejiang Province

Project name	Implementation time	Main content	Project investment (RMB: 100 million)	
			Total investment	Among: The World Bank loan
National afforestation project	1990~1997	Fast growing forest plantation 61,400 ha	2.13	1.14
Forest resource development and conservation project	1994~2000	Fast growing forest plantation 51,800 ha	1.99	0.75
Integrated forestry development project	2011-2016	Ecological restoration of pure forest 24,500 ha	2.86	1.43

Among five projects cities in this project, Lin'an, Fuyang, Lanxi and Longquan all have the experience of implementation of World Bank loans forestry projects. Lin'an has implemented three World Bank project including National Afforestation Project, Forest Resources Development and Conservation Project and Integrated Forestry Development Project. Longquan has implemented the National Afforestation Project; Lanxi has implemented Forest Resources Development and Protection Projects; Fuyang is now implementing Integrated Forestry Development Project. Information of forestry foreign funded projects implemented by each project city is shown in table 1-2.

Table 1-2 Forestry foreign investment projects implemented in different project city

Project name	Time	Lin'an	Fuyang	Zhuji	Lanxi	Longquan
National afforestation project	1990~1997	√				√
Forest resource development and conservation project	1994~2000	√			√	
Integrated forestry development project	2011-2016	√	√			

1.4 Conformance Analysis of Project and Related Policies and Regulations

According to the provisions of the ninth and seventeenth articles of “Regulations of the Environmental Protection Construction Project”, the project execution department should provide EIA report, which shall be approved in the project feasibility study stage. One particular chapter about environmental protection should be in the preliminary design report, including the relevant domestic environmental standards, environmental impact mitigation measures and the corresponding design. In addition, it should also include possible environmental impact brought by the project, measures taken to reduce and prevent these effects as well as potential causes of environmental pollution.

For preparation of report, project execution team closely cooperated with World Bank Loan Forest Project Office in Zhejiang Province, social assessment team and other team members, reviewed the feasibility study report and consulted with local government, communities, farmers and forest managers. Environment assessment team has exchanged extensively with the expert groups in seminars and field investigation process, so as to ensure full understanding of the project. The EIA report was completed in the project preparation stage, and can be regarded as part of a feasibility study. A chapter in the feasibility study report of the project covers related issues illustrated in the EIA report.

1.5 Assessment Content and Organizations

1.5.1 Assessment Content

The project content is *Torreya grandis* afforestation and low-yield bamboo forest transformation. Environmental impact assessment is based on the field investigation, data collection, and interview with the expert group and investigation of environmental sensitivity of project area.

1.5.2 Evaluation Institution

Evaluation institution	Participants	Position/Title
Zhejiang Academy of Forestry	Jiang Bo	Deputy dean, Professor
	Yuan Weigao	Professor
	Zhu Jinru	Professor
	Shen Aihua	Associate professor
	Zhang Jun	Associate professor
	Huang Yujie	Research associate

1.5.3 Procedure of Assessment

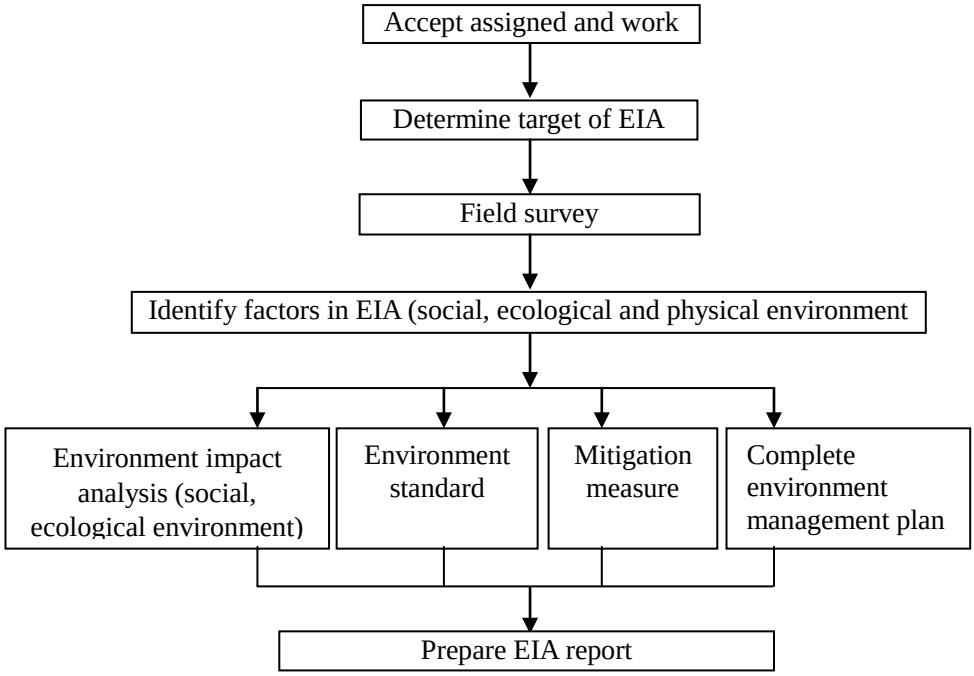

Figure 1-1 Procedure of Assessment

Chapter 2 Policies, Regulations and Management Framework

2.1 Environment and Project Management Framework

2.1.1 Domestic Environment Protection Management Framework

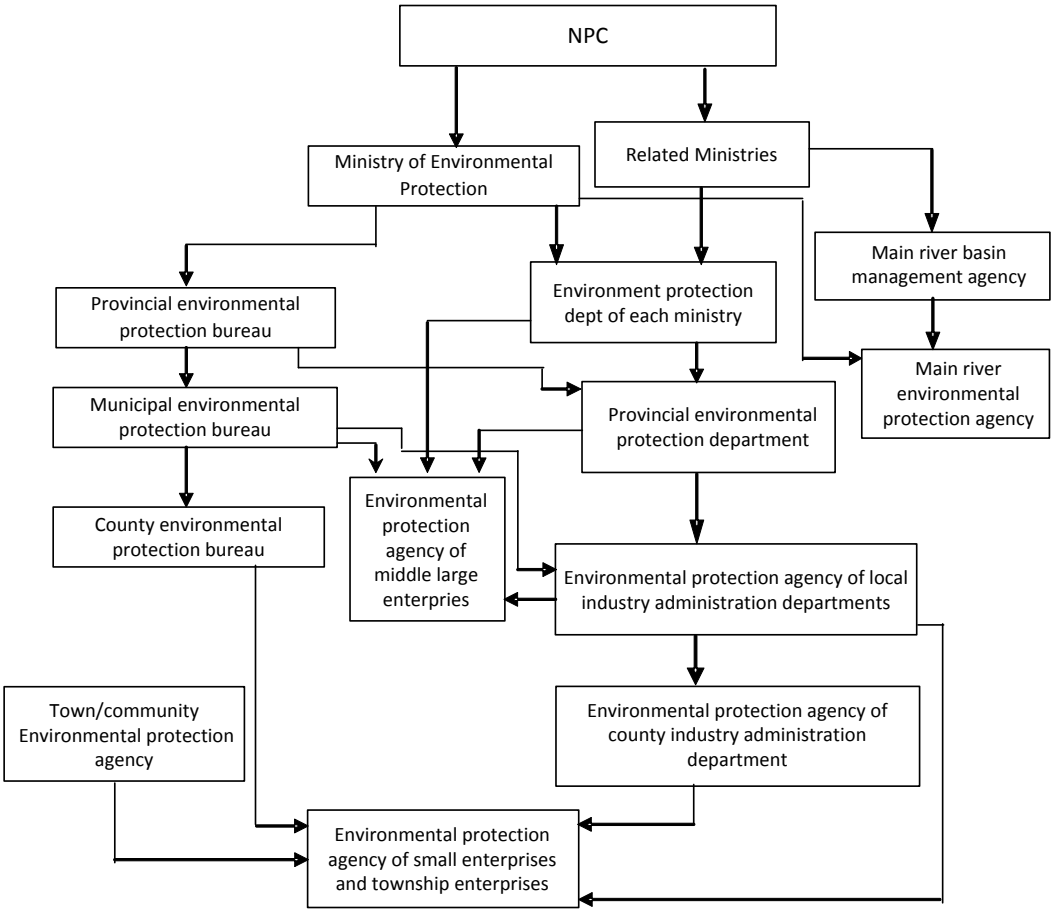

Figure 2-1 Chart of China Environmental Protection Organization

2.1.2 Organization and Management System

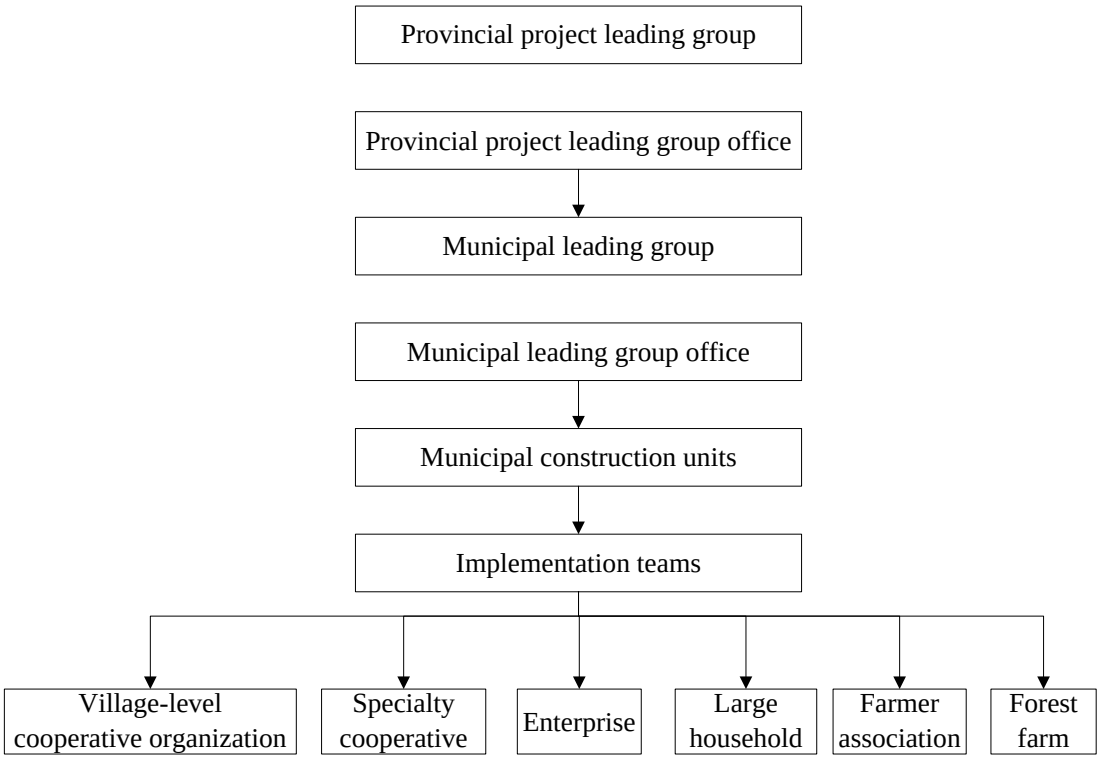

Figure 2-2 Organization and management system

2.2 National and Local Laws, Regulations and Policies

2.2.1 National Laws, Regulations and Polices

1) “Environmental Protection Law of the People’s Republic of China”, 1989

2) “Forest Law of the People’s Republic of China”, 1998

3) “Law of the People’s Republic of China on the Protection of Wildlife”, 1988

4) “Water Law of the People’s Republic of China”, 1988

5) “Law of the People’s Republic of China on Prevention and Control of Water Pollution”, 1996

6) “Law of the People’s Republic of China on Water and Soil Conservation”, 1991

7) “Law of the People’s Republic of China on Environmental Impact Assessment ", 2002

8) “Regulations of the People’s Republic of China on Nature Reserves", the State Council Decree NO.167, 1994

9) “Wild Plant Protection Regulations of the People’s Republic of China, the State Council Decree NO.204, 1996

10) “Circular on Further Strengthening Administrative Management of the Domestic Natural Protection Zone", the State Council Decree NO.111, 1998

11) “Environmental Protection Management Regulations of Construction Project" issued by State Environmental Protection Administration, 1998

12) Four Ministries including the State Environmental Protection Administration EM[1993]NO.324 “Circular on Strengthening Environmental Impact Assessment Management of Construction Project Loans from International Financial Organizations”.

13) “Construction Project Environmental Protection Classification Management Directory” issued by State Environmental Protection Administration, 2002

14) “Forest Pest Control Regulations” issued by State Forestry Administration, 1989

15) “Afforestation Quality Management Provisional Regulations” issued by State Forestry Administration, 2001

2.2.2 Local laws, Regulations and Policies

1) “Terrestrial Wildlife Protection Regulations of Zhejiang Province”

2) “Forest Management Regulations of Zhejiang Province”

3) “Forest Pest Control Implementation Measures of Zhejiang Province”

4) “Implementation Opinions on Environmental Protection Management Regulations of Construction Project” issued by Environmental Protection Bureau of Zhejiang Province

2.3 Related Policies of Europe Investment Bank

European Investment Bank “Manual of Environmental and Social Practice”, Second Edition, February 24, 2012

2.4 Technical Regulations Related with Environmental Impact Assessment

1) “Technical Guidelines for Environmental Impact Assessment” (HJ/T2.1-2.3-93)

2) “Technical Guidelines for Environmental Impact Assessment: Non-polluted Ecological Impact” (HJ/T19-1997)

3) “Technical Specification on Comprehensive Control of Soil and Water Conservation” (GB/T16453.1-16453.6-1996)

4) “Technical Regulation on Water and Soil Conservation Plan of Development and Construction Project” (SL204-98)

5) “Technical Code of Practice on Water and Soil Conservation Monitoring” (Sl277-2002)

6) “Artificial Afforestation Technical Regulations” (GB/T 15776-2006)

7) “Design Code for Afforestation Operation” (LY/T 1607-2003)

8) “Technical Regulations on Reconstruction of low-function Forest” (LY/T 1690-2007)

2.5 Related Document for Construction Project

1) “Feasibility Study Report on Zhejiang Woody Oil Development Project with Loan from European Investment Bank”

Chapter 3 Project Introduction

3.1 Project Objective

3223.3 ha of *Torreya grandis* forest will be afforested, 4860.5 ha of low-yield forest will be transformed, and the project area will be built into important woody oil reserve base, timber reserve base and forest food base, which will continuously provide *Torreya grandis*, bamboo culms, spring and winter bamboo shoots and other high-quality forest products.

Through the project construction, income of local farmers will be improved and more employment opportunities will be created. Advanced technology and management experience on forestry investment projects will be promoted, which will provide a model for other areas in developing special economic forest base construction and low-yield bamboo forest transformation and facilitating forestry development in the surrounding area.

3.2 Project Construction Content

This project will be implemented in 5 cities, including Lin'an, Fuyang, Zhuji, Lanxi, Longquan (county-level city, the same below), the content of construction includes *Torreya grandis* afforestation, low-yield bamboo forest transformation, forest road, management and protection houses, office equipment procurement, technical training and other capacity-building and forest certification. According to the project layout and forest land resource in different cities, production and operation conditions, the forestry industry base and other factors, and after consultation with the beneficiary of the project area, the forest construction content and scale of cities is determined in the way of

participatory consultations, among which, project content in Lin'an, Fuyang and Longquan involves *Torreya grandis* afforestation and low-yield bamboo forest transformation, and that in Zhuji and Lanxi covers *Torreya grandis* afforestation. Totally 3223.3 ha of *Torreya grandis* forest will be afforested and 4860.5 ha of low-yield forest will be transformed. Construction content and scale in different cities is shown in table 3-1.

Table 3-1 Each project city content and scale of afforestation engineering unit: ha

County	Total	*Torreya grandis* afforestation	Low-yield bamboo forest transformation
Total	8083.8	3223.3	4860.5
Lin'an	2104.7	243.0	1861.7
Fuyang	1801.0	400.0	1401.0
Zhuji	1270.8	1270.8	
Lanxi	976.5	976.5	
Longquan	1930.8	333.0	1597.8

3.3 Location of Project Area

Zhejiang is located in the southeast coast of China, south wing of Yangtze River Delta, between east longitude 118 ° 01 '- 123 ° 10' and north latitude 27 ° 06 '- 31 ° 11', adjacent to the East China Sea in the east, bordering Fujian in the south, connecting with the Jiangxi and Anhui in the west, boarding Shanghai and Jiangsu in the north. The total land area amounts to 101,800 km^2.

The project area covers 5 cities, including Lin'an, Fuyang, Zhuji, Lanxi, Longquan, among which, Lin'an, Fuyang city belong to Hangzhou Perfacture City, Zhuji belongs to Shaoxing Perfacture City, Lanxi belongs to Jinhua Perfacture City and Longquan belongs to Lishui Perfacture City. The total land area of 5 cities amounts to11,641 km^2.

Chapter 4 Current Situation of Natural Environment, Society and Economy

4.1 Profile of Natural Environment

4.1.1 Topography

Terrain of Zhejiang Province is high in southwest and low in north-east, descending in the form of ladder. The mountains in southwest are winding, peaks with elevation of over 1000 m stretching continuously. In the central part, the hills below 500 m sea level are seen more occasionally, more than 40 basins with different sizes dotted along the hills, river valley is wide and on the banks of the river, river valley plains discontinuously scatter. Along northeastern and eastern coast, there are accumulation plain, at an elevation of 2.5 ~ 6 m, with flat terrain, dense river network, scattered hills and mountains, part of mountains have extended to the East China Sea, the exposed mountains form peninsulas and islands.

Among 5 cities in this project, Lin' an City and Fuyang City are located in the western hilly area of Zhongshan in western Zhejiang, Zhuji city and Lanxi City are located in Zhejiang Hilly Basin area, Longquan City is located in center part of mountains of south Zhejiang Province. Terrain in 5 cities is mainly low mountains and hills, mountain land resources are rich. See table 4-1.

Table 4-1 Land area of each project city based on elevation grading unit: km^2, %

County	0-20m		20-400m		400-800m		＞800m		Total area
	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage	
Total	718.92	6.18	6623.88	56.9	2723.06	23.39	1575.14	13.53	11641
Lin'an	15	0.48	1840.43	58.71	873.56	27.87	405.78	12.94	3134.77
Fuyang	267.15	14.59	1359.92	74.26	198.32	10.83	5.82	0.32	1831.21

County	0-20m		20-400m		400-800m		＞800m		Total area
	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage	
Zhuji	436.77	18.86	1626.64	70.24	242.35	10.47	9.85	0.43	2315.61
Lanxi	0	0	1175.36	89.58	125.95	9.6	10.76	0.82	1312.07
Longquan	0	0	621.53	20.4	1282.88	42.09	1142.93	37.51	3047.34

4.1.2 Soil

Soil of Zhejiang Province shows a great of variety, according to the second national soil survey data, it can be divided into 10 soil groups, 21 subgroups, 99 soil genera, 277 species of soil. There are 4 soil group in Zhejiang Province with the area of 666,700 ha or more, respectively red soil, paddy soil, Skelton soil and yellow soil. The other 6 soil types are lime (rock) soil, fluvo-aquic soil, purple soil, basic rocks and soil, mountain meadow soil and coastal saline soil. Mountain soil shows obvious vertical distribution and regional distribution, red soil is mainly distributed in the mountains with an altitude of 650 m or below, which is acidic. Yellow soil is distributed above red soil zone, mountains with an altitude of 600 m above, featuring deep soil and high organic matter content. Lime soil (rock) is mainly distributed in limestone mountain and sporadic distributed basalt area. Fluvo-aquic soil is mainly distributed in the two sides of the streams and alluvial land in canyons. Purple soil, basic rocks and soil and mountain meadow soil is sporadically distributed. Except the coastal saline soil, the other 9 soil types are seen in the project area.

4.1.3 Climate

Zhejiang Province is located in southeast China with violent monsoon activities, and impacted by the subtropical monsoon climate. The general climate is characterized by: significantly alternating winter and summer monsoon, moderate temperatures and four distinctive seasons, abundant light and heat, moist air and abundant rainfall. For

many years the annual average temperature is between 15~18℃, annual accumulated temperature more than 10℃ from north to south is about 4800~5600℃. Average annual precipitation is between 1100 mm to 2200 mm in the past years, precipitation areas are unevenly distributed, decreasing from south to north. Average annual sunshine hours have been 1800 to 2100 hours for many years. The main disastrous weather covers flood, typhoon and rainstorm, spring and autumn rainy cold, cold wave, the strong cold air, hail, freezing rain disaster is occasional seen. Monthly precipitation and temperature in Zhejiang are shown in table 4-2.

Table 4-2 Average monthly precipitation and temperature in Zhejiang

Index	January	February	March	April	May	June
Precipitation(mm)	55.2	85.6	119.5	142.1	172.7	204.4
Average temperature（℃）	5	5.9	9.9	15.7	20.6	24.2
	July	August	September	October	November	December
Precipitation（mm）	133.2	139.1	161.4	83.4	62.7	45.7
Average temperature（℃）	28.3	28	23.9	18.7	13.2	7.3

Taking accumulated temperature (5300℃) of more than 10℃ as the classification index, Zhejiang is divided into North tropical and subtropical zones, among which, Lin’an, Fuyang, Zhuji belong to north subtropical zone and Lanxi, Longquan belong to center subtropical zone.

4.1.4 Hydrologic Conditions

Zhejiang Province has the developed river system and dense river network. The main rivers include Qiantang River, Ou river, Yong River, Jiao River, Feiyun River, Ao River, Tiao River and Beijing-Hangzhou Grand Canal. In Zhejiang Hangzhou-Jiaxing-Huzhou plain and Ningshao plain on the South Bank of Hangzhou Bay, lakes are connected and water network is densely covered. The province's average annual runoff amounts to 111.425 billion m^3, equivalent to annual runoff depth of 908

mm, annual runoff coefficient in 0.35~0.75. The river flows into the sea of suspended sediment with an average of 13.05 million tons/year.

In the project area, Fuyang, Zhuji, Lanxi belong to Qiantang River System, Fuchun River traverses through Fuyang, the main river system of Zhuji is Puyang River, tributary of Qian Tang River, Qu River and Jinhua River evolve into Lanjiang River in Lanxi City; Lin'an cuts across Qiantang river system and Tiao River System, and in the city, there are four rivers, i.e., Nantiao River, Zhongtiao River, Tianmu River and Changhua River; the rivers in Longquan belong to Ou River, Qiantang River, Min River System, streams in the west, north and south evolve into Longquan river, and then flow to Ou River; Zhu River and Bilong River in the northwest of the city flow to Qiantang River and Bao River in west of the city flows into Min River of Fujian Province.

4.2 Profile of Ecological Environment

4.2.1 Vegetation Types

Zhejiang Province is located in the subtropical monsoon climate zone, climate features North-South transition and suitability; with abundant precipitation, it integrates mountains, rivers and seas with complex habitat, a wide range of plants and abundant forest resources, its forest vegetation belongs to subtropical evergreen broad-leaved forest area in the eastern part of China vegetation regionalization system-east (moist) evergreen broad-leaved forest sub-area – mid-subtropical evergreen broad-leaved forest zone. The main forest types are: coniferous forest, coniferous and broad-leaved mixed forest, evergreen broad-leaved forest (bamboo). Zhejiang Province strides south subtropical zone and north Asia subtropical transition zone, zonal vegetation is evergreen broad leaved forest.

In the project area, Lin'an City, Fuyang City, Zhuji City and Lanxi

City are in the northern subzone of the mid-subtropical evergreen broad-leaved forest in China vegetation regionalization - Zhejiang Anhui hilly glauca csclerophylla vegetation area - Tianmu Mountain, Gutian mountain and hilly mountain vegetation tablets. Evergreen broad-leaved forest on the south Tianmu Mountain is often seen at the altitude of 600 m to 700 m, the vertical distribution of evergreen broad-leaved forest on North Slope of Tianmu Mountain is much lower than the south slope, generally only seen in hills of 500 m below, mainly composed of *Castanopsis eyrei*, *Cyclobalanopsis glauca*, *Castanopsis sclerophylla*, *Schima superba* etc. and often accompanying *Lithocarpus glaber*, *Machilus thunbergii, Phoebe sheareri* and *katus* trees. At the elevation of 800 m or below, there are Moso bamboo, small bamboo and other bamboo forest, *Cunninghamia lanceolata*, *Pinus massoniana* and other evergreen coniferous forest, evergreen deciduous broad-leaved forest, *camellia*, and walnut, chestnut, tea and other economic forest; in the area at the elevation of 800 m above, there are mainly coniferous forest and deciduous broad-leaved forest, tree species include *Pinus taiwanensis*, *Castanea henryi*, *Cryptomeria japonica*, *Quercus glandulifera* var. *brevipetiolata*, *Liriodendron chinensis*, *Pseudolarix kaempferi*, *Magnolia denudata*, *Liquidambar formosana*, *Betula luminifera*, *Tilia tuan*, *Emmenopterys Henryi*, *Cyclocarya paliurus*, etc. There are mainly alpine shrub and mountain meadow plants with elevation above 1200 m.

The forest vegetation in Longquan belongs to northern sub-zone of the mid-subtropical evergreen broad-leaved forest - southeast Zhejiang and central Fujian area in China vegetation. Its zonal vegetation is in subtropical evergreen broad-leaved forest, due to the effects of altitude, vertical zone spectrum of forest vegetation obviously, there are 6 vegetation type groups, 11 vegetation types, 21 formation groups and 27 formations including coniferous forest, coniferous and broad-leaved

mixed forest, evergreen and deciduous broad-leaved mixed forest, evergreen broad-leaved forest, montane dwarf shrub forest, bamboo forest, shrub, grass, etc.

4.2.2 Forest Resources

Forest resources play an important role in the regulation of water resources in Zhejiang. Most of rivers in Zhejiang Province originate from the province or neighboring border, and flow into the sea in this province, source of rivers is often short, with large upstream gradient and a large variation of flood and low water flow. The rivers rise and fall sharply, prone to flash floods, some rivers often blind during dry season. A large number of runoff floods into the sea in the form of flood, about 30% of which can be used. If forest storage capacity is increased, rainfall loss will be reduced and use of water resources can be increased.

The forest area in Zhejiang Province is large, coverage rate is high, and however, the overall quality is not good enough. Forestry land area amounts to 64% of the total land area of the province. In all forestland area, young forest and middle-aged forest account for 42.69% and 41.36% respectively, over-mature forest area accounts for only 0.66%. More than 80% of forest resources are distributed in South and North Zhejiang Province that of coastal areas and Hangzhou-Jiaxing-Huzhou plain accounts for a relatively small proportion. The grassland area takes up 0.01% of the total land area, which is mainly distributed in hills and mountains.

In the five cities involved in this project, Lin’an City has the second largest land area, and Longquan ranks the third, Zhuji ranks the eighth, Fuyang City and Lanxi City respectively rank the eighteenth and the thirty-second, land resources are relatively rich. All five cities are located in forest zone, forest land area accounted for more than 50% of the land

area of each city. The forest coverage rate of all cities exceeds 50%, except Lanxi, 49.4%, and Longquan up to 87.2%, which is the highest.

Total area involved in the project amounts to 800,700 ha, with 649,300 ha of forestry land, among which there are 594,300 ha of forest land area, 9,300 ha of non-forest land area, and the forest coverage rate amounts to 76.3%. In project area, bamboo forest area sums to 123,200 ha, up to 15.4%; stand volume reaches 27,722,000 m^3. The main data of forest resources in five cities are detailed in related parts of feasibility study report of the project.

4.2.3 Animal and Plant Resources

Zhejiang Province is rich in plant species, there are more than 4,550 species of higher plants (1,407 woody species), among which 53 species are listed as national key protective plants, 88 species as provincial protective plants. There are 35 orders, 126 families and 689 species of vertebrates, including 117 national key protective animal species and 73 provincial protective animal species. There are 99 known mammal animal species, belonging to 10 orders and 33 families; 464 birds animal species and subspecies, belonging to 19 orders and 69 families; 82 species of reptiles, belonging to 4 orders, 15 families and 47 genera; 44 amphibian animal species, belonging to 2 orders, 9 families and 16 genera.

Ecosystem is diversified, including forests, seas and wetlands and other ecosystem with a great variety of biological species. There are 16 national and provincial nature reserves for different species, geological relic and ecological systems, 14 county-level nature reserves, covering an area of about 1.3% of the total land area; 105 forest parks of all levels, 3 geological parks, which plays an important role in the protection of biodiversity and ecological function.

4.3 Current Situation of Social and Economic Development

4.3.1 General Social and Economical Situations

Zhejiang Province has 2 deputy provincial cities, Hangzhou and Ningbo, 9 prefecture-level cities, including Wenzhou, Huzhou, Jiaxing, Shaoxing, Jinhua, Quzhou, Zhoushan, Taizhou and Lishui, under the jurisdiction of which, there are 36 counties, 22 county-level city, 32 municipal districts and 1346 township (towns and streets). In 2012, the province's GDP reached 3.4606 trillion yuan, with a growth rate of 9% compared to the former year. GDP of primary industry amounts to 167 billion yuan, that of second industry reached 1.7312 trillion yuan, that of the tertiary industry reached 1.5624 trillion yuan. The province's urban per capita disposable income amounts to 30971 yuan and per capita net income of farmers reaches 13071 yuan. The resident population of Zhejiang Province is 54,630,000 and the rural labor force sums to 25,553,800.

General situation of economic and social development in different cities involving in this project is shown in table 4-3. Total population of the project cities is 3,209,300, of which agricultural population is 1,654,500. Rural labor force amounts to 949,800, including 431,100 women, accounting for 45.39% in total. GDP of cities involved in the project amounted to 205 billion yuan in 2012, accounting for 3.58% of total in the province; GDP of forestry amounted to 3.495 billion yuan, among which, GDP of forestry in Fuyang is the highest, followed by Lin'an; per capita income of farmers in project area reached 10,103 yuan, of which per capita income of farmers in Fuyang is the highest and that in Lanxi is lowest.

Table 4-3 Economic and social development of each project city (2012)

County	The number of implemented township	Total land area (km^2)	GDP (10^9yuan)	Forestry output value (10^4yuan)	Population (10^4)	Rural labor force (10^4)	Per capita income of farmers (yuan)
Total	64	11641	2050	349521	320.93	165.45	10103
Lin'an	16	3134.77	382.2	67519	52.7	28.39	14169
Fuyang	20	1831.21	541.4	202000	65.38	33.48	16750
Zhuji	10	2315.61	810.7	38486	107.2	59.42	12349
Lanxi	2	1312.07	230	10978	66.64	31.75	4851
Longquan	16	3047.34	85.7	30538	29.01	12.41	8025

4.3.2 Effect and Protection of Historic Sites and Culture Heritage

According to the survey result, there's no natural and culture heritage in project area.

4.3.3 Participation and Benefit of Ethnic Minorities

According to the survey result, there's no ethnic minority in project area.

Chapter 5 Environment Impact Assessment and Mitigation Measures

5.1 Assessment Methodology

5.1.1 Assessment Scope and Time

Environment impact assessment of this project involves 64 towns and 277 villages in 5 cities in the project area. Villages and towns involved in the project are shown in table 5-1.

Table 5-1 Distribution of the project cities and towns

Number	Cities name	City number	Township(town)number	villages
	Total	5	64	277
1	Lin’an	1	16	73
2	Fuyang	1	20	40
3	Zhuji	1	10	75
4	Lanxi	1	2	10
5	Longquan	1	16	79

Environmental assessment covers different periods of project development:

(1) Design phase

(2) Execution phase (4 years)

(3) Operational phase (21 years)

5.1.2 Assessment Factors

Environmental impact assessment is based on field survey, second-hand data collection and exchange views with other experts for environmental sensitivity in the project area. Environment impact and their interaction are comprehensive, so evaluation factor can be identified by use an environment interaction matrix. See table 5-2.

Table 5-2 Initial identification matrix of project environmental impact factor

Project components /activities	Environmental parameters													
	Physical environment					Ecological environment					Social environment			
	Hydrology	Water quality	Soil erosion	Solid Waste	Terrain	Fauna and flora	Biodiversity	Soil fertility	Cherish/endangered species	Pest ecology balance	Land Use	Socio-economic	Public Health	Employment
Low-yield bamboo forest transformation														
Reclamation and soil loosening			-1	-1			-1	-1							1
Increasing fertilizer use			-1						2			1	1		1
Increasing pesticides use			-2				-1			-1	-2		1	-1	1
Tending/Weeding				-1	-1		-2	-2	-1						1
Select woodland	1		1	2			1	1	1		1	1			
Torreya grandis afforestation															
Site preparation, digging			-1	-2			-1	-1							1
Increasing fertilizer use			-2						2			1	1		1
Increasing pesticides use			-2				-1			-1	-2		1	-1	1
Tending/Weeding				-1	-1		-2	-2	-1						1
Select woodland	1		1	2			1	1	1		1	1			

Note: 1 - slightly impact, 2 - moderate impact, "+" - positive impact, "-" - negative impact.

Water and soil environment and the ecological environment factor of project area used to carry out *Torreya grandis* afforestation and low-yield bamboo forest transformation shall be based on monitor results and history data of barren hills and wasteland, low-yield artificial forest and sparse forest in Longquan City, Lanxi City and Fuyang City. Monitoring data of existing base of *Torreya grandis* forest and efficient and intensive bamboo forest will be applied to evaluate the effect of the project construction. Factors of each city will be various according to the meteorological data of different cities.

5.1.2.1 Water Environment

In five project cities including Lin’an, Fuyang, Zhuji, Lanxi, and

Longquan, forest canopy interception capacity, water-holding capacity of litter and water holding capacity of soil non-capillary pore are measured for existing forest stand and target forest stand of 2 construction modes, water conservation amount can be calculated accordingly, thus increment of water conservation before and after construction is estimated.

Estimated water conservation can be calculated according to the following formula:

$S = A (I+K+Q)$

Where S is water conservation (m^3/a), A is forest stand area (ha), I is forest canopy interception ($m^3/ha \cdot a$), K is water-holding capacity of litter ($m^3/ha \cdot a$), Q is water holding capacity of soil non-capillary pore ($m^3/ha \cdot a$).

5.1.2.2 Soil Environment

Soil erosion modulus, annual litter fall and content of nitrogen, phosphorus, potassium in soil of existing forest stand and 2 target forest stand of five project cities was measured, and soil erosion were calculated respectively, thus change of soil erosion before and after construction is estimated. According to annual litter fall and the ration of nitrogen, phosphorus, potassium in the soil, soil improvement benefit increased in each year after completion of project can be calculated.

1) Soil erosion amount

Formula: $G = A(X_2-X_1)$

Where G is predicated soil erosion reduction per hectare (t/a), A is forest land area (ha), X_2 is soil erosion modulus before construction ($t/ha \cdot a$), X_1 is soil erosion modulus after construction ($t/ha \cdot a$).

Where X is evaluated by using “Universal Soil Loss Equation”. As long as the rainfall, soil erosion, slope, vegetation coverage and management, erosion control measures and other factors are available, the

formula can be used for the evaluation of soil loss of any area. The formula is as follows:

X = (R) (K) (LS) (C) (P)

Where R is rainfall, K is soil erodibility, LS is slope length, C is coverage of vegetation, P is erosion control measures factors.

2) Soil improvement efficiency

Formula: $V = \sum A_i L_i \cdot \sum P_{1i} \cdot P_{2i} \cdot P_{3i}$

V is economic value of soil improvement effectiveness of certain forest land (yuan);

A_i is area of certain forest land type (ha);

L_i is annual litterfall (t/ha·a);

P_{1i} is the content of N， P， K of litterfall of certain forest land type (kg/ha·a);

P_{2i} is ratio of pure N, P, k converted into fertilizer;

P_{3i} is the local price of different kinds of chemical fertilizer.

5.1.2.3 Increasing Carbon Sink

The main components of biomass are cellulose and a small amount of N, P, K, Fe, Ca and other ash elements. Calculating on the basis of plant photosynthesis mechanism and metabolism, and assuming biomass containing 1% ash element, each ton of forest biomass can release 1.19t oxygen, assimilate 1.63t carbon dioxide in the air, which equal to 0.44t carbon fixation.

The amount of carbon fixation in the air:

$W_c = \sum A_i \times (B_i \times 0.44 + C_s)$

Where W_c is the amount of carbon sequestration of forest plants every year (t/a); A_i is area of certain forest land type (ha); B_i is annual biomass increase for forest type i (t/a); C_s is forest soil carbon sequestration (t/a).

5.1.3 Assessment Standard

According to environmental function zoning in cities involved in the project by the environmental protection departments, assessment shall be carried out based on the following criteria: quality standards and emission standards. Quality standard shall be adopted in the area where environment is likely to be polluted. If there has emission standard, then the corresponding emission standards shall be implemented. If there has no emission standard for certain pollutant, then each specific pollutant shall be assessed by using the associated emission standard. The following standards shall be applied according to the geographical distribution and environmental characteristics of the project area.

5.1.3.1 Environment Quality Standard

1) Surface water environmental quality shall be assessed by using "Surface Water Environment Quality Standard" (GB3838-2002) Class Ⅲ water quality standard, some river reaches can be assessed based on Class Ⅱ Standard;

2) Soil standard refers to "Soil Environmental Quality Standard" (GB 15618-1995).

5.1.3.2 Pollutant Emission Standard

1) Sewage discharge applies to level Ⅰ standard of "Integrated Wastewater Discharge Standard" (GB9878-1996);

2) "Pesticide use standard" (GB4285-89);

3) WHO recommended insecticides classification according to harmfulness and classification guide 2004-01 (WHO/PCS/01.4).

5.1.4 Assessment Level and Key Points

Expected environmental impact by the project is not serious, through a preliminary calculation, according to assessment level classification

specified in “Technical Guidelines for Environmental Impact Assessment” (HJ/T2.1~2.3-93) and the situation of project area, i.e., rainfall is greater than 800 mm, topography is mainly hills, afforestation is smaller than 10000 ha, we determined that assessment grade shall be Grade Ⅲ; because the main tree species proportion (*Torreya grandis*, Moso bamboo) is greater than 90%, soil environment shall be the key point of assessment. See table 5-3.

Table 5-3 Environmental assessment level of afforestation engineering

Precipitation (mm)	Topography	Afforestation scale (ha)	Proportion of main tree species	Rank	Evaluation focus
>800	Mountain Hills	≥50000	≥90%	Ⅰ	Soil environment, biodiversity
			<90%	Ⅱ	
		10000-50000	≥90%	Ⅱ	
			<90%	Ⅲ	
		≤10000	≥90%	Ⅲ	
			<90%	Ⅲ	Soil environment

Public participation is key point of assessment for EIB’s projects, which is also the focus of this assessment. The purpose of this study is to ensure that the project will not have any major impact on biological, ecological and/or social environment in Zhejiang Province. The study focuses on the potential impact on the project, especially effects of forest clearing and tillage on soil and water; effects of forest cultivation on the ecological environment; effect of fertilizer and pesticide on the ecological environment, as well as the impact on biodiversity, in order to guarantee the sustainable development of the project area.

5.2 Analysis of Positive Environmental Impact Brought by the Project Construction

5.2.1 Impact on Water Environment

All project construction areas are far away from the rivers, reservoirs

and other water conservation locations, therefore, will only have slight impact on the surface water environment. In most occasions, cave-shaped soil preparation will be used, which will have slight impact on the surface water environment. During the whole construction process, there is no pesticides application, and farm manure or compound fertilizer will be applied, so little impact will be exerted on surface water environment. Land clearing and preparation during project construction period will lead to local soil and water loss, but after the completion of the project, water conservation throughout the project area will be significantly improved. See table 5-4.

Table 5-4 Variation of water conservation before and after project implementation

Projcet cities	Construction model (Target stand)	Area (ha)	Water conservation capacity (m^3/ha·a)				Water conservation variation (10^4m^3/a)
			Before construction	After construction	Variation	Change rate (%)	
Lin'an	Bamboo forest	1861.70	5431	5850	419	7.72	78.01
	Torreya grandis forest	243.00	2628	2866	238	9.04	5.78
Fuyang	Bamboo forest	1401.00	5431	5850	419	7.72	58.70
	Torreya grandis forest	400.00	2628	2866	238	9.04	9.52
Zhuji	*Torreya grandis* forest	1270.80	2655	2866	211	7.93	26.81
Lanxi	*Torreya grandis* forest	976.50	2516	2866	350	13.89	34.18
Longquan	Bamboo forest	1597.80	4528	5850	1322	29.19	211.23
	Torreya grandis forest	333.00	2191	2866	675	30.77	22.48
Total		8083.80			552.60	13.45	446.71

Under both modes of construction, water conservation will be greater in varying degree than that before construction (7.72%-30.77%). After the construction and establishment of 8083.80 ha of forests in 5 cities, the average annual water conservation will increase by a total volume of 4,467,100 m^3, an average annual water conservation capacity will increase 552.60 m^3 per hectare (See table 5-4), 13.45% higher than

that of existing forest stand.

5.2.2 Impact on Soil Environment

5.2.2.1 Soil Erosion

In most occasions, cave-shaped soil preparation will be used, which will have slight impact on the earth surface, at the same time, prevent large-area soil bareness and soil erosion. As expected, under 2 modes of construction, the amount of soil erosion will decrease in different degrees compared to that before construction. After the project is completed, the modulus of soil erosion will decrease by 185 t/km^2·a, soil erosion in 5 cities will reduce by 14,900 tons every year. See table 5-5.

Table 5-5 Variation of soil erosion before and after project implementation

Projcet cities	Construction model (Target stand)	Area (ha)	Soil erosion modulus (t/km^2·a)				Soil erosion variation (t/a)
			Before construction	After construction	Variation	Change rate (%)	
Lin'an	Bamboo forestv	1861.70	77	52	-25	-32.73	-465.43
	Torreya grandis forest	243.00	1520	1265	-255	-16.80	-619.65
Fuyang	Bamboo forest	1401.00	77	52	-25	-32.73	-350.25
	Torreya grandis forest	400.00	1520	1265	-255	-16.80	-1020.00
Zhuji	*Torreya grandis* forest	1270.80	1536	1265	-271	-17.65	-3443.87
Lanxi	*Torreya grandis* forest	976.50	2168	1265	-903	-41.65	-8817.80
Longquan	Bamboo forest	1597.80	64	52	-12	-19.32	-191.74
	Torreya grandis forest	333.00	1268	1265	-3	-0.22	-9.99
Total		8083.80			-185	-25.65	-14918.73

Although there may slightly increase the amount of soil erosion in the initial project construction, especially in the strong seasonal precipitation frequent rainstorms, soil erosion will also increase and erosion control measures should be strengthened. But the project after the

completion of the construction, the amount of soil erosion of 2 construction models are greatly reduced, soil erosion is greatly better than before construction, 25.65% less than the existing soil erosion.

5.2.2.2 Soil Improvement Benefit

Under 2 construction modes, soil improvement benefit will increase to varying degrees. After the construction of forest land, average soil improvement benefit will increase 986.28 yuan/ha·a and total project area will increase 7,972,900 yuan/ha·a. After construction, capability of bamboo forest or *Torreya grandis* on improving soil and fertilizer will be significantly improved (average 47.24%). See table 5-6.

Table 5-6 Variation of soil improvement benefit before and after project implementation

Projcet cities	Construction model (Target stand)	Area (ha)	Soil nutrient accumulation (yuan/ha·a)				Soil improvement benefits variation (10^4yuan/ha·a)
			Before construction	After construction	Variation	Change rate (%)	
Lin'an	Bamboo forest	1861.70	2469.45	3848.90	1379.45	55.86	256.81
	Torreya grandis forest	243.00	1512.07	1905.47	393.40	20.65	9.56
Fuyang	Bamboo forest	1401.00	2469.45	3848.90	1379.45	55.86	193.26
	Torreya grandis forest	400.00	1512.07	1905.47	393.40	26.02	15.74
Zhuji	*Torreya grandis* forest	1270.80	1512.07	1905.47	393.40	26.02	49.99
Lanxi	*Torreya grandis* forest	976.50	1512.07	1905.47	393.40	26.02	38.42
Longquan	Bamboo forest	1597.80	2469.45	3848.90	1379.45	55.86	220.41
	Torreya grandis forest	333.00	1512.07	1905.47	393.40	26.02	13.10
Total		8083.80			986.28	47.24	797.29

5.2.3 Ecological Impact

The forest can fix carbon dioxide and release oxygen during photosynthesis, so it plays an important role in the earth's atmosphere balance and can effectively slow down the greenhouse effect. With 2

construction modes, net carbon fixation for unit area will increase to varying degrees compared to that before construction. After the project construction, average annual net carbon fixation in 5 cities will increase 19900 tons, net carbon fixation will increase by 2.46 t/ha, with average increase of 80.57%. See table 5-7.

Table 5-7 Variation of net carbon fixation before and after project implementation

Projcet cities	Construction model (Target stand)	Area (ha)	Net carbon fixation (t/ha·a)				Net carbon fixation variation(t/a)
			Before construction	After construction	Variation	Change rate (%)	
Lin'an	Bamboo forest	1861.70	2.13	5.28	3.15	147.89	0.59
	Torreya grandis forest	243.00	4.46	5.89	1.43	24.29	0.03
Fuyang	Bamboo forest	1401.00	2.13	5.28	3.15	147.89	0.44
	Torreya grandis forest	400.00	4.46	5.89	1.43	32.08	0.06
Zhuji	*Torreya grandis* forest	1270.80	4.46	5.89	1.43	32.08	0.18
Lanxi	*Torreya grandis* forest	976.50	4.46	5.89	1.43	32.08	0.14
Longquan	Bamboo forest	1597.80	2.13	5.28	3.15	147.89	0.50
	Torreya grandis forest	333.00	4.46	5.89	1.43	32.08	0.05
Total		8083.80			2.46	80.57	1.99

5.3 Negative Impact Caused by Project Construction and Related Mitigation Measures

Negative impact caused by project construction and mitigation measures is shown in table 5-8.

Table 5-8 Negative impact caused by project construction and mitigation measures

Phase	Project activities	Negative impact	Mitigation measures
Design phase	Land selection	1. The selection of afforestation land properly, may damage the natural vegetation of ecologically fragile areas; 2. Slope greater than 35 degrees could cause soil erosion;	1. Areas 2000 m from natural or cultural heritage conservation areas, 100 m from public welfare forest and 50 m from both sides of the main rivers, 20 m from both sides of tributaries are not allowed to build *Torreya grandis* forest or revamp bamboo forests. 2. We should pay attention to selection of forest land:

Phase	Project activities	Negative impact	Mitigation measures
		3. Unreasonable layout may affect breeding and habitat environment of the wild animal or destroy activity and migration channel of wild animal.	(1) Sloping field more than 35° cannot be used as land for the project; (2) Soil thickness less than 40 cm cannot be used as area for *Torreya grandis* afforestation , soil less than 50 cm cannot be used as area for revamping of low-yield bamboo forest; (3) Don't use the local wildlife habitat and refuge forest land as project area.
Construction phase	Forest land clearing	Improper forest clearing method is likely to cause soil erosion or destruction of vegetation.	1. Strictly control burning, prohibit the use of herbicides; 2. Remove miscellaneous shrub (grass) in block or in belt shape hindering afforestation activities, and let it rot and decompose naturally; 3. Mainly clean vines, branches, fallen trees and other debris that may hinder growth of *Torreya grandis*, to reduce pests and diseases. Shrubs which do not influence the growth of *Torreya grandis* seedling can be keep to shade and preserve soil and water of native vegetation. 4. For low-yield bamboo forest, mainly clean useless bamboo wood, rotten wood and hollow shrub, and properly preserve indigenous broadleaf trees and rare species with narrow crown, deep roots and fallen leaves and without common diseases and insect pests with bamboo.
	Soil preparation	Improper slope soil preparation method is likely to cause soil erosion.	1. Select cave cultivation or belt cultivation based on slope, damage on ground area is controlled within 25%; no overall cultivation and reclamation is allowed; 2. Between forest block edge and farmland, 10 m wide vegetation protection zone shall be retained; 3. After soil preparation, the land should be covered with withered grass promptly to avoid the topsoil exposed.
Construction phase	Construction of forest road	It will cause damage to vegetation; and make the soil loose, which may cause soil erosion.	1. Forest road width shall be controlled in 1 m and avoid hardening, the impact on the environment will be slight; 2. Design the route scientifically, make full use of the existing road and make improvement, build the road along fire road or compartment line to reduce damage of ground surface and soil erosion.
	Young forest cultivation	When cultivation is performed in the slope, it can cause soil erosion if the method	1. Use local tending method on slope, try to keep vegetation in young forest; residue of vegetation after weeding should remain in the ground as a mulch;

Phase	Project activities	Negative impact	Mitigation measures
		is undeserved	2. Prohibit collecting the leaf litter in forest.
Operation phase	Use of pesticide and fertilizer	1. The use of pesticides may impact the pest natural enemy, resulting in reduction of biological diversity; 2. Improper use of pesticides or fertilizers may lead to surface water pollution.	1. For *Torreya grandis*, use winter deep plowing land, black light lamp, artificial capture and other physical ways to kill insects, and for bamboo forest, use environment-friendly pesticide with high efficiency, low toxicity and low residue; 2. Use scientific and reasonable fertilization and advocate the use of organic fertilizer; 3. Containers of fertilizer shall be stored at the appointed place, strictly prohibit washing the container in the water source or water body for farming and livestock; 4. Train the farmers and workers for safe use of pesticide and fertilizer.
	Cutting and logging	1. Harm other trees or understory vegetation of forest; 2. Logging method is undeserved, which may destroy the surrounding forest; 3. Soil erosion is caused by logging.	1. When cutting bamboo, keep reasonable bamboo number and age structure and make even distribution of bamboo in bamboo forest; 2. Cut bamboo in winter, to reduce the influence on the young bamboo and understory vegetation; 3. When logging the bamboo, use forest road and don’t open up new skidding road.
	Fire, diseases and pests	1. Frequent human activities may increase fire risk; 2. Pure plantation construction may increase the incidence of diseases and pests.	1. Publicize and hold training for fire protection, build biological fire belt and professional fire prevention team; 2. Establish perfect pest quarantine system and monitoring network, so as to realize accurate prediction and timely prevention; 3. Establish biological isolation belt, adopt the physical control and biological control method, when necessary, use efficient low toxicity pesticides for chemical control.

5.4 Analysis of Natural Risks and Precautionary Measures

5.4.1 Analysis of Natural Risks

Natural risk of this project mainly includes fire, chilling injury, frost damage, diseases and insect pests. Risk factors and risk analysis are shown in table 5-9.

Table 5-9 Analysis of natural risks

Factors	Analysis	Risk degree	Environment risk
Fire accident	The project area is covered in the local forest fire prevention system, and biological fire belt and basic construction of fire fighting team is built, so forest fire prevention and fighting ability is relatively powerful. Possibility for large fire in project area is slight.	General	Slight
Chilling injury	Chilling injury has a great influence on tree growth, but when a longer period of chilling injury occurs, and damage extent on the trees is slight. Tree species for the project is suitable for growing in local environment, and has strong ability to adapt to the local temperature. *Torreya grandis* with ability to resist the cold injury shall be chosen.	General	General
Frost damage	Frost has a great influence on the economic forest and forest is vulnerable to frost. Occurrence of damage is generally periodic. In this project, through carefully selection of tree species, damage resistance ability of forest can be greatly enhanced.	General	General
Typhoon	In recent years, the province has increased the intensity of the construction of coastal protection forest system, wind prevention capacity has been significantly improved, and the project area is inland area of Zhejiang, which is far away from the coastline and typhoon will have little effect on the forest.	Slight	Slight
Diseases and pests	Diseases and pests is likely to occur in the project area, as the project has established a comprehensive pest quarantine system and monitoring network for accurate prediction, timely prevention, so that forest health in project area can be ensured.	Moderate	General

5.4.2 Precautionary Measures for Natural Risks

1) Establish sound forest fire prevention institution, strengthen the construction of forest fire prevention team, and develop detailed forest fire prevention system with clear responsibility for everyone according to the relevant laws and regulations, in order to effectively protect forest and prevent fire accident.

2) Prevent chilling and freezing mainly through the use of tree species with cold resistance and frost resistance for afforestation. When necessary apply the trees with white pigment or fuming other methods to prevent or relieve harm caused by low temperature.

3) Use advanced concepts and methods of integrated pest management for forest pest prevention and control work, utilize national and local comprehensive pest and disease monitoring network, and carry

on accurate forecast in the project area, promote physical control, biological control methods, use efficient, low toxicity pesticides for chemical control and realize prevention and control of forest diseases and insect pests of the project.

Chapter 6 Alternatives Analysis

6.1 “Zero” Scenario Analysis

It is a sort of **“**maintaining current development trends” or “no program”, which means the possible developments on the condition that the project is not implemented. Although it helps to save construction funds, comprehensive benefits will definitely go down year by year considering social, economic and ecological benefits.

The direct or indirect effects of the project on ecological environment are significant. The analysis of environmental impact under the project and without the project is shown in table 6-1.

Table 6-1 Comparative analysis of environmental impact under the project and without the project

Environmental impact	Under the project	Without the project
Direct environmental impact	Optimize forest structure; improve forest quality of the project area. It has a positive role in promoting and improving the ecological environment in terms of water conservation, soil and water preservation, as well as increasing the income of farmers within the project area. However, the inappropriate soil preparation transformation and fertilization measures may lead to soil erosion; pest control, fertilization may cause adverse ecological impacts and risks like local water pollution.	Effective degraded forest management and protection cannot be achieved. With barren soil, soil compaction, poor ventilation, serious soil erosion, soil degradation, ecological dysfunction, the overall efficiency of the forest gradually decreases. Sustainable forest management faces major challenges. High incidence of pests and diseases results in decreased yield and quality of forest products and less income of farmers within the project area.
Indirect environmental impact	The ecological and environmental impact on the project area is not obvious during the project construction period, but become gradually clear during the operating period: with bamboo and economic forest production keep stable, farmers have more forest products to take advantage of, hence form a virtuous circle where environment is well protected and income is largely improved.	The local living environment continues to deteriorate, even cause new ecological disaster, and affect the overall ecological environment.
Comprehensive environmental impact	With scientific and rational transformation technology and management solutions, the project	Barren soil and soil compaction cannot be controlled effectively, soil erosion becomes more

	implementation can improve and optimize the structure of forest ecosystem, achieve the organic integration of ecological, economic and social benefits, promote sustainable forest management and utilization; however, the improper transformation methods in design and construction, if any, also has a risk of causing negative impact on the ecological environment.	severe, ecological environment continues to deteriorate, and income of farmers within the project area also decrease.
Programs recommendation	Recommend	Not recommend

6.2 Comparative Analysis of Project Afforestation Program and Conventional Afforestation Program

Based on the successful experience of the past Forest Project Loan-financed by World Bank implemented in Zhejiang, as well as the base construction of economic forest and bamboo forest, the advanced and scientific forest land selection and afforestation technology solutions are designed to make sure that the project has minimum environmental impact during the construction and operation; meanwhile, strengthen the environmental management and monitoring to minimize the project's negative impacts. Comparative analysis between the project's and traditional afforestation and transformation models, and comparative results of environmental impact are listed in table 6-2 to table 6-4.

6.2.1 Forest Land Selection

Table 6-2 Forest land selection analysis

Projects program	Traditional program
1. Forest land used for *Torreya grandis* afforestation shall be forest land with low biomass and comprehensive benefits such as wasteland suitable for afforestation, open forest land, planted forest cut-over land, burned area, open forest land, and degraded planted land. 2. *Torreya grandis* afforest land shall be with a soil thickness of over 40 cm and slope of less than 35 °; 3. Low-yield bamboo forest transformation shall choose land with a soil thickness of over 50 cm and slope of less than 35 °, and choose Mao bamboo forest land with a density of less than 1950 pieces/ hectare or with bamboo average diameter of less than 8 cm.	1. Afforestation project shall be set in the place with convenient transportation and favorable natural conditions as far as possible, so as to facilitate afforestation and management activities, and make sure the planted forest production achieve a relative high standard and gain maximum profits on the condition that environmental protection requirements stay at a low level. 2. Afforestation land shall choose cut-over land, abandoned lands, barren wasteland with relatively good topography and soil conditions; the requirements of soil and slope are low.

Projects program	Traditional program
Conclusion: Recommend	Not recommend

6.2.2 *Torreya grandis* Afforestation Model

Table 6-3 Project afforestation model program analysis

Measure	Project program	Traditional program
Forest land clearing	Adopt block or ribbon style forest land clearing, and burning practice is strictly prohibited. Maintain native vegetation can reduce soil erosion and soil nutrient loss and conduce to biodiversity protection.	Adopt comprehensive clean-up or burning practice. Original vegetation is basically destroyed, which leads to soil erosion and loss of soil nutrients easily, and not conduce to biodiversity conservation.
Preparation mode	Apply hole and ribbon style cultivation for slopes of over 15 degrees, and only hole style cultivation for slopes over 25 degrees; keep grass belt and strive to control ground-breaking surface area at less than 30%, as well as take effective water conservation measures.	Full cultivation or broadband style preparation with a ground-breaking area of 30-100%, which damage more vegetation and lead to severe soil erosion.
Afforestation density	Lower density than conventional afforestation with higher canopy transmittance leaving shrub-grass layer a better condition is conducive to keep forest stands healthy and improve the forest resilience.	Higher density with lower canopy transmittance and early crown closure affects the growth of individual tree, leaving no shrub-grass layer vegetation, so that forest resilience is poor.
Young forest tending	Adopt local tending method, expanding hole, scarifying and weeding around young trees and keep the vegetation as much as possible and remain vegetation residues after weeding in the ground as cover. The above approaches help to conserve water and soil and increase soil fertility.	Adopt comprehensive tending more and clear all the weeds in afforest land, which is not conducive to soil and water conservation.
Fertilization	Use organic fertilizer and compound fertilizer as much as possible; strictly determine the amount of fertilizer according to time and trees amount; Adopt furrow and hole application instead of spreading over the fields and cover the fertilizer with soil after application.	Lack of specificity in fertilization and largely use of fertilizers could easily lead to soil compaction; the unreasonable quantitative and application time also waste fertilizer.
Conclusion	Recommend	Not recommend

6.2.3 Low-yield Bamboo Transformation Model

Table 6-4 Environmental analysis of the low-yield bamboo forest transformation model

Environmental impact	Implementation measures	Project construction model	Traditional construction model
Ecological environment impact	Forest land clearing	Cleanup useless hollow wood, decaying trees and shrubs in order to leave more space and better environment for the growth and development of bamboo. Properly retain deciduous native hardwood and rare species with narrow crown and deep roots who don't share plant disease and insect pest with bamboo.	Adopt comprehensive clean-up. Original vegetation is basically destroyed, which leads to soil erosion and loss of soil nutrients easily, and not conduce to biodiversity conservation.
	Soil preparation method	Adopt ribbon style reclaim with the bandwidth of 3 meters, keep grass belt, minimizing ground-breaking surface, and take effective water conservation measures.	Full cultivation plus ribbon style preparation with ground-breaking area of more than 50%, which lead to more vegetation damage and severe soil erosion.
	Tending management and protection	Choose and retain bamboo shoots according to the principle of "strong, average, and empty" and adopt strip and band type weeding, which are conducive to water conservation and biodiversity protection.	Adopt complete weeding as the tending method, which is not conducive to soil conservation and biodiversity protection.
	Fertilization	Mainly apply compound fertilizer, scientifically determine the amount of fertilizer, and promote the use of organic fertilizer.	Basically apply no fertilizer and adopt an extensive management, and live at the mercy of the heaven; or apply fertilizer with unreasonable quantity and spread over the field.
Complex environmental impact		In strict accordance with the appropriate provisions of the model construction indicators, design transformation technology and environmental protection measures like forest land clearing, reclaim scarification, fertilization etc. in detail and carry out construction strictly under the design. Meanwhile, the preserve of raw grass strip reduces the impact on biodiversity and soil erosion, therefore minimize the project's negative impact on the ecological environment.	No fertilization or unreasonable fertilization and extensive management will result in poor growth of bamboo forest. Unreasonable fertilization is not conducive to soil and water conservation, leading to big ecological hidden trouble, and has a larger negative impact on the ecological environment.
Program recommendation		Recommend	Not recommend

Chapter 7 Environmental Management Plan

The EIA report has clearly formulated the mitigation and monitoring plan, in which coercive measures are adopted to monitor and ensure the implementation of the plan. Environmental management plan has clearly defined the responsibilities of each unit in aspects of plan enforcement and mitigation measures adoption during periods of project design, construction and operation.

For projects partially financed by international financial institutions, the loan agreement shall guarantee that the fund used for the establishment and implementation of environmental management plans is an integral part of the overall project budget.

The environmental management plan made in project EIA includes all mitigation measures requirements stipulated. In case the feasibility study of the project with environmental impact assessment was approved, an executive body responsible for implementing mitigation activities shall be formed as a part of the overall project office.

7.1 Specific Scheme of Mitigation Measures

7.1.1 Preparation and Implementation of “Environmental Protection Regulations”

In order to implement all mitigation measures mentioned in Chapter 5 in the project design, construction and operation, ensure that the implementation of the project further enhance the environmental benefits, as well as minimize or eliminate the potential negative impacts on natural environment, the project office in Zhejiang Province will develop detailed and specific environmental regulations (Annex 1), to address key areas of project implementation, including the choice of afforestation land, forest

land clearance and site preparation, young forest tending, fertilization, logging and forest fires and diseases and pests control, etc. The regulation shall be carefully implemented and enforced in the process of project implementation in order to make sure the full realization of all expected ecological benefits targets.

7.1.2 Preparation and Implementation of “Diseases and Pests Management Plan”

In order to fully implement the related mitigation measures addressing chemical pesticide pollution and prevention measures addressing ecological risks like pest hazards mentioned in Chapter 5, under the policy of "Prevention Prime, Scientifically Control, Governance by Law, and Health Promotion", and according to relative requirements of investment banks of China and Europe, the office hereby formulated the project forest "Diseases and Pests Management Plan" (Annex 3), which provide clear provisions on status of project forest pests occurrence and prevention, prevention objectives and principles, monitoring and forecasting, pest type of main species and control measures, recommendations and application methods of safe pesticides, training for project technique management personnel at all levels and project beneficiaries, etc. and carefully put all the above into practice during the project implementation. As a result, the application of physical and biological control is promoted, the dependence on chemical control is reduced, hence the pollution of chemical pesticides can be prevented on the environment while guarantee the effective control of pests and diseases.

“Diseases and Pests Management Plan” is shown in Annex 3.

7.2 Training Programs

7.2.1 Training Purposes

The purpose of environmental training program is to make sure that personnel of project offices at all levels as well as implementation bodies enforce the requirements of environmental protection, further enhance their environmental protection awareness and ensure that they successfully implement mitigation measures made under environmental impact assessment during project construction and implementation.

7.2.2 Training Contents

Organized by the project office of Zhejiang Province, the environmental training program includes the following aspects:

1) Understanding and application of environmental protection laws, regulations, standards and norms from Chinese government;

2) Environmental management standards that EIB applied;

3) Environmental technologies, as follows:

- Soil erosion control principle, and different ways of soil erosion control;

- Basic understanding of vegetation degradation degree, different vegetation types and ecosystems;

- Environmental protection technology of afforestation;

- Diseases and pests control techniques, integrated pest management plan (IPM) principles;

Faculty members include experts from Zhejiang Environmental Protection Department, project management and technical personnel from Zhejiang Provincial Department of Forestry; besides, experts from academies and institutes such as the Zhejiang Academy of Forestry, Forestry Survey and Planning Academy of Zhejiang Province, Zhejiang A&F University, and Research Institute of Subtropical Forestry of

Chinese Academy of Forestry are invited to assist the training program. In order to reduce training costs, it gives full play to universities and research institutions.

It has carried out a specific training program for farmers with training content of the use of pesticides, diseases and pests control plans, integrated diseases and pests management principles and purposes. This program can be carried out modes - indirect and direct training;

1) Indirect Training: diseases and pests control experts adopt indirect mode of training the trainers, and give lectures to environmental monitoring personnel from city-level project offices with the content of diseases and pests control, integrated diseases and pests management plans and application methods of pesticides. And these trained environmental monitoring personnel are responsible for training local farmers within the jurisdiction.

2) Direct training: diseases and pests control experts directly train farmers with the content of diseases and pests control, integrated diseases and pests management plans and pesticide safety and best application method.

Chapter 8 Public Participation

8.1 Survey Methods and Contents

Public participation is to allow affected individuals and mass organizations to fully express their views in the preparation stage of project construction, therefore the constructors, when make project decisions, can fully take public opinions into consideration, and strive to make the project planning and design more perfect and reasonable. Meanwhile, the involvement of the public in environmental decision-making of the project construction will help to improve the quality of environmental impact assessment and make sure the transparency and credibility of evaluation and decision-making.

8.1.1 Public Participation Survey Methods

According to the requirements of EIB and the Environmental Impact Assessment Law of the People's Republic of China, and in order to better reflect the views of the public of project area, this public participation survey adopts a variety of measures including pasting promotional materials, convening village meetings, group interviews, workshop, individual consulting, etc.

8.1.2 Public Participation Survey Contents

The survey covers all five project cities. Hold workshop for 312 individuals, 270 farmer households, 9 major township (town, forestry station), 5 municipal Forestry bureaus within the project area with the following content:

1) Possibility of necessity of applying for loan;

2) Willingness to participate in project construction;

3) Understanding degree of the environmental impact assessment

report;

4) Negative impact on environment that most worried about during project construction;

5) Which measures shall be adopted to improve the eco-efficiency;

6) What ecological aspects will be improved after the project is completed;

7) Other constructive comments. Meanwhile, opinions of all walks within the project area are gathered and respondents include county and township government functionaries, technical personnel, village cadres, farmers and personnel from other socio-economic organizations.

8.2 Public Survey Result Analysis and Comments

8.2.1 Survey Results Analysis

Among all 312 respondents, 309 people (99.04%) think it's necessary to implement the project with the EIB loan, 239 people (76.6%) think the selection of project area content is reasonable, and 74 people have no idea; 309 people (99.04%) are willing to actively participate in the project, two think they have nothing to do with the project implementation and don't want to be involved in. According to feedback from results of farmers visits, the vast majority of people (over 75%) believe that the project should be implemented, the selection of project area and content is reasonable, and are willing to participate in the project, which show that the project selection is correct.

Among all 312 respondents who are consulted, only 160 people (51.28%) have some understandings towards EIA, 113 people are concerned about the problem of soil erosion during project construction period, 83 people are concerned about soil quality declining, and the rest are concerned about environmental issues like pests and ecological balance; except two people have no idea, the rest all believe that the

living environment will be improved after the completion of the project. The results show that the project is recognized by the vast majority, and its negative impact can be minimized as long as the environmental management is strengthened. The project is feasible in terms of environmental protection.

8.2.2 Public Opinions and Suggestions

For project construction and necessary environmental protection measures, some respondents have given constructive comments and suggestions which can be concluded as follows:

1) Strengthen supervision to ensure farmers enjoy the rights and interests;

2) Enhance publicity to improve public participation;

3) Appropriately increase the loan amount;

4) Improve technical training for farmers and help them to increase their income.

8.2.3 Expert Advice and Recommendations

The survey has also gathered expert opinions, and the main comments are as follows:

1) In order to meet Zhejiang's Eco-province Strategy, it is necessary to increase construction contents and the scale of foreign capital utilization;

2) Minimize soil erosion and impact on the environment;

3) In the project construction period, strengthen management and pay attention to environmental protection. Put forward feasible and operable environmental protection measures in aspects of application of pesticides and chemical fertilizer, soil erosion, etc., and make sure to minimize the impact on the environment;

4) Project design and implementation should conduce to science and

economy, and make sure the realization of the project's expected goals.

8.3 Information Publicity

World Bank Office in Zhejiang Province held preparation meeting and request each project area to strengthen the publicity of the project in various forms such as television broadcasting, newspaper, posting project profiles, issuing brochures, etc.; publicity shall mainly focus on project objectives, the goal of building, construction content, construction scale, project conditions, potential negative impact of project construction on the environment, proposals for the project, etc. Each project city shall conduct publicity according to their construction content. Each project city publicized the results of the participatory consultations in the publicity bar of its administrative village to make sure all stakeholders are fully informed.

8.4 Public Participation Conclusion

According to the above survey results, the public is very concerned about the construction of "Woody Oil Development Project in Zhejiang Province", and the vast majority support the construction by thinking that the project is necessary and it can improve people's living conditions and economic conditions, while its adverse effects is very low. Part of the public hope the project is carried out as soon as possible to improve the ecological environment and overall benefits. Residents within the project area want to get technical training as well as employment opportunities.

Chapter 9 Conclusion

The implementation of the project will increase forest area of project area, enhance forest quality and improve regional ecological environment. It will have a positive impact on forest improvement, water conservation; soil nutrients and carbon sequestration as well as soil erosion and land degradation reduction. Implementation of the project will also increase the income of farmers, and promote local economic and social development.

The project implementation will increase 553 m^3 of water storage capacity per hectare per year of the project area, and 4,470,000 m^3 of the total annul amount, reduce 185 tons of soil erosion per hectare per year, and 14,900 tons of the total annul amount; increase 986.28 yuan of soil improvement benefits per hectare per year, and 7,972,900 yuan of the total annual amount; reach 2.46 tons of net carbon sequestration per hectare per year, and 19,900 tons of the total annual amount. Take project period as 21 years and till the end of the project, the accumulated increased water storage capacity will reach 93,87 million m^3, soil improvement benefit income 167 million yuan, carbon sequestration 417,900 tons, that is assimilating 153 tons of CO_2 from the atmosphere.

The project also has some negative impact. For instance, the improper land preparation and woodland clearance in the early stage of afforestation may lead to local water, soil, and nutrients loss; the bare side-slope of forest road may affect the landscape; the improper use of fertilizer and pesticides will cause varying degrees of harm to surrounding people, livestock, crops, beneficial insects and wildlife. Therefore, the use of fertilizer and pesticide may have a negative impact on the ecological environment.

Although the project implementation process may have potentially negative impact on the ecological environment, its negative side can be minimized even avoided as long as mitigation measures like ecological protection are fully practiced. Therefore, the project's negative impact on the ecological environment is at low risk and can be totally controlled.

Annex 1 Environmental Protection Regulations

1. Overview

With a view to further minimize or eliminate the possible negative impact of Zhejiang Woody Oil Development Project implementation on natural environment, this regulation is hereby formulated to guide project activities such as *Torreya grandis* afforestation and low-yield bamboo forest transformation. This regulation, during its formulation, has fully drawn experience and lessons from the environment management of the past World Bank Loan-financed Forest Project implemented in Zhejiang Province and comprehensively referred to the following legal documents:

1.1 Relevant laws and regulations of the People's Republic of China: Environmental Protection Law, Forest Law, Law on the Protection of Wildlife, Law on Water and Soil Conservation, Environmental Impact Assessment Law, Forest Disease and Pest Control Regulations, Wild Plant Protection Regulations, Regulations on Nature Reserves, Afforestation Quality Management Provisional Regulations and Announcement of Strengthening the Environmental Impact Assessment Management of Projects Based on Funds of International Financial Organizations;

1.2 Relevant Laws and Regulations of Zhejiang Province: Zhejiang Terrestrial Wildlife Protection Regulations, Zhejiang Forest Management Regulations, Zhejiang Forest Disease and Pest Control Implementation Measures and Implementation Opinions on Environmental Protection Management Regulations of Construction Project;

1.3 European Investment Bank regulations: Environmental and Social Practices Handbook (Second Edition).

2. Project Forest land Selection

2.1 *Torreya grandis* afforestation and low-yield bamboo forest transformation of the project shall not be implemented on forest land within 2000 m from the buffer zone outskirts of natural or cultural heritage protection areas, 100 m from outskirts of public welfare forest, 50 m from two sides of main rivers, and 20 m from both sides of tributaries. Besides, selection shall avoid the forest land which functions as habitat and shelter of wildlife as much as possible.

2.2 *Torreya grandis* Afforestation Land Selection

2.2.1. Forest land used for *Torreya grandis* afforestation is as follows: waster

forest land, open woodland, clear-cut area of plantation, burned forestland and degrading plantation forest, etc.

2.2.2. Sloping field over 35° shall not be used for project afforestation.

2.2.3. Land with layer thickness of less than 40 cm shall not be used as *Torreya grandis* afforestation.

2.3 Forest land Selection of Low-yield Bamboo Transformation

2.3.1. Choose bamboo forest stand with unreasonable age structure, low density or low average diameter.

2.3.2. Sloping field over 35 ° shall not be used for project forest land.

2.3.3. Land with layer thickness of less than 50 cm shall not be used for low-yield bamboo forest transformation.

3. Environmental Protection Requirements of *Torreya grandis* Afforestation

3.1 Forest land Clearance

3.1.1. Strictly prohibit the use of burning practices in clearing forest land.

3.1.2. Don’t use herbicides.

3.1.3. Heap up the miscellaneous shrub (grass) between bands or planting holes, and let it decompose naturally.

3.1.4. Clean afforest land and remove debris such as vines, twigs and fallen trees which may influence the growth of *Torreya grandis*, in order to reduce pests. Keep shrubs which don’t affect the growth of *Torreya grandis* seedlings, but function as shelters and play a role in soil and water conservation.

3.2 Soil Preparation

3.2.1. Adopt cave-shaped and banding soil preparation.

3.2.2. Keep a 10 m wide vegetation protection zone between the edge of forest land and farmland.

3.2.3. Cover the land surface with litter, shrubs, weeds, etc. after soil preparation, in order to prevent topsoil expose.

3.3 Tending Management

3.3.1 Weeding and Scarification

3.3.1.1. Do not use herbicides. Adopt local tending method for new forest, and keep natural vegetation of young forest as much as possible during holes expanding, weeding and scarification around the young trees.

3.3.1.2. The vegetation residues shall remain as cover after weeding.

3.3.1.3. Don’t pick litter layer on the forest floor, and let it play a role of

conserving water and maintaining soil fertility.

3.3.2 Fertilization

3.3.2.1. Apply organic and compound fertilizer, and make sure the fertilizing time, frequency, amount and manner is in strict accordance with the features of fertilizer and the requirements of the project.

3.3.2.2. Collect fertilizer containers in a unified way, and strictly prohibit purging containers at water source, or at water bodies for aquaculture and livestock drinking.

3.3.2.3. Make fertilizing schedule according to advanced and applicable scientific research results as well as test results of soil and plants. Adopt furrow application, and apply the fertilizer in the uphill side of the hole. Strictly forbid spreading fertilizer over the field. Recommend covering the fertilizer with soil after fertilizing in order to avoid nutrient runoff and surface water contamination.

4. Environmental Requirements of Low-yield Moso Bamboo Forest Transformation

4.1 Forest land Clearance

Cleanup useless hollow wood, decaying trees and shrubs in order to leave more space and better environment for the growth and development of bamboo. Properly retain deciduous native hardwood and rare species with narrow crown and deep roots who don’t share plant disease and insect pest with bamboo.

4.2 Reclaim Scarification

Adopt belt reclaim with the digging depth of over 20 cm. Remove the old whip, bamboo stump, tree stump and stone, and retain strong whip in order to remove barriers for the growth of the underground rhizome of bamboo.

4.3 Fertilization

Apply organic fertilizer and compound fertilizer. Adopt furrow, hole and stump application instead of spreading over the fields.

Apply in strict accordance with fertilizer rate, and avoid excess fertilization.

5. Bamboo Harvesting

Adopt selective harvesting method to maintain a reasonable number of bamboo and forest age structure, and strive to make sure the proportion of bamboo at 1-2 years, 3-4 years and 5-6 years are the same.

6. Forest Road Construction

Take full advantage of and improve current forest road, and make sure it is constructed along the fire control line or compartment line as much as possible in

order to reduce land surfaces breaking and reduce soil erosion.

7. Forest Diseases and Pests Integrated Management

Diseases and pests management of project targeted forest shall be brought into the local forest pest management system.

For *Torreya grandis* forest, physical approaches like deeply plowing forest land in winter, black light trap and manual capture are applied. State banned high toxic and high residues pesticides are strictly forbidden.

For bamboo forest pest management, shoots and bamboo with diseases and pests as well as litter shall be promptly removed, and natural enemies shall be well protected and used. Rationally use environmental friendly pesticides with high efficiency, low toxicity and low residue, while high toxic and high residues pesticides are strictly forbidden.

Develop Integrated Pest Management Plan, and put into practice in project implementation.

8. Forest Fire Management

Fire prevention work of project targeted forest must be included into local forest fire management system at all levels. Each afforest unit must write forest fire prevention plans and establish fire management agency.

Formulate detailed plans about fire prevention, public education, patrols, law enforcement and fire emergency.

Project forest blocks with an area of over 100 ha must be equipped with fire belts. Fire belts shall be 10-20 m in width. Use rivers and local pyrophytes as natural firebreaks as much as possible.

Annex 2 Diseases and Pests Management Plan

1. Diseases and Pests Risk

Forestry diseases and pests have seriously affected forest quality and system functions, and become the biggest obstacle of ecological construction and forestry development rapidly. 63 of total 91 forestry quarantine and inspection stations of Zhejiang Province have achieved national standards. The province's forest diseases and pests disaster rate has been controlled under 4.4 ‰, pollution-free prevention rate has reached 78% or more, forecasting accuracy rate 82%, and seed producing area quarantine rate 93% or more. All the above show that the province has basically realized continuous control of forestry diseases and pests; Although project afforest land is less likely to be affected by large-scale diseases and pests, prevention and control are still necessary.

2. Diseases and Pests Prevention Mechanism

Strictly control diseases and pests, follow the policy of "Prevention Foremost, Comprehensive Management", and carry out accountability system of operator being responsible for prevention. The project area shall establish and improve forest diseases and pests monitoring and early warning system, and strengthen the forest plant quarantine and diseases and pests disaster mitigation systems.

Diseases and pests prevention and control shall mainly depend on forest management measures, and apply comprehensive measures integrating biological, chemical and physical control.

Make sure to select tree species according to local conditions during afforestation; avoid the use of seedlings with dangerous diseases and pests in reforestation or nursery; conduct timely tending management towards young and middle-aged forest; clear trees infected with diseases and pests; timely clean up burned areas, and remove seriously burned trees; promptly ship harvest trees out of the cutting area and clean up the site.

Townships involved in the project targeted area can establish pharmaceutical, device and storage warehouses based on the existing forest protection system; each city shall set up forecasting laboratory, quarantine laboratory and quarantine isolated trial nursery as well as forestry seedlings and timber fumigation facilities. Each city and township shall set up management and technical personnel, and conduct regular

inspection. Joint prevention and treatment are recommended in areas with relative if possible.

3. Diseases and pests Control Measures

For diseases and pests that already infected, the integrated diseases and pests management measures shall be chosen and publicized, and the use of chemicals shall be reduced. Use pesticides with low toxicity and residues, and avoid the use of any I category pesticide classified by the World Health Organization.

4. Major Diseases and Pests of Project Tree Varieties and Prevention Measures

4.1 Moso Bamboo

4.1.1 *Arthrinium phaeospermum* (Corda) M.B.Ellis

When shoots grow to about 1.5 m high, black to tan dot, stripe or block of spots appear in the third joint at the base of culms, and quickly move upwards, then transverse extend at bamboo joints, causing the death of the whole plant. Early scab surface is black or dark brown, and gradually become brown; with edge color deeper and central lighter, slightly dented or longitudinally wrinkled. In the case of high temperature, the lesion surface may have white mucus or tear-shaped droplet, which becomes powder after dry and hardly to be removed with a finger. Moso bamboo forest in places with high water table, low-lying water, heavy clay soil and poor drainage is easy to get disease.

Control Methods:

First, strengthen forestry management technical measures to improve resistance. ① Drainage ditch. Bamboo forest in places with high water table or heavy clay soil and poor drainage shall be equipped with a ditch with 1 m deep to drain off water, and make sure the bamboo rhizome ventilation conditions. ② Raise big, stout middle- stage shoots. Within 10 days after Qingming Festival is the best time to stay shoots. Early-stage shoots from shallow whip and late-stage shoots after Grain Rain, as well as small and weak middle-stage shoots shall be removed. ③ Reclamation and fertilization.

Second, remove diseased plants and disinfect the soil, to reduce the primary infection source. ① In late April when the shoots grow up to1.5 m, spray 2 m of the surrounding soil and shoots housing block with 40% WP of 200 times to kill bacteria on the soil surface and bamboo shell. Chemical use of one shoot is about1gram. ② Timely remove of seriously ill bamboo of the year, and burned them with

Chlorothalonil disinfection; Clean up old and sick bamboo in autumn cutting year by year gradually.

Three, strengthen prevention and control measures during diseased period. ① When the shoots grow to1.5 m or so, once diseased plants were found, the base of bamboo sheath shall be stripped immediately to prevent water logging in the base of tender bamboo, accelerate woody bamboo epidermis and improve resistance. ② Spray 70% Thiophanate-methyl 200 times immediately on tender bamboo base after sheaths were stripped from shoots.

4.1.2 *Algedonia cociesalis*

Algedonia cociesalis can be classified in over 10 categories, among which *Algdonia coclesalis* Walker, *Crocidophora evenoralis* Walker, borer and other bamboo moire are frequently seen. The above borers often occur together, with *Algdonia coclesalis* Walker distributed most widely with heaviest damage. It mainly damage pubescen, and also damage *Phyllostachys glauca*, *phyllestachys pubescens*, *phyllostachys praecox*, *phyllostachys vivax*, *dianthus chinensis*, etc. This kind of borer, when in large scale, can eat up bamboo leaves, kill bamboo strains reduce shoots production of the next year by 30% to 50%, and reduce new bamboo width of 20 to 30 percent.

Control methods: ① Reclaim in autumn and winter in shoots bumper year can kill 50% of callus of *Algdonia coclesalis* Walker. ② Set up black light in high and broad place near bamboo forest to tramp adult borer during adulthood. For *Crocidophora evenoralis* Walker, use brine or liquid dung of 50 kg with 0.25 kg of (the proportion of 80%) of Dichlorvos to trap adult borer. ③ fully protect and use natural enemies. In the egg stage, release 1200000 *T. dendrolimi* per hectare. ④Spray *Beauveria bassian* in the forest during young larvae stage.

4.1.3 *Hippotiscus dorsalis*

Hippotiscus dorsalis, with form of nymphs and adults, suck juice of bamboo stalk sucking sap, causing bamboo leaves wither, growth recession or even death.

Control methods: ① In early April, butter bamboo base ring with butter plus engine oil at a ratio of 1:3, in order to prevent nymphs from climbing onto bamboo. Oil ring width shall be no less than 10 cm, and when nymphs are blocked and cluster at the bottom of the oil ring, capture artificially or spray tag type insecticide. The time of setting oiled ring is very important. It is necessary to master activity patterns of

local *Hippotiscus dorsalis*, and set oil rings in spring before nymphs climb bamboo, otherwise the prevention function cannot be achieved. ② Reclaim, weeding, and fertilizing, in order to destroy overwintering sites of *Hippotiscus dorsalis*. ③ Spray the green Vario on bamboo before nymphs appear.

4.1.4 Bamboo scale insects

It destroys branches and leaves, and is one of the three major pests that harm bamboo stalks. With form of nymphs and female adults, suck juice of bamboo stalk, causing bamboo leaves wither, growth recession or even death, as well as bamboo sootymould which may cause death.

Control methods: ① strengthen bamboo tending management, maintain a reasonable bamboo density and age structure, timely remove old bamboo of over 3 degrees, clear and burn harmed branches and leaves, which will effectively inhibit the growth of bamboo scale insect populations; ② during nymph period, apply effects JuBama EC or 2.5 percent effort EC with 1000 ~ 2000 times spray; ③ artificial denied.

4.2 *Torreya grandis*

4.2.1 *Pythium ultinum (Rhizoctonia solani, Fusarium culmorum)*

(1)The nursery should choose in the ventilation, sunny, higher, good permeability, convenient irrigation and drainage sand loam.

(2)In the central region of disease nursery， diseased seedling should be promptly removed and burned.

(3)High temperature, drought is prone to seedling roots under strong sunlight and injury. After the infection of pathogens, seedling sick easily. Seedling shading shed should be placed a long time, and it is important to irrigation during the drought.

(4)Recommend 50% Carbendazim 500 times.

4.2.2 *Erwinia carotovora*

Disease of fruit should be promptly removed, and concentrated burned.

4.2.3 *Torreya grandis* stems rot

Apply protective circle of shade or complex grass shade, to prevent stem base being exposed in blazing sun is the key.