Chapter III
Success and sustainability: Lessons from Guangdong Province

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1. Introduction
Guangdong Province, in southern China, had 6.67 million ha of degraded forested land\textsuperscript{1} in 1935 (GFB 1994). In 1949, forests\textsuperscript{2} covered only 3.36 million ha, or 18.7 percent of the province, while degraded forest land equalled 7.67 million ha. Heavy logging, use for farming, war and forest fire led to severe forest destruction and degradation. Since 1949, the province has made continuous efforts to rehabilitate\textsuperscript{3} its degraded areas, driven by national and regional policy initiatives, concerns over deteriorating environmental conditions and timber shortages. The extent and nature of these rehabilitation efforts have changed over time in response to political changes, economic development and land tenure reform.

The province proclaims great successes in its rehabilitation efforts, particularly since 1985. Under the project ‘Rehabilitating degraded forest land in five years,

\textsuperscript{1} There is no official term “degraded forest land” in China. We estimated degraded forest land in Guangdong as the area with non-forest (barren, logged-over and burnt-over forest areas), shrub and sparse forest cover which represent degraded vegetation types in the province. Sparse forests are areas with less than 20 percent tree canopy cover (< 30 percent prior to 1996).

\textsuperscript{2} Forest includes area with greater than 20 percent (> 30 percent prior to 1996) tree canopy cover, bamboo groves, some shrub lands specially prescribed by the State, farmland shelterbelts, and trees planted around villages, rivers, roads and houses (Regulations for implementation of the State Forest Law issued in 2000). It includes timber, shelterbelt, fuelwood, economic (non-timber products) and special purpose forests.

\textsuperscript{3} See Chapter I for details on rehabilitation terminology.
and greening Guangdong in 10 years’ started in 1985, the province achieved its target two years ahead of schedule. Degraded forest land was reduced to 1.19 million ha and forest cover increased to 57 percent of the land area in 2003. Guangdong has won a number of national titles and recognition such as “The first province to rehabilitate and green its degraded forest lands” in 1991 and “The advanced province in greening its plains” in 1993. In 1995, Zhongshan city was awarded the title of “Advanced Greening City” and in 1996 was declared one of China’s eight garden cities. Guangdong took a leading role in developing private sector forestry, both in policy formulation and implementation. It has successfully tried and developed many innovative socio-economic incentives and institutional arrangements, such as jointly-managed or stock-shared forest farms; these have been recommended and extended to other provinces (SFA 1999).

However, the picture is not all positive. Guangdong’s forest rehabilitation efforts, as elsewhere in China, have resulted in vast monoculture landscapes with simple stand structures, low forest quality and productivity, and high vulnerability to pests and diseases (Deng 2001, GFEB 2001). Forest lands have also not been regenerated well after logging and fire damage. Besides, heavy soil erosion, surface water runoff, and droughts and floods continued unabated in Guangdong, despite the large areas rehabilitated and most projects having soil and water conservation objectives. It is necessary to monitor and evaluate the effects of the revegetation, management and use practices on water and soil properties in line with the stated goals.

In this chapter, we assess in detail the characteristics of rehabilitation efforts in Guangdong Province, and their outcomes and influencing factors using the literature and 22 case studies across eight types of rehabilitation initiatives identified. The case studies help to elucidate implementation activities and

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4 Private sector here refers to farmers afforesting and managing their allocated lands, and individual investors and private enterprises afforesting and managing leased or subcontracted forest land for their own income. There is no strict recognised definition and many mixed public-private sector institutional arrangements exist in practice. The term “non-public system” is commonly used in China and refers to afforestation and management of forest land by any individuals or agencies for income with their own investment through lease, tenure transfer, contract, stock-sharing or joint management mode.

5 Joint management refers to cooperative efforts between institutions — such as forestry departments with other government departments, state forest farms with village committees, village committees with individuals and foreign enterprises — with sharing of land, techniques, management and benefits.

6 Farm households contribute land, and companies contribute funds and establish, manage and harvest the timber plantations in a stock-sharing system. Benefit-sharing arrangements would generally be in the ratio 70:30, company to farm households. Fruits and other non-timber products are often included as additional incentives for farmers.

7 “Forest land” includes forests, sparse forests, shrub land, young plantations, seedling nurseries, logged-over and burnt-over forest areas, and all land suitable for planting trees as designated by the different levels of government (Regulations for implementation of the State Forest Law issued in 2000).
outcomes on the ground. Our main objective is to draw strategic lessons for sustaining and guiding current and future efforts both within Guangdong and elsewhere by identifying the:

- Most promising technical, financial, socio-economic and institutional approaches and incentives that have contributed to longer-term sustainability and positive outcomes for different stakeholders.
- Problem areas, constraints and issues needing resolution.
- Gaps in information.

Guangdong’s experiences, over the past 20 years in particular, provide opportunities for learning many useful lessons to guide and sustain future rehabilitation efforts in China and elsewhere. This study can feed into the key policy processes related to forest rehabilitation and management in China, and particularly southern China given common biophysical conditions, land use history and tenure regimes. However the specific conditions of Guangdong — a relatively rich, economically developed area with good market access — will have to be borne in mind when considering the transferability of the lessons learnt.

We present below some relevant background information for the province followed by the methods used in this study. Then we provide a historical review of forest degradation and rehabilitation in the province, assess the characteristics and outcomes of the major initiatives, and finally present the lessons learnt from the analysis.

### 2. Background information on Guangdong Province

#### 2.1 Biophysical conditions

Guangdong is a southern province on the Chinese mainland, next to Hong Kong and Macao (Figure 1). It covers 17.977 million ha or 1.9 percent of China’s total land area. The provincial mainland coastline is 3368 km, the longest in China (GCEB 1998). The Tropic of Cancer passes through the centre of the province, dividing it into tropical and subtropical zones. Mountains (> 400 m altitude), hills and plateaus comprise 77 percent of the total area (Figure 2). Mountains higher than 1500 m in the north give way to hills and plateaus, and then plains in the south. Major rivers include the Pearl, the Hanjiang, the Dongjiang, the Jianjiang and the Moyangjiang.
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The region has a long summer and warm winter with average annual temperatures of 19°C in the north and 23.5°C in the south. Average minimum temperature in January is 9-16°C. Annual mean sunlight hours range from 1750 to 2200 hours. Average annual rainfall ranges from 1400 mm in the north to 2200 mm in the south, with most falling from April to September. Tropical windstorms buffet the province from May to October.

Figure 1. Location and forest cover of Guangdong. World Forest Cover map based on 1992-93 and 1995-96 Advanced Very High Resolution Radiometer (AVHRR) data. Source: Forestry Department, Food and Agriculture Organization of the United Nations (FAO), Rome.

FAO’s standard classification
- Closed forest: Trees with > 40% canopy cover and > 5 m height, includes natural forests and forest plantations
- Open/fragmented forest: Trees with 10 to 40% canopy cover and > 5 m height (open forest), or mosaics of forest and non-forest land (fragmented forest), includes natural forests and forest plantations
- Other wooded land: Land either with a 5 to 10% canopy cover of trees > 5 m height, or with a shrub or bush cover of more than 10 percent and height < 5 m
- Other cover: All other land, including grassland, agricultural land, barren land, urban areas.
The southern part of Guangdong is in the tropical monsoon climate zone, while the northern part is on the southern edge of China’s subtropical monsoon zone. Evergreen monsoon rainforests once dominated the south, with species such as *Endospermum chinense*, *Choerospondias axillaris*, *Ficus altissima*, *Cinnamomum camphora*, *Cryptocarya chinensis*, and *Altingia chinensis*. South-subtropical monsoon evergreen forests with *Castanopsis* species, *Elaeocarpus sylvestris*, *Garcinia multiflora*, *Machilus velutina*, *Cryptocarya chinensis*, *Schefflera octophylla*, *Bischofia javanica*, *Sterculia lanceolata*, *Ilex purpurea* and *Symplocos* spp. dominated the province’s middle areas. Mid-subtropical, evergreen, broad-leaved forests composed of *Castanopsis hystrix*, *Schima superba*, *Altingia chinensis*, *Cinnamomum camphora*, *Castanopsis fissa*, *Choerospondias axillaris* and *Liquidambar formosana* dominated the northern section (GFEB 1990). However, long-term human intervention has made the original forest vegetation types rare.

The main soil types in Guangdong include lateritic red soil (39% of the area), laterite (15%), red earth (15%), paddy soil (14%) and yellow earth (6%) (GCEB 1998). There are small areas of purple soil, dry red soil, meadow soil, limestone, coastal saline and sandy soils and tidal mud (GCEB 1998, GAS 1991). Lateritic red soil is typical in the south-subtropical area and suitable for growing tropical and subtropical fruit trees and other economic plantations, agricultural crops, and some valuable timber trees such as teak (*Tectona grandis*), *Castanopsis hystrix*, *Pterocarpus indicus*, *Betula alnoides*, *Cinnamomum camphora* and *Swietenia macrophylla*. The favourable water, heat and soil conditions in the south subtropical area provide high potential land productivity as compared to the rest of China.

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8 *Economic forests or plantations* are for non-wood products such as fruits, edible oils, beverages, fodder, medicines, spices and industrial materials like rubber for cash income.
Laterite is typical of the tropical area and suitable for growing tropical fruits and crops. Red earth is typical of the mid-subtropical area in the northern mountains, and is good for growing Chinese fir (*Cunninghamia lanceolata*), Masson pine (*Pinus massoniana*), some valuable broad-leaved timber plantations such as *Castanopsis fargesii*, *Altingia chinensis*, *Choerospondias axillaris*, *Betula alnoides* and *Castanopsis carlesii*, and economic plantations. Yellow earth is suitable for developing commercial timber and ecological forests.

### 2.2 Socio-economic conditions

In 2000, agricultural land constituted 83.5 percent of all land use, construction nine percent and other uses 7.5 percent (LRDGP 2000). Of the agricultural land, arable areas comprised 20.44 percent, gardens 5.72 percent, forest land 67.96 percent or 10.2 million ha, grassland 0.19 percent and other agricultural land 5.69 percent.

#### 2.2.1 Population density and composition

The Han ethnic group makes up 98.6 percent of Guangdong’s population, with the rest comprising 53 minority groups, mainly the Zhuang, Yao, She, Hui and Man. The population in 2000 was almost triple that in 1949 (Table 1), with the density rising from 155 to 417 people per km² in 2000. Guangdong’s population is still largely agricultural (69%), but the rural growth rate has been declining due to increasing urbanisation. From 1990 to 2000, the non-agricultural population increased on average by 5.83 percent per annum while the agricultural population increased by only 0.82 percent. A sample survey suggested that Guangdong’s permanent residents totalled 78.58 million by the end of 2002, making it the third most populated province in China.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total population (million)</th>
<th>Non-agricultural population (million)</th>
<th>Agricultural population (million)</th>
<th>Population density (People/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949</td>
<td>27.82</td>
<td>4.37</td>
<td>23.45</td>
<td>155</td>
</tr>
<tr>
<td>1970</td>
<td>43.82</td>
<td>6.93</td>
<td>36.89</td>
<td>244</td>
</tr>
<tr>
<td>1980</td>
<td>52.27</td>
<td>9.09</td>
<td>43.18</td>
<td>291</td>
</tr>
<tr>
<td>1990</td>
<td>62.46</td>
<td>14.77</td>
<td>47.69</td>
<td>347</td>
</tr>
<tr>
<td>2000</td>
<td>74.98</td>
<td>23.38</td>
<td>51.60</td>
<td>417</td>
</tr>
</tbody>
</table>

Source: Guangdong Population Information Centre.

#### 2.2.2 Economy and development

Since China implemented its reform policy and began opening up to the outside world in 1978, Guangdong has enjoyed substantial, sustained economic growth.

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9 Ecological forests or non-commercial forests are for the purpose of maintaining and improving the ecological balance and the environment, conserving biodiversity, and providing non-timber forest products.
that has made it the nation’s strongest economic province. Guangdong ranks the highest in total investment in fixed assets, value of retail sales, value of imports and exports, government revenue and numerous other economic indicators. From 1978 to 2002, the Gross Domestic Product (GDP) grew an average 12.7 percent a year, reaching 1176.97 billion RMB. The service sector has been expanding with its relative contribution to the GDP increasing from 35 percent in 1995 to 41 percent in 2002 (Lu 2003). However, economic development is not uniform across the province. The coastal region, especially the Pearl River delta, has developed rapidly while the mountain region has lagged behind. Forestry is considered a part of the agricultural sector and its specific contribution to the GDP is unknown. However, the contribution of the agricultural sector overall to the GDP has decreased from 15 percent in 1995 to nine percent in 2002 (Lu 2003). People depend on forestry for subsistence more in the mountain region as compared to the coastal areas. Guangdong is one of several provinces with the best infrastructure and transport development in China. It has sea and air connections to many countries and regions across the world. Internal air, road and water transport routes and communication networks are well developed.

2.3 Institutional conditions

Current administrative structure

Guangdong Province
↓
21 district cities
↓
33 cities
↓
43 counties & three autonomous counties
↓
1588 townships & 42 autonomous districts
↓
Villages

2.3.1 Forestry Administration
The Guangdong Forestry Bureau is the province’s highest forestry authority. It is tasked with implementing national forestry policies, laws and regulations;

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10 Roughly 8.27 Chinese Yuan Renminbi (RMB) per US dollar (USD) in June 2005. The exchange rate was 100 USD to 153 RMB prior to 1981, 100 USD to 320 RMB from 1981 to 1985, 100 USD to 370 RMB from 1986 to 1989, 100 USD to 870 RMB in 1994, and 100 USD to 828 RMB after 1995.
drafting forestry development plans; developing local forestry policies and regulations; guiding forest production and development; mobilising the citizens to participate in afforestation\textsuperscript{11} activities; and protecting and rationally utilising the forest resources.

Each district city, city and county government has a forestry administration authority, usually named the Forestry Bureau or Greening Committee. These authorities are responsible for implementing policies and regulations issued by higher-level government agencies; supervising and evaluating performance; conducting forest resource inventories and forest operations layout; guiding state forest farms, collective forest farms, and local farmers; and mediating land tenure conflicts. The capacity of local forestry bureaus or greening committees largely depends on the local government’s economic status. Rich cities and counties tend to have higher capacity and better facilities.

Every town has a forestry station affiliated to the county’s forestry bureau. These stations assist the township government to prepare an annual forestry plan, check afforestation results, verify annual logging quotas and logging sites in forests managed by collectives and local farmers, help to investigate and handle land tenure conflicts, protect forest resources, and provide technical assistance to local farmers. Most forestry stations have low capacity and are poorly maintained because of funding shortages.

2.3.2 Forest land tenure
Before 1949, most forest lands belonged to individuals and clans. After the People’s Republic of China was established, tenure was changed several times. Under the land reform campaign from 1951 to 1953, most forest lands were assigned to farm households. In 1954, the Government regrouped forest lands into cooperative communes for joint management and then into larger people’s communes in 1958. The Government subsequently retransferred forest lands managed by people’s communes into smaller cooperative communes to prevent illegal logging and degradation and stabilise production. Since the 1960s, county and township governments combined and transferred forest lands of cooperative communes into collective forest farms.

From 1981 to 1982, Guangdong implemented the Central Government’s “Three-Fix” forestry policy initiating institutional reform and stabilising use rights to forests and mountains in order to protect and better manage these lands. Much

\textsuperscript{11} Afforestation includes forest establishment through planting trees, aerial seeding or “mountain closure” on barren mountains, barren sandy land, sparse forests, burnt-over and logged-over forest areas, and some shrublands and grasslands. It also includes planting trees along roads and rivers, around houses and villages and as shelterbelts in farms. The term “afforestation” as used in China includes regreening recently deforested areas.
of the collective forest land was allocated to local households to develop, manage and use the forest resources for 30 years (Liu 2001). The farmers could plant trees for fruits and other non-wood products but were not allowed to convert the land to non-forest use. Continuing land reforms allowed farmers and collectives to transfer, lease or otherwise contract out their timber, economic and fuelwood forests and forest lands; or jointly manage them in partnership with other agencies. In 1995, collectives managed 92.4 percent of Guangdong’s forest lands, much of which was contracted out to local farm households (GCEB 1998). The remaining 7.6 percent was in state forest farms owned by the local district city, city or county forestry bureaus.

Forest lands were severely deforested and degraded following each policy change up to the mid-1980s, after which tenure rights were continuously strengthened. However, tenure conflicts persisted till recently over boundaries allocated to households and over land abandoned by households migrating to urban areas. In 2000, the Guangdong Government recertified forest and land tenure, clarifying the boundaries and reflecting the realities on the ground. This recertification aimed to reduce conflict, protect the landholders’ legal rights and interests, and promote investment in rehabilitation (Deng 2002). Household and collective tenure were made permanent if the tenure holders fulfilled their contracted responsibilities (GFEB 2002). Currently, most forests in Guangdong are managed by individual households or other agencies and persons contracted by them, and tenure rights are relatively secure.

### 3. Methods

A review of government reports and other literature was used to trace the history and driving forces behind forest degradation and rehabilitation in Guangdong and to identify and characterise the major rehabilitation initiatives. Since the 1950s, there have been 10 major rehabilitation initiatives or types of initiatives in Guangdong (Table 2). Case studies from eight distinct initiatives provided further information on implementation activities and outcomes on the ground. Twenty two cases were investigated: roughly three sample counties (for province-wide projects), cities (for city projects) or instances (for smaller initiatives) in each of the eight initiatives (Figure 3). See Annex 1 for a list of the case study sites. Hereafter, initiatives are referred to by their abbreviated names in Table 2.

A questionnaire was developed to obtain information on the general characteristics of the 22 cases, the site conditions, implementation activities, institutional

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12 Collectives or farmers lease out their forest land for fixed annual payments to the private sector and other agencies for 30-50 years.
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Table 2. Major types of rehabilitation initiatives in Guangdong since the 1950s and number of cases surveyed in each type. Source: Summarised from Sections 4 and 5.

<table>
<thead>
<tr>
<th>Dates</th>
<th>Abbreviated names</th>
<th>Initiatives</th>
<th>Number</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Since 1950s</td>
<td>State Forest Farm</td>
<td>State forest farms (independent operation + part of larger national/ provincial projects since the 1980s)</td>
<td>233 farms (by 1987)</td>
<td>1 (of 2 large farms)13</td>
</tr>
<tr>
<td>From 1960s</td>
<td></td>
<td>Collective forest farms (independent operation + part of larger national/ provincial/ city projects since 1980s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From 1960s, increased from 1980s</td>
<td>Joint Afforestation</td>
<td>Joint afforestation initiatives</td>
<td>2 cases but also part of all other initiatives below</td>
<td></td>
</tr>
<tr>
<td>From 1980s</td>
<td></td>
<td>Farmers/households (independent operation + part of larger national/ provincial/ city projects)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985-95</td>
<td>Greening Guangdong</td>
<td>Rehabilitating degraded forest land in five years &amp; greening Guangdong in 10 years (Provincial project)</td>
<td>1 project</td>
<td>3 counties</td>
</tr>
<tr>
<td>From 1980s, but increased since 1990s</td>
<td>Private company</td>
<td>Private enterprise afforestation initiatives</td>
<td>540,000 entities</td>
<td>3 cases</td>
</tr>
<tr>
<td>From 1980s, promoted actively since 1999</td>
<td>Private individual</td>
<td>Private individual afforestation initiatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990-96</td>
<td>National Afforestation</td>
<td>National Afforestation Project aided by a World Bank loan</td>
<td>1 project</td>
<td>3 counties</td>
</tr>
<tr>
<td>1991-2010</td>
<td>Coastal</td>
<td>Coastal protective forest system development project (National project)</td>
<td>1 project</td>
<td>3 counties</td>
</tr>
<tr>
<td>From 1990s, increased recently</td>
<td>City landscape</td>
<td>Forest landscape rehabilitation projects by local city &amp; county forestry bureaus</td>
<td>Many cities</td>
<td>4 main cities with landscape projects</td>
</tr>
</tbody>
</table>

Arrangements, and results. Data were gathered on technical, socio-economic, financial and institutional parameters. Project documents or other literature available in 10 cases and interviews with the project managers were used to fill out the questionnaires. People interviewed included directors and deputy directors of 13 There are two big provincial state forest farms plus other much smaller state forest farms owned by the district city, city and county forestry bureaus.
Figure 3. Forest rehabilitation study sample locations in Guangdong Province. The county was the sample unit for the larger National Afforestation, Greening Guangdong and Coastal projects. The city was the sample unit for city landscape projects. Individual cases were the sample units for the remaining four initiatives.
county or city forestry bureaus in the National Afforestation, Coastal, Greening Guangdong and City landscape cases; the deputy director of the state forest farm; senior executives of the private companies; individual investors; and leaders of the town forestry station or village committee in the Joint Afforestation cases.

We reviewed the outcomes and influencing factors within and across the different initiatives and extracted lessons for enhancing the success and sustainability of forest rehabilitation efforts in Guangdong and elsewhere. Rather than talking about absolute unqualified success or failure, this study looked across project types, separated out the different outcomes and explored different factors that contributed to them.

Assessment of outcomes is based on independent project reviews found in the literature (supplemented by government reports) and observations of the people implementing the specific cases and are indicated so. The coastal project is an exception where information comes mainly from a government project report besides case study observations. Further ground-level analysis would be needed to verify environmental outcomes. Also community perspectives may vary from those of the project managers’, and community surveys would be required to clearly establish the socio-economic impacts of the different initiatives.

4. Historical overview of forest land degradation and rehabilitation

Before 1949, forestry development in Guangdong was poor due to persistent war, political corruption and economic depression. Forests in accessible areas were all logged. Few original forests were preserved. There were some limited rehabilitation efforts in this period, insignificant in comparison with the scale of deforestation and degradation. The deforestation directly led to severe wood and fuelwood shortages, and biodiversity depletion. In coastal regions, the destruction of forests left communities exposed to storms and tides. Wind-blown sand buried farmland and destroyed houses (Chen and Gan 1996). Deforestation in mountain areas is also blamed for frequent heavy flooding and droughts. However, links between landscapes and water are complex and all downstream water problems cannot be attributed simplistically to upstream logging (van Noordwijk 2006). FAO and CIFOR (2005) report that forests can affect peak river flows and floods on a small scale, but their effects on major flood events over a large basin are relatively small.
The following is an historical analysis of the changing patterns and driving forces of forest degradation and rehabilitation in different phases since 1949 (see Annex 2 for list of policies affecting degradation and forest rehabilitation in Guangdong).

### 4.1 The first phase (1950-1959)

After the People’s Republic of China was established, large-scale afforestation activities were mainly conducted by the Cooperative Communes and the People’s Communes with little attention paid to technical and management aspects. In 1950, the Guangdong Agricultural and Forestry Ministry issued forestry guidelines for the county level aimed at protecting the forest, logging sustainably and mobilising the public to undertake large-scale afforestation. In that year, 9653.3 ha were afforested. Since 1950, state forest farms have gradually been established to rehabilitate the barren hills, establish timber plantations, and guide local people in afforestation efforts.

In 1958, the Central Government issued a call for large-scale afforestation throughout the country by mobilising the public, developing existing state forest farms, and increasing and establishing new forest farms for afforesting state- and collective-owned barren hills. This led to widespread afforestation activities in the province with 286,667 ha planted. From 1958 to 1959, 130,000 ha were afforested in state forest farms in Guangdong.

More than 70 percent of the land area in 47 counties\(^{14}\) was mountainous or hilly. Afforestation through tree planting was difficult in these areas because of poor road access and transport, so aerial seeding was tried. First successful trials on 667 ha in Wuchuan county in Guangdong in 1956 (Deng 1999) led to nationwide adoption of aerial seeding.

However, large areas were simultaneously degraded in the 1950s-60s with over-logging and illegal logging to meet the increasing demand for timber to reconstruct the country (Chen and Hu 2000). There was a major degradation episode from 1958-1961 to meet the timber and fuelwood needs of “The Great Leap Forward” and “Iron-and–Steel Making” campaigns.

### 4.2 The second phase (1960-1979)

In this period, afforestation efforts were mainly focused on rapidly establishing high-yielding timber plantations and forest farms on degraded forest lands. In 1962, forest farms were granted cash and grain for timber plantation establishment (i.e. 10 RMB subsidy and 2.5 kg grain quota per mu\(^{15}\)). In 1965, the Guangdong Government implemented a revised forestry policy “closely combining planting,  

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14 Administrative divisions and number of counties in the province different at that time.
15 Fifteen mu = One ha
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tending and management” with the main focus on afforestation in collectives, supplemented by afforestation on state-owned and joint forest farms. Joint forest farms here were cooperative efforts between state forest farms and collectives sharing land, techniques, management and benefits. There was a significant increase in the quantity and quality of afforestation efforts. The area afforested increased from 53,900 ha in 1961 to 560,000 ha in 1966. From 1962 to 1979, 5.37 million ha were planted. From 1963-79, 2.18 million ha was aerially seeded with mainly Masson pine and some Acacia confusa (GCEB 1998), and 1.138 million ha were effectively afforested as a result.

Thus from 1962-79, a total of 6.51 million ha was afforested but in general most of the plantations did not survive in the long term. Most of the planting was done on degraded forest land (with a small proportion on areas following timber harvesting), yet degraded forest land decreased by only 2.13 million ha between 1957 and 1978.

There was a major degradation episode from 1966-76 “The Great Cultural Revolution” when forestry administration was in chaos. There was also heavy fuelwood collection from 1970 to 1985 due to high population growth without other fuels that could substitute such as liquefied petroleum gas (LPG). However, due to afforestation efforts occurring simultaneously, forest cover increased from 20.2 percent of land area in 1957 to 30.2 percent by 1978 (Figure 4). But the

**Figure 4.** Trends in degraded forest land, immature forest area, and forest cover in Guangdong.
Note: The definition of forest was changed from 30 percent to 20 percent tree canopy cover in 1996 and thus the rise in forest cover from thereon is slightly inflated.
afforestation efforts did not effectively control environmental deterioration. The area affected by surface water runoff and soil erosion expanded at the rate of 140 km² per year (Deng 1999). This is likely because the afforestation techniques and species choices did not adequately consider soil and water conservation needs in some areas, pressure on forest lands for fuel (wood, litter and ground vegetation) remained high, and areas damaged by fire and logging were not regenerated well. FAO and CIFOR (2005) also suggest that the kind of revegetation and management practices undertaken could have a beneficial or detrimental effect on local soil and water properties.

### 4.3 The third phase (1980-1989)

Forest land tenure rights were granted to households from 1981-83 to improve the rehabilitation success rate and improve the management of forest lands. The main dependence on collectives and state forest farms for afforestation and forestry production was altered. These reforms however led the new tenure holders – the farmers – to rapidly harvest the timber at first given their uncertainties over the policy’s long-term stability. There was thus a brief increase in degraded forest lands and a decrease in forest cover following the 1981-82 tenure reforms (Figure 4).

China opened up its economy to the outside world in this period and implemented wide-ranging reforms resulting in rapid economic development in Guangdong. As timber markets were opened up and prices rose, the economic returns from tree-growing rose along with public interest in rehabilitating degraded forest lands. Forest and forest land tenure reform allowed transfer of use rights and diversified afforestation systems and institutional arrangements emerged, such as joint management, stock-sharing, and contract and lease management. In the past, much of the rehabilitation was funded through national loans at low interest rates and government agencies needed to repay this capital. The diversified arrangements helped to provide alternative financing and management mechanisms. They also significantly enhanced afforestation quality, allowing the different stakeholders to benefit.

There were two main issues of concern linked to forestry at this time. One related to the low volume and poor quality of forest resources and environmental services. In 1983, degraded forest lands covered 5.18 million ha. Soil erosion affecting up to 1.2 million ha in 1985 was linked to a deteriorating forest environment (Lu 2002). Resulting sedimentation in rivers reduced navigable routes by half compared to that in the 1950s. Frequent flooding was again attributed to degraded vegetation conditions.

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16 The Government and others contract landholders or other agencies to afforest and manage the areas in return for payments or seedlings and other inputs.
The other concern was that economic development in the mountainous areas lagged behind that in the coastal and plain areas. In 1984, the 47 mountainous counties occupied half the land area and contained a third of the provincial population, but only had one-sixth of Guangdong’s total Gross Domestic Product. Per capita income was only 290 RMB (MIST 1991). Forests are the major resources available in these mountainous areas. Therefore, rehabilitating the degraded vegetation and soils and developing the forest resources was surmised to be the key to alleviating poverty and enhancing economic development.

Following a Central Government edict to green the country, the Guangdong government launched a massive project in 1985 to “rehabilitate all degraded forest land in five years and green Guangdong in 10 years”. By the end of 1993, 3.33 million ha of degraded forest lands were covered with trees. From 1983-1995, forest cover increased overall from 4.9 to 10 million ha, or 27.2 percent to 55.9 percent of the land area (Figure 4) (GCEB 1998, GFB 1987-2003). Only 784,500 ha of degraded land in remote and inaccessible areas were left. From 1985-95, standing timber volume rose from 170 million m$^3$ to 291 million m$^3$, the mean annual growth increment rose from 10.64 million m$^3$ to 16.8 million m$^3$ and mean annual consumption rose from 8.1 million m$^3$ to 14.77 million m$^3$ (Xu 1999). However, the degraded area rose to 1.35 million ha in 1995-96 after this initiative ended. Some major reasons for forest land degradation after the provincial program (GFEB 2001) include lack of species-site matching, forest pests and diseases, fires and lack of long-term management.

4.4 The fourth phase (1990-present)

The focal point gradually shifted from rehabilitating degraded forest land to protecting and enhancing the established forests to meet industrial and environmental needs. The Guangdong Government decided in 1994 “to strengthen the afforestation achievements and modernise forestry practices” (Li and Deng 2001). In the same year, the Guangdong Province Forest Protection Regulation was issued which stipulated that forests be classified as “commercial” or “ecological” and managed accordingly. Logging was banned in ecological forests. Guangdong became the first province in China to classify its forests in this manner and manage them accordingly (GFEB 2002). It targeted establishing 3.4 million ha of ecological forests, equalling 30-33 percent of the total forest land. The “Development and Planning Compendium of Ecological Forests” identifies the categories and range of ecological forests. Ecological forests consist mainly of water source protection forests around the four major rivers and watersheds; water and soil conservation forests; coastal protection forests; farmland protection forests;
forests along roads, railways and reservoirs; nature reserves; forest parks; and landscape forests. Suggested rehabilitation methods for ecological forests include planting, replanting and intercropping, and “mountain closure” to allow natural regeneration. In 1998, the provincial government called for both speeding up forest industry development and building high-quality ecological forests in Guangdong by adjusting the tree species, forest structure and type (Chen and Peng 2000).

In 1999, a regulation for “Ecological Forest Management and Economic Compensation Measures” was formally introduced. It was decided that funding would be allocated from the provincial budget after failing to secure finance from other sources. Such economic compensation measures have already been used to rehabilitate and protect ecological forests in Guangdong. Up to 2001, 536 million RMB from the provincial budget was paid out in economic compensation (GFEB 2002). In 2002, 249 million RMB was paid out to 25.89 million people in Guangdong (Deng 2002). An early compensation level of 2.5 RMB/mu/year was increased to four RMB/mu/year (Qu 2002). Besides, local funding was added in where possible. For example, Guangzhou city raised the compensation rate for key water conservation forests to 12 RMB/mu/year. With Guangdong government’s call to accelerate the development of mountainous areas in 2002, the provincial compensation rate was increased to eight RMB/mu/year from 2003-07 (Deng 2002, www.szagri.gov.cn —Shenzhen agricultural information web).

In the late 1990s, the Guangdong Forestry Bureau proposed to establish 0.67 million ha (10 million mu) of fast-growing and high-yielding plantations by 2015 to meet the resource needs of the rapidly developing forest industry. Means of investment and timber plantation management were changed. The Government vigorously promoted and facilitated private sector involvement and foreign investment in rehabilitation and development of commercial plantations through a series of preferential policies and regulations. Diverse management options and institutional arrangements among multiple stakeholders are now being tried for commercial forests and it is difficult to find degraded forest land for lease in preferred districts.

From the 1990s to present, a wide range of rehabilitation initiatives were implemented in Guangdong, including the “National Afforestation Project” aided by a World Bank loan (1990-96); the “National coastal protective forest system development project” (1991-2010); forest landscape rehabilitation projects initiated by local city and county forestry bureaus (from the 1990s); the “Plan for

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20 “Mountain closure” means closing public access to degraded forests and forest land with natural regeneration capacity to enable natural forest recovery.

21 The term “Economic Compensation measures or payments” for ecological forests used in Guangdong is equivalent to the term “Payment for Environmental (or Ecosystem) Services” used elsewhere.
rehabilitating degraded forest land within three years” (2002-2004); the Ecological forest system development project” (2000-2005); and afforestation projects initiated by private individuals, private (local and foreign) enterprises, collective and state forest farms. These projects were all promoted and supported by a series of national, provincial, and local policies and regulations and are closely aligned with the recent commercial and ecological forest land classification (see Annex 2 for details on policies).

Up to 1998, Guangdong Province had established 833,000 ha of timber and resin plantations; 333,000 ha of fast-growing Eucalyptus for pulpwood; 933,000 ha of economic plantations; 3400 km of coastal protective forest belts and 208,000 ha of protective farmland forest-networks (Deng 1999). Forestry output was double that in 1978 (Liang 2000). In 2003, total forest cover stood at 10.3 million ha, or 57.3 percent of the land area and degraded forest land at 1.19 million ha (Figure 4).

5. Description of major rehabilitation initiatives

5.1 Rehabilitating degraded forest land in five years and greening Guangdong in 10 years

In 1984, the Central Government issued an edict that the Communist party committees, governments and leaders at all levels should focus on effectively greening the country while also paying attention to the quality of afforestation. They would be evaluated on the basis of their performance within their prefectures. Given the condition of Guangdong’s forest lands and the Central Government’s call for action, Guangdong’s Government and Communist Party Committee decided in December 1985 to “rehabilitate all degraded forest land in five years and green Guangdong in 10 years”. Program targets were formulated as follows:

1) The greening rate of forest land should be over 80 percent
2) Along provincial roads, local roads and railway tracks, over 95, 85 and 95 percent respectively of the total length suitable for greening should be covered with trees (and grass or flowers where trees cannot be planted)
3) In coastal protective shelterbelts and farmland protective forest networks of relevant cities and counties, over 85 percent of the total length and area should be greened with trees
4) The greening rate in counties and townships should be over 30 percent.

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22 Increasing forest canopy cover to a certain percentage or above, and is expected to result from afforestation.
23 Greening rate refers to the ratio of stocked forest plus shrub to forest land
The project was a top-down one with the provincial government assigning the task of funding and implementing the project as targeted to local governments and forestry agencies. Local governments contracted the collectives, local farmers and private individuals to afforest and manage their own or leased lands, while providing technical assistance and some funding for implementation. Local and provincial forestry bureaus and the Guangdong Forest Survey and Design Institute monitored and evaluated the progress during the project period. Local community participation in decision making was low. According to the project managers in the three county cases assessed, communities had low to very low influence and control over decision-making and resources. In two county cases, managers stated that indigenous knowledge and socio-cultural practices were taken into account by planting species that people were familiar with or favoured, such as pines (Pinus) and fruit trees. All three cases had land tenure disputes. Disputes were fully resolved in two cases through negotiation and agreement.

Planting was the dominant method of afforestation with aerial seeding as a supplement. Two of the three cases also had some natural regeneration. Regreening large areas rapidly was the major objective and there were no specifications on species choice as long as the area was greened. Landholders chose available exotic and native fast-growing species that could survive on the barren lands. Species-site matching was not effectively considered. Common species planted were pines (such as Masson pine and slash pine - Pinus elliottii) and Eucalyptus urophylla for timber and pulpwood. However, each case study site had planted three or more species.
that included Masson pine, slash pine, Chinese fir, *Eucalyptus urophylla*, *Taxodium distichum*, *Acacia* sp. and other broadleaved trees for timber, fuelwood and fruits (see Annex 3 for tree species planted on case study sites). The planned harvest technique was mostly clearfelling. *Eucalyptus urophylla* and Chinese fir would be coppiced in subsequent rotations while other species would be replanted.

A series of measures were adopted by the provincial government to ensure the project successfully afforested the targeted areas as per schedule (GCEB 1998, Liang 2000). The main measures were as follows:

1. The provincial government held sixteen successive conferences to raise the awareness and commitment of the Communist party and citizens of Guangdong about the rehabilitation tasks. The provincial government also issued three subsequent directives to speed up the afforestation, complete the tasks on schedule and modernise forestry practices.

2. Leaders in charge at all levels were to establish demonstration sites for rehabilitating barren land to gain experience and to drive project implementation in their prefectures. From 1986-93, 12,500 demonstration sites were established, with the area planted to timber and fruit trees totalling 733,000 ha.

3. The province raised funds from many different channels given the large areas to be rehabilitated and the lack of funds particularly in poor mountain counties. A total of 25,000 million RMB was raised from seven channels: state aid, bank loans, provincial subsidies, city or county financial arrangements, funds from specific government departments, township investment and local people’s self investment. Also one billion man-days of labour were used in the initiative.

4. The provincial government established a targeted management and responsibility system for afforesting for leaders of cities, counties, districts and townships in their prefectures and departments. For example: the transport and communication department would be in charge of afforesting local roads; the road administration department in charge of afforesting national and provincial roads; the urban construction departments in charge of afforesting built zones; and all agencies, schools, factories and mining departments in charge of afforesting their own campuses. Further in 1988, the provincial government issued a scheme to evaluate achievement of targets and assign rewards and penalties. From 1988 to 1993, they conducted eight inspections and the media circulated the results widely. The Government rewarded about 29 directors and Communist Party Committee leaders from 22 counties with increased salaries and commended 157 cities or counties, while they criticised 39 counties and issued a warning card to one city. The system of targeted management and responsibility, rewards and penalties helped to accelerate afforestation.
5. The Government promoted the use of LPG and other fuels to replace and reduce charcoal and fuelwood use. Fuelwood consumption at 7.3 million m$^3$ in 1985 was very high and a major cause of forest degradation. According to 1991 statistics, five million m$^3$ of wood was saved from burning in brickyards, tile and boiler plants. But there was no other information on the outcomes of this effort such as trends in fuelwood use by households.

6. In some areas, seedling survival was low and forest cover did not increase despite annual planting. Subsequently, based on YangJiang city’s successful experience, the Greening administration departments across the province signed formal contracts with the executors who submitted afforestation plans, designs and operational charts. Clear responsibilities (including quality criteria and area to be afforested), rights and benefits were specified in the contracts.

7. Increased and diversified income from plantations was thought to be the key to motivating poor farmers in the mountain areas to plant trees on degraded forest lands. According to the guideline to develop short-term benefits and a diversified economy at the local scale, farm households were encouraged to develop small fruit orchards, bamboo, tea and herb gardens for short-term economic benefits, and in return to accelerate and promote forest restoration for long-term timber and environmental benefits. By 1991, 467,000 ha of fruit gardens had been established on degraded forest land.

By the end of 1993, almost all cities and counties had reached their scheduled afforestation targets and 3.33 million ha of degraded forest lands were covered with trees. Cost per ha planted was moderate at 7507 RMB plus free labour (see Table 3 for cost comparisons). Short-term survival of planted seedlings was very good; over 90 percent. However, in the long-term, 433,000 ha or 13 percent of the afforested areas were degraded (Liang 2000, case studies) due to the following reasons:

1. Once the afforestation tasks were fulfilled and the project was completed, the leaders tended to relax monitoring and control over the areas.
2. Species planted were not well-suited to the sites or climate in these areas; leading to poor growth, frost damage, fire, and pest and disease problems. Most of the degraded sites had exotic species (such as Eucalyptus or Acacia), or had single species planted over large areas and on unsuitable sites as well.
3. Little attention and funds were provided for long-term management after planting targets were met, and for restoration after logging or fire damage.
4. Planting and survival in remote areas were difficult to inspect, particularly without the use of remote sensing and Geographic Information System (GIS) methods.
5. Some landholders did not follow the sustainable logging instructions provided on issue of harvesting licences.
6. High timber taxes and fees and low market prices affected the landholders’ motivation.

Specific environmental benefits were not measured and success was assessed only in terms of achieving planting targets. Two county cases also aimed to conserve soil and water, but used slash and burn practices of site preparation. According to Yang et al. (2005), slash and burn practices lead to substantial removal of nutrients, degradation of soil structure, soil exposure and increased susceptibility to erosion. However, one of the two cases established terraces and rock walls to conserve soil and water. In the third case, the manager believed that the growing ground vegetation and broadleaf trees planted would help conserve the soil and water.

With regard to socio-economic impacts, average income had increased in all three cases due to overall economic development and not specifically due to the forestry sector. Two of the three county cases were highly developed with good roads, transport, market access, and health and education facilities through government programs in the recent past. Pressure on the land for fuelwood, grazing and other subsistence activities had been reduced because of forest patrols and other protection measures, and LPG use substituting fuelwood near more developed areas. However, fire continued despite fire protection measures such as firebreaks, fire towers and fire-fighting teams. Local people’s dependence on forest products for income increased or remained high in all three cases due to the production of mainly fruits and other non-timber products from the rehabilitated areas. The sites had mature timber stocks, yet little timber had been harvested to date. There was no explicit marketing strategy.

There were no long-term management, monitoring and evaluation, and financial reinvestment plans after the project ended. With respect to long-term financial outcomes, managers of one case state that the heavy timber taxes and fees will lead to low returns even though market prospects were good. Also lack of higher-level funding support led to the local forestry bureau becoming heavily indebted. In another case, declining or low timber prices provide doubtful returns. The third case indicated good market prospects but had not yet harvested the timber. Besides, problems of slow growth, damage to trees and low yields on 13 percent of the overall project area makes it difficult to generate sufficient returns to pay back the loans.

5.2 Guangdong Province “National Afforestation Project” funded by a World Bank loan

The National Afforestation Project, partly funded by a World Bank loan was implemented in Guangdong from 1990-96 in 27 counties (NAPOGP 1998).
This is another top-down project that was initiated at the national level and implemented by local governments, state and collective forest farms and households. Implementation contracts or agreements provided well-defined responsibilities, rights and benefits to contracting local farmers and collective, state or jointly-managed forest farms. Local community participation in decision making was low as confirmed by the project managers of the three county cases, though there was some negotiation over benefit-sharing in the jointly-managed forest farm case. The provincial and local forestry bureaus and governments conducted education and awareness building campaigns for forestry farmers and local communities through television and public broadcasts, distribution of propaganda materials, and meetings.

The contracted parties would afforest and manage the areas through low-interest loans, harvest and earn income from the timber and other products, and pay back the loans. The forests established by jointly-managed forest farms accounted for 75 percent of the total project area. One case study illustrates the possible institutional arrangements in a jointly-managed forest farm: The Wengyuan forestry bureau invests in, plants, manages and logs the areas. The local farmers monitor and protect the areas. The local township government provides some assistance. Ten percent of the income is to be used to pay back the World Bank loan; 16 percent reinvested; and four percent for management fees, wages, and taxes. Net profits from timber production were to be shared between the forestry bureau, the forest farmers and the township government in the ratio 57:40:3.

The main objective of the National Afforestation Project was to establish large-scale and high quality, fast-growing and high-yielding timber plantations for building material, pulp, paper and plywood, while simultaneously rehabilitating degraded forest land and low-yielding forests. After planting available degraded forest land, poor disease-impacted pine and other plantations were cut and replanted. These low-yielding plantations arose from past rehabilitation activities, where large areas were planted to pure pine, Chinese fir, *Eucalyptus* and *Acacia* with uniform stand structures and low resistance to pests and other disturbances. Fire, frost, pests, diseases and human pressures left many stands severely degraded with poor form, growth and yield, or resulted in further degeneration into scrub, grass or barren land.

The main species planted in this project were again Chinese fir and Masson pine, and short-rotation *Paraserianthes falcataria* and *Eucalyptus* for pulp and plywood. Number of species planted in each case was low, commonly just two. Natural vegetation was allowed to regenerate in the plantation understorey in two cases. Sites were prepared using slash and burn techniques and terracing for soil and water conservation in the three cases. The planned harvest technique was
clearfelling. *Eucalyptus urophylla* and *Paraserianthes falcataria* would be coppiced in subsequent rotations while Chinese fir and Masson pine would be replanted. Investment totalled 333.239 million RMB with 60 percent through a World Bank loan, 12 percent from the province, 20 percent from the counties and eight percent from self-funding by forest farmers or management entities. Cost per ha afforested was low at 2611 RMB.

Specific regulations and mechanisms were introduced to ensure seed, seedling and afforestation quality. Inspection arrangements were formulated to check and certify each step of the project, such as land preparation, tending and planting. This included self-inspection by project executive units, comprehensive inspection by the county project office and random inspection by the Guangdong Forest Survey and Design Institute. Forestry research findings were extended and applied to ensure afforestation quality. Seven extension groups provided technical assistance and training and conducted research on high quality seedling production, fertilisation, land preparation, planting density control and superior provenances and clones.

The project afforested 127,600 ha, much more than the targeted 85,000 ha (NAPOGP 1998). First, available degraded forest land was planted (equalling 50 percent of the area afforested) and then low-yielding stands were cut and replanted. Average short-term seedling survival was good at 80-95 percent on the three cases. Good growth was recorded in 23,792 ha of high-yielding and fast-growing *Eucalyptus urophylla* plantations of superior provenance (Wu 1999, Cheng 1998). In 1995, a final evaluation indicated that the area in first grade plantations was 85 percent, 12 percent higher than the national project average. The area in second and third grade plantations was 12.9 percent and 2.32 percent respectively, nine percent and three percent lower than the national average (Wu and He 1997).

Most plantations were doing well but the second and third grade plantations covering 27 percent of the area had some problems (Wu and He 1997) which were reflected in the case studies as well:

1. Species planted did not match site conditions, resulting in low survival and poor growth.
2. Uneven stand growth due to poorer quality of some seedlings.
3. Frost damage to *Eucalyptus* and *Paraserianthes falcataria*.
4. Fire and pest problems on some sites. Pines were particularly affected by pests.
5. Attempts to plant large areas with a single species for aesthetics and for operational efficiency. However, this tended to lead to site matching problems and increased vulnerability to fire, pests and diseases.
Two county cases were highly developed with good roads, transport, market access, and health and education facilities through government programs in the recent past. Transport and health facilities were still low on the third site. Local people depended on the products (resin, fruits, timber and fuelwood) from the rehabilitated areas for both income and subsistence to a moderate extent in all three cases. External pressure on the land for grazing and fuelwood had been reduced with forest patrols and other protection measures. There has only been a little timber harvesting on the sites till present because the plantations were still young. In one case, thinning was not done because of high thinning costs, inadequate funds, and problems getting logging licenses. There was no explicit marketing strategy in all cases. Average income had risen in the three counties due to overall economic development and not specifically due to the forestry sector. The project was oriented towards timber production and regreening and other environmental outcomes were not assessed.

In general funding availability enabled planting targets to be met. However, the project lacked focus on and funds for long-term management (Wu and He 1997). This was true for two of our cases where individual farms or farmers were contracted, but different in the joint management case which had long-term management and financial reinvestment plans. Overall, problems of slow growth, tree damage and low yields on 27 percent of the area afforested makes it difficult to generate sufficient returns to pay back the loans. In one case, the contractor was seriously indebted and unable to repay the loan because of poor tree growth and yield, low Chinese fir prices, heavy timber taxes and fees, and loan payback time being in advance of harvest time. However, in the joint management case, the project managers expect that the loan could be paid back due to good management, anticipated high yields and good market prospects despite poor tree growth in some areas.

5.3 Private sector rehabilitation initiatives

Most counties in Guangdong, particularly the mountainous or undeveloped regions, have limited funding for forestry, comprising less than one percent of the government budgets. Promoting private sector investment is a useful way to obtain funds to rehabilitate the remaining degraded forest land and develop commercial forestry.

Private sector efforts had already started on a small-scale in the 1980s as timber markets were liberalised and prices and economic returns increased. Institutional reform contracting land to households, and allowing forest farms and households to subcontract or lease the land to other entities and agencies facilitated this process. But private sector efforts have increased in importance since the late 1990s with supportive policies, economic development and rising timber demand.
Different types of institutional arrangements characterise private sector efforts. In this volume, we focus mainly on the following:

- Farmers afforesting and managing their allocated forest lands.
- Private individuals and foreign and domestic companies afforesting, managing, logging and earning income from forest land leased or subcontracted from collectives/farmers for fixed annual payments. Lease periods tend to be 30 years for private individuals and 50 years for companies.
- Farm households contributing land, and companies contributing funds and establishing, managing and harvesting the timber plantations in a stock-sharing system. Costs and revenue from timber harvesting and sale would generally be shared in the ratio 70:30, company to farm households. Economic plantations are often included as an additional incentive for farmers. Up to 2001, 12,200 households were involved in stock-sharing systems with companies, leading to a 1225 RMB/year increase in household income (Deng 2003).

Many additional institutional arrangements, including mixed public-private sector arrangements, exist in practice. In China, the term “non-public system” is commonly used instead of private sector. “Non-public system” may include afforestation and management of forest land by any individuals or agencies (including state and collective institutions) for income with their own investment through lease, tenure transfer, contract, stock-sharing or joint management mode.

The case studies suggest that local communities had medium-high participation in decision-making on site identification, rights, authority, and benefit and cost sharing in private sector initiatives. Clear legal contracts were signed between the stakeholders with cost and benefit sharing arrangements, rights and responsibilities spelt out.

The Government’s main measures to promote private sector initiatives were as follows:

1. Established favourable policies
   From 1997 onwards, governments at different levels issued numerous regulations and policy incentives promoting private sector (both domestic and foreign) involvement in commercial forestry. The regulation “Administrative measures for afforestation through foreign business investment in Guangdong” (Wang and Hu 2002, Chen and Peng 2002) issued in 1997 provided for longer-duration forest land tenure, reduced forest tending and maintenance fees, and priority rights for obtaining logging quotas and licences. Afforestation implemented in mountainous areas would receive further special favourable policies. These policies attracted many foreign investors from Thailand, Singapore, Malaysia, Indonesia, Canada, and Taiwan and increased the rate of rehabilitation of degraded forest land.
and establishment of fast-growing and high-yielding forests in Guangdong. As compared to other provinces in China, Guangdong attracted the most foreign capital investment in afforestation.

Private individuals and civil society were further encouraged to develop commercial plantations and actively invest in afforestation with the “Resolution to develop individual and private economy in Guangdong” in 1999. Also, the “Resolution to strengthen afforestation achievements, and enhance the economic, social, and ecological benefits of forestry” issued in 2000 by the Guangdong government stipulated that:

- Private forest farms holding more than 1667 ha of forest land would enjoy the same favourable privileges as state forest farms in terms of logging quotas and reduced timber taxes after approval by the Guangdong forestry and financial authorities.
- Individuals afforesting over 66.67 ha in a single instance; or state, collective and private enterprises afforesting over 666.67 ha in a single instance could enjoy the same favourable privileges as foreign investors (Deng 2003).

Additionally, based on local conditions, some cities formulated more favourable policies simplifying forest land transfer and lease, providing credit facilities, and reducing taxation. All these policies speeded up the development of private commercial forestry.

2. Established demonstration forests
Provincial, city and county forestry authorities all paid attention to establishing fast-growing and high-yielding forest plantations. By the end of 2001, forestry authorities had set up 415 demonstration sites covering 90,000 ha in Guangdong to further encourage private investment in commercial forestry.

3. Supported lead enterprises
The management model of lead private enterprise plus farm households for establishing timber plantations was promoted in 2001 to encourage forest farmers to plant timber and fruit trees to alleviate poverty, maintain afforestation achievements and ensure sustainable rehabilitation in mountainous areas (Deng 2003). Ten (domestic and foreign) forestry enterprises adopted the stock-sharing institutional arrangement whereby the company and farm households came together to rehabilitate degraded forest lands and develop timber and economic plantations. The companies included Weihua Ltd. in Meizhou city, Jiayao Ltd. (part of Sino-forest Corporation Hong Kong) in Gaoyao city, Lianxing Ltd. in Xinyi county, Shenhua Ltd. in Jiaoling county and Maoyuan Ltd. in Qingxin county.
4. Established a technical service system

The city and county forestry authorities were to offer private investors support in afforestation planning, and to provide technical guidance through each step of the process such as seedling production, land preparation and planting. Training in forestry techniques was also provided to accelerate the development of private individual and enterprise efforts and improve their chances of success. Some private companies also availed of the technical services of forest research institutes while the bigger corporations had their own research and development departments.

According to incomplete statistical data, by 2003, 540,000 private entities had invested 2300 million RMB in afforestation in Guangdong (Deng, 2003) and established 1.04 million ha of fast-growing and high-yielding plantations. Cost per ha on average amounted to 2211 RMB. Much of the 2300 million RMB invested was foreign capital. By the end of 2001, 10 foreign enterprises had invested 1356 million RMB and planted 50,000 ha in Guangdong (Chen and Peng, 2002; Jiang, 2003), incurring a much higher average cost of 27,120 RMB per ha. The leading international companies were Sino-forest Corporation from Hong Kong and Asia Pulp and Paper Co. Local companies and private individual investors also play an important role and funding is often through low interest loans available for forestry. In our case studies, a private company planting teak invested 22,760/ha, two private individual initiatives incurred 8700-9600 RMB/ha and three other private sector cases incurred < 4000 RMB/ha, showing the wide range in investments made by this sector. Higher costs reflect higher inputs, more intensive management and post-planting maintenance, and spending on research and technology.

The private sector initiatives were mainly focused on exotic timber species, primarily for pulpwood. The private company case studies evaluated had two to five mixed short- and long-rotation species per site. Dominant species were Eucalyptus urophylla, Acacia mangium, Acacia crassicarpa, pines and some high-value teak. Private individual cases had fewer species, mainly short-rotation Eucalyptus urophylla with some longer-rotation teak, Paraserianthes falcatoria and Betula alnoides on one site. The company cases had fire-break forest belts that were planted with species like Schima superba or naturally regenerated. Natural regeneration was allowed in the understorey of two sites. Open land and degraded poor plantations were planted. Except for two company cases, others practised slash and burn techniques of land preparation. Cases on sloping land used terracing, hedgerows or rock walls for soil and water conservation. The planned harvest technique was clearcutting on all sites. Eucalyptus would be coppiced and the rest replanted in the second rotation.
Average short-term survival of plantings was over 90 percent in the six cases. Some pest damage occurred on at least three sites though this was not indicated as a serious problem. One company case had concerns that site productivity may degrade over time with continuous rotations of pure *Eucalyptus*. In another case, *Acacia mangium* planted was destroyed by extreme cold winds and there was fire damage too. It is relatively early to judge the long-term sustainability and production, socio-economic and environmental outcomes of these private sector efforts and information is scarce in the literature. Available knowledge from the literature and case studies is presented below.

In terms of production, Deng¹ (2003) reported that income from timber and forest products in the private forestry system totalled 7.6 billion RMB up to 2001. The private sector cases believed there were good market prospects for timber, woodchips and fuelwood and that the demand would increase with economic development. They had all done some market analyses and had some marketing strategy.

Local income increased in all cases with rapid economic development and not specifically due to the forestry sector. All case study sites were highly developed with good roads, transport, market access, and health and education facilities through government economic development. Disputes over benefit sharing (one private company), and land boundaries (in all six cases) were resolved through negotiation and agreement. Local people depended more on the forest lands for income now in all cases — obtaining rent from land leased to the private sector or a share of the timber profits in joint venture projects. Local pressures for fuelwood, grazing and other resources appear to have been reduced on three sites, while people were now using the wood available in two private individual and one private company case. Protection was minimal on these latter sites and there was high subsistence use. Developing good relations and short- and long-term local livelihood benefits through *economic plantations* were recommended for project sustainability.

Specific environmental benefits of these initiatives were not measured and success was assessed only in terms of achieving planting targets. In general, the private sector initiatives had low biodiversity potential, with mostly exotic and fast-growing species planted. However, private company sites had slightly higher diversity than private individual sites and included firebreaks of broadleaf species (Chokkalingam and Zhou 2006).

Private sector initiatives were implemented by parties with longer-term interest in the land, with leases ranging from 30-50 years. They had plans for continued management, accrual of benefits and reinvestment through the lease period.
Long-term returns on such investment and sustainability of these efforts remain to be seen. Heavy timber taxes and fees were identified as a constraining issue in two cases leading to low returns and an unfavourable environment for investing in trees.

5.4 Coastal protective forest system development project
The coastal region adjacent to the South China Sea is relatively well developed economically and covers 48.2 percent of the land area of Guangdong. It has a complicated land relief with interlaced mountains, hills, plateaus, plains and beaches (GAS 1991). Since 1949, the region has been active in establishing a shelterbelt against typhoons and sandstorms through large-scale afforestation along the long, 3041 km coastline.

Given the region’s importance for China’s economic development, the National Coastal Protective Forest System Development Project was initiated in 1991, to be implemented in two phases from 1991 to 2000, and 2001 to 2010. The project aimed to stabilise sand dunes and establish shelterbelt forests to protect agriculture, fisheries and salt fields from typhoons and sandstorms; safeguard life and property; and promote coastal tourism and further economic development (Chen and Gan 1996, Chen and Hu 2000). Guangdong is one of seven provinces implementing this project and the afforestation target was 450,000 ha. Project plans were to:
1) Rebuild, regenerate and modify the main skeleton of the coastal protective forest belt.
2) Rebuild and modify the hedges around agricultural fields.
3) Afforest the first range of mountains/hills adjacent to the coastline.
4) Protect and develop mangrove forests on the beaches.

The project was another top-down program, initiated at the national level but executed by local forestry bureaus as well as two state forest farms. The Guangdong Forestry Bureau in turn passed measures and regulations to support project implementation. Financial support from the state was low and funds had to be raised from different local sources. The actual investment was 1063.301 million RMB, with the state financing 3.4 percent; the province 2.4 percent; the cities, districts, townships and various departments providing 66.3 percent; and local farmers 27.8 percent as well as 48.752 million man-days of free labour (SMD 2000). Cost per ha afforested excluding the free labour was low at 1754 RMB.

Local forestry bureaus contracted special afforestation teams or the landholders (farmers, collectives, state forest farms) to rehabilitate and manage their own areas. The greening companies or professional afforestation teams selected through open bidding were responsible for land preparation, afforestation, tending, and quality
of the forest within the contract period. Tenure remained with the collectives or households who were to protect the area. The landholders who were contracted to afforest were provided seedlings, subsidies and loans. Local forestry bureaus were responsible for project management, technical guidance, supervision and funding. Township governments were responsible for solving land tenure conflicts and protecting the ecological forests. Coastal shelterbelts were to be protected as ecological forests and tenure-holders receive economic compensation on such sites. In commercial forest areas (hill sites), tenure-holders could grow and derive income from timber and economic plantations.

Joint management arrangements were adopted on some sites in this project as well. This is illustrated in one case study where the forestry bureau and local village entered into a 60-year agreement. In this case, the Yangxi Forestry Bureau would plant, manage and log the commercial forest areas for 70 percent of the profit from timber sales while the local community would protect the area for 30 percent of the profits.

Participation of local people in decision making is unclear. In the jointly-managed case, local people participated only in site identification but not in deciding which sites should be included or what rehabilitation methods should be used. In two other cases, project managers said communities had high influence on decision making, but the claim cannot be validated due to a lack of information on the degree of participation in different processes. However, all projects involving multiple stakeholders had clear, signed contracts setting out benefit and cost-sharing agreements and rights, authority and responsibilities.

In the coastal protective shelterbelts now classified as ecological forests, species such as *Casuarina equisetifolia*, *Acacia confusa* and *Acacia auriculiformis* were planted for their fast growth and ability to endure wind, sand and saline conditions. Native *Acacia confusa* was also chosen for its natural regeneration capacity besides its suitability to the site. Natural regeneration was allowed in the understorey. Fast-growing timber and economic plantations were developed on suitable slopes and foothills of the mountains using species such as *Eucalyptus urophylla*, *Dimocarpus longan*, *Litchi chinensis*, olive, waxberry, and bamboo. Other areas were naturally regenerated by way of mountain closure or planted with broadleaf species to conserve water and soil. Any harvesting was to be done through selective cutting.

The Guangdong Forestry Bureau issued in 1991 and reissued in 1995 revised guidelines for inspection to enhance the afforestation quality and strengthen supervision and management. On this basis, the local forestry bureaus, the Guangdong Forestry Bureau and the Guangdong Investigation and Design Institute of Forestry monitored and evaluated the sites annually during the project
They monitored the area afforested and its quality, stand maintenance and the funding situation. Mobilisation and propaganda efforts via public broadcast, television and newspapers were held to increase the awareness of government authorities and the people about the protective forest system.

Within 10 years, a total 606,000 ha was afforested as against a target of 450,000 ha, with 480,000 ha by planting, 16,000 ha by aerial seeding and 110,000 ha through mountain closure or natural regeneration. The breakdown in terms of forest purposes was 325,553 ha of protective forests, 147,533 ha of timber plantations, 100,813 ha of economic plantations, 353 ha of special use forests and 31,633 ha of fuelwood forests (SMD 2000). The area planted by the special afforestation teams amounted to 298,380 ha and the rest was planted by collectives and farmers on their allocated lands.

Short-term survival of plantings was quite high at 80-95 percent but it was difficult to maintain the plantations in the long run. From 1991 to 2000, the forested area in the coastal region increased from 1.21 to 1.38 million ha (SMD 2000) only despite 606,000 ha being afforested, though some of it may have still been young plantations. Typhoons (about five-six per year) destroy the protective forests, particularly the coastal shelterbelts. In 1995, a typhoon destroyed 20,573 ha. There was also poor growth or degradation in areas or of species due to poor species-site matching and pest, frost and fire damage. *Casuarina equisetifolia* was affected by numerous pests and diseases. Similar reasons — frequent typhoon
attacks and mono-specific single-strata forest stands — were blamed for site degradation in the coastal areas prior to this project as well, suggesting that the underlying causes of degradation were not addressed or were difficult to address. Whether the protective forests are indeed serving their function of protecting inland areas while absorbing some of the typhoon impacts, should be assessed.

The Coastal sites did not use slash and burn techniques to clear the land which could have increased soil exposure. From 1991 to 2000, the area affected by soil erosion was reduced from 109,900 to 60,700 ha in the overall coastal region (SMD 2000). The project planted shelterbelts of species suited to the harsh conditions and thus able to survive and perform a protective function, though some of the planted areas were destroyed as indicated above. Little information exists on whether the coastal shelterbelts did serve to protect the agricultural areas, salt fields and living environment beyond. Rice yield in the coastal area increased from 5.3 billion kg to 6.3 billion kg from before the project to 2000 (SMD 2000), and the relationship between rice yields and afforestation versus other factors needs to be assessed.

The three case study sites were highly developed with good roads, transport, market access, health and education facilities through government economic development in the recent past. From 1991 to 2000, per capita income/year in the coastal region increased from 1760 to 3882 RMB (SMD 2000) due to overall economic development. Per capita income/year from fruits increased from 174 to 464 RMB and this is more directly linked to the rehabilitation activities. However, dependence on forest/tree products was low for both income and subsistence in the cases assessed.

A lack of local support affected rehabilitation efforts in two cases that were mainly for protection purposes, and a tenure conflict affected the third case which was for commercial purposes. The forests were protected through patrols and notices on the two ecological forest cases. Economic compensation for ecological forests was insufficient given people’s substantial investment in funds and labour and the lost income from the land. If the compensation fees were not increased, then protection and management could become a problem. Already governance and protection systems needed strengthening to prevent illegal logging, encroachment and forest fires. However, whether even current compensation rates can be sustained in the long term is an open question. It was also recommended in one case that tenure of protective forests is best held by the community or group, and not by households.

With low state investment, it was necessary to raise funds from many channels and this was accomplished following the experience of the Greening Guangdong
project. However there was a shortage of funds for maintenance of the areas afforested (SMD 2000). Local forestry bureaus (ecological forest sites) and communities (hill forests) were to protect the rehabilitated areas in the long term. No financial or market analysis was undertaken on even the hill forests because the overall project was mainly concerned with environmental benefits. Typhoon damage and poor growth hampered production on some sites. Problems with implementing logging quotas and issuing logging and transportation licences affected sustainable forest management in the hills.

5.5 City forest landscape rehabilitation projects

Since the 1990s, some developed cities in Guangdong, such as Guangzhou, Shenzhen and Zhongshan sanctioned plans and projects and disbursed funds to transform their degraded forests and forest land into appealing forested landscapes. The driving force was that a green aesthetically-pleasing environment for living and working would encourage economic investment by national and foreign agencies and help promote tourism, besides benefiting local residents. The objectives were to rehabilitate existing degraded forest land, improve forest stand structure and function and increase its capacity to resist natural disturbances, and improve landscape beauty.

From 1991-93, the Guangzhou city and district governments and forestry bureaus initiated and executed a project to rehabilitate 5386 ha of degraded forestland surrounding the ten entrances and exits to Baiyun district. In 1997, Shenzhen city passed a five-year plan (2001-2005) to develop 44795.3 ha of ecological forests with the district greening committees being responsible for accomplishing tasks (SDASFB 2000, RITF et al. 2002). The Zhongshan municipal government sanctioned a project to rehabilitate 4618 ha of degraded forest land and establish ecological forests in the Changjiang tourism zone and hills adjacent to three lines of roads in the city from 2000 to 2008. Shaoguan City decided to afforest 45,500 ha of barren lands from 2002-04 for both economic (timber production) and environmental reasons (biodiversity and forest cover). The project was to be executed by local forestry bureaus and collective and state forest farms within. Other cities like Kaiping adopted the lessons learnt from Shenzhen and Zhongshan and established their own projects to rehabilitate degraded forests and barren land along main roads. Costs/ha varied from 9961 RMB in Zhongshan city to < 1600 RMB in Shaoguang, Shenzhen and Guangzhou cities. Funding was to come mainly from the city, county, district and township governments and forestry bureaus.

As in other projects, in commercial forest areas, the landholders or communities are allowed to use and earn income from the forest products. In ecological forest areas, the landholders are not allowed to harvest the timber and are instead paid economic compensation and allowed to harvest fruits and other non-timber forest
products. The government makes most decisions with regard to the rehabilitation project and there is little local participation.

In commercial forest areas, local governments contracted landholders to plant trees and manage the areas for the products, while providing technical and funding assistance. The ecological forest projects were mostly executed by commercial greening companies who compete through a public bidding system and are selected through just, fair and open procedures. Clear contracts are signed between the successful bidders and the city governments, setting out the tasks and responsibilities. The greening companies are usually required to plant and maintain the area for a few years and ensure survival and high quality of the afforestation efforts as planned and agreed on. The city governments have monitoring and evaluation measures to ensure successful rehabilitation. After the establishment period, the areas are returned to the landholders (township government or village committee) for continued maintenance.

The city landscape projects tend to emphasise high planning and management standards (FSDIGD and ZFB 1999, Liu 1999) and clear delineation of rights, responsibilities and benefits so that the projects operate smoothly. In the Zhongshan project, management teams of government representatives were set up for different aspects such as bidding, quality monitoring, and financial management. A high quality seedling nursery was set up and special technicians made responsible for ensuring the quality and quantity of seedlings.

City forest landscape rehabilitation with mixed species, Guangzhou. (Photo by Takeshi Toma)
In keeping with the objectives, the methods used were different from other rehabilitation projects. The City landscape projects aimed to create improved forests in terms of species, stocking, structure, environmental and economic benefits, and aesthetics. To this end, they planted a mix of species for their differing characteristics such as fast growth, sprouting ability, site adaptation, aesthetics, bearing fruits and other economic products, water conservation and fire resistance properties. Almost all species planted were native, the common ones being *Castanopsis* species, *Schima* species, *Elaeocarpus sylvestris* and numerous fruit tree species. Natural regeneration and aerial seeding was also used in the Shaoguang case. Sites were commonly prepared through spot brushing and not slash and burn practices, and terracing was common.

In the Shenzhen project, 21 native tree species were chosen for planting on six trial sites of 340 ha between 1998-99, based on species-site matching and aesthetic considerations (Lin and Mo 2003). In the Zhongshan project, 8-10 tree species (slow and fast growing, native and exotic) were selected for each type of forest based on the plan and objectives, local site conditions and availability. More than 30 broadleaved tree species and 75 percent native tree species were used. Native broadleaved tree species currently occupying the land were to be retained.

City landscape projects also tend to use available technical expertise to guide the rehabilitation efforts. In Shenzhen’s case, an expert group composed of experienced forestry professors and associate professors from the Research Institute of Tropical Forestry (RITF) was established to provide technical guidance and instruction. In Zhongshan, the Guangdong Forestry Bureau (GFB) and the Guangdong Forest Survey and Design Institute assisted with preparing the project’s plan and layout. The plan was subsequently evaluated by an expert group composed of professionals from university and research institutes. Forestry experts from the Guangdong Academy of Forestry (GAF), RITF and South China Agriculture University (SCAU) were invited to identify tree species. Technical cooperation with relevant forestry research departments was undertaken and training was given to the labourers to help them clearly understand the plan and technological requirements. Local forestry bureaus provide assistance technical guidance, training in other cities (Guangzhou and Shaoguang).

The city and local forestry bureaus and governments conducted education and awareness building campaigns for forestry farmers, local communities and citizens through television and public broadcasts, distribution of propaganda materials, and meetings. Inspection and evaluation measures were in place to ensure quality and fulfilment of plans. In Shenzhen, a special inspection group of forestry experts was set up to supervise, inspect and evaluate the project in each phase and resolve
the problems. The group was to also carry out a final inspection of the quality of the rehabilitation accomplished. In Zhongshan, all processes such as clearing, digging, fertilising, planting and tending would be checked and the contractor could not proceed with the next step if found lacking.

It is still too early to judge the outcomes but preliminary results indicate good survival (≥ 95 percent) and growth of rehabilitated city landscape forests with improved quality, particularly the ones established by the greening companies. In the Zhongshan project, the RITF is tracking and monitoring the environmental and social benefits and effects of the project (including effects on soils, water, air, and forest quality) but results are not published yet. Some early plantings of *Acacia* and pine monocultures were severely affected by pests and subsequently replaced with mixed species plantings. Some areas were affected by forest fires and firebreaks of *Schima superba* were recommended.

All city cases were highly developed with good roads, transport, market access, health and education facilities except for Shaoguan. All cases had forest patrols and fire prevention measures, and external pressures for grazing and other uses had decreased. Local people depended little on forest/tree products except in Shaoguan where dependence increased because people were using the products available in the rehabilitated areas they held. Near Guangzhou, increased LPG use reduced pressures for fuelwood. Average income increased in all four city cases due to overall economic development and not due to the forestry sector.

All city landscape projects had no long-term management, monitoring and evaluation, and financial reinvestment plans beyond the project period. Heavy timber taxes and fees were identified as a constraining issue in Guangzhou leading to low returns, but not so in the recent Shaoguan project since policies are more favourable for commercial forestry now. Marketing strategies are absent but the project managers believe market prospects are good. Deng (2002) and Qu (2002) concluded that the overall compensation level of four RMB/mu/year for ecological forests in Guangdong Province was very low, probably only 5-10 percent of the actual opportunity costs. In 2001, the average output value that could be earned from one *mu* of forest land was 85 RMB (Deng, 2002). The provincial compensation rate was increased to eight RMB from 2003 but is still very low. Whether even the current rate of payment can be sustained long-term is an open question. A combination of incentives such as the inclusion of economic plantations in these city landscape projects appears more promising. Su (2004) assessed two city landscape projects and suggested that long-term management was critical along with inclusion of economic options in ecological forests in less developed cities with more forest dependence.
Learning lessons from China’s forest rehabilitation efforts

Other cities are adopting these successful approaches and establishing their own projects. The Guangdong Government’s new “ecological province creation campaign” encourages cities and counties to adopt these successful greening experiences. However, cities rehabilitating their degraded forest landscapes tend to be economically well off with high employment and income levels. City funds are available for investing in forest rehabilitation and paying economic compensation to landholders, local dependence on forest land is lower, and LPG rather than fuelwood is used for cooking.

5.6 State Forest Farm and Joint Afforestation initiatives

State forest farms are owned by the local district city, city or county forestry bureaus. They have played an important demonstrative role in developing collective forests, rehabilitating degraded forest lands and establishing timber plantations. By 1987, Guangdong had 233 state forest farms that afforested 695,300 ha (GCEB 1998, Yun and Xie 2003). More than 948.4 million RMB was spent on rehabilitation from 1952 to 1987, equalling greater than 1364 RMB/ha afforested. Costs were relatively low but may not include staff and overhead costs generally included in projects and private initiatives. Afforestation activities were funded by the State and province, national bonds and low-interest loans. Activities were initiated and executed by the provincial forestry bureau, and monitored and evaluated by the provincial forestry bureau and the Guangdong Forest Survey and Design Institute. Periodic technical assistance was provided by the local forestry bureaus and the research institutes.

State forest farms have had independent forest rehabilitation and management activities since the 1950s and have participated in larger national and provincial projects since the 1980s. The state forest farms rehabilitate and manage the commercial forest areas for timber production and receive policy incentives such as reduced taxes and expanded logging quotas to facilitate this. They receive economic compensation for protecting the ecological forest areas. The main afforestation species used were long-rotation timber species - Masson pine and Chinese fir, with some broadleaved tree species for soil and water conservation and fruits. In the Xijiang state forest farm case, the site was prepared using brushing and scarification, and burning was done only where it was difficult to kill the weeds. Cover cropping was used to protect the soil and some areas were naturally regenerated. Timber harvesting was done through clearfelling, with selective cutting in soil and water conservation areas.

Average short-term survival rates in the Xijiang state forest farm were good at 80-90 percent and the area is still afforested at present. The State Forest Farm has been producing timber, fuelwood, herbs, resin and fruit for a long time now. Market prospects were good in the Xijiang case despite low prices and the timber was
saleable. The farm fared well in terms of long-term management, monitoring and evaluation, and financial reinvestment plans and implementation. High timber taxes and low economic compensation for ecological forests were some constraining factors.

Average income in the Xijiang state forest farm area has increased due to overall economic development and local people have reduced dependence on forest/tree products. Project benefits go to the State forest farm employees after paying taxes. Local community participation in decision making was low to absent, but the farmers were allowed to use fuelwood, litter, herbs and other non-timber products for subsistence though use is now low due to development in the area. The State Forest Farm and Joint Afforestation cases now have good roads, transport, market access, health and education facilities. The afforestation sites were well protected with firebreaks, patrols and policing. Some low-level fires continued but other pressures decreased. A land dispute between the state forest farm and surrounding farmers was resolved early on.

State forest farms have also engaged in joint or cooperative efforts with collectives. In the two Joint Afforestation cases assessed, the state forest farms invest in, plant, manage and log the areas. The communities (village committees) provide the land and assist in managing, monitoring and protecting the areas. The township forestry stations provide guidance. Benefits/profits from timber production were to be shared between the stakeholders in the ratio 50:40:10. These cases were initiated and executed collaboratively by the three stakeholders in village water protection areas; with medium-high local community participation in decisions on rights, responsibilities, authority, and cost and benefit sharing over a 30-year contract period.

The areas were well developed in terms of roads, transport, market access, and health and education facilities. Local dependence on forest/tree products was never very high and the sites were well-patrolled and protected. Afforestation cost per ha was low at 1400 RMB, similar to that in the state forest farms. The cases had 30-year management and financial plans, and had checked out the market prospects for the products to be generated. The managers believe that the provincial government’s reducing taxes and fees and easing logging rights will help project viability.

Unlike the state forest farms, these sites were planted with exotic fast-growing slash pine and Acacia mangium for timber, resin and fuelwood. The main goals were to increase forest cover; produce timber, resin and fuelwood; and conserve soil and water. The sites were newly planted and have not yet started producing timber, fuelwood and resin. One case used slash and burn practices of site preparation
though it aimed to conserve soil and water. According to Yang et al. (2005), slash and burn practices lead to substantial removal of nutrients, degradation of soil structure, soil exposure and high susceptibility to erosion.

Overall, project managers in both the State Forest Farm and Joint Afforestation cases assumed environmental objectives (improve environment, protect watershed, control soil erosion and runoff) would be fulfilled when plantations were established, but specific environmental benefits were not measured. Success was measured only in terms of achieving planting targets.

5.7 Plan for rehabilitating degraded forest land within three years

Guangdong Forestry Bureau planned to rehabilitate 419,186 ha of degraded forest land within three years (from 2002 to 2004). The task has mostly been accomplished with 95 percent of the targeted area or 397,620 ha having been afforested: 276,534 ha through planting and 121,086 ha through mountain closure (Deng 2005). Ten collectives and 30 individuals were commended and given awards.

5.8 Ecological forest system development project

The tenth “five year forestry development plan” (2000-2005) of Guangdong had three projects related to rehabilitation (GFB 1996):

- The key ecological forest development project included rehabilitating 826,300 ha in the four big watersheds of Guangdong from 2000-2005, by planting 17,900 ha, enrichment planting of 395,100 ha, and regenerating 413,300 ha of forests by way of mountain closure.

- The second phase of the coastal protective forest system development project (2001-2010) was expanded to cover 45 counties (or cities and districts) and five state forest farms. The tasks were to establish 750,000 ha of protective forests, regenerate 475,000 ha through “mountain closure”, refurbish 218,900 ha of low-yielding forests, and tend 22,500 ha of young forests (FSDIGD 2002).

- The soil erosion control project aimed to enhance soil and water conservation on 1,152,000 ha affected by soil erosion in 21 district cities by planting trees and grasses.

From 1999-2004, Guangdong Province invested 160 million RMB into the Ecological forest system development project. They rehabilitated 44,987 ha of degraded forestland through afforestation and enrichment planting, and established 693 ha of demonstration plantations in the four watersheds. They afforested 29,100 ha of protective forests and regenerated 28,767 ha of forests through mountain closure in the coastal area (Li 2005).
6. **Summary of some key characteristics of rehabilitation efforts over 50 years**

### 6.1 Site conditions, degrading factors and project objectives

Case study analysis suggests that most of the rehabilitation project sites were open grass, shrub or barren lands, and not natural forest or cultivated areas. Some sites were degraded plantations arising from past unsuccessful rehabilitation attempts by collective and state forest farms and by the Greening Guangdong project. In these earlier projects, large areas were planted to pure pine, *Eucalyptus* or *Acacia* with uniform stand structures and low resistance to pests and other external disturbances. Repeated human and natural disturbances left many stands severely degraded with poor form, growth and yield, or resulted in further degeneration into sparse forest, shrub, grass or barren land. Their history underlines the importance of dealing with site-degrading factors as part of rehabilitation efforts.

Intensive logging (81%), fuelwood extraction (77%), fire (64%, escapes from ceremonial burning), and pest and disease infestation in established plantations (41% or more) were the dominant factors leading to sites being degraded in the hilly areas. Frequent typhoon attacks and wind damage, coupled with the monospecific single-strata forest stands were blamed for site degradation in the Coastal areas.

The National Afforestation Project, private sector, State Forest Farm and Joint Afforestation initiatives were primarily focused on timber production. The remaining public sector projects — Coastal, Greening Guangdong, City landscape and ecological forest system development project — had mainly environmental objectives.

### 6.2 Funding sources and financial costs

More than 29.81 billion RMB has been spent on forest rehabilitation in Guangdong since the 1950s, much of it by the provincial project “Greening Guangdong” (Table 3). A substantial
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Proportion of the investment did not bear fruit due to subsequent degradation of the project sites by natural and human factors and poor long-term maintenance. This was true for many of the state and collective efforts prior to the 1980s, besides a proportion of the Coastal, National Afforestation and Greening Guangdong project sites as indicated in Section 5. Funds were invested again and again in new projects to rehabilitate degraded plantation areas arising from earlier unsuccessful rehabilitation efforts.

The cost per hectare planted was very high in foreign enterprise investments (> 25,000 RMB), while the Greening Guangdong, Zhongshan city and some private initiatives were also costly at 7000-10,000 RMB. These private initiatives and the Zhongshan city landscape project had much higher inputs, more intensive management and post-planting maintenance, and spent more on research and technology. It remains to be seen as to whether these higher investments mean better establishment, maintenance and yields. Other public and private initiatives had lower costs at < 4000 RMB. Some government projects, such as Greening Guangdong and Coastal, also depended on free labour to establish plantations.

Most projects were implemented and funded at local levels even if initiated at higher levels. They were top-down approaches with the national and provincial agencies instructing local governments to achieve certain targets within a defined time frame. The area to be planted through the provincial program was particularly

### Table 3. Financial costs of rehabilitation initiatives in Guangdong Province (Summarized from Section 5 above).

<table>
<thead>
<tr>
<th>Initiatives</th>
<th>Total cost (million RMB)</th>
<th>Area rehabilitated (ha)</th>
<th>Average cost/ha (RMB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Afforestation Project</td>
<td>333.23</td>
<td>127,600</td>
<td>2611</td>
</tr>
<tr>
<td>Greening Guangdong project (+ one billion man-days of labour)</td>
<td>25,000</td>
<td>3,330,000</td>
<td>7507</td>
</tr>
<tr>
<td>Coastal project (+48.752 million man-days of labour)</td>
<td>1063.3</td>
<td>606,000</td>
<td>1754</td>
</tr>
<tr>
<td>City landscape project (4 main city efforts)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Zhongshan city</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State forest farms (1952-87, includes infrastructure)</td>
<td>948.4</td>
<td>695,300</td>
<td>1364</td>
</tr>
<tr>
<td>Private sector initiatives (Up to 2003)</td>
<td>2300</td>
<td>1,040,000</td>
<td>2211</td>
</tr>
<tr>
<td>• Foreign enterprises (Up to 2001)</td>
<td>(1356)</td>
<td>(50,000)</td>
<td>(27120)</td>
</tr>
<tr>
<td>• Some cases</td>
<td></td>
<td></td>
<td>(8000-10,000)</td>
</tr>
<tr>
<td>• Other cases</td>
<td></td>
<td></td>
<td>(&lt; 4000)</td>
</tr>
<tr>
<td>Joint Afforestation initiatives</td>
<td>No info</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collectives, households</td>
<td>No info</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29,810</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
enormous, but also large in the two national programs. Estimates of the relative investment by different sectors since the 1950s suggest that local city, county and township governments may have borne the bulk of the expenses, about 58 percent (Figure 5). The second largest source has been self-funding by farmers and local management units, about 24 percent, without taking into account the free labour provided in the Greening Guangdong and Coastal projects. Bank loans with low interest rates were a major local source of funds. The private sector has been a relatively recent player and its contribution can be expected to increase in the future. Private sector initiatives often use low interest loans available to promote private forestry enterprise on degraded forest lands. Contributions from national and provincial sources have been insignificant although three projects were initiated at those levels. Foreign funding has played a role in only one recorded government project in Guangdong: the National Afforestation Project which was roughly 60 percent funded by a World Bank loan which ultimately has to be paid back by the Government.

![Relative contribution of different sectors to forest rehabilitation investment](image)

**Figure 5.** Relative contribution of different sectors to forest rehabilitation investment (Total 29.81 billion RMB +) in Guangdong since the 1950s (Summarized from Section 5 above).

### 6.3 Silvicultural practices
Case study analysis provided some clues into silvicultural practices conducted at the site level. Land clearing was done through spot and/or strip brushing on 12 sites, slash-and-burn on 8 sites and both practices on 2 sites. Slash and burn practices were primarily carried out in the National Afforestation, Greening Guangdong, private individual and Joint Afforestation initiatives. Some sort of soil and water conservation measures, mostly terracing, were applied in 10 sites. Nine project sites stated that there was either no need (Coastal and private sector...
initiatives mainly) or they depended (Greening Guangdong, City landscape and Joint Afforestation initiatives) on the growing ground vegetation and trees to conserve the soil and water (in one site, broadleaf trees were planted for this purpose).

Planting trees was the dominant initial revegetation method in all cases. Natural regeneration was also allowed in 50 percent of the samples: planting and then allowing natural regeneration, or natural regeneration with or without enrichment planting. Natural regeneration was found mainly in the four government projects, the State Forest Farm and in vegetation belts separating the *Eucalyptus urophylla* in two private company sites. Aerial seeding was mentioned in one City landscape site but formed a part of the overall Coastal and Greening Guangdong projects.

The most common species planted were *Eucalyptus urophylla* (32 percent of samples) with rotation periods of five to seven years, and the native Masson pine and Chinese fir (22-27 percent of samples) with rotations ranging from 15-30 years for timber (Annex 3). Earlier government initiatives (National Afforestation, Greening Guangdong and State Forest Farm) favoured the long-rotation native Masson pine and Chinese fir which had good timber and matched local conditions. Fast-growing and high-yielding *Eucalyptus urophylla* primarily for pulp was found in recent private sector initiatives plus two earlier government programs.

City landscape projects had the highest diversity with three to six species per site as suited to their objectives of creating long-term stable forests with mixed
species and structure for ecological benefits, aesthetics, and for producing fruits, fuelwood and perhaps timber in the long run. Private company initiatives and the Greening Guangdong project had the next highest diversity with mixed short- and long-rotation timber species in each site. Planted species diversity was much lower in other project types.

The National Afforestation, City landscape and State Forest Farm initiatives had > 50 percent native species planted. Native broadleaved species were stated to be chosen for suitability to local site conditions and water retention capacity. Native Betula alnoides, Masson pine and Chinese fir were chosen for their rapid growth, favourable timber quality, site suitability, and available timber market. Two additional native species – Acacia confusa and Castanopsis fissa – were also chosen for their natural regeneration capacity as well as site suitability. In the coastal sites, specific exotic species such as Casuarina equisetifolia were chosen for their ability to withstand the harsh conditions. The Greening Guangdong project involved planting large areas with poor site quality, and available exotic species were chosen to green the land rapidly given the limited funds and five-year timeline. The private sector and Joint Afforestation initiatives were all wood production-oriented, primarily pulpwood, and focused on exotic, fast-growing species.

Most projects planned to harvest through clear cutting except for the Coastal project, which planned selective cutting; one Greening Guangdong case which planned a combination of selective and clearfelling; and the State Forest Farm, which planned to use some selective cutting for soil and water conservation purposes. Two City landscape projects had no planned harvests, being purely for ecological purposes. Revegetation methods planned for the second and subsequent rotations were largely to replant the sites with the same species, except for Eucalyptus urophylla, Albizia falcataria and some fir which would be coppiced. Some natural regeneration was specified on three sites.

7. Lessons learned

7.1 Success
Guangdong Province in Southern China has successfully rehabilitated a large portion of its degraded forest lands as defined, reducing the area from 7.67 million ha in 1949 to 1.19 million ha in 2003. However, successful rehabilitation does not necessarily mean an increase in ecological integrity of the land (See Section 7.3.2 on environmental outcomes). Most of the decrease in degraded forest land was achieved from 1985-93 through a single large program, “Rehabilitating degraded forest land in five years and greening Guangdong in 10 years”, initiated
by the provincial government in response to a Central Government edict to
green the country. Prior to that project and subsequently as well, numerous
other initiatives on a smaller scale have been undertaken. Earlier efforts were
undertaken primarily by the state and collective forest farms and forestry bureaus
in response to numerous edicts and/or supportive policies issued in this regard by
the Central or provincial government. Efforts in Guangdong from the mid-1980s
include targeted, top-down government projects such as the above-mentioned
Greening Guangdong project, the National Afforestation Project, the National
Coastal Protective Forest System Development Project and City Landscape Forest
Rehabilitation Projects. Additionally, timber plantations on degraded forest lands
by the private sector emerged with favourable policy incentives and burgeoning
markets for commercial forestry development. The province has thus been
generally successful in achieving targeted planting, survival and increased forest
cover in the short-medium term; as well as attracting and sustaining interest in
forest rehabilitation by different actors.

Factors contributing to this general success:

7.1.1 Public sector projects
1. Political support for rehabilitation and for specific projects with many edicts,
   regulations and guidelines to government agencies and state and collective
   forest farms since the 1950s. These edicts related to rehabilitation tasks to
   be accomplished, quality standards, forest protection and management,
   classification into “ecological” and “commercial” forests, and timber
   production among others.
2. A working forestry administration at different levels with targeted management
   and responsibility systems for fulfilment of the project tasks, which provide
criteria for performance evaluation. Good supervision, inspection, and
   reward-and-punishment systems linked to wages and political positions
   served as major incentives in the Greening Guangdong project.
3. Effective leadership, organisation and project management at each
   administrative level. Setting up a leading group and specific project office
   for the Greening Guangdong project within the forestry administrative
   authorities in each county and city helped to assign clear responsibility
   for project organisation, implementation and inspection. Similarly for the
   National Afforestation and City landscape projects.
4. Well-designed and planned schemes in all projects. Implementing units
   were to submit project plans, design specifications and annual operative flow
   charts.
5. Establishment of demonstration sites for afforestation by the administrative
   authorities in each county to guide and lead the work in the Greening
   Guangdong project.
6. Large mobilisation and propaganda efforts via the public media and conferences helped to increase awareness and participation of farmers and communities in all projects, and also of government authorities in the Greening Guangdong and Coastal projects. Both good and bad examples and experiences were reported by the media with due praise or criticism in the Greening Guangdong project. To a lesser extent, awareness campaigns were conducted in private sector initiatives too.

7. Numerous revegetation methods used to fulfil the tasks. Planting was the dominant method but was combined with natural regeneration in all government projects, and aerial seeding in the two larger projects, Greening Guangdong and Coastal. Many trials and substantial experience with aerial seeding helped in successfully applying this strategy.

8. Promoting the use of LPG and other fuels instead of fuelwood in the Greening Guangdong and City landscape projects. This took some pressure off the rehabilitated areas.

9. In general funding available through loans or from local government sources has enabled all sites to meet targets. Funds were raised through innovative mechanisms from several different channels in the Greening Guangdong and Coastal projects.

7.1.2 Private sector projects

1. Grant of tenure to households and longer-term stabilisation of tenure rights ultimately helped to support rehabilitation efforts after a small increase in degradation. Households and communities were then able to benefit from growing trees for timber or non-timber forest products and environmental service payments depending on the land classification.

2. Flexibility for tenure holders to transfer, lease or contract their land holdings led to numerous other actors being involved (most notably the private sector) and outside capital becoming available for rehabilitation. It also led to diverse and effective institutional arrangements such as jointly-managed or stock-shared forest farms. These collaborative efforts provide promising models, whereby skills and assets of different stakeholders can be combined for mutual benefit.

3. Resolution of land tenure and benefit-sharing disputes on project sites, and clarified tenure.

4. Improved open wood markets led to higher economic returns from tree growing and raised public interest in rehabilitating degraded forest lands. Most, though not all, sample sites indicated good market prospects.

5. Supportive policies issued by the Central or provincial government for private sector involvement such as priority rights for obtaining logging permits and quotas, credit assistance, decreased taxes and fees, and establishment of demonstration sites.
7.1.3 Across sectors

1. Favourable site conditions for tree growth including *economic plantations* (non-wood products such as fruits and spices for cash income) in most areas, except the exposed coastal areas.

2. Rapid economic growth, urbanisation and infrastructure development leading to improved markets for forest products from the rehabilitated areas, availability of prosperous city funds for rehabilitation and environmental service payments, and reduced local dependence on forests with improved incomes in the urban areas. Rozelle *et al.* (2003) also note that economic growth had a positive effect on forest cover in parts of China. However, increased forest product demand in China has had negative impacts on forests in the Asia Pacific Region (Katsigris *et al.* 2004, White *et al.* 2006).

3. Targeted benefits for communities in all projects such as timber, fruits and other products, rental payments, profit-sharing and economic compensation payments. *Economic plantations* (non-timber products) and profit-sharing are the most promising incentives, the former partly due to non-timber products having lower tax and harvesting restrictions when compared to timber products.

4. Clear legal contracts between the stakeholders and arrangements for sharing rights, responsibilities, costs and benefits.

5. Inclusion of monitoring and evaluation arrangements on all projects (local forestry bureaus, expert teams, or provincial institutes). Inspection and evaluation by specialist teams for each stage in the afforestation process helped to ensure quality in the National Afforestation and City landscape projects.

6. Provision of technical assistance from the local forestry bureaus and research institutes to people implementing the projects on the ground. Free supply or availability of technical assistance for afforestation by the private sector. Inviting experts from research institutes as technical consultants for project design, training and guidance enhanced the technical viability in the National Afforestation and City landscape projects.

7.2 Sustainability

Assessment of 22 individual cases also suggests that the efforts since the 1980s have been quite successful in terms of target planting, survival and increased forest cover in the short-medium term. But how about the long-term sustainability of the afforestation efforts? In general, forest cover was maintained on much of the sites in the long-term, though of varying quality and ecological functionality. However, some project sites have been the target of repeated rehabilitation attempts, suggesting that some initiatives lacked long-term sustainability. Projects not only attempted to rehabilitate open lands but also degraded plantations arising from earlier unsuccessful rehabilitation efforts. The long-term sustainability problems
and issues that Guangdong forestry faces can be divided into three aspects: a) technical, b) socio-economic, and c) long-term management and financing.

7.2.1 Technical
Roughly half the 17 cases with sufficient time to allow assessment had some loss and degradation problems in the longer term due to poor growth, pests and disease, frost or fire damage. Storm and typhoon damage affected some coastal sites. In the overall Greening Guangdong and National Afforestation projects, 13 percent and 27 percent respectively of the afforested areas were degraded in the long-term. City landscape sites were doing quite well in terms of long-term growth and forest quality.

Factors leading to technical sustainability or lack of it include:
• Limited species-site matching, particularly of exotic species, and the establishment of vast monoculture landscapes of pine, *Eucalyptus* and Chinese fir with uniform stand structures that led to poor growth and yield as well as increased risk of pests, disease and fires on some sites. This is particularly so in the past rehabilitation activities by collective and state forest farms, the Greening Guangdong and National Afforestation projects.
• Using superior certified seeds and seedlings helped to ensure forest stand quality, while low quality seedlings resulted in poor growth in the National Afforestation Project.
• Mono-specific and single-strata forest stands were also partially blamed for past site degradation in the coastal areas. In the recent Coastal project, natural regeneration was allowed for and species were chosen for their suitability to site conditions and their ability to resist and contain wind and sandstorms. Only selective cutting was permitted.
• Private sector and Joint Afforestation initiatives had mostly exotic species monocultures, despite risks associated with site suitability and pest and disease susceptibility. One company site had concerns that site productivity may degrade over time with continuous rotations of pure *Eucalyptus*.
• City landscape sites did well in terms of long-term growth and forest quality because they planted a mixture of species (much of them native) to specifically create improved forest diversity, structure and function. Species choice was matched to site conditions, the ecological functionality required and local needs.
• Using a bidding system and contracting the afforestation task of the project to a qualified agency ensured quality standards in City landscape and Coastal sites.

The technologies chosen did not specifically match with site conditions in most samples, except for the Coastal and City landscape sites.
7.2.2 Socio-economic

Logging, fuelwood collection, grazing and other unauthorised human disturbances were reduced on most sites except for some private sector sites where people took wood. There was insufficient local community support for some private sector efforts, and on some coastal project sites that were established purely for environmental purposes.

Factors reducing unauthorised logging and other human disturbances on most sites:
- Good patrol and protection measures and agreements with local people for protection.
- Longer-term stabilisation of tenure rights, and diverse and effective institutional arrangements with clear contracts allowing households and communities to derive economic benefits from rehabilitation.
- Targeted benefits for communities in all projects – timber, fruits and other products, rental payments, profit-sharing, and economic compensation for ecological forests. Economic plantations and profit-sharing are promising incentives.
- Education and awareness campaigns for farmers and communities.
- Reduced dependence on forests for subsistence with increased income and substitution of fuelwood with LPG, mainly in the urban areas.

Insufficient local community support and unauthorised logging on a few sites was due to lack of site protection, and failure to provide adequate benefits to the community and ensure their involvement and stake in protecting the resources. The specific private sector cases facing the problem did not offer any additional benefits except rent for the land leased and they did not have specific patrol or protection of their sites. Economic compensation for ecological forests was inadequate. It did not provide sufficient returns to people for their substantial investment in funds and labour and the income lost from the land.

Local community participation in decision-making was very low in all government projects/cases, where communities had to undertake the projects on their allocated lands. Private sector and small local Joint Afforestation initiatives were more participatory.

7.2.3 Long-term management and financing

With low state investment and short project durations, there was a lack of focus on and funds for long-term management of the areas afforested in the four government projects (Greening Guangdong, National Afforestation, Coastal and City landscape). This lapse contributed to degradation in the long term in at least the first three cases. The rehabilitation edicts had to be executed at lower levels
by officials raising their own funds and the focus was only on achieving planting targets. Little attention was paid to regeneration after logging of the timber or after fires. In some areas governance was also relaxed with respect to enforcing logging quotas and guidelines, and preventing illegal logging and occupation.

Recent efforts initiated and implemented by landholders such as the private sector, collectives and state forest farms individually or jointly with other actors had long-term management plans. This was because of their investment in the land over a long-term lease or contract period, and expected benefits accruing over that time.

Long-term financial viability through reinvestment in production forests was constrained in seven of the 18 cases with timber production objectives. In six cases across actors, heavy timber taxes and fees led to low investment returns. In two government project cases, market prospects were low but elsewhere, prospects were favourable. Low growth and yield on one site also led to lower potential returns. The State Forest Farm had an ecological forest section where economic compensation payments did not meet the management costs. The long-term sustainability of paying economic compensation for ecological forests even at the current rate is open to question but more assured in richer cities and areas.

7.3 Meeting other planned objectives

7.3.1 Production and marketing
Of the five sample sites with mature trees for timber, a private company site and the State Forest Farm had harvested the trees, while the three government project sites had not. Deng1 (2003) indicates that the private sector had already generated substantial income from timber and forest products by 2001. This can be expected to increase. Good market prospects and marketing plans led to good production outcomes for the private sector initiatives. The government project sites do not appear to have timber marketing plans although market prospects were good. The farmer households and communities involved in these projects need timber production and marketing support systems. However, the government project sites with fruit tree and other economic plantations were contributing substantially to income for local communities given shorter time to production, no harvesting restrictions, few taxes and high returns.

7.3.2 Environmental outcomes
Most sites and initiatives appear to have fulfilled their afforestation objectives. The managers of the four government projects and the State Forest Farm expressed the belief that they had fulfilled other environmental objectives with plantation establishment, i.e. improving the environment, protecting watersheds, controlling
runoff and soil erosion, and protecting the coastal area from sandstorms and typhoons. However, specific environmental benefits were not measured. Further ground level analysis would be required to verify any such outcomes. This analysis is particularly important given that concerns over soil erosion, frequent droughts and floods continue to be major factors driving rehabilitation.

Also the Government pays economic compensation to landholders of ecological forests for environmental benefits though such benefits remain unquantified (Qu 2002). Increased forest cover with regreening of barren or grasslands does not necessarily mean an increase in ecological integrity of the land, since there has been no meaningful measurement of biodiversity, ecosystem function, or ecological resilience of the plantations. The logging ban in the ecological forests could augment natural regeneration and thereafter biodiversity. In general, scientific evidence is needed to make the term ecological forest appear more meaningful.

7.3.3 Livelihood outcomes
Communities were the targeted beneficiaries on all sample sites. Project managers said that local income had increased everywhere, although they related this largely to overall economic development. However, communities strongly depended on the forest lands for their income on 12 sites and for subsistence on eight sites, suggesting that the rehabilitation projects contributed to higher incomes in part at least. The reasons for high dependence included the availability of forest products (particularly fruits and other non-timber products) from the rehabilitated areas for their use and sale, rental payments from the private sector and profit-sharing arrangements on some sites. The high subsistence use on just three private sector sites reflected poor on-site protection. The livelihood outcomes on the ecological forest sites of the Coastal project appear unsatisfactory, with economic compensation payments not balancing the investment made and the income lost from the land.

The information above on livelihood outcomes is indicative, but community perspectives on socio-economic impacts may vary from those of the project managers. Community surveys would be required to clearly establish whether the targeted beneficiaries received the expected benefits, whether it was adequate, and what the socio-economic impacts of the different initiatives were.

8. Conclusions
To implement any future plans, successful approaches and incentives identified from past rehabilitation experiences such as demonstration sites, the bidding system, joint ventures and incorporating economic plantations could be adopted and utilised. Furthermore, the quality and long-term sustainability of public and
private rehabilitation efforts for both production and environmental objectives needs to improve. This is the main challenge in Guangdong besides determining whether the projects are meeting the desired environmental and socio-economic objectives. Given that many projects are driven by environmental concerns, and forest development has been identified as the poverty alleviation strategy in the mountain region, it is important to ensure that rehabilitation efforts actually meet these goals. Recommendations based on the lessons learned from the Guangdong study are provided in Chapter V along with insights obtained from the national review in Chapter II.

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## Annex 1. Listing of 22 sample sites.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Name</th>
<th>Location</th>
<th>Main funding source</th>
<th>Time period</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Afforestation</td>
<td>National Afforestation Project</td>
<td>1. Shixing county</td>
<td>World Bank</td>
<td>Jan 91-Dec 94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Wengyuan county</td>
<td></td>
<td>Sep 90-Jul 96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Yangchun city</td>
<td></td>
<td>Sep 90-Jul 96</td>
</tr>
<tr>
<td>Greening Guangdong</td>
<td>Rehabilitating degraded forest land in five years &amp; greening Guangdong in 10 years</td>
<td>1. Luoding city</td>
<td>Local governments</td>
<td>Oct 85-Oct 92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Xinhui city</td>
<td></td>
<td>Jan 86-Dec 88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Yunan county</td>
<td></td>
<td>Jan 86-Dec 92</td>
</tr>
<tr>
<td>Coastal</td>
<td>Coastal protective forest system construction project</td>
<td>1. Yangxi county</td>
<td>National &amp; local governments</td>
<td>Feb 01-Sep 07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Dianbai county</td>
<td>National, provincial, local governments</td>
<td>Jan 96-Dec 05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Huidong county</td>
<td>Provincial &amp; local governments</td>
<td>Jan 00-Dec 01</td>
</tr>
<tr>
<td>City landscape</td>
<td>Forest landscape rehabilitation project for Changjiang tourist zone and first course of hills along three lines of roads</td>
<td>1. Zhongshan city</td>
<td></td>
<td>Apr 99-Dec 08</td>
</tr>
<tr>
<td></td>
<td>Afforestation of degraded forest land in Shaoguang city</td>
<td>2. Shaoguan city</td>
<td>Local governments</td>
<td>Jan 02-Dec 04</td>
</tr>
<tr>
<td></td>
<td>Ecological landscape forest project in Baoan district, Shenzhen special economic zone</td>
<td>3. Baoan district, Shenzhen city</td>
<td></td>
<td>Jan 01-Dec 03</td>
</tr>
<tr>
<td></td>
<td>Rehabilitation project of degraded forest land surrounding 10 entrances to and exits from Guangzhou</td>
<td>4. Guangzhou city</td>
<td></td>
<td>Jan 91-Aug 93</td>
</tr>
<tr>
<td>State Forest Farm</td>
<td>Afforesting degraded forest land in Xijiang State Forest Farm</td>
<td>Hilly area along Xijiang watershed from FengKei county of ZhaoQing city to Shanshui county of Foshan city, eight counties</td>
<td>National government</td>
<td>Jan 54-present</td>
</tr>
</tbody>
</table>
## Chapter III  Success and sustainability

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Name</th>
<th>Location</th>
<th>Main funding source</th>
<th>Time period</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private company</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fast-growing short-rotation Eucalyptus plantation investment project</td>
<td>1. Gaoyao city</td>
<td></td>
<td>1996-2044</td>
</tr>
<tr>
<td></td>
<td>Fast-growing and high-yielding industrial plantation base project</td>
<td>2. Meizhou city</td>
<td>Private companies</td>
<td>Oct 97-Oct 46</td>
</tr>
<tr>
<td></td>
<td>Rehabilitation of a barren hill as a teak plantation demonstration base</td>
<td>3. Dongjing tea plantation of Jiedong county, Jieyang city</td>
<td></td>
<td>May 99-Apr 44</td>
</tr>
<tr>
<td><strong>Private individual</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reforestation projects on degraded forest lands (Leases to private individuals)</td>
<td>1. Liuhe village, Cangcheng town, Kaiping city</td>
<td></td>
<td>Jan 03-Dec 32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Nanlian village, Xiangang town, Cangcheng county, Kaiping city</td>
<td>Individual investors</td>
<td>Jan 03-Jan 38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Hekou county, Yuncheng District, Yunfu city</td>
<td></td>
<td>Jan 03-Jan 33</td>
</tr>
<tr>
<td><strong>Joint Afforestation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joint afforestation projects on degraded forest lands</td>
<td>1. Sanguishan in Hulong village, Chikan town, Kaiping city</td>
<td></td>
<td>Jan 00-Dec 29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Area around Shuixing Reservoir in Xiadong village, Xiangang town, Kaiping city</td>
<td>State forest farm</td>
<td>Jan 02-Dec 31</td>
</tr>
</tbody>
</table>
Annex 2. *Policies and regulations that influenced forest land degradation and rehabilitation since the 1950s.*

<table>
<thead>
<tr>
<th>Year</th>
<th>Relevant policies</th>
<th>Effect</th>
<th>By which actor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>‘Forestry working guideline and operational outline at the county level for Guangdong Province’ (draft) — Pay high attention to afforestation, prevent forest fire and illegal logging</td>
<td>Promoted rehabilitation</td>
<td>County governments, forestry administration and public</td>
</tr>
<tr>
<td>1954-1958</td>
<td>Agricultural cooperative movement and then the People’s Commune Movement transferred individually-managed forest land to Cooperative Communes</td>
<td>Frequent tenure change and tenure conflicts led to severe deforestation in some areas</td>
<td>Communities, local farmers</td>
</tr>
<tr>
<td>1958</td>
<td>Central Government directive to undertake large-scale afforestation throughout the country — mobilise the public, develop existing state forest farms, and increase and establish new forest farms for afforesting barren hills</td>
<td>To promote rehabilitation but see ‘Great Leap Forward movement’ below.</td>
<td>General public, forest farms</td>
</tr>
<tr>
<td>1958-61</td>
<td>‘The Great Leap Forward movement’ — focused on rapid industrial development and iron and steel production in China</td>
<td>Promoted degradation</td>
<td>Government &amp; people</td>
</tr>
<tr>
<td>1961</td>
<td>Policies to confirm forest tenure, protect forests and develop forestry issued by the Central Government</td>
<td>Promoted rehabilitation in the regions executed</td>
<td>Local government</td>
</tr>
<tr>
<td>1962</td>
<td>Guangdong’s policy to establish timber forest plantations and grant cash and grain support</td>
<td>Promoted rehabilitation</td>
<td>Forestry department, local governments, forest farms</td>
</tr>
<tr>
<td>1963</td>
<td>Guangdong Communist Party Committee’s directive to actively develop state farms</td>
<td>Promoted rehabilitation</td>
<td>Forestry bureaus and state forest farms</td>
</tr>
<tr>
<td>1965</td>
<td>Guangdong Government’s revised forestry policy to ‘closely combine planting, tending and management’ with the main focus on afforestation in collectives, supplemented by afforestation in state-owned and cooperative forest farms</td>
<td>Promoted rehabilitation</td>
<td>Forestry bureaus, state and cooperative forest farms</td>
</tr>
<tr>
<td>1966-76</td>
<td>Cultural revolution nationwide. During this period, the policies formulated could not be effectively implemented</td>
<td>Promoted degradation</td>
<td>All — period of anarchy</td>
</tr>
<tr>
<td>Year</td>
<td>Relevant policies</td>
<td>Effect</td>
<td>By which actor</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>1981</td>
<td>Central Communist Party Committee and State Council resolutions on ‘various problems related to forest protection and forestry development’</td>
<td>Generally promoted rehabilitation</td>
<td>Government and forestry authorities at all levels, and all forest land holders (State and collective forest farms, and households)</td>
</tr>
<tr>
<td></td>
<td>Guangdong’s Government and Communist Party Committee’s resolutions to ‘stabilise land and forest ownership and implement the forestry production responsibility system.’</td>
<td>Commonly called the Three Fix Policy</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>‘Detailed rules for implementation of civil compulsory tree planting’ in Guangdong</td>
<td>Promoted rehabilitation</td>
<td>Civil society</td>
</tr>
<tr>
<td>1984</td>
<td>Central Government directive to ‘green the motherland with high attention and effective implementation’</td>
<td>Promoted rehabilitation strongly</td>
<td>All actors</td>
</tr>
<tr>
<td>1984</td>
<td>Guangdong Government’s report on relaxing restrictions to ease some policy problems</td>
<td>Promoted rehabilitation</td>
<td>Forestry authorities, State and collective forest farms, and farmers</td>
</tr>
<tr>
<td>1984</td>
<td>Regulations to speed up economic development in mountainous areas by Guangdong’s Government and Communist Party Committee — to promote forestry and alleviate poverty</td>
<td>Promoted rehabilitation strongly</td>
<td>Administrative authorities, farmers, communities, collective and state forest farms, state and foreign enterprises, agricultural banks</td>
</tr>
</tbody>
</table>

Supplementary regulations (1985)
### Learning lessons from China’s forest rehabilitation efforts

<table>
<thead>
<tr>
<th>Year</th>
<th>Relevant policies</th>
<th>Effect</th>
<th>By which actor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>‘Resolution to speed up afforestation and greening of Guangdong Province as soon as possible’ (Synonymous with the decision to ‘rehabilitate degraded forest lands in five years and green Guangdong in 10 years’)</td>
<td>Promoted rehabilitation strongly</td>
<td>The party committee and government at all levels, enterprises, communities, forest farms, farmers, and all people in the province</td>
</tr>
<tr>
<td>1985</td>
<td>‘Temporary regulation on annual forest logging quota management’ by the State Forestry Administration.</td>
<td>Prevented degradation</td>
<td>All forestry administrative authorities, forest farms and forest management units</td>
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<tr>
<td></td>
<td>‘Temporary regulation on forest logging quota management’ in Guangdong by the Guangdong Forestry Bureau.</td>
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<td></td>
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<tr>
<td></td>
<td>‘Operative criteria (draft) for forest logging quota management’ in Guangdong (1992)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>‘Detailed rules for administration of Guangdong’s forest and wildlife nature reserves’</td>
<td>Promoted rehabilitation and protection</td>
<td>Forestry and nature reserve authorities, local farmers</td>
</tr>
<tr>
<td></td>
<td>Amended in 1997</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>‘Methods for forest administration in Guangdong Province’ To promote afforestation and greening of degraded forestland, and regeneration of logged-over land</td>
<td>Promoted rehabilitation</td>
<td>Provincial and city forestry administrative authorities, and assigned individuals in the local county and town governments</td>
</tr>
<tr>
<td>1988</td>
<td>Guangdong’s decision on ‘fulfilling greening standards, monitoring and evaluation, awards and punitive measures’</td>
<td>Promoted rehabilitation strongly</td>
<td>City and county administrative authorities and departments, City governments, Provincial Greening Committee, Guangdong Forestry Bureau</td>
</tr>
<tr>
<td>1990</td>
<td>State Council’s ‘Planning compendium for nationwide afforestation and greening from 1989-2000’</td>
<td>Promoted rehabilitation strongly</td>
<td>Provincial governments</td>
</tr>
<tr>
<td>Year</td>
<td>Relevant policies</td>
<td>Effect</td>
<td>By which actor</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
<td>--------</td>
<td>---------------</td>
</tr>
<tr>
<td>1991</td>
<td>‘Directive to continuously make strong efforts for five years to fulfil planned targets for the Greening Guangdong project’ — Adopting targeted management and responsibility system</td>
<td>Promoted rehabilitation strongly</td>
<td>The party committee &amp; government at all levels, enterprises, communities, forest farms, farmers, and all people in the province</td>
</tr>
<tr>
<td>1991</td>
<td>‘Afforestation, monitoring and evaluation measures for coastal protective forest system development project’(temporary) by the Guangdong Forestry Bureau</td>
<td>Promoted rehabilitation of coastal protective forests</td>
<td>All levels of forestry administration, greening committees</td>
</tr>
<tr>
<td></td>
<td>‘Afforestation, monitoring and evaluation measures for coastal protective forest system development project’ issued in 1995.</td>
<td></td>
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<tr>
<td>1992</td>
<td>Directive to ‘Inform staff at lower levels about forest development targets and establish a responsibility system for leaders’ in Guangdong</td>
<td>Promoted rehabilitation strongly</td>
<td>Chiefs at all levels of government, Guangdong Forestry Bureau, greening committees, forest farms</td>
</tr>
<tr>
<td>1994</td>
<td>Directive to ‘Consolidate the greening achievements and speed up modernisation of forestry practices’ by Guangdong’s Government and Communist Party Committee</td>
<td>Promoted rehabilitation</td>
<td>Government and party committee at all levels, forestry authorities</td>
</tr>
<tr>
<td>1994</td>
<td>‘Notice to further boost and accelerate afforestation and greening of degraded land’ by the Central Greening Committee and the State Forestry Administration</td>
<td>Promoted rehabilitation</td>
<td>City and county forestry bureaus, greening committees</td>
</tr>
<tr>
<td></td>
<td>Notice on ‘the notice’ by the Greening Committee and Forestry Bureau of Guangdong province</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>‘Planning compendium on ecological forest system development in Guangdong’ – To develop protective forests in the watershed area of four rivers</td>
<td>Promoted rehabilitation</td>
<td>Government at all levels and forestry authorities</td>
</tr>
</tbody>
</table>
## Learning lessons from China’s forest rehabilitation efforts

<table>
<thead>
<tr>
<th>Year</th>
<th>Relevant policies</th>
<th>Effect</th>
<th>By which actor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>‘Guangdong Province Forest Protection Regulation’—classification and management of forests as “commercial” or “ecological”, with a logging ban on ecological forests</td>
<td>Promoted rehabilitation &amp; strengthened forest protection</td>
<td>Government at all levels, forestry authorities, forest farms, farmers, local communities</td>
</tr>
</tbody>
</table>
| 1995 | ‘Measures for monitoring and evaluating the fulfilment of forest resource protection and development responsibilities’ in Guangdong.  
‘Detailed criteria for monitoring and evaluating fulfilment of responsibilities’ in Guangdong. | Promoted rehabilitation | Government at all levels, chiefs of administrative authorities, Guangdong Forestry Bureau, Guangdong Greening Committee |
<p>| 1996 | Notice to ‘speed up city forestry planning and development’ by the Guangdong government | Promoted rehabilitation | City, county and township governments |
| 1997 | ‘Administrative methods and measures for afforestation projects invested in by foreign businessmen and companies’ in Guangdong — Provision of preferential policies to promote investment in the forestry industry | Promoted rehabilitation | Foreign businessmen and companies |
| 1997 | ‘Notice on further strengthening the governance of forest resources in Guangdong, and strictly forbidding illegal logging and denudation’ | Promoted protection of rehabilitated areas and prevented degradation | All forestry authorities in Guangdong |
| 1998 | ‘Decision on organising the second forestry initiative to speed up forestry industrialisation and build high-quality ecological forests’ in Guangdong | Promoted rehabilitation | Government and forestry authorities at all levels, forest farmers, communities, collective and state forest farms, state enterprises |
| 1999 | ‘Administrative methods for ecological forests and its economic compensation measures’ in Guangdong | Promoted rehabilitation | Government and forestry authorities at all levels |
| 1999 | ‘Decision on developing individual and private economy’ in Guangdong province — to encourage the private and civil society to develop commercial forests | Promoted rehabilitation | Local individuals and civil society |</p>
<table>
<thead>
<tr>
<th>Year</th>
<th>Relevant policies</th>
<th>Effect</th>
<th>By which actor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>‘Decision to strengthen afforestation and greening achievements, and enhance forestry’s three benefits (economic, social and ecological benefits)’ by the Guangdong Government — Provision of some preferential policies to the non-public sector to speed up rehabilitation and develop commercial plantations</td>
<td>Promoted rehabilitation</td>
<td>All actors</td>
</tr>
<tr>
<td>2000</td>
<td>Guangdong government’s clarification and recertification of forest and forest land tenure</td>
<td>To clarify tenure, reduce conflict and promote investment in rehabilitation</td>
<td>All levels of government, forestry authorities, local farmers, communities, collective forest farms, civil society, enterprises</td>
</tr>
<tr>
<td>2001</td>
<td>‘Suggestion for developing and supporting forestry lead enterprises’ at the provincial level</td>
<td>To motivate local forest farmers to participate in joint afforestation efforts with companies</td>
<td>All administrative authorities, lead enterprises, local farmers</td>
</tr>
<tr>
<td>2001</td>
<td>‘Advice on accelerating afforestation and greening of degraded forest land in Guangdong’ — emphasised the responsibility system and related forestry policies</td>
<td>Promoted rehabilitation</td>
<td>All levels of government and forestry administrative authorities, farm households, foreign enterprises, private sector</td>
</tr>
<tr>
<td>2002</td>
<td>‘The decision on accelerating the development of mountainous areas in Guangdong’ by the Guangdong Government and Communist Party Committee</td>
<td>Promoted rehabilitation by developing the local economy and establishing ecological forests</td>
<td>All actors</td>
</tr>
<tr>
<td>2002</td>
<td>‘Approaches to certify qualified afforestation teams for project design, implementation and inspection’ in Guangdong</td>
<td>Enhanced afforestation quality</td>
<td>Forestry authorities at all levels and state forest farms attached to Guangdong Province, afforestation teams</td>
</tr>
<tr>
<td>2003</td>
<td>Approved ‘Scheme for creating forestry ecological counties in Guangdong’ Aims to improve environmental quality and green degraded lands through eight ecological projects</td>
<td>Promoted rehabilitation</td>
<td>All administrative authorities (city, county)</td>
</tr>
<tr>
<td>2003</td>
<td>Central Government’s ‘Decision on speeding up forestry development’</td>
<td>Promoted rehabilitation strongly</td>
<td>All actors</td>
</tr>
</tbody>
</table>
**Annex 3. Trees species planted by the sample rehabilitation initiatives.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Exotic/Native</th>
<th>Timber rotation</th>
<th>NAP</th>
<th>GG</th>
<th>Coast</th>
<th>City</th>
<th>SFF</th>
<th>PC</th>
<th>PI</th>
<th>JA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalyptus urophylla</td>
<td>Exotic</td>
<td>5-7</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masson pine (Pinus massoniana)</td>
<td>Native</td>
<td>18-30</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese fir (Cunninghamia lanceolata)</td>
<td>Native</td>
<td>15-30</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slash pine (Pinus elliottii)</td>
<td>Exotic</td>
<td>12-20</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td></td>
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</tr>
<tr>
<td>Acacia spp.</td>
<td>Exotic</td>
<td>5-8</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Acacia auriculiformis</td>
<td>Exotic</td>
<td>10-15</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Acacia confuse</td>
<td>Native</td>
<td>10-15</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
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<td></td>
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<tr>
<td>Acacia mangium</td>
<td>Exotic</td>
<td>6-8</td>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
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<tr>
<td>Schima superba</td>
<td>Native</td>
<td>7-15</td>
<td>3</td>
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<td>4</td>
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<tr>
<td>Castanopsis hystrix</td>
<td>Native</td>
<td>15-20</td>
<td>3</td>
<td>3</td>
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<td>3</td>
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<tr>
<td>Casuarina equisetifolia</td>
<td>Exotic</td>
<td>10-15</td>
<td>3</td>
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<tr>
<td>Albizia falcataria</td>
<td>Exotic</td>
<td>12</td>
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<tr>
<td>Teak (Tectona grandis)</td>
<td>Exotic</td>
<td>20-25</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Castanopsis fissa</td>
<td>Native</td>
<td>7-15</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Elaeocarpus sylvestris</td>
<td>Native</td>
<td>10-15</td>
<td>2</td>
<td>2</td>
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<td>2</td>
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<tr>
<td>Schima wallichii</td>
<td>Native</td>
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<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Lysidice rhodostegia</td>
<td>Native</td>
<td></td>
<td>1</td>
<td>1</td>
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<td></td>
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</tr>
<tr>
<td>Ormosia pinnata</td>
<td>Native</td>
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</tr>
<tr>
<td>Taxodium distichum</td>
<td>Exotic</td>
<td></td>
<td>1</td>
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</tr>
<tr>
<td>Pinus caribaea</td>
<td>Exotic</td>
<td>15-25</td>
<td>1</td>
<td>1</td>
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<td></td>
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<tr>
<td>Pinus taeda</td>
<td>Exotic</td>
<td>20-25</td>
<td>1</td>
<td>1</td>
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<td>1</td>
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</tr>
<tr>
<td>Acacia crassicarpa</td>
<td>Exotic</td>
<td>5-7</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Mytilaria laosensis</td>
<td>Native</td>
<td>20</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Betula alnoides</td>
<td>Native</td>
<td>20-30</td>
<td>1</td>
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<td>1</td>
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<tr>
<td>Other broadleaved trees (some fruit trees)</td>
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<td>30</td>
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<td>1</td>
<td></td>
<td></td>
<td>2</td>
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<td></td>
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</tr>
<tr>
<td>Fruit trees (Dimocarpus longan, Litchi chinensis, Camarium alba)</td>
<td>Native</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
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</tbody>
</table>

**Total samples** | 3 | 3 | 3 | 4 | 1 | 3 | 3 | 2

NAP – National Afforestation, GG – Greening Guangdong, Coast – Coastal, City – City landscape, SFF – State Forest Farm, PC – Private company, PI – Private individual, JA – Joint Afforestation