Processes Driving the Forest Transition in China

Perspectives from a livelihood-centred approach with empirical focus on Daxi village, Anji county

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Summary

The People's Republic of China (PRC) today confronts urgent environmental problems caused by demographic and consumption pressures which have historically led to forest loss and degradation. Millions have left poverty behind in China since 1978, although rising ecological footprints have caused widespread erosion, desertification, biodiversity decline, severe floods and draughts, connected both to deforestation and livelihood hardship. These inherited and new socio-ecological disturbances deeply moved Chinese society, whose growing environmental awareness resulted in the adoption of the New Forest Policy in the late 1990s. These 'Six Key Forestry Programmes' (*liu da linye zhongdian gongcheng*) have permitted to halt deforestation thereby catalysing a forest transition (FT) in the PRC, moving from an initial long period of forest decline – highly associated to demographic and agricultural expansion –to a period of forest recovery.

Within the PRC's borders, human-made forest plantations have expanded while natural forests yet present early-to-intermediate succession phases. Time is needed to consolidate the new achievements, improve the quality of forest ecosystems and further heighten the rural poor's living standards. At an international level, the FT in China has coincided with increased timber and agricultural imports linked to transboundary deforestation impacts. From a socio-ecological perspective, the FT in the PRC can be a positive signal to improve conservation and forest-dependent livelihoods in other developing countries and to raise critical concerns on highly-unequal resource distribution flows between income groups.

Research goal and Methods

In this PhD we try to assess the dynamics of livelihood strategies during the FT in rural China, exploring the theoretical and empirical implications about the role of forestry for poverty reduction and environmental conservation. We do so by combining macro and micro geographical scales of analysis – country level (PRC and international) and local level (Daxi village in Anji county, Zhejiang province) – which we hope can contribute to the understanding of processes driving the FT in China. We argue that the FT cannot be purely determined as a mere result of economic development – as if it were part of an inverse U relationship between income and the environment (e.g. environmental Kuznets curve) – given that *human agency* is one of its main causes through political-economic readjustment and policy implementation.

Historical statistical data were employed to analyse macro-level processes driving the FT in China, while local statistics and field work (questionnaires and forest inventories) were used to analyse micro-level processes permitting a fine-tuned understanding of the FT in the PRC. Bibliographic research on both Chinese and English information sources complemented this work, allowing for a theoretical perspective on the FT, forestry and poverty issues, and land tenure in the PRC and elsewhere.

Processes Driving the Forest Transition in China

FT's causes must be traced back to the interaction among: the underlying *demographic-technologic-economic-ecological* processes; the *political-economic* processes; and the *environmental consciousness* of a given society, in this case the modern Chinese society.

The FT in the PRC has been chronologically preceded by a long historical period of natural forest loss and land degradation (prior to 1949 and continued up to the late 1990s); a demographic transition in the mid-1970s; by a major political-economic transition brought by 1978 Reform – from the collective planned towards a socialist-market economy – readjusting work incentives and techno-environmental productivity at the livelihood base (first in farm activities and later in off-farm activities); and by an impending ecological crisis (daily affecting Chinese society at the livelihood base) epitomised by 1997 Yellow river draught and 1998 Yangtze river floods. Upon a growing ecological awareness in China in the end of the 1990s, the New Forest Policy was designed and implemented triggering the FT in China and paving the path for the development of ecotourism and forest environmental services.

As a consequence of these processes, forest area and standing volume have expanded from 121.9 million ha (12.7% forest cover) and 8,655.8 million m^3 in the first national forest survey (1973-76) to 195.5 mill ha (20.4% forest cover) and 13,720.8 mill m^3 in the last survey (2004-2008). This growth in area and volume were mainly attributed to pioneering plantation programmes that were complemented, after 1998, with the effective stabilisation and conservation of natural forests. Notwithstanding this progress, average volume density in Chinese forests still equals to 85.9 m^3/ha, being just 78% of the world average, while volume density in plantation forests is even lower with only 49.0 m^3/ha. Besides, current forest cover, per capita forest area and per capita standing volume only represent respectively two thirds, one fourth and one seventh of world averages.

Since the Reform of 1978 economic sectors in China have gradually internationalised their production leading to a rapid rise of living standards – and increasing per capita ecological footprints which already exceed the available national per capita biocapacity. The PRC's growth-based economic development model – in a manner similar to western societies – has reached a critical point where ecological pressures are increasingly put over forests and natural resources located in other regions of the world. Yet, developed countries' globalised economies do show comparatively higher per capita ecological footprints leading to forest loss and degradation mainly concentrated in the tropics. In this context, the PRC plays an intermediary role between net exporters (normally developing countries) and net importers (normally developed countries) of forest raw materials: first by importing from the former ones, later doing the processing in China and finally transferring part of the finished-end products to the latter ones.

Forestry, Poverty and Rural Development in China

Geographical isolation, poverty and lack of adequate technology in forested areas have traditionally resulted in low land productivity, linked to environmental degradation processes such as forest substitution by agricultural cultivation on slopes in western China. Increased land productivity through technological modernisation, however, has had a bigger rebound effect promoting further forest to cropland conversion in some regions, e.g. through the 1990s in northeastern China. One of the main 'Key Forestry Programmes' – The Sloping Land Conversion Programme (*tuigeng huanlin gongcheng*) – is aimed at stabilising the forest-agricultural frontier by reverting potentially-eroding cropland on slopes toward forest and pasture uses.

Within the forest sector itself, a first analytical distinction must be made between State-owned forests in the northeast and Collective-owned forests in the southern region; the southwest region contains a mixture of both State and Collective forests and concentrates important minority ethnic groups. A second division is made between two differentiated production regimes, i.e. timber forest vs. mixed (timber and non-timber) forest, the former type is highly associated to the State-owned category while the latter is related to Collective-owned forests.

Generally speaking, State timber forests also overlap with the remaining natural forests of the country which, due to the limited resource base, are managed under highly regulated timber markets leaving lower benefits to local rural populations. Up to the late 1990s this kind of forests has been employed as an industrial source of raw materials to foster economic growth, where 'a negative modernisation' followed provoking the forest reserve's exhaustion, amplified environmental problems and a State timber sector crisis. Under these circumstances, the Natural Forest Protection Programme (*tianranlin ziyuan baohu gongcheng*) meant the adoption of the 'logging ban' on natural forests, what has also negatively impacted local forest livelihoods with reduced harvests and forest workers' laid-offs. The Fast-growing Forest Production Programme (*susheng fengchan yongcailin jidi jianshe gongcheng*) has the objective of establishing human-made timber plantations in the south that can effectively optimise the still-unbalanced skewed-to-young timber reserve.

Collective non-timber forests such as bamboo plantations have benefited from more flexible ecological, managerial and economic regimes, i.e. shorter rotation periods, absence of allowable logging quotas and less regulated markets. Moreover, these forests have been subject to a process of 'devolution' – the dismantling of the Commune system in the early 1980s – allocating forest resources to household units. Under the Contract Responsibility System (*lianchan chengbao zeren zhi*) individual inputs were linked to individual returns, thereby improving work and investment incentives and promoting active afforestation by local communities. For these reasons, Collective non-timber forests have often witnessed a 'local forest modernisation path' characterized by technological innovation, diversification of goods and services and increased benefits associated to increased farm and off-farm incomes. From an ecological perspective, rural economic growth following 1978 Reforms was nonetheless linked to both forest-plantation expansion and natural forest degradation, thereby being subject to trade-offs between biodiversity and development goals. In some cases, non-timber plantations have substituted valued natural forests (such as the tropical area of Xishuangbanna), although such situations have been reduced since 1998. The implementation of the New Forest Policy, which meant the official recognition of the severe ecological crisis, has effectively redressed these problems protecting natural forests and further promoting the expansion of plantations.

Concerning the implementation of a successful forest modernisation path, we think several factors must be comprehensively explored. Firstly, forest technological innovation and extension plays an important role by linking together scientific research, collective action, farmers' individual behaviour and knowledge. Secondly, in the Collective-owned forested areas, the decentralised Contract Responsibility System is highly advisable for non-timber forest household management, where universal egalitarian land-rights provide households with important forest income-equalising sources. Thirdly, the New Forest Policy has shown positive outcomes in the case of the Sloping Land Conversion Programme – one of the greatest pro-poor conservation programmes in the developing world – whereas the Natural Forest Protection Programme has been linked to some social negative impacts. In a context of fast economic growth and widening income inequalities, pro-poor forest strategies based on both regional and local economic redistribution are an essential tool to lift rural living standards. Fourthly, forest-based eco-tourism may contribute to improve the rural livelihood-base while forest harvests provide the poor with *economic safety nets*. Both farm and off-farm income sources will thus continue to play a key role in forestry and poverty alleviation in China.

Micro-level Perspective from Daxi village, Anji county

Our direct source of information comes from Daxi village (大溪村), located at East 119^{o} 34' North 30^{o} 26' within Anji county (安吉县) in the eastern province of Zhejiang, also belonging to the Southern Forest Collective Region. Anji is a well-known bamboo homeland in China awarded with the title of 'National-level Ecological Model Area' (国家级生态示范区 *guojia ji shengtai shifanqu*) in 2002. This county is undergoing a deep transformation from a raw-material based forest industry towards a multi-purpose forest management with special emphasis on landscape values.

With a total area of 23.4 km^2 and a local population of 2,099 inhabitants, Daxi is made of eleven hamlets – former production teams in the Commune period – scattering across a local terrain ranging from 300 to 1,167 m.a.s.l. This village presents a low mountain monsoon climate with well-differentiated four seasons and an average annual rainfall of 1,570 mm (humid season in summer and snow precipitation in winter). Daxi is a highly forested village (90% forest cover), whose main forest uses are moso bamboo (*Phyllostachys edulis*), natural evergreen broadleaf forest (a highly biodiverse local secondary forest), Chinese hickory (*Carya cathayensis*), conifers (such as *Cunninghamia lanceolata*) and tea plantations (*Camellia sinensis*).

These forests are Collective-owned and managed under the Contract Responsibility System, i.e. households manage forests under very long-term contracts obtaining private income while formal property is vested at the Village Committee. On the other hand, Daxi has been part of the yearly official survey carried out in rural China, thereby providing a socioeconomic data track required for longitudinal research. These records were complemented by in-depth field research at Daxi consisting of a socioeconomic survey on the local population (92 households), forest ecological inventory (biodiversity, biomass and coverage measured across 32 forest plots) and another socioeconomic survey on ecotourism (both locals and visitors).

Macro-Structural Change, Livelihoods and the Forest Transition

In the last three decades Daxi village has undergone a 'forest modernisation path', a deep transformation in forest use and exchange values. A traditional forest culture, essentially an economic activity (direct production) highly integrated within the ecosystem biophysical limits, has been gradually replaced by a modern forest culture distinguished by increasing physical productivity and a higher degree of economic exchange (landscape use). In the Collective Era low work incentives – and concomitant low productivity – were linked to highly constrained incomes at Daxi, of just 273 RMB per capita-year (1978-79). Ecological footprints were presumably kept under considerably low levels but material standards were also very low. The fact that natural forests kept under a certain high pressure was the most noticeable ecological impact.

At the broad political-economic level, in December 1978 the 11th Central Committee at the Third Plenary Session initiated a key *macro-structural* adjustment in China. In Daxi, its first consequences were felt in 1982 with the adoption of the Household Responsibility System for agriculture, and in 1984 with the Contract Responsibility System for forestry. People's Communes were dismantled into a decentralised egalitarian forest management – now run directly by households – improving individual work incentives that led to a moderate income increase, 317 RMB per capita-year (1990-91). Farmers maintained a high degree of economic equality (Gini 0.21), although living under still autarchic conditions and their income and purchasing opportunities being rather limited.

During this phase 1978-1990 Daxi's economy was still largely planned and could be regarded as a 'collective-decentralised economy'. The majority of peasants made a living by investing their physical work into intensive bamboo plantations – the basic livelihood in the village – whose harvests were used for yet limited exchange and self-consumption (housing, bamboo shoots). Natural secondary forests were still suffering heavy pressure (firewood), while some rice plots were cultivated for self-consumption in the suitable-but-limited lowlands (valleys). Bamboo management was thus the most attractive available income source while off-farm activities were still almost inexistent.

Under these circumstances of high reliance on direct forestland productivity, a local land tenure institutional innovation appeared – the IFCS (Inter-household Forest Compensation Scheme) – in order to tackle household demographic changes which distorted the original egalitarian distribution of forestland (applied in the early 1980s). We argue that the IFCS has promoted a compromise between equity and efficiency, able to solve typical plot boundary conflicts after the CRS was implemented, thereby raising forest physical productivity by 33%.

The IFCS can be considered as an effective transitional redistributive system from a collective towards a market economy, although nowadays plays a very discrete role in Daxi's local economy – per capita compensation just representing only 1.5% of annual net per capita income.

Since 1992 building a reversible hydroelectric station and a new road has brought a major change in the livelihood-base at the village. The establishment of these infrastructures, which meant an important negative ecological impact over households living at hamlet 10, simultaneously let Daxi integrate into the regional thriving economy (Shanghai – Hangzhou – Nanjing triangle). In other words, the recent changes in the broad political-economy in China – since 1992 called socialist-market economy – could be fully felt at the village, once techno-economic conditions (new road and the attractive effect of the dam) had been improved at the local level. Moreover, the opening of Daxi to the external world has occurred just few years earlier than the adoption of the New Forest Policy and an increasing demand for environmental services and forest-based ecotourism. This has also permitted Daxi village to swiftly accommodate to these new policy changes, thereby a major forest transition following at the local level.

The local mode of production or livelihood-base – i.e. the way Daxi inhabitants sustain their basic-daily economic subsistence – has been deeply transformed from traditional socially-generalised forests harvests (supported by physical work) towards a modern fast-growing ecotourism (managerial and service work) compatible with forest-wage labour. As a result, a dramatic improvement in material standards has followed, per capita income reaching 8,820 RMB in 2005-06 or an 8 fold increase in real RMB terms since 1978. Traditional intensive forest extractive activities have been simultaneously replaced by a new model of sustainable management in Daxi, combining an extensive bamboo regime with the conservation of natural secondary forests.

These two types of forests have complementary ecological characteristics, bamboo with high alpha biodiversity index at shrub and herb layers and natural forests with an extraordinarily diverse tree layer. Natural forests have also begun a slow but significant recovery after decades of overexploitation and do have a great potential for carbon sequestration. However, the local carrying capacity can be easily overloaded with increasing ecological footprints - waste and sewage from hostels - and loss of land biodiversity/integrity – expansion of tea intensive plantations, tourist housing settlements, roads and other infrastructure (power station). Therefore, we can talk about a *partial* forest transition in Daxi, which has been propelled by the shift in the local mode of production (from intensive forest harvests towards extensive bamboo management, natural forest conservation, intensive tea plantations and ecotourism hostels) and the expansion of the local and (especially) tourist populations.

Recent changes in the local mode of production and the massive arrival of a visitor population, indeed, pose a qualitative shift in human-forest relations that obviously goes beyond that previous rather integrated culture of intensive bamboo plantations and natural forest harvests. Firstly, autarchy no longer holds and thus incomes have increased– something that most local inhabitants greet (88% of those interviewed said their livelihoods had improved somewhat or significantly) – what means that economic exchange flows nowadays transcend the biophysical limits of Daxi. Personally, we believe this is very positive to the extent that it increases local material living standards. On the negative side, we also contend that 'unlimited' and uncontrolled growth would just undermine the very existence of local ecotourism and could severely degrade local forest ecosystems and their integrity. Unlimited is just a paradox itself – ecosystems are finite – and realistically cannot be a model for development.

Land Equality, Inequality, Gender and the Forest Transition

This 'forest modernisation path' has hinged on an equally important specific characteristic of the Southern Collective Forest Region in China – forest land allocation on a per-capita basis among the local population. The collective property of land, inherited from the Maoist period, meant the egalitarian allocation of bamboo, hickory and tea during the implementation of the CRS and its strengthening through the adoption of the IFCS. This situation has provided local dwellers with their equal right to access and benefit from natural resources, thus guaranteeing a basic farm-based income potential – especially that coming from bamboo safety-net income sources.

The profound change in the local livelihood-base, however, has brought new income differences along a *spatial gradient* between richer down-hill hamlets and poorer up-hill hamlets. Gini coefficient has rose up to 0.28 reflecting a higher inequality within the local population, a trend mimicking the general increase in income inequalities for the whole of China. High-income farmers tend to dominate those forest-related activities showing highest economic returns, maximising capital and wage-labour investments, whereas middle and low income households are economically more dependent on less-profitable forest activities and will diversify them to cope with economic risks.

The case of Daxi reveals the highly dynamic economic roles of forest resources during the development process taking place in in Anji county, where formerly attractive intensive bamboo harvests (in 1990) have gradually been displaced by a new bourgeoning ecotourism and intensive tea plantations. Bamboo is nowadays acting as an important local safety-net being the poor's key-strategic resource, hickory trees being an attractive resource in isolated hamlets which are linked to middle incomes, while rural hostels (*nongjiale*) are associated with more restrictive initial capital conditions (dominated by higher income groups) and favoured by more limiting geographic locations (down-hill well communicated areas).

Upon this reality, we believe that in the near and mid-term forest/agricultural land privatisation is not the solution, neither from a theoretical nor from a practical standpoint. A hassled privatization could lead to some not-yet-present problems in rural China such as land concentration in a few hands, landless farmers, and ultimately the privatisation of commons.

During this recent period we have also found an increasingly gender-age specialisation in the forest-based ecotourism sector, especially at down-hill hamlets, by which younger women often tend to run or work as wage labour in ecotourism hostels-shops while younger men often tend to work at jobs generally located outside the village. Obviously, we think it is quite positive that women are directly capturing an important share of exchange value, what very likely will empower them to make decision choices within the family sphere and the broader society. However, the very same ‘forest modernisation path’ is also reinforcing traditional patriarchal roles which could exert negative outcomes in the long run, what might hinder their access to power within the broader society.

Livelihoods, Conservation and Development in Rural China

Forest ecosystems in this country, limited as we have seen both in absolute and relative terms, are subjected to a still heavy demographic pressure and newly expanding consumption demands for both timber products, forest environmental services and forest recreational uses. The current strategy outlined in the New Forest Policy tries to conserve the remaining 133 million ha of natural forests, to foster the today yet-limited productive potential of 62 million ha of plantation forests, and to promote further afforestation efforts on low-productive marginal lands.

The Chinese experience teaches us that extreme autarchy – which proved ineffective, not realistic and sometimes tragic in the Maoist period – did not succeed as a ‘way out of poverty’, especially in a world dominated by acutely unbalanced North-South power relations. However, some concepts such as economic redistribution and pro-poor growth – widely popularised in the PRC respectively through the early 1950s’ agrarian movement and later in the early 1980s - are worth regaining for the present and future, in China and in the developing world. Within the boundaries of a finite ecosystem, this means that higher incomes must decrease redistributing in favour of poorer groups and peasants, whose living standards must increase: there is thus a differential degree of responsibility within a global and regional context of exacerbated inequalities. From our analysis it can be also deduced there are important trade-offs between living standards and ecological integrity, thereby reinforcing the need for imposing absolute ecological-footprint limitations to higher income groups who must ecologically and economically compensate to raise lower income groups’ material living standards.

Endless economic growth is thus unfeasible in physical terms – at global, national and regional dimensions – usually becoming a source of environmental distress posing negative effects within both the intertwining socioeconomic and ecological levels. Globally, we are today consuming 1.5 times the goods and services that the Biosphere provides us in a year, in other words, world ecosystems, and notably forests, are retreating and shrinking. Since the 1970s, the PRC has also surpassed its available per capita bio-capacity, putting overwhelming pressures over its natural resources and on the global ecosystems. Higher income groups and developed countries nowadays rely on an economic model that is highly unsustainable, unrealistic and unjust. Therefore, we need alternative perspectives to build up a new socio-ecological paradigm which could be practicable, universalised and adapted across our cultures, which conveniently tackles the forest-poverty link from a multidimensional standpoint.

概述

中国目前面临着重要的环境问题：如水土流失、沙漠、旱涝、洪灾的扩大和生物多样性的下降。这些与林业相关的问题来自于人口与经济增长产生的给森林的压力，而这个毁林过程在古代与现代的历史上都产生重大影响。随着 1978 年的改革开放政策的实行，虽然几亿农民脱贫致富，但是天然林不断加剧的退化导致了农民生计的严重流失。在九十年代末这些环境危机使中国社会深受冲击，对生态的意识越来越高，从而为新的林业政策的出台铺平了道路。“六大林业重点工程”的实施有效地阻止了天然林的退化以及扩展了人工林的面积，于是能够进行从长期毁林阶段到最近的森林恢复阶段的过程, 这就是“中国森林转型”。

中国的森林还处于初期恢复阶段，这表现在一方面天然林还处于早期或中期的脆弱生态演替中，而另一方面新建立的人工林还未达到最高的生产潜力。根据实际情况，为了健全中国森林生态系统相关服务功能和提高中国森林社区的生活条件，需要继续实行中国新的林业政策。此外，中国森林转型是与由于世界经济全球化趋势在国外导致的毁林有关过程同时发生，为解决这些森林破坏与贫困相关的国际冲突需要增强国际合作。从社会与生态角度来看，中国森林转型对发展中国家提高森林保护与农民生计的条件传递重要的信号，它又强调了森林破坏与贫困相关的国际冲突显示的森林资源在不同收入阶层之间分配不均的意义。

研究目标与方法

当中国森林转型发生时，这项研究任务以森林生计有关动态的估量为目标，对于中国林区摆脱困境与森林保护寻求了理论和证据的含义。理解到中国森林转型的原因过程，我们考虑到宏观和微观两种地理级别。于是，我们一方面分析了中国国内外因素引起中国森林转型的过程，另一边以浙江省安吉县大溪村为例分析了当地因素引起的当地森林转型的过程。关于引起森林转型的原因过程，研究结果表明它不可能纯粹由经济发展所导致，即不可能由收入与环境之间倒 U 型的关系所决定（环境 Kuznets 曲线），因为新的林业政策作为其主要原因中之一扮演着决策性的重点角色。森林转型是通过积极的政治经济调整以及实行政策的因素而产生的。

我们使用了关于中国森林与农业面积的历史性统计资料，来分析宏观级引起的中国森林转型的过程。与此同时，还使用了安吉县大溪村的当地统计资料以及实地考察农户和游客调查问卷以及森林资源清查分析微观级所引起的详细过程。根据这两种方法，我们希望对理解中国森林转型这个过程能够给大众提供其理论和证据的贡献。我们的研究工作通过参考中文与英文的相关文献、书籍以及相关资料，得到了对森林转型、森林与贫困方面以及中国土地获得权的理论。

引起中国森林转型的原因过程

中国森林转型是在三种原因过程互相作用下而产生的。第一种过程，是由人口、经济、技术以及环境的生计基础因素所引起的。第二种就是政治经济的过程。第三种则是由社会的意识对环境所引起的。按时间顺序，在“中国森林转型”之前发生了几个与生计基础、政治经济以及社会意识有关的重要实际事件：

一. 天然林的流失和退化，既是在长期作用下（1949 年前），又是在短期作用（1949 年后以及 1978 年后）下所产生的。其主要原因是人口与经济的增长。
二. 在七十年代出现的早期的人口转型，逐渐把人口增长给中国森林的压力缓解了。
三. 1978 年的改革开放政策，在生计基础上，刺激和提高了农林和非农林工作的奖励、技术与环境的相互影响的效率以及乡镇企业的扩展。
四. 在九十年代末出现的严重的环境危机，在生计基础上，中国社会已经感受到了其消极的作用。

随着中国社会对环境的意识越来越高，新的林业政策推动了中国森林转型的发生，因此为森林社区的生态旅游和森林环境生态服务功能开辟了新的林业经济领域。

中国森林转型使森林面积从第一次全国森林资源普查的 12186 万公顷增加到第七次的 19545 万公顷，也使森林蓄积从第一次全国森林资源清查普查的 865579 万立方米增加到第七次的 1372080 万立方米 （国家林业局森林资源管理司, 2010）。森林覆盖率从 12.7%增长到 20.4%，是由于培育人工林先驱工程以及 1998 年后天然林资源保护工程建成的。

除了这些进步以外，与世界森林覆盖率、世界森林人均面积以及世界森林人均蓄积的平均数相比，中国森林资源分别只有世界平均数的三分之二、四分之一和七分之一。而且，中国森林资源的平均密度为 85.9 立方米/公顷（等于世界平均数的 78%），中国人工林的密度甚至只有 49.0 立方米/公顷。也就是说，中国的森林还处于初期恢复阶段，而庞大的人口和快速的经济增长仍然给国内的森林业巨大的压力。

随着 1978 年的改革开放政策的实行，中国经济逐渐的国际化普遍改善了人民生活条件。尽管如此，与西方国家基于破坏大自然的历史性经济模式相同，中国基于经济增长的迅速模式已经超过了中国国内生态服务功能所能提供的容量。从这个社会与生态角度来看，中国的经济发展不仅达到了对生态环境的临界点，甚至把国内人口与经济的压力放在世界国外其他地区的森林和自然资源了。但是，根据世界经济全球化趋势现有的实际情况，中国和发达国家相比，中国还未达到发达国家对世界森林资源不可持续的人均生态足迹的程度。在世界热带原始森林正在发生其流失和退化中，中国扮演着一个媒介的角色：先从发展中国家输入森林原料，再把这些原料在国内加工，最后把森林成品输出发达国家。这些国际关系显示非常不平衡的交易过程。

在中国农村的森林、贫困和发展

中国林区原本是与地理隔离、贫困以及技术缺欠密切相关的。在这条件下，农业土地生产率不高更促使森林改成为农业田地，如在中国西部的山坡上的当地环境的恶化。当技术现代化终于到达了这些边缘的林区时，农业土地生产率的提高常常产生一种土地反弹，如在九十年代中国东北林区中森林被耕地所替换的增加。对于农业对林业的有害代替，由于中国林区已实行了十多年的退耕还林工程，其目标为阻止因在山坡上农田引起的潜在的水土流失而归还林草土地使用，这些地区就进步了不少。

从中国林业的角度来看，首先得按照林区现有的生产模式以及所有权，把森林地区划分为东北林区、西南林区和南方林区（还有北方林区和西北林区，但其森林资源相对较少）。东北林区主要具有由国有体制所管理的用材林的特征。西南林区主要具

有由国有、集体体制和少数民族所管理的用材林和非用材林的特征。南方林区主要具有由集体体制所管理用材林和非用材林的特征。

中国剩余的天然林与国有用材林大有重叠，一直到二十世纪九十年代末，这种“国有天然用材林”为了经济增长而受到了严重破坏。基于森林相关原料的“消极现代化”，促使这种森林资源的减少和衰竭，森林环境的干扰的扩大化在九十年代末导致了国家木材领域的经济危机。因为中国的国有林资源实在有限，所以木材的供应量目前由严格的生态要求所管理，天然林资源保护工程就诞生了。根据以上情况，天然林被禁止的采伐意味着中国林区生计的恶化。天然林资源保护工程先推动了森林相关收获的降低，再引起了林区林场员工的下岗。除了这“六大林业重点工程”中之一外，还有速生丰产用材林基地建设工程，其目标为促进用材林资源的快速发展与稳定，从而把现有偏向年轻树木的中国森林改成更有平衡和生产性的资源结构。

与国有天然用材林相比，中国的集体经济林给农民提供更有利的形式，其生态、管理和经济条件更为灵活，如竹子相关收获的短周期、不受禁采伐以及具有比较繁荣的市场。另外，这些森林由于八十年代初人民公社制度的逐渐消失，给分配到每个农户单位。在林业联产承包责任制下，个人劳动和个人回报相挂钩，因此当地社区提高了农户的工作效率、投入的奖励以及造林的实施。由于这些原因，集体经济林经历了一个有创新技术的当地“森林现代化之路”、林业货品和林业服务的多样化以及与农林和非农林使用相关的增长的奖金激励的进程。从生态的角度来看，随着 1978 年的改革开放的农村经济增长却是和扩大造林规模与天然林的损耗紧密联系，显示了生物多样性和经济增长目标的矛盾。存在一些例子是经济林的种植园代替了宝贵的天然森林（如西双版纳的热带区），即使从 1998 年开始这个情况已经改善。新的林业政策的实施意味着当局对严重生态危机的认知，并且有效地通过保护天然森林和对扩大造林规模的促进大大地缓解了相关的压力。

鉴于森林现代化之路的成功，我们认为还有一些值得开拓的关键点。首先，林业技术的创新和传播对于科学研究、团体合作和农民的个人技术与知识扮演重要角色。第二，在集体所有林区的林业联产承包责任制，对于非用材林区的农户管理，是高度被推崇。在这些集体林区，常规的土地平等获得权提供给农户重要与收入相关的林业资源。第三，新的林业政策在退耕还林工程——在发展中国家中脱贫的其中最成功的林业政策之一，显示出非常正面的结果，虽然天然林资源保护工程与一些负面的社会冲击有关。在经济高速发展和贫富悬殊的扩大的背景下，基于地区和当地经济再分配的脱贫的林业策略是提高乡村生活条件的重要工具。第四，基于森林资源的生态旅游可以改善农村生活条件。另外，森林的收获可以给贫困百姓提供基本经济收入。无论是农林还是非农林的收入资源都会继续在中国的森林业和脱离贫困化，这两个领域扮演着关键角色。

以安吉县大溪村为例的微观视角

位于浙江省的安吉县（东经 119º 34′ 北纬 30º 26′）为我们提供直接的信息来源。它属于南方集体林区，是中国著名的竹乡，在 2002 年被评为国家级生态示范区。安吉县正在经历从林业基本原料的工业向一个以珍贵风景为重点的多个森林管理目标的深刻转变。

大溪村拥有 23.4 平方公里的面积和 2099 位居民，由十一个村落小组构成的。这些小组是以前公社时期的生产队，散落在由 300 到 1167 米海拔高度之间。大溪这条村庄拥有四季分明的低山脉季风气候，年平均降水量为 1570 毫米（夏天湿润，冬天有雪水）。大溪村的森林覆盖率很高（90%），森林主要是由毛竹林(*Phyllostachys edulis*)、天然常绿阔叶林（当地次生森林的生物多样性非常丰富）、中国山核桃(*Carya cathayensis*)、针叶林（*Cunninghamia lanceolata*）和茶叶种植园（*Camelia sinensis*）所构成的。

这些树林均属于集体所有体制，按照林业联产承包责任制来管理，即村委持有这些森林的土地所有权时，而农户在长期合同基础上获得林业私有收入。另一方面，大溪村是一条属于中国农村年度官方调查的村落，则给我们提供了长期研究所需要的社会经济的数据来源。通过深入的实地研究收集了当地居民（92 个农户）的社会经济调查，森林资源的生态清查（分布在 32 块用地的生物多样性、生物量以及覆盖率），和关于生态旅游社会经济调查问卷（当地居民和游客）。

在中国的宏观的结构调整、农村林业生计以及当地森林转型

过去的三十年，大溪村经历了一个关于林业资源使用价值与林业经济交换价值的深度变革，这也可被称为“森林现代化之路”。过去的森林文化，完全是为了林业生产的使用价值而由高度和生态系统生物物理限制整合的经济行为所代表的，现在则逐渐地被一种现代的森林文化所替代。而这种新的森林文化的特点是高度的林业生产率与高度的经济交换（风景价值）。在过去的集体时期，迫于低廉的工作奖励和相关低下的生产效率，每年人均收入十分有限仅为 273 元人民币（1978 年−1979 年）。那时大溪的物质条件非常贫穷，即使当地生态足迹得到了平衡的程度，我们也不能称这情况为一条“可持续发展之路”。而且，天然林在那时期中也受到了不少的压力。于是，农民生活的物质条件与森林的生态环境保护显示的矛盾，让我们对此得深思熟虑。

从政治经济的角度来看，中国共产党于 1978 年十二月在北京举行的第十一届中央委员会第三次全体会议，提出了重点宏观的结构调整。关于我们研究区，改革开放政策的实行意味着大溪村在 1982 年农业家庭承包责任制和 1984 年林业联产承包责任制的贯彻落实，以致人民公社体制被拆卸。按照当时的政策规定，森林资源从集体管理改为一种分散的由农户单位所负责的管理，这个重要变化具体地改善了各人的工作奖励而使实质收入适度地增加到 317 元人民币（1990 年−1991 年）。

在这段早期（1978 年至 1990 年）的改革时期中，大溪的生计活动还是大部分地被计划经济制度所决定，而这段时期可以被认为是一种“使集体经济分散化的阶段”。虽然当地农民持有相对较高的经济平等程度（Gini 指数为 0.21）, 但是因他们还生活在自给自足条件下而其经济收入与购物力还较有限。当时，本地多数人的基本生计主要是依靠把体力劳动投资在竹子集约型的森林中生活的，另外竹子收获还用于有限的经济交换和家庭自足消耗（如房子和竹笋）。由于非农林活动当时还非常有限，竹林管理与收获代表了最有吸引力的经济活动。除此之外，天然林受到了为获得木柴而引起的重大压力，同时在少有的适当低洼地还有栽种一些让农民在自足消耗中收获大米的水稻。

在此生态生活条件的基础上，当地人口高度依靠着林业土地的生产率，从而出现了一个关于森林土地获得权的当地创新，即“家庭间森林补偿计划”。其目标为抵消由每个家庭的人口变化而产生的对八十年代初森林责任权平等分配的不公平的影响。我们认为家庭间森林补偿计划的主要成果是达到一种平等与效率的折衷妥协，这能够解决那些和进行林业联产承包责任制后有关的常见的森林土地农户间的边际冲突。研究结果表明，林业土地生产率在 1986 年至 2004 年其间有了 33%的实质增长，因此我们有证据评定到家庭间森林补偿计划是一种有效地作为从集体计划经济经济到社会主义市场经济的转型的再分配制度制度。既然家庭间森林补偿计划的人均补偿目前只是年度人均收入的 1.5%，它就仅仅扮演着对大溪经济的一个的微小角色。

大溪村在 1992 年建造的基础设施，即高科技的水坝电站和新开的公路，对当地的基本生计带来了重要的变化。这些基础设施，对居于大溪十组的农民的生态与生活条件带来重要的消极冲击，但是却使大溪村和兴隆的上海、杭州以及南京三角的经济结合起来。在中国政治经济的巨大变化（改革开放政策）中，一旦当地的技术与经济形势被这崭新的投资所改善，这些重点变化就对大溪生计基础产生非常明显的影响。况且大溪村对于外世界的开放，仅仅比新的林业政策的实行、中国社会增加对生态服务功能的需求以及中国社会增加对基于森林的生态旅游的需求等较早几年发生。据这事实，大溪的生计就快速地适应了这些新的林业政策，从而新的变化准许“当地森林转型”的发生。

当地的生计基础或生产方式，即大溪居民持有其日常与基本经济性生存的方式，从过去的社会性普遍依靠体力劳动的林业收获被变革成为现代的快速增长的依靠经营与服务工作的生态旅游与林业雇工整合而产生的全新的生产方式。研究结果表明，随着这新的和生计基础有关的重点变革，大溪村的物质条件显示显著的提高：从 1978 年开始以实质价值八倍地增加到人均收入为 8820 元人民币（2005 年-2006 年）。与此同时，传统的集约型经营的森林收获被新的可持续森林管理所替代，后者的主要特征是毛竹林粗放型经营模式和天然林保护整和的森林管理体制。

当然，这两种森林有着互补的生态特点：毛竹林在灌木层与草本层上拥有高度的 α 生物多样性指数，而天然次生常绿阔叶林在桥木层拥有相当可观的 α 生物多样性指数。更重要的是，经历了几个年代后的过度地开采，天然林已进入一段恢复的时期，这种森林表现出非常高的吸收碳的潜力。与此相反，近年来生态足迹的提高不幸地威胁着大溪村的生态自力更生能力，如集约型经营的茶叶种植园的扩大、“农家乐”和基础设施的扩建。总体上，当地的森林转型由当地的生产方式变革（从过去的集约型林业收获到竹林粗放型经营、天然林保护以及新来对环境的矛盾扩大）和最近游客人口增长所引起的，其实是一场部分森林转型。

近年来在大溪村中这两种生产方式与游客人口增长的精深变革，对于人与森林之间的关系，超越了由竹林与天然林过去集约型收获的高度整合而组成的生存文化。这些系统性的变化不是简单的定量变化，而是对大溪居民和环境的复杂的定性挑战。从积极的角度来看，因为今日的经济交换超过了大溪村的生物物理性限制，所以过去的自给自足的生活条件已经消失了，而人均收入的提高特别快速——在实地考察中访问的 88%农户发表了对这些变革的肯定意见。也就是说，当地居民觉得自己的生活条件得到了明显改善。我们亲眼地看到，关于当地生计基础的根本变化提高了的物质条件，

这些生产方式的变化果然是十分积极的。但是，从批评性角度来看，我们判断目前的无限制经济增长可能会败坏当地森林生态系统，因此恶化本地生态旅游的物质基础。

森林平等获得权、经济不等式、性别研究和森林转型

围绕着南方集体林区的“森林现代化之路”有一个重要特点：当地农民拥有一种根据人均森林资源来分配的林业土地获得权。从集体时代继承的土地集体所有制，在我们研究区通过林业联产承包责任制与家庭间森林补偿计划的实行，产生了竹林、山核桃和茶树在农户之间的平等性分配制度。既然集体体制给本地居民提供了林业土地平等获得权以及森林资源的效益权利，就保证了共同源于林业收获的基本收入，特别是那种来自于竹林的基本经济来源。

目前这种与林业土地获得权相关的基本收入之所以变得特别重要是因为，随着中国普遍的贫富不均趋势，当地生计基础的变革导致了新的经济差距（Gini 指数已为 0.28）。大溪村现在有一个根据海拔高度而波动的收入坡度：海拔较低更容易到达的村落小组有着比较繁荣的生活条件，而海拔较高的小组却表现着相对贫穷的经济生活。这些经济距离也意味着农民间不同生计的含义：一方面高收入的农户常常控制那些有最高经济回报的林业活动，其资本与雇工投资增加到最大限度；另一方面低收入的农户一般依靠有较低收益的林业活动，为了应付经济风险而表现多样化的经济行为。

大溪村的例子显示了在安吉县发展过程中关于森林资源的具有高度活力的经济角色。在过去（1990 年）的引人注目的竹子收获已经逐渐地被蓬勃发展的生态旅游和集约型的茶叶种植园所取代。在当代社会，作为贫穷阶层的关键策略性资源的竹林是当地一种重要的经济保证的自然资本。而作为一种在隔绝村落小组里有吸引力的森林资源的山核桃林，由于“农家乐”受限于经济水平（多数是高收入群体）以及对于地理位置的高度挑剔（交通发达的低海拔区），是和中等收入密切相关。

根据这一现实，我们相信短期和中期的森林/农业土地的私有化，无论是从理论或实际的角度来说，都不会是一个解决方法。而关于私有化的争论会在中国农林区导致一些为时尚早的问题：如少数农户或公司掌握多数土地、无田可耕的农民以及最后共同资本的私有化。

近期内，我们也发现在以森林为基础的生态旅游中一种不断增长的和性别与年龄相关的特点。特别是在低海拔的村落小组，年轻女性经常会在生态旅游的旅馆和商店从事工作，而年轻男性则一般在大溪村外工作。显然地，我们认为女性在这项生态旅游的产业里直接参与经济交换活动是非常积极的，因为这能赋予她们对家庭和广阔的社会作出更多决策权。然而，同样的这种“森林现代化之路”也会加剧传统父权制的性别分工，从而会长期产生消极效果，有可能妨碍她们对于广阔社会的参与和影响。

在中国农村的森林生计、森林保护和发展

无论是在绝对的还是相对的角度来说，在中国的森林生态系统仍然受限于沉重的人口压力和对于林木产品、森林环境服务功能以及森林的娱乐消遣使用的快速消耗需求。在新的林业政策里，一项被强调的策略是保护剩余的 13300 万公顷天然林；培育现今只具有限生产潜力的 6200 万公顷人工林；以及提高低效的边缘土地的再造林改造。

在中国的经验让我们学会，完全的自给自足是无效的、不实际的甚至是悲剧的，它并在集体时期中没有使中国人民走出贫穷之路，特别是当世界还处于尖锐的南北部不平衡的权力关系。但是，诸如经济再分配和脱贫的发展之类的概念——五十年代初农业土地改革运动和之后的八十年代初在中国被广泛的提出，在当今和将来在中国和其他发展中国家值得再发扬和提倡。由于生态系统的限制化，高收入群体必须向益于贫穷阶层和农民作出财富再分配，使得他们的生活状况提高。因为在这个全球和局部地区日益加剧的不平衡的环境下存在着不同程度的责任。通过我们的分析可以推断出，生活条件与生态融入能够产生重要的交易，从而需要有效地限制高收入群体的生态足迹。同时，在生态和经济上，高收入群体又必须赔偿给低收入群体提高后者的生活条件。

无限制的经济增长，无论是全球、国家级还是局部地区，在自然界中是无法实现的，通常只会变成一种纠缠在社会、经济和生态层面上的投射出负面效应的环境压力来源。我们现在每年消耗着生物圈能够给我们提供的 1.5 倍的原料资源和生态服务功能，也就是说，全球生态系统和森林资源正在消减。自七十年代中国已经超过了其人均能够获得生物容量，从而在天然资源和全球生态系统上施加巨大压力。高收入群体和发达国家现在依靠着一种不能受到支持的、不现实的以及不公平的经济模式。因此，我们需要有前景的解决办法来建立一个实际的、综合的和适用于我们各种文化的，能够方便于解决这个的森林和贫困相连的新型多视角的社会与生态模型。

Resumen

En la actualidad, la República Popular China (RPC) se enfrenta a urgentes problemas medioambientales causados por presiones demográficas y económicas que históricamente han estado asociadas a la pérdida y degradación de bosques naturales. Desde la Reforma iniciada en 1978 millones de personas han escapado a la pobreza en la China rural, si bien la creciente huella ecológica ha provocado el agravamiento de la erosión, desertificación, la pérdida de biodiversidad, así como severas sequías e inundaciones, todos ellos vinculados a la deforestación y la amenaza directa a los modos de subsistencia de la población (especialmente rural). Estos fenómenos adversos conmovieron profundamente a la sociedad china, cuya creciente conciencia ecológica llevó a la adopción de la Nueva Política Forestal a finales de los años 1990. Los 'Seis Programas Forestales' (*liu da linye zhongdian gongcheng*) han permitido detener la deforestación catalizando de un modo eficiente el proceso de Transición Forestal (TF) en la RPC. En consecuencia, se ha logrado dejar atrás un largo período histórico de pérdida forestal – directamente asociado a la expansión demográfica y económica – encaminándose hacia una nueva etapa de recuperación de los bosques.

Dentro de las fronteras chinas, las plantaciones forestales se han fortalecido mientras que los bosques naturales todavía presentan fases tempranas-intermedias de sucesión. Por ello, se requiere tiempo para consolidar los objetivos ya alcanzados, mejorar la calidad de los ecosistemas forestales y profundizar aún más en la mejora del nivel de vida de los habitantes del medio forestal-rural. En un plano internacional, la TF en China ha coincidido con el incremento de las importaciones de productos agrícolas y forestales vinculados a impactos de deforestación transfronteriza. Desde una perspectiva socio-ecológica, la TF en la RPC supone una señal positiva para la conservación forestal y la mejora de las condiciones de vida de la población forestal-dependiente en países 'en vías de desarrollo', al tiempo que contribuye a concienciarnos de los patrones desiguales de distribución de huella ecológica entre distintos grupos de ingresos.

Objetivo de Investigación y Metodología

En este trabajo queremos estudiar la dinámica de los modos de vida campesinos durante la TF en China, explorando las implicaciones teóricas y empíricas sobre el rol de los recursos forestales en el desarrollo rural y la conservación de la naturaleza. Se combina una perspectiva con escalas macro- y microscópica – a nivel de China y a nivel local en el municipio de Daxi en el condado de Anji (provincia de Zhejiang) – que se espera pueda contribuir a la compresión de los procesos causales de la TF en la RPC. A lo largo de esta páginas, se argumentará que la TF no se puede determinar como un resultado automático del desarrollo económico – como si fuese parte de una supuesta relación de U inversa entre la renta per cápita y la deforestación (ej. Curva ambiental de Kuznets) – dado que *la acción humana* es una de sus principales causas a través del reajuste político-económico y del diseño e implementación de políticas forestales.

Se han empleado datos históricos de estadísticas forestales, agrícolas y demográficas para evaluar los procesos generales causales de la TF en China mientras que, a nivel local, se han

utilizado las fuentes de las estadísticas oficiales y trabajo de campo (cuestionarios y muestreos forestales) permitiendo comprender el modo concreto en que operan dichos procesos. Complementariamente, la investigación sobre las publicaciones disponibles en idioma chino e inglés ha proporcionado la formación teórica para abordar el estudio de la TF, la conexión pobreza-recursos forestales, y la tenencia forestal y agrícola en China como en países en desarrollo.

Causas de la Transición Forestal en China

Las causas de la TF se encuentran en la interacción de: factores demográficos, tecno-económicos y ecológicos; procesos político-económicos; y la conciencia medioambiental de la sociedad, en este caso la sociedad china contemporánea.

La TF en China ha venido precedida por un largo proceso histórico de pérdida de bosques naturales y degradación de la tierra (previo a la fundación de la RPC y prolongado hasta los años 1990); por una transición demográfica a mediados de los años 1970; por una transición político-económica desde 1978 – la Reforma de Deng Xiaoping desde una economía planificada-colectiva hacia la denominada 'economía socialista de mercado' – que supuso el reajuste de los incentivos laborales individuales con la consiguiente creciente productividad tecno-ecológica y la transformación del modo de producción[1]; y finalmente precedida también por una creciente crisis ecológica que, afectando directamente al modo de vida de la población (especialmente rural), se materializó en la larga sequía del Río Amarillo en 1997 y las devastadoras inundaciones del Río Yangtzé en 1998. Ante la magnitud de estos hechos y de los acuciantes problemas ecológicos del país es produjo una progresiva concienciación ambiental de la sociedad china, resultando en el diseño e implementación de la Nueva Política Forestal. Los 'Seis Programas Forestales' han permitido a China entrar en la senda de la TF, reforzando el rol del ecoturismo y los servicios forestales ecosistémicos en el desarrollo rural.

Como consecuencia de dicho procesos socio-ecológicos, tanto el área como volumen forestales totales se han expandido en China desde las 121,9 millones de ha (una cobertura del 12,7% del total del país) y 8.655,8 millones de m^3 en el primer inventario forestal (1973-76) hasta alcanzar los 195,5 mill ha y (20,4% cobertura forestal) and 13.720,8 mill m^3 en el último inventario nacional (2004-2008). Dicho crecimiento del área y volumen forestal se atribuye a la promoción gradual de los programas de plantación forestal desde los inicios de la RPC y a la más reciente estabilización y conservación efectiva de los bosques naturales. A pesar de este progreso, la densidad media forestal todavía tan sólo alcanza los 85,9 m^3/ha (78% de la media mundial) mientras la densidad de las plantaciones es de solamente 49.0 m^3/ha. Adicionalmente, la cobertura forestal actual y el área y volumen per cápita únicamente representan 1/3, 1/4 y 1/7 de sus respectivas medias mundiales.

Así mismo, desde la Reforma de 1978 la economía china ha ido progresivamente internalizando su producción, hecho que ha estado asociado al incremento de los niveles de

[1] El modo de producción, siendo transformado desde una economía basada en las cosechas agro-forestales hacia un modo diversificado y con creciente papel de los ingresos del sector secundario y terciario (especialmente el ecoturismo en las regiones forestales).

vida como también a una creciente huella ecológica que ya rebasa la bio-capacidad per cápita disponible a nivel nacional. El modelo de crecimiento económico de la RPC, al igual que en los países occidentales, ha alcanzado un punto crítico al trasladar las crecientes presiones demográficas y económicas hacia los recursos forestales y naturales ubicados en otros países. Sin embargo, los denominados 'países desarrollados' todavía muestran unas huellas ecológicas comparativamente mayores que conllevan procesos de deforestación y degradación forestal en los trópicos. En este contexto, China desempeña un papel intermediario entre los países exportadores (generalmente 'en vías de desarrollo') y países importadores (generalmente 'desarrollados') de materia prima forestal.

Bosques, Pobreza y Desarrollo Rural en China

Aislamiento geográfico, pobreza y carencia de tecnologías en las regiones forestales han estado tradicionalmente ligados a una baja productividad de la tierra y procesos de degradación ambiental, tales como la sustitución de bosque natural por cultivos en la zona del Oeste de China. El incremento de la productividad mediante el avance tecnológico, asimismo, sin embargo ha tenido un 'efecto rebote' mayor promoviendo una incluso mayor sustitución forestal por cultivos en algunas regiones, ej. Noreste de China a lo largo de los años 1990. Uno de los principales entre los 'Seis Programas Forestales' – El Programa de Conversión de Cultivos en Laderas a Bosques o Pastos (*tuigeng huanlin gongcheng*) – tiene el objetivo de estabilizar la frontera agrícola-forestal revirtiendo cultivos potencialmente muy erosivos a usos ecológicamente deseables.

Dentro del propio sector forestal, en primer lugar, se debe hacer una distinción analítica entre los Bosques Estatales del Noreste, los Bosques Colectivos del Sur y la región Suroeste de gestión forestal mixta Estatal-Colectiva donde además habitan varias minorías étnicas. Una segunda división debe realizarse entre dos regímenes de producción forestal diferenciados: bosque de producción maderera y bosques de producción mixta (Productos Forestales no maderables y maderables); el primer tipo está relacionado con los Bosques Estatales mientras el segundo está más vinculado a los Bosques Colectivos.

En términos generales, los Bosques Estatales muestran un alto solapamiento con los bosques naturales del país que, debida a su limitada reserva, son gestionados mediante un mercado de madera más rígido que deja menores beneficios a las poblaciones locales. Hasta finales de los años 1990 estos bosques fueron empleados como una fuente industrial de materia prima orientada a acelerar el crecimiento de la economía, en un proceso de 'modernización negativa' que provocó el agotamiento de las reservas, importantes problemas ecológicos asociados y una crisis socioeconómica en el Sector Maderero Estatal. Bajo estas circunstancias, el Programa de Protección de los Bosques Naturales (*tianranlin ziyuan baohu gongcheng*) supuso la prohibición efectiva de las talas lo que, a su vez, ha impactado de forma negativa sobre los modos de vida de la población campesina y los trabajadores del sector en las regiones en que se ha aplicado. En este sentido, el Programa de Producción Forestal de Rápido Crecimiento (*susheng fengchan yongcailin jidi jianshe gongcheng*) tiene el objetivo de establecer en el sur del país una importante reserva de plantaciones artificiales para re-equilibrar una estructural forestal altamente sesgada hacia edades prematuras.

Los Bosques Colectivos vinculados a productos no-maderables, tales como el bambú, se han beneficiado de unas condiciones ecológicas, regímenes de gestión y comercialización más flexibles: cortos períodos de rotación, ausencia de prohibición de cosechas, mercados menos estrictos. Además, estos bosques han pasado por un proceso de 'devolución', caracterizado por el desmantelamiento de las Comunas Populares a principios de los 1980 a favor de una gestión familiar descentralizada (hogares como directos gestores forestales). Bajo el Sistema de Responsabilidad Contractual (*lianchan chengbao zeren zhi*), se estableció una conexión directa entre el trabajo individual invertido y el rendimiento individual obtenido, de este modo mejorando la estructura de incentivos y promoviendo una reforestación directa por parte de los campesinos. Por estos motivos, los Bosques Colectivos vinculados a productos no-maderables han experimentado repetidamente una 'ruta local de modernización forestal' caracterizada por la innovación tecnológica, la diversificación de bienes y servicios, y el incremento de los beneficios campesinos asociados tanto a fuentes de ingresos forestales primarias como del sector secundario y terciario. Desde una perspectiva ecológica, el crecimiento económico rural ha estado asociado tanto a una expansión de las plantaciones forestales como a la degradación del bosque natural, por tanto, produciéndose un compromiso entre objetivos de biodiversidad y desarrollo. En algunos casos, las plantaciones de productos no-maderables han sustituido a bosques naturales de un valor irremplazable (como en la zona tropical de Xishuangbanna), aunque este tipo de situaciones se ha venido reduciendo desde 1998. La aplicación de la Nueva Política Forestal, que supuso a nivel nacional el reconocimiento oficial de una crisis ecológica severa, ha resuelto dichos problemas con la protección efectiva de los bosques naturales y continuación de la expansión de las plantaciones forestales.

De cara a la implementación exitosa de la ruta de modernización forestal, creemos que diversos factores merecen ser estudiados con detenimiento. En primer lugar, la innovación tecnológica y extensión forestales desempeñan un rol clave dado que estrechan puentes entre la investigación científica, la acción colectiva y el conocimiento-comportamiento individual de los campesinos. En segundo lugar, en las zonas con Bosques Colectivos el sistema de gestión familiar descentralizada es altamente recomendable para la explotación de productos forestales no-maderables, donde los derechos universales de acceso a la tierra tienen una función importante en la ecualización de los ingresos. En tercer lugar, la Nueva Política Forestal ha tenido muy buenos resultados con la implementación del Programa de Conversión de Cultivos en Laderas a Bosques y Pastos – uno de los mayores programas de conservación y erradicación de la pobreza en el mundo – mientras el Programa de Protección de los Bosques Naturales ha ocasionado algunos impactos socioeconómicos negativos. En un contexto de rápido crecimiento económico y crecientes desigualdades socioeconómicas, las estrategias forestales de desarrollo rural basadas tanto en la redistribución local como regional son esenciales para la mejora de las condiciones de vida de las comunidades rurales. En cuarto lugar, el ecoturismo forestal puede realizar una importante contribución a la mejora del modo de vida campesino mientras las cosechas forestales proporcionan una red de seguridad económica a los campesinos más pobres. Por tanto, la combinación de ambas fuentes de ingresos (cosechas forestales y ecoturismo) resultan indispensables para el desarrollo y la erradicación de la pobreza en la China rural.

Trabajo de Campo en Daxi, Anji

Nuestra fuente directa de información proviene del municipio de Daxi (大溪村), con coordenadas geográficas E 119° 34' N 30° 26', perteneciente al condado de Anji (安吉县) de la provincia oriental de Zhejiang, dentro de la Región Forestal Colectiva del Sur. Anji es conocido China por ser una región ancestral del bambú, habiendo sido reconocido en 2002 como un 'Área Ecológica Modelo a Nivel Nacional' (国家级生态示范区 *guojia ji shengtai shifanqu*). Este condado está atravesando por una etapa de transformación desde una economía industrial forestal (materia prima) hacia una gestión forestal multi-objetivo con especial énfasis en los valores ecológicos del paisaje y ecoturismo.

El municipio de Daxi, con una extensión de 23,4 km^2 y 2.099 habitantes, está compuesto de once aldeas (antiguos equipos de producción correspondientes a la etapa de las Comunas) dispersas en un territorio accidentado con un rango de elevaciones que va desde los 300 hasta los 1.167 metros de altitud. Este municipio presenta un clima monzónico de baja montaña con cuatro estaciones bien diferenciadas y una pluviosidad media de 1.570 mm (estación húmeda en verano y precipitación de nieve en invierno). Daxi consta de una alta cobertura forestal (90%), cuyos usos forestales principales son el moso bambú (*Phyllostachys edulis*), el bosque natural perennifolio de hoja ancha (un bosque secundario con alta biodiversidad), el nogal chino (*Carya cathayensis*), coníferas (*Cunninghamia lanceolata*) y plantaciones de té (*Camellia sinensis*).

La tenencia forestal se corresponde con el régimen Colectivo gestionado bajo el Sistema de Responsabilidad Contractual, es decir, los hogares campesinos gestionan directamente los bosques con contratos largos de explotación obteniendo importantes beneficios privados al tiempo que la propiedad formal se mantiene bajo el Comité municipal. Asimismo, Daxi forma parte del listado de municipios empleado para la Encuesta Rural Nacional China (llevada a cabo con carácter anual), en consecuencia, proporcionando una información forestal y socioeconómica directas muy pertinente para la realización de estudios longitudinales. Estos registros oficiales fueron complementados con una investigación exhaustiva de campo consistente en una encuesta socioeconómica a 92 hogares campesinos, un inventario ecológico-forestal de 32 parcelas (biodiversidad, biomasa y cobertura) y otra encuesta sobre el ecoturismo realizada tanto a la población local como a los visitantes.

Reajuste Macro-estructural, Modos de vida campesina y la Transición Forestal

En las tres últimas décadas Daxi ha experimentado una ruta de modernización forestal, una profunda transformación en los valores de uso y cambio de los recursos forestales. La economía forestal tradicional, donde la actividad económica estaba esencialmente altamente integrada dentro de los límites biofísicos del ecosistema, gradualmente ha dado paso hacia una cultura forestal moderna caracterizada por un nítido incremento de la productividad forestal y mayor grado de intercambio económico basado en valores paisajísticos. Durante la etapa de las Comunas, bajos incentivos al trabajo ligados a una baja productividad forestal resultaban en unos ingresos claramente constreñidos de tan sólo 273 RMB anuales per cápita (años 1978-79). Los niveles de huella ecológica eran presumiblemente bajos si bien los niveles materiales de vida eran también muy reducidos. El impacto ecológico característico de dicha época estaba representado por la alta presión sobre los bosques naturales.

En un nivel político-económico general, en Diciembre de 1978, durante la Tercera Sesión del 11º Congreso del Partido Comunista se iniciaba en China un reajuste macro-estructural de gran calado. En nuestra zona de estudio, sus primeras consecuencias fueron la adopción del Sistema de Responsabilidad Familiar para la agricultura en 1982 y del Sistema de Responsabilidad Contractual para los bosques en 1984. Las Comunas Populares se desmantelaron a favor de una gestión forestal descentralizada igualitaria – a partir de entonces llevada a cabo de modo individual por cada hogar – mejorando así la estructura de incentivos al trabajo siendo seguida por un incremento moderado en las rentas, con 317 RMB anuales per cápita (1990-91). Los campesinos mantenían un grado importante de igualdad en los ingresos (Gini 0,21), si bien vivían bajo unas condiciones todavía de autarquía su nivel adquisitivo y de renta mostrando unas condiciones ciertamente limitadas.

Durante la etapa 1978-1990, la economía de Daxi estaba en gran medida planificada correspondiéndose a lo que podría denominarse una 'economía colectiva-descentralizada'. El modo de vida campesino se definía por la dependencia directa del trabajo invertido en las plantaciones intensivas del bambú – siendo entonces el modo principal de subsistencia – cuyas cosechas eran empleadas para la subsistencia (construcción, brotes de bambú) y un todavía-limitado intercambio económico. Los bosques naturales todavía sufrían una importante presión (leña), mientras algunos arrozales de auto-consumo se cultivaban en las escasas zonas bajas disponibles en el territorio. Entonces, la explotación del bambú era la actividad económica más atractiva sin que por el momento se hubiesen apenas desarrollado las actividades fuera del sector primario-forestal.

Bajo tales condiciones de alta dependencia de la productividad física, se desarrolló un sistema innovador de tenencia forestal – El Sistema de Compensación Forestal Inter-familiar (SCFI) – con el fin de neutralizar el efecto des-ecualizador de los cambios demográficos familiares sobre la distribución inicial igualitaria de la tierra (aplicada a principios de los 1980). En base a los resultados obtenidos, aquí se argumenta que el SCFI ha tenido un papel determinante en la promoción de una gestión forestal equitativa y eficiente, capaz de solucionar las disputas por la tierra entre familias típicas del momento (descentralización forestal), promoviendo un incremento de la productividad forestal física del 33%. El SCFI se considera como un sistema efectivo de redistribución transitorio desde una economía colectiva hacia una economía de mercado, si bien este sistema hoy en día desempeña un rol muy discreto – la compensación per cápita representando tan sólo el 1,5% de la renta anual per cápita.

Desde 1992 la construcción de una presa reversible y de la nueva carretera dentro de la demarcación de Daxi ha supuesto un cambio trascendental para el modo de vida de su población. Dichas infraestructuras, que conllevaron un importante impacto ecológico negativo sobre los hogares ubicados en la aldea[2] nº 10, han permitido simultáneamente la

[2] Los números de las aldeas todavía se emplean y se corresponden con los de los antiguos equipos de producción.

integración económica de Daxi dentro de la región dinámica de Shanghai – Hangzhou – Nanjing. Es decir, una vez las condiciones tecno-económicas habían sido mejoradas substancialmente en Daxi (nueva carretera y el efecto atractivo de la presa), sólo entonces los cambios realizados a nivel general en la política-económica china (denominada economía socialista de mercado desde 1992) pudieron tener enteramente su efecto sobre el modo de vida campesino. Aún más, tal apertura de Daxi al mundo exterior ocurría tan sólo pocos años antes de la adopción de la Nueva Política Forestal coincidiendo en el tiempo con el incremento gradual de la conciencia medioambiental en la sociedad y con las crecientes demandas de servicios forestales y ecoturismo. Ello ha posibilitado que Daxi se acomode suavemente a estos nuevos cambios de política forestal, permitiendo así la consecución de una transición forestal a nivel local.

El modo de producción local o modo de vida campesina, en definitiva entendido como la manera en que los habitantes de Daxi mantienen su subsistencia económica diaria en un nivel básico, ha sido profundamente transformado desde un modo tradicional socialmente-generalizado de cosechas forestales (mantenidas con trabajo físico) hacia un modo moderno definido por un ecoturismo (trabajo emprendedor y servicios) asociado a un rápido crecimiento económico y compatible con la contratación de jornales forestales. Como resultado, se ha producido un incremento espectacular de la renta per cápita alcanzando los 8.820 RMB anuales (2005-06), o un incremento real de 8 veces desde 1978. Las actividades forestales tradicionales de carácter intensivo han sido reemplazadas por una gestión forestal enfocada a la conservación de los bosques naturales y la explotación extensiva de las plantaciones de bambú.

Estos dos tipos de bosques presentan unas características ecológicas altamente complementarias, las plantaciones de bambú con unos índices de diversidad-Alfa elevados en los estratos herbáceos-arbustivos y los boques naturales con un estrato arbóreo asociado a una diversidad-Alfa extraordinariamente elevada. Los bosques naturales han comenzado una lenta pero significativa recuperación, después de varias décadas de sobreexplotación, y presentan un alto potencial para la fijación de carbono. Sin embargo, la capacidad de carga del ecosistema local está siendo superada por los crecientes niveles de consumo (huella ecológica) – mayores deshechos y desagües de los hostales – y por la pérdida de integridad ecológica/biodiversidad – expansión de plantaciones intensivas de té, equipamientos turísticos/urbanos, carreteras e infraestructuras (presa). De este modo, se concluye que podemos hablar de una transición forestal parcial en Daxi, causada por la transformación del modo de producción local (desde unas cosechas forestales intensivas hacia unas plantaciones extensivas de bambú, una conservación efectiva de los bosques naturales, unas plantaciones intensivas de té y la proliferación de hostales rurales) y la expansión de las poblaciones local y (especialmente) visitante.

Los recientes cambios en el modo de producción y la llegada masiva de turistas han supuesto un cambio cualitativo en la relación humana-forestal que obviamente va más allá de la cultura previa relativamente integrada de las plantaciones intensivas del bambú y explotación de los bosques naturales. En primer lugar, la autarquía ya no domina la actividad económica local haciendo que los ingresos hayan incrementado – algo que la mayoría de los habitantes de Daxi agradecen (el 88% comunicó en la encuesta que su nivel de vida había mejorado) – lo que, de otro modo, implica que los flujos de intercambio económico hoy en día trascienden los límites biofísicos de Daxi. En su vertiente negativa, también creemos que un crecimiento ‘ilimitado’ y ‘sin control’ podría socavar la misma existencia del ecoturismo local al provocar una degradación severa de la integridad de los ecosistemas forestales locales. ‘Ilimitado’ es un concepto en sí mismo paradójico – los ecosistemas son finitos – que no puede proponer un modelo realista de desarrollo.

Tenencia Igualitaria, Nuevas Desigualdades, Género y la Transición Forestal

La ruta de modernización forestal ha girado en torno a una característica clave de la Región Forestal Colectiva del Sur – la inicial asignación igualitaria (en base per cápita) de los recursos forestales entre la población local. La propiedad colectiva de la tierra heredada de la etapa Maoísta implicó un proceso de descentralización/distribución de parcelas de bambú, nogal chino y té durante la implementación del Sistema De Responsabilidad Contractual, más tarde fortalecido con la aplicación del Sistema de Compensación Forestal Inter-familiar. Esta situación ha posibilitado que los habitantes de Daxi dispongan de unos derechos igualitarios e universales de gestión de los recursos naturales, de esta manera garantizando un potencial básico de ingresos forestales – especialmente aquel proveniente de la red de seguridad económica del bambú.

El profundo cambio producido en el modo de vida campesino, sin embargo, ha ocasionado la aparición de nuevas desigualdades socioeconómicas a lo largo de un gradiente espacial entre las aldeas ricas de las tierras bajas y aquellas aldeas más pobres e inaccesibles de las zonas elevadas. El coeficiente Gini ha incrementado hasta 0,28 reflejando una mayor desigualdad dentro de la población local, una tendencia que se ajusta a las crecientes disparidades encontradas en China. Aquellos individuos con rentas altas tienden a dominar las actividades forestales más rentables maximizando las inversiones de capital y de trabajo contratado, mientras que los hogares con rentas medias y bajas son económicamente más dependientes de las actividades forestales menos rentables siguiendo una estrategia de diversificación económica.

El caso de Daxi muestra el carácter económico altamente dinámico de los recursos forestales conforme con el modo en que se ha producido el desarrollo en el condado de Anji, donde una gran actividad industrial forestal del bambú (en explosión a inicios de los años 1990) ha ido progresivamente madurando y transformándose en un nuevo ecoturismo forestal y expansión de plantaciones de té. El bambú hoy en día actúa como una red de seguridad económica determinante en la calidad de vida del los habitantes con rentas bajas, el nogal chino siendo una fuente atractiva de ingresos en las aldeas más aisladas y asociado a rentas medias, mientras que los hostales rurales (*nongjiale*) están asociados a unas condiciones de entrada mucho más restrictivas (dominadas por el grupo de ingresos más alto) y favorecidos por unas condiciones geográficas también muy limitantes (aldeas de las tierras bajas, mejor conectadas).

Dadas las condiciones actuales, creemos que la privatización de la tenencia forestal/agrícola no proporciona soluciones reales, ni desde un punto teórico ni práctico. La facilitación de una privatización de la tierra podría generar problemas socioeconómicos hoy inexistentes en la China rural, tales como la concentración de la propiedad, la aparición de campesinos sin tierra y, en definitiva, la privatización de los recursos comunales.

Durante este período reciente también se ha detectado una creciente especialización económica según las variables de género y edad, especialmente en las aldeas bajas de Daxi, donde mujeres jóvenes tienden a gestionar hostales rurales o a trabajar como empleadas del sector turístico mientras que los hombres jóvenes muestran una mayor actividad en actividades económicas localizadas fuera del municipio. Obviamente, creemos que es muy positivo que las mujeres estén capturando una importante porción del creciente valor de cambio lo que, seguramente, las podrá empoderar de cara a tomar decisiones tanto dentro de la esfera familiar como en el ámbito amplio la sociedad. Sin embargo, tal ruta de modernización forestal está simultáneamente fortaleciendo roles patriarcales tradicionales que podrían conllevar efectos negativos a largo plazo, pudiendo dificultar el acceso al/ ejercicio del poder de las mujeres dentro de la sociedad.

Modos de vida campesina, Conservación y Desarrollo en la China rural

Los ecosistemas forestales en este país, como se ha visto limitados tanto en términos relativos como absolutos, siguen estando sujetos a una gran presión demográfica y crecientes demandas de consumo de productos forestales, servicios forestales ambientales y usos forestales recreativos. La estrategia actual recogida en la Nueva Política Forestal trata de conservar y proteger 133 mill ha de bosques naturales de un modo efectivo, promover el todavía potencial productivo de las 62 mill ha de plantaciones forestales así como el establecimiento de nuevos usos forestales sobre tierras agrícolas marginales de baja productividad.

El caso chino ilustra claramente cómo la autarquía extrema – que se probó ineficiente, no realista y en ocasiones trágica en la etapa Maoísta – no supuso una solución al problema de la pobreza, especialmente en un orden internacional dominado por relaciones desiguales de poder. No obstante, algunos conceptos como la redistribución económica o el crecimiento económico de los segmentos pobres – ambos popularizados en la RPC primero en el movimiento agrario de los años 1950 y luego a principios de los años 1980 – tienen un valor de gran actualidad, tanto en China como en los países en vías de desarrollo. Asumiendo los límites finitos del sistema ecológico, ello implica que los grupos de rentas altas han de redistribuir a favor de los grupos de rentas bajas y campesinos, cuyo nivel de vida ha de ser incrementado: por tanto, existe un grado diferencial de responsabilidad en un contexto de exacerbadas desigualdades globales y regionales. Según el análisis aquí realizado, se reconoce también la existencia de compromisos/intercambios entre el incremento de los niveles materiales de vida y la conservación de la integridad de los ecosistemas (lo uno frecuentemente supone la reducción de los otro, y viceversa). De ello se deriva la necesidad de imponer límites a los niveles de huella ecológica de las rentas mayores, las cuales deben ecológica y económicamente compensar para incrementar los niveles materiales de los grupos de renta baja.

El crecimiento económico ilimitado es inalcanzable en términos físicos – a nivel global, regional o local – a menudo convirtiéndose en fuente de estrés medioambiental en consecuencia presentando efectos negativos tanto a nivel ecológico como socioeconómico (y estando mutuamente interrelacionados). Globalmente estamos consumiendo a un ritmo de 1,5 veces los bienes y servicios que la Biosfera nos proporciona de manera anual, en otras palabras, los ecosistemas del planeta (entre ellos los bosques) están retrocediendo y degradándose. Desde la década de 1970 la RPC ha superado sus propios límites de bio-capacidad, poniendo con enormes presiones sobre los recursos naturales y los ecosistemas globales. Los grupos de rentas altas y los países desarrollados actualmente dependen de un modelo económico que es altamente insostenible, irrealista e injusto. Por tanto, se necesitan perspectivas alternativas para construir un nuevo paradigma socio-ecológico que pueda ser aplicable, universalizable y adaptable a nuestras diversas culturas, que afronte la interacción pobreza-bosques desde un punto de vista multidimensional.

FIRST SECTION

Chapter 1. Introduction

Our complex societies have followed a development path that nowadays unfortunately makes them more than ever dependent on economic growth, ultimately causing a serious environmental threat for the entire Biosphere and the needs of billions throughout the world (Vitousek et al, 1997; Irwin and Ranganathan, 2007; Rockström et al, 2009; WWF, 2012). In this sense, environmental degradation in the People's Republic of China (PRC) poses no exception, given its severe effects with significant domestic and global dimensions (Liu and Diamond, 2005; Day, 2005; Ruiz Pérez, 2006).

Chinese society is in urgent need for conveniently tackling the environmental challenges confronted by urban and rural millions who depend on natural stocks and flows to make their living. A concept of 'Ecological Civilisation' (*shengtai wenming*) has emerged in the PRC, which has received the influence of the international environmental movement since 1970s, of Chinese ecologist scholarship commitment since 1980s, as well as Eco-Socialist theory and Chinese traditional naturalist roots (Chen and Pan: 陈洪波, 潘家华, 2012[1]). In an official level, the 'Ecological Civilisation' concept was first raised within the 17th Congress of the Communist Party of China (CPC) in 2007, and has seen further strengthened its position within the 18th CPC Congress in Dec 2012. In this latter the 'Ecological Civilisation' is a strategic integrating goal which, simultaneously, permeates economic, political, cultural and social goals (Deng: 邓翠华, 2013).

As a researcher with a particular focus on China, I do have the conviction that Chinese people offer a great knowledge and understanding in dealing with environmental problems generating scientific answers adapted to their local reality. At the same time, I am also aware of the need for strengthening a close cooperation at international level as these ecological processes in China also have global implications and so are at the very core of our survival as humankind. In this sense, this PhD has benefitted from a long-lasting cooperation between the Research Institute of Subtropical Forestry (RISF)-Chinese Academy of Forests (CAF), the Center for International Forestry Research (CIFOR) and the Autonomous University of Madrid (UAM).

1.1 The Forest Transition Theory and its applicability in China

1.1.1 A critical review of the Forest Transition Theory

The Forest Transition (FT) was initially proposed by Mather as 'the change from decreasing to expanding forest areas that has taken place in many developed countries' and which would also be predicted to occur in developing countries (Mather, 1992; Mather and Needle,

[1] For the completion of this PhD we have used a variety of references in English and Chinese. For the latter, we refer to them using the italicized names followed by their Chinese names. In the Results chapters –corresponding to already published articles or manuscripts under revision- we have maintained its individual chapter references. Following the recommendation of an external reviewer, we have compiled the references of the remaining chapters (Introduction, Methods, Discussion, and Conclusions) into a single list of references at the end.

1998). According to Mather, trends in population and resource perceptions, agricultural technology improvements and urbanisation would be the factors leading to this transition.

The FT theory is related to the concept of the Environmental Kuznets Curve (EKC) that postulates an inverted-U relationship between economic growth (usually measured as per capita income) and environmental degradation such that as the economy in a developing country grows so does the negative environmental effects, up to a point when society starts placing higher values on the environment and starts investing in reducing the cost associated to development (Dinda, 2005; Chowdhury, 2012). Although the EKC has been criticized on theoretical, econometric and policy prescription grounds (Müller-Fürstenberger and Wagner, 2007; Chowdhury and Moran, 2012), it is still a very influential hypothesis to analyse the relationship between economic growth and the environmental outcomes.

The link between EKC and FT theories in the context of deforestation has been analysed by Culas (2007), who suggests that the forest-loss rate first increases, later reaches a maximum and then falls as economic growth (income growth) proceeds. However, the FT theory has a wider scope than the EKC theory given that the Forest Transition tries to integrate more factors than the solely effect of economic development.

Concerning the FT theory, a number of criticisms have been raised. A first point relates to quality of forest cover data as well as quality of the forest itself, more difficult to express than a single pollution index factor. Thus, FT data tend to rely mainly on official forest areas (and not on Remote Sensing sources), do not distinguish between primary and secondary forests, and do not consider multiple temporal and spatial scales (Perz, 2007). Putz and Redford (2010) point out that natural forest loss is indeed very different in biodiversity and ecological service quality from those newly established plantations. Moreover, Geist and Lambin (2002) found multiple proximate causes and various underlying forces driving deforestation in the tropics, while complex interactions among political, economic, ecological and demographic processes would portray land use dynamics in the tropical agricultural-forest frontier (Carr, 2004; Santos Martin et al, 2012).

Furthermore, Perz (2007) argues that the FT is deeply associated to development-modernisation theory as it would follow an inevitable, isomorphic and universal pattern. Rather, the same author writes that a context-specific historical perspective would be more appropriate to analyse complex forest changes. Conversely, Ehrhardt-Martinez et al (2002) interpret deforestation processes as a self-corrective ecological and modernisation process inherent in development.

Rudel et al (2005) have theorised that there could be two causal directions for the FT. On one hand, the ‘economic development path’ would be typical of affluent nations where increasing urbanisation would pull labour out of agriculture and rural areas, thus allowing for forest re-growth (as a saving-labour mechanism) in these regions. On the other hand, the ‘forest scarcity path’ would be more typical of poorer countries with low forest cover, where increased forest-product prices or loss of ecological functions (biodiversity, erosion, water cycle, carbon) would drive policy changes. Similarly, Angelsen (2007) and Barbier et al (2010) explain both pathways in terms of the relative values of forest-land vs. agricultural-land. In earlier historical stages agriculture has a higher relative value than that of forest-land, but this relationship is gradually shifted in favour of increasing forest values and decreasing agricultural rents. Complementarily to these approaches, Meyfroidt et al (2010) also put their attention on the land-use displacements that occur across different societies, emphasising the role of trade in reinforcing such international exchange processes.

We suggest that the FT and its potential causal processes should be tested explaining similarities and differences among the empirical phenomena that are being described. Indeed, the FT theory builds on empirical evidence across different contemporary societies (Rudel et al, 2005). As Rudel (1998) points out, 'every turnaround in forest cover trends results from a unique constellation of historical forces but there may be patterns which recur across these historical conjunctures'. Therefore, the FT can be hypothesised as a broad universal pattern in forest dynamics which does have room for local/regional differences in both deforestation and reforestation trends as well as in the turning point at which the transition would take place (Angelsen, 2007). In the following section we present both the general and contingent circumstances that might have influenced the recent change in forest cover trend in China.

1.1.2 Causal Factors explaining the Forest Transition in China

The recent stabilization of natural forests and the expansion of forest plantations in China can be analysed with a Forest Transition lens. In explaining this process, we explore the underlying factors (demographic, economic, technological and environmental), and the role of policy design able to impact over these *inherited-but-changeable* underlying conditions.

Due to a long historical period of deforestation, mainly caused by a steadily expanding population with increasing agricultural pressures over forest resources, forest cover decreased from 25.8% in 1700 to 11.4% in 1949 (He et al: 何凡能等, 2007). At the moment of the PRC's founding, the country had already a big population with a severe constrain due to limited land availability, both in relative and absolute terms. This forest and agricultural land scarcity would later condition the process of the FT in China. Furthermore, by that time living standards were generally very poor in China explaining the special focus on agricultural development and land reform in the early 1950s.

After the establishing of the PRC, its society experienced important advances in the fields of public health, basic education, gender equality and through the egalitarian distribution of food supplies (Banister, 1984; Gu et al: 顾杏元等, 1992; Putterman, 1993). Infant mortality rates declined from 201/1000 before 1949 to 47/1000 in the mid-1970s (Zhou et al: 周有尚等, 1989, Gu et al: 顾杏元等, 1992) and medical assistance covered close to 90% of the population by 1975 (Hesketh and Zhu, 1997; World Bank, 1997; Wu, 1997), resulting in a rise in life expectancy from 39 years in 1949 to 66 years in the mid-1970s (Gu et al: 顾杏元等, 1992). Population thus expanded, putting further pressures over land resources. Basic-life conditions were deeply marked by the disastrous famine of 1959-61 (Lin, 1990; Yao, 1999) and remained stagnant through the 'Cultural Revolution' up to the end of the Maoist period (Putterman, 1993). Poverty, although diminishing and not as crude as before 1949, was still widespread, affecting particularly badly the countryside where around 80% of the population lived (Fan et al, 2004).

During the same period, forests experienced a significant decline, due to overcutting during the 'Great Leap Forward' campaign and also to agricultural expansion policies in the 'Cultural Revolution' decade, reaching a historical lowest level in the early 1960s. The continuous forest degradation during the first two decades since the establishment of the PRC led to a gradual change in the 1970s preparing the ground for a forest transition. The increasing pressure over land resources would progressively result in the adoption of agricultural technology leading to the intensification of agriculture and the expansion of forest plantations, although degradation and loss of natural forests kept its pace until the end of 1990s.

The recovery of China's forests has been facilitated by three other major transitions that have shaped China since the 1970s, namely demographic, broad political-economic (1978 Reform and its associated agricultural and forestry policies), and on its techno-economic livelihood base (see figure 1.1).

Before the forest transition could take place in China, one necessary condition was the demographic transition. A first stage (1950s-60s) of post-war exceptional population expansion (interrupted by the severe famines of 1959-1961) would reinforce both short and long term land scarcity. A second stage starting in the early 1970s initiated a demographic stabilising trend. Higher life expectancy along with the increased status of women brought a gradual increase in marriage age leading to diminishing fertility rates around the mid-1970s (Banister, 1984). This resulted in a decreasing population growth from an annual rate above 2.5% in 1966 to less than 1.5% in 1978, before the 'One Child Policy' (*jihua shengyu*) was promulgated (Hussain, 2002). Both forest land scarcity and the asymptotic trend to a stable population, along with several other factors explored below, would later make possible the implementation of the new forest policy for the 21st century.

The Reform initiated after the 11th Central Committee meeting of the Chinese Communist Party in December 1978 marked the key political-economic transition. It started off from the countryside with the adoption of new programmes oriented to further increase land productivity and farmers' income (Tisdell, 2009). The Household Responsibility System (HRS, *jiating chengbao zeren zhi*) in agriculture (Nolan, 1983; Lin, 1987) and Contract Responsibility System (CRS, *lianchan chengbao zeren zhi*) in forestry (Yin and Newman, 1997; Liu and Edmunds, 2003) meant the decentralisation of rural collective units into household units, linking directly individual input with individual return, thereby improving work and investment incentives (Putterman, 1993; Li et al, 1998). The adoption of the HRS led to a more efficient agricultural management well-adapted to land shortages which, however, would yet favour the expansion of agriculture at the expense of natural forests. The CRS applied to forests would start two years after the HRS and, due to tenure insecurity caused by frequent changes in ownership especially during the 1950s-60s, would reinforce deforestation patterns due to farmers' short-term opportunistic behaviour to realize standing forest values.

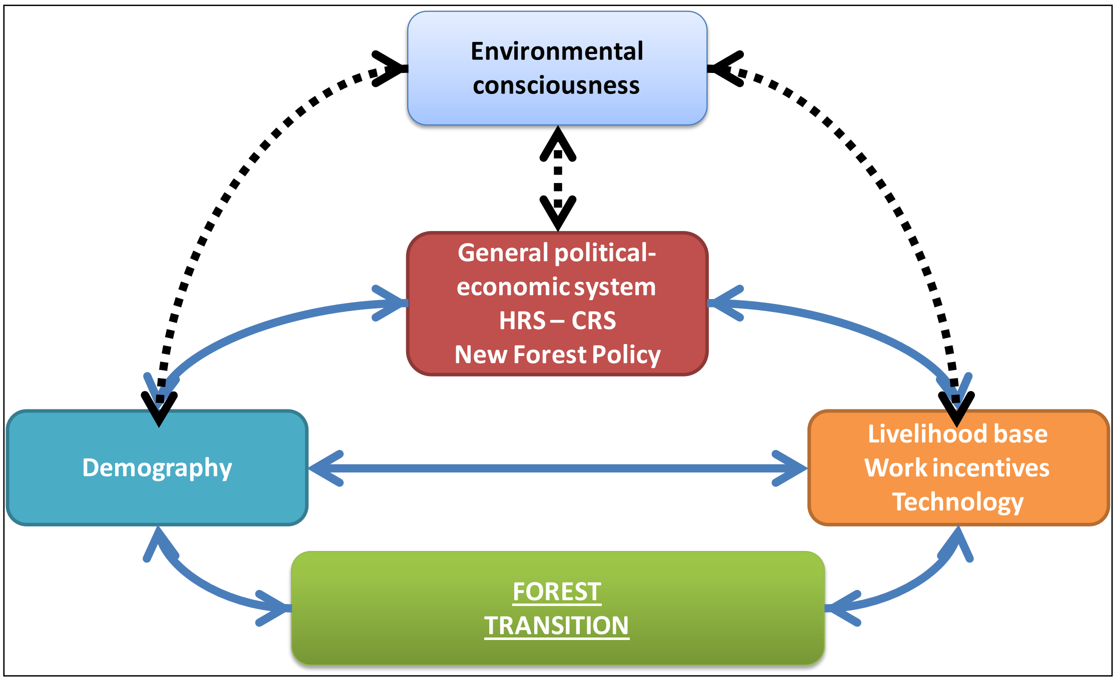


Figure 1.1. Interactions among demo-techno-economic-environmental factors, broader political-economic factors, environmental consciousness and their influence on the forest transition. Forest and broader political-economic policies - via demography and techno-economic livelihood base - operate over forest resources.

These changes at the rural political-economic level, plus an early-developed agro-forestry technology and a preferential policy for grain prices would thus have immediate consequences, triggering the shift from a planned to a market-based economy that constituted the main pillar of the economic transition. As a result the techno-economic livelihood base was dramatically improved, several hundred million peasants getting out of poverty through the 1980s in the PRC (World Bank, 2009). Moreover, a still huge rural population with expanding per capita consumption involved increasing agricultural demands, also driven by raising city consumption patterns. Improvement in land productivity and concomitant agricultural surpluses fuelled the impressive expansion of the rural off-farm sector, initially through collective 'Township and Village Enterprises' (TVEs, *xiangzhen qiye*)[2]. Countryside economic growth followed, linked with newly created environmental impacts (deforestation, soil and water pollution) and general environmental disturbance (Muldavin, 1996; Harkness, 1998). The profitability of the TVEs and their integration by improved communications into the larger economy could again be employed back for agriculture and forestry investments. However, this fast economic growth would thus further aggravate the problem of forest-products scarcity and loss of ecosystem services in the late 1990s.

As a consequence of privileged economic growth in coastal areas and the gradual relaxation of the residence permit system (*hukou*) through the 1990s, young and middle aged people migrated from villages to the thriving eastern cities. A diminishing rural population, which had decreased up to 50% by 2010 (UNDP-China), relieves direct pressure onto forests.

[2]Some authors (Zhang, 1999) have traced back the origin of TVEs to the early and failed attempt of rural industrialization of the 'Great Leap Forward'.

Nonetheless, one cannot downplay the role of urban inhabitants, i.e. 'indirect' pressure onto forests, whose forest ecological footprints are often higher than their rural counterparts' (WWF China, 2010; WWF China, 2012).

Rural energy consumption, being integrated into the techno-economic livelihood base, is also an important variable that affects patterns of forest resources use. Since Reform, aggregate energy demand has exploded[3] in rural China, as rural aggregate firewood consumption grew from 103 Mega tons coal-equivalent (Mtce) in 1979 to 142 Mtce in 2007 (Zhang et al, 2009); although there is evidence that fuelwood has been increasingly decoupled from degradation of natural forests[4]. At the same time, the rural energy-base structure has been profoundly altered and diversified, as firewood and straw are no longer the primary sources.

Fuelwood is no longer perceived by rural communities as one of the key resources provided by forests and there is a growing recognition of the complementary uses and environmental services offered by forests (FAO, 2010). From another perspective, and in spite of a growing use of renewables (Huang, 2009), this energy transition has also been linked to different environmental impacts throughout China (Fang and Zeng, 2007).

The positive effects of the forest transition in China should not hide the very negative impact of urban and industrial expansion mostly at the expenses of agricultural land. This has represented the fastest loss of agricultural land due to urban expansion ever recorded, with 8 million ha lost between 1995 and 2005 (China Watch-World Watch 2006). Moreover, urban encroachment into arable lands puts further agricultural pressure back onto forest lands (Shi and Wang: 石春娜, 王立群, 2008). This is a sober reminder of the environmental challenges faced by China, of which Chinese authorities are well aware and are trying to control (China Daily 2008).

1.1.3 Changing forest policies and their impact on the Forest Transition in China

Throughout history, agriculture has been a major driver of deforestation in China substituting for forest land uses, even at hilly slopes, well into the 1990s. These unsustainable practices would in turn aggravate the scarcity of forest resources and their environmental-related problems (Li: 李育材, 2005). Within the forest sector, State enterprises had in recent decades overexploited natural forests as a source of timber, leaving a much degraded forest ecosystem by the late-1990s (Li: 李育材, 2004). With regard to Collective forests, natural forests suffered from degradation processes during the Great Leap Forward, the expansion of grain policies during the 'Cultural Revolution' and the dismantling of People's Communes into household management in the early 1980s (Liu, 2001).

[3]Total energy consumption more than tripled in rural China, from 307 Mtcoal-equivalent in 1979 to 977 Mtce in 2007. Growth in per capita energy consumption in rural China has been even more acute, from 388 kgce in 1979 to 1343 kgce in 2007 (Zhang et al, 2009). The higher increase in per capita terms than in aggregated terms is explained by the rural-urban migration.

[4]By 1998 over 5.3 million ha of fuelwood forests had been established (Zhang et al, 2009).

The severe drought of 1997 (Fu et al, 2004) and the catastrophic floods of 1998 (Zong and Chen, 2000) - the inflection point marking the forest transition in China - would involve a major qualitative shift in forest policy[5]. A humbling awareness of the environmental fragility of the country and the emergence of a middle class with growing environmental concerns brought the environment into the first line of the PRC's political agenda, leading to the establishment of a proper environmental policy (Murray and Cook, 2002), which also extended to forest policies.

From a socio-economic perspective, demography was under control and even decreasing in rural areas; while land productivity, peasants' needs and (farm and off-farm) incentives – these factors all subsumed within the techno-economic livelihood base - had been improved due to a major policy re-structuring (1978 Reform). From an ideological point of view the impending ecological crisis[6], which had begun to negatively affect the lives of Chinese people (Muldavin, 1996; Murray and Cook, 2002; Zhang: 张秀芬, 2009), thus resulted in a greater environmental consciousness across scientists, the Communist Party cadres and leadership, and the broad Chinese society (UNDP China, 2010).

The re-alignment and integration of these underlying demo-techno-economic-environmental factors, broader political-economic policies, and ideological factors would finally permit a new approach to forest land uses with the adoption after 1998 of the 'Six key forest programmes' (*liu da linye zhongdian gongcheng*), among which the Sloping Land Conversion Programme (SLCP, *tuigeng huanlin gongcheng*) and the Natural Forest Protection Programme (NFPP, *tianranlin ziyuan baohu gongcheng*) formed the core of the new forest policy for the 21st century (Zhou Shengxian: 周生贤, 2002).While the influence of the aforementioned *underlying* factors was important, *the role of policy* has proven equally determinant for reaching the tipping point that marks the forest transition.

One lesson that can be derived from the forest transition in the PRC is that, although our societies are evolving under the drive of historical forces (especially those interacting with the environment at the production and demographic levels), these forces are shaped by human action. We need to stress the *role of human agency* in driving such historical process and affirm our common social responsibility through *policy implementation* for improvement and directing change for the better.

There is also another very important factor which cannot be overlooked from our analysis: after 1978, the People's Republic became gradually more integrated into the World economy. Prior to that year, the Maoist guiding policy had stressed self-sufficiency and rural autarchy although, as we have seen, rural inhabitants basically remained under widespread poverty. Later on, coupled with an unprecedented historical success in rural poverty reduction, Deng Xiaoping embraced an 'Open Door' policy that would have far-reaching consequences for the whole society. The 'Open Door' policy paved the way for an impressive

[5] The degradation of natural forests and the expansion of the agricultural frontier into hilly slopes had had tremendous effects in terms of water and soil erosion. The new forest policy would thus have to be built upon these degraded ecosystems, although there was still some room for forest recovery.

[6] Since mid-1970s China's ecological footprint had started exceeding its ecosystems' self-regulating capacity (WWF China, 2010).

economic growth with both urban and rural incomes increasing at quick paces. This, however, was not without negative consequences. Some conflicts would be reinforced, like the environmental degradation, and others would newly appear like a growing economic inequality.

1.1.4 China's contribution to global environmental pressure

We have a general picture where China imports, processes and sells products both to its domestic and foreign markets (mainly the European Union, Japan and U.S.A). China is increasingly perceived as a major contributor to global environmental problems by activities conducted within its own territory or elsewhere. These range from CO_2 emissions to pollution, overfishing and deforestation. However, focussing on national environmental accounts would miss the important contribution that international trade poses to global environmental pressures. Using an 'embedded' or 'embodied' approach (i.e., detracting from a given country the ecological costs of those productions that are exported to be consumed elsewhere, while adding those imported and consumed nationally) gives a more balanced picture. From this perspective, China is a net exporter of embodied CO_2 (Davis and Caldeira, 2010; Zhang, 2011), and a net importer of land (Weinzettel et al, 2013) and 'virtual water' (Hoekstra and Mekonnen, 2012).

From our research perspective, how has the increase in trade affected Chinese and global forests? International trade forms an essential dimension given that timber imports have been on the rise since 1978 and, even more, after the Chinese new forest policy for the 21st century: once the 'logging ban' (NFPP) was put into effect these imports soared and have been incessantly on the rise (especially for tropical timber). In the case of the SLCP, the substitutions of crops and abandonment of agricultural lands on hilly slopes and the increase in productivity of Chinese agriculture have also been coupled with a rebound effect due to an increasing food demand (both quantitative and qualitative), resulting in increased food imports (Qiang et al, 2013) that have been linked to global deforestation processes (Gibbs et al, 2010). The forest transition in China has thus been associated to environmental pressure and forest degradation at a global scale (Meyfroidt et al, 2010; Lambin and Meyfroidt, 2011; EIA, 2012).

Again using an 'embeded' analysis approach gives a somewhat different picture. By the early 2000's China had become the first exporter of processed wood products, displacing Italy to a distant second position (Hashiramoto et al, 2004; Lu 2004). Consequently, China has also become the global workshop of forest-related industries with a significant part of its production being re-exported and consumed abroad. Nie et al (2010) analyse the forest ecological footprint of Chinese log imports indicating that Chinese log consumption relies mostly on domestic resources, finding little evidence that Chinese log imports are a significant threat to the world's forests. A special concern has been raised regarding the role of China in boreal and tropical deforestation (Sun et al 2004; Lambin and Meyfroidt, 2011). Although tropical timber trade was initially reduced as a result of the global financial breakdown in 2008 (Cheng, 2009; Cheng et al, 2010), a reported recovering trend is shifting towards domestic demands in Asia (especially within China), whereas Euro-American imports have cooled off to a certain degree (ITTO, 2012). Under this new international situation, the Chinese government issued a stimulus plan directed to increase the domestic demand and some specific measures were focused on forest conservation and management at the national level (Ma et al, 2009; Zhang, 2009). While this strategy is proving very successful in raising the general living standards of Chinese people, global forest displacement cannot be disregarded from critical analysis.

1.2 Forestry and Rural Development – Exploring poverty issues

1.2.1 Forestry and Poverty

Population growth, low land productivity and poor living standards in the countryside have close ties with forest degradation (Angelsen and Wunder, 2003; Sunderlin et al, 2004; Chomitz, 2007; Sunderlin et al, 2007). In the case of China, poverty has been frequently associated to forested mountainous areas (Elvin 1998, Han et al. 2006, Li and Veeck 1999). During Reform in China, under diminishing per capita land availability (ha/person) and the necessary growing grain per-capita consumption (kg/person), the desirable outcome would have been raising grain yields (kg/ha) on the existent arable lands without resorting to land use conversion.

The Chinese case succeeded in this only to some extent through agricultural research and technological extension (Fan and Pardey, 1992). It took nearly two decades (1960s and 1970s) to set the technological basis of a modern agriculture, able to meet a minimum average per capita standard[7] (Riskin, 1987). This standard was reached after 1978, when institutional political-economic changes (the Household Responsibility System) lined up with technological factors impacting at the rural livelihood base (Huang and Rozelle, 1996).

However, the land-rebound effect of expanding aggregate food demands in China has been much greater than its land-spare effect[8], explaining widespread land use changes that even continued occurring through the 1990s mainly in the form of natural forest substitution by agriculture, especially in the Northeast region (Zhang et al: 张国平等, 2003). In fact, these contemporary land use changes together with those historical pre-1949 land-use changes, plus further recent increases in population pressure, were identified as the main factors explaining the floods of 1998 (Zhou Shengxian: 周生贤, 2002).

There are two potentially important causal roots of this degradation process at the forest frontier (i.e. natural forest replacement by agricultural land uses). Both low agricultural yields in poverty-stricken regions (lacking adequate technologies) and high agricultural yields (with high-tech inputs) may encroach into forest lands (Angelsen & Kaimowitz, 1999;

[7]It was not until the early 1970s that per capita calorie consumption exceeded the levels of the late 1950s. By 1979, daily per capita availability of energy, protein and fat reached 2,562 Kcal in China (Riskin, 1987).

[8] A rebound effect greater than spare effect, following a technological improvement in agricultural efficiency/productivity, is explained by so-called Jevons' paradox (Alcott, 2005). In our case, higher agricultural land productivity is first followed by a decrease in agricultural production costs resulting in an initial price reduction. However, this initial price reduction is then followed by a disproportionately higher aggregate demand increase thereby increasing the aggregate agricultural production, which results in higher agricultural land usage and substitution for forest uses. In conclusion, higher agricultural land productivity promotes disproportionately higher aggregate demand, hence, resulting in higher land occupation and substitution.

Chomitz, 2007). In the first case farmers fall into poverty-deforestation traps, while in the second case the poverty cycle is broken with intensification and expanding per capita consumption although forest losses may account for future ecological-income drawbacks (erosion, decreasing yields and floods). Both poverty and modernisation dynamics have been responsible for deforestation in the PRC, the first type of process has been more prevalent in the Western region (Shen, 2004) and the second type in the Northeast region (Zhang et al: 张国平等, 2003).

Focusing within the forest sector itself, poverty and modernisation come again hand by hand in the depletion of natural forests, where population density has been a major driver causing their ecological degradation in area and stock (Köthke et al, 2013). In developing countries, remote communities usually present constrained living standards holding a weak position within a frame of unbalanced power relations (Larson and Ribot, 2007). From a formal economic perspective, they are forced to waste their natural endowments - their unique 'competitive advantage' – outsourcing natural forests' products with low exchange values that converge into expanding regional markets. More than often, poor rural populations only obtain the forest leftovers when trying to fulfil their subsistence needs.

A cycle of deforestation and poverty develops as outside capital intensifies extractive activities in which local inhabitants become entangled. As city-based economic growth drives impressive demand forces, peasants fall into local poverty-degradation traps that just form the first line in the supply chains (Barrett et al, 2011; Coomes et al, 2011). Therefore, while the poverty-forestry link occurs at a local level, it becomes reinforced by regional and global 'modernisation' processes (Weinzettel et al, 2013). By focusing solely on the farmer micro-level we risk losing the necessary general perspective which integrates major ecological processes. Both macro-level and micro-level analyses are needed.

In the PRC, rural self-sufficiency and collectivised economy did not prove effective in solving poverty during 1960s and early 1970s, when peasants' consumption levels were highly depressed (Putterman, 1993). With regard to the forest sector, at that time unpredictable changes in land ownership among peasants - Collectives - the State discouraged forest management, which typically accrues economic returns only after prolonged long-term investments. After forest decentralisation, growing demand for forest products and the final opening of timber markets by mid-1980s, Chinese forest households interpreted those signals as an all-at-once chance being highly mistrustful of their future. As other economic opportunities were yet absent and low incomes widespread, they had almost no choice but to fell down and sell the remaining trees to capture their whole exchange value. The conjunction of tenure insecurity and poverty was particularly harmful, what caused the further degradation of natural forests.

1.2.2 Poverty, land tenure and forestry in China

Since 1978, land-right reforms have permitted Chinese households to raise their living standards on a broad-basis and this has been possible *while keeping the collective property of land* (Zhang and Donaldson, 2012). This is especially important in a country with around 665 million of rural inhabitants, where an equal-per-capita right to access scarce land resources essentially becomes the foundation of a food social-security net and a *de-facto* contract between peasants and the whole society.

After post-78 Reforms, two basic types of forest land entitlements were established: the State forests and the Household Contract Responsibility forests within the former Collective forests, which still hold the formal property of the land (Liu, 2001; Liu & Edmunds 2003). Since then, additional arrangements like shareholder cooperatives or mixed private enterprise-cooperative have emerged. State forests predominate in the temperate-boreal forests of the North-East; household contract forests are most common in the East and South-East subtropical and tropical regions; whereas a mixture of State and Household forests coexists in the South-West where many minority groups are present (Hyde et al, 2003).

Generally speaking, more constrained income opportunities for rural inhabitants have dominated the timber sector in the PRC, which has been subjected to higher regulation mainly due to ecological strategic purposes articulated through the annual allowable harvest quota (Xu J.T. et al, 2004). In contrast, non-timber forest products (NTFPs) such as bamboo (the predominant forest use in our case study) have proven more effective in broadening the poor's scope for increasing their incomes in China (Hyde et al, 2003). There are several reasons explaining their success, one key being the wide egalitarian distribution of land assets in rural China (Wang et al, 2011). The others are the higher management flexibility of NTFPs (shorter rotation period and less regulated supply market than timber) and thriving demands for these products (Ruiz Pérez et al, 2000). The case of bamboo is even more striking due to the great variety of uses to which is associated (Yang and Hui, 2010), and to the scientific-technological progress and extension that has been made so far in the PRC (Fu Maoyi: 傅懋毅, 2000).

Given the distribution of forest land in China, there is enough evidence supporting the hypothesis that bamboo harvests are protecting the poor's incomes, providing farmers with equal opportunities for development and even buffering those income differences brought by off-farm activities (Hogarth and Belcher, 2013; Hogarth et al, 2013). As almost every rural household has several plots of land under long-term contracts, collective property then guarantees *in most cases* a basic economic right covering the subsistence needs of the household unit. While there is not a broad coverage of medical service in Rural China yet, this basic farm right let households take economic risks given that land is acting as a *safety net* and *economic insurance* (Piotrowski, 2009; Wang et al, 2011).

For example, someone in the family may move to the city in search for a wage-paid job and, if it does not work out, he or she just can return to the village to work the land (Zhang et al, 2001; Li and Yao, 2002). Therefore, a key issue is to unleash the potential to increase farm incomes while maintaining such equitable economic security-net.

Besides the importance of land collective property per se, there are other collateral land-based redistributive institutions that are worth exploring. Much research efforts have been put into the analysis of periodic agricultural land redistributions among households at the village level, for they reveal the deep impact that collective egalitarian farming (lasting for more than 25 years) had had on the lives of Chinese peasants (Kung, 1995, 2000; Kung and

Liu, 1997; Kung and Bai, 2011). Even today, a majority of farmers are in favour of such redistributive mechanisms, given that they perceive these protect effectively their common and private interests (Wang et al, 2011).

At the beginning of Reform, an egalitarian land distribution was implemented at the production team level, so every household within a given team had the same per capita forest resources. However, as time passes household demographic fluctuations would shift the original land allocation, skewing it towards a more unequal distribution. In the case of forestry, periodic land reallocations have not been the rule because they would have discouraged long-term investments and forest management[9]. Instead, forest shareholding schemes were established in several provinces (Song et al, 1997, 2004; Kang et al, 2010). Other arrangements have also been developed and in this PhD we analyse the particular case of an Inter-household Forest Compensation scheme (IFCS) in Anji county (Zhejiang province), arguably a compromise solution between equity and efficiency.

1.3 Forestry and Rural Development – A Way-out of Poverty?

During the mid-1960s, rural China had collective institutions that were effective in redistribution but rather inefficient in offering individual incentives for production. They also yet lacked technological advancement while prevalent autarchic conditions hindered rural income diversification. Selecting agricultural development as one of the main goals in China after 1978 has been one of the major poverty-reduction achievements in our recent History (Montalvo and Ravallion, 2009).

In spite of this success, protection of natural forests was broadly neglected up to the turn of the new century. Although offering a much limited variety of ecosystem services when compared with natural forests, the establishment of forest plantations, inter-cropped trees and specially cash crops has shown a positive trend in contrast with the contemporary decline in natural forests (Fang et al, 2001). In this final section of the Introduction, we explore some of the key factors that potentially can contribute to break the poverty-forestry link in China.

1.3.1 Forest Technological Innovation

In the first years of the PRC, the Chinese government organised afforestation campaigns that resulted in low tree-survival rates. These campaigns were re-launched in the mid-1960s. An applied forestry research where research institutions[10], forest farms and county-level bureaux closely cooperated would create better afforestation techniques thus enhancing farmers' adoption rates (Ruiz Perez et al, 2004(a)). In this way, farmers' individual behaviour and knowledge, which had been overlooked in the past, was progressively channelled through the implementation of the recent land-tenure reforms and the New Forest policy

[9]Agriculture, especially rice, is dominated by short-term investments and annual returns, so land redistributions within each 3-5 years (as once had been the case in Anji County) would not pose a serious disincentive for economic performance.

[10] Notably the Chinese Academy of Forestry with its 19 research institutes and centres, and 10 provincial branch academies.

(especially the Sloping Land Conversion Programme and despite the more controversial social effects of the Natural Forest Protection Programme).

1.3.2 Forest Land tenure and Forest Collective Institutions

With regard to land reforms, the 'Three Agricultural questions' (*sannong wenti*) have remained as one of the main priorities in poverty alleviation programmes in China (Huang et al, 黄祖辉等, 2009). These agricultural questions reflect the fact that there are still major income differences between urban and rural areas, and these differences have grown in recent years, partly explaining the migration to cities from rural areas in China. The questions focus on the economically lagging position of rural areas (*nongcun*), peasants – the core question - (*nongmin*) and agriculture (*nongye*) within current Chinese society.

As we have explained, these *sannong wenti* are fully applicable to forest areas, forest peasants and forestry in the PRC. What specific land-tenure measures have been taken to tackle the poverty-forestry link in China? An important step was to free farmers from the burden of agriculture and forestry taxes in 2006, a historical claim against what was widely perceived as a traditionally oppressive system, in order to raise households' land rents. The second step has consisted of consolidating the HRS (agriculture) and CRS (forestry) in rural areas, extending farmers' land contracts up to 50-70 years while preserving the collective property of land (vested in the village committee).

The recent further decentralisation into household units of remaining Collective forests (*linquan gaige*), basically composed of timber-plantation forests, would have in theory allowed to increase farmers' incomes (Shen et al, 2009; Zhang: 张海鹏, 2010) and forest efficiency and productivity (Yin et al, 2013). Other authors (Wang: 王文烂, 2009; Liu et al: 刘小强等, 2011), however, did not find a significant increase in farmers' income following the implementation of Collective forests' Reform. In the case of Fujian province, this is allegedly due to the existing conflict between the small-scale household decentralised CRS model and the larger-scale requirements of sustainable timber management (Wang: 王文烂, 2008). As a solution, Wang (王文烂, 2008) suggests to scale-up forest units through farmer cooperatives and key government forestry regulation[11].

Furthermore, Zhang and Wen (张 蕾,文彩云, 2008) argue that this Collective forests' Reform has promoted an increase and diversification of farmers' incomes, although at the expense of higher forest fragmentation and conversion from timber to cash crops (NTFPs). On the other hand, some potential inequity issues were raised during the decentralisation process, as found by Song and Cannon (2011). Several authors (Zhu and He: 朱冬亮 ,贺东航, 2007; He and Zhu: 贺东航, 朱冬亮, 2009; Liu and Zhao, 2009) have pointed out that the recent Collective Forest Reform has actually resulted into a de-facto privatisation of collective forests into the hands of a few specialised enterprises thereby harming the interests of most farmers.

[11] We consider this suggestion as valid for timber resources. At the same time, other models could apply to bamboo and NTFPs (not to timber), as explained in Chapter 8.

These trends in forestland tenure relations are reflecting the pressures, brought by a transition from a collective planned economy towards an increasingly market-led economy, over Collective Institutional schemes inherited from the pre-1978 period. The extent to which land-tenure relations are being affected by this broader political-economic transition is therefore deep and important. Some authors have argued that should China move into a fully land-privatisation context, a more stratified countryside and new emerging poverty issues would be expected (Piotrowsky, 2009; Wang et al, 2011; Zhang and Donaldson, 2012).

1.3.3 The New Forest Policy

A third step to promote poverty-alleviation and forest conservation has been articulated through the New Forest policy, in order to reconcile both collective action and small-holders' individual behaviour. The Sloping Land Conversion Programme, in spite of its shortcomings (Xu Z.G. et al, 2004), can be regarded as one of the greatest pro-poor payment-for-ecological-services schemes in the developing world (Uchida et al, 2007).

Under the SLCP, forest seedlings, grain and monetary subsidies given to farmers have led to an increased exchange value of plantation trees located on slopes, thus proactively enforcing the conservation of the remote national forest frontiers (Liu et al, 2008). The Natural Forest Protection Programme has been more controversial as it implied the prohibition of logging, first in State natural forests and later in Collective natural forests, with important negative economic impacts over rural communities living in forested regions (Liu et al, 2008).

The general strategy has therefore consisted of increasing the direct exchange value of tree plantations while decreasing that of natural forests, thereby promoting afforestation efforts (first case) and enforcing more debatable conservation measures (second case). The adoption of the 'Six key forest programmes' (*liu da linye zhongdian gongcheng*) has allowed for a incipient recovery of forest resources, while the extent of their contribution to poverty alleviation has been mixed depending on the specific programme. The SLCP has frequently been beneficial to forest farmers, whereas the NFPP has tended to worsen their situations (Liu et al: 刘璨等, 2006; Liu and Lin: 刘璨, 林海燕, 2011).

In this sense pro-poor conservation strategies based on either economic redistribution from urban to rural areas (such as the SLCP) or redistribution processes operating at the local level, are an essential tool to lift rural living standards. By promoting a deep transformation in the rural livelihood base – from farm towards off-farm incomes - they have opened the way for a forest transition.

1.3.4 Changing Livelihood-base in Forest areas

In many rural areas of the world off-farm income generating activities are growing in importance, gradually displacing traditional on-farm ones (Lanjouw and Feder 2001; Haggblade et al 2002, Reardon et al 2007). This process is even more noticeable in China, affecting agriculture as well as forest-related activities. A major economic transformation is occurring from direct on-farm forest self-consumption and production goods (food, timber, fuelwood and many other NTFPs) towards forest-based environmental services (including watershed, soil and biodiversity conservation, carbon storage, landscape scenery and recreational values). Furthermore, the recent growing demands for these environmental and recreational services can be explained by increasing environmental awareness in China, being favoured by the implementation of the New Forest Policy.

Today we are witnessing an impressive change in forest use and exchange values across rural China. The PRC is experiencing a forest transition that can be depicted as a 'forest modernisation path' characterized by technological innovation, diversification of goods and services and increased benefits associated to increased farm and off-farm incomes, which is rooted in its huge though stabilising demography, its broader political-economic Reform and agriculture and forestry policies, and the subsequent techno-economic adjustment at the livelihood-base of the Chinese rural and urban inhabitants.

The improvement in the rural livelihood-base, with increased income levels and diversification, has resulted in a forest area and standing volume recovery. Forest-based off-farm economic diversification such as ecotourism, facilitated by the adoption of the New forest policy and the growing environmental consciousness, is playing a determinant role in breaking the local forestry-poverty linkage in rural China.

As the country develops and new economic activities appear, the forest sector has shifted from a an income generating opportunity that benefited many rural households to a less attractive option left for those who have no better choice, and from direct family work on forest plots to hired labour while prosperous forest owners devote most of their time to more lucrative activities. A similar process can be observed in the forest processing in counties whose former industrial structure hinged around primary harvests and that have now entered into other secondary and tertiary sector activities (Ruiz Perez et al, 2004(b); Yin, 2009).

Forests have, simultaneously, attracted new opportunities as a source of cultural, aesthetic and leisure related activities and some potentially important climatic, watershed and biodiversity functions. Consequently, new policies are being established to help develop and realise these new opportunities. This new landscape-related forest uses imply a turning point at the local economic level, which enable farmers to access better living conditions and by-pass their dependence on the local forest resources promoting a new and more comfortable forest-human culture.

By looking through the small window of our case study, we hope to be able to illustrate some of these changes and to extrapolate their implications to other parts of China and the world.

1.4 Research goal and objectives

This PhD thesis is an attempt to assess the applicability of the forest transition in rural China and its effects on the dynamics of livelihood strategies, exploring the theoretical and empirical implications about the role of forestry for poverty reduction and environmental conservation. By analysing both macro- and micro-level processes shaping the forest transition and livelihood strategies, we aim at deepening in our understanding of potential relationships that help explain these complex socio-ecological realities. We hope this knowledge can contribute to improving the material and environmental conditions which rural livelihoods today face in forested regions of the PRC.

Our general goal can be further structured into three specific objectives of this thesis. Firstly, we will lay the theoretical foundations explaining the causal factors of the forest transition in China, and the specific role that forest policy has had in this process. Secondly, we will analyse the linkage between forestry and rural development during the forest transition in China, focusing especially on forestry, poverty, and land tenure relations. Thirdly, we will explore the potential for improving forest conservation values and rural inhabitants' life quality - the way out of poverty - in our case study based on a major economic shift towards a forest-based ecotourism and environmental services.

The goal and objectives have been pursued through specific questions that can be formalized:

At a general level:

1. Can recent China's forest changes be associated to a Forest Transition theory?
2. What have been the main drivers of these changes?

At a case study level:

1. What have been the forest changes (land use) and how have they affected the environmental values (biodiversity and carbon sequestration) in Daxi?
2. Do they reproduce a Forest Transition theory at local level?
3. What have been the main drivers at the local level?
4. How have they affected farmers' livelihoods and what has been the changing role of forests on it?
5. How has the link between on-farm (mainly forest) and off-farm developed and how it contributed to social differentiation in Daxi?
6. What is the role of land tenure institutions in the local Forest Transition?
7. What have been visitors' perceptions on forest-based ecotourism during this local Forest Transition? What are their suggestions?

Chapter 2. Structure

Throughout these pages we will first look at the general transition occurring at forest-dependent communities in rural China and then gradually immerse into our direct source of field information, a case study at Daxi village (Zhejiang province). By comparing general and specific levels at which the forest transition is developing, we want to learn *how, why and under which conditions* a 'forest modernisation path' can be opened resulting in an effective and comprehensive increase in farmers' living standards.

In chapter 3, we will provide the details of the methods, data and study area within which we have carried out this thesis. Our goal here is to lay the methodological foundations to further explore the way in which a formerly isolated-poor local community, Daxi village, has experienced a major forest transition towards a new utilisation of natural resources providing local dwellers with increased incomes, new opportunities and challenges.

In the Results Section, chapters 4 and 5 analyse the general processes depicting the forest transition in the PRC with a focus on the special case of the bamboo sector (chapter 5). In chapter 6, our work will explain the specific forest ecological setting and dynamics on which local livelihoods depend at Daxi village; particular emphasis will be put into the complementary roles of bamboo plantations and natural broadleaf-evergreen forests.

Chapters 7, 8 and 9 will show results concerning the socioeconomic and environmental features of the forest transition at Daxi village. In chapter 7 a detailed account of the changing roles of local forest resources will be made, with special attention to the evolving use that different income-groups make of bamboo, hickory and tea and of newly emerging opportunities such as forest-based ecotourism. Simultaneously, we will explore the key implication that some improvements – road building and access to the regional economy – have in driving these remarkable changes.

In the last three decades local livelihoods have gone through a deep transition at Daxi village, from a collectivised economy towards a so-called 'socialist-market' economy[1], in which the Contract Responsibility System and the Inter-household Forest Compensation Scheme have appeared to be the main policy innovations allowing for a socially-sensitive change in the local mode of production and a sustainable forest management. The concrete results will be given in chapter 8, while chapter 9 will introduce us to the new ecotourism sector to which the local socio-ecosystem is moving with socioeconomic and ecological outcomes.

Chapter 10 wraps up the different results in a general discussion, linking them to the research questions formulated in the Introduction. Chapter 11 sums up the main conclusions of the PhD.

The different result chapters have been published, presented in congresses or are currently under review, as specified below.

[1] While we are aware of the contradictions and debates around this term, we have retained it through this document as it represents the official terminology used by the Chinese government.

Chapter 4. La Transición Forestal en China [The Forest Transition in the PRC]. Revista Iberoamericana de Estudios de Asia Oriental (REDIAO Hispano-American Journal of East Asian Studies). Accepted, will be published at the end of 2013. Authors: Lucas Gutiérrez Rodríguez and Manuel Ruiz Pérez.

Chapter 5. From basic raw material goods to environmental services: the Chinese bamboo sophistication path. 中国竹业由作为基本原材料到实现其生态环境服务功能的变革过程. Authors: Manuel Ruiz Pérez, Lucas Gutiérrez Rodríguez, Yang Xiaosheng, Xie Jinzhong, Fu Maoyi. Manuscript submitted to Ecology and Society, currently under review (ES-2013-5954). An earlier version presented at the 8th Chinese Bamboo Congress, held in Zhuji in November 2012.

Chapter 6. Ecological functionality of Phyllostachys edulis (Moso Bamboo) within a Subtropical forest community in Eastern China - A Quantitative analysis of biodiversity, biomass and coverage parameters at Daxi village, Anji County. 毛竹 Phyllostachys edulis 在中国华东亚热带森林群落中的生态功能---以安吉县大溪村为例对生物多样性、生物量以及覆盖率进行定量分析. Presented at the 8th Chinese Bamboo Congress, held in Zhuji in November 2012. Authors: Lucas Gutiérrez Rodríguez, Fu Maoyi, Geriletu, Li Zhengcai, Manuel Ruiz Pérez, Xie Jinzhong, Yang Xiaosheng, Zhou Benzhi.

Chapter 7. Changing contribution of forests to livelihoods: evidence from Daxi Village, Zhejiang Province, China. International Forestry Review Vol.11(3), 2009, pp. 319-330. Authors: Lucas Gutiérrez Rodríguez, Manuel Ruiz Pérez, Xiaosheng Yang, Maoyi Fu, Geriletu and Dandan Wu.

Chapter 8. Maintaining the contract responsibility system of forest land distribution in China: Evidence from a novel financial compensation scheme in Daxi Village of Anji County, Zhejiang. Land Use Policy 30 (2013), pp. 863– 872. Authors: Lucas Gutiérrez Rodríguez, Manuel Ruiz Pérez, Xiaosheng Yang, Geriletu, Brian Belcher, Benzhi Zhou, Zhengcai Li.

Chapter 9. From Farm to Rural Hostel: New Opportunities and Challenges Associated with Tourism Expansion in Daxi, a Village in Anji County, Zhejiang, China. Sustainability 2011, 3, pp. 306-321. Lucas Gutierrez Rodriguez, Manuel Ruiz Perez, Xiaosheng Yang and Geriletu.

Chapter 3. Methods

3.1 Our approach

We have employed two different though complementary approaches to fulfil this thesis's goal and objectives and to answer the key research questions. In the Introduction chapter and the first chapter of the Results section – The Forest Transition in the People's Republic of China – a macroscopic perspective governs the analysis of general causes and trends in the prior degradation and later recovery of forest ecosystems in the PRC This transition has been detailed in the second chapter of the Results section – From basic raw material goods to environmental services: the Chinese bamboo sophistication path – that looks at the specific way how bamboo, a particularly relevant forest sub-sector that predominates in Anji county, has evolved in China since the early 1980s at the beginning of the Reform.

In the remaining articles contained in the Results section a microscopic perspective based in a case study has been used to depict the specific causes and trends driving the local forest transition at Daxi village, Anji county of Zhejiang province in China.

With regards to the macro-level of analysis, a thorough bibliographical search of English and Chinese references has been conducted. Historical statistical data on forest area, agricultural area and total population in China have been employed so as to grasp a general understanding of dynamic processes driving the forest transition. Two main sources of information have been the China Forest Inventories and the China Statistical Yearbooks. FAO forestry statistics have also provided complementary information. They have been complemented with specialized journal articles and reports. This has allowed to respond to the two general level questions related to the Forest Transition in China and its main drivers.

In the case of the micro-level of analysis, we have also conducted a bibliographical review and employed official forest and economic statistics provided by the Village Committee of Daxi, the Forest Station of Tianhuangping township, and the Forest and Statistical Bureaus of Anji county. We have tapped on local archives and official documents provided by these three administrative levels, along with key interviews with officials either at the committee, township or county. A particularly fortunate circumstance is the fact that for over two decades Daxi village has been part of the China Yearly National Rural Survey Panel, allowing for a detailed recording of socio-economic data based on a village farmers' sample. This has resulted in a unique and robust picture to compare past situations with recall data from questionnaires and to establish trends, particularly important for the subject of the PhD.

These data and interviews were focused on the understanding of the forest transition happening at Daxi village, exploring its connections with: early-1980s agriculture and forestry land reforms; the origins and development of the Inter-household Forest Compensation Scheme; the ecological and economic processes of local development; the new diversified forest roles giving special weight to the thriving eco-tourism sector. In all cases, we explored the linkages either at the village (Daxi), township (Tianhuangping) and county (Anji) levels.

In order to validate the official statistics, we conducted a Remote Sensing (RS) analysis based on three SPOT satellite images of the years 1988 (prior to the establishment of the hydroelectric station), 1996 (shortly after it was constructed) and 2005. The analysis was done in collaboration with the Institute of Forest Resources Information, Chinese Academy of Forestry. This has allowed us to partially respond to the first two research questions at a case study level, related to land use changes and the applicability of the Forest Transition theory at the local level.

Further from these remote sensing, statistical and official sources of information, our team carried out several in-depth field surveys. These consisted of a socio-economic survey of 92 households at Daxi village (2005), an ecological survey of 32 forest plots at Daxi village (2006) and a socio-economic tourist survey of 68 households and 243 visitors at Daxi village (2007). The data gathering benefited from previous exploratory work, based on former and long-term collaboration between UAM, CIFOR and RISF-CAF (particularly the team of Prof. Fu Maoyi 傅懋毅) mentioned in the Introduction chapter. The exploratory work included field visits, presentation of research agenda to counterparts (figure 3.1) and pre-tests of different questionnaires (figure 3.2). This has allowed completing the answers to the first two questions at case study level and the remaining questions related to the drivers of change, its effects on farmers' livelihoods, the link between on-farm and off-farm incomes, and the role of land tenure institutions.

Figure 3.1. Discussion of the project's organisation in October 2004 at RISF, Fuyang, Zhejiang. Profesor Xie Jinzhong 谢锦忠 (left) and author (right).

Figure 3.2. One of the interviewed peasants during the pre-testing field campaign in Daxi Village, October 2004.

Before we explain the details of these three different surveys let's first turn to the presentation of the Study Area.

3.2 Study Area - Daxi village of Anji county (Zhejiang province)

Daxi village (大溪村) is located at East 119^{o} 34'North 30^{o} 26'. The village belongs to Tianhuangping township (天荒坪镇) and is located in Anji county (安吉县) within the Chinese Eastern province of Zhejiang (figure 3.3). Anji is a very well-known bamboo homeland in China, featured by its prominent moso bamboo plantations and associated industries (Mertens et al, 2008). The first reforms were implemented in Anji in 1982 when the HRS was applied to the few areas suitable for rice land. In 1984 forests were allocated to households through the CRS. In Anji this was particularly relevant as it applied to the large-scale and valuable bamboo plantations. The county, which was awarded the title of 'National-level Ecological Model Area' (国家级生态示范区 *guojia ji shengtai shifanqu*) in 2002, in the second national round of approval by the Ministry of Environmental Protection[1], has undergone a recent forest transition from a raw-material based industry towards a newly diversified multi-purpose forest management with special emphasis on landscape-

[1] In the first national-level round 33 counties received this standard by the Ministry of Environmental Protection. In the second round, a total of 49 counties (including Anji) received this standard. So far, there have been 7 national-level rounds approving the 'Ecological Model Area' (国家级生态示范区) for a total of 528 counties in the PRC (Ministry of Environmental Protection of the PRC: 中华人民共和国环境保护部, 2012), out of a total of 1,464 counties (县) [or 2,862 county-level divisions (县级行政区)]. Before Anji received this standard, other counties in Zhejiang province had previously receive it: Shaoxing county (绍兴县), Lin'An city (临安市), Pan'An county (磐安县), Kaihua county (开化县)and Taishun county (泰顺县).

tourist values (Ministry of Environmental Protection of the PRC: 中华人民共和国环境保护部, 2012; Ruiz Pérez et al, 2001).

Daxi village, with a total area of 23.4 km^2 (equivalent to 35,036 mu) [2] presents a rough geomorphology with heights ranging from 300 m.a.s.l to 1,167 m.a.s.l (see figure 3.4).

Most of the area has steep slopes unsuitable for agriculture, having determined the dominant forest land use of the village. Hamlets tend to be located in more moderate altitudes, mainly between 400 and 800 m.a.s.l. Daxi belongs to the subtropical belt of East China with an annual average temperature of 13.4°C (throughout 1974-2007), a maximum of 38.3°C (July) and a minimum of -16.4°C (January). Therefore, Daxi presents a low mountain monsoon climate with well-differentiated four seasons and an average annual rainfall of 1,570 mm (humid season in summer) (Daxi village records edition committee: 大溪村志编纂委员会, 2009).

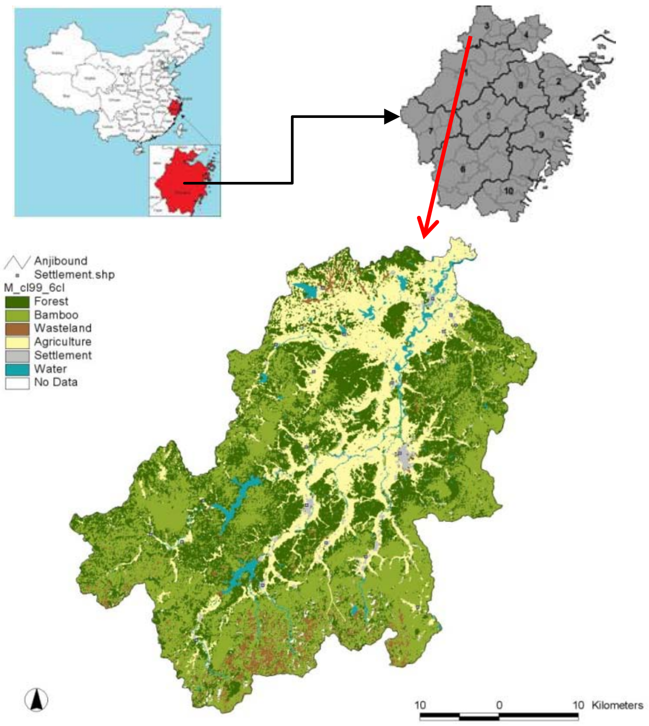


Figure 3.3. Location of Zhejiang province in China (top-left); the administrative division of Zhejiang (top-right) where number ‘3’ refers to Huzhou city (within which Anji county is located); and Anji county (bottom).

[2] The ‘mu’ (亩) is the standard unit used in rural China; 15 mu= 1 ha.

Figure 3.4. Daxi village. A water surface can be identified within the borders of Daxi village. It corresponds to the famous hydro-power plant named as 'Tianhuangping power station'. It is one of the biggest reversible hydroelectric stations in Asia.

Given its topographical and climatic characteristics, Daxi has traditionally been a forest area, currently covering around 90% of the land. The four main forest uses are moso bamboo (*Phyllostachys edulis*), natural evergreen broadleaf forest (a highly biodiverse local secondary forest), Chinese hickory (*Carya cathayensis*), conifers (such as *Cunninghamia lanceolata*) and tea plantations (*Camellia sinensis*). The beautiful scenery and idiosyncratic bamboo culture of Daxi village contributed to its denomination as Anji County Level Ecological Village (*Anji xianji shengtai cun*) in 2005 and Zhejiang Provincial Level Village with Comparatively Good Living Standards in 2006 (*Zhejiang shengji quanmian xiaokang jianshe shifan cun*) (Daxi village records edition committee: 大溪村志编纂委员会, 2009).

3.2.1 Evolution of the Local Demography in Daxi village

Daxi village committee has a detailed record of the evolution in the local population, roughly, since 1956. These records show a steady increase during the first two decades since the establishment of the PRC, that started levelling out at the beginning of the Reform in the early 1980s. By 2009 the village had 2,099 people, 51% female and 49% male. However, due to the recent economic expansion of tourism, there has been a subsequent increase in the local population (see figure 3.5).

The population is distributed in 11 settlements or hamlets (*xiaozu*). These 11 hamlets are the current equivalent to the former eleven production teams that formed the production brigade (Daxi brigade, part of the old commune of Shanhe, presently Tianhuangping Township) during the People's Communes' period (1958-1983). As we will see later, the scale of the hamlet plays an important role in shaping the local institutional arrangement of the Inter-household Forest Compensation Scheme (IFCS) – a policy that has been in place for over twenty years at Daxi village.

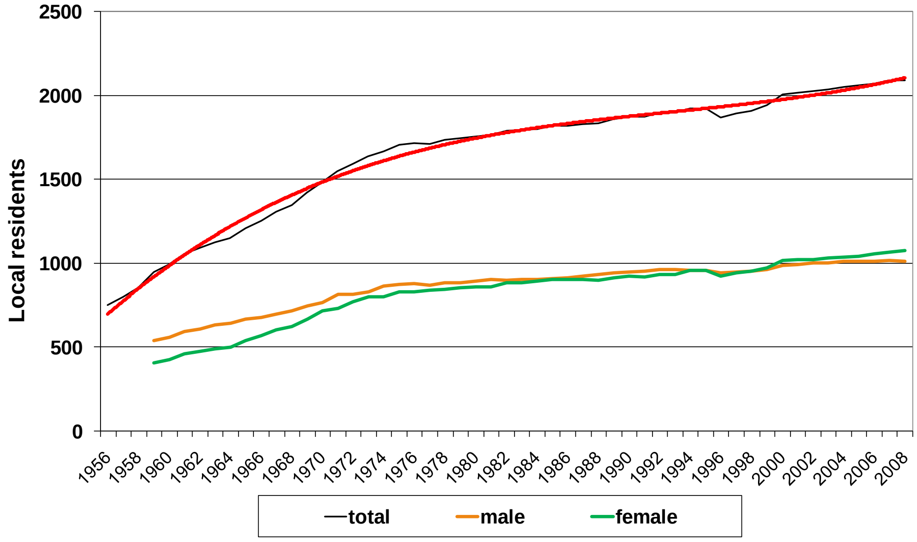


Figure 3.5. Evolution in the local population of Daxi (1956-2008).

3.2.2 Empirical evidence of a Local Forest Transition in Daxi village

According to the statistics provided by Tianhuangping Forest Station, Daxi village is experiencing a forest transition. In figure 3.6 a recovery trend in 'current forest area' is reported, whereas the area covered by shrubs gradually shrinks. On the light of these statistics, the local forest structure in Daxi shows a gradual change from dominant bamboo intensive plantations in 1998 towards the rapid expansion-recovery of natural evergreen-broadleaf hardwoods in 2007 (see Annex 1). In fact, using the same source of statistics, a considerably fast upturn in tree density has been reported (see figure 3.7). Nonetheless, as noticed in this latter figure, tree density values are still quite low (especially in the natural evergreen-broadleaf forests) reflecting the historical degradation processes to which forest resources have been exposed in Daxi, as in many other regions of the PRC.

The analysis on the SPOT satellite images (see figure 3.8) shows a more nuanced picture of the land use changes that have taken place at Daxi village. It confirms the important change from bamboo intensive plantations towards a prominent recovery of natural evergreen-broadleaf forests. However, RS analysis does not support the view that shrub area has been decreasing as stated in Tianhuangping official statistics. Our analysis in fact reports an increase in shrub area. This is most probably due to the fact that some of the land classified as evergreen natural forests in Tianhuangping official statistics are in fact early successional stages of recently abandoned bamboo and, to a lesser extent, agricultural plots, as indicated by the transition probability matrices (Annex 2).

At the same time, RS analysis informs us of another transition from agricultural plots (rice) towards intensive tea plantations, which have been spurred by the recent opening of Daxi to market forces and the tourist sector. On the other hand, bare land (mainly occupied by roads) and settlement areas have shown an important expansion in recent times.

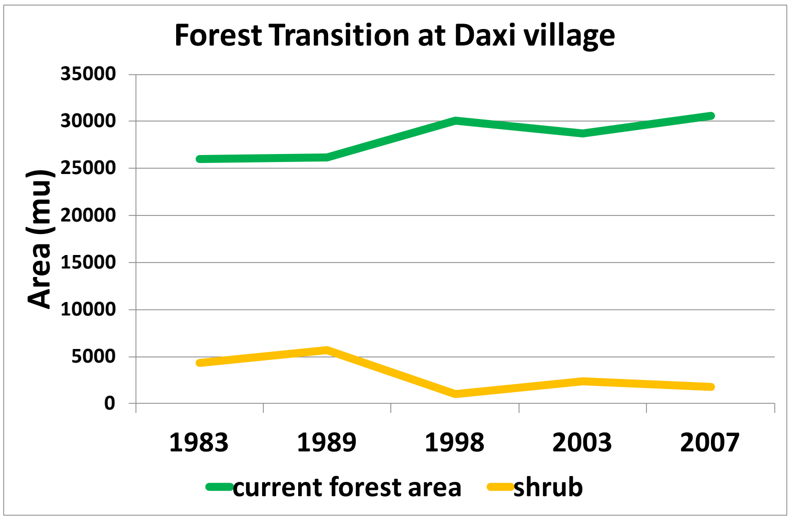


Figure 3.6. Evolution of current forest and shrub areas at Daxi village, as reported by Tianhuangping Forest Station.

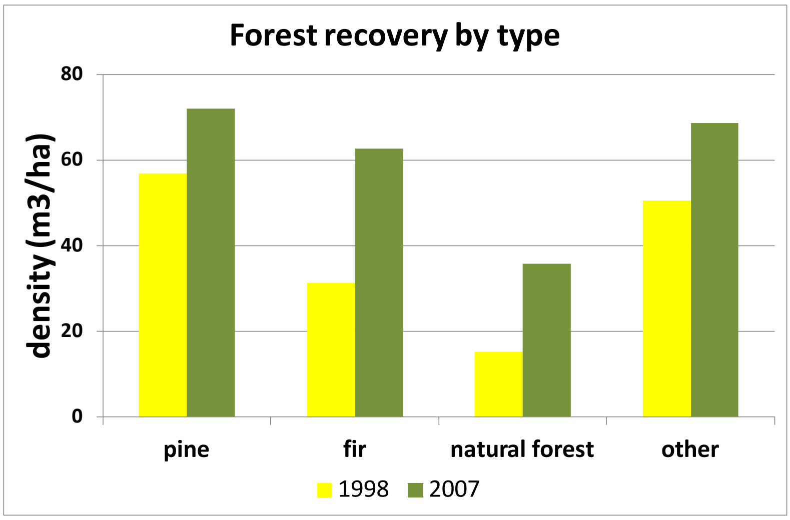


Figure 3.7. Evolution of tree densities at Daxi village, as reported by Tianhuangping Forest Station. 'Other' is referred to some residual (in area) broadleaf-softwoods (软阔叶林 *ruankuoyelin*), whose occupied area was only 147 mu in 2007 (see Annex 1).

Based on these two sources of information (forest statistics and RS analysis) we can infer the existence of a *partial* forest transition in Daxi, which is featured by a changing forest structure evolving from intensive bamboo management towards less intensive bamboo plantations and rapidly recovering natural evergreen-broadleaf forests. A significant driver of this change has been a 'Forest Ecological benefit-compensation fund' (*senlin shengtai xiaoyi buchang zijin*), promoted by Zhejiang province, implemented at the village since 2005 in order to protect these natural evergreen-broadleaf forest formations. The economic compensation of 8.5 yuan/mu, though being small, can be regarded as a positive signal sent to farmers to recognize the ecological services that these natural forests have for them and the general society.

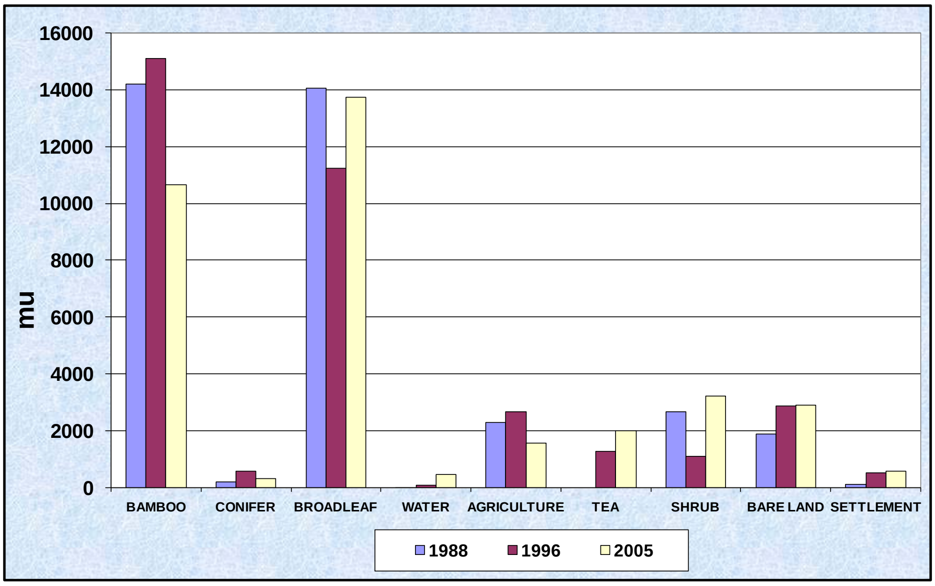


Figure 3.8. Land-use evolution in Daxi village, between 1988 and 2005 (from our analysis of SPOT images)

While the recovery of natural forests is a very positive step, the enlargement of settlements and other infrastructures is a clear negative by-product of the recent expansion of tourism in Daxi, which in the future could undermine the very natural basis for these eco-tourist activities.

3.3 Socioeconomic, Forest-ecology and Eco-tourism Surveys

3.3.1 Local Households' Data

The aim of this investigation was to characterize local households' different sources of income in order to understand the role of forests in the local economy. By comparing the data of our survey with those recorded for the official China Rural Economy surveys dating back over 20 years, we could explore the particular path of the forest transition. We also studied the impact of the Inter-household Forest Compensation Scheme (IFCS) on household income and forest institutional stability based on the survey and Daxi village official records.

The questionnaire (see Annex 3) consisted of social and demographic variables (No. household members, sex and age, level of education, possible political affiliation and village management responsibilities), economic sources of income (agriculture, husbandry, forestry and off-farm), and perception/opinion on the IFCS. Income data were recorded for two consecutive years in order to cope with the biennial production cycle[3] typical of Moso bamboo, one of the village's most important sources of income.

[3] A given plot of Moso bamboo produces new shoot in one year ("on-year") but not in the following year ("off-year"). As it happens, most of Daxi bamboo is 'on-year' in even years (2004, 2006, 2008, …) and 'off-year' in odd years (2005, 2007, 2009). Plots are managed with 2-year-spaced harvests

The sample was randomly allocated to cover the 11 hamlets, with a minimum of six a maximum of 11 interviews per hamlet, depending on its population size. The sample was also stratified between paying and receiving families[4] in order to study the effect of the Inter-household Forest Compensation Scheme (IFCS). The average sampling density was 14%. The core of this survey was conducted between June and August 2005. We counted with the support of two members of our research team (Prof. Zhou Benzhi周本智and Prof. Li Zhengcai李正才) plus a local Chinese official (Mr. Xu Kefa). Official statistical data, including the full IFCS archives, were collected in subsequent visits in 2007, 2009 and 2010.

The IFCS is a very interesting approach that has emerged spontaneously in Anji and other counties of that part of Zhejiang Province. It is analysed in chapter 8 (results section). Given the usual space limitations requested by journals, important working details of the scheme were omitted from that article. We present an elaborated description of it in Annex 4.

Figure 3.9. Field research in June 2005. Professors Fu Maoyi 傅懋毅 (centre-right), Manuel Ruiz Pérez (right) and Zhou Benzhi 周本智 (centre-left). Driver Pan (left).

Parametric and non-parametric tests as well as multiple regression models were used to assess which of several potential factors had the greatest influence on per capita income. We employed a parsimonious Corrected Akaike Information Criterium calculation (AICc) (Burnham and Anderson 2002) to assess the trade-offs between model complexity and data fit. Time series analysis was used to study the trend in the economic contribution of

normally occurring in “on-years”. For example, in 2014, there will be on-year for the majority of bamboo plots (with shoots) and off-year for the remaining minority of bamboo plots (with no shoots on the ground). On-year plots will be harvested in autumn while off-year plots will be left for the next year (2015) to be felled down.

[4] For each hamlet, the village committee has a list including all households with their corresponding amounts of compensation, either paid or received. Then, for each hamlet, we divided all households between those who paid and those who received compensation in order to have a similar allocation of samples between both groups.

different sources of income. Chow tests were used to check for structural breaks in each income component in order to identify the changes in trend. Gini coefficients were employed to calculate changes in the distribution of income for different periods, income categories and economic activities.

3.3.2 Forest inventory and biodiversity sampling

The aim of this survey was to estimate forest diversity, density, biomass and coverage parameters in order to characterize the local forest ecosystems.

We used a stratified sample of 32 forest plots distributed across the five main forest ecosystems. They were established proportionally to the relative importance of each type of forest use, with the following distribution: bamboo forest (10 plots), natural evergreen broadleaf forest (6 plots), Chinese hickory (6 plots), conifers (5 plots) and tea plantations (5 plots) (see figures 3.10 to 3.15). Each plot had 30m x 30m, and was itself subdivided in five randomly placed subplots of 5m x 5m. Within each of these 5mx5m subplots another smaller quadrant of 1m x 1m was randomly placed.

At the 30m x 30m plot level, every single tree was identified (species) and measured its diameter-at-breast-height (dbh), height and canopy crown. At the 5m x 5m subplot level, every single shrub was identified (species) and measured its height and canopy crown. Within the 1m x 1m quadrant level, every single herb species was identified. Voucher samples of each species were deposited at the RISF laboratory for identification and storage.

The biological diversity analysis was based on species abundance matrices for tree, shrub and herb layers. With regard to biomass, within the tree layer, we estimated each tree dry weight using Yuan Weigao et al (2009) models, specifically developed and tested for Zhejiang Province. Within the shrub and herb layers, we conducted in-situ above-ground wet-weight harvests in five quadrants of 2x2m (taken inside the 5x5m) and 1x1m, respectively. The samples were oven-dry at the RISF laboratory in order to obtain final above-ground dry-biomass figures.

Below, an example of culm biomass model (Yuan Weigao, 2009) for Moso Bamboo (*Phyllostachys edulis*) is shown. The same iterative process, but with different biomass models, was used for each tree species.

- Crown: $W_2 = 0.0398H^{0.5778}D^{1.8540}$
- Stem: $W_3 = 0.280D^{0.8357}L^{0.2740}$
- Root: $W_4 = 0.371H^{0.1357}D^{0.9817}$
- Total: $W_1 = W_2+W_3+W_4$

Where: W is biomass in Kg, H is height in m, D is dbh in cm and L is Mean crown in m.

Figure 3.10. Moso bamboo plot. June 2006.

Figure 3.11. Natural evergreen broadleaf secondary forest. June 2006.

Figure 3.12. Chinese hickory plot. June 2006.

Figure 3.13. Tea plot. June 2006

Figure 3.14. Conifer plot. June 2006.

Figure 3.15. Revisiting forest plots in summer of 2007. Manuel (centre) and author (left).

The preparation of the data matrices was done based on Excel (see Annex 5 for the detailed list of forest species). Species richness, Shannon Alfa and Whittaker Beta diversity were calculated using the software Diversity. Ordination and clustering multidimensional analysis were carried out using PC-ORD 6 and SPSS 19 software.

3.3.3 Eco-tourism surveys

This survey had two main components: one focused on the role of ecotourism in rural livelihoods and other focused on the perceptions of visitors coming to Daxi village. In the preparatory phase meetings with tourism administration officers at county, township and village levels were held in order to identify policies, trends, constraints and opportunities through semi-structured, key informant interviews. During this phase, we also had access to bibliographical sources and local level statistics that were made fully available to our team.

For the first component of the survey a stratified sample of 68 rural households was randomly selected among the 11 hamlets of Daxi, with a minimum of five and a maximum of eight households per hamlet depending on its size. Detailed information on family structure, education, income generating activities, tourism-related investment and their opinion about the role of tourism (including recall data for 1990 to analyse the changes in the last two decades) was collected from each of the selected households (see Annex 6).

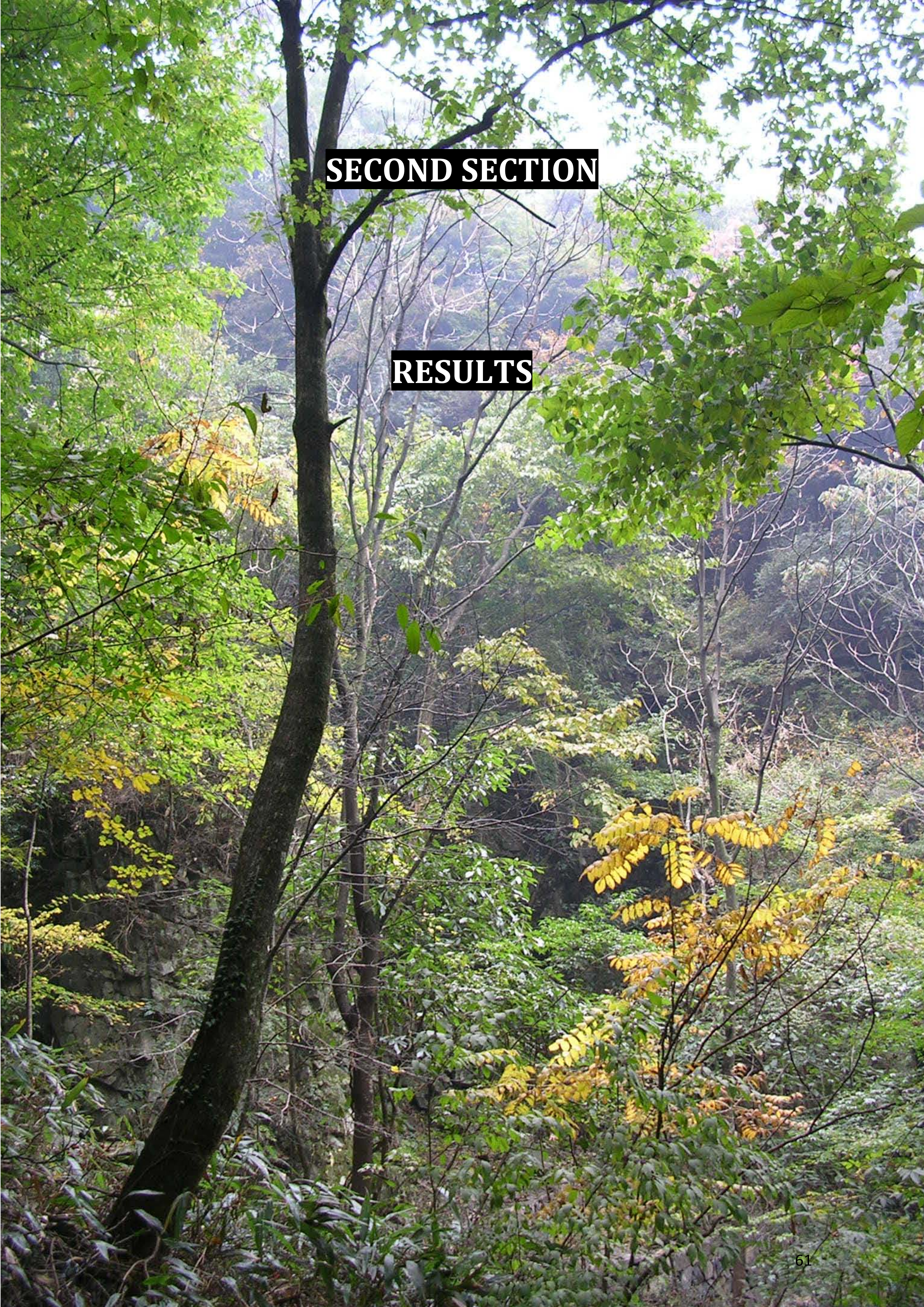
On the other hand, another questionnaire (see Annex 7) was administered to 243 visitors, who were selected from the main four tourist facilities located at Daxi village. Information reported included socioeconomic variables (provenance, age, gender. education, profession, income level), mode of transportation, time spent, number of visits, and general information about their knowledge of the area, degree of satisfaction, problems encountered and opinion about the ecological sustainability of Daxi (see figure 3.16).

Figure 3.16. Interviewing two visitors at the entrance of the power station. July 2007.

We used non-parametric tests to assess changes between 1990 and 2007. Non-linear regression models were used to explore future trends in tourism at county and village level. Categorical Principal Component Analysis was used to characterize the relationship between type of tourists and their perceptions and attitudes. The information from both questionnaires was codified in Excel and data were analyzed using SPSS 17.0.

SECOND SECTION

RESULTS



Chapter 4.

The Forest Transition in the People's Republic of China

La Transición Forestal en China (in Spanish)

The Forest Transition in the People's Republic of China

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(Abridged translation of 'La transición Forestal en China'-Revista Iberoamericana de Estudios de Asia Oriental, accepted article)

Abstract. China's forest policies play a key role in environmental conservation, being essential for the cohesion of its whole society. As in other regions of the world, population growth and increasing per capita consumption have led to a surge in the demand of forest products and pressures on forest ecosystems, which have resulted in forest loss and degradation. This article analyses the historical process of a forest transition in China, featured by a long term decrease in forests followed by a recent process of recovery. The causes of the forest transition lie in an unprecedented ecological crisis that has prompted an environmental awareness and the implementation of an active conservation policy. The forest transition in China has led to a displacement of impacts over other regions.

Key words: Forest transition, deforestation, international impact displacement, China.

4.1 Introduction

Environmental conservation has become a critical challenge, in both a national level for China and at a global level in the 21st century. In the People's Republic of China (PRC), a huge population of over 1.4 billion in tandem with the largest sustained economic growth period in History have resulted in severe erosion, desertification, depletion of water reserves, imbalanced urban development and reduction of arable land, air and water pollution, degradation of natural forests, biodiversity loss and a raising incidence of natural disasters (Rozelle et al, 1997; Ho and Vermeer, 2006; Ruiz Pérez, 2006; Ministry of Environmental Protection of the PRC, 2009; WWF China, 2010, IIED, 2011).

In spite of the PRC's impressive record of extracting several hundred millions out of poverty (World Bank, 2009), these environmental issues are causing social conflicts, socioeconomic costs and important consequences as measured in economic and public health standards (SEPA, 2004; World Bank & CSEA, 2007; Liu and Diamond, 2008; Wen & Chen, 2008). This environmental degradation process in the PRC has, nonetheless, been coupled with a raising social consciousness in environmental issues (Yang, 2005; Thompson and Lu, 2006) and the implementation of environmental policies (Wang and Lin, 2010). According to FAO (2011) forest policies can play a strategic role in contributing to the solution of some of these environmental problems, which are especially relevant in the PRC.

Due to historical deforestation, Chinese forests are nowadays certainly limited both in absolute and relative terms. In the PRC, forest coverage just represents 2/3 of the World average, while per capita forest area and per capita timber volume availability only reach, respectively, 1/4 and 1/7 of the World averages due to high population pressures (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010). Given their important ecological and socioeconomic functions, the Chinese government has made efforts since 1998 to protect forests by implementing six key forest programmes – '*liu da linye zhongdian gongcheng*' (Zhou Shengxian: 周生贤, 2002). These measures have resulted in both quantitative and qualitative changes, enabling forestry to evolve from a production-oriented forest management towards a multi-purpose forest perspective which is already rendering positive environmental outcomes.

In this article, we want to analyse the historical and contemporary processes which explain the current situation of the forest sector that have ultimately led to the forest transition in the PRC. We will consider the environmental outcomes of the forest transition, both in China and on an international level.

4.2 Forest Management and Conservation in the PRC today

China's Forest Administration is structured into three main regions[1], resulting from the confluence of ecological, socio-cultural and political factors (see figure 4.1). The Northeast Region (*dongbei linqu*) contains 24% of the country's forest (volume) reserve and is administered by State forest farms. The Southwest Region (*xinan linqu*) has 38% of reserve, administered by both the State and Collectives. The Southern Collective Region (*nanfang jiti linqu*) holds 19% of reserve and more than 80% of their forests are directly managed by households through Contract Responsibility Systems (*shengchan chengbao zeren zhi*).

Figure 4.1. Forest administrative regions in the People's Republic of China. Modified from http://www.guoqing.china.com.cn.

[1] Apart from these three regions, there are also the North and Northwest Forest Regions, but these present relatively and absolutely smaller quantities and qualities of forest resources.

Concerning the composition of the forest formations, the Northeast and Southwest Regions contain a high proportion of natural forests; more than 90% and 85% of forest area are covered by such primary formations, respectively. In contrast, the Southern Collective Forest Region presents a much higher proportion of forest plantations (more than 40% of its total forest cover) with lower biodiversity values, a fact that is explained by higher intensification of production (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010).

On a socio-economic level, forest counties do show a considerably higher prevalence of poverty than non-forest counties in the PRC, with 31.5% of the former classified as poverty-stricken counties, whereas in the latter poor counties only represent 21.5% (Feng and Xia: 冯菁, 夏自谦, 2007). The isolated and rural characteristics of forest regions, together with gender, educational and ethnic factors help explain the socio-cultural process of poverty within forest areas of the PRC (World Bank, 2009). Currently, there is a Conservation versus Development conflict in these forest regions of the country, whose solution is paramount for improving forest people's living standards and effectively protecting the ecological integrity of forest resources which are essential for Chinese society as a whole.

Forest ecosystems in China currently spread throughout 195.5 million ha (20.4% of the country's territory), with 34,984 vascular plant species including 2,800 tree species (Richardson, 1990; Ministry of Environmental Protection of the PRC, 2009). This high biodiversity is explained by a great geo-climate gradient correlated with an extraordinary ecosystem variation (Baker et al, 2010), the PRC being the fifth mega-biodiverse country in the World (Paine et al, 1997) and hosting some of the biodiversity hotspots of the Planet (Myers et al, 2000).

China official statistics indicate that there are still 133 million ha of natural forests kept with different conservation status (but see FAO, 2010[2]), in an ecological gradient ranging from boreal forests in the Northeast to subtropical and tropical formations in the Southeast and Southwest (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010; see figure 4.2). This original potential vegetation has suffered a deep transformation through History, characterized by an important loss of natural forests and a recent expansion of forest plantations[3], which today reach 62 million ha (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010)- a figure that constitutes one-third of total plantations in the world. Included within this category of plantations, non-timber forest products or 'forest cash crops' occupy 20.4 million ha, demonstrating Chinese peasants' higher acceptance of these forests as as they can produce fruits, bamboo, rattan, oils, medicines and industrial raw biomaterials. The bamboo sector, with a forest cover of 5.4 million ha[4], has played a determinant role in promoting rural development in the PRC (Ruiz Pérez et al, 2004; Gutiérrez Rodríguez et al, 2009).

[2] According to FAO statistics, in China there are 125 million ha of natural forests out of a 206.8 million total forest ha (FAO, 2010).
[3] According to FAO statistics, in China there are 64 million of forest plantations. The remnant of 17.8 million ha mainly consists of sparse low-density forest areas (FAO, 2010).
[4] According to FAO statistics, there are 5.7 million ha of bamboo forest (FAO, 2010).

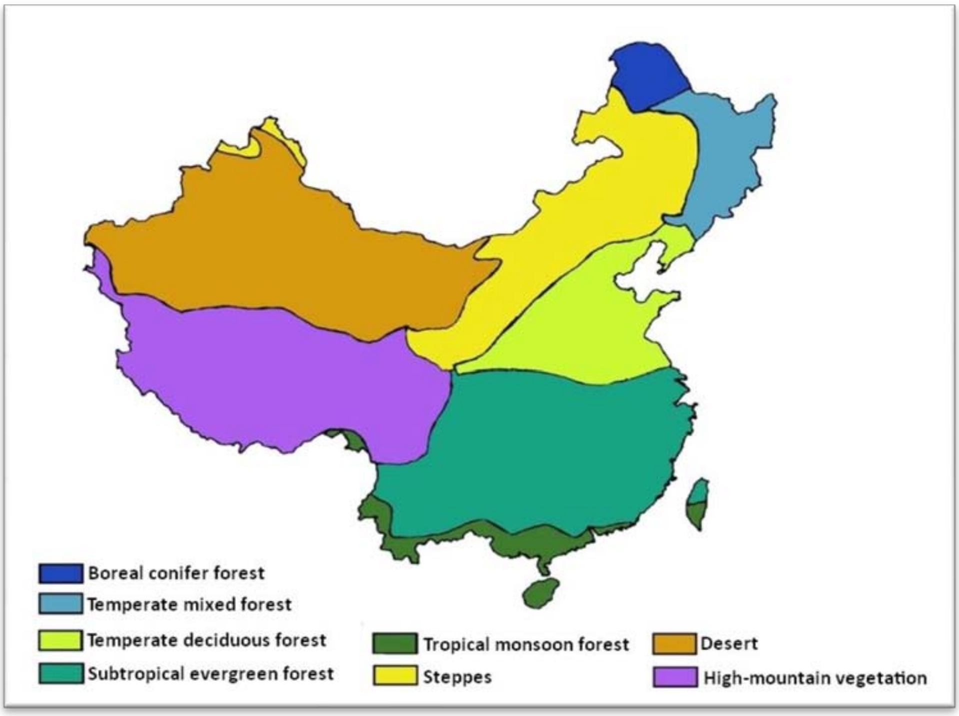

Figure 4.2. Forest ecosystem regions in the PRC. Modified from Olson Terrestrial Biomes and Chinamaps.org.

4.3 Historical Deforestation Processes

4.3.1 Forest deterioration during Imperial China

In prehistoric times, potential forest cover was already confined to 48% – 60% of the current PRC's territory (Lin Daxie: 凌大燮, 1983; Zhao Gang: 赵冈, 1996; Fan and Dong: 樊宝敏, 董源, 2001; Ren Guoyu, 2007), as an important part of those ecosystems consisted of elevated mountains, steppes and deserts located in the western regions. Ren Guoyu's work shows how there was a first forest-expansion phase (8,000 – 4,000 b.C) caused by climatic factors, followed by a later deforestation phase (4,000 b.C – current times) explained by anthropogenic factors[5].

It is within this later phase when, century after century, deforestation has been gradually advancing from the northern plains towards the Southwest of the country (Elvin, 2004), thereafter provoking both an important biodiversity loss and an intensification of erosion whose effects have been felt in recent natural disasters. As McNeill (2006) points out, in this process of forest destruction and replacement, China has not been an isolated case as both Europe's (Kaplan et al, 2009; Bryant, 1997) and Africa's forests (Bayon et al, 2012; Dupont, 2012) have also suffered from similar human activities.

[5] Based on Ren Guoyu (2007), forest cover was around 30% by 8,000 b.C and increased up to 48% by 4,000 b.C.

Preindustrial deforestation in China, as in other world regions, is driven by demographic expansion (Mather, 1992) through land reclamation for agriculture and settlement, as well as concomitant firewood and wood demands for energy and construction (Elvin, 2004; Kaplan et al, 2009; Bayon et al, 2012). As a result, by 1,700 A.C forest cover had already been reduced to 25.8% (around half of the original potential forest cover). Further population growth during the eighteenth and nineteenth centuries caused a displacement of the forest-agriculture frontier towards peripheral regions in the North and towards West and Southwest mountain ranges with subsequent impacts over forest resources. By 1,900 A.C He Fanneng et al (何凡能等, 2007) estimate that forest cover had already decreased to 16.7%, showing how the extraction of forest resources was amplified and had become increasingly unsustainable due to war conflicts at the end of the nineteenth- and beginning of the twentieth-century (Zhang, 2000; Yu et al, 2011).

4.3.2 Forest dynamics in the People's Republic of China

When the PRC was founded in 1949, forest lands covered only 109 mill ha, 11.4% of the country (He et al: 何凡能等, 2007). Despite the launch of pioneer forest programmes during the 1950s, net deforestation did not stop and reached its maximum at the Great Leap Forward Campaign (1959-1961) (Ashton et al, 1984; Peng, 1987; Lin, 1990; Yin, 1994; Chang and Wen, 1997; Yao, 1999; Wang and Chokkalingam, 2006). During these three years, forest resources were over-exploited in order to fuel backyard steel furnaces designed to raise industrial production; forest cover was thus reduced to 8.9% (Ge et al: 葛全胜等, 2000). Along with adverse climatic conditions, this industrial collectivization process that had disregarded agricultural management resulted in a famine catastrophe of tremendous dimensions.

After a brief period of economic readjustment, in the early 1960s net forest area began to recover because of the establishment of production plantations. A total of 23.7 mill ha were established in the 1949-1976 Maoist period, although forest resources kept degrading due to fires and the overuse of natural forests. In aggregate net terms, forest biomass decreased from 5,060 mill Tons Carbon in 1949 to 4,380 mill in the 1977-81 national forest survey (Fang et al, 2001).

From 1978 to 1998, the Chinese government had been gradually implementing eleven afforestation programmes, among which the 'Three Norths Protection Forest[6]' - *sanbei fanghu lin* - (Dai et al: 代力民等, 2000) was a remarkable representative, aimed at containing the desert's advance in the northern part of the country. Consequently, aggregated biomass grew up to 4,750 mill Tons Carbon in the 1994-98 national forest survey (Fang et al, 2001) in a process that was, nonetheless, characterised by an increase of 450 mill Tons Carbon in plantation forests but a decrease of 140 mill tons in natural forests (between 1977-81 survey and 1994-98 survey).

For the first 20 years of Reform, a loss of 9 mill ha of natural forest had been reported (Sayer and Sun, 2003). This degradation and substitution effect has taken place both in natural forests administered by Collectives (households in the great part) and the State. In the

[6] Also known as 'The Green Great Wall'.

former case, the implementation of the Contract Responsibility System (*jiating lianchan chengbao zeren zhi*) in the 1980s resulted in more than 1 mill ha deforested (Song et al, 1997; Liu, 2001; Weyerhaeuser et al, 2006), what has been ultimately attributed to tenure insecurity rooted in the frequent changes in forest land ownership and management during the Great Leap Forward and the Cultural Revolution (Gutiérrez Rodríguez et al, 2013). As an example, between 1948 and 1993, in the North-eastern State forested province of Heilongjiang the proportion of mature forest over total forest decreased, respectively, from 50% to 13.3% (area) and from 76.6% to 20.6% (volume) (Li Wenhua: 李文化, 2002).

Due to this deterioration process in mature natural forests, forest age structure is today clearly skewed towards younger- and middle-aged strata (essentially degraded natural forest and plantation forest), which currently concentrate 70% and 40% of the total forest area and standing volume of the country. Average volume density in Chinese forests equals 85.9 m^3/ha, just 78% of the World average, while volume density in plantation forests is even lower with only 49.0 m^3/ha (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010).

4.4 The Forest Transition and the New Forest Policy

The Forest Transition (FT) theory (Mather, 1992) states that a deforestation process fuelled by demographic and economic growth eventually halts and is followed by a forest recovery in area and biomass[7]. Based on the evidence provided by different sources, the very same process has been in action for at least a decade in the PRC, just after the New Forest Policy was first implemented.

Figure 4.3 shows a clear inverse relationship between forest area and total population – the forest degradation period - from the eighteenth-century to the end of 1950s. A subsequent period, which consisted on the expansion of plantations while natural forests were still degrading, occurred between the 1960s and late 1990s. These two phases resulted in both a historical (pre-1949) and contemporary (post-1949) increase in erosion intensification processes located at the Yangtze and Yellow River basins[8].

In line with the argument developed by Meyfroidt and Lambin (2011), we agree that the FT is a process found in different regions of the World, although it is contingent to each place and cannot be determined and predicted within a purely mechanistic framework. In other words, although the FT process can be favoured by socioeconomic factors, it is not an inevitable outcome (Rudel et al, 2005). It requires *human agency* – its practical consecution requires the larger society's determination to implement an active forest conservation policy. The roots of the FT in the PRC lie in the forest ecological degradation crisis – epitomised with the 1998 massive floods – which would later be socially recognised and targeted with the New Forest Policy for the 21st century.

[7] Forest area and standing volume have expanded from 121.9 mill ha and 8,655.8 mill m^3 in the first national forest survey (1973-76) to 195.5 mill ha and 13,720.8 mill m^3 in the last survey (2004-2008) (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010).

[8] For instance, in 1950 there were already 300,000 km^2 of eroded surface in the higher Yangtze basin that expanded reaching 390,000 km^2 in 2002 – 39.1% area of the basin (Li Wenhua: 李文化, 2002).

Therefore, the FT represents a change in policy direction from a former timber-focused forest production model (typical of the Maoist period) towards a new perspective centred in forests' multiple ecological functionality and protection (since 1998). While several causal socioeconomic factors [See Introduction chapter of this thesis] explain the FT, there is no doubt that *policy decisions* such as the 'logging ban' – Natural Forest Protection Programme – and the Sloping Land Conversion Programme have been determinant in having a net positive outcome. Today, forests in the PRC are in an incipient recovery stage and still present fragile natural formations in early or middle ecological succession phases, as well as newly afforested plantations that have not yet reached their productive potential.

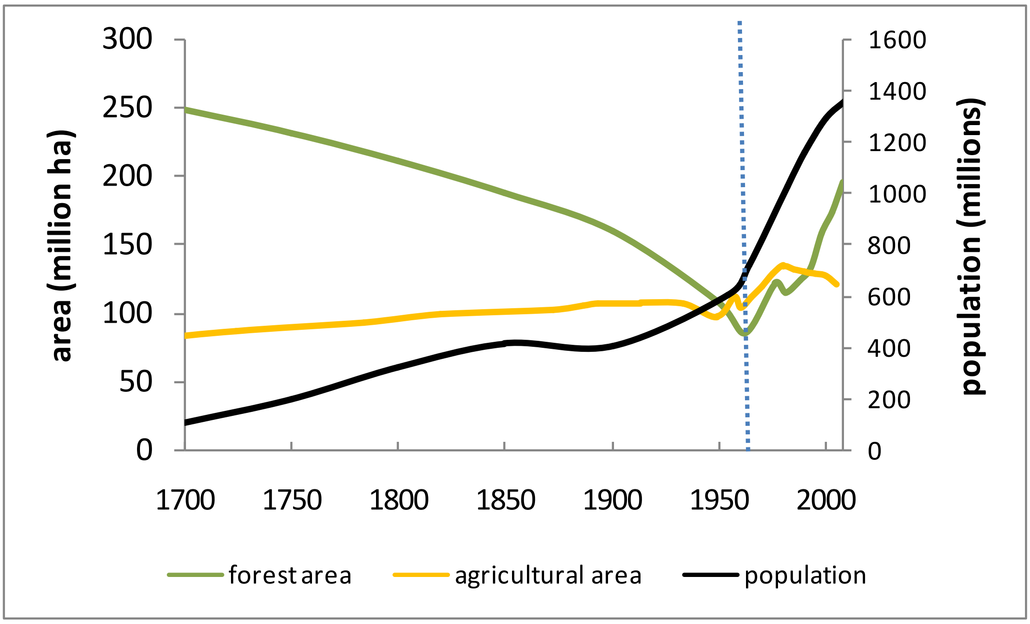

Figure 4.3. Evolution of population, forest and agricultural area. Source: forest area data taken from He Fanneng et al (何凡能等, 2007) and Ge Quansheng et al (葛全胜等, 2008), agricultural area between 1700-1949 taken from Ge Quansheng et al (葛全胜等, 2003), 1957-1985 from Feng Zhiming et al (封志明等, 2005) and since 1990 taken from Wang Yong et al (汪涌等, 2008). Population data between 1700-1900 have been taken from Luo Yi (骆毅, 1998) and since 1950 from the PRC's National Statistical Bureau (中华人民共和国国家统计局, censuses of 1954, 1964, 1982, 1990, 2000, 2010).

The New Forest Policy for the 21st century has been articulated through six key forest programmes - *liu da linye zhongdian gongcheng* – (Zhou Shengxian: 周生贤, 2002), which have been granted a much higher budget than previous forest programmes. The core of this new strategy is constitutes the first two programmes (see table 4.1), whose outcomes have been quite successful, though not exempt of critique.

Between 1999 and 2009, the SLCP afforested 9.1 mill ha has actively involved more than 120 mill peasants and has been renowned as the biggest conservation programme in the developing World. On its behalf, between 1998 and 2009 the NFPP has achieved the ground-based afforestation of 2.6 mill ha and an aerial-based afforestation of 3.2 mill ha, whilst also imposing the closure of 12.1 mill ha for natural regeneration.

Forest Programme	Features	Budget	Time horizon
Sloping Land Conversion Programme[97] (***tuigeng huanlin gongcheng***)	Agricultural fields located in slopes are to be converted into forest use or pasture. 80% of converted-to-forest area must be classified as 'ecological forest'.	225 billion yuan	2001-2010
Natural Forest Protection Programme (***tianranlin ziyuan baohu gongcheng***)	Prohibition of harvests in the higher watershed of Yangtze River and in the middle and higher reaches of Yellow River.	96 billion yuan	2000-2010
Wildlife and Reserves Conservation Programme (***yesheng dongwu zhiwu baohu ji ziran baohuqu jianshe gongcheng***)	Priority protection areas are under management by the central government.	135 billion yuan	2001-2050
Forest Shelterbelt Protection Programme (***sanbei he changjiang deng fanghulin gongcheng***)	It includes the 'Green Great Wall' and other forest shelterbelts located in Taihang mountains as well as in Yangtze and Zhujiang watersheds.	70 billion yuan	2001-2010
Beijing and Tianjin Erosion Control Programme (***jingjin fengshayuan zhili gongcheng***)	Rehabilitation of forest uses and pastures. Control of over-grazing.	57 billion yuan	2001-2010
Fast-growing Forest Production Programme (***susheng fengchan yongcailin jidi jianshe gongcheng***)	Increase domestic supply of timber production.	71,8 billion yuan	2001-2015

Table 4.1. Description and budget of the six key forest programmes. Source: adapted from Yin (2009).

Criticisms of New Forest Policy by Chinese and foreign experts can be classified into four groups: efficiency of the programmes, peasant incentives, ecological measures and transnational impacts. Firstly, the selection procedures of agricultural land cultivated on steep slopes to be converted to forest or pasture have frequently been below optimal standards, while fund allocation and redistribution among several administration levels and households have sometimes been far from the stipulated objectives (Xu et al, 2004; Uchida et al, 2005). Secondly, low incentives and high opportunity costs for farmers, especially in the NFPP, have had a negative impact over forest people's livelihoods; after the enforcement of the 'logging ban', the only choice left to some peasants has been to abandon their own villages *in search for work elsewhere* (Wang and Chokkalingam, 2006; Yin, 2009). Thirdly, forest plantations usually present a mono-species composition, a simplified age structure that is too concentrated on young stems and non-adapted to local climatic conditions, sometimes without the capacity for self-regeneration (Wang and Chokkalingam, 2006; Cao, 2008; Liu et al: 刘庆等, 2010; Xu, 2011). Fourthly, the implementation of the 'logging ban' has been linked to international displacement of deforestation impacts (Sun et al, 2004; Meyfroidt et al, 2010).

Despite these critiques and existing limitations, there is enough evidence to conclude that both the SLCP and the NFPP have decisively contributed to the structural economic transformation of rural forest-dependent communities, achieving a net increase in per capita income levels through job opportunities outside the primary sector and in agricultural productivity (Yin, 2009). However, there are some essential differences between these two programmes: while the SLCP's implementing process have relied on compensation payments to households who switched from agricultural to forest/pasture uses (which meant the complete abandonment in agricultural production), the NFPP have only compensated State forest farms and not households in Collective forest lands (under the Contract Responsibility System).

Consequently, some Chinese ecologists have proposed a readjustment to the 'logging ban', suggesting that the implementation of ecological selective harvests would provide both enterprises and workers of the extractive timber sector with sustained incomes, and would also improve forests' ecological structure and resilience (Liu et al: 刘庆等, 2010).

4.5 Forestry Challenges in a Globalised World

As the six key programmes are being enforced, in the international arena the PRC appears as the undisputed leader in the establishment of plantation forests and preservation of natural forests within its national borders. However, in parallel to this forest transition, we are witnessing the displacement of negative forest impacts derived from both forest and agricultural imports, which are bound first to China and then partly re-exported to Europe, Japan and U.S.A. While the PRC fosters its forest resources, expanding market-driven demands affects deforestation processes in Siberia, Southeast Asia and Africa (Sun et al, 2004; Meyfroidt et al, 2010; Putzel et al, 2011; EIA, 2012), to cite a few examples.

Therefore, we argue that there is a shared responsibility in these global processes which are connected through the whole international supply chain: from the raw material harvested in, for example, Southeast Asia through its transformation in China and to its final consumption in Europe. Concepts such as 'embodied trade emissions' and 'consumption-based accounting' are being increasingly employed in research analysis applied to countries' environmental balance and global trade (Li et al, 2007; Davis and Caldeira, 2010). There is an urgent need of addressing questions like: Who is responsible for deforestation through international trade? Which effective measures should be implemented? Firstly, China should continue implementing its NFPP halting natural forest degradation, although introducing stronger, socially-sensitive measures to back this programme are recommended. Simultaneously, fast-growing plantations are being implemented in China to tackle its forest supply's shortage in order to be more self-reliant on its own natural resources, which would eventually allow for gradually reducing its forest and agricultural imports. The six key forest programmes, especially the SLCP and the NFPP, are strongly needed to re-organise and optimise the current unbalanced forest age structure, and to solve some of the environmental pitfalls found in the forest plantations of the PRC. Though some problems persist, we believe that China is doing well at the national forest policy level.

Secondly, there is the big problem of forest impact displacement at the international level. This is a question that especially pertains to growth-dependent markets in a world of unbalance income structures and, still, prevalent poverty in tropical developing countries. Is it possible to escape poverty while protecting forests?

Often, reinforcing local poverty and growing market dynamics drive such deforestation processes, although responsibilities are clearly different: the poor peasants are left without any real options for development (except cutting down trees and expand their agricultural and pasture lands), whereas richer consumers do have more available livelihood options, not to mention those of large national and transnational companies which often are the direct and main agents of destruction. Clearly, the poor should not be blamed for the rich's fault.

We are talking about the need of change for the current socio-economic model. Redistribution, within and across countries, that would go from the high-income groups towards the low-income groups is essential. The poor have the right to improve their living standards while the rich *have to be less rich* and to take a higher responsibility in the protection of global natural resources.

The PRC does already have the needed resources and capital to face this challenge for a change at the national level and, furthermore, has a positive experience in dealing with the how-to-escape-poverty question. Of course, higher income countries should also become involved in this global change process and show their willingness to reduce proportionately higher ecological footprints. Within the PRC context, this change requires support for unfettering the potential of active forest management for rural employment, deepening into the rural modernisation, investment in renewable energies and due compensation for rural Collectives being affected by the 'logging ban'. The current blind-growth economic model is not viable, in the long run, neither in China nor at a World's level.

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La Transición Forestal en China

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Resumen. Las políticas forestales en China desempeñan un papel clave en la conservación del medio ambiente resultando esenciales para la cohesión del conjunto de su sociedad. Al igual que ha ocurrido en diversas regiones del planeta, el incremento de la presión poblacional y del consumo per cápita se ha traducido en el aumento de la demanda de productos forestales y en la presión sobre estos ecosistemas que históricamente ha conducido a la pérdida y degradación de los bosques. En el presente trabajo se analiza el proceso histórico de la transición forestal en China, caracterizado por un fuerte descenso del capital forestal seguido de un reciente proceso de recuperación. Las causas de la transición forestal se hallan en el inicio de una crisis ecológica sin precedentes seguida de una toma de conciencia de la misma y la determinación en la aplicación de políticas activas de conservación. Así mismo, la transición forestal en China ha estado caracterizada por un desplazamiento de los impactos hacia otras regiones.

Abstract. China's forest policies play a key role in environmental conservation, being essential for the cohesion of its whole society. As in other regions of the world, population growth and increasing per capita consumption have led to a surge in the demand of forest products and pressures on forest ecosystems, what has historically resulted in forest loss and degradation. This article analyses the historical process of a forest transition in China, featured by a rapid decrease in forest capital followed by a recent process of recovery. The causes of the forest transition lie in an unprecedented ecological crisis that has prompted an environmental awareness and the implementation of an active conservation policy. The forest transition in China has led to a displacement of impacts over other regions.

Introducción

Durante las tres últimas décadas, la sociedad china ha experimentado una rápida mejora en sus condiciones de vida en términos de reducción de pobreza (estimada en cientos de millones de personas entre 1981 y 2004[1]), de incremento de esperanza de vida, niveles educativos y otros indicadores generales de desarrollo[2]. A pesar de este histórico avance, han surgido nuevos retos, tales como la creciente brecha económica entre ciudad y campo, la desigualdad local entre grupos de renta y entre hombres y mujeres[3], o la mercantilización de servicios públicos otrora universales, como nuevas aspiraciones que presionan los límites del actual marco jurídico-político[4].

Entre estos nuevos desafíos hay que añadir uno de la mayor importancia para China en el siglo XXI: la conservación del medio ambiente. La presión ejercida por una población de más de 1.350 millones y una tasa media de crecimiento económico del 9,8% desde 1979[5] ha generado la acentuación de los procesos erosivos, desertificación, escasez de agua, urbanización y reducción de la tierra cultivable, contaminación del agua y del aire, degradación de los bosques naturales, pérdida de biodiversidad y un aumento de la incidencia de los desastres naturales[6], entre otros problemas que están ocasionando conflictos sociales, costes socioeconómicos e importantes repercusiones sobre la salud pública[7].

De manera simultánea a este deterioro ambiental se ha producido en China una creciente concienciación social[8] y la aplicación de políticas gubernamentales dirigidas al medio ambiente[9]. Las medidas orientadas hacia el sector forestal ocupan un lugar estratégico dado que la conservación de los bosques contribuye positivamente a la solución de buena parte de los problemas ambientales[10], siendo particularmente aplicables al caso de China.

Los bosques chinos han estado sometidos a una continua sobreexplotación a lo largo de la historia hasta fecha muy reciente, resultando en una cobertura forestal actual equivalente tan sólo a las 2/3 partes de la cobertura media mundial. El capital forestal de China es ciertamente limitado, encontrándose además acuciado por la presión de la mayor población del planeta. Como ejemplo, la disponibilidad de superficie forestal per cápita es inferior a 1/4 de la media mundial y la reserva de madera per cápita es sólo 1/7 de la media mundial[11].

Dada la importancia de sus funciones socio-ecológicas, recientemente se han realizado esfuerzos enfocados a la protección de los bosques con la puesta en marcha, al inicio del nuevo milenio, de los llamados “seis programas forestales clave” “*liu da linye zhongdian gongcheng*”[12]. Con estas medidas se ha producido un cambio en la concepción de los bosques desde un enfoque exclusivamente productivista hacia una nueva visión integral que valora también los procesos ecológicos y que ya está teniendo efectos positivos sobre el medio ambiente. Se ha conseguido así invertir el patrón histórico de deforestación, posibilitando el acontecimiento de la transición forestal china.

En el presente artículo ofrecemos un análisis histórico y contemporáneo del sector forestal en China que nos ayude a comprender las claves y el alcance de un cambio cuya contribución resulta estratégica para el futuro desarrollo del país (protección de cuencas hidrográficas, control de desertificación, cambio climático, cohesión de la sociedad rural), considerando sus posibles repercusiones a nivel nacional e internacional.

Gestión y Conservación de los Bosques en China

La gestión forestal en China se estructura a través de tres regiones principales, resultado de la confluencia de factores ecológicos, socio-culturales y políticos (ver Figura 1). La Región del Noreste (*dongbei linqu*) de gestión prominentemente estatal, la Región del Suroeste (*xinan linqu*) administrada tanto por el Estado como por los Colectivos, y la Región Colectiva del Sur (*nanfang linqu*) gestionada fundamentalmente por los campesinos mediante los ‘Contratos de Responsabilidad Familiar’ (*shengchan chengbao zeren zhi*) que suponen más del 80% de la superficie forestal de esta región[13]. Las mayores concentraciones de bosque natural se localizan en la Regiones Suroeste y Noreste[14], con el 38% y el 24% respectivamente de las reservas forestales del país[15]. Los bosques presentes en la Región Forestal del Sur en cambio están sometidos a una mayor presión demográfica, presentando una menor biodiversidad y una menor concentración de recurso con el 19% de reserva forestal de China[16].

Las zonas forestales de China muestran así mismo una clara correlación con la pobreza. El 31,5% de los 302 condados forestales son oficialmente clasificados como pobres, superando en diez puntos la incidencia de pobreza en el total de condados del país (21,5%)[17]. Ello se explica principalmente por el carácter aislado y rural[18] de las zonas forestales, convergiendo factores de género y nivel educativo en el proceso sociocultural de la pobreza, y solapándose con ciertas regiones montañosas donde viven minorías étnicas[19]. Existe un conflicto de conservación-desarrollo en las zonas forestales del país, cuya solución es indispensable para la mejora de las condiciones de vida de sus habitantes y para la protección de la integridad de unos recursos naturales, con un valor estratégico esencial para la sociedad china en su conjunto.

Figura1. Distribución de las grandes regiones forestales desde un punto de vista administrativo en China. Modificado de: http://www.guoqing.china.com.cn.

La superficie forestal cubre actualmente 195,5 millones de ha, el 20,4% del territorio. A pesar de la fuerte deforestación sufrida, China conserva una altísima biodiversidad habiéndose identificado 34.984 especies de plantas superiores y 2.800 especies arbóreas[20]. Ello se explica porque su territorio alberga una enorme variación geo-climática[21] que encuentra paralelo en su gran riqueza de ecosistemas, siendo considerado el quinto país mega-biodiverso[22] albergando algunos de los 'hotspots' de biodiversidad del planeta (Himalayas y bosques del Suroeste, bosques de la zona tropical del Sur[23]). Hoy se mantienen 133 millones de ha de bosque natural en diversos estados de conservación[24], constituyendo un gradiente ecológico desde los bosques del noreste hasta los subtropicales y tropicales del sureste y suroeste[25] (ver figura 2).

Comenzando desde el norte y limitando con Rusia se encuentra el bosque boreal de coníferas, que poco a poco es sustituido hacia el sur por el bosque templado mixto de coníferas y caducifolias de hoja ancha. Seguidamente en latitudes algo más meridionales, se encuentra una vasta región de bosque templado caducifolio de hoja ancha. Todavía más al sur, se encuentra el bosque mixto de caducifolios y perennes de hoja ancha con una gran biodiversidad sin que haya especies dominantes.

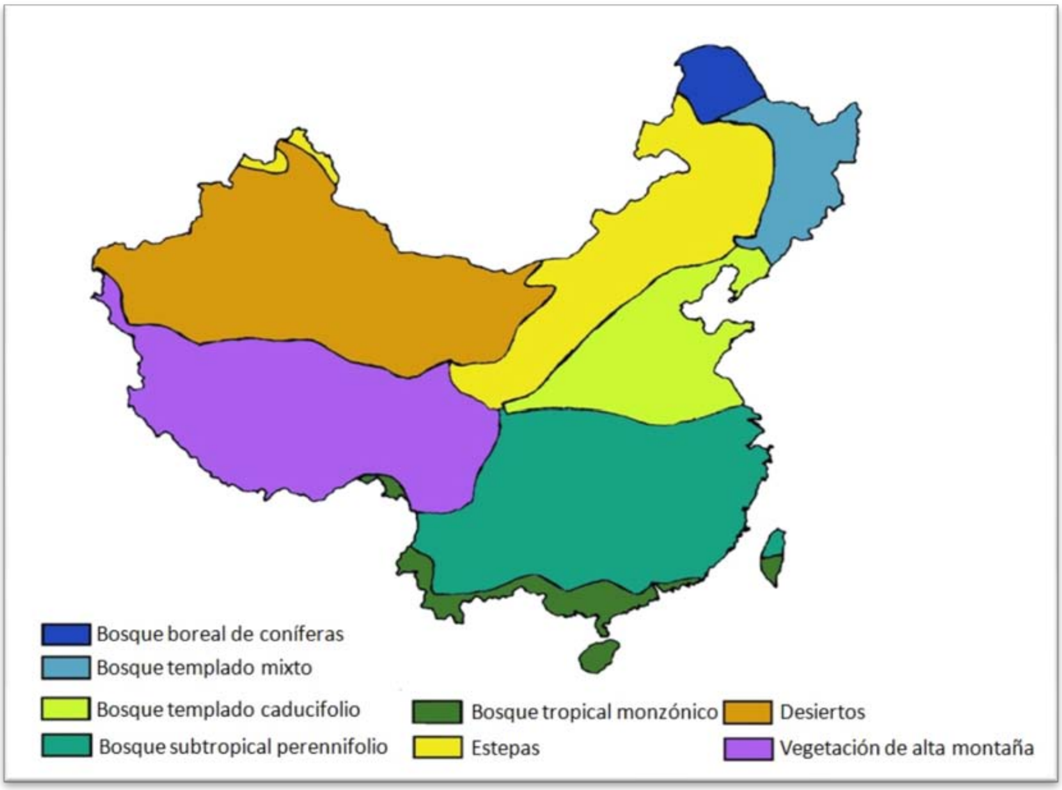

Figura 2. Formaciones forestales y otros biomas presentes en China. Modificado de: Olson Terrestrial Biomes y Chinamaps.org.

Al sur del paralelo 32º aproximadamente se encuentra el bosque subtropical perennifolio húmedo, muy característico del Este de Asia, que presenta una breve parada biológica en invierno (al darse temperaturas inferiores a los 0º C). Finalmente, las zonas más meridionales estarían ocupadas por el bosque húmedo de carácter monzónico con una flora mucho más diversa que los demás tipos de bosques.

Esta vegetación potencial originaria de China ha sufrido una transformación profunda a lo largo de la historia, marcada por una fuerte pérdida de bosque natural y una reciente expansión de plantaciones, las cuales alcanzan hoy en día los 62 millones de ha[26], concentrando un tercio del área total de repoblación del planeta. Entre las especies de plantación empleadas, destacan las coníferas *Picea asperata*, *Pinus elliottii*, *Pinus massoniana*, *Pinus yunnanensis*, *Cunninghamia lanceolata*, el género *Populus* (chopos y álamos), el género *Eucaliptus* y plantaciones de caucho (*Hevea brasiliensis*) en las zonas más meridionales[27].

El esfuerzo de China en el establecimiento de plantaciones forestales ha sido valorado positivamente[28], si bien no ha estado exento de críticas particularmente en zonas áridas y semiáridas[29]. En este sentido, en comparación con los altos servicios ecológicos provistos por el bosque natural, las plantaciones suelen presentarse en formaciones monoespecíficas, con estructura simplificada, altamente densificadas y con excesiva concentración de materia orgánica en suelo, lo que explica su menor funcionalidad ecológica, menor eficacia de cara a la protección de cuencas hidrográficas y la incapacidad de regeneración de la propia masa forestal[30]. China tiene también un extenso programa de desarrollo de plantaciones forestales modificadas genéticamente, especialmente del género *Populus*[31], siendo el principal comercializador de tal tipo de variedades[32]. Aunque el uso de especies forestales modificadas genéticamente ha sido bien recibido en algunos medios[33], en otros ha causado preocupación dada la altísima complejidad de los procesos potenciales de dispersión genética desde dichas variedades hacia las poblaciones naturales locales[34].

Incluidas también dentro de los 62 mill ha de plantación forestal, se encuentran unos 20,4 mill ha de los llamados *cultivos forestales económicos no-maderables*[35], particularmente bien acogidos por los campesinos y en los cuales se producen frutas, aceites, bambú, caucho, especias, medicinas y materiales industriales. El sector del bambú, con una cobertura actual de 5,4 mill ha[36] y pese a no estar exento de los problemas ecológicos descritos para las plantaciones, ha desempeñado un papel clave en la promoción del desarrollo rural en China[37].

Procesos Históricos de Deforestación

El Legado Histórico de los Bosques en la China Imperial

El trabajo de Ren Guoyu[38], basado en análisis de mapas polínicos del Holoceno muestra la existencia de una primera etapa (8000 – 4000 a.C) de expansión forestal tras las glaciaciones motivada por factores climáticos, y de una etapa posterior (4000 a.C – actualidad) de pérdida y degradación forestal causada por factores antropogénicos[39].

Es en esta última etapa donde a lo largo de los siglos se ha producido una deforestación que ha ido avanzando progresivamente desde las llanuras del norte hacia el suroeste del país, y que ha ocasionado una importante pérdida de biodiversidad e intensificación de la erosión[40]. Como bien señala McNeill[41], este proceso de destrucción y sustitución de los bosques no ha sido exclusivo de China sino que en Europa[42], y también en África Central[43], también se produjo una transformación ecológica de similar alcance motivada por factores humanos.

La deforestación durante la fase económica preindustrial, en China como en otras regiones del mundo, viene explicada principalmente por la roturación de tierras para la agricultura, el establecimiento de asentamientos y la resultante presión de las demandas de leña y madera para el consumo energético y la construcción[44], factores que en última instancia se encuentran altamente relacionados con la expansión poblacional[45].

Las zonas tradicionales agrícolas se asentaron en el este, primero en la cuenca del Río Amarillo y más tarde en la cuenca del Yangtsé, donde se produjo la temprana sobreexplotación de los bosques ubicados en las planicies y fondos de valle. Hoy sabemos que la meseta del Loess, cuna de la civilización China, fue ampliamente deforestada durante la dinastía Han-Oeste (206 a.C – 8 d.C) y posteriormente a partir del siglo VI d.C, dando lugar a la sedimentación en el Río Amarillo y sus conocidas inundaciones y cambios de curso[46]. Así mismo, entre los años 1004 y 1085 d.C (en plena dinastía Song del Norte), tanto en las cuencas del Amarillo y Huai, los tramos medio y bajo del Yangtze, como en la cuenca de Sichuan[47], ya se alcanzaba un alto grado de densidad poblacional asociada a una explotación agrícola que llegaba a cubrir en algunas zonas hasta un 85% del territorio[48].

Como consecuencia de estos procesos de roturación y degradación forestal, en el año 1700 d.C la cobertura forestal del conjunto de China ya se había reducido hasta llegar al 25.8%[49], en torno a la mitad de la superficie forestal original.

Debido al rápido crecimiento demográfico entre los siglos XVIII y XIX, en dichas regiones tradicionales agrícolas del este de China se comenzó a cultivar sobre colinas onduladas llevando consigo un deterioro ulterior de los bosques. El incremento de la población también se tradujo en el traslado de la frontera agrícola-forestal hasta las regiones periféricas del norte del país y montañas del oeste–suroeste con los subsiguientes impactos sobre la vegetación. Los registros históricos[50] dan cuenta del alcance de la degradación forestal de la época, en tanto la frecuente escasez de grano, madera, leña y bambú conducían a la reiterada ocupación de nuevos territorios y su posterior abandono ante la insostenibilidad de la presión a la que se sometía el nuevo espacio ocupado.

Para 1900 d.C, He Fanneng et al. (2007) estiman que la superficie forestal ya había descendido hasta el 16.7% poniendo de relieve (al margen del efecto de la expansión demográfica), cómo la extracción forestal asociada a los conflictos bélicos de finales del siglo XIX y principios del XX iría adquiriendo un patrón cada vez más insostenible y que continuaría minando las reservas forestales del país hasta bien llegados los años 60 del siglo XX[51].

Dinámica del Medio Forestal en la República Popular China

En el momento de la fundación de la República Popular, los bosques contaban tan sólo con una extensión de 109 millones de ha, el 11.4% del territorio del país[52]. Después de 1949, a pesar de la implementación de programas pioneros en la década de los 50 orientados a la expansión de la superficie forestal, la destrucción de los recursos naturales no se detendría y alcanzaría su cénit durante la desastrosa campaña del Gran Salto Adelante (1959-1961)[53]. En esta época la cubierta forestal llegó a su mínimo histórico quedando reducida al 8.9%[54].

Ya a principios de la década de los 60 se establecieron barreras forestales de protección y se aceleró el desarrollo de plantaciones con fines productivos, si bien su calidad distaba mucho de la esperada dadas las bajas tasas de supervivencia de los árboles, en torno al 30%[55]. Además, en los primeros años de la Revolución Cultural, la mayor parte de las agencias forestales presentaba un funcionamiento ineficiente y el programa de plantaciones se detuvo hasta que fuera otra vez retomado a principios de la década de los 70[56].

Consecuentemente, durante la etapa maoísta (1949-1976) aún habiéndose establecido un total de 23,7 millones de ha de plantaciones forestales[57] y producido una cierta recuperación del área forestal desde la década de los 60, se continuó perdiendo calidad debido fundamentalmente al deterioro de bosques naturales[58]. Sirvan de ejemplos la provincia de Yunnan, donde la sobreexplotación provocó un descenso de la cobertura de bosques naturales desde el 47% a principios de los años 50 hasta un 24% en los años 70[59], y la isla de Hainan donde se produjo un descenso de bosque natural desde el 35% hasta el 12% de cobertura durante el mismo período[60]. Al mismo tiempo, el minucioso estudio de Fang et al (2001)[61] sobre la biomasa forestal en China nos ofrece datos de alto interés que ponen de relieve como en las tres primeras décadas de la República Popular continuó y se profundizó en el proceso de degradación heredado de los tiempos imperiales. Mientras que en 1949 los bosques acumulaban una biomasa total de 5.060 millones de Tm de carbono, esta cifra se redujo hasta los 4.380 millones en el muestreo nacional de 1977-1981.

Desde 1978 el gobierno chino decide dar un nuevo impulso a las plantaciones forestales con el lanzamiento gradual de 11 programas de repoblación hasta 1998, entre los que destaca el conocido como “La Gran Muralla Verde”[62]. Se trataba entonces de construir una barrera de protección natural que impidiese el avance del desierto en el Norte de China[63]. El efecto inmediato de todas estas medidas de reforestación ha sido el incremento forestal tanto en términos de área como de reserva de madera. Entre el inventario nacional de 1977-1981 y el de 1994-1998, se produjo un incremento de biomasa hasta los 4.750 millones de Tm de carbono[64].

Este importante cambio neto se ha debido fundamentalmente al establecimiento de plantaciones, mientras que el bosque natural ha continuado deteriorándose hasta hace muy poco tiempo. Según Fang et al (2001), desde los años 70 hasta 1998 se produjo una pérdida estimada en 140 millones de Tm de carbono de bosque natural y una ganancia de 450 millones de Tm de plantación forestal.

Sayer y Sun (2003)[65] estiman en más de 9 millones ha la deforestación del bosque natural durante los primeros 20 años de la reforma. La destrucción reciente del bosque natural ha tenido lugar tanto en los bosques gestionados por los campesinos como en aquellos administrados estatalmente. Por una parte, la descentralización en la Región Colectiva del Sur a mediados de los 80 mediante la aplicación a las tierras forestales del Sistema de Responsabilidad Familiar (*jiating lianchan chengbao zeren zhi*)[66] tuvo como consecuencia inmediata la pérdida de más de 1 millón de ha en dicha región afectando mayoritariamente al bosque natural de mayor calidad y madurez[67], lo que se explica por el clima de inseguridad de la tenencia forestal generado por los cambios bruscos de gestión durante la Colectivización de los años 50 y la Revolución Cultural[68]. Por su parte, la provincia boscosa de Heilongjiang situada dentro de la Región Forestal del Noreste, supone un ejemplo representativo de la continuidad que la degradación del bosque natural gestionado por el Estado tuvo tras las reformas[69].

Como producto del deterioro del bosque maduro natural, actualmente la estructura de edades de los bosques está claramente sesgada hacia los estratos más jóvenes. Cerca del 70% del área forestal en China está constituida hoy por masas de clases de edad joven y mediana que concentran en torno al 40% del volumen, poniendo de relieve el importante peso específico de las repoblaciones forestales. Así, el volumen medio de una hectárea forestal con estrato arbóreo es de sólo 85,9 m^3 (el 78% de la media mundial), siendo todavía inferior la reserva de las plantaciones con 49,0 m^3/ha[70].

Por ello, aun reconociendo el enorme esfuerzo de recuperación forestal realizado por la sociedad china, debemos contemplar con cautela los logros conseguidos[71]. Entre tanto, el caso de China está proporcionando datos empíricos de interés para analizar la teoría de la transición forestal[72] que presentamos en el siguiente apartado.

La Transición Forestal en China

La Teoría de la Transición Forestal[73] plantea un proceso de deforestación asociado a la expansión demográfica y al crecimiento económico que toca fondo y comienza a revertirse una vez se alcanza un cierto nivel de desarrollo. Diversas fuentes tanto independientes como oficiales confirman el fenómeno de la transición forestal en China, consistiendo en un primer descenso histórico de biomasa y área forestales seguido de una posterior reciente recuperación en ambos parámetros.

El proceso de rápido crecimiento demográfico originado desde el siglo XVIII y acentuado tras 1949, había propulsado la tala del bosque natural de ladera para el establecimiento de unos usos agrícolas altamente erosivos en las cuencas altas del Yangtsé y Río Amarillo. Desde los años 1950 el área de erosión de la cuenca alta del Yangtsé se incrementó espectacularmente, pasando de unos 300.000 km^2 hasta llegar a los 393.000 km^2 (el 39.1% del área total de la cuenca) en el año 2002[74].

Los datos históricos de cobertura forestal desde el siglo XVIII hasta finalizar la década de los 50 en el siglo XX (ver figura 3) muestran claramente una relación inversa con el incremento de la población, asociado éste también a un incremento del área agrícola. Desde finales de los 80 del siglo XX y a pesar del ascenso continuado de la población china, se ha consolidado un cambio paulatino en la eficiencia de uso de los recursos forestales que ha posibilitado la ya comentada expansión de la superficie y reserva forestal. Las detalladas estadísticas oficiales muestran cómo la cubierta y volumen de los recursos forestales se han expandido a un ritmo anual del 1.9%, desde las 121,9 mill ha y 8.655,8 mill m^3 en el primer inventario nacional (1973-1976) hasta las 195,5 mill ha y 13.720,8 mill m^3 en el séptimo y último inventario (2004-2008)[75].

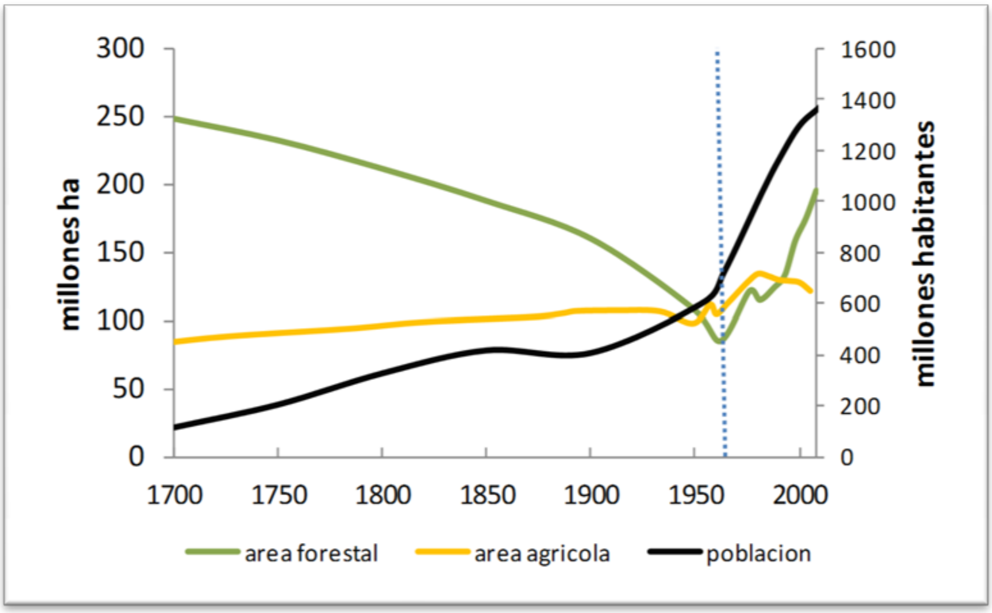

Figura 3. Evolución de la superficie forestal y agrícola de China. El crecimiento de la población se ha representado en un segundo eje. Fuente: datos de área forestal tomados de los trabajos de He Fanneng y Ge Quansheng (2007, 2008), datos de área agrícola entre 1700-1949 proceden de Ge Quansheng et al (2003), entre 1957-1985 de Feng Zhiming et al (2005) y desde 1990 Wang Yong et al (2008). Datos de población entre 1700-1900 procedentes de Luo Yi (1998) y del Bureau Nacional de Estadística de la RP China (censos de población de 1954, 1964, 1982, 1990, 2000, 2010)[76].

En línea con el argumento expuesto por Meyfroidt y Lambin (2011)[77], consideramos la transición forestal como una regularidad empírica contingente a lo largo de muchos países del planeta, y no como una concatenación de estadios insertada en un proceso predecible y determinista. Es decir, la transición forestal no es un proceso inevitable[78] y, aun siendo favorecida por ciertos factores estructurales, su consecución práctica requiere principalmente de la determinación del conjunto de la sociedad mediante la aplicación de políticas forestales de conservación activas. Éstas últimas han desempeñado un papel crítico en el origen de la transición forestal china[79], siendo la crisis ecológica del país, el reconocimiento social de su magnitud y la implicación gubernamental en la búsqueda de soluciones sus principales motores.

La transición forestal sólo pudo realizarse tras la aplicación de la nueva política forestal al comenzar el siglo XXI, con la prohibición de las talas del bosque natural, el mantenimiento de la política de plantaciones y la prohibición de cultivar en laderas de fuerte pendiente, junto con un nivel de desarrollo que permitió cambiar la base energética, especialmente en zonas rurales. Por ello, muchos de los bosques que encontramos en China se hallan en una fase incipiente de recuperación, presentando unas formaciones naturales debilitadas y en fases tempranas o medias de sucesión ecológica, y unas repoblaciones en expansión que aún no han alcanzado su potencial productivo.

La Nueva Política Forestal

El desencadenante de las últimas políticas forestales y el cambio en la percepción oficial del alcance de la crisis ecológico-forestal de China cristaliza a finales de los años 90 con el advenimiento de las graves inundaciones de 1998. Éstas provocaron una parálisis social en las cuencas del Yangtsé y Amarillo[80]. El gobierno reconoció la gravedad de la situación concluyendo que estaban en juego la propia supervivencia y las expectativas de desarrollo de la sociedad china en su conjunto[81].

A pesar de que entre 1970-90 se había producido una recuperación neta del área y volumen forestal en China, la marcada disparidad en la funcionalidad ecológica entre los bosques naturales y plantaciones no había recibido la debida atención. El gobierno heredaba de la época maoísta una visión forestal productivista, fuente de materias primas baratas para la construcción de la economía nacional, ignorando la importancia del cambio profundo que se seguía produciendo en la estructura de los bosques. El aumento de las plantaciones no había compensado ni estructural ni funcionalmente el declive de las masas naturales. La figura 4 ilustra el cambio en valor total y medio por ha forestal.

Con el cambio de siglo, la sociedad china va a experimentar el paso de dicho modelo forestal productivista hacia un nuevo modelo que concentra todos sus esfuerzos en la construcción y protección de la funcionalidad ecológica de los bosques[83]. El valor medio por ha de la figura 4 refleja esta tendencia, con una pérdida entre 1977 y 1998, resultado de la deforestación del inicio de este período y del aumento de las plantaciones que aumentan la superficie forestal pero añaden poco valor al inicio. A partir de 1998 la prohibición de explotación de bosques naturales, junto con la maduración progresiva de las plantaciones, revierten la tendencia y comienza un marcado incremento del valor medio por ha forestal.

La incorporación de criterios de valoración ambiental, en línea con la paulatina incorporación de valoraciones ambientales en la contabilidad general del país, ha

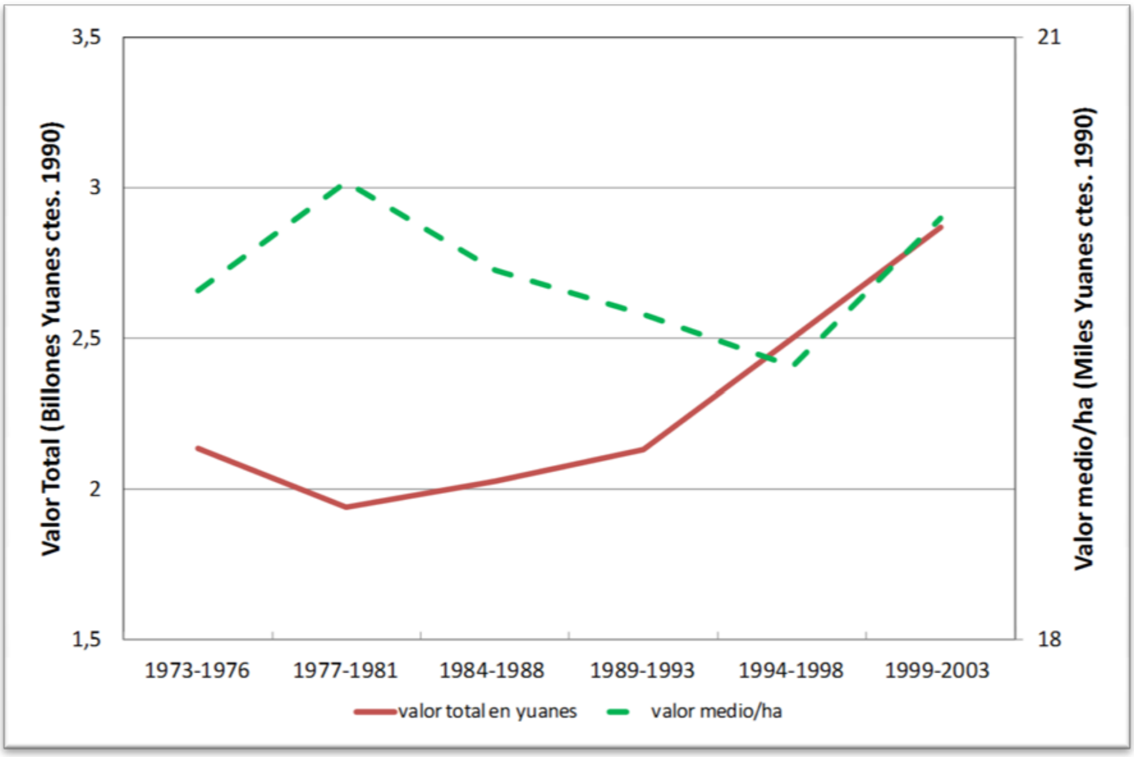

Figura 4. Evolución del valor total y por ha en yuanes constantes de 1990. Basado en Wang et al. (2009)[82].

supuesto la práctica duplicación del valor total forestal. En base al último inventario forestal nacional (2004-2008), se estima en 10 billones de yuanes (1,3 billones de €) el valor económico anual de los servicios ecosistémicos de los bosques en China, valor total que se distribuye entre la conservación del ciclo hidrológico (40% del valor total), conservación de la biodiversidad (24%), fijación de carbono (16%), conservación del suelo (10%), purificación de la atmósfera (8%), y acumulación de nutrientes (2%)[84].

Los Seis Programas Forestales

Los cambios de tendencia han sido posibles gracias a la aplicación de 6 programas forestales clave "*liu da linye zhongdian gongcheng*"[85] (ver tabla 1), provistos de un presupuesto mucho mayor al invertido en épocas pasadas en este sector. De esta forma, se ha promovido una recuperación de área-volumen forestal mediante la conversión de tierras agrícolas de ladera en plantaciones forestales, y se ha puesto freno a la destrucción del bosque natural (prohibición de talas) cuyas funciones ecológicas son irreemplazables[86]. Se reconoce también la necesidad de desarrollar una base forestal productiva de rápido crecimiento que satisfaga la demanda de productos forestales, con el fin de sustituir las extracciones que se realizaban desde el bosque natural.

Los dos primeros programas han recibido la máxima prioridad del gobierno y mayor atención de la sociedad china. Todo indica que han tenido un éxito notable aunque no exento de críticas en la consecución de sus objetivos[87]. El Programa de Conversión de Laderas ha conseguido repoblar 9,1 millones de ha entre 1999 y 2009[88], cuya implementación ha implicado activamente a 120 millones de campesinos[89]. El Programa de Protección de Bosques Naturales ha conseguido entre1998 y 2009 la repoblación de 2,6 mill ha de plantación artificial, 3,2 mill ha mediante plantación aérea y ha supuesto el cierre de otras 12,1 mill ha para su regeneración natural, proporcionando un total de 621.000 puestos de trabajo[90]. Ante la importancia estratégica de ambas políticas el gobierno chino ha decidido mantener la vigencia de las mismas.

Las críticas que se han hecho a estos dos programas se centran en la discutible eficacia en la priorización de los cultivos susceptibles de conversión a uso forestal o pasto, la distribución ineficiente de fondos entre las administraciones implicadas y los hogares destinatarios finales, la escasez de incentivos y altos costes de oportunidad no compensados a los campesinos, como también la ineficiencia de algunas medidas de carácter ambiental[91]. Además, como resultado de su implementación en algunas comunidades rurales los modos de vida de los campesinos han sufrido importantes impactos negativos[92] quedando sólo la opción de abandonar sus pueblos para buscar otras alternativas económicas. Finalmente, también se ha mencionado el efecto de desplazamiento que ha tenido la prohibición de talas dentro del territorio nacional, resultando en un rápido incremento de las importaciones de madera desde otros países[93].

A pesar de las críticas y limitaciones existe suficiente evidencia para concluir que los dos programas han contribuido decisivamente a la transformación estructural de la economía de las comunidades rurales, logrando un incremento de la renta per cápita y de las oportunidades de trabajo fuera del sector agroforestal así como un aumento de la productividad agrícola[94]. No obstante, hay diferencias importantes entre ambos: así el Programa de Conversión de Laderas se ha implementado por medio de la concesión de ayudas económicas y en grano a los hogares campesinos con el objetivo de compensar las pérdidas ocasionadas por la transformación de terreno agrícola en uso forestal o pastoril (área que ya no produce cosecha); en cambio, el Programa de Protección de los Bosques Naturales, que en un inicio sólo se contemplaba para las grandes compañías estatales (que sí fueron compensadas económicamente), no ha ofrecido ninguna compensación económica para los Colectivos que gestionan bosque natural (fundamentalmente hogares campesinos). Consecuentemente, algunos ecólogos forestales chinos han propuesto un reajuste de la política de prohibición de talas, proponiendo la aplicación de cortas selectivas que proporcionen ingresos a las empresas y trabajadores del sector extractivo hoy en crisis severa y que mejoren la estructura interna y fortaleza biológica de las plantaciones (muchas sin capacidad de auto-regeneración)[95].

Ante los problemas ecológicos detectados en las plantaciones, especialistas chinos han llamado la atención sobre la necesidad de establecer masas forestales con especies, estratos de edad y masas mixtos, adaptadas a las condiciones climáticas y geográficas locales, de aplicar clareos selectivos facilitando la entrada de luz en la masa, y de utilizar fertilizantes naturales para así mejorar la calidad de las plantaciones, garantizando la sostenibilidad y mayor biodiversidad de los recursos forestales[96].

Retos de la Gestión Forestal en un Ámbito Nacional Globalizado

Como resultado de la aplicación de sus políticas internas de conservación, China se presenta en la escena internacional como el líder indiscutible en regeneración forestal a través del establecimiento de plantaciones. Sin embargo, de manera simultánea al fenómeno de la transición forestal en China, se está produciendo un incremento de sus

Política Forestal	Características	Presupuesto	Plazo
Programa de Conversión de Laderas[97] **(*tuigeng huanlin gongcheng*)**	Los cultivos en laderas son transformados en uso forestal o pasto. El 80% del área convertida debe consistir de bosque "ecológico".	225 millard. yuanes	2001-2010
Programa de Protección de los Bosques Naturales (*tianranlin ziyuan baohu gongcheng*)	Prohibición de extracciones en cuenca alta del Yangtsé y cuenca alta y media del Río Amarillo.	96 millard. yuanes	2000-2010
Programa de Conservación de Especies y Espacios Naturales (*yesheng dongwu zhiwu baohu ji ziran baohuqu jianshe gongcheng*)	Las áreas de protección prioritaria son gestionadas por el gobierno central.	135 millard. yuanes	2001-2050
Programa de Desarrollo de Barreras Protectoras Forestales (*sanbei he changjiang deng fanghulin gongcheng*)	Incluye la "Gran Muralla Verde" y otras barreras situadas en las montañas Taihang y en las cuencas del Yangtsé y Zhujiang.	70 millard. yuanes	2001-2010
Programa de Control de Erosión en torno a Beijing y Tianjin (*jingjin fengshayuan zhili gongcheng*)	Rehabilitación de usos forestal y de pastos. Control del sobrepastoreo.	57 millard. yuanes	2001-2010
Programa de Producción Forestal de Rápido Crecimiento (*susheng fengchan yongcailin jidi jianshe gongcheng*)	Incremento de la oferta doméstica de productos forestales.	71,8 millard. yuanes	2001-2015

Tabla 1. Descripción y presupuesto de los 6 programas forestales principales. Nota: 1 millard. (millardo) equivale a 1.000 millones de yuanes. Fuente: información adaptada procedente de Yin et al. (2009)[98].

impactos negativos derivados fundamentalmente de sus importaciones de productos forestales. Mientras que China conserva los bosques naturales y establece repoblaciones en su territorio, la imparable demanda del mercado traspasa sus fronteras ocasionando importantes pérdidas de bosque natural en Siberia, el Sureste Asiático y África[99].

A su vez, China es también el primer exportador mundial de muebles y bienes basados en la madera, actuando así como un punto intermedio de transformación con un consumo final que se realiza en otros lugares. El debate sobre el punto de la cadena materias primas-transformación-consumo final en el que debe imputarse un determinado efecto ambiental ha suscitado gran interés, con conceptos como 'embodied trade emissions' y 'consumption-based accounting'[100]. Su aplicación reduce en parte la importancia de la presión global de China al ser este país un transformador intermedio de productos consumidos en otras regiones.

Para evaluar el impacto neto de la transición forestal china, por tanto, es preciso evaluar no sólo las variaciones en área de plantación y bosque natural, dada la mayor calidad ecológica del segundo sobre la del primero en términos de fijación de carbono, biomasa, biodiversidad, y otros. También hay que cuantificar su balance neto a escala global y la externalización a otros territorios de los efectos de determinados modelos de producción y consumo.

Ante esta situación contradictoria de conservación "hacia el interior" y deforestación "hacia el exterior", cabe preguntarse cuáles son las soluciones potenciales de dicho conflicto, con sus componentes ecológicas, económicas y sociales.

En primer lugar, reforzar los programas de conservación de bosques naturales, deteniendo los procesos de pérdida y degradación y dotándoles de un mayor contenido e inversión en programas sociales dirigidos al medio rural. Dada la pujanza de la economía china y sus tendencias de consumo al alza, se precisa con urgencia mejorar la gestión del programa de plantaciones que le permita corregir algunas de sus deficiencias ambientales y confiera una mayor autosuficiencia y menor dependencia de importaciones procedentes de otros países. La contribución de las plantaciones forestales es todavía bastante limitada ya que se trata esencialmente de una reserva joven que no ha alcanzado su madurez, si bien existe un amplio margen de mejora conforme pasen los años y teniendo en cuenta que aún existen 35 mill ha que potencialmente pueden ser repobladas[101].

En segundo lugar, resulta evidente que el mero establecimiento en China de plantaciones en producción no supone una propuesta suficiente que ponga fin a los impactos negativos sobre la biodiversidad y modos de vida asociados a los bosques naturales, situados tanto en China como en otros países. La causa última de estos conflictos frecuentemente asociados a procesos de pobreza y degradación forestal es la combinación de un consumismo desbocado y una presión poblacional, aspectos ambos a los que China contribuye de modo significativo.

Con todo, podemos ver que la resolución de los conflictos emergentes, nacionales y globales, en el proceso de la transición forestal nos lleva a la necesidad de abordar abiertamente un cambio de paradigma socioeconómico. China potencialmente está dotada de los recursos y capital social necesarios para enfrentarse al problema de la deforestación y cambio globales. Dicho cambio de modelo, en su dimensión social, económica, ecológica y energética, exige que se reconozca la necesidad de limitar el crecimiento económico de las regiones y grupos de renta más opulentos y, simultáneamente, el derecho de crecer de aquellas regiones y grupos de renta más desfavorecidos. Dentro de este proceso dinámico, la redistribución, tanto entre grupos favorecidos y desfavorecidos como entre beneficiarios y gestores de los servicios ecológicos forestales, desempeña una función esencial.

En el contexto de China, ello supone apostar por el potencial de la gestión forestal activa en el empleo rural, el ecoturismo, la profundización en la modernización del campo, la inversión en energías renovables y la compensación económica a las comunidades rurales afectadas por la restricción de las extracciones. Así mismo, conjuntamente con otros países, China debe plantearse que el modelo de crecimiento actual no es viable a largo plazo.

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Una parte importante de los ecosistemas presentes en China consiste de elevadas montañas, estepas y desiertos localizados en la vertiente más occidental del país (ver Figura 2), todos ellos paisajes no forestales que ya estaban presentes con anterioridad a la aparición de la agricultura. La superficie forestal ya se encontraba en la prehistoria limitada a una cobertura potencial estimada en el 48% - 60% del territorio actual de China (Lin Daxie, 1983; Zhao Gang, 1996; Fan Baomin y Dong Yuan, 2001; Ren Guoyu, 2007).

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Zheng, Y., "Research, deployment and safety management of genetically modified poplars in China", en *Forests and Genetically Modified Trees*, Roma: FAO, 2010, pp. 135-144.

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González-Martínez, S.C.: Smouse, P.E., “Theoretical and practical considerations of gene flow”, Forests and Genetically Modified Trees, Roma: FAO, 2010, pp. 147-162).

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[39] Según este estudio, la cobertura forestal queda estimada en el 30% en 8000 a.C, y se incrementaría hasta llegar al 48% en el 4000 a.C (Ren Guoyu, 2007).

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Kaplan et al, “The prehistoric and preindustrial deforestation of Europe”, 2009, pp. 3016–3034.

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Dai Limin 代力民; Wang Xianli 王宪礼; Wang Jinxi 王金锡, "Sanbei fanghulin shengtai xiaoyi pingjia yaosu fenxi"三北防护林生态效益评价要素分析, *Shijie linye yanjiu* 世界林业研究, Vol.13, No.2 (2000), pp. 47-51

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Gutiérrez Rodríguez, Lucas; Ruiz Pérez, Manuel; Yang, Xiaosheng; Gerilet u; Belcher, Brian; Zhou, Benzhi; Li, Zhengcai, "Maintaining the contract responsibility system of forest land distribution in China: evidence from a novel financial compensation scheme in Daxi Village of Anji County, Zhejiang", *Land Use Policy*, in press, article accepted on the 18th of June (2012).

[69] Mientras que, en 1948, el 50% del área forestal y el 76.6% de la reserva forestal estaban clasificados como bosque maduro en esta provincia, en 1993 ambas cifras se habían reducido hasta llegar al 13.3% y 20.6%, respectivamente. El volumen medio de una hectárea forestal en Heilongjiang descendió desde 199 m3 en 1948 a los 100 m3 en 1993 (Li Wenhua, 2002). La prohibición de talas introducida en 1998 ha permitido iniciar una recuperación en la cobertura forestal, que ha pasado del 41,9% hasta el 43,6% entre 2001 y 2005 (Heilongjiang nongye xinxiwang, 2001; Xinhua, 2005).

Li Wenhua 李文化, "Jiuba hongshui de shengtaixue fansi" 98 洪水的生态学反思 [Repensando la ecología de las inundaciones del año 1998], en Zhou Shengxian (ed.), *Zaizao xiumei shanchuan de zhuangju* 再造秀美山川的壮举 [La hazaña de reconstruir las bellas montañas y ríos], Beijing: zhongguo linye chubanshe, 2002, pp. 12-14.

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Además de deberse a la sustitución del bosque natural por cultivos, estas cifras también se explican por la degradación de lagos y humedales donde un 1/3 de los lagos (aproximadamente 1,000) habían sido desecados desde 1949 afectando un área de 13,000 km^2. La capacidad de retención de las aguas que ofrecen lagos y humedales se redujo en 50,000 hm^3 (Li Wenhua, 2002).

[75] Guojia linyeju senlin ziyuan guanglisi, "Diqici quanguo senlin ziyuan qingcha ji senlin ziyuan zhuangkuang", *Linye ziyuan guangli*, 1 (2010), pp. 1-8.

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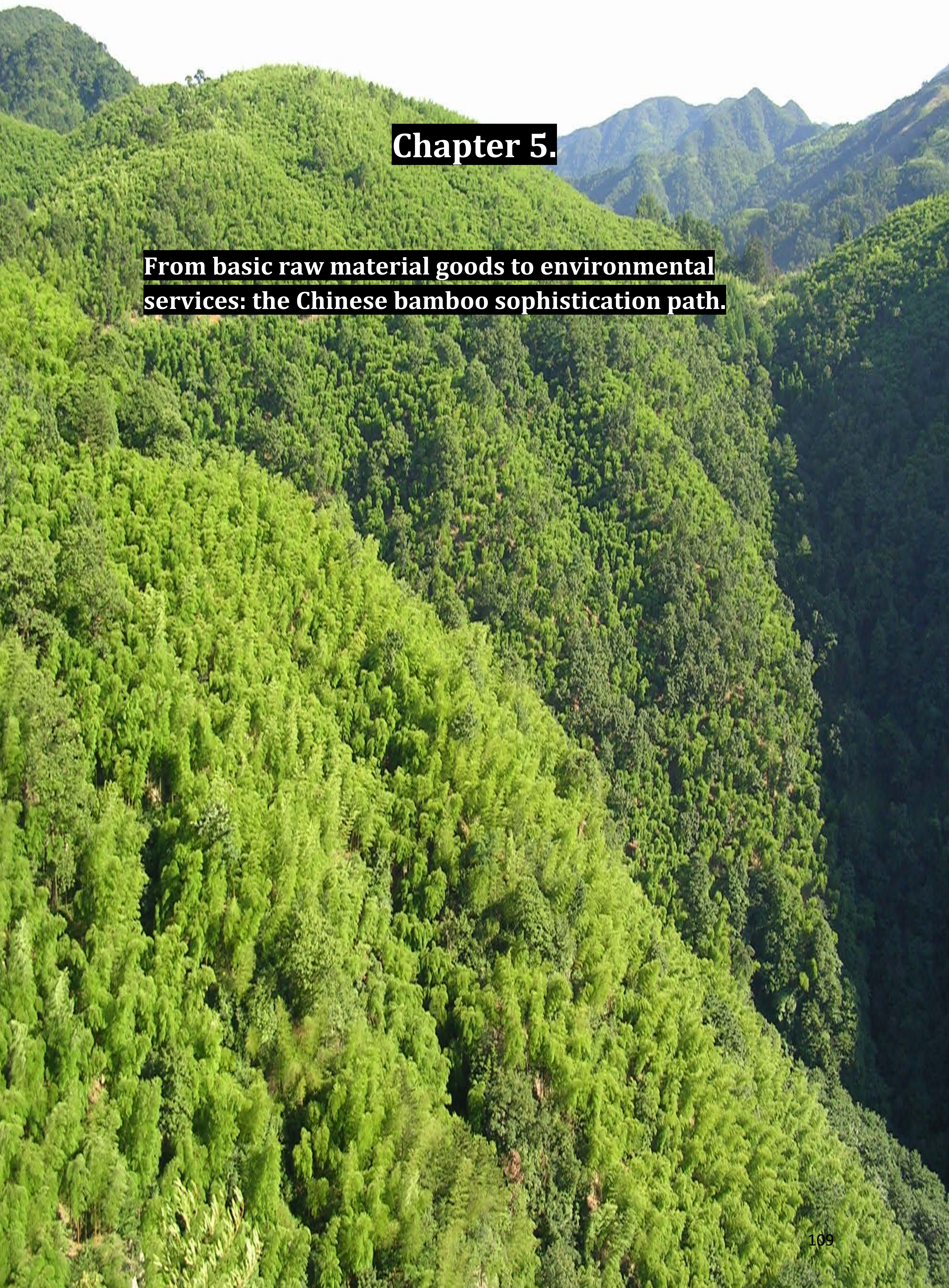
Chapter 5.

From basic raw material goods to environmental services: the Chinese bamboo sophistication path.



From basic raw material goods to environmental services: the Chinese bamboo sophistication path.

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(ARTICLE SUBMITTED TO ECOLOGY & SOCIETY, MANUSCRIPT ES-2013-5954)

Bamboo has deep cultural and economic roots in China, the country with the largest bamboo area, production and consumption in the world. In the last three decades bamboo has evolved from a supplier of raw material for basic goods to an increasingly diversified array of products and, more recently, to a potentially important source of environmental services. Based on a general review and the lessons learnt from detailed case studies in different regions of China, our paper will explore the changing role of bamboo, its effects on local economies and farmers' livelihood strategies. As the country develops and new economic activities appear, the bamboo primary sector has shifted from a superior income-generating opportunity that benefited the better-off to a less attractive option left for those who have no other choice. The nature of the work has also changed, from direct family work on bamboo plots to hired labor while prosperous bamboo owners devote most of their time to more lucrative activities. A similar process can be observed in bamboo processing in counties whose former industrial structure hinged around primary harvests, but have now entered into other secondary and tertiary sector activities. At the same time, bamboo has attracted new opportunities as a source of cultural, aesthetic and leisure-related activities, as well as some potentially important climatic, watershed and biodiversity functions. We analyze the potential tension between goods and services provided by bamboo and discuss some of the policies that may help overcoming this conflict.[1]

(4114 words)

[1] An earlier version was presented at the 8th Chinese Bamboo Congress, Zhuji, Zhejiang (PRC), 22-24 November 2012.

INTRODUCTION

China, a fast changing country

In 1978, at the onset of the reform that has resulted in one of the most dramatic changes in human history, China had 963 million people, of which 82% were rural population. By 2010, 32 years later, the population was 1341 million; urban population exploded with a six-fold increase, while rural population decreased both in absolute and relative terms, representing only 50% of the total population. During that period, the GDP multiplied by 19 in real terms, with a sustained yearly increase of around 10% for most of the time (National Bureau of Statistics of China, UNDP-China 2010).

In 1978 China was a rural, very poor country with hundreds of millions of peasants who constituted 70.5% of total labor and produced 28.2% of GDP. By 2010 the country had become urbanized, agriculture occupied 36.7% of total employment (about half of the pre-reform period) and its contribution to GDP had declined to only 10.1% (see figure 1). It is worth stressing that while the industry has kept a relative constant contribution to GDP (albeit with a significant increase in employment), the opposite shift to that observed in agriculture has taken place in the tertiary sector, that nowadays absorbs a similar level of employment than agriculture with a four times larger contribution to GDP.

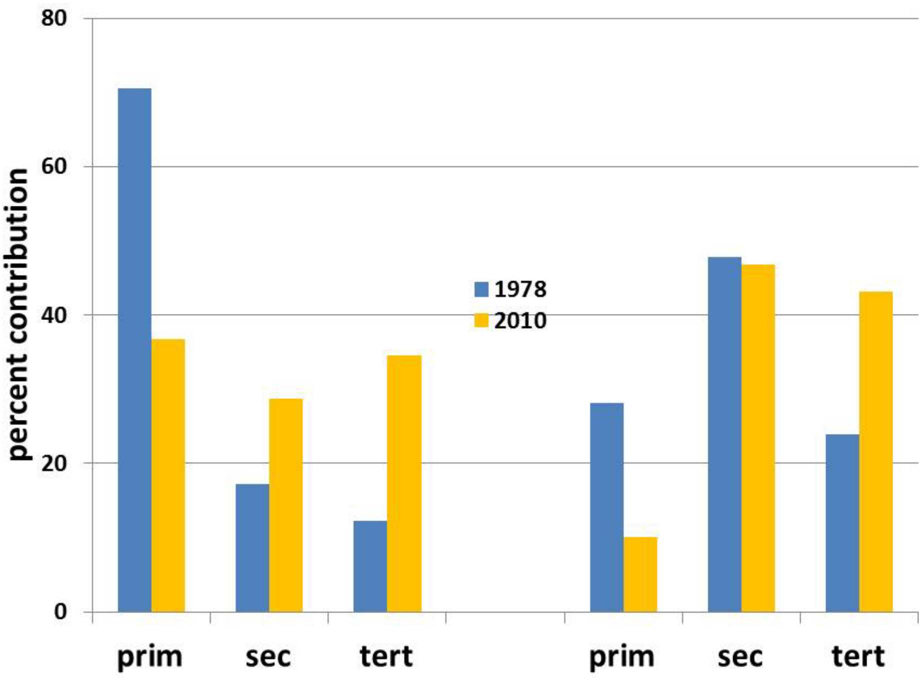

Figure 1.- Contribution to employment and GDP of primary, secondary and tertiary sectors of the economy in 1978 and 2010. Source: Based on China Statistical Yearbook.

China's opening to the world has not only meant increasing production, consumption and trade. It has also meant increased travelling, both for foreign visitors coming as for Chinese travelling abroad. In 1990 China received 10.5 million tourists. By 2011, the country had become the 3rd world international tourist destination with 57.6 million visitors (UNWTO 2012). More relevant to our bamboo world, China has also opened to itself, with domestic tourism increasing from 524 million person-day in 1994 to 2.1 billion person-day in 2010 (China Statistical Yearbook). China's travel and tourism sector directly generated 2.6% of total GDP in 2011, reaching 9.2% of GDP share if we also include the indirect crossed-benefits, particularly relevant for the agricultural sector (WTTC 2012). Chinese society is becoming more cosmopolitan and, as we shall see, this has opened new opportunities to farmers in traditionally well-known bamboo areas.

China's fast development poses a number of environmental, social and political questions and challenges. How has it been possible? What effects has it had on rural areas? And more to the focus of this paper, how are these changes reflected on the forestry and, in particular, the bamboo sectors? In this paper we will try to answer some of these questions, based on general literature review, expert understanding and our own long-term field research results. The latter, although spread in different provinces, focus on Anji county, Zhejiang.

Bamboo in the context of the Chinese forest transition

China has traditionally been considered a country with poor forest resources endowment. The available per-capita forest area represents 1/4 and the standing timber volume only 1/7 of world averages (Forest Resources Administration 2010). This has been the result of a long process of human expansion since the Neolithic shared with many other areas of the world (MacNeill 2006, Kaplan et al. 2009, Bayon et al. 2012), which has been subsequently accentuated by demographic expansion, social crisis and wars between the 18th and 20th centuries. By 1900 forest cover had decreased to 16.7% (He Fanneng et al. 2007).

At the time of the founding of the People's Republic of China there were only 109 million ha of forests that covered11.4% of the country. In spite of pioneer reforestation programmes during the 1950s, deforestation was still rampant, with forest cover reaching its historical minimum of 8.9% during the Great Leap Forward (1959-1961) (Yin 1994, Ge et al. 2000). Forest barriers and new forest plantations were established during the 1960s and 1970s with poor results due to bad practices and the social unrest of the Cultural Revolution period. Forest cover started a slow recovery but forest quality, especially of natural forests, kept degrading (Wang and Chokkalingam 2006, IIED 2011).

The reform initiated in 1978 gave a new emphasis to plantations and has been fundamental to improving forest cover and industry performance (Hyde et al. 2003), facilitating a 'forest transition' in China (Gutierrez et al. 2012)- although it was not until the 2000s when natural forests have partially started recovering after the implementation of the ‘Six key forest programmes’ ” *liu da linye zhongdian gongcheng”* (Zhou 2002). The last forest inventory of 2004-2008 shows 195.5 million ha of forests, just above 20% of the national territory, and 13.720,8 mill m^3 of standing volume, a remarkable recovery from the situation 50 years ago.

What has been the specific evolution of bamboo in this tumultuous history of Chinese forests?

Bamboo is an important forest resource and has a major cultural role in China (Yang et al. 2010). The country, rich in bamboo species, has the world’s largest bamboo surface area and production. A long history of bamboo cultivation has resulted in a mixed gradient from wild, naturally occurring bamboo forests to intensively managed monoculture plantations in which moso bamboo (*Phyllostachys edulis*) is the dominant species, although other species, including a number of sympodial bamboos which are associated to a growing and diversified demand are expanding fast (Ruiz Perez et al. 2009).

Bamboo has contradictory features: it is strong and hard, but also flexible; elegant and spiritual, yet capable of serving as raw material for hundreds of different uses; taxonomically, it is a grass that grows to tree heights and has timber-like properties. Likewise, it also shares qualities of timber and economic tree forests. Bamboo plantations are permanent crops that offer good soil coverage, high standing biomass and aesthetic sceneries comparable to natural forests. However, they tend to be intensively managed like a tree orchard, employing high levels of agrochemicals and reducing biodiversity. The main product, bamboo culms, is a substitute for timber and shares some of the latter’s market features. At the same time, a fast growing, short rotational cycle offers regular (yearly or biennial) harvests similar to cash crops. This has contributed to playing a very specific role in rural economies and farmers’ livelihoods, as we shall explore in the following sections.

Some of these unique features of bamboo may help explain why it seems to have escaped from the ups and downs of other Chinese forests during the second part of the 20th century. We lack suitable data to analyze what happened to naturally occurring bamboo forests, but it is plausible that they may have followed a similar fate of degradation than that of other natural forests. This is a potentially interesting research subject that to our knowledge has not been comprehensively explored. However, total bamboo area (natural forests and plantations) has kept a steady increase during the past 50 years, unlike the severe deforestation experienced in the late 50s and 60s. Similarly, bamboo culm production has maintained a steady increase in the past decades, having partially contributed to buffer the decrease in timber production experienced for nearly a decade in the whole of China as a result of the 1998 logging ban (figure 2). Bamboo therefore seems to have fared the turmoil of the 60s and 70s better than other type of forests, vindicating once again its adaptive and flexible nature.

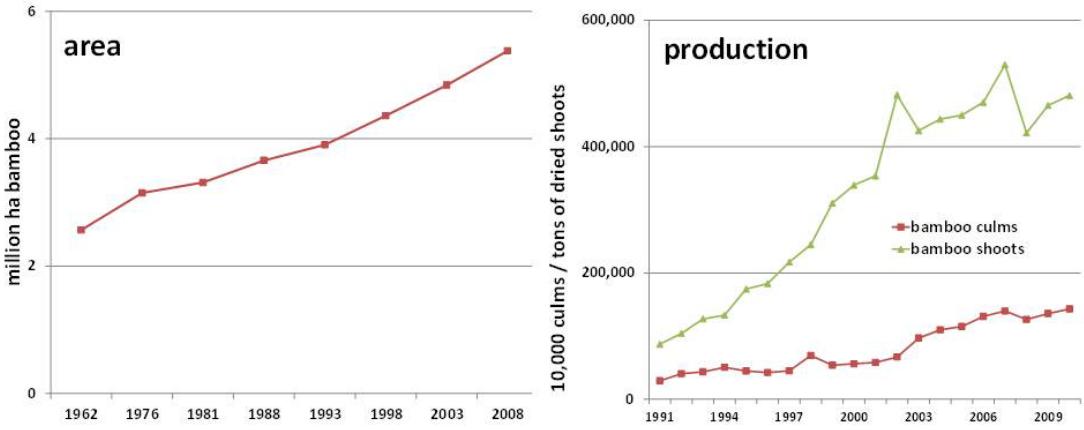

Figure 2.- Evolution of bamboo total area and culm and shoot production. Source: China Forestry Statistics

THE ECONOMIC AND ENVIRONMENTAL ROLES OF BAMBOO

Bamboo: the poor man's timber or an economic opportunity for the better-off?

A classical view of bamboo portrays it as the 'Poor man's timber' (Rao et al. 1987) or, to accommodate to the current climate change concern, 'The poor man's carbon sink' (Lobovikov et al. 2009). According to this view, bamboo serves as the option that allows the poor to thrive, eventually helping poverty mitigation and elimination. The evidence for this hypothesis is the frequent higher contribution of bamboo to household economy in poorer households (Hogarth et al. 2012) and the possibility to climb up the social ladder and move from lower to higher income groups through bamboo cultivation (Kant and Chiu 2000).

A more nuanced view would need to consider bamboo dynamism and the changing opportunities that the past three decades of impressive development have offered to Chinese farmers. An earlier study showed that in the mid-1990s, bamboo in Anji County, Zhejiang, was relatively more important for the middle-income group of farmers, although the richest farmers were still generating more bamboo-based income in absolute terms (Ruiz Perez et al. 1999). This paper also suggested the growing role played by off-farm income in rural economies, something that was being postulated at the time for other areas and that is nowadays broadly acknowledged (Haggblade et al. 2002, Reardon et al. 2007). This study led us to three key questions: When is bamboo a good opportunity for farmers? Is there a point when they would be interested in shifting to a more lucrative activity? And if so, what role should bamboo play in this transition?

To answer them we followed a two-ways complementary approach, linking the relative level of development of the village or county and the income generating opportunities available. Using a cross-sectional study in six counties placed in three provinces along an East-West gradient of development, we showed that the role of bamboo in farmers' livelihoods changed depending on the level of development and the off-farm opportunities available (Ruiz Perez et al. 2003, 2004). In the most developed counties, with higher per capita income and more economic opportunities, bamboo was more important for the poorest farmers; in least developed counties, bamboo was more important for middle and high income categories. Interestingly, in poor counties and provinces, bamboo-industry wages were close to average provincial level industry wages, whereas in richer counties and provinces, bamboo industry wages lagged behind average provincial level wages (figure 3). As rural areas developed, not only bamboo cultivation, but also the associated bamboo industries lost ground in terms of relative income and salaries.

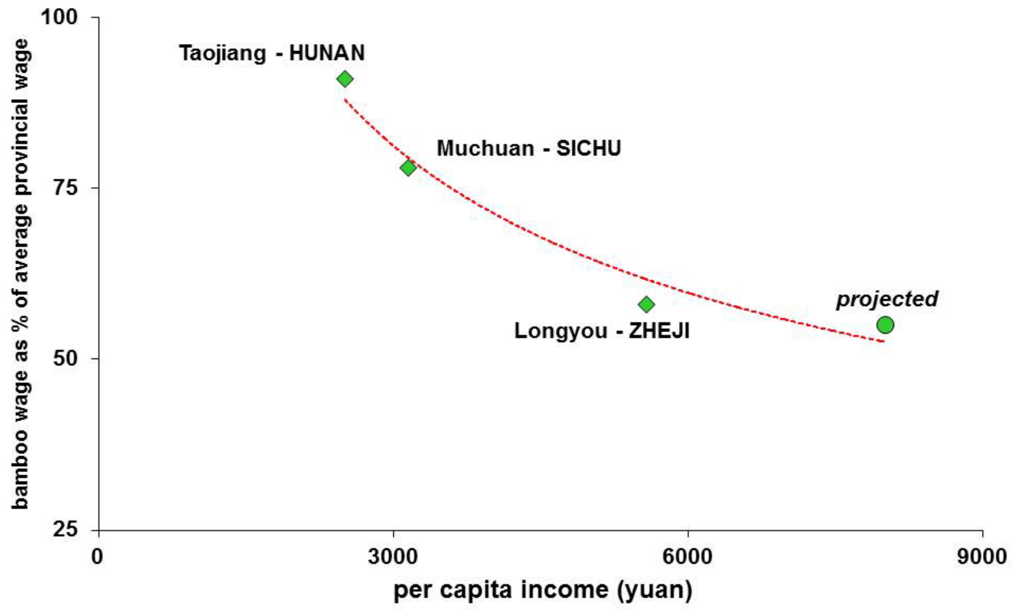

Figure 3.- Ratio bamboo industry to average provincial industry wages in relation to county's per capita income. Source: Modified from Ruiz Perez et al. 2004.

At the same time, we used longitudinal time series in Daxi village of Anji county (a densely forested village where bamboo is the main forest cover) to study the precise change that was taking place. Daxi was a mountainous, very isolated village that depended on forest income (bamboo, hickory and tea) until the construction of a big hydro-electric dam in the early 1990s improved transportation and offered new income opportunities through construction and lodging of the outside workers that came to the site. This brought dramatic changes to the village. Agriculture income kept the same declining trend that was observed since 1973 at the time of the first data available. Forestry, which had been the core economic activity representing around 2/3 of total village income before the construction of the dam (mainly due to bamboo, itself contributing to around 2/3 of total forest income), started a sharp decline. Off-farm income was taking the place left by agriculture and forestry (Gutierrez et al. 2009; see figure 4). It was apparent that new income sources were expanding the development options of the village that formerly relied on bamboo. Where these new opportunities being seized equally by all farmers? Was the relative weight of bamboo in farmers' economies changing for different income categories?

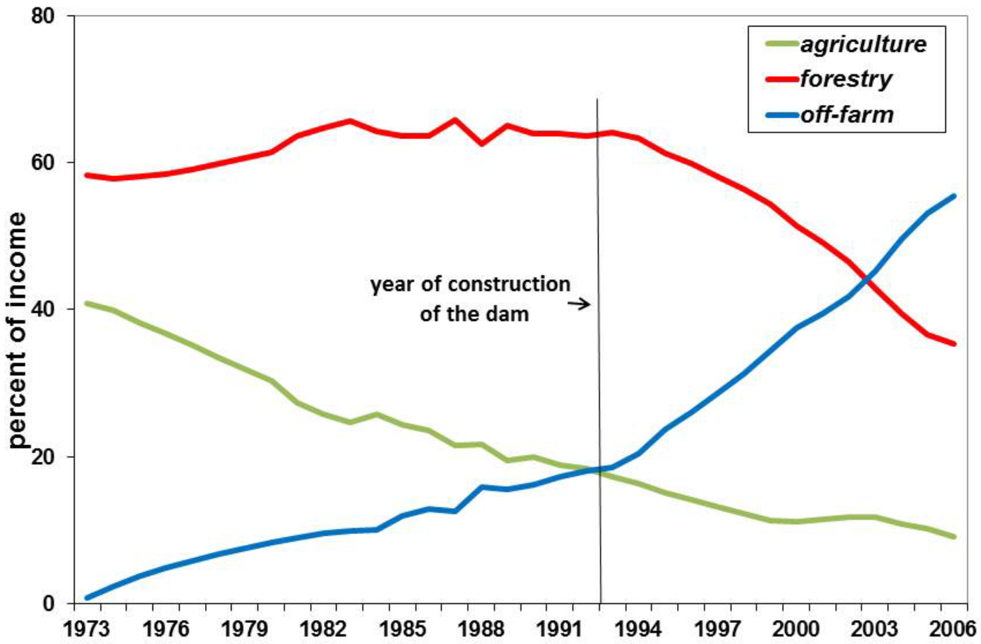

Figure 4.- Changes in income from agriculture, forestry and off-farm activities in Daxi village, Anji, Zhejiang, 1973 to 2006. Source: Modified from Gutierrez et al. based on Daxi village statistics.

We were fortunate that Daxi had also been for a long time a reference village in the yearly national rural population economic surveys. This permitted a detailed assessment of income structures and the changing role of forests, and specifically bamboo, to be compared to old farmers' income data with our own survey conducted in 2006. As figure 5 shows, bamboo was in relative and absolute terms more important for the better-off income groups before the dam, indicating that this was the best opportunity for them at that time. By 2005, however, bamboo had reduced its relative weight in all income categories (in consonance with the aggregated village data discussed above) and, more significantly, its role had changed, becoming more important for the poorest income category of farmers. Bamboo was no longer the best income opportunity; hence, it became relatively more important for the low income farmers. Unable to benefit from the new economic options, poor farmers were locked on bamboo as their main source of income, twice more important in relative terms for them than for the high income group.

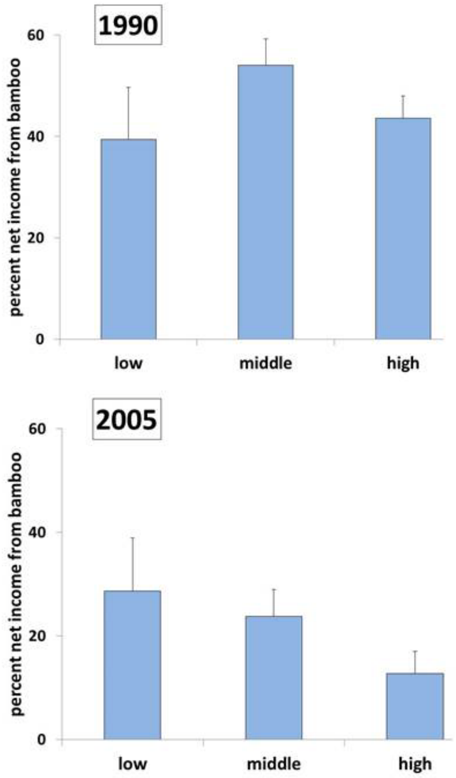

Figure 5.- Changes in relative contribution of bamboo to household income for the three income tertile groups. Source: Daxi village statistics for 1990; our own survey data for 2005.

Given the egalitarian nature of the forest contract system (see section 5), wealthier farmers kept their bamboo plots and were able to obtain similar or even higher income from them than poor farmers. However, the opportunity cost of labor for middle- and high-income farmers meant that they were more interested in employing it in more lucrative activities, frequently hiring poor farmers from Daxi and other villages as laborers to work their bamboo plots.

New economic roles for bamboo

The conclusions from cross-sectional and longitudinal studies pointed in the same direction, and were in agreement with what economic theory would predict: the most dynamic and entrepreneurial farmers were spearheading local innovation (Feder et al. 1985). In early development stages, when the primary sector was vital for employment and GDP, bamboo plantations and their associated industry were a superior economic opportunity that attracted innovator farmers. As the country developed and the primary sector reduced its contribution to employment and GDP, bamboo was no longer a superior opportunity, reducing its relative weight and giving way to more lucrative activities. So, what were these new opportunities and what was the new role that bamboo took on?

New economic options change with place and time, and we do not have a sufficiently large sample to extrapolate to the whole of China. In our case study, during the 1990s they related to construction (dam, roads and new houses), bamboo industry and trade. In the 2000s a new opportunity linked to tourism emerged. Anji county has become a famous tourist destination, mainly from the Hangzhou-Shanghai-Nanjing triangle. Tourism has experienced an spectacular climb from 150,000 tourist and 0.4% of total county GDP in 1996 to 5,440,000 tourists and 13.8% of GDP in 2009 (Gutierrez et al. 2011). Daxi village's outstanding mountain forest scenery (with bamboo as a central part of it) has attracted an important section of Anji's tourism. Based on our 2007 survey, tourism represented 27% of total income, being the best off-farm income option in Daxi. The young, more dynamic generation is benefiting most, with many 'farmer rural home' hostels (*nongjiale*) having been built in the past decade. Similar situations centered on an increasing demand for rural tourism are occurring in other regions of China (Gao et al. 2009) and elsewhere (Fontana and Paciello 2009).

Again, bamboo has played a major role in attracting this tourist influx. A survey of Daxi visitors indicated that bamboo was the main known feature and a major attractor, with 93% of the interviewees acknowledging having previous knowledge of beautiful bamboo sceneries before arriving. Obviously, bamboo is not the only reason why people go to the area, and the conditions and fame of Anji as a bamboo county may not be replicated everywhere. The point, however, is that this new opportunity is deeply rooted in the bamboo culture (both farmer and visitor) of the region, going beyond the material output of the primary sector to the services of the tertiary sector. As Chinese economy progress, the trend will consolidate, pointing at an important future economic avenue for bamboo farmers. At this point, it is worth reminding that the tourist sector is expected to grow faster than the general Chinese economy in this decade (WTTC 2012).

As is frequently the case, new opportunities also bring new problems, and in this case massive tourism has already increased environmental pressure in Anji county, a fact well acknowledged by the authorities who recognize an unsustainable increase of waste and water pollution associated to a huge increase in urban development

(Tianhuangping Tourist Reception Centre 2006). As an example, Daxi village has increased its urban space 4.8 times between 1988 and 2005 (Gutierrez et al. 2011). The need to carefully balance new demands and their environmental costs is clearly warranted here.

Forest tenure and income equality: is there anything special with bamboo?

The land reform launched with the Household Responsibility System (HRS, *jiating lianchan chengbao zeren zhi*) has been one of the cornerstones of China's development (Nolan 1983, Lin 1987). Its extension to forests through a Contract Responsibility System (CRS, *shengchan chengbao zeren zhi*) found a number of difficulties associated to the specific nature of forests, namely its long rotation, landscape persistence and high environmental values. At the early stages, with farmers doubting that the policy would be maintained, some forests and plantations were cut to obtain short-term benefits leading to an estimated loss of over one million ha of forest in the southern collective forest region (Song et al. 1997, Liu 2001), although the authorities reacted quickly to address the issue. In the absence of specific data, we would hypothesize that the peculiarities of bamboo plantations preserved them from the destruction seen in other forests during this period. This again could be an interesting research topic.

A more insidious problem was the attempt to maintain the original egalitarian nature of land reform under changing demographic conditions that inevitably led to changing the per capita land allowance. Different solutions were found for the agricultural sector that in the early stages focused on periodic land reallocations, but these proved to be more difficult for forests, due again to long term rotation, investment recovery and convenience of unified management. An option has been establishing forest shareholding cooperatives (*linye gufen hezuo zhi*) that contract the land and share the benefits with its members (Kong and Liu 2000, Song et al. 1997). The system focuses in timber production forests or plantations, offering a stable and unified forest management that avoids the fragmentation typical of the CRS (Kang et al., 2010).

Again, the specificities of bamboo plantations may recommend other alternatives. Gutierrez et al. (2013) have illustrated an interesting option established in Anji, based on a compensation scheme between families at different demographic stages. We believe that other systems trying to combine an egalitarian land distribution with demographic trends and the advantages of standard management must have been developed in different regions of China, but to our knowledge no systematic comparison of how the bamboo CRS developed has been conducted.

The recent trends in land regulation in China may render these systems obsolete. However, further from the academic interest, we believe that conducting such a China-wide bamboo tenure arrangements study could prove important because the CRS has been crucial for one of the most interesting features of bamboo in rural development: its high egalitarian nature. As demonstrated by Kant and Ciu (2000), Ruiz Perez et al. (2004), Gutierrez et al. (2009), and Hogarth et al. (2012), bamboo income shows relatively low Gini coefficients, indicating a rather egalitarian economic activity (see table 1). In rural areas with a strong tradition on bamboo plantations, they partially act as a buffering of the growing income disparities that are currently considered one of the key problems of China. Surely bamboo's contribution to solving this huge problem may be rather limited, but its roots lay in an egalitarian land distribution and the ability to offer regular income to farmers at different scales in the income ladder.

INCOME	GINI 1990	GINI 2005
bamboo	0.26	0.32
hickory	0.47	0.56
tea	0.46	0.74
off-farm	0.53	0.76

Table 1.- Changes in Gini coefficients for main sources of income in Daxi village between 1990 and 2005. Source. Daxi village statistics and Gutierrez et al. 2009.

Some lights and shades on the environmental values of bamboo

Naturally occurring bamboo forests, like any other natural forest, tend to have important environmental values associated to a high biodiversity and biomass, soil retention and hydrological cycle control. Indeed, the world-acclaimed pandas live in natural bamboo forests. However, most of China's bamboo area corresponds to plantations, which tend to be intensively managed monocultures. What are their environmental shortcomings? To what extent do they contribute to global forests environmental values?

Numerous authors have studied the issue (Zhou et al. 2005, Xie 2006, Ruiz Perez et al. 2009; Yang et al. 2010). Plantations in general have less diversity and biomass, and more disturbances due to management and extraction than mature natural forests. Bamboo plantations are no exception in this regard. However, bamboo plantations still maintain a good level of soil coverage and biomass, and although their tree alpha diversity tends to be lower than natural forests, it can be partly compensated by a higher shrub and herbaceous layers' diversity (Xie 2005). Indeed, extensive bamboo can compare favorably with timber plantations like Chinese fir (*Cunninghamia lanceolata*), although its biodiversity value diminishes significantly with intensive management. Moreover, extensive bamboo plantations tend to have high beta (between plots) diversity, due to variations in management that are expressed at the herbaceous and shrub levels (Xie 2005, Gutierrez et al. 2012). This contributes to the high scenic and cultural values of many bamboo areas, an important feature to attract rural tourism.

At the same time, many bamboo species tend to be very fast-growing, having an excellent carbon sequestration performance. This again may contribute to generate income for bamboo farmers as part of carbon emissions compensation schemes, as already noticed by some authors (Lobovikov et al. 2009). Here again we find trade-offs between intensively managed plantations with faster growth and higher biomass and other environmental values like biodiversity, soil disturbance, levels of agrochemicals and water quality (Ruiz Perez et al. 2009).

The environmental pros and cons of bamboo plantations should be assessed in relation with their management and level of intensification, and in the context of other (current or potential) alternative land uses. Bearing this in mind, it is nevertheless clear that their environmental value will be increasingly important and could play a significant role in guiding farmers' management practices and bamboo-related income. In this respect, a systematic review of the various types of payments for environmental services as applied to bamboo plantations in China also seems to be a much needed and promising research topic.

CONCLUDING REMARKS

Bamboo plantations fall somewhere in between natural forests and other agrarian uses, closer to forests in some environmental and raw material output respects, yet closer to economic tree crops in income, labor, tenure and other socio-economic considerations in others. Unsurprisingly, they meet the standard economic theory of farmers' expectations in relation to the opportunity costs of factors of production: seized by the wealthier when they are a good opportunity and passing the flag down to low-income farmers when better opportunities appear.

A balanced view should find an equilibrium between unreasonable expectations of bamboo-based wealth and social promotion on one hand, and the stereotype 'poor man's timber' on the other, between an ecologically mature natural forest and a disturbing intensive plantation or crop. Bamboo has played a significant role in China's rural development and its continuous expansion proves that is will be here for a long time. Yet, having fulfilled that foundational role, the rest of the building will have to be worked out in order to realize its full potential. Thus, the material output of the bamboo sector will remain and will have to be reinforced, but additional recreational, cultural and environmental opportunities have emerged. Helping to seize them should be an important role for new forest policies. Bamboo could represent an excellent example of a much needed compromise between production, culture and conservation in rural China.

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Chapter 6.

Ecological functionality of *Phyllostachys edulis* (Moso Bamboo) within a Subtropical forest community in Eastern China

Ecological functionality of *Phyllostachys edulis* (Moso Bamboo) within a Subtropical forest community in Eastern China - A Quantitative analysis of biodiversity, biomass and coverage parameters at Daxi village, Anji County.

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In recent decades, Chinese and international scholars have been carrying out an innovative set of studies focused on the ecological functionality of bamboo stands. This scientific perspective regained vitality since the adoption of the Natural Forest Protection Programme (*tianranlin baohu gongcheng*) and the Sloping Land Conversion Programme (*tuigeng huanlin gongcheng*) at the end of the 1990's. From then on, the ecological services provided by bamboo forests have received increasing recognition and have progressively been integrated in the agenda of China's rural institutions so as to promote an all-around environmentally-sound development into remote isolated areas of the country. In this brief communication, we analyse Moso bamboo's (*Phyllostachys edulis (Carriere) J.Houz.*) ecological functionality within a Subtropical forest community (located at Daxi village – Anji County), this latter being composed of five major land uses: Moso bamboo, secondary evergreen broadleaf forest, Chinese hickory, conifer and tea plantations. Quantitative factors analysed correspond to alpha and beta biodiversity, biomass and canopy coverage measured from a total of 32 land plots distributed across these five forest landuses. Our results indicate that Moso bamboo preserves considerable biodiversity values at shrub and herb levels, is also able to absorb high values of biomass thus contributing to the fixation of atmospheric CO_2, and contain a high density of vegetation per ha associated to high landscape aesthetic values. The other four land uses are featured by the high ecological services of the secondary evergreen natural forest, followed by the open hickory forest and finally by the highly intensified conifer and tea plantations. All together, these five land uses form a mosaic of interrelated ecosystems which provide the Chinese Rural inhabitants with indispensable environmental values that need to be effectively protected.

毛竹 Phyllostachys edulis 在中国华东亚热带森林群落中的生态功能---以安吉县大溪村为例对生物多样性、生物量以及覆盖率进行定量分析

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近年来，中国与国外专家进行了一系列关于竹类生态功能的创新研究。上世纪九十年代末，在实施天然林保护和退耕还林的工程后，林业科学取得了重大的发展并且日益体现出其重要性。其中，由于其对中国偏远乡村环境保护与可持续发展的作用，竹林的生态服务功能逐渐受到关注并成为中国乡镇机构经济发展与环境保护的议题之一。本文我们分析了毛竹 Phyllostachys edulis (Carriere) J.Houz. 在中国华东亚热带森林群落中的生态功能，以安吉县大溪村为例，调查的森林群落主要由以下五种植被组成：毛竹林，次生常绿阔叶林，山核桃林，针叶林以及茶种植园。我们以定量分析的方法，

对 32 块用地进行了（分别为毛竹林十块，常绿阔叶林六块，山核桃林六块，针叶林五块以及五个茶园）α 及 β 生物多样性分析，并对生物量及植物覆盖率进行了测量。结果分析表明，毛竹林在灌木及草本地层中拥有较高的生物多样性价值。而且由于较高的生物量指数，它们对空气中的二氧化碳有吸收作用。除此之外，其植被的高密度也提高了风景与环境的美观度。关于其他类型的林业用地，它们都具有较高的生态服务功能，排名次序由高到低分别如下：次生常绿阔叶林，山核桃林，针叶林以及茶种植园。总之而言，这五类林业对生态系统的维持与保护具有相当重要的作用并且对中国广大乡村居民而言是一种无可比拟的生态财富，因此需要动员全体社会公民一同参与保护工作。

Introduction

Moso bamboo, *Phyllostachys edulis* (Carriere) J.Houz., is the most representative bamboo species in China, where it spreads across 3.4 mill ha covering 70% of the total bamboo area. This evergreen endemism grows within the range of 800 - 1,800 mm rainfall and extreme temperatures typical of the Subtropical monsoon area (Fu 2001), being one of the fastest growing plant species on Earth. Its ecological versatility makes possible attaining maximum constant yields only 9-10 years after establishment (Lou et al 2010, Lobovikov et al 2012), a rotation cycle much shorter than that of other woody species compatible with a low capital intensity that fulfils Chinese smallholders' basic subsistence needs. While its production techniques and economic scale have been incessantly expanding for the last half century, a more recent emphasis has been given to Moso bamboo environmental performance.

The massive floods that swept Rural China in 1998 acted as a catalyser in a manner that made the former dispersed forest conservation measures integrate into "the 6 Key Forest Programmes" (Zhou Shengxian 2002), hitherto giving more weight to the ecological factors affecting forestry. Since the start of the 21st century total forest area and volume have been steadily increasing in China, although there have been some criticisms on the reduced resilience of forest ecosystems as a result of the degradation of the natural forests (while plantations have been on the rise) (Xu 2011). In this context, several studies have stressed the potential role that Moso bamboo may play with regard to environmental conservation, as well as its limitations.

Moso bamboo's extensive shallow root-rhizome system (first 30 cm deep) has proven highly effective in stabilizing soils, especially when combined with a forest mixed-species structure, thereby preventing erosion, rehabilitating degraded lands and securing hydrological functions at soil scale and watershed-landscape levels; all these features having been found in different eco-climate conditions across the world, not only in China (Bystriakova et al 2003, 2004; Zhou et al 2005). Nonetheless, in some Moso bamboo monocultures, soil erosion problems driven by nutrients depletion and spread of chemicals (pesticides and fertilizers) plus the lack of a deep root system (that would better support transpiration as it occurs in arbour-layer biodiverse ecosystems) have been reported (Buckingham 2009).

Moso bamboo shows a comparable potential for biomass fixation and carbon sequestration in Subtropical China when compared with Chinese Fir (a major planted species in that region), always provided that the former is managed with regular harvest cycles (Lou et al, 2010). In this sense, we must also acknowledge the high rate of convertibility that the bamboo raw resource presents into the production of multiple goods, thus increasing the pool of stored carbon removed from the atmosphere.

Perhaps in one of the most sensitive areas of ecological inquiry, the intensification of bamboo groves and the conversion of mixed forests into Moso bamboo monocultures have been associated with an important decrease in biodiversity levels. In spite of the advantages of forest engineering, such as the increased yields and farmers' income in the short run, this biodiversity loss is already diminishing bamboo forests' resilience and could cause a reduction of physical productivity in the long run (Buckingham 2009, Lou and Henley 2010). For this reason, the attention is now redirected to research into the biodiversity of Moso stands, where mixed understory layers have shown to play a major role in diversity maintenance in bamboo forests: higher biodiversity at shrub levels are closely interrelated with better soil-conservation properties and nutrient re-cycling thus allowing for sustained yields without those degradation processes observed in bamboo monocultures (Zhang et al 2010).

Last but not least, Moso bamboo presents a dense forest cover that is closely related to aesthetic landscape values. Experiments held in field sites demonstrate how canopy closure is reached only 6-8 years after planting. "Bamboo Seas" have been actively promoted as part of rural development policies in China, which ultimately rely on the visitors' experience within the environment. Moso bamboo thus forms a physical resource on which whole rural economies sometimes entirely depend, what explains the attention that researchers give to risk management of fires, pests, weather stressing conditions and the destructive outcomes of cyclical gregarious flowering (Lou et al, 2010).

In this communication, the ecological functionality of Moso bamboo is assessed within a Subtropical forest community located in Eastern China (Anji County). Taking biodiversity, biomass and forest cover as parameters for analysis, results confirm the important environmental values attached to this type of bamboo forest when managed under extensive modes of extraction.

More concretely, Moso bamboo preserves a highly diverse number of plant species at shrub and herb layers, fixes a considerable level of biomass comparable to other landuses and keeps a dense canopy very representative of cultural landscapes. Meanwhile, secondary formations of evergreen-broadleaf forest preserve the highest diversity at the arbour layer and have the greatest potential for future carbon accumulation. Tea plantations, very profitable in the short-run, reflect the lowest environmental values and their recent expansion has often been associated to significant forest degradation activities.

Finally, multivariate statistical analysis is a powerful tool that helps us comprehend in a parsimonious fashion the complex dimensions that interplay in ecological processes. In this case study, both man-made stands (e.g. Moso bamboo) and natural evergreen broadleaf patches do present complementary functions, which can be effectively preserved through a multi-purpose forest management centred at rural residents' living standards. Future lines of research are outlined with the aim of improving the understanding of the local forest ecosystem dynamics.

Methods

Study Area

Placed at the heart of Eastern China (Zhejiang province), Anji is a well-known Bamboo County where forestry has experimented a deep transformation from a previous production-oriented management towards a current integrated ecological approach. Its economic infrastructure today revolves around the multiple ecosystem services provided by Moso bamboo plantations, so-called key ecological (evergreen broadleaf) forests and other important landuses. Fully incorporated into a forest transition that affects every aspect of the local daily life, from improved environmental standards to their dependent thriving “green tourism”, ecological forestry is thus making a contribution to socioeconomic development in the region.

1,600 mm and 15^{o}C annual averages (having snow in winter and a rainy season in summer) portrait a subtropical humid climate, where moso bamboo (毛竹 *Phyllostachys edulis*) is the dominant vegetation use. Natural relict formations of evergreen broadleaf forest are represented by a mix of 东南石栎 *Lithocarpus harlandii,* 青冈 *Cyclobalanopsis glauca,*合欢 *Albizzia julibrissin,*化香树 *Platycarya strobilacea,*豹皮樟 *Litsea coreana var.sinensis,* 石竹 *Bambusa lapídea,*茅栗 *Castanea seguinii,* 山胡椒 *Lindera glauca* and other varied hardwood species. Apart from bamboo, other important forest economic species are Chinese hickory (山核桃 *Carya cathayensis*) and Chinese fir (杉树 *Cunninghamia lanceolata*). The main cash-crop is represented by tea (茶 *Camellia sinensis*).

Research was undertaken at Daxi village (East 119^{o} 34’, North 30^{o} 26’), which has more than 2,000 inhabitants and lies at the southernmost mountain ranges of the county, within Tianhuangping township. Daxi has officially been approved as an ecological village at provincial level. Its natural environment is featured by a rough terrain with altitudes ranging from 250 to 1,169 m.a.s.l., being 89% of its land classified as forest use. Under these general ecological conditions, the objective was to analyse biodiversity, biomass and forest cover parameters across the main five forest landuses: conifers, hickory, Moso bamboo, evergreen broadleaf forest and tea plantations. Below, we explain how this vegetation survey was conducted.

Sampling Method and Data Collection

32 plots (each of 30x30 m) were spatially distributed across these five forest types according to their dominance in the landscape, so as to collect a representative sample of forest biodiversity, biomass and cover in the area. Plot samples were attributed according to the relative frequency of each landuse. Moso bamboo received the highest sampling effort (10 plots), followed by evergreen broadleaf forest and hickory (each with 6 plots). A minimum sampling effort was set at 5 plots, used to measure these parameters either in conifer and tea plantations.

The survey was structured into three tree, shrub and herb layers. Within each 30x30m (big) plot, for tree layer, every single stem with diameter at breast height ≥ 5cm and/or ≥ 5m height was associated to its identified species, DBH (in cm), H (m) and Mean Crown (m).

Within the big plot, we also randomly selected five subplots of 5x5m (shrub layer) and other five subplots of 1x1m (herb layer), where measures were carried out recording each stem's species, H(m) and Mean Crown (m). On the other hand forest cover measures were taken inside each big 30x30m plot, from the juncture (25) points formed by the intersection of the 36 5x5m subplots' boundaries (Figure 1).

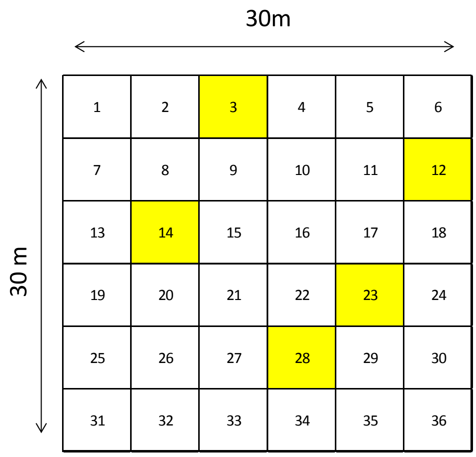


Figure 1. All tree stems are measured within the 30x30m (totalling 900 m^2) plot, while shrubs are measured within the random-selected yellow subplots and herbs within the smallest subplots (inside the 5x5 subplots).

Species abundance matrixes were used as the raw data for analysing the biodiversity dimension for three tree, shrub and herb layers. With regard to biomass, within the arbour layer, we estimated each stem's dry weight content using Yuan Weigao et al (2009) models, specifically developed and tested for Zhejiang Province. Within the shrub and herb layers, we conducted in-situ wet-weight harvests in five quadrants of 2x2m (taken inside the 5x5m) and 1x1m, respectively (we would later obtain final dry-biomass figures after making use of the laboratory oven).

Results

Forest Inventory

Among the five forest types Moso bamboo presents the highest stem density and forest cover (in this latter paired with the evergreen broadleaf formations), thus giving shape to a closed canopy that reinforces the local landscape values (Table 1). Evergreen broadleaf plots showed a quite lower density, except for one plot having around 3,500 individuals/ha. Conifer trees were also associated with a high density and forest cover, while hickory plots were essentially made of big and sparse trees. In marked contrast with other forest uses, intensive tea plantations seldom present any individuals at the tree layer.

Landuse	Sampled plots: Tree (30x30m)	Sampled plots: Shrub (5x5m)	Sampled plots: Herb (1x1m)	Tree Stems/Ha (mixed sp.): Mean	Tree Stems/Ha (mixed sp.): St.dv	Forest cover (%)
Conifer	5	24	23	**2,480**	640	**69**
Hickory	6	30	30	**460**	145	**57**
Moso Bamboo	10	50	50	**3,520**	685	**75**
Evg. Broadleaf	6	30	25	**1,560**	1,130	**78**
Tea	5	25	25	**98**	105	**5**

Table 1. Forest density and cover at the arbour layer. Density figures are shown for a mix of species.

Biodiversity

Species Density

As expected, moso bamboo and Chinese fir were positively correlated with dense species concentrated at the tree layer hence fulfilling their timber or bamboo production objectives. In Daxi village moso bamboo is generally extracted under an extensive regime[1] as most stands are within the range of 3,400 stems/ha (Table 2), what also allows for a relatively thick density occurring within the shrub layer. Within this layer, a tree species金钱松 *Pseudolarix amabilis* with a very relevant conservation value was found at concentrations higher than 4,500 stems/ha (437 small individuals were found within one plot). Notwithstanding only one herb species was found at a high density in the moso forest, other parameters must be taken into account when considering biodiversity (as we will see later). Moreover, Chinese fir forest did reveal high density values at either the arbour, shrub or herb layers.

Hickory forests showed a different pattern when compared with pure bamboo stands, given that *Carya cathayensis* tends to be scattered throughout the landscape and appears with a much lower density, although the size of its individuals is also much bigger than those of moso or Chinese fir. With respect to this variable (density) hickory forest, which contains important species density values within the shrub and herb layers, is in an intermediate position between the production forests and the secondary evergreen forest. This latter's species present an even much lower density as they naturally form mixed conglomerates at tree and shrub layers, what indicates a higher degree of ecological complexity. Besides, tea plantations consist of the most simplified man-made ecosystem with almost no density at the tree layer.

[1] Only one plot under intensive management was detected, with more than 4,500 stems/ha.

Landuse	Tree layer (individuals/ha)		Shrub layer and small trees (individuals/ha)		Herb layer (individuals/m^2)	
Conifer	**杉树 *Cunninghamia lanceolata***	**1,740**	楤木 *Aralia chinensis*	850	铁角蕨 *Asplenium austro-chinense*	8.0
	毛竹 *Phyllostachys edulis*	585	茶 *Camellia sinensis*	1,030	淡竹叶 *Lophatherum gracile*	8.7
			浙江大青 *Clerodendrum cyrtophyllum*	1,450	金星蕨 *Parathelypteris glanduligera*	3.2
			柃木 *Eurya japonica*	530	毛蓼 *Polygonum barbatum*	1.8
			伞形绣球 *Hydrangea chinensis*	1,450	南山堇菜 *Viola chaerophylloides*	2.7
			山苍子 *Litsea cubeba*	600		
			掌叶复盆子 *Rubus chingii*	570		
			中南悬钩子 *Rubus grayanus*	3,400		
			木莓 *Rubus swinhoei*	880		
			菝葜 *Smilax china*	1,830		
			野珠兰 *Stephanandra chinensis*	885		
Hickory	**山核桃 *Carya cathayensis***	**320**	紫金牛 *Ardisia japonica*	8,530	鸭跖草 *Commelina communis*	2.5
	毛竹 *Phyllostachys edulis*	50	茶 *Camellia sinensis*	3,880	鱼腥草 *Houttuynia cordata*	1.6
			阔叶箬竹 *Indocalamus latifolius*	970	柔枝莠竹 *Microstegium vimineum*	1.1
			山橿 *Lindera reflexa*	1,810	金星蕨 *Parathelypteris glanduligera*	1.0
			金银花 *Lonicera japonica*	850		
			金钱松 *Pseudolarix amabilis*	710		
			寒莓 *Rubus buergeri*	12,010		
			山莓 *Rubus corchorifolius*	1,450		
			蓬蘽 *Rubus hirsutus*	6,430		
Moso Bamboo	**毛竹 *Phyllostachys edulis***	**3,360**	紫金牛 *Ardisia japonica*	5,560	淡竹叶 *Lophatherum gracile*	3.8
	山核桃 *Carya cathayensis*	140	茶 *Camellia sinensis*	1,950		
			山胡椒 *Lindera glauca*	610		
			山橿 *Lindera reflexa*	670		
			金银花 *Lonicera japonica*	1,970		
			金钱松 *Pseudolarix amabilis*	4,850		
			白栎 *Quercus fabri*	1,090		
			山莓 *Rubus corchorifolius*	660		
			菝葜 *Smilax china*	1,700		
Evg. Broadlf.	合欢 *Albizzia julibrissin*	100	石竹 *Bambusa lapídea*	2,930	淡竹叶 *Lophatherum gracile*	3.0
	山合欢 *Albizzia kalkora*	40	茶 *Camellia sinensis*	1,100	金星蕨 *Parathelypteris glanduligera*	1.3
	锥栗 *Castanea henryi*	35	杉树 *Cunninghamia lanceolata*	680	南山堇菜 *Viola chaerophylloides*	1.2
	茅栗 *Castanea seguinii*	50	青冈 *Cyclobalanopsis glauca*	1,050		
	甜槠 *Castanopsis eyrie*	40	阔叶箬竹 *Indocalamus latifolius*	1,130		
	灯台树 *Cornus controversa*	45	若竹 *Indocalamus tessellates*	10,470		
	杉树 *Cunninghamia lanceolata*	70	金毛竹 *Phyllostachys nigra var. henonis*	1,330		
	青冈 *Cyclobalanopsis glauca*	125	野珠兰 *Stephanandra chinensis*	1,680		
	四照花 *Dendrobenthamia*					
	japonica var. Chinensis	40				
	东南石栎 *Lithocarpus harlandii*					
	豹皮樟 *Litsea coreana*	150				
	var.sinensis	50				
	化香树 *Platycarya strobilacea*					
	短柄枹栎 *Quercus serrata Var.*	65				
	Brevipetiolata	45				
Tea	杉树 *Cunninghamia lanceolata*	60	**茶 *Camellia sinensis***	**15,820**	矮飞蓬 Erigeron divaricatus	1.0
			山莓 *Rubus corchorifolius*	880	淡竹叶 *Lophatherum gracile*	3.3
			蓬蘽 *Rubus hirsutus*	720	柔枝莠竹 *Microstegium vimineum*	7.0
					求米草 *Oplismenus undulatifolius*	1.0
					毛蓼 *Polygonum barbatum*	2.1
					络石 *Trachelospermum jasminoides*	1.1
					南山堇菜 *Viola chaerophylloides*	2.8

Table 2. Most abundant species-density values in the different five forest landuses at arbour, shrub and herb layers.

Species Richness, Alpha and Beta diversity

During the survey campaign, a total of 93 tree species, 181 shrub species and 116 herb species were identified. There were four tree, five shrub and fourteen herb unidentified species.

In terms of species richness, Moso forest contained a high biodiversity in both shrub and herb layers in a pattern that was similar to hickory and Chinese fir, albeit this latter had a lower number of herb species (Figure 2). These three types of forest are featured by one (sometimes two) dominant species at the tree layer, while preserving a high degree of heterogeneity in the other layers.

Evergreen broadleaf forest presented the highest number of tree species, a high number in shrub species, whereas indeed did not have more than 25 herb species. The ecological pattern of distribution is undoubtedly differentiated from the other actively managed man-made forests, as secondary natural formations concentrate their highest complexity at the tree layer (and very little in the herb layer).

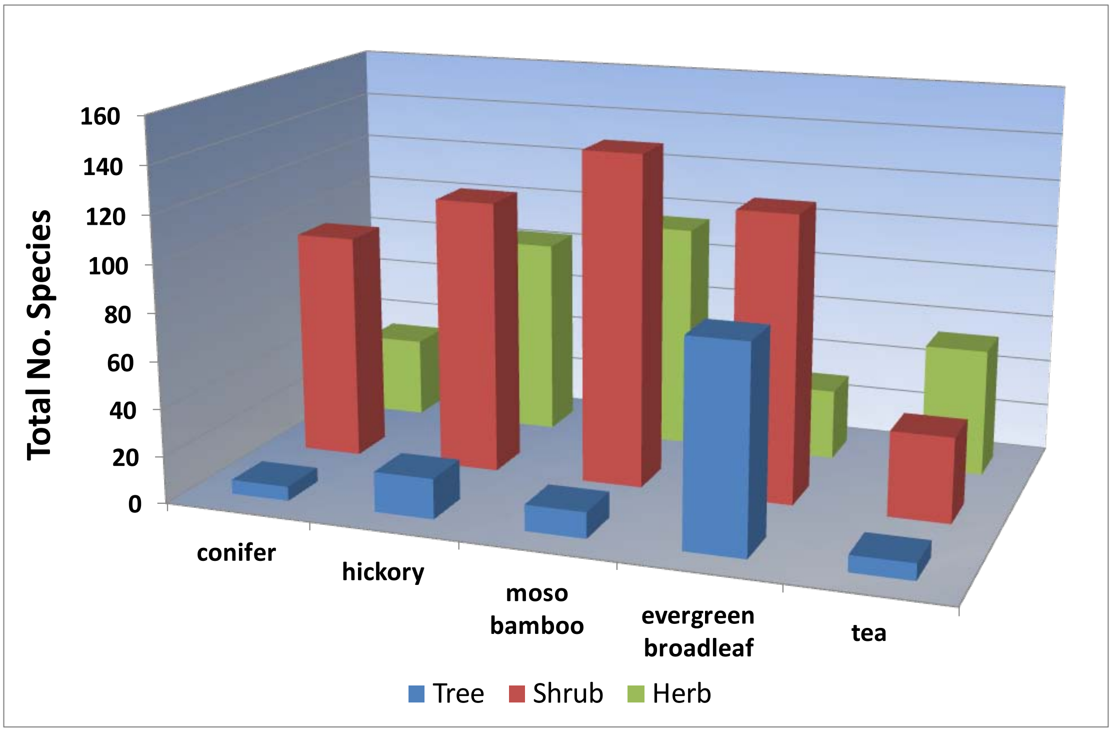
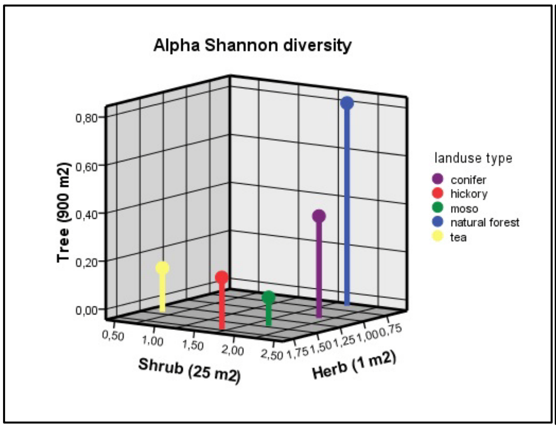


Figure 2. Species richness across five forest uses, found from 32 plots. A similar distribution was detected across five landuses with respect to richness density (No. species per plot).

In Figures 3 and 4, the different five forest uses have been represented in a tri-dimensional space composed of tree, shrub and herb layers' Alpha and Beta diversity.



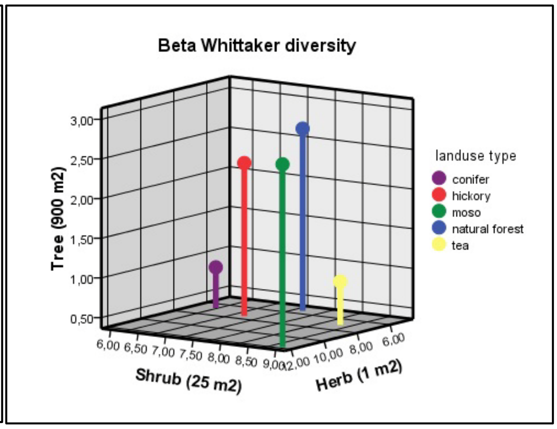


Figure 3. Apha Shannon diversity.

Figure 4. Beta Whittaker diversity.

With regard to Alpha diversity index man-made uses were situated in a distant position from the evergreen broadleaf forest, confirming the complementary patterns that we had previously found at the richness level, while the Beta diversity figure brings us new information at the landscape level. From this latter we can infer that Moso bamboo forests present a valuable diversity between plots, as well as the evergreen broadleaf and hickory forests do, a fact that should be considered when designing forest management plans.

Biomass

The differential contribution of the major five forest types to aboveground biomass fixation was calculated. Moso bamboo forest stored nearly 80 tons/ha of dry biomass, showing a similar functionality to Chinese fir and Chinese hickory forests with 80 and 90 tons/ha, respectively. Applying a 0.46-0.47 conversion factor, this means these three forest ecosystems are fixing around 40 carbon tons/ha (aboveground). Note that tea plantations fixe a very low amount of carbon, under 5 carbon tons/ha.

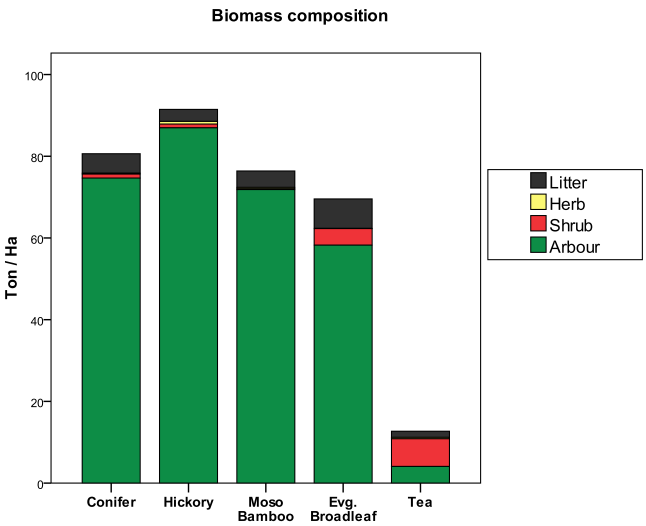


Figure 5. Total mean dry biomass stored within each of the five forest types (soil biomass is not included).

These data again confirm the predominant extensive character of bamboo management in Daxi, provided that its carbon sequestration capacity lies within the range[2] of 39-51 carbon tons/ha (Lou et al, 2010). In spite of the fact that Moso bamboo forest would still have room for sequestration improvement in Daxi, the same intensification techniques would cause a considerable reduction in terms of biodiversity. So probably that would not be the most desired strategy for ecological conservation, which could be built on the grounds of the complementary forest uses.

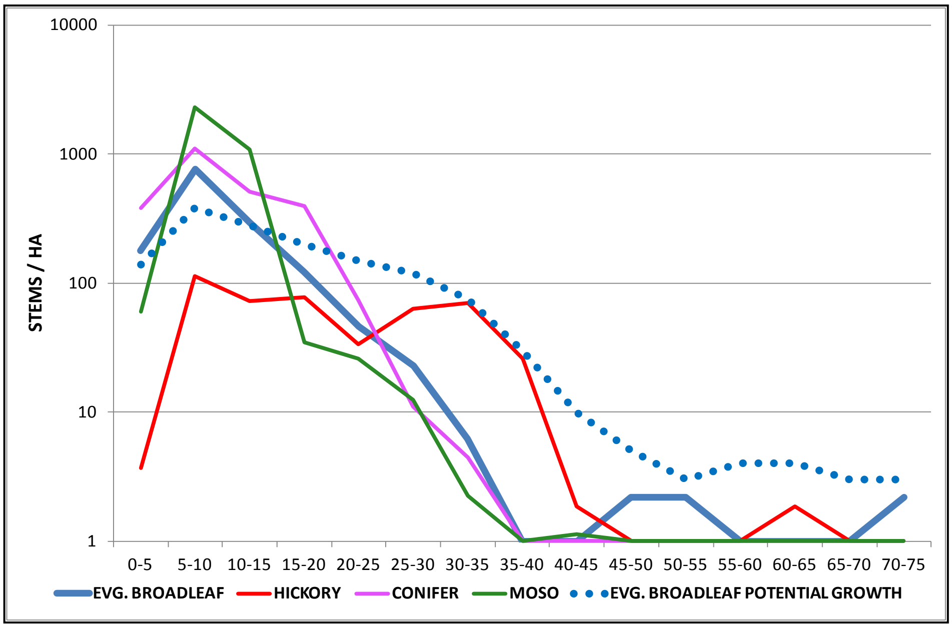


Figure 6. Tree DBH classes (in cm) and their frequencies (stems/ha) in logarithmic scale, evergreen broadleaf in blue colour. These data are shown for a mix of species within each five forest types (e.g. Moso bamboo in green colour contains a mix of species at the tree layer: dbh > 19 cm are bigger trees different from Moso bamboo), being an aggregate proxy value. Nonetheless, as shown in previous analysis, Moso species is the dominant within the Moso forest, the same as Chinese fir and hickory within their respective forests.

This inevitably points to considering the evergreen broadleaf forest as the main actor in carbon sequestration in the area. It currently stores only 70 dry biomass tons/ha (35 carbon tons/ha), what inherently is an unequivocal sign of forest degradation through past times. We must bear in mind that the evergreen broadleaf plot identified with the highest density (3,500 stems/ha) is storing a quantity of 120 dry tons/ha (60 carbon tons/ha). Available statistics from mature forest sites across China, reveal that this kind of forest regularly

[2] This figure corresponds to the carbon sequestration profile as found in the extensive management regimes of moso bamboo forests in other areas in China, whereas intensively managed moso stands are able to store a total of 51-74 carbon tons/ha. These figures are both relative to the arbour layer (a good proxy of aboveground biomass). This study was focused on the above ground biomass so caution should be taken when drawing general conclusions as for total biomass. Research demonstrates that the greater share of the biomass pool is stored within the soil layer; in the case of moso bamboo soil carbon (in the form of rhizomes, litter and fixed C) represents between 67-81% of total stored carbon(Lou et al 2010).

contain 79 carbon tons/ha (aboveground biomass, Lou et al 2010), so the figure in Daxi is well below its potential. What is happening then within the broadleaf forest?
Figure 6 reveals that these natural formations are in a secondary succession stage, as they contain proportionately a great concentration of small DBH trees[3], while hickory forests contain the biggest trees and thus storage maximum biomass values. If forest conservation measures continue in place under the implementation of the Natural Forest Conservation Programme, we can expect these evergreen broadleaf trees to grow in the future and therefore higher DBH classes to have a greater weight in the frequency distribution (See below).

Multi-functional management of Moso bamboo

As we have seen, the extensive management of Moso bamboo plays a very important role in providing rural inhabitants with a continuous stream of direct income (harvests) and environmental services, such as a high forest cover linked to Beta landscape diversity, biodiversity at shrub and herb layers (richness and Alpha diversity index) and a valuable moderate carbon sequestration capacity. These environmental services, being essential part of the ecosystem and our well-being, furthermore contribute to the improvement of the local livelihoods as long as eco-tourism is able to increase household income levels and sustain environmental quality standards. At the same time, the role played by different forest landuses should be acknowledged as the total socio-ecosystem processes rely on their complementary functions. Our task is to better understand these underlying processes and the linkages they form with communities in the shake of rural development.

In Figure7, multivariate analysis (PC ORD 5.0 software) of tree species abundance matrix permits us to explore the relationships among the different forest uses and species. Our results clearly indicate that evergreen broadleaf plots were linked to a highly diverse range of broadleaf species and litter biomass formation, whereas Moso bamboo, hickory (in an intermediate position) and conifer forests are associated to single species pattern of extraction (1 or 2 managed species per plot), a high diversity at the herb layer and higher biomass at the herb layer.

Axis I explained 53.71% of total variance, Axis II 16.21% and Axis III 6.96% (this latter not being portrayed). The graph differentiates a space associated to natural evergreen broadleaf forest characterised by high Alpha diversity index at the tree layer and high litter biomass, and a space associated with managed forests epitomised by bamboo plots characterised by high Alpha diversity index at the herb layer and high herb biomass. A dendrogram has been included in the Annex showing the similarity distance analysis for the 32 plots, as being applied to the whole set of 514 species (arbour, shrub and herb).

[3] The evergreen broadleaf plot with 3,500 stems/ha had most of the trees classified within the 5-10 DBH cm class (and also within the 0-5 cm and 10-15 cm classes), what explains its current constrained potential for carbon sequestration.

The previous figure reminds us of combining different parameters in assessing forest ecosystem services, where managed forests (including Moso bamboo) and unmanaged natural stands show high complementary values.

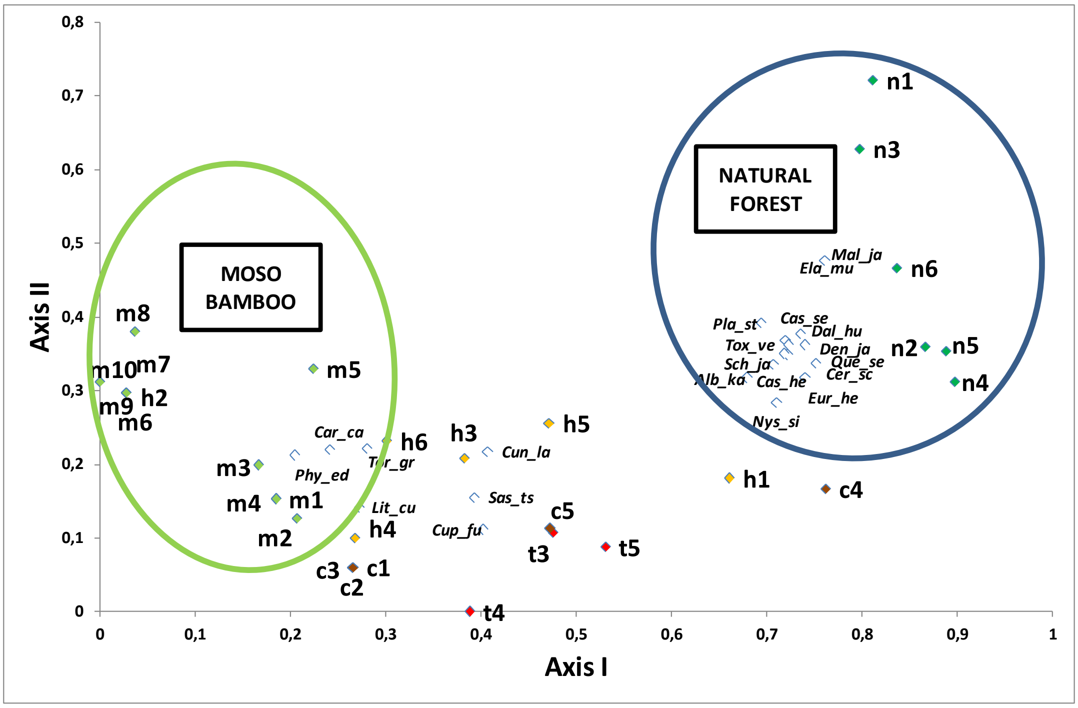


Figure 7. Multivariate analysis (based on Sorensen (Bray-Curtis) similarity index) applied to the tree abundance-species matrix across the 30 plots with a tree layer. Codes: c1, c2, c3, c4, c5 (conifer plots); h1, h2, h3, h4, h5 (hickory plots); m1, m2…m10 (Moso plots); n1…n6 (evergreen broadleaf plots); t3, t4, t5 (tea plots). Arbour species have been displayed in Italics, their codes and IV are explained in the Annex table.

Conclusions and Future Lines of Research

Daxi village is a highly forested landscape that attracts many visitors, contributing to conserve the environment and to generate income for the local population. Moso bamboo as the dominant landuse is complemented by secondary natural forest, hickory, conifer and tea plantations. This mosaic maintains a high diversity and canopy cover, and a medium level of biomass, which is expected to increase as natural forests advance to more mature successional stages.

Bamboo plantations are characterised by a low tree alpha diversity index due to the dominance of *Phyllostachys edulis*. At the same time, it has a medium to high shrub and herbal alpha diversity index typical of an extensive management system. Natural secondary forests, on the other hand, show opposite traits, with high tree and low herbal alpha diversity index. While the other landuses have a standing biomass close to the optimal for their respective productive functions, natural secondary forests have a much higher potential for future carbon sequestration as these formations are still far from their optimum being nowadays in a recovering phase.

On the whole, different forest landuses in Daxi integrate a highly diverse landscape where Moso bamboo under extensive management plays a major role providing local inhabitants with a continuous stream of ecosystem and socioeconomic services.

In the near future, authors will carry out an ecological qualitative characterization of all indentified species (taxonomic classification at higher levels as family and genus), will analyse their bio-geographical range, their stage of succession, their conservation-protection status and their scarcity-rarity situation. In the mean time, a classification of tree age-groups will be performed as well as an analysis of succession dynamics within major forest landuses, with subsequent changes in biomass (projection models). Economic uses of species will also be described.

Acknowledgements

Authors would like to thank Anji Forest Bureau and Tianhuangping Forest Station for their close interest in the project and their helpful assistance, as well as the local authorities and residents of Daxi village, specially to Xu Kefa who participated in the forest inventory measures. Also special thanks to Professor Ai Jianguo (Zhejiang Agriculture & Forestry University) who contributed to the identification of vegetation species.

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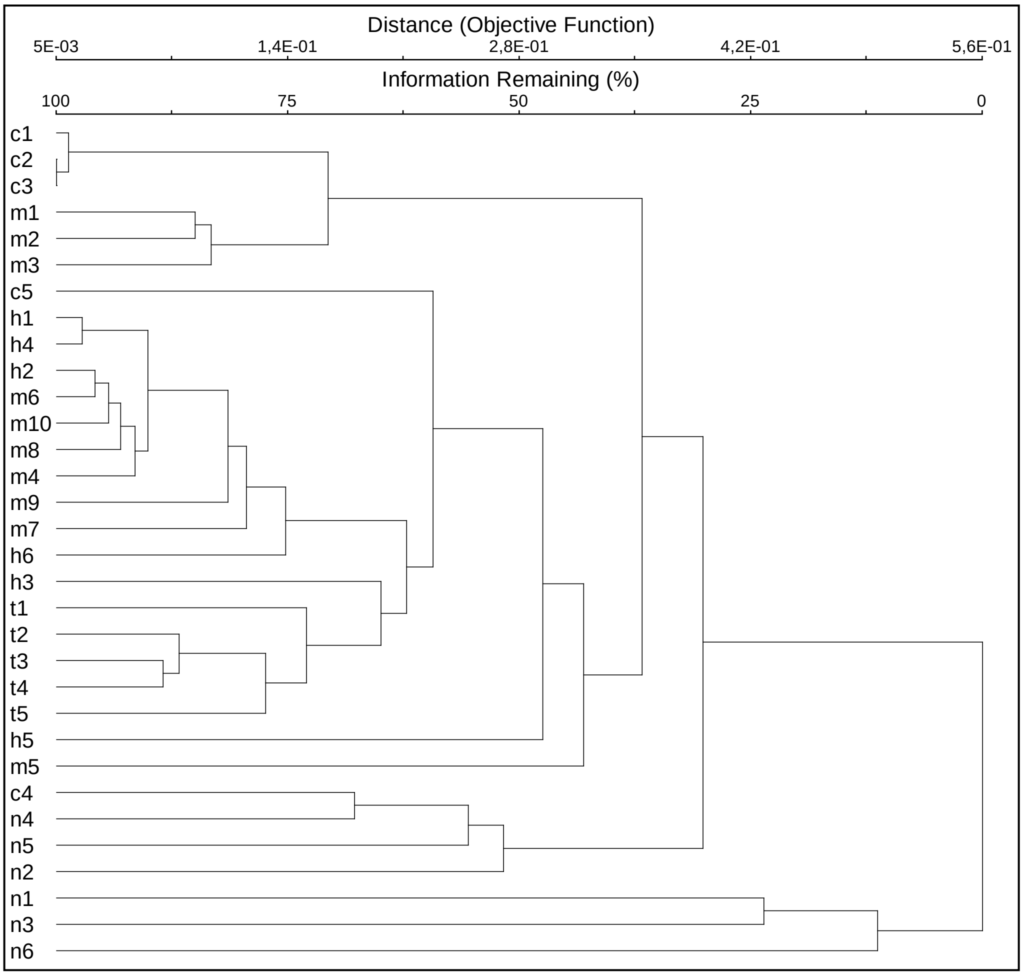
ANNEX to Figure 7

species code	species name	Landuse	Value (IV)	Mean	S.Dev	p *
Cun_la	杉树 *Cunninghamia lanceolata*	conifer	90,4	39	12,44	0,0002
Lit_cu	山苍子*Litsea cubeba*	conifer	60	18,1	10,56	0,0148
Sas_ts	檫树 *Sassafras tsumu*	conifer	44,3	23,2	11,17	0,0516
Car_ca	山核桃 *Carya cathayensis*	hickory	67,7	25,6	8,55	0,0002
Tor_gr	榧树 *Torreya grandis*	hickory	38,5	18,5	10,47	0,0656
Phy_ed	毛竹 *Phyllostachys edulis*	moso bamboo	83,9	24,9	8,01	0,0002
Cas_se	茅栗 *Castanea seguinii*	evg. broadleaf	100	22,5	11,94	0,0002
Dal_hu	黄檀 *Dalbergia hupeana*	evg. broadleaf	83,3	22,6	11,99	0,0014
Den_ja	四照花 *Dendrobenthamia japonica var. Chinensis*	evg. broadleaf	83,3	19,8	10,91	0,002
Cas_he	锥栗 *Castanea henryi*	evg. broadleaf	66,7	18,6	10,59	0,0024
Pla_st	化香树 *Platycarya strobilacea*	evg. broadleaf	64,6	19,8	10,7	0,0028
Cer_sc	浙闽樱桃 *Cerasus schneideriana*	evg. broadleaf	50	17,3	10,1	0,0296
Ela_mu	木半夏 *Elaeagnus multiflora Thunb.*	evg. broadleaf	50	17,6	10,22	0,0306
Eur_he	微毛柃 *Eurya hebeclados*	evg. broadleaf	50	17,4	10,1	0,0284
Mal_ja	野桐 *Mallotus japonicus*	evg. broadleaf	50	18,2	10,48	0,0294
Nys_si	蓝果树 *Nyssa sinensis*	evg. broadleaf	50	17,3	10,03	0,0288
Que_se	短柄枹栎 *Quercus serrata*	evg. broadleaf	50	19	10,59	0,0284
Sch_ja	青皮木 *Schoepfia jasminodora*	evg. broadleaf	50	16,8	10,14	0,0348
Tox_ve	漆树 *Toxicodendron vernicifluum*	evg. broadleaf	50	17,4	10,04	0,0306
Alb_ka	山合欢 *Albizzia kalkora*	evg. broadleaf	49,1	20,4	10,76	0,0228
Cup_fu	柏木 *Cupressus funebris*	tea	66,7	17,2	9,15	0,0052



Bray-Curtis Cluster Distance Analysis (Dendrogram) for all species (tree, shrub, herb). Natural unmanaged evergreen broadleaf plots are clearly distinct from the rest (managed) forests.

Chapter 7.

Changing contribution of forests to livelihoods: evidence from Daxi Village, Zhejiang Province, China

Changing contribution of forests to livelihoods: evidence from Daxi Village, Zhejiang Province, China

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SUMMARY

There are positive and negative feed-back links between forestry and poverty. The role of forests as part of a rural development strategy is much debated in literature. We have explored this role and links for a montane forest village in East China using official historical data and our own field survey of 92 households. The opportunities that forest resources have offered to farmers at different stages of socio-economic development are identified. The changes in farmers' livelihood strategies caused by using forest products and the associated increase of inequalities are assessed. Forest management has been gradually shifting from a focus on forest production centred on bamboo to a multipurpose orientation in which conservation to promote tourism has become increasingly important. While bamboo still remains the main income equaliser factor, different forest products add to the portfolio of opportunities of upper and lower income farmers as they move along their development ladders.

Keywords: farm income, forest functions, rural development, bamboo, tourism, China

Contribution changeant des forêts à la création de revenus: preuves en provenance du village de Daxi dans la province de Zhejiang en Chine

L. GUTIERREZ RODRIGUEZ, M. RUIZ PÉREZ, X. YANG, M. FU, GERILETU et D. WU

Les liens reliant la foresterie à la pauvreté sont à la fois positifs et négatifs. Le rôle des forêts comme faisant partie de la stratégie du développement rural est très souvent débattu dans la littérature. Nous avons exploré ce rôle, et ces liens, dans un village de forêt montagneuse dans la Chine de l'est, en utilisant des données historiques officielles, et notre propre étude sur le terrain, dans 92 foyers. Les opportunités que les ressources forestières ont offert aux fermiers à différents stades du développement socio-économique sont identifiées. Les changements dans les stratégies adoptées par les fermiers pour assurer leurs revenus, causés par l'utilisation des produits forestiers, et la croissance des inégalités qui y sont associées, sont évaluées. La gestion forestière s'est petit à petit déplacée d'une concentration sur une production forestière centrée sur le bambou à une orientation à plusieurs visées, dans laquelle la conservation pour promouvoir le tourisme tient une place d'une importance croissante. Alors que le bambou demeure encore le principal facteur égalisateur des revenus, des produits forestiers différents s'ajoutent au portefeuille des opportunités offertes aux fermiers, que leurs revenus soient importants ou faibles, alors qu'ils se déplacent sur leurs échelles de développement.

Cambios en la contribución de los bosques al sustento de la comunidad: experiencias del pueblo de Daxi, Provincia de Zhejiang, China.

L. GUTIERREZ RODRIGUEZ, M. RUIZ PÉREZ, X. YANG, M. FU, GERILETU y D. WU

Existen interrelaciones positivas y negativas entre la gestión forestal y la pobreza, y a menudo el material publicado ha examinado el papel de los bosques como parte de una estrategia de desarrollo rural. En este estudio se analiza este tema y las conexiones mencionadas en lo que se refiere a un poblado de bosque de montaña en el este de China, con base en los datos oficiales históricos y una encuesta sobre el terreno de 92 hogares, realizada para este estudio. Se identifican las oportunidades que los recursos forestales ofrecen para agricultores en diferentes fases de desarrollo socioeconómico, y se evalúan los cambios producidos en las estrategias de ganarse el sustento debidos al uso de productos forestales, y el aumento asociado de la desigualdad. El modelo de gestión forestal ha ido cambiando poco a poco, desde una estrategia forestal basada en la producción de bambú hacia un modelo de usos diversos en que la conservación y promoción del turismo son cada vez más importantes. Aunque el bambú sigue siendo el mayor factor de equiparación de ingresos, los diferentes productos forestales aumentan el portafolio de oportunidades para los agricultores de mayores o menores ingresos mientras avanzan por su escala de desarrollo.

INTRODUCTION

Forestlands have been widely associated with the incidence of rural poverty throughout the world (Angelsen and Wunder 2003, Chomitz 2007, Kaimowitz 2002, Sunderlin *et al*. 2005). Although forests and poverty tend to co-occur, the existence of a causal link between them is still debated. Isolation, poor infrastructure, and limited income opportunities and market access are all root causes of poverty in areas with high forest resource endowment (Sunderlin *et al*. 2005, Vedeld *et al*. 2004, Wunder 2001).

National and international efforts to reduce poverty in forested areas have been based on two complementary paradigms: aiding forest communities to capture a larger portion of benefits from their traditional forest-related activities, and establishing alternative income generating options (Arnold 2001, FAO 2006, Hudson 2005, Persson 2003, Wollenberg and Inglis 1998). The ability to obtain benefits has provoked an interesting debate about who takes advantage of forest-based opportunities. Some authors (eg, Dove 1993, Iversen *et al* 2006) have argued that the already privileged local elites are in a better position to appropriate benefits of potentially superior, forest-related economic opportunities. Others (Cavendish 2000, Falconer and Arnold 1989, Jodha 1986, Kant and Chiu 2000, Vedeld *et al*. 2004) confirm the well-known fact that the poorest groups within rural communities are often relatively more dependent on, and trapped in forest-based income and suggest that poverty alleviation strategies can be based upon forest. Ambrosse-Oji (2003), Kamanga *et al* (2009) and Ruiz Perez *et al*. (1999) have found that the relative contribution of forest income to different farmers' revenues depends upon the alternative options available, and that in forested regions the middle income group of farmers tends to depend more on forest activities under mature economic conditions. These studies tend to be based on the assumption that forest-related incomes and opportunities for poverty alleviation are relatively stable over time which depends on context and cannot be generally assumed.

THE SITUATION IN CHINA

China has a large rural population and, in spite of significant improvement, rural poverty is still prevalent in some regions (CPRC 2004, UN 2004, World Bank 2000). A combination of natural and historical factors has resulted in a frequent occurrence of poverty in forested mountainous areas (Elvin 1998, Han *et al*. 2006, Li and Veeck 1999; Liu and Yin 2004). Because of that, China has experienced a vicious circle of increasing pressure on its forests while being unable to bring these rural areas out of poverty (Harkness 1998, Kejian and Yang 1996, Niu and Harris 1996). At the same time, China has made a significant progress not only on the economic and social fronts but also in environmental and natural resources management (Day 2005, Economy 2006). Consequently, the country offers a good opportunity to study the forest-poverty relationship during periods of fast economic and social change.

The market and social reforms initiated in the early 1980s brought major changes to China's forests and the rural populations depending on them (Hyde *et al*. 2003). The most significant recent shift in Chinese forest policy starting in the late 1990s focussed on reducing environmental pressure and expanding the area and quality of forests (Wang *et al*. 2004). The new programmes (like the Sloping Land Conversion Programme, SLCP, or the Natural Forest Protection Programme, NFPP) also provided for some economic cushioning to farmers through direct in kind and monetary compensations and by developing novel on-farm and off-farm income generating activities. The environmental, socio-economic and food security aspects of these new programs have been studied, with the general agreement that they have had little effect on the latter; their influence in affecting farmers' livelihoods is ambiguous (Feng *et al*. 2005, Grosjean and Kontoleon 2009, Weyerhaeuser *et al*., 2005, Xu *et al*. 2004, Xu *et al*. 2006), while the effect on the environmental conditions of the forests tends to be neutral or positive (Morell 2008, Xu *et al*. 2004).

Rural development has traditionally depended on agriculture and forestry. Off-farm income opportunities (like food and forest processing, construction, handicraft and other tourism-related activities) are becoming more attractive and are now widely perceived as the main route out of poverty in China and elsewhere (Haggblade *et al*. 2002, Lanjouw and Feder 2001, Otsuka and Yamano 2006 Reardon *et al*. 2007). In this sense, perhaps the most relevant issue for poverty reduction and rural development in forest regions and in rural China generally is the set of off-farm options available to farmers and the relationship between on-farm and off-farm activities in buffering economic boom and bust cycles (Zhang *et al*. 2001). The tremendous effort to bring people out of poverty in rural China (UN 2004) would not have been possible without a rapid increase in non-farm opportunities. Non-farm jobs increased from 67 to 130 millions between 1985 and 1996 fuelled by the 18% annual growth rate of rural industries since 1980 up to the mid-90's (State Statistical Bureau several years).

However, different levels of engagement in non-agricultural activities have widened income gaps and thus raised within-village inequality. This process explains at least 50% of current rural inequality in China (Benjamin *et al*. 2004) and has restrained improvement of the living standards and purchasing power of the poorest since the mid 1990s in a country that has one of the largest rural-urban divides in the world (Benjamin *et al*. 2000, Yao

[1] Ravallion and Chen (2004) offer a contrasting perspective of income inequality rise in China, differentiating between periods and decoupling growth and inequality. Their estimates of income inequality based on corrected data for urban-rural differences in cost of living give lower inequality than most estimates.

2002)[1]. Recent measures to close the gap and revert the process of increasing inequality include suppression of the national agriculture tax (Han *et al*. 2006, Xinhua 2005), support for school fees in rural areas, and farm subsidies under the implementation of ecosystem-service schemes, e.g. the SLCP and the Forest Compensation Programme (Scherr *et al*. 2006). The rural society in China, in spite of its inherent dynamism, continues to lag behind urban areas in capturing the benefits of development. Poverty still affects a significant part of the rural population and is especially prevalent in remote regions with a high forest cover (Tang and Zhou 2003).

The purpose of this paper is to analyse the role of forests in generating income and offering livelihood opportunities to Chinese farmers. This is done from a dynamic perspective, where not only forest income, but also on-farm *versu*s off-farm incomes are changing quickly and are contributing to an increasing differentiation within rural communities. Building on Ruiz Perez *et al*. (2004), our main hypothesis is that forests can offer a good starting point at early stages of development, but after a certain level farmers will have to shift to other activities to keep increasing their incomes. We test this hypothesis with respect to some of these newly arising opportunities and consider the role left to forests in the emerging economic conditions based on a comprehensive sampling of farm households and detailed long time series statistics in a mountain forest village in Eastern China.

THE STUDY AREA

Daxi village (*cun*) is situated in the southern mountains of Anji, a middle income county of Zhejiang province, East China, close to the Shanghai-Nanjing-Hangzhou region. The village is composed of 11 groups (*zu*, settlements that basically correspond to the former Commune) and has 2 069 people (2006 data). A steep topography has marked the life of Daxi's residents, isolating the village from the county's capital and the range of activities offered by its lowlands and the opportunities of the metropolitan region until very recently. The village territory of 2 335 ha is largely unsuitable for agriculture, 82% are covered by forest, 6.7% by scrub, 7.5% by arable land, and 1.8% by settlements and other land and water bodies (Tian Huang Ping Forest Station 2003, and our own remote sensing data).

The Household Responsibility System (agriculture) and the Contract Responsibility System (forest) (*jiating lianchan chengbao zeren zhi*) were implemented in Daxi in 1985 and 1986 respectively, two years after their starting in Anji County (Meng 2009). At that time bamboo (mainly *moso* bamboo, *Phyllostachys edulis*, ((Carrière) J. Houz), covering 58.5% of village land, constituted the main forest use, representing also the main source of income to farmers. Secondary natural forests were mostly a source of fuelwood, while Chinese hickory (*Carya cathayensis*, Sargent), scattered in the landscape as clusters of trees planted within larger bamboo plots, provided a supplementary source of nuts for sale and home consumption. There were a few plots of green tea (*Camellia sinensis* (L.) Kuntze); naturally occurring white tea (a variety of green tea) was traditionally collected from the forest for home consumption.

The construction of a large dam and hydropower plant (co-financed by Southeast Electric Net Ltd. and The World Bank) in 1992 – 1996 changed the lives of people in Daxi and brought new off-farm job opportunities. Large numbers of workers (unskilled, and specialists) were lodged in purpose-built residences and in farmers' houses, providing new and additional sources of income and a learning experience in dealing with visitors (Meng 2009). Construction of heavy-duty roads from Daxi's main settlement to Tian Huang Ping and Di Pu (the Township and the County's capital respectively) in 1993 dramatically improved access and contact to the outside world. The attractive forest scenery, capital accumulation by farmers through their engagement in off-farm activities, an improved infrastructure and the experience of receiving visitors opened the way for Daxi to initiate its long march towards the tertiary sector economy represented by tourism.

METHODS

A household field survey was conducted in Daxi in 2005 and supplemented with data from the official Daxi records of 1969 to 2006 provided by the local administration. These data are complemented by key informant interviews, Tian Huang Ping's Forest Station statistics and our own land-use survey based on remote sensing analysis. The household survey used a structured questionnaire that requested information about family composition, land holding, economic activities, labour allocation, expenditure, income and taxes. Production data referred to the years 2003 and 2004 to capture the bi-annual production cycle of bamboo and the corresponding variation of households' income. Home consumption of each family was recorded and valued at current market prices.

The questionnaire was administered to a stratified random sample of 92 households selected proportionally to household and population numbers from the 11 settlements. The sampling density was 15%, with 81.5% of respondents being male and 18.5% female.

Daxi has detailed records dating back to 1969, the year of the administrative reform that put villages under the control of larger townships. These records provide an invaluable socioeconomic history of the village. We have selected key demographic and economic data to construct a 37-year time series. Moreover, Daxi was selected in different periods as a reference village for the yearly National Household-level Rural Survey (*quanguo nongcun shehui jingji diaocha, nonghubiao*). The samples in the years 1988 to 1991, with 16 farmers each year, were the largest. We have used the panel of 1990 as the baseline to assess household economic changes because it offered the most detailed income structure, separating different sources of income in a way compatible with our questionnaire. When appropriate, the data were converted to constant RMB (yuan) using Zhejiang province's general consumer price index for rural areas

(Zhejiang Statistical Yearbook 2006) since 1983 and China level inflation figures for the period prior to this year.

Per capita income is affected by family structure (size, age, gender balance and education), land and assets availability, and distribution of labour among different potential income-generating opportunities (Barham *et al*. 1999, Sunderlin *et al*. 2005, Wollenberg and Inglis 1998). Multiple regression models were used to assess which of these factors have the greatest influence on per capita income; we have added a variable capturing the political role (Communist party or Village Committee membership) to include a possible effect on income appropriation by the local political elite postulated by some authors (Bramall and Jones 1993, Lu 1997, Wang 1997). We employed a parsimonious Corrected Akaike Information Criterium calculation (AICc) (Burnham and Anderson 2002) to assess the trade-offs between model complexity and data fit.

The data were analyzed using descriptive statistics, parametric and non-parametric tests, regression models, time series and multivariate analysis based in SPSS-16. Gini coefficients (a commonly used index of income distribution that ranks from 0, complete equality, to 1, maximum inequality; see Gastwirth 1972) were calculated in order to assess disparities between different sources of income.

RESULTS

Historical time series income

Prior to the 1979 reforms, Daxi was a typical poor mountainous village. Net per capita yearly income was 273 RMB (or 182US$) in 1978-79. Income data from historical village records were grouped in three main categories: agriculture (including livestock), forestry and off-farm income. Sixty nine percent of total income was derived from forestry (most of it from *moso* bamboo), underscoring the importance of and strong dependence on forest resources. Agriculture (crops and livestock) represented 29.3% of income, while only 1.6% came from off-farm activities (Daxi village historical records).

Since then Daxi's economy has experienced dramatic changes, both quantitative and qualitative. Village's current annual per capita income (average 2005-06) amounts to 8 820 RMB (1 102US$), an 8 fold increase in real RMB terms or 6 fold increase in US$. Forest-based income amounts to 40.7% of total income, agriculture 6.4%, whereas off-farm income is the largest source, representing 52.9% of total income (Daxi village Statistics).

The first four years of the series, 1969-1973, used different income categories incompatible with the rest. Therefore, we have used a time series covering the period 1973-2006 to assess income changes. We have applied a Holt lineal smoothing transformation (SPSS 2007) to analyse the main trend (figure 1). The trend of the contribution of agriculture to total income was monotonic linear decline over the whole period, matched by a corresponding increase in off-farm income. The contribution of forest to total income remained stable or increased slightly for two decades until 1992 when a sharp decrease followed the construction of the hydroelectric dam.

In order to capture the change in trend experienced as a result of the dam and the improved accessibility that it brought, linear regression models have been calculated for two subsets of the series, prior to and after the beginning of the construction of the hydroelectric dam and plant. The regression lines appear in figure 1. During the pre-dam period (1973-1991) agriculture had a negative slope (-1.27) that was maintained after the construction of the dam (slope -0.57); forestry and off-farm incomes show a parallel upward trend between 1973 and 1991 (slopes of 0.42 and 0.85 respectively). Once the construction of the dam started in 1992, the contribution of forestry-derived income declined sharply, resulting in a shift in trend with a steep negative slope (-2.21). The contribution of off-farm income increased sharply during this period, with a steep positive slope of 2.78.

Chow tests to check for structural break in each income component before and after the dam are highly significant in all cases ($p<0.001$). This supports the hypothesis that the construction of the dam represented a structural shift in Daxi's economy, accelerating the trends of agriculture and off-farm income and initiating the relative decline of forest-based income.

Income structure at the beginning of the household responsibility system

The panel of 1990 reports detailed income components for a sample of 16 families in Daxi village. The data, part of the China Yearly National Rural Survey, correspond to the early stages of implementation of the household responsibility system, with forestry rights allocated to individual families, and prior to the construction of the dam (table 1). They reflect an economy where farmers' individual entrepreneurship had begun to be released from earlier constrains of the commune period. Forest based income was at its highest, accounting on average for 76% of household income for the 16 families of the panel, with almost 2/3 of it coming from bamboo. Agriculture continued to decline in relative terms and accounted for 11% of household income, whereas the incipient off-farm sector averaged 13%.

The panel of 1990 was split into terciles representing the income brackets - low (5 cases), middle (6 cases) and high (5 cases). Farm-based income was still predominant in all income categories, but was relatively more important in the middle-income bracket. Inversely, off-farm income was the highest relative income contribution in the high-income bracket, and lowest in the middle bracket. Forest income showed a bell-shaped distribution with the middle-income bracket having the largest relative income. The same pattern was observed for bamboo. The contribution of hickory, the second most important source of forest income, increased from the low to the high income groups, whereas tea, a marginal product at that time in Daxi, was most important for the low income group of farmers (figure 2).

FIGURE 1 *Change in the relative contribution of the main sources of income, 1973-2006. The strait lines represent the regression models for the pre-dam and post-dam periods. The effects of the dam, started in 1992, are clearly visible in the changing trends of different income sources.*

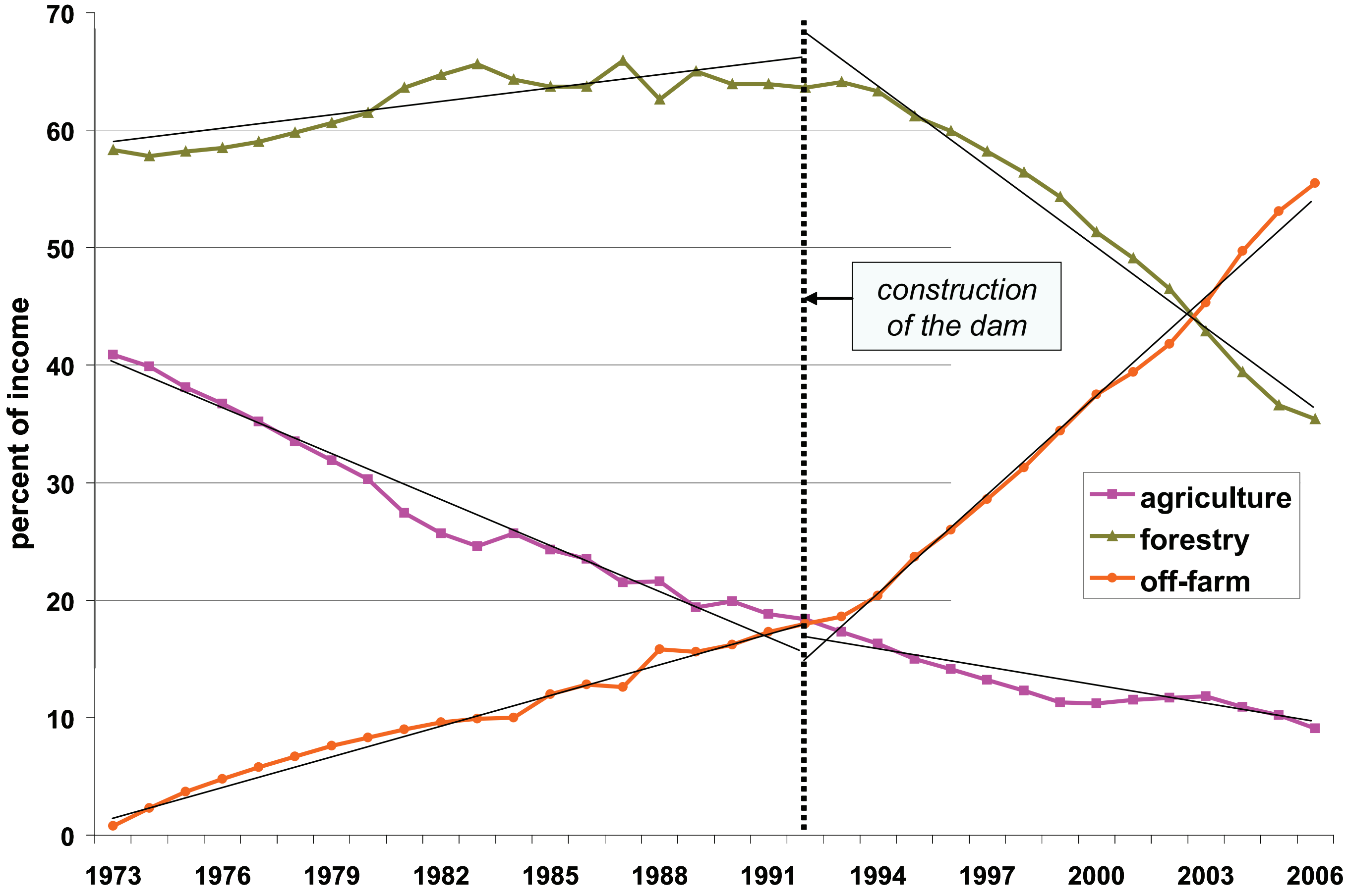


TABLE 1 *Changes in percent of income from different activities in Daxi village between the 1990 National Rural Survey Panel (n=16) and the 2005 field survey (n=92)*

	1990	2005
Bamboo	46.9%	17.6%
Tea	19.3%	10.7%
Hickory	9.7%	12.3%
Other forest	n.a.	9.0%
Agriculture	3.9%	3.7%
Livestock	6.9%	2.4%
Tourism	n.a.	21.9%
Off-farm (including tourism)	13.4%	44.4%

These results are consistent with findings of Ruiz Pérez *et al*. (1999) based on field research conducted in Anji County in the mid 90s. The differences are statistically significant (at p=0.10) for the on-farm and off-farm (F=2.794; p=0.098), hickory (F=4.221; p=0.039) and tea (F=2.764; p=0.100). Post-hoc pair-wise comparisons between income categories showed significant differences for other sources of income, notably for forests (middle versus high in<TO

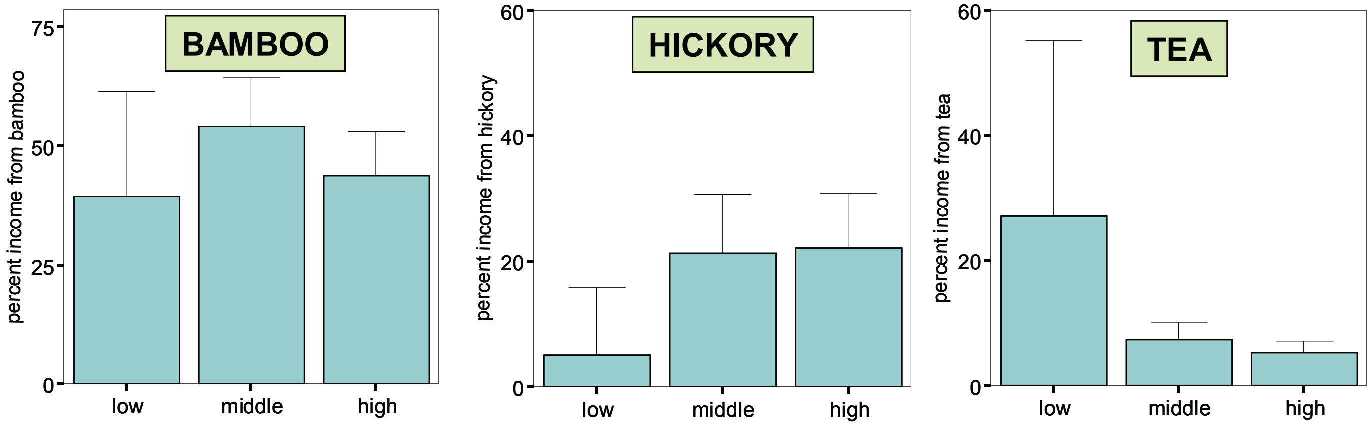
Gini coefficients were used to assess income distribution, which was at that time still rather egalitarian, with a Gini coefficient of 0.21. While farm-based income showed a fairly equitable distribution (Gini 0.19), the still small but fast growing off-farm income showed strong differences (Gini 0.53) indicating a specialization trend. Among the forest-based sources of income, bamboo had the most egalitarian distribution, with a Gini coefficient of 0.26, whereas hickory and tea Gini coefficients were 0.47 and 0.46 respectively.

Present family structure and land holding

In 1973, still under the Commune regime, Daxi village had 1 635 people in 328 households. By 1992, at the beginning of the construction of the dam, the population had risen to 1 898 people in 531 households. The latest census of 2006 records 2 069 people in 616 households living in the 11 hamlets that constitute Daxi village (Meng 2009). There are 102.6 females per 100 males, unlike the general pattern of male-bias that characterises current Chinese demography. The low yearly demographic increase of 0.8% during that period is the result of the 'one child' policy and reduced out-migration rates due to the emergence of attractive income opportunities for the local population.

The average household in our sample has 3.7 members, of whom 2.6 are actively engaged in farm work or/and off-

FIGURE 2 *Relative contribution of bamboo, hickory and tea income for different income categories in Daxi from the 1990 panel of the China Yearly National Rural Survey. At the time bamboo was relatively more important for middle income farmers, hickory for middle-high income farmers, and tea for low income farmers*



farm activities. A household in Daxi manages an average of 30 *mu* equal to 2 ha (15 *mu* = 1 ha). This area is made up of 18 *mu* (60%) of *moso* bamboo, 50 trees of Chinese hickory, 3 *mu* of tea and 6 *mu* of natural secondary forest located in the higher parts of the hills. The remaining land consists of 3 *mu* of other species of small bamboo (mainly for bamboo shoots), some clusters of conifers (just 10 trees per family on average), and 0.5 *mu* of fruit and vegetable gardens to supply household consumption. The very small area of rice fields that existed in the past has disappeared being replaced by orchards and new houses and all rice consumed in Daxi is imported.

The local forest management by the farmers is characterised by a considerable degree of land fragmentation, the average family holding of 30 *mu* (2 ha) being divided into 13 plots, which is typical of the former collective forests run under the Contract Responsibility System scheme in China (Liu 2001, Liu and Edmunds 2003, Song *et al*. 2004, Zhang 2001). This reflects the egalitarian principle in the ownership pattern of land and the high levels of diversity and heterogeneity of soil types and qualities of mountainous areas. This patchiness is an obstacle for efficient and sustainable forest management, but the resulting mosaic of landscape is attractive for tourists.

The changing base of income in Daxi village

The 2005 survey of data of 2003-04 reveals the major changes that have taken place in Daxi in the past 15 years of transition from a farm to an off-farm based rural economy. The contribution of agriculture has continued to shrink, now representing 6% of total income of the sample (about 70% of this home consumption). Forestry has experienced a dramatic reduction in relative terms, down to a share of 50% of total income. The off-farm sector grew to 44% of total income, half of which comes from tourism (table 1). The data in our sample correspond well with the official Daxi village statistics for the same period, differences are mostly due to differences in the assessment of the self-consumption component of farmers' household economy.

The 92 farm households of the sample were also stratified into the income terciles - low (30 cases), middle (31 cases) and high (31 cases). The relative importance of farm-based income declines as we move from the low to the high-income terciles, and of off-farm income increases (see figure 3). The differences are statistically significant ($F=14.888$; $p<0.001$).

The relative economic value of forest as the main source of farm-based income decreased significantly from low to high-income terciles ($F=9.292$; $p<0.001$). The relative importance of different components of forest income for the different income terciles had also changed (figure 4). Bamboo, still the main component of forest income, is less important for middle and high-income terciles ($F=14.471$; $p<0.001$). Rich farmers still maintain their bamboo plots hiring local or immigrant labour to work on them, while they devote their time to more remunerative activities. Hickory has become a relatively important forest-based income source for middle-income farm households, but differences are statistically significant only between the middle versus high-income terciles of farms for the relative income from hickory ($p=0.084$). Tea, the fastest expanding crop, increased in relative importance from low to high-income terciles of farm households.

Factors affecting income distribution

All indicators show an increasing disparity in the distribution of income between 1990 and 2005. The Gini coefficient for total per capita income increased to 0.28, reflecting the general trend that has accompanied China's rapid development (Benjamin *et al* 2000, 2004, Bramall and Jones 1993, China Daily 2007). The increase of disparity happened in all main economic activities. On forest-based income, bamboo, that has become particularly important to poor farmers, has experienced the lowest increase in income disparity. Tea, the emerging forest product associated with tourism and currently particularly important for farmers in the richer tercile, has experienced the fastest increase in income disparity with a Gini coefficient of 0.73. This is mainly due to one specific part (settlement) of the village having specialised on its production.

FIGURE 3 *Relative contribution of on-farm versus off-farm based income for different income categories in the 2005 panel. The relative importance of farm-based income decreases from low to high income groups, just opposite to the trend for off-farm income*

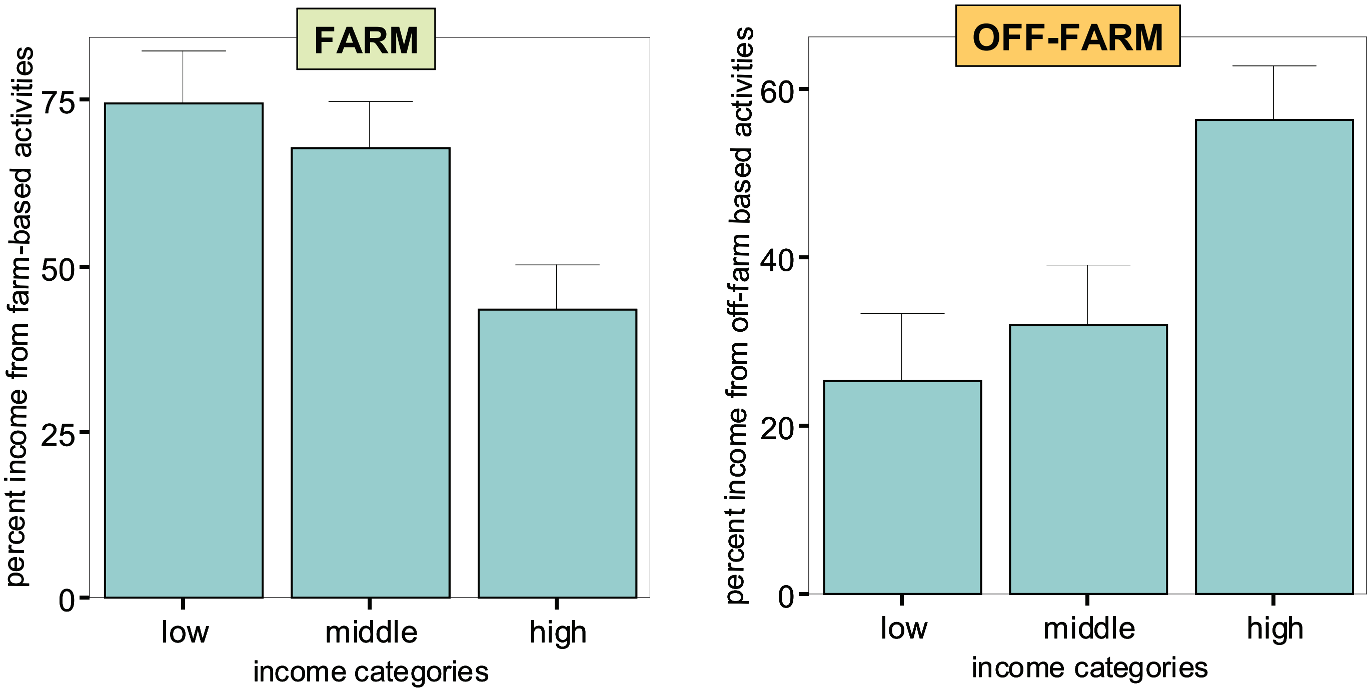


FIGURE 4 *Relative contribution of bamboo, hickory and tea income for different income categories in the 2005 panel. Their relative contribution has changed significantly when compared with the 1992 panel of figure 2. Bamboo has become relatively more important for low income farmers, and tea for high income farmer.*

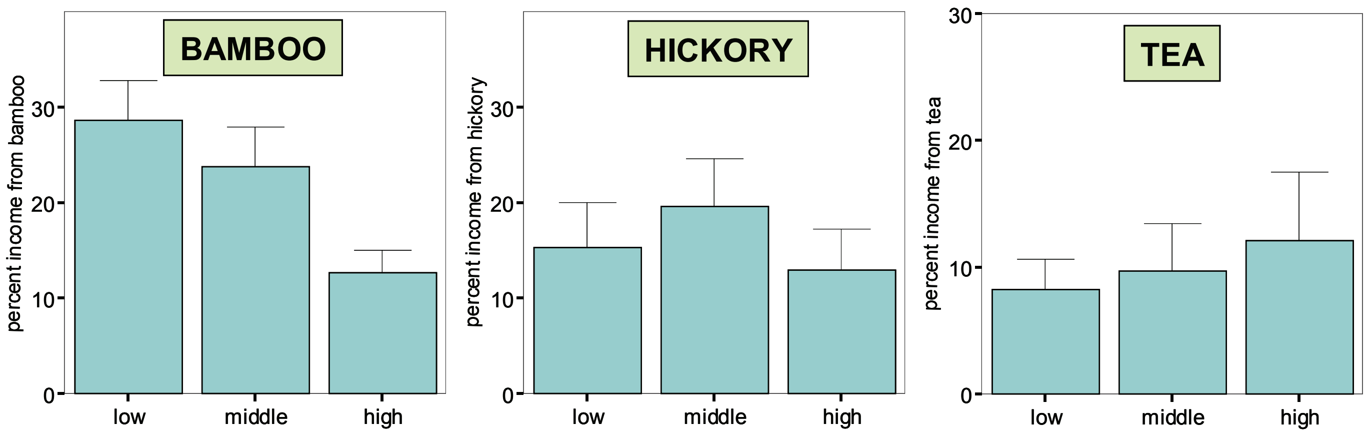


Table 2 present the summary statistics of the variables entered in the multiple regression models used to assess the factors with greatest influence on per capita income. The best model selected using the parsimonious Corrected Akaike Information Criterium that optimises the trade-offs between model complexity (related to the number of variables) and model fit (related to the adjusted R-square value) appears in table 3.

Distance from the farm to the village entry point by road (measured as $\log_{10}$ of travel time), amount of forest land other than bamboo, and percentages of income derived from bamboo and off-farm activities are the predictor variables of the best model. Off-farm income and land other than bamboo have a positive coefficient indicating a spin-off effect on per capita income. Distance and bamboo income have negative coefficients; distance constrains farmers' opportunities for more profitable activities, bamboo is an inferior income opportunity that has proportionally more weight and importance in the poor-farm tercile.

DISCUSSION AND CONCLUSIONS

The trends expressed by the statistics in the Daxi time series and by the data from the surveys of 1990 and 2005 portray a fundamental change from a poor mountain village at the

TABLE 2 *Descriptive statistics of the variables of the 2005 field survey used in the regression models*

Variables	Min	Max	Mean	St. Dev.
Family size	1	7	3.66	1.32
Ratio male/female family members	0	3	1.09	0.65
Number of family workers	0	5	2.56	1.08
Ratio male/female family workers	0	2	1.01	0.45
Ratio workers/family size	0	1	0.71	0.25
Years of formal education	6	12	7.40	1.80
Household head engagement in the CPC or village committee (no=0; yes=1)	0	1	0.21	0.41
Per capita net income	1 460	28 126	8 241	4 629
% net income from agriculture	0	43	5.2	7.91
% net income from animal husbandry	0	25	2.8	4.73
% net income from bamboo	1.6	62.4	21.7	13.52
% net income from hickory	0	69.2	16.0	15.27
% net income from tea	0	68.3	10.1	13.19
% net income from other forest products	0	15.4	1.5	2.34
% net income from extra forest activities	0	48.8	4.7	10.49
% net income from forestry	5	100	53.9	23.87
% net income from on-farm (agriculture. livestock & forest)	5	100	61.9	26.69
% net income from off-farm secondary sector and other jobs	0	76.4	13.4	21.52
% net income from off-farm tourism	0	93.1	17.5	24.03
% net income from bonus and pensions	0	64.2	7.2	11.17
% net income from off-farm (tourism, secondary sector and other jobs)	0	95	38.1	26.69
Bamboo land in mu	2.3	75	17.9	15.19
Other forest land in mu	0	94	11.2	15.56
Orchard land in mu	0	2	0.4	0.53
Total land in mu (bamboo, other forest, orchards)	4.3	130.1	29.5	22.20
Rents land to others (no=0; yes=1)	0	1	0.20	0.40
Log 10 travel time	0.70	1.93	1.47	0.43

TABLE 3 *Regression model of per capita net income (outcome) and the predictor variables selected using the Corrected Akaike Information Criterium*

R	R Square	Corrected R Square	Standard error	F	Sig.
0.659	0.434	0.408	3561.029	16.694	0.000

Outcome variable: per capita net income

Predictors	Unstandardized coefficients	Standardized coefficients	t	Sig.
Constant	10 962.756		5.668	0.000
% net income from bamboo	-94.537	-0.276	-2.778	0.007
% net income from off-farm	27.697	0.160	1.598	0.114
forest land other than bamboo in mu	114.489	0.385	4.692	0.000
log 10 travel time	-2 041.921	-0.188	-2.220	0.029

end of Mao's period focussed on the primary-production forestry sector and the developing village in the transition to a dynamic and diversified economy with increasing focus on the tertiary, tourist-based forestry sector.

Originally, primary-production forestry, especially growing of bamboo, was the traditional economic activity which dominated village life and offered the best income opportunities to the middle and high-income terciles of farms. Forestry's share of total village income had remained fairly stable, around 60% to 65% for two decades (1970-1990). Income from the incipient off-farm activities, initially work in construction and forest-related rural industries, was gradually replacing the less remunerative agricultural income, an example of the classical process of change from inferior to superior economic activities associated with structural change and economic growth as described by Fan *et al* (2003). The initially hesitant changes in the relative contribution of the three main sources of income of the eighties were accelerated in the 1990s by the construction of a hydroelectric dam and power plant and the improved accessibility and contacts with the outside world which brought diversity, information and opportunity to all farmers.

The dam-induced opening up of Daxi initiated the relative decline of forest-based income and the expansion of revenue earning from off-farm activities. This process is characteristic for the period in rural coastal regions of China. It is driven by factors occurring in the expanding metropolitan centres and industrialising zones outside the rural areas (Ke 1996). The new socio-economic context in principle opened income options for all terciles and the whole local population equally. However, these opportunities have been realised to different degrees by farmers, reflecting inherent variations in household dynamism. The trend in our case is typified by bamboo which shifted as traditional economic base and superior opportunity crop of the upper tercile farmers to an inferior economic activity which has gained importance as staple among poor farmers.

A traditional forest product is emerging as superior in the new markets of the mountains of East China. The white-tea market is rapidly expanding by the growing demand of tourists for local natural products. This opportunity has been most effectively exploited since its inception eight years ago by the upper-tercile, better-off households who enjoy a significantly larger share of tea and off-farm incomes than households in the poor tercile. Daxi´s tea market has currently reached a quasi-equilibrium state, dominated by the upper tercile households, and opportunities to participate are now very limited for the poor. The richer households manage intensive plantations with high investment, hired labour and often special marketing channels within their tourist infrastructure (shops and small rural hostels, *Nongjiale*), which secures dominance and competitiveness.

However, the existing context of equitable land-rights, at least in principle, permits households from different economic backgrounds to participate and compete when new farm-based opportunities emerge. Consequently, although the better-off farmers are taking a larger share of the new opportunities around forests, particularly with the white-tea plantations, most farmers in Daxi village are able to derive some direct monetary benefits from them. This situation is quite different from that typical of an off-farm tourist sector that requires relatively high capital investments. The initial development is led by families with a better-off household economy who offer part-time employment to members of poorer farm households.

The arrival of visitors to Daxi has also encouraged the cultivation of other forest plant species. Hickory has recently opened an interesting option for farmers living in the more inaccessible areas, where isolation and a poor road network have so far precluded a rapid development of tourism. In these uphill locations, hickory returns and net per capita income show a positive correlation. Unlike tea, the potential of hickory to become a driving economic source has been constrained by its slow growth rate and variable annual yield. This again limits the access to poor farmers with a more limited time horizon and flexibility.

The increase in wealth has been accompanied by an increase in income disparity, notably as a result of off-farm activities and more recently with the intensification of tea growing which are currently the superior income opportunities. The dominant economic position of off-farm income is the main factor contributing to a general rise of income disparity in Daxi as part of the general pattern of social inequality, which has reached alarming proportions in China (China Daily 2007). While farm-based income has tended to be more egalitarian than off-farm income in rural China (Bramall and Jones 1993), bamboo, with the lowest Gini coefficients, has been and remains the main income equaliser in Daxi. This is the result of the combined effect of an egalitarian distribution of land under the Household Responsibility System and the socio-economic role of bamboo as the spatially largest land use in the village. Therefore, beyond its safety net role for the poor, bamboo currently represents a key factor in maintaining social cohesion, reducing to some extent the income disparities produced by the new economic opportunities.

Recently established forest land use other than bamboo has a positive effect on income, being associated with better-off, middle-to-rich tercile farmers, while bamboo forest land, formerly more important for the higher income tercile, tends now to be associated with the lower-income tercile. This fact reinforces the concept of a shift of the role of forests in the spheres of fighting poverty and generating sustainable income and other benefits. It validates the early warning of Dove (1993) about elite appropriation of potentially promising forest resources, but also shows dynamic livelihood strategies around forest products. The appropriation of and dependence on forest resources may change in the context of a dynamic, fast developing socio-economic framework, questioning the rigid, static models that tend to mechanically relate forests and poverty. In the case of China, since the 1980s, abundantly available system analytical resource planning aids (Bruenig *et al.,* 1986) has helped to accelerate these changes.

Finally, while bamboo has suffered a decline in relative socio-economic weight in the income portfolios of the households of better-off farmers, it has shown a high resilience in maintaining a key role in the poor-tercile farm household portfolios and in attaining a new prominence in the new economic setting as the most idiosyncratic cultural landscape feature that attracts tens of thousands of metropolitan tourists to Daxi. This is complemented by the increasing appreciation of the natural secondary forests, which are currently recovering in Daxi due to the combined effect of a gradual shift from fuelwood to gas and solar heating, and the implementation of the Natural Forest Protection Programme. This marks a changing role of forests not only for poverty alleviation but also of its resource function from raw material production to environmental services, reflecting similar processes elsewhere in China (Liu 2005, Zhang and Wen 2008) and at a global scale (FAO 2007).

ACKNOWLEDGEMENT

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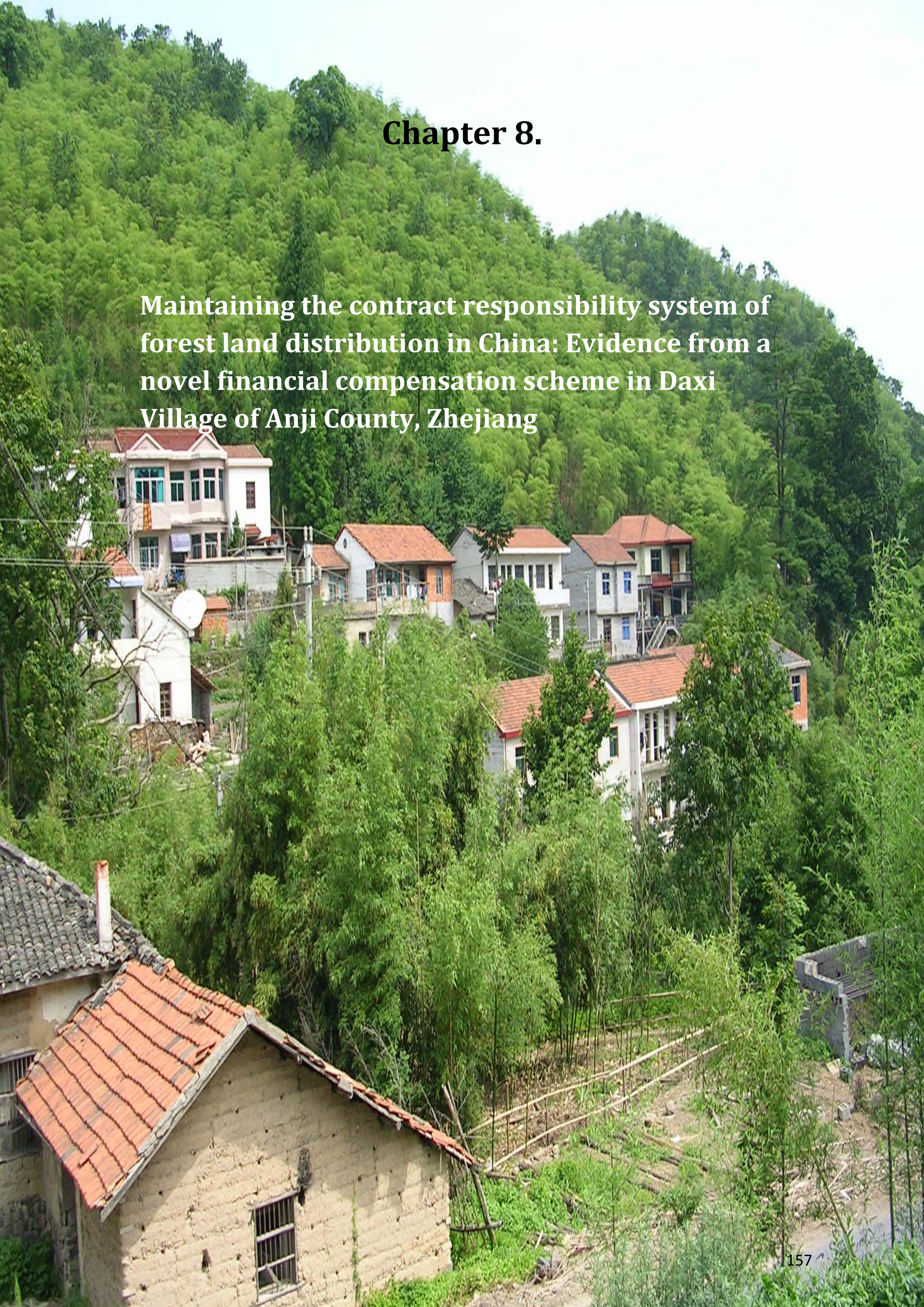
Chapter 8.

Maintaining the contract responsibility system of forest land distribution in China: Evidence from a novel financial compensation scheme in Daxi Village of Anji County, Zhejiang



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Maintaining the contract responsibility system of forest land distribution in China: Evidence from a novel financial compensation scheme in Daxi Village of Anji County, Zhejiang

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ABSTRACT

Guaranteeing households' equal access to land has long been advocated as paramount to implement development policies in Rural China. Given the chronic land scarcity in densely populated regions of China, finding a compromise between private and collective land rights has been important to protect livelihood safety nets and to address poverty issues in rural areas, especially in the initial stages of reform. In this sense, land reallocations in a context of demographic changes within households used to be a common practice in the agricultural sector as a way to protect the equal-per-capita land access right, whereas other mechanisms were required for longer-rotation forest resources. In this case study, we present the Inter-household Forest Compensation Scheme (IFCS), a local innovation in forest management that originated spontaneously in Anji county, in which households that have gained disproportionately large per capita forest resources due to a decrease in household members compensate households that have smaller per capita endowments due to expanding household size. Based on field interviews and household and village socioeconomic data from Daxi village, we analyze the effects of population, economic, household and opinion dynamics on the IFCS as well as its evolution and implementation problems. The compensation, which represents between 7% and 9% of household forest income and less than 2% of current total household income, has allowed for a significant increase in land productivity. The IFCS has proven to be an effective instrument to adjust a system based on a per-capita land allocation without resorting to potentially unsustainable forest reallocations, thus achieving a valuable compromise between equity and efficiency during a major transition from a planned to market economy. Increased population, off-farm income growth and differences in household structure bring new challenges to the policy.

Introduction

The Household Responsibility System (HRS, *jiating lianchan chengbao zeren zhi*), in which individual households were allocated land formerly managed communally, was the first and one of the most fundamental policy reforms that moved China toward a market oriented economy (Nolan, 1983; Lin, 1987). The approach was developed in Anhui province in the late 70s and was adopted and implemented as an official policy in 1981, leading to substantial increases in agricultural productivity (McMillan et al., 1989; Lin, 1992) and a dramatic and quick reduction in official poverty incidence (Fan et al., 2004).

In 1981, building on the success of the HRS in the agricultural sector, the government initiated a similarly fundamental change in forest policy with the 'resolution on issues concerning forest protection and development' (*guanyu baohu senlin, fazhan linye ruogan wenti de jueding*), known as the 'Three Fixes' (*sanding*; Hyde et al., 2003; Han and Xu, 2009). This policy shifted the management responsibility of collective[1] forests from the former "production teams" to households, based on an universal equal-per-capita land access principle, under a Contract Responsibility System (CRS,

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[1] Chinese forest policy distinguishes between State Forests, mainly in the North-East and SouthWest, and the Collective forests of the South. State Forests are administered by the State Forest Bureau, while Collective Forests are kept under communal (before 1978) or family (after 1981) management.

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shengchan chengbao zeren zhi; Liu, 2001; Liu and Edmunds, 2003). Many farmers expected that the policy would not be maintained and so tried to realise short term benefits by cutting and selling timber on their contracted land, resulting in the estimated loss of over one million ha of forest in the southern collective forest region (Song et al., 1997; Liu, 2001; Weyerhaeuser et al., 2006). The government reacted by freezing the implementation of the CRS in a rare case of official hesitation within the overall trend from planned to a market economy. It was resumed in a step-wise and more cautious way in 1987.

Farmers reacted positively to the CRS incentives within a stable forest policy environment in the 90s, leading to gradual forest regeneration (Yin and Newman, 1997; Yin, 2003). A second wave of devolution of Collective Forest management began in this context in Fujian, Jiangxi, Liaoning and Zhejiang in 2003 (Ren and Yang, 2008; Yang, 2008; Zhu and Cheng, 2008) and was extended to the whole of China in 2008 when the State Council issued 'a suggestion concerning the comprehensive promotion of a reform in the collective forest rights' system' (*guanyu quanmian tuijin jiti linquan zhidu gaige de yijian*; He and Zhu, 2009; Liu and Zhao, 2009). The stated aim was to consolidate and to expand the model to clarify forest property and usufruct rights, reduce rural taxes and increase benefits to farmers from timber and other resources, as well as to reform the by then residual 'logging quota' (Xu et al., 2006, 2010; Shen et al., 2009).

Given the chronic land scarcity and rural livelihoods' dependence on agriculture at the time of the reform, a broad-based equal right to access land was proposed and enforced acting as a safety net in rural China. The main aim was to increase farm productivity enough to improve rural living standards and attain the country's food self-sufficiency goal in a manner that did not distort the equal-per-capita based land distribution, which could worsen the condition of tens of millions of rural poor and threaten social stability (Putterman, 1993; Piotrowski, 2009). China's two-tier land system, combining private (household) use rights with collective land ownership, was the chosen option during a period when the country made dramatic steps toward devolving the authority for forest management (Liu and Edmunds, 2003) implementing one of the most egalitarian land distributions in the developing world (World Bank, 2009). This helped prevent the widespread incidence of landless impoverished farmers and the social conflicts associated with a fully private land tenure system (Li and Yao, 2002; Piotrowski, 2009; Jiang and Qian, 2010; Wang et al., 2011).

In the early stages of the reforms, the egalitarian character of these land distribution systems was maintained through periodic reallocations to adjust for changes in family size (Kung and Liu, 1997; Kung, 1995, 2000; Lin, 2009). A much cited developmental dilemma has been the choice between protecting equal-per-capita land access rights through collective reallocation versus protecting long-term private investments through tenure security and consolidation (Putterman, 1993; Kung, 1995; Brandt et al., 2002; Li and Yao, 2002; Kung and Bai, 2011; Wang et al., 2011). The practice of reallocation declined as the central government attempted to increase productivity, to comply with WTO agreements, and to continue a gradual transition to a full market economy (Huang and Rozelle, 2002). In fact, the new Property Law (Fang, 2007) restricts land reallocation to sporadic, small adjustments between individual families, which must be approved by at least 2/3 of the villagers or members of the village committee. Despite these efforts by the Chinese authorities to promote a stable agricultural tenure, farmers' opinions still appear to be widely divided with respect to land reallocations depending on their family changes and their reliance on agricultural production (Piotrowski, 2009; Wang et al., 2011).

Arrangements for forest land under the CRS have a number of points in common with those for agricultural land, notably the two-tier land system. However forest-based redistribution schemes have received much less attention from scholars. Reallocations of forest plots have been less frequent given the long term nature of forestry investment compared with agriculture. Insecure tenure would clearly have discouraged sustainable forest management, as seen with the widespread deforestation during the early stages of CRS. The remarkable heterogeneity in the way national policies have been implemented locally (Liu et al., 1998; Rozelle and Li, 1998; Brandt et al., 2002; Krusekopf, 2002) has resulted in a range of responses to the gradual erosion of the equal land division principle due to demographic changes that have also affected the forest sector.

Indeed, some less-documented economic redistributive experiments have taken place in China's forests. One solution to maintain the equal-per-capita access right to forest land has been a forest shareholding cooperative system (*linye gufen hezuo zhi*) that originated in Luonan county of Shaanxi province and has been used with local adaptations in other regions (e.g. Fujian, Hunan), having also been applied to agricultural land (Gao, 2005; Yu, 2011). Under this system, forest management is done based on tenure contracts issued to households, local forestry agencies or forest enterprises and the profits are distributed through dividend paying shares to all members of the community (Kong and Liu, 2000; Song et al., 1997, 2004). The system, focused mainly in timber production forests or plantations, has provided rural inhabitants with a stable and unified forest management that avoids the fragmentation typical of the CRS (Kang et al., 2010).

In this paper we present an innovative alternative approach that was developed in some villages of Anji County (Zhejiang), part of the Southern Collective Forest Region. In this approach, households that have experienced a decrease in per capita forest resources due to household demographic changes are financially compensated by those who have experienced an increase. We analyze the evolution of the Inter-household Forest Compensation Scheme, its impact in local and household economies, and farmers' attitudes and opinions about the effectiveness and fairness of the system. Our aim is to better understand the interactions that occur between land rights' institutions and forest management, as a contribution to the literature on rural land reform and particularly focused on forest redistributive practices in China.

This compensation scheme revolves around an equal-per-capita land access principle which, being the cornerstone of the HRS and CRS across Rural China, shaped households' forest endowments at the onset of post-78 reforms in our study area. At its core, the scheme brings up the new notion of redistributing a certain amount of the community's forest production, compensating those households with increased family size but without curtailing private forest entrepreneurship. We hypothesize that the combination of a land revenue compensation corresponding to a small fraction of household forest income and stable land rights has played a major role in both protecting the broad-based equal land right without resorting to potentially unsustainable reallocations, thus finding a valuable compromise between equity and efficiency around a proper forest management. This research takes place in a context of rapid change from a planned, forest-based economy to a diversified market economy where off-farm activities, especially tourism, are increasingly becoming the main sources of income (Gutierrez Rodriguez et al., 2009).

Origins of the inter-household forest compensation scheme in Anji

Anji County's collective economy was organized in large communes (Qingshan People's Commune) until the late 1950s, and then replaced by a tripartite 'commune-brigade-team' between 1961 and 1982. During this period, farmers had a very egalitarian rent, while their net income and consumption were constrained as any capital accumulation was claimed by the collective (Jiang et al., 2009). The first reforms were implemented in Anji in 1982 when the HRS was applied to rice land and the workpoints system and the restrictions on individual farmers' income were abolished. In 1984, the allocation of resources to households was extended to forests through the CRS. In Anji this was particularly relevant as it applied to the large-scale and valuable bamboo plantations.

The old commune of Shanhe (presently TianHuangPing Township) classified moso bamboo (*Phyllostachys edulis*, (Carriere) J. Houz) stands by quality within each of the production teams of the former brigades. In the case of Daxi, three types of moso bamboo stands were identified and then distributed to households according to family size. Households within a given production team were each allocated the same amount per capita of each quality of bamboo stand. A similar system was applied to Chinese walnut (*Carya cathayensis*, Sargent) and tea (*Camellia sinensis* (L.) Kuntze). The households received rights of production (*shengchan*), forest management (*jingying*) and economic administration (*guanli*). The former collective (Village Committee) retained the bamboo and other forest land ownership, and maintained a key role in economic planning, capital and seed distribution to families.

This allocation of resources quickly experienced problems as natural changes in household sizes due to births, deaths and relocations of household members changed households' per capita resource availability. Given the importance of forests, and especially of bamboo, in the local economy, and in the context of the egalitarian ideology from the Maoist era (Kung, 1995), some villages in Anji County started a spontaneous process of compensation to mitigate the growing inequalities due to changes in demography. Families with growing per capita bamboo resources agreed to pay a certain amount to those with decreased per capita resources. This system redistributed resource rents to avoid further land reallocation that would have undermined the sustainability of bamboo management. Unlike the early rice land reallocation every 3–5 years,[2] bamboo was to be kept under stable plots for an initial duration of at least 20 years (official document issued by Daxi Village Committee, 1986).

This ad hoc but apparently effective approach attracted the attention of County forestry authorities, who formally proposed an Inter-household Forest Compensation System (IFCS) in the late 80s.[3] The slogan of 'Redistributing money instead of land' (*dong qian bu dong shan*) was commonly sanctioned as 'economic adjustment' (*jingji tiaojie*) or 'profit redistribution' (*lirun zaifenpei*). The official system was initiated with bamboo and later extended to other forest resources. Moreover, this compensation system was coupled with the 'one child' policy; families were not entitled to compensation for children above the legally established limit.

Daxi's Inter-household Forest Compensation Scheme (IFCS)

Daxi, a mountainous village in the south of Anji County, covering a total area of 35,036 mu[4] (2335 ha), is part of the headwaters of the Huang Pu River that ends in Shanghai. The village, part of TianHuangPing Township, has 2099 people in 549 households distributed in 11 hamlets corresponding to the old production team groups (see Fig. 1). Daxi's IFCS follows a 'virtual economy' model. The compensation system is applied at the scale of the hamlet (*xiaozu*), which corresponds to the "Production Team" (*shengchan dui*) under the commune system. The virtual forest revenues from bamboo, hickory and tea resources in the hamlet are estimated based on resource assessments made at the time the CRS was implemented and distributed equally among households in that hamlet, taking into account the number of household members. Households with reduced numbers pay compensation to households with expanding families.

The system works as follows: Inventories were done on the key forest resources within each production team at the time that the CRS was implemented. Bamboo stock estimates were done (measured in *jin* = 0.5 kg) in 1984–85 and tea and hickory were completed later, at the end of the 80s. The total resource was divided by the population of the hamlet to get a per capita base number that was then multiplied by the population of each household to determine the resource allocation or base number (*jishu*) for each household. That is, CRS's allocation of forest resources was based on keeping an equal-per-capita distribution of forest endowments between households within each hamlet.[5]

Each household in a team received the same per capita base-number for hickory and tea in each year, based on an inventory done at the end of the 1980s. Bamboo is more complicated because it has a biannual growth cycle (Chen, 2010). Each household was allocated a per capita base-number for even years (1992, 1994, . . ., 2008) and a different per capita base-number for odd-years (1993, 1995, . . ., 2009). Furthermore, bamboo stocks (base-numbers) were estimated using two ages (2-year old culms and 4-year-old culms).[6]

Each household was originally contracted to manage an equal per-capita portion of the collective resource. For example, in Longchitang hamlet, the former production team 1, the per capita base-number for bamboo was approximately 12,400 *jin* in 1984 (applied to calculate the compensation in even years) and 4650 jin in 1985 (applied in odd years), while they were 9.4 *jin* for hickory nuts and 17.6 *jin* for tea (these latter two used to calculate the compensation in all years). A household of 3 members was allocated a base-number with 37,200 *jin* of bamboo located at even on-year plots and 13,950 jin of bamboo located at odd on-year plots, 28.2 *jin* of hickory nuts and 52.8 *jin* of tea.

Each year, according to the average prices calculated by the Forest Bureau (county-level) and Forest Station (township-level), the Village Committee of Daxi along with the corresponding production team committee establishes the virtual profit per unit of forest resource stock (*danwei lirun*) in *yuan/jin* and this is used to calculate the total value of the hamlet's forest stock and the virtual net profit for each household. Each household will theoretically produce an aggregated, forest-based economic benefit from the total amount of forest resources contracted. This virtual net profit is then compared with a current year household's pro-rated (per capita) share of the total forest stock for the hamlet. If a household's virtual net profit

[2] Wide-village redistributions of agricultural land in Zhejiang were formally abolished in 2006 (Xu et al., 2007), although they have not completely disappeared in China (Wang et al., 2011).

[3] This coincided with a period when the Central Government was encouraging to experiment with different forest devolution systems after the above mentioned severe deforestation that followed the failed first contract responsibility systems in the southern collective forests (Han and Xu, 2009).

[4] Mu is the area unit used in Chinese statistics. 15 mu = 1 ha.

[5] It is worth recalling that hamlets or villages have different land endowments and therefore equal per capita land allocation within them do not imply equal land allocation for the whole county. This difference is magnified when comparing across provinces.

[6] A given plot of Moso bamboo produces new shoot in one year ("on-year") but not in the following year ("off-year"). Plots are managed with 2-year-spaced harvests occurring in "on-years". In "on-years" a plot will have new shoots on the ground ("0" year-old culms), a stratum of 2-year-old culms and a stratum of 4-year-old culms, while older culms (rotation above four years of age) are being harvested. At the landscape scale, some plots are "on-year" in even years and others in odd years. For this reason, bamboo stock was measured over two consecutive years to calculate a per capita base-number for on-year plots in 1984 and another per capita base-number for on-year plots in 1985, in each plot estimating weight in *jin* for both 2-year-old and 4-year-old ages. In Daxi, the majority of moso bamboo "on-year" in even years (per capita base-numbers of 1984 tend to be much higher than those of 1985).

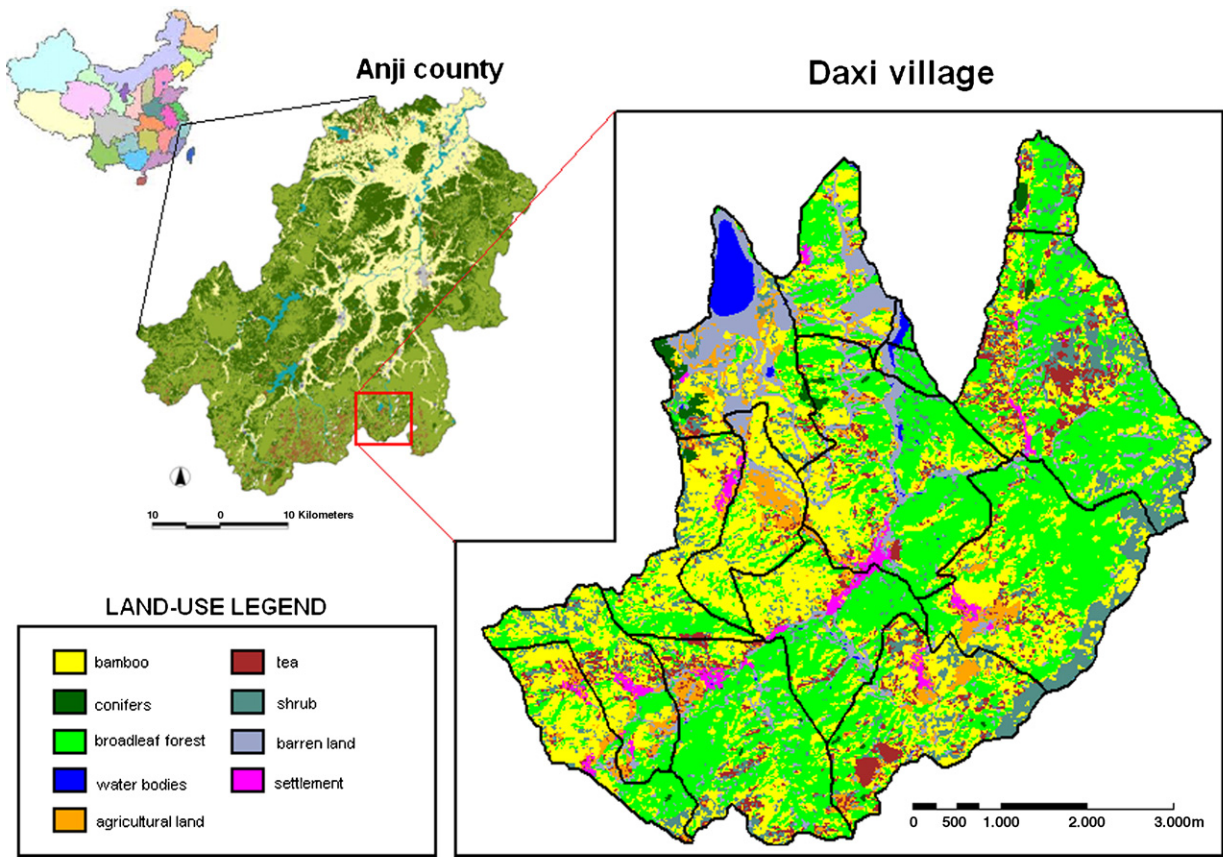

Fig. 1. Map of Daxi Village and its hamlets in Anji County, Zhejiang, East China.

exceeds its per capita share, the household pays the difference as compensation and if its virtual net profit is less than its per capita share, it receives compensation. Fig. 2 represents a schematic diagram of the compensation scheme. As shall be seen in the following section, this compensation in fact represents a small percentage of household forest income.

The virtual profit per unit of stock (*danwei lirun*) is calculated following the expression below. As can be seen, for each forest resource and each year, the formula contains an average estimated market price and a CRS fee multiplied by a contract fee rate. The model therefore contains the distinctive planning tools of a transitional stage from collective to market economy, providing an estimate of the monetary value of the forest resources' stock, that later is to be redistributed among all household members of a given hamlet. The CRS fee can be viewed as a bundle of administration, capital and forest stock costs/inputs, to be paid to the production team, as this organizational unit was responsible for providing households with capital and technology in the former planned economy.

$$p(j,t) = [ep(j,t) - f(j,t)] \times r(j)$$

where

j_{1-3}, moso bamboo; Chinese hickory; tea
t, current year
p, virtual profit per unit of stock (*yuan*/*jin*)
ep, average estimated market price (*yuan*/*jin*)

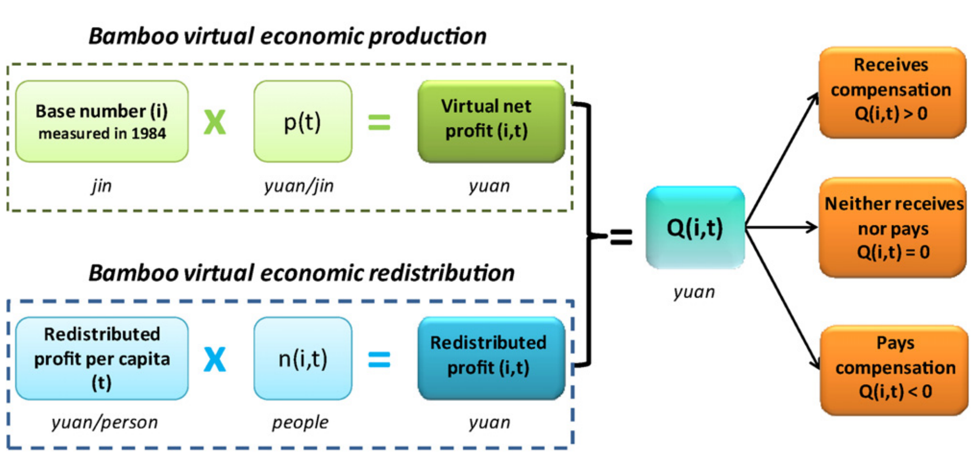

Fig. 2. Diagram of the inter-household forest compensation scheme based on a hamlet-level 'virtual economic' model for a given household (i) in a given year (t).

f, CRS contract fee applied per unit of stock (*yuan*/*jin*).
r, contract fee rate, is a coefficient applied to each contract fee to deduct labor costs. For moso bamboo, $r = 65$ (that means that 35% is considered as non-taxable labor), for hickory and tea is, respectively 0.35 and 0.25 (as they have higher labor costs, 65% and 75%, than moso bamboo).

More formally, this can be presented as:

$$\text{virtual net profit}(i,t) = \sum_{j=1}^{3}[b(i,j)\times p(j,t)]$$

$$= n(i, CRS)\times\sum_{j=1}^{3}[bpc(j)\times p(j,t)]$$

$$\text{redistributed profit}(i,t) = n(i,t)\times\sum_{j=1}^{3}[rppc(j,t)]$$

$$= n(i,t)\times\frac{N(CRS)}{N(t)}\times\sum_{j=1}^{3}[bpc(j)\times p(j,t)]$$

$$Q(i,t) = \text{redistributed profit}(i,t) - \text{virtual net profit}(i,t)$$

$$= \left[\left(n(i,t)\times\frac{N(CRS)}{N(t)}\right) - n(i, CRS)\right]\times\sum_{j=1}^{3}[bpc(j)\times p(j,t)]$$

$Q(i,t) > 0$, household (i) receives $Q(i,t)$ in yuan
$Q(i,t) < 0$, household (i) pays $Q(i,t)$ in yuan
$Q(i,t) = 0$, household (i) neither pays nor receives

where

i, an individual household
t, current year
b, base number (*jin*). In the case of bamboo, there is a base-number in even-years and another in odd-years.
bpc, base-number per capita (*jin*/person). In the case of bamboo, there is a base-number per capita in even-years and another in odd-years.
j_{1-3}, moso bamboo; Chinese hickory; tea
p, virtual profit per unit of stock (*yuan*/*jin*)
rppc, redistributed profit per capita, which equals the sum of virtual net profits across all households within a team divided by the current population of the team in year *t*.
$n(i, \text{CRS})$, number of household members at the moment of the CRS forest resource's allocation
$n(i,t)$, number of household members at the current year
$N(CRS)$, Hamlet population at the moment of the CRS forest resource's allocation
$N(t)$, Hamlet population at the current year

For a given hamlet having "*x*" households the sum $\Sigma_{i=1}^{x} Q(i,t)$ equals zero, since the sum of the amount paid by paying households is the same as that distributed among receiving households. If the total hamlet's population remains constant $[N(CRS)/N(t) = 1]$, households that have increased in size (relative to the CRS allocation) show a positive balance (receive compensation); those with fewer members have a negative balance and pay compensation; households with no change of numbers do not pay or receive. However, if the total population increases $[N(CRS)/N(t) < 1]$, as in the case of all 11 hamlets in Daxi, there is an imbalance that has to be managed by spreading compensation payments more thinly, with resulting stresses to the original scheme, as we shall see later.

It is important to note that the base-number has not been re-estimated since the resource inventories were done in the mid-to-late 1980s because detailed forest stock inventories have not been updated. Nonetheless, in 1999 Tianhuangping Forest Station decided to reduce each household's bamboo base-number by half.[7] The purpose of this change was to better represent actual bamboo *production* in each hamlet, instead of using the valuation of the *stock* that was applied at the beginning. In fact, the new incentives and opportunities offered by the CRS resulted in improved productivity through improved resource management (Ruiz Pérez et al., 1996).

Methods

Key informant interviews were conducted with leaders of Anji County Forest Bureau, TianHuangPing Township Forest Station and Daxi Village Committee and Forest managers. This provided a comprehensive understanding of the compensation scheme. We reviewed the village archives, with detailed data on the implementation of the scheme since its beginning in 1992. Time series village statistics were also obtained, giving a detailed record of population and income by different economic activities.

To assess farmers' opinions on the functioning, appropriateness and future options of the compensation scheme, we used a structured questionnaire administered to a stratified random sample of 92 households distributed among the 11 village groups. Sampling density was 14% of total households. A similar number of paying and receiving families was selected within each of the groups. The questionnaire also elicited household demographic and socio-economic information, which allowed us to explore relationships between compensation and a range of household characteristics.

The questionnaires were codified and the data analyzed using descriptive statistics, parametric and non-parametric tests and regression models using SPSS 18.0.

Results

Population changes and IFCS's economic redistribution

Since the original forest land distribution allocated land according to household size, demographic changes constitute one of the key drivers for the implementation, degree of satisfaction and potential policy adjustments. Population grew slowly but steadily from 1819 inhabitants in 1986 to 2099 in 2009, punctuated by a small decrease in 1996–1997 after the completion of a large hydro-electric dam. The Contract Responsibility System for forest land started in Daxi in 1986. It took six years to realise that demographic change was undermining the equal per capita distribution originally envisaged and to establish a compensation system. As explained above, this was done using a virtual profit per unit of stock (*danwei lirun*) for each of the three types of forest products (bamboo culms, tea and hickory).

For a hypothetical household composed of only one member with no change in size since the implementation of the CRS, population growth in the hamlet would result in a reduced-profit index (*renkou zengzhang lirun cha*), represented by the formula:

$$I(t) = \left(\frac{N(CRS)}{N(t)} - 1\right)\times\sum_{j=1}^{3}[bpc(j)\times p(j,t)]$$

where

$I(t)$ is the difference in profit index corrected by population growth, $N(CRS)$

[7] Following this halving of the bamboo base-number, the virtual profit per unit of stock was doubled to offset the effect on the compensations paid and received between households. As a result, the reduction of the base-number did not have any immediate consequence over the IFCS's practical implementation, although made the system more realistic.

$N(t)$ are the hamlet population in the year of the CRS allocation and year t respectively
$bpc(j)$ is the per-capita base-number for forest resource j, and $p(j, t)$ is the virtual profit per unit of stock in year t for each of the three forest products j.

This index allows us to quantify the amount of money that this hypothetical household will have to pay in a context of a growing population. This means that even a household that does not change in size will have to pay compensation due to the increasing pool of people, and vice versa (if there is a trend of diminishing population, which has not been the case in Daxi, then this household will receive compensation). This is illustrated in Fig. 3.

The general increase in population means that households that grew in size received less compensation and households that shrunk had to pay more than they would have with an overall stable population ($N(t) = N(CRS)$). Even households that did not experience a change in size have to pay some. While the balance 'total paid-total received' is still zero, this system means that the cost of an increasing population is being shared by all households, as can be seen in Fig. 4 for a specific group and year.

Economic considerations of the compensation system

If the compensation system was based on actual forest income, it might have acted as a disincentive to forest investment and improved management. In practice, the virtual net profit on which the compensation system relies substantially underestimates the actual profit. For example, our detailed data based on the farmers' questionnaire show that in 2004 the virtual average household bamboo net profit used as a baseline for the compensation was 3584 yuan whereas actual net profit was 7696 yuan, 115% above the baseline calculations. Two thirds of this increase corresponds to differences between real and estimated prices and the remaining third is due to differences between real and estimated land productivity.

Large scale economic changes have also affected the compensation system. Since the beginning of the IFCS in 1992–2009, per capita income in real terms (constant yuan corrected to account for inflation) increased 7.5 times, accelerated in the last decade by the arrival of new economic opportunities in tourism and other off-farm activities that brought a major economic shift. In 1986 agriculture represented 22.1% of total income, forestry was 72.7% and the remaining 5.2% came from off-farm activities. By 2008 agricultural income had shrunk to 8.6%, forestry represented 33.2% and off-farm (mainly tourism related) was 58.2% (Daxi Statistical Yearbook, several years).

Between 1992–1993 and 2008–2009, real per capita compensation increased 2.1 times. This reflects the effect of the estimated virtual profit improvement factor that assumes a gradual growth in profit. This growth has been due to the increase of average estimated market prices, and is equivalent to the actual increase in real total forest rent over the same period. Consequently, forest land compensation has remained within an average range of 7–9% of total household forest income (estimated based on a two-year moving average to correct fluctuations due to bamboo on and off years). However, per capita income in real terms increased 7.5 times, so the relative share of the compensation scheme in total income has decreased from 5.8% in 1992 – when forestry was the main economic activity – to 1.5% in 2009, as can be seen in Fig. 5.

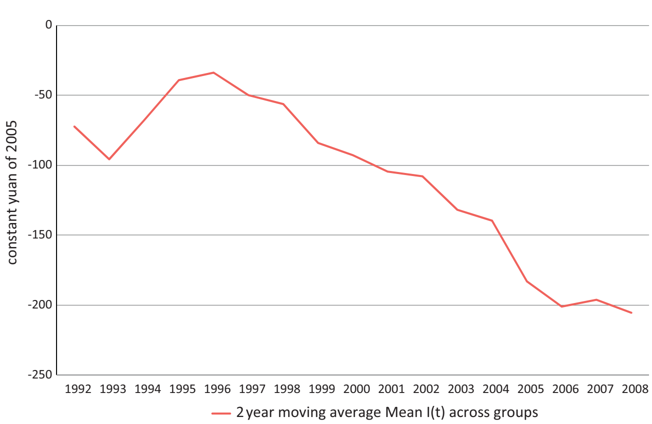

Fig. 3. Two-year moving average of household profit index $I(t)$ for Daxi Village.

Income structure of paying and receiving farmers

Whether a household receives or pays compensation is directly related to demographic changes and is independent of actual household income. In fact, average per capita income of both groups of farmers was very similar, averaging 8185 yuan for receiving families and 8301 yuan for paying farmers (ANOVA $p = 0.905$). However, there are two main differences between the groups, related to family and income structure (see Table 1).

Households that receive compensation are younger and have larger family size than those paying compensation. This is to be expected, since families having to compensate are those who tend to be at the end of their family cycle, with older adults whose children have left home. Younger families half-way through their family cycle tend to have experienced a family increase compared with their situation in 1986 (some were actually established after that date), hence being candidates to receive compensation. Per capita total income for households grouped in three age categories tends to decrease with age, whereas per capita forest income tends to increase with age. These differences are not statistically significant (ANOVA $p = 0.98$ for per capita total income; ANOVA $p = 0.26$ for per capita forest income). However, forests had a statistically significant higher percent contribution to household income in older households ($F = 2.801$; $p = 0.07$).

The contribution of agriculture and of other sources to total family income is similar between groups (Table 1). However, forest income is relatively more important for paying families, whereas income from tourism (the most recent, dynamic and fast expanding activity) is more relevant for receiving families.

Farmers' attitudes towards the compensation system

A majority (89.0%) of interviewed farmers think that the idea of a compensation scheme is appropriate and support keeping it (73.5%). They consider that the degree of enforcement is high (87.9%) and 75.9% think that the scheme has an average to high fairness. Given the diminishing relative weight of the compensation in total income, 54.4% of farmers consider that its effect in their household economy is not important. There are not significant differences in these opinions between paying and receiving farmers (see Table 2).

Unsurprisingly, opinions about the appropriate amount of compensation paid differ significantly ($X^2 = 41.663$, $p < 0.001$); most paying families consider the current amount to be "enough" (69.0%) whereas the majority of receiving families (68.9%) think it is

Table 1
Average age, size and income structure of receiving and paying households.

	Receiving	Paying	F	p
Age (years)	44.2	52.8	17.38	<0.001
Family size	3.9	3.4	4.137	0.04
% Forest	49.2	59.1	4.157	0.04
% Agriculture	7.0	8.9	0.798	0.37
% Tourism	22.1	12.4	3.844	0.05
% Other	21.7	19.5	0.205	0.65

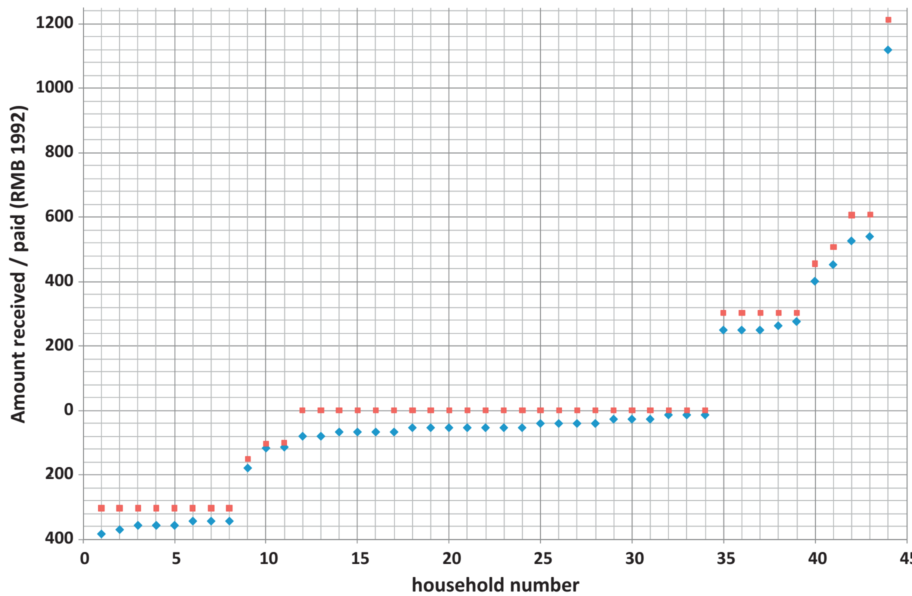

Fig. 4. Comparison between actual growing population conditions (blue diamonds) and hypothetical stable population conditions (red squares) in group 1 in 1992 (composed of 44 households). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

"insufficient". Paying and receiving families also have different (at $p < 0.10$) perceptions of the reality (as opposed to the ideal) of the compensation system ($X^2 = 4.790$, $p = 0.091$), the former showing a substantial approval of the real operation of the compensation system (67.5%) whereas in the latter this opinion is divided between those who believe it is good (44.7%) and those who think it is bad (42.6%).

Discussion and conclusion

Daxi's forest compensation system originated spontaneously as a bottom-up approach that tried to maintain the equal-per-capita distribution of land resources and has now been in operation for 20 years. During this period, it has fulfilled its objectives, buffering demographic shifts that otherwise might have undermined the original egalitarian land distribution and acting as a land-based redistributive mechanism in a transition towards a market economy. In the context of an initially autarchic system based on primary sector activities and with strong population pressure on natural resources, the original compensation proposal was widely approved and is still supported. The fact that the scheme is managed completely within village-level institutions helped achieve its high initial acceptance. Most of the farmers interviewed consider it to be properly implemented and want it maintained. This mechanism seems to be an effective solution to the problems of land reallocation (Wu and Li, 2007; Wang et al., 2011) and an alternative to the forest shareholding cooperative system (Kang et al., 2010) found in other rural areas on China.

As a new institution, the Inter-household Forest Compensation Scheme achieved and maintained a broad consensus on forest resource allocation, while stimulating individual entrepreneurship and avoiding land conflicts in Daxi. This scheme can be considered a Pareto improvement over an equal per capita land allocation system, as it satisfies both the subsistence constraint of China's rural economy, yet it is institutionally flexible enough to make room for allocative efficiency (see Lin Chunjin et al., 1991 cited by Kung, 1995 (p. 92) who apply this argument in relation to redistribution of agricultural land).

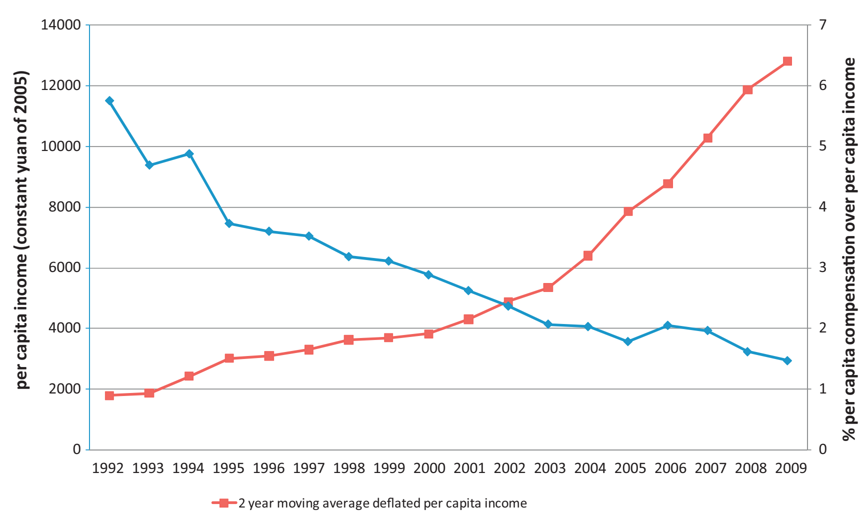

Fig. 5. Evolution of per capita income in Daxi village, and percentage of the compensation over total income.

Table 2
Comparison of perceptions by receiving and paying households.

	All	Receive	Pay	X^2	*p*-Value
Continue					
Yes	73.5	72.7	74.4	0.028	0.867
No	26.5	27.3	25.6		
Amount					
Insufficient	37.9	68.9	4.8	41.663	0.000
Enough	49.5	31.1	69.0		
Excessive	12.6	0.0	26.2		
Fairness					
Low	24.1	31.1	16.7	2.678	0.262
Average	34.5	33.3	35.7		
High	41.4	35.6	47.6		
Weight					
Non-important	54.4	54.2	54.8	0.410	0.815
Some importance	12.2	10.4	14.2		
Important	33.2	35.4	31.0		
Enforcement					
Low	9.9	10.6	9.1	2.014	0.365
Average	2.2	4.3	0.0		
High	87.9	85.1	90.9		
Idea					
Not good	6.6	6.2	7.0	0.839	0.657
Average	4.4	6.3	2.3		
Good	89.0	87.5	90.7		
Reality					
Not good	33.3	42.6	22.5	4.790	0.091
Average	11.5	12.7	10.0		
Good	55.2	44.7	67.5		

To date, the IFCS has succeeded in maintaining social cohesion around forest management and has facilitated an increase both in bamboo productivity and a net recovery of semi-natural forest area (Tianhuangping Forest Station), avoiding some of the forest policy related problems that have arisen in other regions of China (Rozelle et al., 2003). This has been achieved by modulating the forest compensation scheme to an average range between 7% and 9% of forest household income throughout the study period, enough to maintain the original egalitarian legitimacy while allowing for individual household incentives. In fact, forest real income has nearly doubled during this period, providing empirical support to the IFCS's forest management economic efficiency.

The IFCS adapted well and gave stability to the decentralized CRS management of "forest cash crops", such as bamboo and tea, which have shorter rotation cycles than timber, the main product managed under the shareholding system. Avoiding forest land redistribution while partly maintaining an egalitarian allocation of forest benefits by 'Redistributing money instead of land' (*dong qian bu dong shan*) has played a central role in both IFCS and shareholding options. However, higher investment costs, lower yields per unit of land and longer rotation cycles typical of timber favoured the bigger operational scale of the cooperative shareholding system. While this brings benefits associated with economy of scale and rationalisation of forest management in larger plots, it has also caused some unexpected problems such as increased conflicts and transaction costs of maintaining the shareholding system (Huang et al., 2008). In comparison to the shareholding system, the IFCS seems to have found a compromise between equity (especially for the farm-based component of the household economy) and efficiency (the need to improve productivity), although it is more relevant for short-rotation cash crops like bamboo, tea and hickory than to timber.

Notwithstanding this success, Daxi, like many other rural areas of China, has experienced demographic and economic changes that present two main challenges to the IFCS compensation scheme. On one hand, the increase in population means that more people expect to share the benefits from a fixed pool of resources: receiving households get less and paying families must pay more. This has contributed to the most significant disagreement between both groups of farmers, related to the amount of the compensation, considered insufficient by receiving and enough by paying farmers, which has recently led to occasional conflicts between families (Yao Xianguo, hamlet leader, personal communication).

On the other hand, strong economic growth based on the tertiary sector, similar to what is happening in other rural regions of China and elsewhere (Haggblade et al., 2002; Otsuka and Yamano, 2006; Reardon et al., 2007), has decreased the relative contribution of forestry to total income. Per capita forest income has increased in real terms by 1.8 times between 1992 and 2009. However, total per capita income has increased 7.5 times during the same period, dwarfing the direct income contribution of forests and displacing forestry from its role as the village's economic foundation. The forest compensation scheme, pegged to forest production, has become relatively less important (a fact equally acknowledged by receiving and paying families), and has consequently lost its former income-equalizing relevance. The boom in tourism has caused a major shift in the local political economy, giving way to new non-farm-induced disparities (tourism income Gini = 0.76) that were not anticipated when the IFCS was designed. This has reduced the effectiveness of its original income redistribution role since it only applies to forest resources (whose income has a lower Gini = 0.35). In fact, while the IFCS has tried to adjust an original equal per capita land distribution principle, overall economic development has resulted in a significant increase in total income disparities mainly due to non-forest activities (Gutierrez Rodriguez et al., 2011).

Moreover, although there is no statistically significant difference in total per capita income between paying and receiving households, differences in age and income structure could affect the IFCS equalizing role. That is, older households that tend to be more dependent on forests for their income and tend to be paying compensation might paradoxically find themselves in a situation of relative disadvantage with regards the more dynamic, younger families who have entered more proactively into the tertiary, particularly tourist, sector (Gutierrez Rodriguez et al., 2011). This may lead to changing perceptions about the effectiveness and fairness of the scheme and to possible conflicts between groups in spite of the fact that compensation payments currently represent on average only 1.5% of total household income. There was already some indication of this detected in recent discussions with key informants like village and county forest leaders.

It is increasingly difficult to maintain a system that has fixed transaction costs but declining benefits and that may strain peasants' relations in a context of increasing income inequalities created by a fast development and new income opportunities. In fact, in the last couple of years some hamlets have discontinued the scheme, as rising labor costs (due to the expansion of tourism) reduce the profits from forestry, making some contributing households reluctant to pay the compensation. Our last record from 2010 shows that only 6 out of 11 groups implemented it, involving 353 families out of a total of 549 living in Daxi.

In the light of these events, Daxi village legal representatives are discussing the future of the IFCS, and how to enforce the delimitation of clear forest rights included in the recent Forest Tenure Reform (*linquan gaige*) in China. On their behalf, Anji Forest Bureau's authorities are encouraging the local government of Daxi to implement tenure policies that bring social stability, and propose the active cooperation among farmers, forest stations and forest private companies, in order to overcome some of the problems of the implementation of the CRS in Southern China (Yang et al., 2010b).

This may signal the end of the Inter-household Forest Compensation Scheme. In line with other pragmatic approaches to policy design and implementation in China (Fan, 2001), after the policy is adopted and achieves its purpose, changes may be induced either by individuals or institutions. At some point the old policy is no longer viable, stimulating the development of a new policy and/or explicit cancellation of the old one. From this perspective, the IFCS could be understood as a stepping-stone or a strategy to buy-time in a major transition from a planned to a market economy, following the ‘Crossing the river while feeling the rocks’ principle applied to land and general economic reform in China (Nolan, 1994; Bruce and Li, 2009).

In any case, the new policies will have to take into account the changing role of Daxi's forests. They have evolved from being the main source of direct economic income to a landscape with high scenic value that attracts tourists and supports an emerging new economic foundation. Whatever course the new forest tenure policies take, they will need to guarantee a proper management that takes into account these new forest values. In this sense, Daxi may be an excellent laboratory to learn from the fascinating and innovative changes taking place in China's forest sector (Hyde et al., 2003; Yang et al., 2010a).

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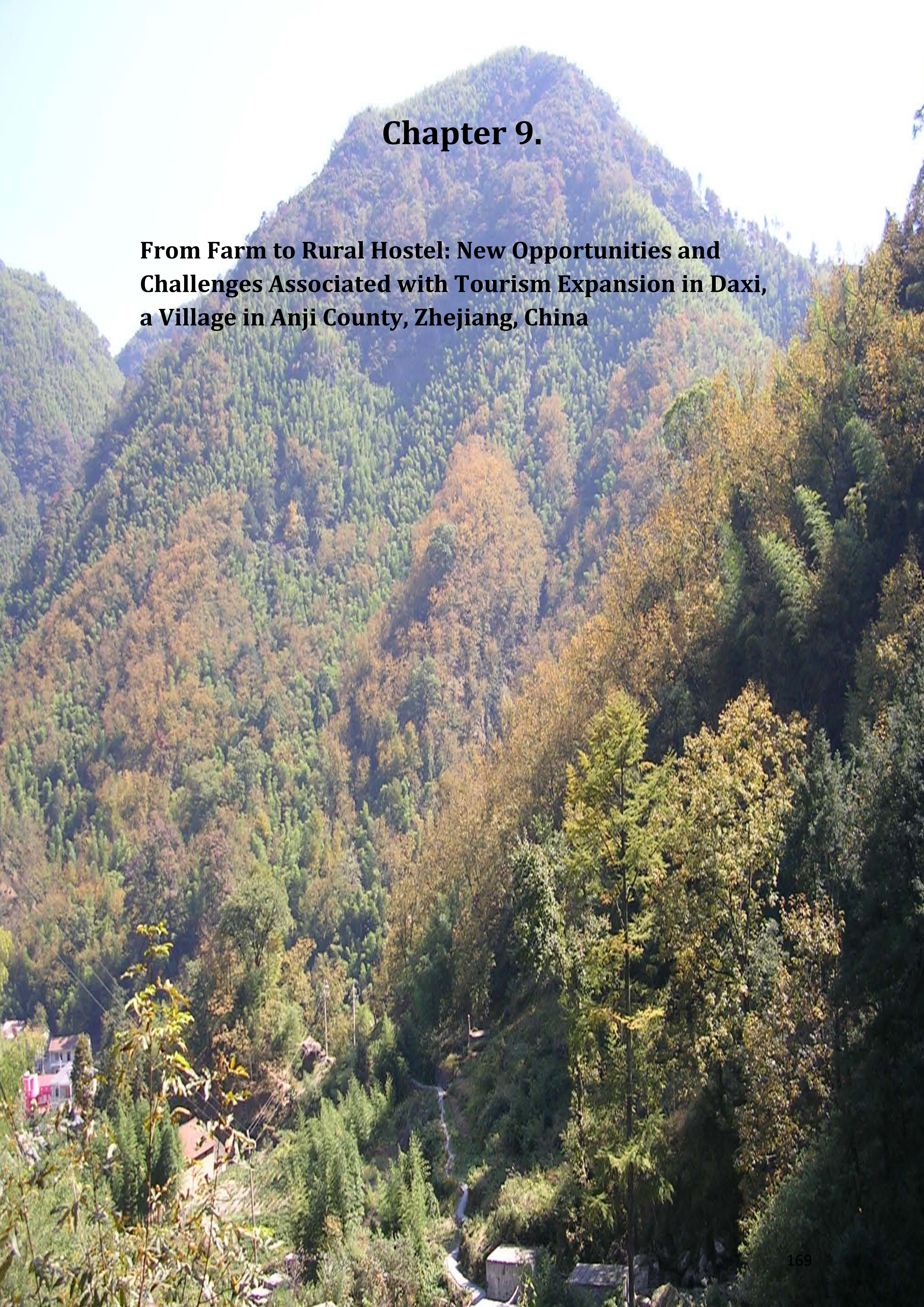
Chapter 9.

From Farm to Rural Hostel: New Opportunities and Challenges Associated with Tourism Expansion in Daxi, a Village in Anji County, Zhejiang, China



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Article

From Farm to Rural Hostel: New Opportunities and Challenges Associated with Tourism Expansion in Daxi, a Village in Anji County, Zhejiang, China

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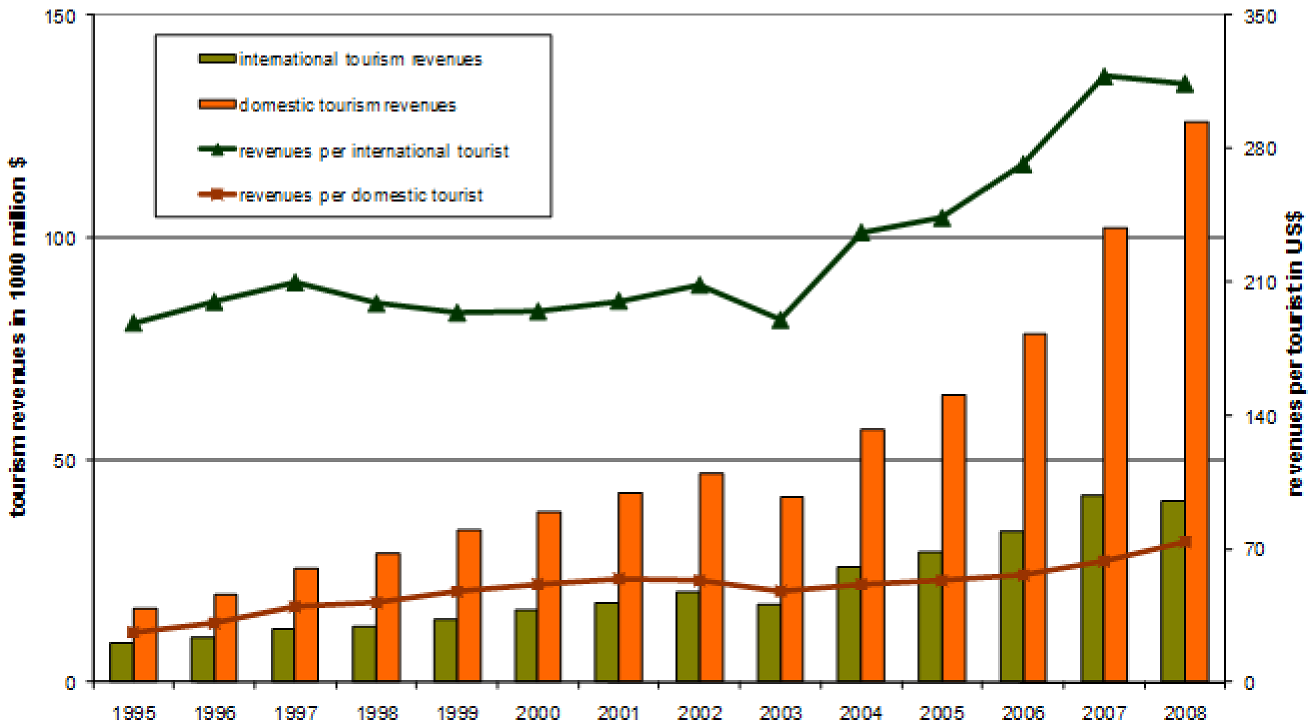
Abstract: China has become one of the leading international tourism destinations, ranking third at a world level. A fast expanding domestic tourism offers new development opportunities to rural areas. Our results from Daxi Village of Anji County, a popular tourist destination in East China, show that farmers are seizing this opportunity that currently represents 27% of total household income. The better educated young generation is benefitting most, being particularly relevant for women that can develop off-farm activities around the family hostels (*nongjiale*) and tourist shops. Visitor's general satisfaction is high, although there is some concern for environmental quality and overcrowding due to the very high number of tourists that come to the village. Our model suggests that tourism will keep growing at least for another decade, which will strain the area, posing potentially severe environmental problems and challenging the long term sustainability of the tourism development model.

Keywords: tourism; *nongjiale*; rural development; off-farm income; China

1. Introduction

China has become one of the world's leading international tourism destinations [1], having increased from 20 million tourists in 1995 to 57 million in 2010, ranking third after France, and USA [2]. In parallel to opening the door to foreign tourism [3], domestic tourism has experienced an even more spectacular increase, from 629 million person-day in 1995 to 1712 million in 2008 [4], underscoring the transformation of the country in the last two decades. Total tourism revenues in 2008 amounted to US$ 166.7 billion, representing 3.9% of China's GDP. Although revenues per tourist are higher for international tourists (US$ 314) when compared with domestic tourists (US$ 73), given the much larger size of the later, domestic tourism represents three quarters of the total tourism revenues (see Figure 1).

Figure 1. Evolution of international and domestic tourism revenues in China 1995–2008 in current US$ (Adapted from [4]).



It is therefore not surprising that domestic tourism has been used as part of a strategy of poverty reduction and development in rural China. This has allowed for an increase in per capita income, absorbing excess farm labor and diversifying the sources of income [5]. The shift from a farm-based to an off-farm rural economy has been common to many developing countries [6,7], with a particular relevance of the tertiary sector in the Chinese case. The opening up of rural family hostels known as *nongjiale* under a somewhat idealized 'visit the happy farmer's family' campaigns has allowed many Chinese rural people a reduction in hard farm work and improved living conditions [8].

Green tourism aimed at visiting outstanding natural areas has increased in popularity, especially after 1999, which was declared a 'Year of Ecotourism' by the Chinese Tourism State Administration [9,10]. The importance of planning and scientific research in the development of ecotourism in China has been stressed by different authors [11,12], having detected some shortcomings in the recent establishment of natural parks throughout the country. It is in this context that a set of management indicators has been proposed [13] in order to control the impacts associated to ecotourism within natural reserves. At the same time, the increase in protected areas from 926 (7.6% of the national territory) to 2,531 (15.2% of the national territory) since 2000 [4] has propelled the development of an ecotourism (*shengtai lüyou*) with its own characteristics [14].

Rooted in Chinese cultural traditions, the definition of *shengtai lüyou* differs from the Western concept of ecotourism [15], and includes human health in relation to nature being transformed by people [10]. This 'ecotourism' has brought many urban residents to rural areas, offering new development opportunities [16].

Advocates of ecotourism have presented it as a solution that brings a symbiotic relationship between conservation and development, proposing a non-consumptive use of the natural capital, and also as the least worst option for the environment, though there is room for criticism given that their vision has sometimes overlooked the interests and rights of the poor [17]. Social capital has been analyzed in several case studies in which it was found to play a determinant role both in the positive and negative outcomes of ecotourism development, in a context of expanding opportunities in remote rural areas of Africa and Latin America [18-20].

In the case of China, scholars have focused their attention on the effects of tourism on local rural populations from two complementary perspectives: participating in the policy and decision-making process, and sharing of economic benefits. Thus, Xu *et al.* [21] emphasize the importance of local participation in order to facilitate conflict resolution in protected areas. He *et al.* [22] stress the need to combine local participation in decision making with sharing of economic benefits derived from tourism; farmers should obtain tourism-based revenues since they are the ones who have to put up with the costs of environmental conservation. Ying and Zhou [23] show how a collective perspective may bring benefits to the whole rural community provided that local authorities maintain and defend collective competencies and interests against the intervention of powerful external investors from rich urban areas.

The early off-farm activities were basically led by men as part of the household nonagricultural small business (*geti hu*) within a general trend where women would keep working on agriculture while men would specialize on off-farm opportunities [24]. Further rural economic development in the late 1990s allowed for a gradual incorporation of women in off-farm activities through out-migration and involvement in family-based enterprises [25]. As women gain access to education, they can participate in better paid off-farm activities [26]. In the Chinese rural context, this has allowed many women to take an active role in the establishment and management of small hostels, restaurants, shops and other tourist-oriented opportunities. Nevertheless, women have frequently taken inferior jobs while still being responsible for their usual housewife activities, thereby increasing their work burden [27].

A similar situation occurs in relation to the opportunities offered by tourism to minority groups. In a study on ethnic areas in southern China, Howard [28] found that in the early stages of tourism development local minorities can benefit from small business in the informal sector and that most economic gains were kept within the community, whereas important economic leakages to outside investors appear as the formal sector gains importance.

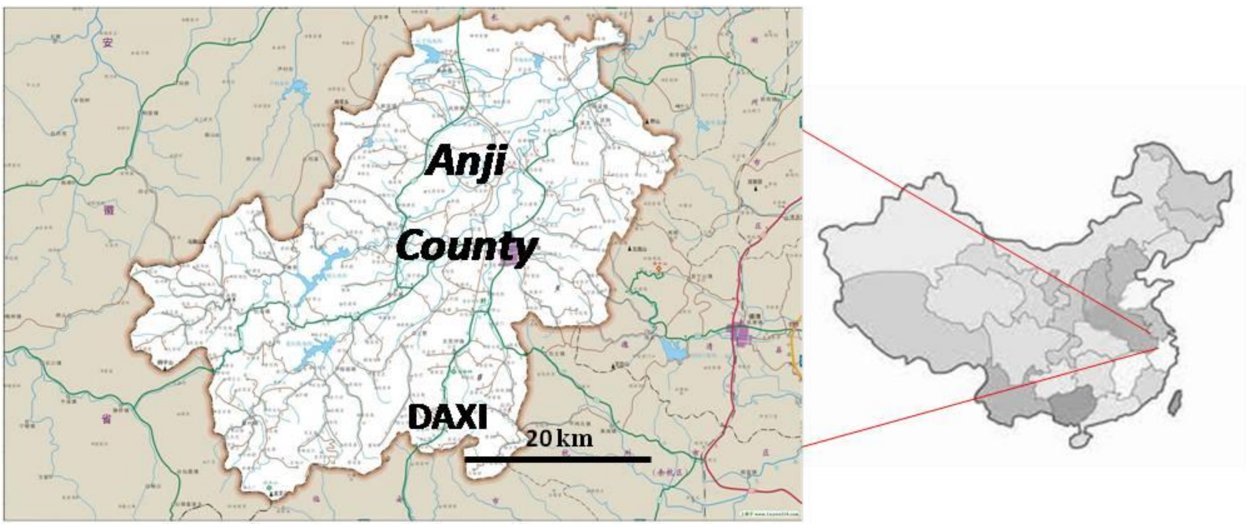
The increasing presence of tourism in rural areas has altered both the social and the ecological systems. Recent research on visitors' perception of the roles, functions, policies and uses of forest parks in China, show that they ascribe a high priority to protecting the ecological integrity of the area, supporting a limit on the number of tourists [29]. Simultaneously, in the context of China, cultural values such as Human-Nature interactions and collectivism have been found to have an influence on consumers' attitudes towards green purchases [30]. These trends present in the Chinese society suggest a potential demand for better planning of tourism activities in order to protect natural resources and environmental values, what could lead to the development of a more encompassing 'ecotourism'.

The paper analyses the evolution and effects of tourism in Daxi village of Anji County (Zhejiang Province), an area much visited by tourists coming from the urban triangle of Shanghai, Hangzhou and Nanjing (*changsanjiaoqu*). The aim is to study the trend of rural tourism, its role as a new driver of peasants' economy, the gender differences that it involves, and the attitudes of visitors. Building on the anthropological view of tourism developed by Burns [31] and Stronza [32], it takes an integrated perspective that combines the views of local residents and visiting tourists. It also analyses the limits and potential problems of this huge tourism expansion.

2. Rural Tourism in Anji County

Anji County lies in the northwest of Zhejiang Province, Eastern China (see Figure 2). Forest resources—in particular bamboo—and associated industries have traditionally played a significant role in Anji's economy [33]. At the turn of the century, the county embarked upon a 'green policy' [34] aimed at developing the 'three ecologies': Economy (*shengtai jingji qiangxian*), culture (*shengtai wenhua daxian*), and human habitat (*shengtai renju mingxian*). Consequently, it has obtained the label of 'National Ecological Model County' (*guojia shengtai shifanqu*) given by the State Environment Administration.

Figure 2. Map of Anji County in Zhejiang Province, East China.



The following has contributed to reinforce a rural tourism offer that rests upon four main pillars [35]: (i) The scenic beauty of bamboo forests in a county considered one of the 10 bamboo cradles (*zhongguo zhuxiang*) of China; (ii) the Longwang Mountain, one source of the HuangPu river the mouth of which is situated in Shanghai; (iii) the Tianhuangping pumped-storage reversible hydropower station (*jiangnan tianchi*), one of the largest of its kind in Asia; (iv) and the existence of a prosperous rural culture (*changshuo wenhua*) rooted around these natural values.

The 'ecological county' (*shengtai li xian*) label is bringing an increasing number of tourists attracted by the county's environmental quality, mild summer temperatures and local products. The area of Tianhuangping township offers a variety of tourist attractions, including the above mentioned hydropower station, extensive views of rolling bamboo forests known as 'Bamboo Sea' (*zhongguo dazhuhai*), the Chinese Museum of Bamboo (*zhongguo zhuboyuan*), a so-called 'red tourism' (*hongse lüyou*) around monuments associated with the Chinese Communist Party, the natural area of *tianxia yinkeng* (literally 'world silver pit') where popular films are made, and many farmers-based hostels (*nongjiale*) that facilitate a specific rural tourism (*xiangcun lüyou*).

Our fieldwork took place in Daxi, a provincial level ecological village with comparatively good living standards (*shengji shengtai cun, xiaokang shifan cun*) to the south of the Tianhuangping township. Daxi is a rough landscape ranging from 250 to 1,169 m.a.s.l. with a total area of 23.35 km^2 and a population of 2069 people (2006 census) distributed in 11 hamlets (*zu*) that correspond to the old communes. Eighty-two percent of Daxi is covered by a subtropical evergreen broadleaf forest that has been greatly transformed since old times to incorporate large areas of moso bamboo (*Phyllostachys edulis*, ((Carriere) J. Houz) plantations. The climate is a low mountain monsoon with an average yearly temperature of 15 ℃ and 1,567 mm annual rainfall.

The pre-tourist experience in Daxi started in the early 1990s with the construction of the Tianhuangping dam as individual farmers opened canteens to cater for immigrant workers. In 1998 a county initiative to develop tourism in Daxi and Wuhe led to the opening of the first 10 *nongjiale*. Although farmers were originally skeptical, the initiative was successful, and two years later it was being exported to other neighboring villages [36].

Early tourism in Daxi was attracted by the anthropic landscape of the hydropower plant and the view of the bamboo plantations. In 2000 the first natural reserve was opened, known as 'The Hidden Dragon's one hundred waterfalls' (*canglongbaipu*), followed two years later by the 'The Nine Dragons' Gorge' (*jiulongxia*), both of them having mature and secondary high growth natural forests. Bamboo plantations and natural forests combine in a landscape that constitutes the base of a number of tourism activities that have promoted development and diversification of tertiary sector opportunities. The physical activities offered to visitors are guided tours to each of the two natural reserves, and a recently introduced rafting experience.

Tourism is a seasonal activity that is concentrated in spring and summer, during the weekends, and on the major national public holidays of Labor's Day (1–7 May) and National Day (1–7 October). The recent opening of a ski resort near the upper part of the Tianhuangping hydropower complex aims at maintaining a tourist presence in winter.

3. Methods

The work is based on four main data sources. Meetings with tourism administration officers at county, township and village levels were held in order to identify policies, trends, constraints and opportunities through semi-structured, key informant interviews. During this phase, we also had access to bibliographical sources and local level statistics that were made fully available to our team.

A questionnaire requesting information about family structure, education, tourism-related investment and activities with recall information for 1990 and the current year (2007) was administered to 68 randomly selected families taken from Daxi village census. The sample represents 10% of the total population of Daxi village and was distributed proportionally among the 11 settlements according to the number of families with a minimum of five and a maximum of eight per settlement.

Finally, another questionnaire, aimed at recording tourist-related information, was administered to a stratified sample of 243 visitors distributed among the four main tourist facilities of Daxi. The questionnaire included socio-economic information (provenance, age, gender. education, profession, income level), mode of transportation, time spent, number of visits, and general information about their knowledge of the area, degree of satisfaction, problems encountered and opinion about the ecological sustainability of Daxi.

The information from both questionnaires was codified in Excel and data were analyzed using SPSS 17.0.

4. Results and Discussion

4.1. General Trends of Tourism in Anji

Anji County in general, and Daxi village in particular, have experienced an explosive growth of tourist visits in the last 15 years. At a county level, the number of tourists grew from 150,000 in 1996 to 5,440,000 in 2009; tourism-based income increased from 15 million constant 1996 CNY (US$ 1.80 million) in 1996 to 1,942 million constant CNY (US$ 233.7 million) in 2009 [33,34]. The expenditure per tourist in constant 1996 CNY increased 3.6 times, underscoring the growing importance of affluent urban visitors from the main metropolis of the region [35,36].

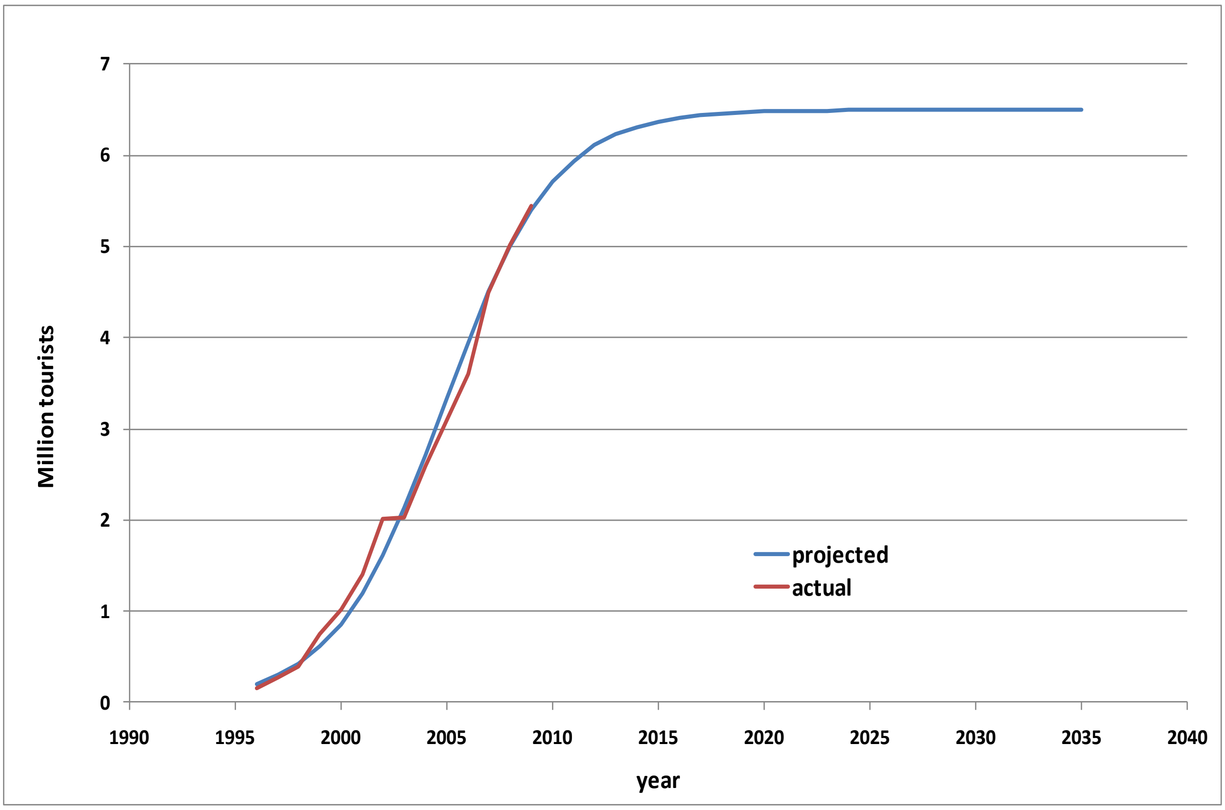
A fast increase in number of tourists coupled with higher per capita expenditures has meant a growing role of tourism in the county's economy. In 1996, tourism-based income contributed 0.4% of the total county GDP; this figure had increased to 4.4% in 2001, and it represented 13.8% of Anji's GDP in 2009 [37]. In fact, tourism has been one of the drivers to expand the tertiary sector at a county level and to allow farmers a significant increase in off-farm income at a local level as we will see later, thus confirming the generalized trend to non-farm based income development in rural areas exposed by Haggblade *et al.* [7].

Based on 14 years data series, we have used non-linear regression models to explore future tourism trends in Anji. The assumptions are that after an initial fast increase in number of tourists, their growth will slow down and eventually level-off. We used a parsimonious logistic regression with upper bound (K) change intervals of half a million tourists. The best fit ($R^2 = 0.988$; $P < 0.0001$), represented in Figure 3, corresponds to a logistic model such as

$$Y = 1/(1/K + (b_0 * (b_1\hat{}t)))$$

where Y = number of tourists; K = 6.5Eˆ6; b_0 = 6.9Eˆ6; b_1 = 0.68.

Figure 3. Evolution of number of tourists and expected trend in Anji County.



The upper amount (K) of 6.5 million tourists would be reached by the early 2020s. Therefore, if the model projections hold, the yearly number of tourists visiting Anji will likely increase by over a million above the current levels. These estimates would significantly increase if the proposed winter tourism facilities are developed and attract a new kind of visitors. Tianhuangping Tourism Plan considers a number of nature conservation measures (forest protection, waste management and water pollution control) to limit the environmental pressure generated by tourism [35]. However, local authorities acknowledge that the massive arrival of visitors has already damaged the environment, with an unsustainable increase of waste and water pollution associated to a huge increase in urban development [38]. The estimated increase of at least another million tourists will aggravate these problems. This should move Anji tourism authorities to start thinking on a shift from quantity to quality, trying to increase the expenditure per tourist and to control the already detected environmental impact of a massive arrival of tourists.

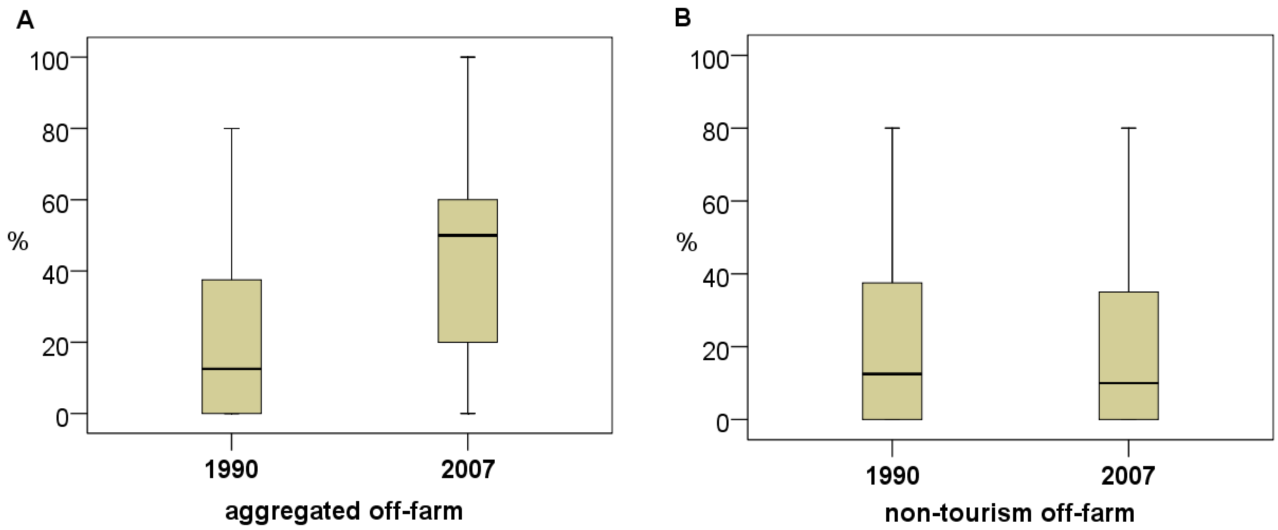
In Daxi, our case-study village, local authorities are aware of the environmental problems derived from the expansion of tourism and have developed a number of planning proposals to control its negative effects [39]. They include limitations to the intensification of plantations (like the use of pesticides in bamboo and tea plantations, prohibition of planting bamboo in slopes greater than 30°) to keep an attractive landscape, and treatment of domestic waste and used waters badly polluted by the increasing number of visitors. Nevertheless, the construction of infrastructure, second homes for urban residents and other facilities to accommodate tourism, has meant a substantial expansion in urbanized land that, according to our own satellite image-based estimates, has increased 4.8 times between 1988 and 2005. This reveals the dilemmas faced by technological solutions to a massive increase in tourism that may prove to be insufficient if current tourism expansion is not curtailed.

4.2. From Farm Towards Tourism Based Economy in Daxi Village

Daxi village's economy has experienced a fundamental change in the past 25 years, characterized by a substantial increase in per capita income (in common with other rural areas of China) and a growing importance of non-farm activities. Per capita income increased from 273 CNY (US$ 182) in 1979 to 8,820 CNY (US$ 1,102) in 2006 [40].

Two main interrelated factors have contributed to this change: Improved accessibility due to the construction of a paved road, and the development of tourism. While forests still play a major role in the village's economy, representing 50% of total income generated, off-farm activities cover most of the remaining 50%. Off-farm activities were already present in 1990, before the construction of the dam (see Figure 4a), representing 13% of total income [40]; however, this was based solely on construction and forest enterprises work in the county, without any tourism activities present at the time. This situation had changed by 2007 (year of our survey), when off-farm represented 44% of total income, most of it derived from tourism, that amounted to 27%; the difference between both periods are statistically significant (Wilcoxon Z, $p < 0.001$). Since contribution of non-tourism off-farm income has not changed during this period (Wilcoxon Z, $p = 0.292$; see Figure 4b), the observed difference in off-farm income can be entirely attributed to tourism.

Figure 4. Percent of off-farm (**A**) and non-tourism off farm (**B**) of total household income in Daxi village in 1990 and 2007 (Source: sample data).



Access to off-farm income has become more widespread, as can be seen in Figure 4a. The coefficient of variation of the contribution of off-farm income in 1990 was 1.14, while this coefficient decreased to 0.61 in 2007. This indicates that new off-farm income opportunities are being seized by many families in the village. The coefficient of variation of off-farm, tourism-based income (0.97) is lower than that of off-farm-non tourism income (1.21), indicating that tourism is a more attractive and generalized option to generate off-farm income than other activities like construction or industry work.

Consequently, labor allocation has also changed significantly during the period, with tourism accounting for 24% of total family labor in 2007 (see Figure 5). This is composed of 18% labor dedicated to rural hostels and catering (*nongjiale*) and 6% working on tourist shops. Age and gender have an influence on tourism-related labor opportunities. Being a relatively recent activity, the young generation (under 40 years old) has a significantly higher percent of labor on tourism and other off-farm activities than the older generation ($\chi^2 = 22.817$; $p < 0.001$). Women also devote more time to tourism-based activities than men ($\chi^2 = 9.767$; $p = 0.008$). However, this gender difference is only significant within the young generation, where women have specialized in the more home-centered tourism activities (*nongjiale* and shops) whereas men have searched for off-farm opportunities in trade, construction and forest industry sectors ($\chi^2 = 9.807$; $p = 0.007$). Higher education and the small-scale, family-based enterprise represented by most tourism activities have facilitated this process, as has happened in other areas of China [26]. For the generation over 40 years old, the gender differences in the three main types of activities are not statistically significant (see Figure 6).

The farmers' survey included questions concerning changes in quality of life since 1990. The answers were recorded as a four rank ordinal variable from 1 (worse off) to 4 (significant improvement). The vast majority (88%) of those interviewed thought that their lives had improved somewhat or significantly; 9% of respondents felt that their lives had not changed; and only 3% thought that it had become worse. Farmers from the three hamlets that house the tourist activities tended to have a more positive view of changes (Kruskal-Wallis $\chi^2 = 4.972$; $p = 0.026$), suggesting a positive influence of tourism in general quality of life (Figure 7).

These findings are consistent with Gao *et al.* [5], who analyze the link between tourism and rural development in other areas of China, underscoring the potential contribution of tourism to rural development.

Figure 5. Farm, tourism and non-farm, other than tourism, labor distribution in Daxi village, in 1990 and 2007. Source: sample data.

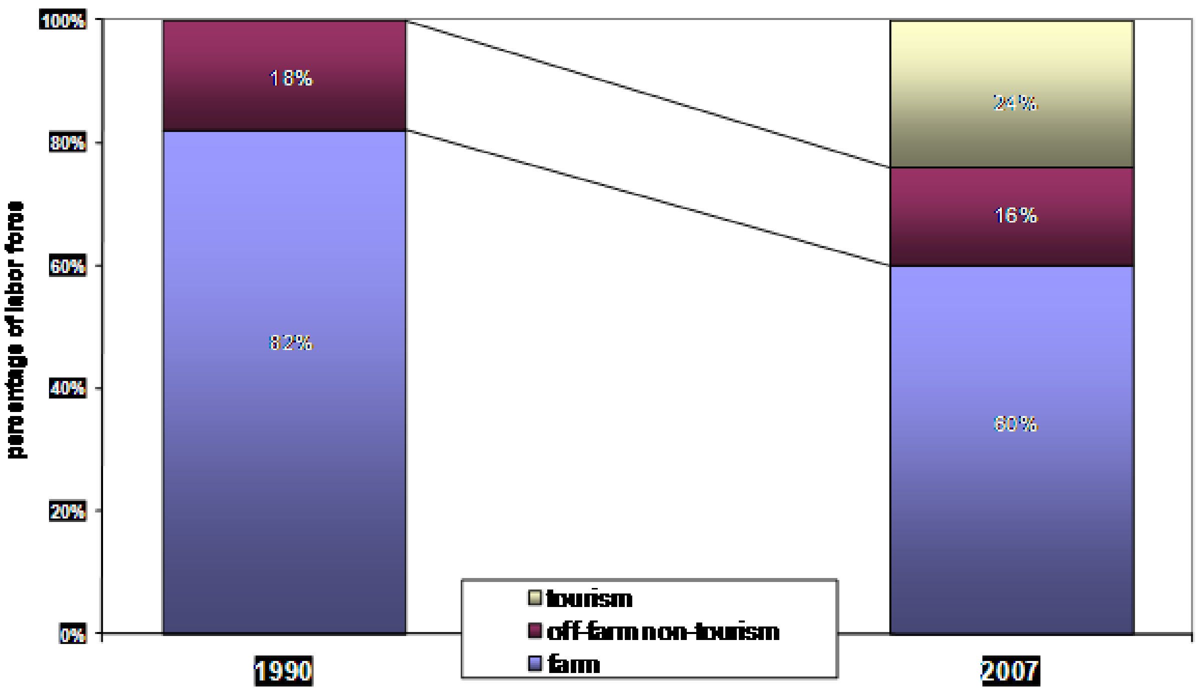


Figure 6. Current distribution of labor among the three main activities by gender and age. (Source: sample data).

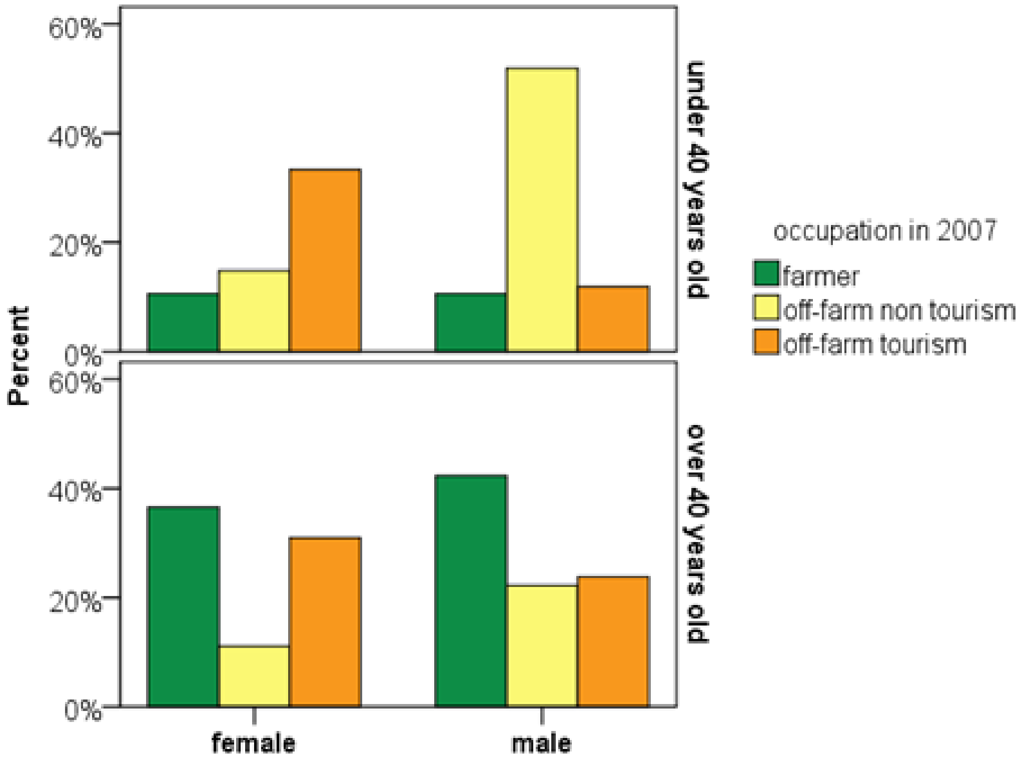


Figure 7. Farmers' opinion on changes in quality of life since 1990. (**A**) Hamlets with high incidence of tourism; (**B**) Hamlets with minimal or no tourism (Source: sample data).

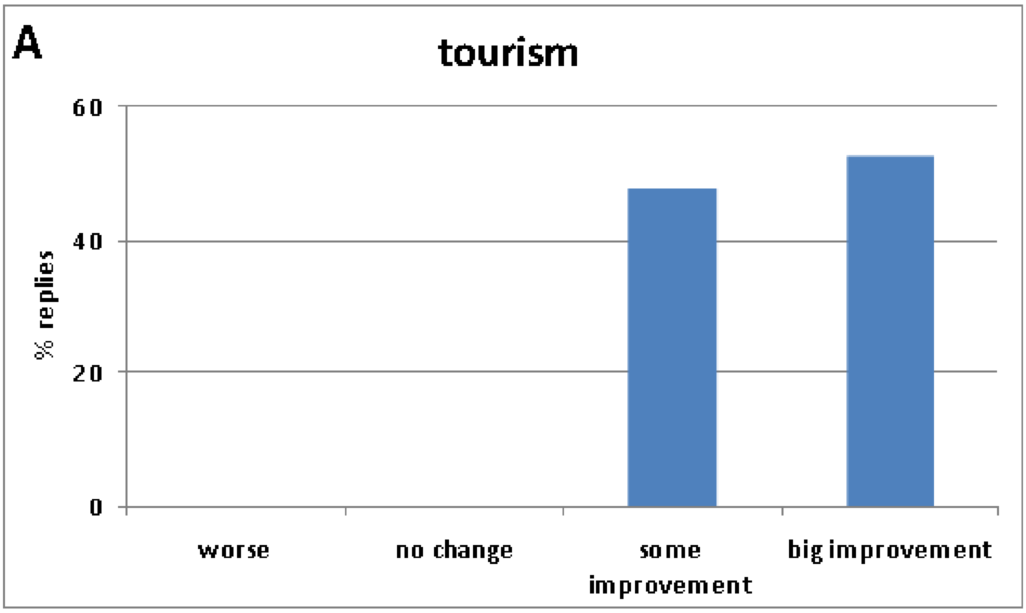
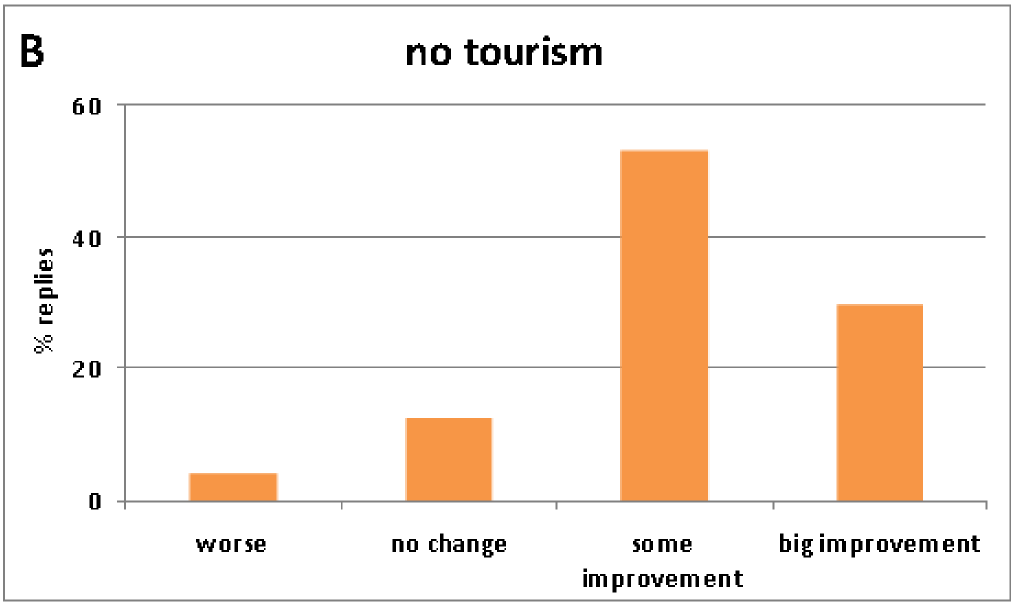


Figure 7. *Cont.*



4.3. Perceptions and Degree of Satisfaction of Tourists Visiting Daxi

Most tourists visiting Daxi come from the eastern provinces of Zhejiang (43%) where Anji County is situated, Shanghai (33%) and Jiangsu (19%). Only one tourist in our sample was foreign (US national), underscoring the importance of domestic tourism in Chinese rural areas. Distances travelled by domestic tourists ranged from 25 to over 1,500 km, with the typical distance being between 250 and 300 km.

Over 50% of respondents are middle aged (31 to 50 years old), and almost two thirds are male. Monthly income of visitors follows a bi-modal distribution, with two maxima corresponding to 1,500–2,500 CNY (low-middle income) and >7,500 CNY (high income) due to the majority coming from the high income segment of Shanghai. Employees is the largest group (37%) followed by students (14%), businessmen (13%) and civil servants (10%).

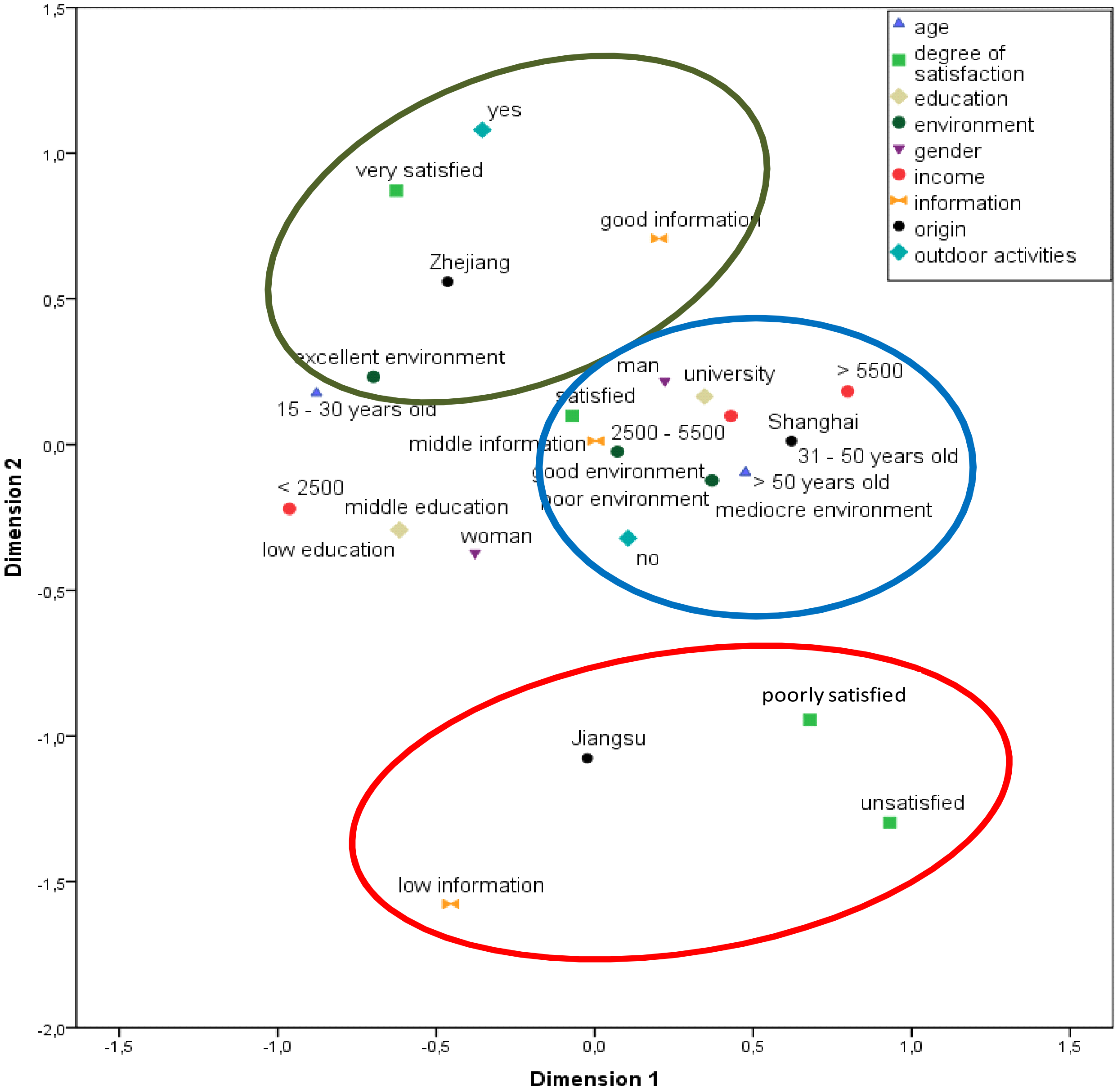
A majority of tourists have some previous knowledge of Anji, bamboo being the most known element (93% knew of it), followed by Tianhuangping hydropower station (79%) and the sources of the Huangpu river (61%). This shows the importance of bamboo and other forest landscapes in attracting tourists to the area, reinforcing the need to conserve them to offer attractive scenery and a high quality environment. However, most people (78%) are passive users interested in scenic views but had no plan to conduct outdoor activities. Again, this reflects on the special nature of current Chinese rural tourism, more linked to contemplation and experiencing traditional lifestyles than to nature-related physical activities.

Private car (54%) is the main form of transportation, followed by tour operator buses (29%). This is indicative of the relatively prosperous type of tourism, in accordance with the level of development of Eastern China. Fifty-six percent are first-time visitors, who tend to spend one night in a *nongjiale*; 53% of all visitors come exclusively to Daxi, the remaining having also visited other nearby places.

Eighty percent of respondents were satisfied, and 89% were willing to recommend it to relatives and friends. However, 40% acknowledged a mediocre to poor level of environmental protection, 62%

recommended better cleaning and general environmental maintenance, and 63% identified the need for improved services. Likewise, 11% were in favor of reducing the number of hostels, and 27% that of local tourist shops, a situation found in other areas of outstanding natural values in China [29]. This suggests that the massive increase in tourism in Daxi is reaching an unsustainable level, having created a number of environmental and other types of problems that could compromise the long-term viability of the economic development strategy.

Figure 8. Categorical Principal Components Analysis of key variables characterizing tourists and their attitudes, perceptions and degree of satisfaction with the visit.



We have used the Categorical Principal Components Analysis to characterize different types of tourists depending on their attitudes, opinions, provenance and other personal features (see Figure 8). The first dimension associates income with age and education on the positive side, and the perception of environmental quality with the degree of satisfaction and outdoor activities on the negative side. The second dimension looks at information and outdoor activities *versus* age. The combination of these factors indicates that a high degree of satisfaction correlates with good information, a high appreciation of environmental conditions and a positive attitude towards outdoor, nature-related activities; this is classically associated with visitors from Zhejiang province. Tourists from Shanghai tend to be older, more educated and to enjoy a higher income; they are not particularly interested in outdoor activities, and have a variety of opinions about the environmental quality of the area. Finally, a poor level of satisfaction with the visit is associated with a low level of information, being relatively more common in tourists from Jiangsu and other provinces. Similar results related to preferences and behavior of visitors has been found in European protected areas [41].

5. Conclusions

The huge expansion of tourism experienced by China in the past two decades has brought opportunities to rural economies, contributing to the shift from farm to off-farm based economies that characterize many rural areas in developing countries [6]. Tourism-related activities in our study area have benefited the more educated younger generations, having been taken up particularly by women, whereas men have opted for other non-farm income opportunities. This has contributed to a growing gender specialization as observed in other rural-based industries [42].

Tourists visiting Daxi tend to stay for a short period, attracted by the scenic and cultural values (especially the beauty of its forests and bamboo plantations) but generally show little interest in outdoor, nature-related physical activities. Currently the degree of satisfaction is high, but there are differences depending on age, education, income and provenance. A small but significant number of visitors have already detected problems of saturation with tourist services and environmental degradation that make the area less attractive.

It is expected that tourist numbers will continue to increase for at least a decade, and this growth could continue if the planned new investments associated with winter tourism finally take place. Although local authorities seem to be aware of the risks encompassed by mass tourism, the steps taken so far correspond to limited environmental damage control, rather than a thorough plan that anticipates and limits the number of visitors and the infrastructure available.

Anji County, and in particular, Daxi village, could be considered a success story until now. However, the long term sustainability of the model will depend on the ability to optimize its potential through a clear choice based on minimizing the environmental and social costs and a shift in emphasis from quantity to quality.

Acknowledgements

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THIRD SECTION

10. Discussion

11. Conclusion

Chapter 10. Discussion

10.1 The Chinese Forest Transition

World forests are being depleted at an alarming pace with a gross yearly loss of 13 million ha through the 2000s (FAO, 2011, 2012). When regeneration and afforestation efforts are included, global deforestation accounts are reduced to a net 5.2 million ha/year loss in the 2000s. However, beyond this aggregate figure we find regional trends that are clearly differentiated: natural forest loss concentrates in tropical countries while forest gain mainly occurs in temperate and boreal zones (FAO, 2011, 2012). This situation is explained by differentiated economic and population growth patterns, as well as inequitable ecological footprint flows from lower income toward higher income groups and regions (Rice, 2007; Lenzen et al, 2012; WWF, 2012), i.e. forest transitions tend to be associated to global land use displacements brought from higher income toward lower income regions (Steen-Olsen et al, 2012; Weinzettel et al, 2013).

In the developing world, the PRC officially recognised the deforestation link with an impending ecological crisis that had dramatic environmental effects in 1997 and 1998 (Zong and Chen, 2000; Fu et al, 2004). The adoption of 'Six key forestry programmes' (*liu da linye zhongdian gongcheng*) – the new forest policy for the 21st century that integrated demographic, techno-environmental and economic factors (Zhou Shengxian: 周生贤, 2002), has relatively succeeded in enforcing a more efficient use of forest resources ultimately leading to the forest transition in China. Despite this success, natural forests still present fragile ecological succession stages while forest plantations also need time to reach their full productive potential (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010). From a socioeconomic standpoint, forest dwellers today still face higher poverty rates than their rural counterparts living in other non-forested regions of the PRC (Feng and Xia: 冯菁, 夏自谦, 2007).

Improving living standards compatible with forest conservation in these forest frontiers is an urgent and daunting task in China, given current surmounting pressures caused by its population and expanding economy, being critical to the provision, regulation and support of ecosystem services for its whole society (WWF China, 2012). Up to recent times, geographic isolation and locally abundant though still-frail natural resources depicted the basic conditions that forest communities typically encountered in China (Ruiz Pérez et al, 2000, 2003).

We are nowadays witnessing an impressive change in forest use and exchange values across rural China and many forested regions of the Planet (see chapter 7). Increased economic interconnectedness has made the world's forests ('supply') more accessible to market demands, often located several thousand miles away from the peasant's farm (Mills Busa, 2013). A 'forest modernisation path'[1] or 'forest-led development' (Wunder, 2001; Angelsen and Wunder, 2003) is now deeply transforming local livelihoods from forest self-consumption and production in household traditional farm systems, towards forest wages and indirect landscape-exchange values accrued through environmental services, ecotourism and other economic activities.

Under conditions of stabilised population in China, this shift in the local mode of production matched by a more favourable forest policy has both enabled the forest transition and raised forest-based incomes - whether farm or off-farm - while increasing ecological footprints and environmental displacement at a regional and international level. We have seen such an economic-growth process in chapter 5 and chapter 7.

In this work, the case study that we have come to analyse is defined by a subtropical mountainous forest community located in Eastern China (Zhejiang province). By year 2009, a local population of 2,099 inhabitants distributed along 11 hamlets occupied a natural territory basically made of endemic evergreen broadleaf forests, moso bamboo plantations, Chinese hickory formations, tea plantations and conifers. We regard Daxi village in Anji as representative of the changing economic roles of forests in the most developed forest areas of China (Ruiz Pérez et al, 2001) and, to a certain extent, of less developed forest locations that are also moving towards that direction (Ruiz Pérez et al, 2003, 2004(b)).

In this sense, a feature that our case study has in common with some forested regions of China is the initial regeneration of natural forests (Fang et al, 2001; Qi et al, 2013), leading to increased cover and carbon sequestration in China's forests (He et al, 2013). Daxi has also experienced an expansion of infrastructure and built area that is affecting most of the country both in rural and urban areas (Chen, 2007). Finally, the growing importance of the off-farm economy in rural areas in China is well captured in our case study. Indeed there is evidence that the implementation of the NFPP and SLCP in less developed forest locations (though these programmes are not present in Zhejiang and other Chinese coastal provinces) have achieved a high degree of economic transformation (Liu et al, 2009), from farm to off-farm incomes, which is considered by the PRC Forestry Ministry as a pre-condition for forest modernisation throughout the country (Yin, 2009). We are aware that the key role of rural tourism as a major source of off-farm income in Daxi, while also occurring in other areas of China (see Chapter 9) is not fully applicable in all forested regions. Bearing all this in mind, we believe that we can derive some learning and broader implications from Daxi's research presented in this PhD.

The transformation in the local forest economy directly interacts with the forest physical resource and, when there is an appropriate policy environment, can foster the forest transition. Similar processes have been detected in other places like Yunnan province, Southwest China, where the changing economic structure from farm-based towards off-farm-based livelihoods combined with the NFPP enforcement has triggered a local forest

[1] Here, 'modernisation' is understood as the process led by economic growth and increased land productivity, and characterized by technological innovation, diversification of goods and services and increased benefits associated to increased farm and off-farm incomes (see Chapter 1).

transition (Xu et al, 2007). At the same time, while this 'forest modernisation path' is succeeding as far as local forest resources can be channelled through environmental services payments (such as the SLCP), ecotourism and off-farm activities, there are cases of 'negative modernisation' when these innovative options have been absent, and forests have been lost or replaced by less valuable plantation crops. The case of Xishuangbanna in tropical China (also in Yunnan province) was featured by natural forest substitution for rubber plantations, agro-biodiversity loss and increased livelihood vulnerability (Li et al, 2007; Li et al, 2009; Fu et al, 2010).

The relative success of the 'forest modernisation path' must be assessed in a fully-integrated manner given that ecotourism can act as a double-edged sword in forest areas (Zhong et al, 2011; Wang et al, 2012). In the same way that, at an aggregated level, the forest transition in the PRC has been related to urbanisation and global land use displacement; the effects of ecotourism, at a local level, can bring either positive, ambiguous or negative outcomes from a socio-ecological perspective (Lacitignola et al, 2007). In fact, Brandt et al (2012) detected the linkage between the occurrence of a local forest transition and a loss of old-growth forest in Northwest Yunnan, explained by the implementation of the logging ban – leading to a net increase in forest area - and the expansion of ecotourism – whose demands for wood-based housing fuelled selective harvests of mature trees.

Consequently, while general processes and trends like the 'Forest Transition' in China can be identified at an aggregated level, they have to be illustrated and fine-tuned at a local level to understand how local conditions affect and are affected by these general trends. The 'forest modernisation path' followed in Daxi village can inform us how this transformation has proceeded and what specific contributions/shortcomings poses for livelihoods' improvement and forest conservation. There are several *socioeconomic and ecological effects* that can be explored across *temporal and spatial* variables in this case study, which are relevant for the forest sector in China (especially in the Southern Collective Forest Region) and even for other forest regions.

10.2. Change in forest uses in Daxi

The profound change in forest use and exchange values – the human-forest relationship – has been characterised by a gradual change from a collective-planned economy towards a socialist-market economy, by regional economic integration and also a moderate local demographic increase (later complemented by a high inflow of tourists). In figure 10.1 we briefly explain how the local socio-ecosystem has been transformed at Daxi village, as the general economy has been reformed in China and several policy interventions have been applied at the local level, thereby impacting over the local population and its mode of production and resulting in important socioeconomic and ecological shifts.

Daxi village and Tianhuangping township forest inventories, together with our remote-sensing based cartography, confirm that in the later 1980s Daxi was a highly forested area (88% under forest cover) dominated by moso bamboo plantations. Natural secondary forests were still suffering heavy pressure, while hickory, different conifer plantations and to a lesser extent tea completed this forested landscape. The small non-forested area corresponded to the small rice plots, basic settlements and infrastructure, as well as some bare land that had suffered severe pressure and had difficulties in recovering.

Twenty years later Daxi was still predominantly forested but had experienced three important land use changes. Part of the forest and agricultural land had been lost to a hydroelectric dam, road infrastructure and settlement growth, mostly to cater for the new tourism industry. Most of the bare land had been transformed to plantations or early secondary forests and shrubs, while some forest uses, notably tea plantations, had expanded at the expense of former rice fields and bamboo with the relative replacement of intensive bamboo plantations in favour of a more sustainable extensive management. And natural forests have begun a slow but significant recovery after decades of overexploitation. Therefore, we can talk about a *partial* forest transition in Daxi (characterized by a slight increase in forest area but also an increase in infrastructure, built areas and tea plantations that have affected the environmental values of some forests), which has been propelled by the shift in the local mode of production (from forest intensive bamboo harvests towards extensive bamboo management, intensive tea plantations and ecotourism hostels) and the expansion of the local and (especially) tourist populations.

This change in land use has brought changes in biodiversity, biomass and canopy cover as well as new environmental pressures, resulting in important ecological trends. A more extensive bamboo forest management is increasing alpha diversity index at shrub and herb layers, while maintaining a significant level of biomass (as found in chapter 6). This is complemented by the recovery of natural evergreen-broadleaf forests with high alpha and beta diversity indexes at the tree layers, which also offer an important mid-to-long term potential for biomass growth and carbon sequestration. Last but not least, the local stream of ecological goods and services provided by this interweaving forest mosaic has increasingly been affected by the adoption of some unsustainable practices: low-diverse tea plantations have often substituted for ecologically-richer natural forests and bamboo grooves, while there are growing waste and sewage emissions caused by flourishing tourist hostels and facilities.

10.3. The drivers of change

The first *structural* adjustment in Daxi came with the launching of the HRS and CRS in Anji County, respectively, in 1982 and 1984. People's Communes were dismantled in favour of a decentralised egalitarian forest management formed by household units while keeping the collective property of land. Individual work incentives improved resulting in a mild increase in local net per capita income, from 273 RMB in 1978-79 to 317 (deflated to 1978) RMB in 1990-91 (16% increase in real terms), due to the quick simultaneous development of bamboo sector in Anji at that time (Ruiz Pérez et al, 1999). Farmers still maintained a high degree of economic equality (Gini 0.21), although lived under autarchic conditions and their income and purchasing opportunities were still considerably constrained.

At that stage of development, forest activities were the main economic driver (representing slightly more than 60% of aggregated village income) and agriculture had already declined to

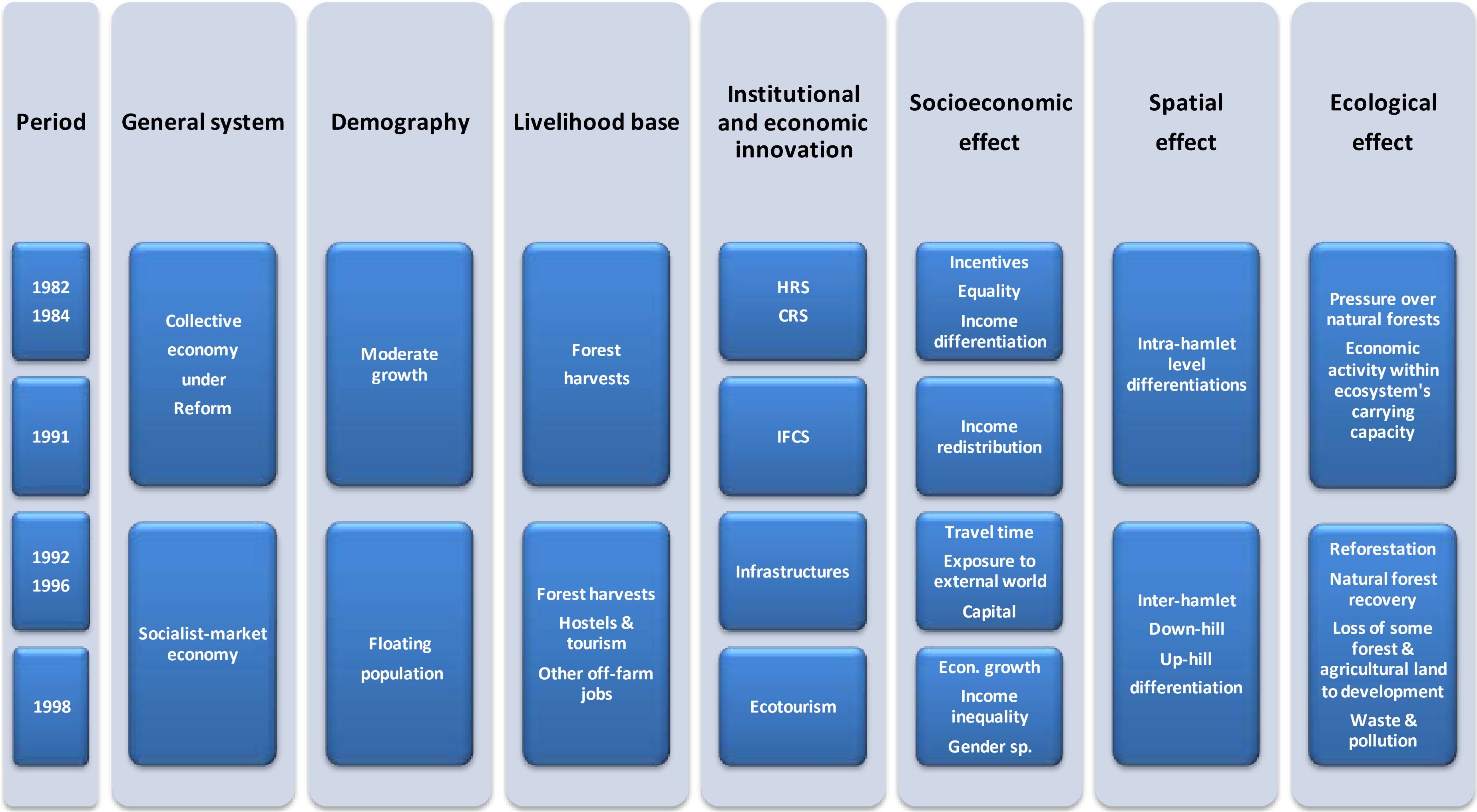


Figure 10.1. Evolution of the local socio-ecosystem at Daxi village since the beginning of Reform.

20% at Daxi (chapter 7). Bamboo harvests were thus the most attractive available income source while off-farm activities were still almost inexistent. Under such isolated conditions bamboo has been found a convenient pro-poor livelihood strategy (Hogarth and Belcher, 2013), for it shows a more flexible economic response than the timber sector and a rather equitable distribution of its land assets (Ruiz Pérez et al, 2003). As poorer households tend to be much more dependent on farm-based incomes and forest safety nets, it is highly advisable to promote policies that secure the poor's access to land resources and to increase their land productivity levels (Hogarth et al, 2013).

During this phase (1978-1990), the economy was largely planned. Daxi village could be regarded as having a 'collective-decentralised economy', the majority of peasants typically tending to invest their work power into their contracted bamboo plots thus relying on their traditional agricultural and forest tools to make a living. Under these circumstances of high reliance on forest harvests, a novel land tenure policy appeared – the IFCS (Inter-household Forest Compensation Scheme, see chapter 8) – in order to tackle household demographic changes which distorted the original egalitarian distribution of forestland.

For instance, a newly established household of two people that so had received a 'two-persons' contract of land by the early 1980s, in case of having just one child, needed to support their household economy with the same 'two-persons' land. This limited per capita land availability would even get worse if parents opted for having a second child[2]. This example illustrates the classical problem faced by Chinese in the post-78 Reform, where a huge rural population meant an important degree of land scarcity (Putterman, 1993; Piotrowski, 2009). In most agricultural regions of China, land reallocations were frequent mechanisms in villages provided to maintain peasants' economic security (Kung and Liu, 1997; Kung, 1995, 2000; Lin: 林苇 2009).

We have explained that such reallocations would have involved problematic challenges in the case of forest management, for this latter is often subject to long-term economic returns and therefore forestland redistributions could hamper individual incentives and productivity. They could even promote forest over-exploitation under contexts of tenure insecurity as it happened in Southern China after the opening of timber markets in the mid-1980s (Song et al, 1997; Liu, 2001; Weyerhaeuser et al, 2006).

For these reasons, we argue that the IFCS has promoted a compromise between equity and efficiency, able to solve typical plot boundary conflicts after CRS was implemented, thereby raising forest physical productivity by 33%. Although other arrangements like the forest shareholding cooperative systems (*linye gufen hezuo zhi*) exist, being especially relevant the case of Sanming (Fujian province) (Song et al, 1997; Kong and Liu: 孔明, 刘璨, 2000), the irruption of external forces have made these latter systems highly burdensome in a increasingly competitive market, so they are being gradually revised and dismantled once the original economic conditions have changed and after the second wave of Collective forests reforms (Song et al, 2004).

[2] The 'One child policy' strictly applies in urban areas. In rural areas people have the right to a second child if the first is a girl. The legally recognized Ethnic Minority groups have no child restrictions.

In fact, the IFCS nowadays plays a very discrete role in Daxi's local economy – per capita compensation just representing around only 1.5% of net per capita income – becoming a residual redistributive device inherited from the Collective era. Beside market forces, the effect of an increasing local population in Daxi's hamlets has made the IFCS more difficult to implement, as households with constant family size now must even pay to compensate an ever increasing number of expanding households. Therefore, the IFCS can be considered as an effective transitional redistributive system from a collective towards a market economy, which has been overcome and outdated by both expanding demographic and economic conditions.

Building a reversible hydroelectric station at the top of Daxi village meant an important ecological and livelihood impact over the farmers living at hamlet 10, whose contracted lands were occupied by the new dam[3]. The establishment of the new infrastructures (road and station) let Daxi integrate into the regional thriving economy (Shanghai – Hangzhou – Nanjing triangle). Travel times have shortened and the village has attracted important capital investments both from the hydroelectric company and two Shanghai-based ecotourism enterprises.

From 1992 on, a major *structural* break with ecological and socioeconomic dimensions (see chapter 7) has shaped an emerging new culture of forest-human relations. A deep change in the local mode of production has raised material living standards and per capita income, which reached 8,820 RMB in 2005-06 an 8 fold increase in real RMB terms since 1978, marking the start-up of a 'forest modernisation path'. Generally speaking, forest harvests have become a less attractive activity while ecotourism has fuelled the proliferation of local family-run hostels (*nongjiale*). This implies a major shift from traditional forest self-consumption and exchange values, intensive in physical labour, towards modern landscape-based exchange values compatible with forest wage labour.

The 'forest modernisation path' has, on the other hand, hinged on an equally important specific characteristic of the Southern Collective Forest Region in China – forest land allocation on per-capita basis among the local population (see chapter 8). Firstly, the collective property of land, inherited from the Maoist period, meant the egalitarian allocation of bamboo, hickory and tea during the implementation of the CRS and its strengthening through the adoption of the IFCS. This situation has provided local dwellers with their equal right to access and benefit from natural resources, thus guaranteeing a minimum farm-based income potential – especially that coming from bamboo safety-net income sources.

[3] Households living in this hamlet today receive a yearly-adjusted economic compensation, different from the IFCS, related to the establishment of the new infrastructures (road and power station). Most households of Daxi village also receive these types of economic disbursements, to compensate them for their land being occupied by the new road and station. This process of land compensation (which is not related to the IFCS) happened as follows: the electricity company in charge of the power station transferred a lump-sum compensation funds to Anji's Land Resources Bureau and this latter to Tianhuangping's Land Resources station which, in turn, transferred compensation to Daxi village committee. The village committee then decided to set up both a collective fund for all Daxi inhabitants and specific collective hamlet-level funds for hamlet 10 and the other remaining hamlets. These funds have allowed a high number of Daxi residents to borrow from the village committee in order to build their hostels.

The current land-property system does have some problems such as corruption cases that in some occasions exclude farmers from effectively utilising and accessing local resources (Ho 2006; Gong, 2012), especially in suburban locations exposed to urban expansion (Ho, 2005; He et al, 2009; Li, 2011). From a larger perspective, however, we think the current land system has more social advantages than drawbacks: *the majority* of farmers still have access to land resources. In line with a number of authors (Li and Yao, 2002; Piotrowski, 2009; Jiang and Qian: 蒋剑勇, 钱文荣, 2010; Wang et al, 2011; Wang et al, 2013), we believe that in the near and mid-term forest/agricultural land privatisation is not the solution, neither from a theoretical nor from a practical standpoint. A hassled privatization could lead to some not-yet-present problems in rural China such as land concentration in a few hands, landless farmers, and ultimately the privatisation of commons (Zhang and Donaldson, 2012).

10.4. The new opportunities create new differences

This socioeconomic and forest transition has been mediated by a *spatial gradient*, where more accessible hamlets have broadly benefited from ecotourism whereas more isolated hamlets have remained more dependent on forest direct usages. Now, there is a much higher degree of work specialisation as roughly a privileged third of locals – mostly those who live at down-hill areas more accessible to tourists - no longer work their bamboo forests but, instead, they run their own family hostels while hiring poorer up-hill wage-farmers to do the annual bamboo harvest. The Gini coefficient has rose to 0.28 reflecting a higher income inequality within the local population, a trend mimicking the general increase in income inequalities for the whole of China (see chapter 7). In some occasions, formerly poor peasants have specialised into fast-expanding tea production, well integrated to the market exchange through tourist demand[4], resulting in their gradual ascent along the local income-ladder.

High-income farmers will tend to dominate those forest-related activities showing highest economic returns, maximising capital and wage-labour investments, whereas middle and low-income households will be economically more dependent on less-profitable forest activities and will diversify them to cope with economic risks (Ruiz Pérez et al, 1999, 2003; Hogarth and Belcher, 2013; Hogarth et al, 2013). The case of Daxi reveals the highly dynamic economic roles of forest resources during the development process in Anji county, where formerly attractive intensive bamboo harvests (in 1990) have been displaced by a new bourgeoning ecotourism and intensive tea plantations.

Today bamboo is acting as an important local safety-net being the poor's key-strategic resource, hickory trees being an attractive resource in isolated hamlets which are linked to middle incomes, while rural hostels (*nongjiale*) are associated with more restrictive initial-capital conditions (dominated by higher income groups) and favoured by more limiting geographic locations (down-hill well communicated areas). In this socio-ecological context of natural resources management, there are two emerging properties coming out of the 'forest modernisation path'. On the one hand, Daxi livelihoods' deep transformation can be regarded as being highly dependent on a 'forest-led development' process (Angelsen and Wunder, 2003), which started once key techno-environmental improvements – the new road – were

[4] Daxi is famous for its high quality White tea, much appreciated by tourists.

made. In a sense ecotourism entrepreneurs are as dependent on forests as are bamboo farmers, although for the former it is the environmental, scenic and cultural values what counts, whereas for the latter the forest physical output is still the main base.

Another interesting aspect to explore, which was presented briefly in the Introduction Chapter as one of the causes of the demographic transition in the PRC, is that of gender equality and relations as far as these are connected to our subject – the 'forest modernisation path' during the development process. Our observations are centred on the more recent (between 1990 and 2007) shift in the local mode of production at Daxi village, from a forest farm-based towards a forest off-farm economy, particularly on the development of ecotourism activities.

During this recent period we have found an increasingly gender-age specialisation in the off-farm sector, especially at down-hill hamlets, by which younger women often tend to run or work as wage labour in ecotourism hostels-shops while younger men often tend to work at jobs generally located outside the village (see chapter 9). Farm-based forest activities are thus disproportionately associated to older women and men, frequently living in up-hill hamlets. At the same time similar educational standards between the sexes were identified at Daxi, both in 1990 and 2007 (Annex 8), with raising educational degrees inversely correlated with age, i.e. from primary (older individuals), through secondary, high school and to some university students (younger generations). The high attention paid to education (both for boys and girls) may have helped making less prominent the current gender gap.

Before the construction of the new road in 1992, the limited number of available off-farm posts was at a higher proportion held by men (Annex 9). Women had fewer chances to work at these limited off-farm jobs, thus tending to be in charge of forest harvests and household chores. Nonetheless, there were also at the time a small number of women who worked in local collective enterprises (TVEs). The recent opening of the local economy has allowed a broad number of women to incorporate to the ecotourism off-farm sector, while men are occupying almost all off-farm jobs outside the village.

We think it is quite positive that women are directly capturing an important share of exchange value, what very likely will empower them to make decision choices within the family sphere and the broader society. However, the very same 'forest modernisation path' is also reinforcing traditional patriarchal roles – the classical opposition between female home-based and male out-home work – which could exert negative outcomes in the long run, what might relegate women at the house while not being able to access power within the broader society. It is also paradoxical the fact that even though both sexes hold very similar educational attainments, individuals tend to select their occupations according to culturally-grounded roles. A possible explanation is that, like in many Western societies, women tend to face lower salaries and conditions than men in the formal employment (out-home) sector[5] (Zhang et al:

[5] The PRC today presents a 0.213 value for Gender Inequality Index, ranking 35th in the World, showing a relatively high gender equality when compared with middle-income countries (UNDP, 2013). However, there is still room for improvement taking into account the gender unbalanced ratio within the 'formal' labour sector – 67.7% of Chinese women participate in the formal labour sector as compared with 80.1% of Chinese men. This gender gap reflects both women's under-valued production and reproduction

张雪梅等, 2011), what would *structurally* promote their occupation in more rewarding ecotourism hostels more associated to the family sphere.

10.5. A new Nature paradigm

The fact that ecotourism has and is re-shaping local livelihoods in Daxi village is, simultaneously, explained by the impressive surge in domestic demand for environmental services and nature-based tourism in the PRC (see chapter 9). A 'return to Nature' is attracting more urban dwellers towards rural areas in China (Huang et al, 2008; Chen and Nakama, 2012) hence promoting a sociological exchange between locals and visitors. In our case study a high 80% of tourists were satisfied with their visit experience to Daxi, mainly featured by aesthetic nature-contemplating activities (rather than nature-related physical activities), although an increasing number of visitors were claiming that higher environmental standards were needed at the village. This reality, already detected by more than 40% of tourists, shows that this 'forest modernisation path' has also brought some noticeable negative environmental impacts which should be redressed.

From an ecological perspective, the utilisation of forest resources has experienced a deep change from a *relatively integrated* culture of nature, essentially defined by the manual labour investment into forest and agricultural production, towards a *modernised* culture of nature where this latter is dominated through the deployment of technical-capital inputs and skilled-labour diversification. As a result, land productivity and local incomes are further improved although local carrying capacity can be easily overloaded with an increasing environmental disturbance - waste and sewage from hostels - and loss of land biodiversity/integrity – expansion of tea intensive plantations, tourist housing settlements, roads and other infrastructure (power station).

At the same time, today there is an *eco-cultural cross-sectional gradient* along poor, middle and rich income groups, overlapping with the aforementioned *spatial gradient*, defined by different human-forest relations: where up-hill poor inhabitants nowadays show a closer and more integrated attachment to forest resources mediated by their own labour; whereas a growing number of down-hill richer inhabitants show a more distant relationship with nature (linked to more comfortable life-styles), which is mainly mediated not by themselves but by their up-hill poor wage-labourers employees.

Recent changes in the local mode of production and the massive arrival of a visitor population, indeed, pose a qualitative shift in human-forest relations that obviously goes beyond that previous integrated culture of intensive bamboo plantations. Firstly, autarchy no longer holds and thus incomes have increased– something that most local inhabitants greet (88% of those interviewed said their livelihoods had improved somewhat or significantly) – what means that matter/energy flows nowadays transcend the biophysical limits of Daxi. Personally, we believe this is very positive to the extent that it increases local material living standards. On the negative side, we also contend that 'unlimited' and uncontrolled growth would just undermine

activities within society and the family, the feminization of poverty having multi-dimensional factors (Zhang et al: 张雪梅等, 2011).

the very existence of local ecotourism and could severely degrade local forest ecosystems and their integrity. *Unlimited* is just a paradox itself – ecosystems are finite – and realistically cannot be a model for development.

10.6. Some suggestions

Endless economic growth is thus unfeasible *in physical terms* – at global, national and regional dimensions – usually becoming a source of environmental distress posing negative effects within both the intertwining socioeconomic and ecological levels. We are today consuming 1.5 times the goods and services that the Biosphere provides us in a year, in other words, world ecosystems, and notably forests, are retreating and shrinking (WWF, 2010, 2012). Since the 1970s, the PRC has also surpassed its available per capita bio-capacity, putting overwhelming pressures over its natural resources and on the global ecosystems (WWF China, 2010, 2012). Higher income groups and countries nowadays rely on an economic model that is highly unsustainable, unrealistic and unjust. Therefore, we need alternative perspectives to build up a new socio-ecological paradigm which could be *practicable*, *universalised* and *adapted* across our cultures, which conveniently tackles the forest-poverty link from a multidimensional standpoint.

The Chinese experience teaches us that extreme autarchy – which proved ineffective, not realistic and sometimes tragic in the Maoist period – did not succeed as a 'way out of poverty', especially in a world dominated by acutely unbalanced North-South power relations. However, some concepts such as *economic redistribution* and *pro-poor growth* – widely popularised in the PRC respectively through the early 1950s' agricultural movement and later in the early 1980s - are worth regaining for the present and future, in China and elsewhere. Within the boundaries of a finite ecosystem, this means that higher incomes *must decrease* redistributing in favour of poorer groups and peasants, whose living standards *must increase*: there is thus a *differential degree of responsibility* within a global and regional context of exacerbated inequalities.

In the PRC, forest management has progressively integrated social and ecological criteria to deal with one of the most pressing challenges for Chinese society – the Environmental Crisis. The Six key forest programmes are proving an interesting ecological approach to poverty alleviation through *income redistribution* from wealthier coastal provinces to inner regions and isolated forested mountainous areas. We are confident that the New Forest Policy backed by a socially and environmentally sensitive agenda, coupled with effective rural Collective institutions (such as the current land-access right) and implemented by an active Forest Administration well connected with local Research centres, can offer poorer forested locations a way-out-of-poverty through the 'forest modernisation path' in rural China. More unpredictable outcomes, which go beyond *forest policy* alone, could be derived from the current rapid urbanisation process in the PRC with increasing ecological footprints impacting over agricultural land at a national level and having also broader-global land-use implications.

With regard to our study area, this same 'endless' economic-growth process could undermine the very regulating and supporting ecosystem services in Daxi and de-naturalise the very 'forest modernisation path'; resulting in decreased economic returns, ecological fragmentation, higher economic disparities and economic leakage through Shanghai-based tourist enterprises.

Local economic growth, which in Daxi has been so far compatible with a shift in the local mode of production raising living standards and promoting sustainable forestry, needs to be redressed through institutional governance. This should be done by putting special care on the equitable CRS forestry and controlling the expansion of low-diverse, low-biomass and low-tree-coverage intensive tea plantations, as well as that of highly-impacting settlements and infrastructures. At this stage of the ‘forest transition’, we are very aware of Anji Forest Bureau’s commitment with the ecological strategy aimed at fostering a sustainable forest management in the county and Daxi village where, expectedly, bamboo extensive forest management and autochthonous evergreen-broadleaf forest conservation will play major ecological-socioeconomic roles for local livelihoods.

Chapter 11. Conclusion

AT A GENERAL LEVEL:

1. China has experienced a long historical process of deforestation and forest degradation that reached dramatic levels during the 1960s. Since the early 1970s the People's Republic of China initiated a gradual demographic transition and a major Reform with subsequent increases in land productivity and economic growth – millions of rural people escaping poverty through the 1980s. Environmental disturbance, however, did also amplified and natural forests kept degrading until the mid-1990s.

By the turn of the century, as a result of historical and contemporary forest degradation and loss, the PRC was at the brink of a major ecological crisis epitomised by the Yellow River drought in 1997 and Yangtze River floods in 1998. These events were landmarks signalling a major shift in China's forestry, from a quantity (total surface and standing volume) oriented policy to a quality (conservation of natural forests, biodiversity and environmental services) policy.

Forest area and standing volume have expanded from 121.9 mill ha and 8,655.8 mill m3 in the first national forest survey (1973-76) to 195.5 mill ha and 13,720.8 mill m3 in the last survey (2004-2008) (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010). Forests in the PRC are today in an incipient recovery stage presenting still fragile natural formations in early or middle ecological succession phases and newly afforested plantations that have not yet reached their productive potential. The recent forest land-use changes in the PRC – mainly, natural forests' stabilisation and forest plantation expansion – are consistent with a Forest Transition (FT) theory from a quantitative point of view. They are also beginning to be consistent with FT theories from a forest quality perspective.

Despite the progress made, China still presents daunting environmental challenges, rooted in its fast industrialization, economic development and urbanisation pace and the size of its demography, which pose important socio-ecological pressures at national and international levels.

2. The active political integration of demographic, techno-economic and environmental drivers has been the main factor leading the FT in China. The late 1990's ecological crisis was straightforwardly brought into debate, paving the road for the emergence of the New Forest Policy and such innovative concepts for Chinese politics as the 'Ecological Civilisation'. A growing ecological awareness within Chinese society has made possible the implementation of the 'Six Key Forest Programmes' (*liu da linye zhongdian gongcheng*), halting natural forest degradation and loss, while the forest frontier gaining land over marginal agricultural crops. Human-agency through policy design, participation and implementation has played a determinant role in redressing these environmental forest-related questions.

The FT in China has been linked to a global land-use displacement, resulting from the increasing globalisation of World economies, so bringing in deforestation impacts over other developing countries (Brazil, Southeast Asia, Congo Basin) and Russia's boreal forests. Responsibility should not be exclusively placed on the Chinese side, but also on affluent income groups with highly unsustainable consumption patterns, mostly from the developed world. International cooperation should be strengthened to search for ecologically-plausible solutions to deforestation and poverty issues.

AT A CASE STUDY LEVEL:

1. Daxi's forests are experiencing a relative recovery in autochthonous secondary broadleaf evergreen forest area and density (with high alpha diversity index at tree layer and a great potential for future carbon and biomass fixation), and also the generalisation of an extensive management in bamboo plantations with substantial complementary conservation values (high alpha diversity index at shrub and herb layers). On the other hand, the expansion of local urban settlements, infrastructures and highly impacting intensive tea plantations (with low diversity, low carbon absorption and low forest-tree coverage) has impacted forests, increasing local ecological footprints and environmental disturbance displacements.

2. Our case study of Daxi village in Anji County (Zhejiang province), provides fine-grained empirical data to complement, from a local perspective, our understanding of the FT process in the PRC. In the past three decades there has been an aggregated increase in forest area, density and quality, although with loses of forest values and land in some places. At the same time, there has been a decrease in ecological self-reliance and an increase in environmental impacts due to the new economic activities. These local changes do represent a '*partial* forest transition' featured by forest gains and losses that have taken place in a non-linear way. This micro-world has certain similarities with the general FT process that has happened in China that combines increasing forest cover and an incipient natural forest recovery with expansion of urban areas and increased ecological footprints.

3. The drivers of this local *partial* FT in Daxi – the 'forest modernisation path' – can be traced back to a relative control on the population pressure, the early improvement on land work incentives (HRS and CRS), the innovative collective egalitarian resilient institutions (IFCS), and a dramatic shift of local economy towards forest-based ecotourism since 1992. This latter shift has been mainly attributed to critical investments in key infrastructures (road and power station), the major transition from a collective-planned towards a socialist-market economy in the PRC, and the key role of emerging social demand for forest environmental services through the 1990s.

4. Our case study stresses forests' dynamic potential for both generating new economic opportunities and preserving safety-nets for the poor. In a context of isolated autarchic conditions, bamboo proved to be the most attractive forest activity, given its flexible commercial and managerial properties, although poor farmers appeared to derive relatively lower incomes from bamboo when compared with middle and high income farmers. Similar results have been found in Anji and elsewhere in China.

Local livelihoods at Daxi - formerly based on physical work applied to intensive bamboo and natural forests harvests - have now been improved through a new forest-based opportunity – ecotourism – which has effectively raised and diversified material living standards. From another perspective, ecotourism at Daxi village shows a high degree of age and gender specialisation, with young women nowadays accessing to this important source of income. The downside is the potential reinforcement of traditional patriarchal values that could narrow women's opportunities to interact in the broader society.

5. As the economy develops, forest-related activities also evolve and in a context of rural integration into large urban regions with raising demands for environmental services, they may transform into landscape-based off-farm activities that have proven highly effective in rapidly increasing rural living conditions in Anji and elsewhere in China.

In the case of Daxi, forest-based ecotourism is currently the main engine of economic growth, but given its high entry costs it may only help the poor through a 'trickle-down effect', i.e. the rich may contract the poor's labour to do the forest harvest in the former's land or also as service personnel in their hostel business.

Consequently, new income inequalities have appeared associated to these burgeoning ecotourism. In this sense, Daxi could also be considered as a microcosm reflecting the social stratification and growing inequalities currently affecting China.

6. In our study area the Contract Responsibility System provided every household with an equal land-access right to local forest resources - especially bamboo, Chinese hickory and tea - thereby assuring a basic forest income source for the poor. More importantly, today equal land-access rights are still playing a key role by allowing poor farmers to benefit from CRS forests, from which they obtain the highest (in relative terms) bamboo income shares.

A local innovation applied to forest management in Anji County – the Inter-household Forest Compensation Scheme – was designed to neutralise the un-equalising effect of demographic changes over the initial egalitarian forest allocation (in 1984-85), so as to secure the local population's universal equal land-access right in rural China. The IFCS has, subsequently, enforced a *de facto* social contract between households with disproportionately higher and lower per-capita forest resources. Our results show that the scheme is still widely supported by the local population, fulfilling both equity and efficiency goals, and thus contributing to the emergence of the local FT.

Inherited from the Collective era, the IFCS has elements of a collectivised economy, redistributing – according to each household's current family size - 7-9% of forest harvest income among households in each hamlet (the former production team). At the same time, the remaining 93-91% of forest income is privately disposed by households, offering large room for individual economic incentives to increase land productivity. Following the implementation of the CRS and IFCS, during the 1986-2004 period, forest physical productivity raised by 33%.

7. Anji county in general and Daxi village in particular are widely appreciated for its cultural and aesthetic values. Indeed, the county is credited with having one of the sources of the Pu river, on which mouth the old Shanghai was originally built. Visiting the area has also a sense or 'returning to the origin', what raises high expectations among visitors.

   While Daxi keeps still most of its cultural and environmental charm, our results prove that a growing segment of tourists has expressed direct environmental concerns that signal a potential saturation of the local reception capacity and a backlash that could threaten the new economic opportunity in the long term.

   Likewise, the fast 'tourism bubble' could also undermine the control of economic activities by locals, as most benefits are increasingly accrued by Shanghai-based enterprises.

To conclude, the on-going Forest Transition in China has also marked a deep cultural change with regard to the human-forest relationship. It includes a change in the perception and relation with nature, an increasing commodification of land, as well as positive and negative land use changes. A trade-off between ecological integrity's loss and local livelihoods' improvement does exist, being legitimate to increase some rural ecological footprints though within certain thresholds that permits the rural poor to keep on the 'forest modernisation path'.

十一章。结论

从宏观规模研究问题而得到结论

1. 中国土地使用的最近变化是否符合森林转型的理论？

   中国曾经过长期的与历史相关的毁林过程，在六十年代达到了严重的程度。随着中国七十年代早期的人口转型和 1978 年改革开放政策的实施, 农业家庭承包责任制和林业联产承包责任制得以落实，乡镇企业在中国农村的也得以扩展。于是，促进了农业和非农业工作的奖励，提高了技术与环境的相互影响的效率和土地生产率，人工林面积得到了增长，数亿农民在八十年代脱贫致富。然而，对环境的影响也被扩大了；天然林的采伐也持续到了九十年代中期。

   在这些新的影响因素和之前长期的历史性毁林过程共同作用下，九十年代末出现了重大自然灾害例如 1997 年黄河极端旱灾与 1998 年长江极端洪灾。这些灾难驱使中国林业政策从强调数量改成强调质量，即从以森林面积与蓄积为目标变为以保护天然林、生物多样性以及生态服务功能为目标。

   中国森林面积从第一次全国森林资源普查(1973 年至 1976 年)的 12186 万公顷增加到第七次普查(2004 年至 2008 年)的 19545 万公顷，从而使森林蓄积从第一次全国森林资源清查普查的 865579 万立方米增加到第七次的 1372080 万立方米（国家林业局森林资源管理司，2010）。尽管如此，中国的森林还处于初期恢复阶段，这表现在一方面天然林还处于早期或中期的脆弱生态演替中，另一方面，新建立的人工林还未达到最高的生产潜力。

   从数量和质量的角度来看，中国土地使用的最近变化符合森林转型的理论，即天然林得到了稳定而人工林正在扩大规模了。除了这些进步以外，中国仍然面临着极大的环境挑战。这源于其庞大的人口、快速的工业化和经济发展以及迅速的城市化。同时这也产生了重大的社会和生态的压力。

2. 中国土地使用的这些变化是被哪些因素所产生的？

   中国的森林转型是在积极的政策指导下由人口,经济,技术以及环境等因素结合起来而产生。九十年代末，严重的环境危机引起了社会的广泛讨论，为新的林业政策的出台铺平了道路，同时也为中国的政治带去了新的理念比如“生态文明”。随着中国社会对环境的意识越来越高，“六大林业重点工程”（周生贤，2002）得以实施，天然林的流失和退化得以被阻止，并且通过人造林把森林边境扩展到了农业用地边缘地带。中国新的林业政策的制定和实施在改善这些与林业相关的环境问题时扮演了一个非常重要的角色。

   “中国森林转型”是与全球土地使用方式的改变相关的。首先，我们得考虑到它主要原因是实行中国新的林业政策，即天然林资源保护工程和退耕还林工程, 因为后者减少了国内供应的农林产品。当实行中国新的森林政策时，世界经济

全球化趋势又推动了中国进口农林产品的增长，这导致了发展中国家如巴西、东南亚、刚果盆地和俄罗斯的森林也受到了砍伐。对于这一点，我们应强调不能把对森林破坏的责任全部推给中国，因为森林损失和退化主要与富裕阶层不可持续的消耗模式有关，况且这种昂贵的环境消耗方式主要来源于发达国家。从这个角度来看，为了在全球规模内寻求能够有效解决森林破坏和贫困的方法，应增强在研究森林生态、社会和经济等方面的国际合作。

以浙江省安吉县大溪村为例，从微观规模研究问题而得到结论：

1. 大溪村土地使用最近有哪些变化？这些变化对环境价值带来了什么影响？

   大溪村土地使用的最近变化包括对环境的积极和消极的影响：

   一．当地天然次生常绿阔叶林在森林面积与蓄积上出现了相对的恢复，其桥木层拥有相当可观的 α 生物多样性指数，而且这种森林将来更具有碳与生物量固定增长的潜力。毛竹林由以前的集约型变为了现在的粗放型经营模式，其灌木层与草本层已经拥有了相当可观的 α 生物多样性指数。所以，天然常绿阔叶林与毛竹林粗放型经营对于林业可持续管理拥有补充环境保护的价值。

   二．大溪村的“森林现代化之路”正受到当地旅游定居点和基础设施的扩建与集约型经营的茶树种植的威胁（低生物多样性,低碳吸收率,低森林覆盖率）。而且“农家乐”所引起的旅游者的增多导致了当地生态自力更生能力的减弱以及对环境影响的增加和扩大。

2. 大溪村最近的与土地使用相关的变化是否符合森林转型的理论？

   我们的国际合作项目给在中国发生的〈森林转型〉提供了微观的实证支持。根据上述的当地土地使用的变化，我们可断定大溪村正在经历的森林转型是一场部分森林转型。其生态特征表现在森林增加和损失程无线性变化。于是，我们的案例大溪村“森林现代化之路”与中国森林转型的宏观过程呈现出共同的特征，即一边有着森林面积、蓄积的增加以及森林质量的变化,一边又有着定居点和基础设施的扩建以及对环境影响的扩大。

3. 村级土地使用的这些变化是被哪些因素所产生的？

   产生大溪的部分森林转型的原因有：对人口压力初期的相对控制、（通过初期农业家庭承包责任制与林业联产承包责任制）对农林土地工作的奖励，对具有弹性的集体平均主义机构的创立（林业经济调节利润再分配，即我们把它称为“家庭间森林补偿计划”The Inter-household Forest Compensation Scheme）以及当地经济从 1992 年以来的巨大变化。后者主要源于大溪村对关键基础设施（公路和水坝电站）的投资，中国从计划经济到社会主义市场经济体制的转型以及对生态旅游和森林生态服务功能的社会需求。

4. 大溪村的与森林有关活动对当地社会经济扮演了什么角色？大溪村的变化过程对当地生计有什么影响？

   我们的案例研究注意到了森林在产生新的经济机会以及为贫穷人口提供基本保障的方面的潜力。1992 年前在自给自足条件下，虽然贫困阶层农民比富裕或中产阶层农民从竹子种植中获得的相对收入更低，但是栽种竹林被证明是最有吸引力的造林活动。因为竹子具有商业及管理的灵活性。类似的结果，已经在安吉县、在中国的其他地区被发现了。

   大溪当地生计，曾经以与竹子有关的体力劳动为基础。现在则通过生态旅游的新机遇，提高并丰富了农林收入与非农林收入。农民生计得到了十分重要的改善。此外，大溪生态旅游在性别与年龄方面的分化有比较高的程度。年轻女性在其中占有较高的比例，并且从中得到了大量的收入。但是，生态旅游缺陷在于加强了传统的重男轻女的价值观。因为这些新景观林业活动可能会缩女士参加更广泛的社会活动的机会。

5. 大溪村级与新景观林业活动对当地生活条件的改变扮演了什么角色？

   随着中国经济的发展，在农村与城镇经济一体化的过程中，对生态服务功能的需求也开始增多。在这一过程中改变非农林收入的新景观林业活动能够有效地把安吉县农村以及中国其他农业地区的生活条件快速地提高起来。

   当地经济增长主要来源于森林生态旅游，虽然这能通过一种涓滴型经济效应帮助低收入农民提高生活条件（如为中高收入农民或者为“农家乐”工作），但是这些非农林收入的新景观林业活动也有很高的启动成本，而对低收入农民来说他们付不了出这样的高成本。于是，大溪当地生计显然出现了新的收入不平等。大溪村这个微观世界反映了中国现在的社会分层和不平等。

6. 大溪村的土地获得权制度对当地生计以及对进行当地森林转型扮演了什么角色？

   在我们的研究区，林业联产承包责任制为每个农户家庭都提供了对森林资源（毛竹、山核桃、茶叶）的公平的获得权，从而保证了贫困农民的基本生计。更重要的是，这种由林业联产承包责任制保障的公平的土地获得权，使贫困农民在总收入中能够得到相对较高的林业收入部分。

   安吉县关于森林管理的创新（家庭间森林补偿计划），是为了抵消由每个家庭的人口变化而产生的对八十年代初森林责任权平等分配的不公平影响，从而保证每个当地人都有公平的土地获得权。1986 年根据现有的森林资源在农户间人均地把森林责任权进行了平等性分配，但因在农户间存在的不同的家庭人口变化而造成了人均森林资源的差别。在当地受到广泛支持的家庭间森林补偿计划，促使多有人均森林资源的农户和少有人均森林资源的农户建立起了一个事实上的社会契约。这样满足了效率和公平两方面的要求，因此增加了当地森林转型发现的可能性。

源于集体经济概念的家庭间森林补偿计划与集体经济的利润分配形式相似，每年按照每个农户现有的家庭人口，把大溪村林业人均收入的 7%至 9%在每个村落小组（生产队）的农户之间进行再分配；而剩余的 93%至 91%则由农户们自行积累。随着林业联产承包责任制与家庭间森林补偿计划的落实，林业土地生产率在 1986 年至 2004 年其间有了 33%的实质增长。

7. 在当地森林转型中，来大溪的游客对新景观林业活动的看法如何？对基于森林的生态旅游，游客提了那种建议？

   安吉县和大溪村有着重要文化与景观价值。它们吸引了很多来自上海的游客，因为流经上海中心的黄浦江的源头就位于安吉县南部。于是游览安吉县便有了回归溯源的内涵。

   从大溪村生态旅游的微观角度来看，尽管来大溪的 80%的游客对其旅游经验表示满意，但是仍然有一部分游客担心当地对客流量的承载能力已经饱和。并且最近几年进入大溪村的游客流量已经威胁到了当地的可持续性发展。因此，这可能会破坏生态旅游的环境基础，从而使当地的旅游不再对游客有吸引力。再者，由于位于上海的旅游公司从中获取了越来越多的利益，那么如果出现旅游泡沫，由当地人所进行的经济活动就会受到影响。

总而言之，中国森林转型意味着一种深层次的人与森林之间的文化变化。这包括了人与自然的认知变化，当地土地的商品化以及林业土地使用的变化。理所当然，存在一个保持生态完整性与提高农民生活水平的权衡。为让低收入农民赶上森林现代化之路应该在保持合理的生态水平的同时增加农村相关的经济活动与再分配。

Capítulo 11. Conclusión

A NIVEL GENERAL:

1. China ha atravesado un largo proceso histórico de pérdida y degradación forestales alcanzando niveles dramáticos en la década de 1960. Desde principios de los años 1970 la RPC inició gradualmente una transición demográfica y una amplia Reforma con el consiguiente incremento de la productividad de la tierra y del crecimiento económico – millones de habitantes rurales dejando atrás la pobreza durante la década de los 1980. Sin embargo, se produjo también la amplificación de los problemas medioambientales, y los bosques naturales continuaron siendo degradados y deforestados hasta finales de los años 1990.

Con la llegada del siglo XXI, como resultado de la pérdida-degradación histórica y contemporánea de los bosques, la RPC estaba al borde de una crisis ecológica de gran magnitud manifestada con la sequía del Río Amarillo en 1997 y las inundaciones del Río Yangtzé en 1998. Estos episodios supusieron un nuevo punto de partida para la política forestal de China, cuya anterior orientación caracterizada por parámetros cuantitativos (área y volumen forestales) fue sustituida por criterios de calidad forestal (conservación de bosques naturales, biodiversidad y servicios ambientales).

El área y volumen forestales se han expandido desde 121,9 millones de ha y 8.655,9 millones de m^3 en el primer inventario nacional (1973-76) hasta los 195,5 mill ha y 13.720,8 millones m^3 en el último inventario (2004-2008) (Guojia linyeju senlin ziyuan guanglisi: 国家林业局森林资源管理司, 2010). Los ecosistemas forestales en la RPC hoy se encuentran en una incipiente fase de recuperación con unos bosques naturales todavía en fases tempranos o medios de sucesión ecológica y unas plantaciones forestales recientes que aún no han alcanzado su potencial productivo. Los cambios recientes de uso forestal en la República Popular China (RPC) – la estabilización de los bosques naturales y la expansión de las plantaciones forestales – se asocian de manera consistente a la teoría de la Transición Forestal (TF) desde un punto de vista cuantitativo. Dichos cambios también comienzan a ser coherentes con las teorías de la TF vinculadas al incremento paulatino en la calidad de los ecosistemas forestales.

A pesar de los logros alcanzados, China todavía presenta graves problemas medioambientales, enraizados tanto en sus procesos de rápida industrialización, desarrollo económico, urbanización como en el tamaño vasto de su demografía, características ambas que suponen importantes presiones socio-ecológicas a nivel nacional e internacional.

2. La integración política activa de causas demográficas, tecno-económicas y ambientales ha sido el factor principal promoviendo la TF en China. La crisis ecológica de finales de los 1990 tuvo una gran repercusión social, creando un amplio debate a nivel nacional y abriendo la puerta al diseño e implementación de una Nueva Política Forestal, como también al surgimiento del concepto de 'Civilización Ecológica' en un nivel oficial. La creciente concienciación ambiental en el seno de la sociedad china ha dado pues paso a la aplicación de los 'Seis Programas Forestales Clave' (*liu da linye zhongdian gongcheng*), lo cual ha supuesto el freno efectivo de la deforestación-degradación de los bosques naturales, y el avance de la frontera forestal recuperando terreno a las tierras agrícolas de productividad marginal. La acción humana a través del diseño, participación e implementación de políticas forestales ha desempeñado una función fundamental en el replanteamiento y solución de problemas ambientales vinculados a los bosques.

La TF en China ha estado asociada a un desplazamiento global de impactos territoriales sobre los bosques tropicales de otros países en desarrollo (Brasil, Sureste Asiático, Cuenca del Congo) y los bosques boreales de Rusia (Sun et al, 2004; Meyfroidt et al, 2010; Putzel et al, 2011; Qiang et al, 2013). La responsabilidad de dichos efectos no puede cargarse exclusivamente sobre la parte china, como también en grupos de ingresos altos con patrones de consumo altamente insostenibles mayoritariamente asociados a los denominados 'países desarrollados'. La cooperación internacional debiera reforzarse con el fin de encontrar soluciones ecológicamente plausibles a los problemas de pobreza y deforestación.

A NIVEL LOCAL:

1. Los bosques de Daxi están atravesando una recuperación de los bosques autóctonos secundarios perennifolios en términos de área y densidad (asociados a un índice elevado de diversidad Alfa en el estrato arbóreo y con un gran potencial de absorción de carbono) y también por una generalización de un modelo de gestión extensivo de las plantaciones de bambú (con un índice elevado de diversidad Alfa en el estrato herbáceo y arbustivo). Por otro lado, la expansión de los usos urbanos, infraestructuras y de unas plantaciones intensivas del té altamente impactantes (con bajos índices de diversidad, baja absorción de carbono y baja cobertura forestal) ha supuesto el crecimiento de la huella ecológica local e incremento de la degradación y desplazamiento ambientales.

2. Nuestro estudio de caso en el municipio de Daxi en Anji (provincia de Zhejiang) nos proporciona unos datos empíricos de alto detalle que permiten, a un nivel local, analizar y comprender el proceso de la TF en la RPC. En las tres últimas décadas, se ha producido un incremento agregado del área, densidad y calidad forestales, aunque en algunas zonas se han dado también pérdidas de valores forestales. Simultáneamente, se ha producido la erosión de la autosuficiencia ecológica local como también del incremento de impactos medioambientales asociados a la nueva actividad económica. Los cambios producidos a nivel local representan una 'transición forestal parcial' caracterizada por ganancias y pérdidas forestales acontecidas de un modo no-lineal. Este microcosmos efectivamente tiene ciertas similitudes con el proceso general de TF que se ha observado en China, en el que se ha producido una recuperación incipiente de los bosques naturales así como una expansión urbana ligada al incremento de la huella ecológica.

3. Las causas de esta TF parcial local – la 'ruta de modernización forestal' – se localizan en un relativo control de la presión poblacional, la temprana mejora de los incentivos laborales en la productividad forestal (Sistema de Responsabilidad Familiar y Contractual), el establecimiento de una institución igualitaria-colectiva altamente resiliente (el Sistema de Compensación Forestal Inter-familiar), y la profunda transformación del modo local de producción hacia un creciente ecoturismo forestal durante la década de los 1990. Este último cambio se atribuye a la inversión crítica en infraestructuras (carretera y presa), la amplia transición desde una economía colectiva hacia una economía 'socialista de mercado', y la creciente demanda social de servicios forestales ambientales desde la década de 1990.

4. Nuestro estudio de caso proporciona evidencia sobre el potencial dinámico de los bosques en la generación tanto de nuevas oportunidades económicas como en la conservación de redes de seguridad económica para los pobres. En un contexto de autarquía, el bambú ha demostrado la actividad forestal más atractiva, dadas sus propiedades flexibles de comercialización y gestión forestales, aunque los campesinos más pobres tienen rentas del bambú considerablemente menores a las de los grupos de rentas medias y altas. Resultados similares se han encontrado en Anji y en otras regiones de China.

El modo de vida campesino en Daxi – anteriormente basado en la inversión de trabajo en las plantaciones intensivas del bambú y en la extracción de leña de los bosques naturales – ha sido recientemente mejorado a través de una nueva oportunidad económica – el ecoturismo – que ha supuesto el incremento efectivo y diversificación de la renta per cápita. Por otro lado, el ecoturismo de Daxi hoy presenta un alto grado de especialización por género/edad, esta fuente de ingresos siendo alcanzada en buena parte por mujeres jóvenes. El efecto negativo potencial es el fortalecimiento de valores patriarcales tradicionales que podrían reducir las oportunidades de interacción de las mujeres en un nivel amplio de la sociedad rural.

5. Conforme la economía se desarrolla las actividades forestales también evolucionan y, en un contexto de integración rural en una economía urbana con creciente demanda de servicios medioambientales, pueden transformarse en actividades terciarias asociadas a valores forestales del paisaje que han demostrado ser altamente efectivas en la mejora de la calidad de vida de la población rural tanto en Anji como en otras regiones de China.

En el caso de Daxi, el ecoturismo forestal es el principal motor del crecimiento económico pero, debido a sus altos costes de capital de entrada, tan sólo puede contribuir a las rentas bajas mediante un efecto económico 'de goteo', es decir, los grupos de rentas altas pueden contratar la fuerza de trabajo de los pobres para trabajar en las parcelas forestales contratadas por los primeros o también para trabajar como personal de servicio en sus negocios de hostelería.

Como resultado, se han producido nuevas desigualdades asociadas al boyante ecoturismo forestal. Daxi representa un microcosmos que contiene grandes similitudes con la estratificación social y crecientes desigualdades hoy presentes en China.

6. En nuestra zona de estudio el Sistema de Responsabilidad Contractual proporciona a cada hogar con un derecho igualitario de acceso a los recursos forestales locales – especialmente bambú, nogal chino y té – en consecuencia asegurando una renta básica forestal para el grupo de renta más pobre. Más importante todavía, el derecho igualitario de acceso a la tierra hoy está desempeñando una función especial al ofrecer a los hogares pobres las rentas forestales relativas más altas (cosechas del bambú).

Una institución innovadora local aplicada a la gestión forestal en Anji – el Sistema de Compensación Forestal Inter-familiar – fue diseñado para neutralizar los efectos des-ecualizadores de los cambios demográficos familiares sobre la asignación igualitaria inicial de los recursos familiares (realizada en 1984-85), con el fin de preservar el derecho igualitario (universal en la China rural) de acceso a la tierra por la población rural. El Sistema de Compensación Forestal Inter-familiar, por ende, ha conseguido aplicar un contrato social de facto entre hogares con recursos forestales per cápita desproporcionadamente mayores y menores, siendo apoyado por la mayoría de la población local, alcanzando objetivos de equidad y eficiencia y facilitando el surgimiento de una TF local.

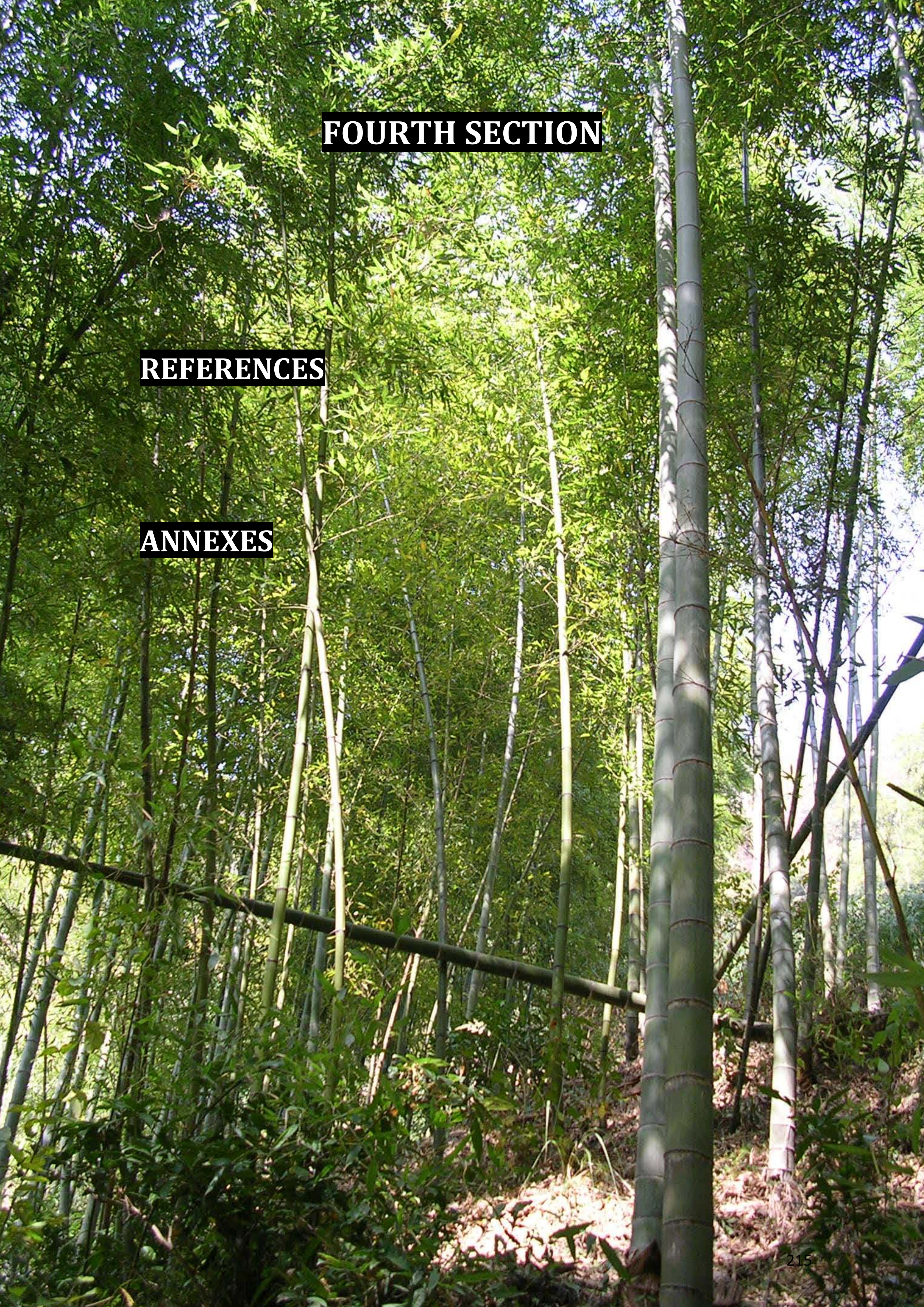
Heredado de la etapa colectiva, el SCFI presenta elementos de una economía colectivizada, que redistribuye – de acuerdo con los tamaños actuales familiares de cada hogar – aproximadamente entre el 7% y el 9% de la renta per cápita de la cosecha forestal entre los hogares pertenecientes a cada aldea (antiguo equipo de producción); el 93% - 91% de la renta forestal restante siendo acumulada por los hogares de modo privado. Después de la implementación del Sistema de Responsabilidad Contractual y del Sistema de Compensación Forestal Inter-familiar, durante el período 1986-2004, la productividad física forestal se vio incrementada en un 33%.

7. La región de Anji – en un plano general – y el municipio de Daxi – en particular – son muy apreciados por sus valores culturales y estéticos. De hecho, Anji está reconocido por albergar una de las cabeceras del río Pu, sobre cuya desembocadura se erigió el casco antiguo de Shanghái. La visita a la zona tiene un sentido de 'vuelta a los orígenes', que crea altas expectativas entre los turistas.

Mientras Daxi todavía conserva la mayor parte de su encanto cultural y ecológico, nuestros resultados manifiestan que existe un segmento creciente de visitantes con una preocupación medioambiental directa apuntando a una incipiente saturación de la capacidad de carga del ecosistema local y un efecto rebote que podría amenazar las bases de la futura actividad económica.

Una 'burbuja turística' podría asimismo cercenar el control de la economía por parte de la población local, dado que la mayoría de los beneficios son obtenidos por dos empresas con base en Shanghai.

Para concluir, el proceso actual de Transición Forestal en China ha supuesto un profundo cambio cultural respecto a la relación humana-forestal. Incluye un cambio en la percepción y relación con la naturaleza, una creciente mercantilización de la tierra, así como otros cambios de usos tanto positivos como negativos. Con todo, existe un compromiso/intercambio entre la pérdida de biodiversidad y el incremento del nivel material de la población local, siendo legítimo incrementar la huella ecológica aunque dentro de ciertos umbrales que así permitan a la población rural pobre continuar en la 'ruta de la modernización forestal'.



FOURTH SECTION

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ANNEXES

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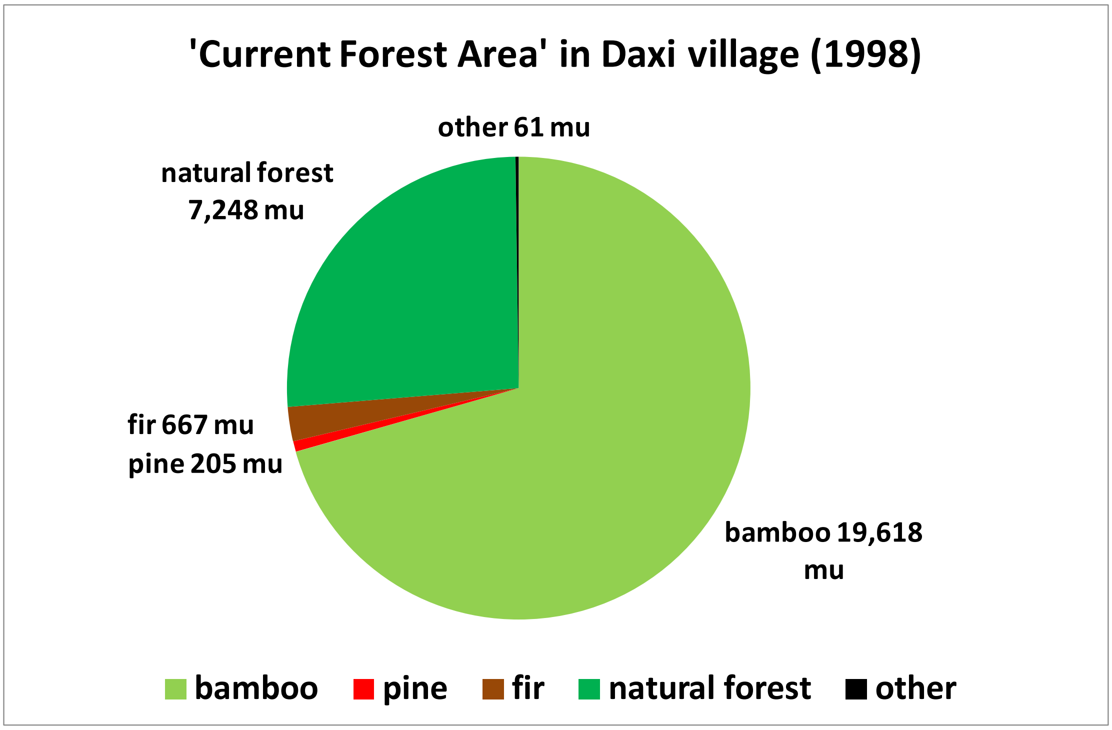
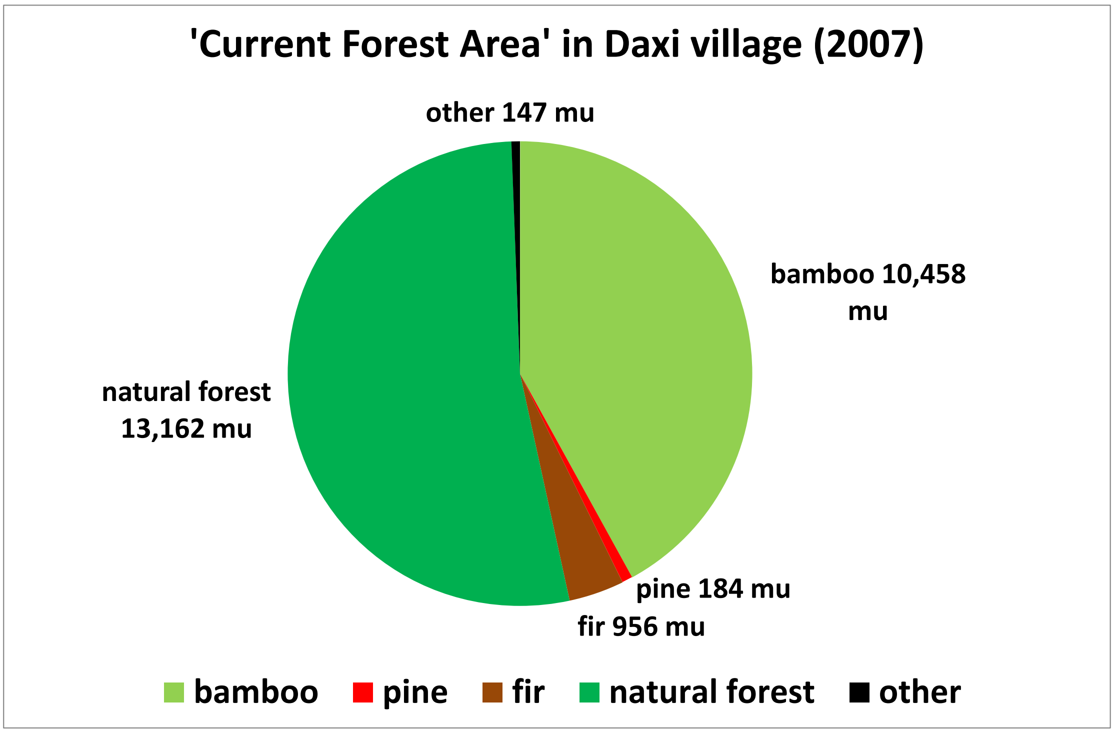
ANNEX 1. Tianhuangping Forest Station Statistics – Forest Structure in Daxi.





ANNEX 2. Land-use Transition Probability 1988-2005 (based on SPOT images analysis).

transition（ha)	bamboo_05	conifer_05	natural forest_05	water_05	agriculture_05	tea_05	shrub_05	bare land_05	settlement_05
bamboo_88	395,8	7,3	243,5	14,4	24,1	76,9	117,0	66,2	1,9
conifer_88	1,6	6,3	0,4	0,0	1,5	0,0	0,7	3,2	0,4
natural forest_88	166,9	6,6	623,2	7,1	9,0	14,5	42,4	65,1	1,7
water_88	0,0	0,2	0,1	0,0	0,0	0,0	0,0	0,1	0,0
agriculture_88	27,8	0,5	13,6	0,4	47,9	13,5	9,3	22,0	17,8
tea_88	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
shrub_88	85,6	0,2	19,9	2,7	6,5	17,9	35,1	9,6	0,7
bare land_88	31,3	0,4	14,2	7,1	14,4	10,4	10,5	27,3	11,2
settlement_88	0,7	0,0	1,2	0,0	1,9	0,4	0,1	0,1	4,1
total_88	709,7	21,4	916,0	31,7	105,2	133,5	215,0	193,6	37,8

transition (%)	bamboo_05	conifer_05	natural forest_05	water_05	agriculture_05	tea_05	shrub_05	bare land_05	settlement_05
bamboo_88	41,8	0,8	25,7	1,5	2,5	8,1	12,4	7,0	0,2
conifer_88	11,4	44,8	2,8	0,0	10,4	0,0	4,9	23,1	2,6
natural forest_88	17,8	0,7	66,5	0,8	1,0	1,5	4,5	7,0	0,2
water_88	0,0	55,0	13,2	6,0	0,0	0,0	0,0	25,8	0,0
agriculture_88	18,2	0,3	8,9	0,3	31,4	8,9	6,1	14,4	11,6
tea_88	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
shrub_88	48,0	0,1	11,1	1,5	3,7	10,0	19,7	5,4	0,4
bare land_88	24,7	0,3	11,2	5,6	11,4	8,2	8,3	21,5	8,9
settlement_88	7,9	0,0	13,9	0,1	22,3	4,4	1,1	1,6	48,8

ANNEX 3. Farmers' Questionnaire, delivered in 2005 (summer).

Code: ___________

Date: ____________ Investigator: ________________

Name of Household's head: ___________________ ☐

Group: __________

1. **Family structure at present**

Household		Family number	Labor	
Gender	Age		From the family	Hired

2. **Land-use structure** (mu)

Current situation (2005)

Agriculture		Forestry								
Rice land	Dry land	Moso		Hickory	Tea		Other bamboo	Timber (firs, pines	Natural forest (fuel)	Others
		ON	OFF		W	G				

- Were your land use areas significantly different in 2003 and 2004? In what extent? (indicate resource and mu)

- Since HRS was implemented, have you seen any land use changes in your group? What has been the general trend? Any change from agriculture to mountain land, and viceversa?

- Would you like to do any land use change in your plot? Why? What would the change consist on?

- In case of changing land uses, would you expect to get benefits in the short/medium/long term? Years of return: ____ What would it be your criteria for increasing one resource's area or the others'? What resource's natural (growth rate and productivity) and economical (price) characteristics adapts better to your current economical situation?

- **Only for group 4 and group 5's farmers**: is all of your moso land currently (2005) at off-year production?

Forest production and forest net income (2003-2004)

	Moso culms		Moso shoots		Moso by-products		Small bamboo shoots		Other bamboo products	
	jin	yuan	jin	yuan	jin	yuan	jin	yuan	jin	yuan
2003 sold										
2003 self.										
2004 sold										
2004 self.										

self.= self-consumed products

	Hickory		White Tea		Green Tea		Timber		Natural forest (fuel, wood, food, …)		Other forest by-products	
	jin	yuan	jin	yuan	jin	yuan	jin	yuan	jin	yuan	jin	yuan
2003 sold												
2003 self.												
2004 sold												
2004 self.												

Labor in charge of each resource-product unit (2003-2004)

Nº labour-days	Moso culms	Moso shoots	Moso by-products	Small bamboo shoots	Other bamboo products
2003					
2004					
Nº Labour-days	Hickory	White tea	Green Tea	Timber	Natural forest
2003					
2004					

5. **Net income structure in Yuan (2003-2004)**

(Without including none self-consumed products)

Year	Agriculture	Forestry	Industry (forest factory too)	Tourism, 3rd sector	Others	Total (Yuan)
2003						
2004						
Specify kind of work						

(In case they grow rice) Are you receiving any compensation? From which administration level?

2003 Yuan / rice mu = _____ 2004 Yuan / rice mu = _____

Non-forest self-consumed products:

Year	Agriculture				Breeding		Total (Yuan)
	item (jin)	est. value	item (jin)	est. value	item (jin)	est. value	
2003							
2004							

6. **Taxes paid (2003-2004)**

year	Agriculture	Forestry	Industry (forest factory too)	Tourism, 3rd sector	Others	Total (yuan)
2003	---	---				
2004	---	---				

7. What is the situation of the natural (fuel) forest in your group?

Very good Good Normal Not Good Not Good at all

Don't know

In your plot, how do you use the natural (fuel) forest ("ecological closed forest")?

9. Do farmers get any resource from the collective forests? What kind?

THE INTER-HOUSEHOLD FOREST COMPENSATION SCHEME (IFCS)

a) Your family… 1 Receives 2 Pays 3 Neither receives nor pays

b) Amount to pay (-) /receive (+) in 2003 = ______ ; 2004 = _____

c) The compensation you <u>receive</u> is: directly / indirectly paid (discounted on taxes)

The compensation you <u>pay</u> is: directly / indirectly paid (through taxes)

d) You think the amount you <u>receive</u> is… (don't ask those who neither receive nor pay)

Very Good Good Enough Little Very Little

You think the amount you <u>pay</u> is…

Convenient Suitable Enough More than enough Excessive

e) The IFCS's level of fairness is…

Very High High Middling (so-so) Low Very Low

Why?

f) The amount you pay / receive, for your household's economy, has a…

Very important (Quite) Important Some Little important Not important at all

<u>weight.</u>

g) You think the central prices (decided within village) of the IFCS are:

Very High High Reasonable Low Very Low

For any special resource? Moso Hickory Tea Other bamboo

h) You think the IFCS's rates (%) applied in your group are:

Very High High Reasonable Low Very Low

For any special resource? Moso Hickory Tea
Other bamboo

i) You think the base number applied in your group are:

Very High High Reasonable Low Very Low

For any special resource? Moso Hickory Tea
Other bamboo

k) Must the IFCS be held? It should long (how many years):

No more (0 years) "_____" years (> 0)

l) Currently, in your group, the IFCS's level of implementation (in practice) is…

Very High High Middling (so-so) Low Very Low

m) On your global opinion, the IFCS is…

Very Good Good Middling (so-so) Not Good Not Good at all

n) Are there any improvements that could be applied to the IFCS? Any alternatives?

ANNEX 4. The Inter-household Forest Compensation Scheme (IFCS)

The IFCS works as a Collective redistributive mechanism which allocates forest yearly-produced income across all households forming each hamlet according to their current family size. The result is that households with shrinking family size (therefore with increased forest per capita benefits due to demographic changes) pay some compensation - a percentage of forest management benefits around 7-9% of total forest income – to households with expanding family size (with decreased forest per capita benefits due to demographic changes). In practice, the IFCS is applied within the frame of the 'One Child' policy, as children exceeding the stipulated number in that policy are not counted by the IFCS and thus would not receive their corresponding compensation. In this manner, the IFCS does not stimulate households to have more children than those permitted by the 'One Child' policy.

Figures A.4.1 and A.4.2 provide the reader with an explanation of how the IFCS works within a given hamlet. The IFCS contains the production and redistribution process relative to bamboo, Chinese hickory and tea; for simplification, here we have just displayed how the scheme works in the case of bamboo (is the very same procedure for Chinese hickory and tea, with the exception that in these two cases there is only a single base number, as explained in chapter 8).

In Figure A.4.1, a diagram explaining the allocation of bamboo resources in 1984 and 1985, respectively, is presented. Those were the years when the Contract Responsibility System (CRS) was implemented for the first time at Daxi village. The CRS consisted of the dismantling gradual process of the People's Communes, by which forest plots were assigned in usufruct right to each household while maintaining the Collective property of land (held by the Village Committee). This process of transferring management authority from the former *production team* (hamlet) towards individual households rested on an egalitarian distribution principle.

In order to implement the CRS policy, forest teams measured the existing bamboo resources in on-year plots within each hamlet, i.e. in 1984 they went to those bamboo plots which were sprouting new shoots and weighted in jin[1] the amount of culms at both the 2-year-old stratum and 4-year-old stratum. In the next year, 1985, they went to the other remaining bamboo plots which now were sprouting new shoots and weighted their 2-year-old and 4-year-old culms. Moreover, within each 1984 and 1985 survey, bamboo plots were also measured in a step-wise way: firstly, those plots located at the foot of the mountains; secondly, those located at the middle of the mountain and finally those at the top of the mountains.

Once each hamlet's bamboo resources were measured, the forest team proceeded to allocate those resources to individual households under an egalitarian basis depending on family size. Besides, in order to provide households with similar quality of bamboo plots within each hamlet, some households were given bamboo plots located at the middle of the

[1] Jin is a Chinese weight unit equalling 0.5 kg.

mountain while remaining households were given both foot and top of the mountain's bamboo plots. This allocation was done randomly, as a lottery assignment. As a final result of the CRS allocation, every household within the same hamlet had the very same per capita bamboo forest resources with comparable qualities.

The hamlet's total bamboo resource had been previously divided by the hamlet's total population (whether in 1984 or 1985), thereby obtaining a per capita Bamboo base number (jin/person) being the amount of resource to be allocated to each person within the hamlet. Then, each household would obtain the exact amount of bamboo resource equalling its family size (number of members) multiplied by the per capita bamboo base number. The same process would be followed in 1985 (See Figure A.4.1). In the case of Chinese hickory and tea, these resources would be later allocated to households at the end of 1980s and also following this egalitarian procedure. Nonetheless, in the case of these two forest crops, allocation surveys were just done in one year (being a much simpler process than that of bamboo).

This is the process by which the CRS was implemented through the 1980s, generating a deep institutional and social transformation from the former People's Communes towards a decentralised household forest management, by that time, still within a planned economic collective system. It is during this forest politico-economic transition when the Inter-household Forest Compensation Scheme became a reality.

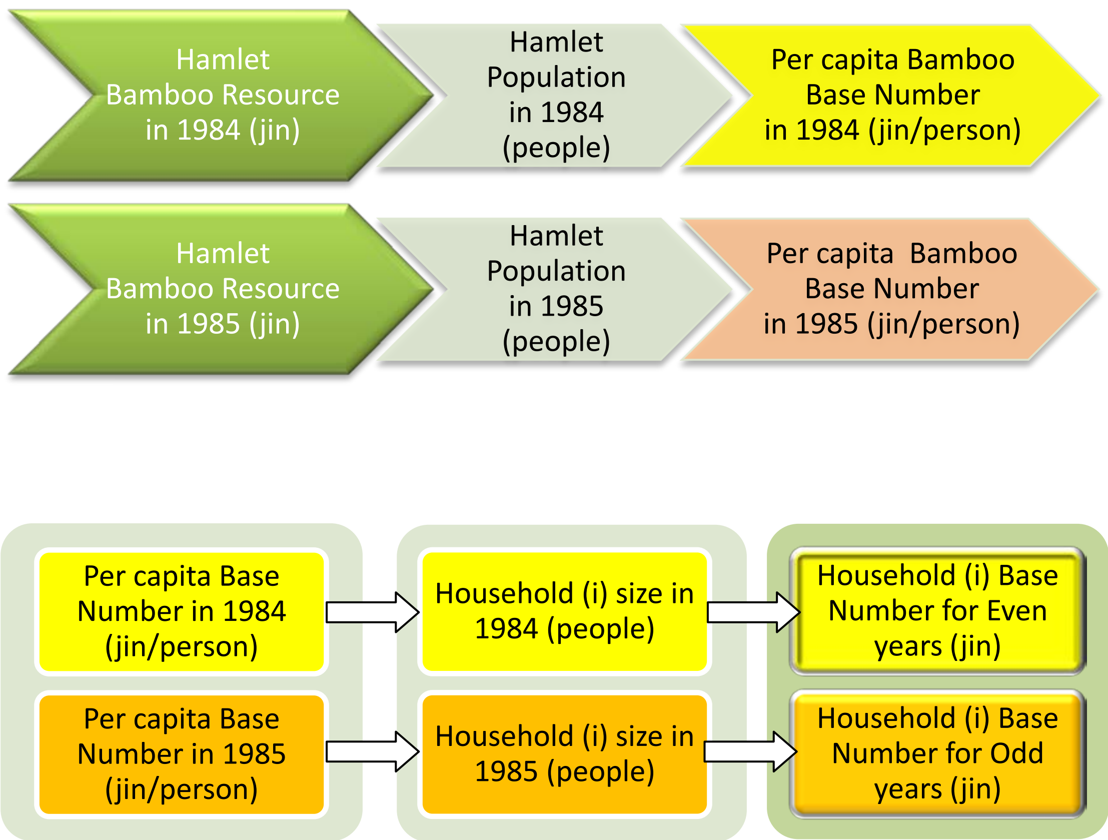


Figure A.4.1. Household allocation process of bamboo forest resources in 1984 and 1985.

The origins of the IFCS can be traced back to a historical period when egalitarianism was a key determinant in the formulation of the early 1980s' Land Reform and when Chinese economy was still largely planned and collectivised. After the CRS had been implemented, due to the local livelihoods' highly reliance on forest resources (especially bamboo) and the scarcity of land, household demographic changes seemed to be hindering rural development. After a few years, the original egalitarian allocation of resources was skewed, as in the late 1980s some households with growing family size (relative to 1984-85) had little land to work in, whereas other households with decreasing family size (relative to 1984-85) had an excess of land.

This problem – the distortion of the original land allocation of natural resources among households – is a typical one in the Chinese agricultural context (see chapter 8 of this PhD for a detailed background discussion on the subject). Indeed, given that agriculture usually is associated to short-term economic returns, Anji households did resort to periodic land reallocations for each 3-5 years at the beginning of the Reform. However, the case of forestry and bamboo is quite more complex, as forest activities are usually connected to longer economic returns to inputs. So periodically redistributing forest land to households could slow down individual economic incentives, considerably limit the scope of investment and jeopardy the sustainability of forest management.

Instead of forest land reallocation, some households in Anji decided to economically compensate each other when some demographic changes had occurred. This was still done under the collective-planned economy, and will help us to understand how the IFCS actually works. Then, households with shrinking bamboo land (due to increases in household members) were paid some sort of compensation (in work points) by households with augmenting bamboo land (due to decreasing household size). Concretely, the origins of the IFCS date back to the late 1980s.

The system of the IFCS works as explained in Figure A.4.2. Let's say, it is a way of conceiving decentralised household forest management as if it was working still under a collective-planned economy.

What is happening is that every household's bamboo resource is yielding an economic virtual profit: p(t) in yuan/jin (where t refers to the year for which the IFCS is applied). Each household's allocated bamboo resources (Base number 1984 for even years and Base number 1985 for odd years) produce yearly 'virtual profits' [p(t)], rendering each household's virtual net profit. Then, all households' 'virtual net profits' are merged together (as if they were handed to the Collective – hamlet) rendering a 'Total virtual net profit' (controlled by the Collective).

This amount, the Total virtual net profit [in Figure A.4.2 would equal to = Virtual net profit (1, t) + Virtual net profit (2, t) + Virtual net profit (3, t)], is divided by the total population of the hamlet in the current year t [total population (t)= n(1,t) + n(2,t) + n(3,t)], equalling to 'Redistributed profit per capita' (yuan/person). This latter amount is then assigned to each household (as if it was redistributed to each household by the Collective), according to its family size in year t, equalling to = 'Redistributed profit per capita' x n(1,t) = 'Redistributed profit (1,t)' [for household 1]. The final result for household 1 in year t is Q(1,t) = 'the assigned redistributed amount' [Redistributed profit (1,t)] minus 'the handed amount to the Collective' [Virtual net profit (1, t)]. Q(1,t) is the amount that household 1 has to receive (when redistributed profit is higher than virtual net profit) or to pay (when lower), it could even be '0' (in case the redistributed profit = virtual net profit).

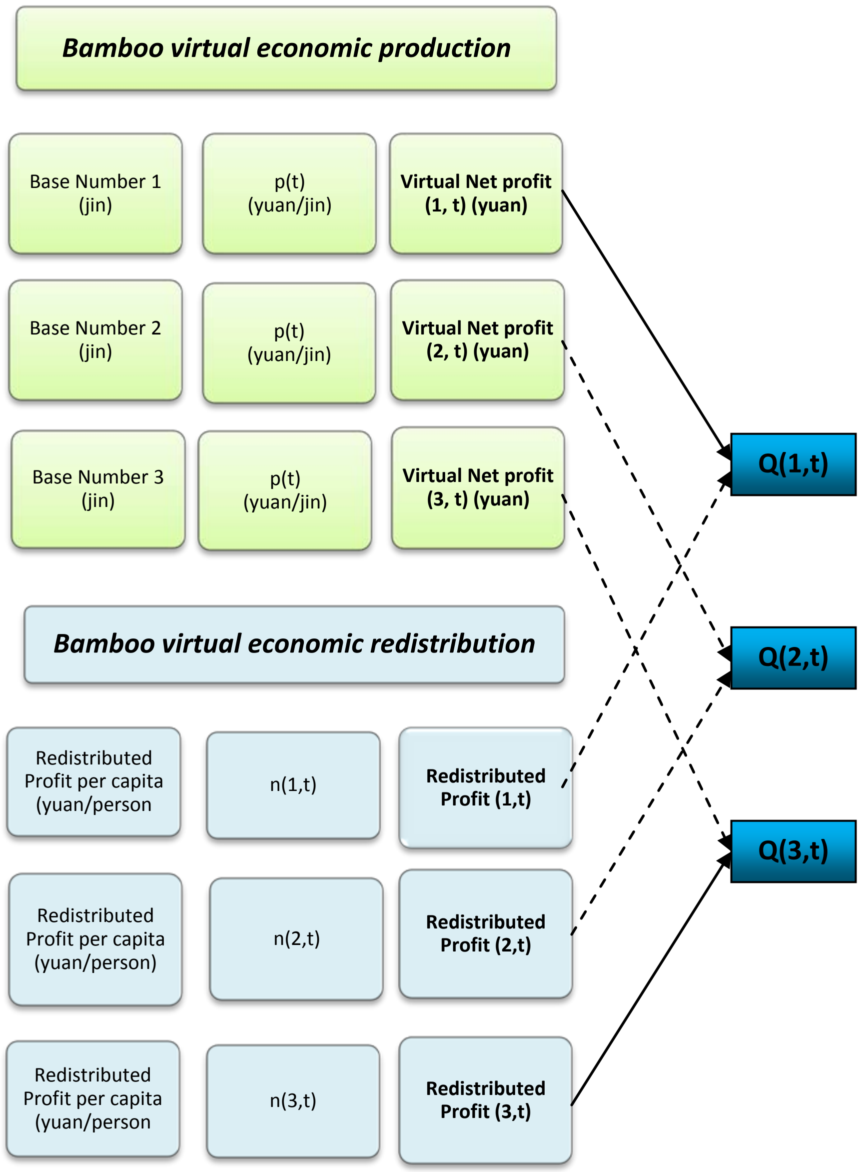


Figure A.4.2. Theoretical example of Production and Redistribution mechanisms in the IFCS for a hypothetical hamlet composed of three households. 1, 2, 3 refer to three different households; Base number is the total amount of contracted bamboo resource by each household (in even years 1984 Base number is employed, and 1985 Base number for odd years); t refers to the year in which the IFCS is applied; n(1,t) refers to the number of members that household1 presents in year t.

Put in other words, Collective Bamboo land, under household management, still produces yearly benefits that accrue to the Collective which, in turn, redistributes them back to households according to their current family size and the current total hamlet population. From the individual household perspective, let's suppose in 1990, a given household holds a certain bamboo resource (in jin, and proportional to its number of members in 1984) which produces a certain virtual net profit (according to the year's value of the virtual profit). Then it happens as if this given household handed all this virtual net profit to the Collective (hamlet), and then the household would receive from It a prorated amount (the redistributed profit, proportional to its number of members in 1990). In reality, this given household need neither to hand the Collective all that virtual net profit nor to receive from It the redistributed profit, i.e. the household only receives or pays the difference Q(i,t).

This has been a very effective way of assuring the workability of the IFCS. It works as a Collective but the only economic flow is done only in differential terms. This forest economic model applies to bamboo in even and odd years (respectively, with the 1984 and 1985 base numbers), and also to Chinese hickory and tea. The model resembles the economic functionality of a Collective and has been quite effective in implementing a sustainable forest management.

In the next table A.4.1 we show an example of how the IFCS worked at former production team 1 in 1992. In that year the Total virtual net profit was 46,391 yuan, which theoretically would have been handed by all households to the Collective and later redistributed by this latter back to households (according to their current family size in 1992). To simplify its workability, the IFCS is done in differential terms (households only receive or pay the final amount Q(t)) in a manner that the actual economic flow was 4,333 yuan. This was the total amount contributed by paying households, which was transferred to receiving households.

THE INTER-HOUSEHOLD FOREST COMPENSATION SCHEME IN FORMER PRODUCTION TEAM Nº1															
(t) = 1992	n	n(i,hrs)*	[n(i,1992)×N(hrs)/N(1992)]-n(i,hrs)	base number (i,j) (jin)			virtual net profit (i,1992) (yuan)				redistributed profit (i,1992)	Q(i,t)	Paid	Received
(i)	(i,1992)			Moso (j=1)	Hickory (j=2)	Tea (j=3)	Moso (j=1)	Hickory (j=2)	Tea (j=3)	Total	rdp = 289.9 yuan			
				bpc = 12400	bpc = 9.4	bpc = 17.6	p = 2.28 yuan/100 jin	p = 0.72 yuan/jin	p = 0.75 yuan/jin					
1	5	3,00	1,78	37190	28,3	52,7	849,72	20,38	39,53	909,62	1449,73	540,10		540,10
2	4	4,00	-0,18	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	1159,78	-53,05	53,05	
3	5	5,00	-0,22	62000	47,1	88	1416,20	33,91	66,00	1516,11	1449,73	-66,39	66,39	
4	3	3,00	-0,13	37200	28,3	52,7	849,72	20,38	39,53	909,62	869,84	-39,79	39,79	
5	2	2,00	-0,09	24800	18,3	35,2	566,48	13,18	26,40	606,06	579,89	-26,17	26,17	
6	4	4,00	-0,18	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	1159,78	-53,05	53,05	
7	1	1,00	-0,04	12400	9,4	17,6	283,24	6,77	13,20	303,21	289,95	-13,26	13,26	
8	6	4,00	1,74	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	1739,67	526,84		526,84
9	3	2,00	0,87	24800	18,8	35,2	566,48	13,54	26,40	606,42	869,84	263,42		263,42
10	6	6,00	-0,26	74400	56,5	105,6	1699,44	40,68	79,20	1819,32	1739,67	-79,65	79,65	
11	2	2,50	-0,59	31000	23,5	44	708,10	16,92	33,00	758,02	579,89	-178,13	178,13	
12	4	2,50	1,33	31000	23,5	44	708,10	16,92	33,00	758,02	1159,78	401,76		401,76
13	4	5,00	-1,18	62000	47,1	88	1416,20	33,91	66,00	1516,11	1159,78	-356,33	356,33	
14	4	4,00	-0,18	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	1159,78	-53,05	53,05	
15	4	3,00	0,83	37200	28,3	52,7	849,72	20,38	39,53	909,62	1159,78	250,16		250,16
16	3	3,00	-0,13	37200	28,3	52,7	849,72	20,38	39,53	909,62	869,84	-39,79	39,79	
17	6	7,00	-1,26	86800	65,9	123,2	1982,68	47,45	92,40	2122,53	1739,67	-382,86	382,86	
18	5	5,00	-0,22	62000	47,1	88	1416,20	33,91	66,00	1516,11	1449,73	-66,39	66,39	
19	2	2,00	-0,09	24800	18,8	35,2	566,48	13,54	26,40	606,42	579,89	-26,53	26,53	
20	2	2,00	-0,09	24800	18,8	35,2	566,48	13,54	26,40	606,42	579,89	-26,53	26,53	
21	2	1,00	0,91	12400	9,4	17,6	283,24	6,77	13,20	303,21	579,89	276,68		276,68
22	4	3,00	0,83	37200	28,3	52,7	849,72	20,38	39,53	909,62	1159,78	250,16		250,16
23	3	4,00	-1,13	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	869,84	-343,00	343,00	
24	7	3,00	3,69	37200	28,3	52,8	849,72	20,38	39,60	909,70	2029,62	1119,92		1119,92
25	1	1,00	-0,04	12400	9,4	17,6	283,24	6,77	13,20	303,21	289,95	-13,26	13,26	
26	3	4,00	-1,13	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	869,84	-343,00	343,00	
27	5	5,00	-0,22	62000	47,1	88	1416,20	33,91	66,00	1516,11	1449,73	-66,39	66,39	
28	4	3,00	0,83	37200	28,3	52,7	849,72	20,38	39,53	909,62	1159,78	250,16		250,16
29	4	5,00	-1,18	62000	47,1	88	1416,20	33,91	66,00	1516,11	1159,78	-356,33	356,33	
30	4	4,00	-0,18	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	1159,78	-53,05	53,05	
31	3	4,00	-1,13	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	869,84	-343,00	343,00	
32	1	1,00	-0,04	12400	9,4	17,6	283,24	6,77	13,20	303,21	289,95	-13,26	13,26	
33	4	4,00	-0,18	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	1159,78	-53,05	53,05	
34	5	5,00	-0,22	62000	47,1	88	1416,20	33,91	66,00	1516,11	1449,73	-66,39	66,39	

Table A.4.1. Calculations corresponding to the IFCS at former production team 1, in 1992. (It continues in next page).

(t) = 1992	n	n(i,hrs)*	[n(i,1992)×N(hrs)/N(1992)]-n(i,hrs)	base number (i,j) (jin)**			virtual net profit (i,1992) (yuan)**				redistributed profit (i,1992)	Q(i,t)	Paid	Received
(i)	(i,1992)			Moso (j=1)	Hickory (j=2)	Tea (j=3)	Moso (j=1)	Hickory (j=2)	Tea (j=3)	Total	rdp = 289.9 yuan			
				bpc = 12400	bpc = 9.4	bpc = 17.6	p = 2.28 yuan/100 jin	p = 0.72 yuan/jin	p = 0.75 yuan/jin					
35	4	2,33	1,50	28892	21,9	41	659,95	15,77	30,75	706,47	1159,78	453,31		453,31
36	1	1,33	-0,37	16492	12,5	23,4	376,71	9,00	17,55	403,26	289,95	-113,31	113,31	
37	1	1,34	-0,38	16616	12,6	23,6	379,54	9,07	17,70	406,31	289,95	-116,37	116,37	
38	4	4,00	-0,18	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	1159,78	-53,05	53,05	
39	4	5,00	-1,18	62000	47,1	88	1416,20	33,91	66,00	1516,11	1159,78	-356,33	356,33	
40	3	3,00	-0,13	37200	28,3	52,7	849,72	20,38	39,53	909,62	869,84	-39,79	39,79	
41	6	6,00	-0,26	74400	56,6	105,4	1699,44	40,75	79,05	1819,24	1739,67	-79,57	79,57	
42	3	3,00	-0,13	37200	28,3	52,7	849,72	20,38	39,53	909,62	869,84	-39,79	39,79	
43	5	6,00	-1,22	74400	56,5	105,6	1699,44	40,68	79,20	1819,32	1449,73	-369,59	369,59	
44	4	4,00	-0,18	49600	37,6	70,4	1132,96	27,07	52,80	1212,83	1159,78	-53,05	53,05	
Total	**160**	**153,00**	**0,00**	1897190	1440	2692	43336	1037	2019	**46391**	**46391**	**0,00**	**4333**	**4333**

* Note: decimals in the "n(i,hrs)" column are due to the fact that some families had already divided between H.R.S and 1992, so they had divided their base-numbers among their members.

** Note: in 1992, other bamboo (j=4) was not included yet in the compensation scheme

Table A.4.1. Calculations corresponding to the IFCS at former production team 1, in 1992.

ANNEX 5. List of Herb, Shrub and Tree species (2006 Forest-Ecology survey).

stratum	Chinese name	Latin name
herb-1	乌头	Aconitum carmichaeli Debx.
herb-2	杏香兔儿风	Ainsliaea fragrans Champ.
herb-3	铁灯兔儿风	Ainsliaea macroclinidioides Hayata
herb-4	白毛夏枯草	Ajuga nipponensis Makino
herb-5	三籽两型豆	Amphicarpaea edgeworthii Benth.
herb-6	紫花前胡	Angelica decursiva (Miq.) Franch. et Sav.
herb-7	三脉紫菀	Aster ageratoides Turcz
herb-8	紫菀	Aster tataricus L. f.
herb-9	苎麻	Boehmeria nivea (L.) Gaud.
herb-10	荞麦叶大百合	Cardiocrinum cathayanum (Walson) Stearn
herb-11	弯囊苔草	Carex dispalata Boott
herb-12	三穗苔草	Carex tristachya Thunb
herb-13	单花莸	Caryopteris nepetaefolia (Benth.) Maxim.
herb-14	东亚市藜	Chenopodium urbicum L. subsp sinicum Kung et G. L. Chu
herb-15	女萎	Clematis apiifolia DC.
herb-16	风轮菜	Clinopodium chinensis (Benth.) O.Ktze.
herb-17	鸭跖草	Commelina communis L.
herb-18	田麻	Corchoropsis tomentosa (Thunb.) Makino
herb-19	蕙兰	Cymbidium faberi Rolfe
herb-20	沙草科	Cyperaceae
herb-21	扇脉杓兰	Cypripedium japonicum Thunb.
herb-22	宝铎草	Disporum sessile D.Don
herb-23	东风菜	Doellingeria scaber (Thunb) Wees.
herb-24	六角莲	Dysosma pleiantha (Hance) Woods
herb-25	庐山楼梯草	Elastostema stewardii Merr.
herb-26	一年蓬	Erigeron annuus (L.) Pers.
herb-27	矮飞蓬	Erigeron divaricatus Michx.
herb-28	泽兰	Eucopatorium japonicum Thunb.
herb-29	三裂叶泽兰	Eupatorium japonicum var. tripartitum Makino
herb-30	何首乌	Fallopia multiflora (Thunb.) Harald
herb-31	薜荔	Ficus pumila L.
herb-32	野草莓	Fragaria vesca L.
herb-33	龙胆	Gentiana scabra Bunge
herb-34	糯米团	Gonostegia hirta (Bl.) Miq.
herb-35	萱草	Hemerocallis fulva （L.) L.
herb-36	半蒴苣苔	Hemiboea henryi Clarke
herb-37	玉簪	Hosta plantaginea (Lam.) Aschers.
herb-38	鱼腥草	Houttuynia cordata Thunb.
herb-39	小连翘	Hypericum erectum Thunb. ex Murray
herb-40	地耳草	Hypericum japonicum Thunb.ex Murray
herb-41	凤仙花	Impatiens balsamina L.
herb-42	白茅	Imperata cylindrica (L.) Beauv.var.major (Nees) C.E.Hubb
herb-43	小花鸢尾	Iris speculatrix Hance

herb-44	山苦荬	Ixeris chinensis (Thunb.) Nakai
herb-45	茎苦荬菜	Ixeris sonchifolia Hance
herb-46	马兰	Kalimeris indica (L.) sch. - Bip.
herb-47	野芝麻	Lamium barbatum Sieb. et Zucc.
herb-48	野百合	Lilium brownii F.E.Brown ex Mieller
herb-49	淡竹叶	Lophatherum gracile Brongn.
herb-50	海金沙	Lygodium japonicum(Thunb.)Sw.
herb-51	过路黄	Lysimachia christinae Hance
herb-52	珍珠菜	Lysimachia clethroides Duby
herb-53	仙草	Mesona chinensis Benth.
herb-54	柔枝莠竹	Microstegium vimineum (Trin.) A.Camus
herb-55	山类芦	Neyraudia montana Keng
herb-56	麦冬	Ophiopogon japonicus (L.f.) Ker-Gawl
herb-57	华南紫萁	Osmunda vachellii Hook.
herb-58	酢浆草	Oxalis corniculata L.
herb-59	蟹甲草	Parasenecio forrestii W. W.
herb-60	山椒草	Pellionia minima Makino
herb-61	紫苏	Perilla frutescens (L.) Britt.
herb-62	显子草	Phaenosperma globosa Munro
herb-63	松蒿	Phtheirospermum japonicum (Thunb.) Kanitz
herb-64	车前	Plantago asiatica Linn.
herb-65	北美车前	Plantago virginica L.
herb-66	桔梗	Platycodon grandiflorus (Jacq.) A. DC.
herb-67	白顶早熟禾	Poa acroleuca Steud.
herb-68	狭叶香港远志	Polygala hongkongensis var. stenophylla
herb-69	毛蓼	Polygonum barbatum L.
herb-70	扛板归	Polygonum perfoliatum L.
herb-71	中华水龙骨	Polypodiodes chinensis (Christ) S. G. Lu
herb-72	台湾翅果菊	Pterocypsela formosana (Maxim.) Shih
herb-73	鹿蹄草	Pyrola rotundifolia subsp. chinensis H. Andres
herb-74	爵床	Rostellularia procumbens (L.) Nees
herb-75	茜草	Rubia cordifolia L.
herb-76	太平莓	Rubus pacificus Hance
herb-77	华鼠尾草	Salvia chinensis Benth.
herb-78	舌瓣鼠尾草	Salvia liguliloba Sun
herb-79	莎草蕨	Schizaea digitata (L.) Sw.
herb-80	类头状花序藨草	Scirpus subcapitatus Thw.
herb-81	费菜	Sedum aizoon L.
herb-82	凹叶景天	Sedum emarginatum Migo
herb-83	卷柏	Selaginella tamariscina (P.Beav.) Spring

herb-84	天葵	Semiaquilegia adoxoides (DC.) Makino
herb-85	千里光	Senecio scandens Buch. - Ham. ex D.Don
herb-86	绿玉菊	Seneciomacroglossus
herb-87	牛尾菜	Smilax riparia A.DC.
herb-88	白英	Solanum lyratum Thunb.
herb-89	龙葵	Solanum nigrum L.
herb-90	一枝黄花	Solidago decurrens Lour.
herb-91	百部	Stemona sessilifolia (Mig.) Mig.
herb-92	兔儿伞	Syneilesis aconitifolia (Bunge) Maxim.
herb-93	雀草(孔雀草)	Tagetes patula L.
herb-94	台湾赤瓟	Thladiantha punctata Hayata
herb-95	短柱络石	Trachelospermum brevistylum Hand. - Mazz.
herb-96	华双蝴蝶	Tripierospermum chinense (Migo) H. Smith ex Nilsson
herb-97	龙珠	Tubocapsicum anomalum (Franch. ex Sav.) Makino
herb-98	七层楼	Tylophora floribunda Miq.
herb-99	南山堇菜	Viola chaerophylloides (Regel) W.Beck.
herb-100	紫花地丁	Viola philippica spp. munda W.Beck
herb-101	三角叶堇菜	Viola triangulifolia W. Beck.
herb-102	结缕草	Zoysia japonica Steud.
herb-103	NI-herb-1	NI-herb-1
herb-104	NI-herb-2	NI-herb-2
herb-105	NI-herb-3	NI-herb-3
herb-106	NI-herb-4	NI-herb-4
herb-107	NI-herb-5	NI-herb-5
herb-108	NI-herb-6	NI-herb-6
herb-109	NI-herb-7	NI-herb-7
herb-110	NI-herb-8	NI-herb-8
herb-111	NI-herb-9	NI-herb-9
herb-112	NI-herb-10	NI-herb-10
herb-113	NI-herb-11	NI-herb-11
herb-114	NI-herb-12	NI-herb-12
herb-115	NI-herb-13	NI-herb-13
herb-116	NI-herb-14	NI-herb-14
stratum	**Chinese name**	**Latin name**
shrub-1	五加	Acanthopanax gracilistylus W.W.Smith
shrub-2	秀丽槭	Acer elegantulum Fang et P. L. Chiu
shrub-3	苦茶槭	Acer ginnala Maxim.subsp.theiferum (Fang) Fang
shrub-4	葛萝槭	Acer grosseri Pax
shrub-5	中华猕猴桃	Actinidia chinensis Planch.
shrub-6	木通	Akebia quinata (Houtt) Decne.
shrub-7	三叶木通	Akebia trifoliata (Thunb.) Koidz
shrub-8	八角枫	Alangium chinensis (Lour.) Harms

shrub-9	楤木	Aralia chinensis L.
shrub-10	紫金牛	Ardisia japonica (Thunb.) Bl.
shrub-11	细辛	Asarum sieboldii Miq.
shrub-12	铁角蕨	Asplenium austro-chinense Ching
shrub-13	石竹	Bambusa lapidea McClure
shrub-14	大叶勾儿茶	Berchemia huana Rehd.
shrub-15	小勾儿茶	Berchemiella wilsonii (Schneid.) Nakai
shrub-16	悬铃叶苎麻	Boehmeria tricuspis (Hance) Makino
shrub-17	藤葡蟠	Broussonetia kaempferi Sieb.
shrub-18	华紫珠	Callicarpa Cathayana H. T. Chang
shrub-19	白棠子树	Callicarpa dichotoma (Lour.) K. Koch.
shrub-20	茶叶	Camellia sinensis O. Ktze
shrub-21	小杭子梢	Campylotropis macrocarpa f. microphylla K. T. Fu
shrub-22	鹅耳枥	Carpinus turczaninowii Hance
shrub-23	乌蔹莓	Cayratia japonica (Thunb.) Gagnep.
shrub-24	大芽南蛇藤	Celastrus gemmatus Loese
shrub-25	毛脉显柱南蛇藤	Celastrus stylosus Wall. var. puberulus (Hsu) C.Y.Cheng et T.C.Kao
shrub-26	迎春樱桃	Cerasus discoidea Yu et Li
shrub-27	紫荆	Cercis chinensis Bunge
shrub-28	柱果铁线莲	Clematis uncinata Champ.
shrub-29	大青	Clerodendrum cyrtophyllum Turcz.
shrub-30	木防己	Cocculus orbiculatus (L.) DC.
shrub-31	中国旋花	Convolvulus arvensis L.
shrub-32	灯台树	Cornus controversa Hensl.
shrub-33	蜡瓣花	Corylopsis sinensis Hemsl.
shrub-34	山楂	Crataegus pinnatifida Bge.
shrub-35	拓树	Cudrania tricuspidata （Carr.) Bur.
shrub-36	小叶青冈	Cyclobalanopsis myrsinaefolia (Bl.) Oerst.
shrub-37	四照花	Dendrobenthamia japonica var. chinensis (Osborn) Fang
shrub-38	小槐花	Desmodium caudatum (Thunb.) DC.
shrub-39	圆锥山蚂蟥	Desmodium elegans DC.
shrub-40	宁波溲疏	Deutzia ningpoensis Rehd.
shrub-41	薯蓣	Discorea opposita Thunb.
shrub-42	蛇莓	Duchesnea indica (Andr.) Focke
shrub-43	八角莲	Dysosma versipellis (Hance) M.Cheng
shrub-44	胡颓子	Elaeagnus pungens Thunb.
shrub-45	肉花卫矛	Euonymus carnosus Hemsl.
shrub-46	扶芳藤	Euonymus fortunei (Turcz.) Hand-Mazz.
shrub-47	中华卫矛	Euonymus nitidus Benth.
shrub-48	柃木	Eurya japonica Thunb.
shrub-49	格药柃	Eurya muricata Dunn
shrub-50	珍珠莲	Ficus foveolata Wall.

shrub-51	梧桐	Firmiana simplex (L.) W.F. Wight
shrub-52	小叶白蜡	Fraxinus bungeana DC.
shrub-53	猪殃殃	Galium aparine L.var. tenerum (Gret.et Godr.)
shrub-54	扁担杆	Grewia biloba D. Don
shrub-55	银钟花	Halesia macgregorii Chun
shrub-56	中华常春藤	Hedera nepalensis var. sinensis (Tobl.) Rehd.
shrub-57	中华青荚叶	Helwingia chinensis Batal.
shrub-58	鹰爪枫	Holboelia coriacea Diels.
shrub-59	腊莲绣球	Hydrangea strigosa Rehd.
shrub-60	金丝桃	Hypericum monogynum Linn.
shrub-61	冬青	Ilex chinensis Sims (Ilex purpurea Hassk.)
shrub-62	构骨	Ilex cornuta Lindl.
shrub-63	庭藤	Indigofera decora Lindl.
shrub-64	阔叶箬竹	Indocalamus latifolius (Keng) Mcclure
shrub-65	若竹	Indocalamus tessellatus Keng f.
shrub-66	齿缘苦荬菜	Ixeris dentata (Thunb.)
shrub-67	南五味子	Kadsura longipedunculata Finet et Gagnep.
shrub-68	刺楸	Kalopanax septemlobus(Thunb.) Koidz
shrub-69	棣棠花	Kerria japonica (L.) Dc.
shrub-70	毛果草	Lasiocaryum densiflorum (Duthie) Johnst.
shrub-71	中华胡枝子	Lespedeza chinensis G.Don
shrub-72	短叶胡枝子	Lespedeza mucronata Rick
shrub-73	蹄叶橐吾	Ligularia ficheri (Ledeb.) Turcz.
shrub-74	小蜡	Ligustrum sinense Lour.
shrub-75	红果钓樟	Lindera erythrocarpa Makino
shrub-76	山橿	Lindera reflexa Hemsl.
shrub-77	石栎	Lithocarpus glabra (Thunb.) Nak.
shrub-78	东南石栎	Lithocarpus harlandii (Hance) Rehd.
shrub-79	金银花（忍冬）	Lonicera japonica Thunb.
shrub-80	下江忍冬	Lonicera modesta Rehd.
shrub-81	檵木	Loropetalum chinense (R.Br.) Oliv.
shrub-82	点腺过路黄	Lysimachia hemsleyana Maxim.
shrub-83	红楠	Machilus thunbergii Sieb. et Zucc.
shrub-84	博落回	Macleaya cordata (Willd.) R.Br.
shrub-85	天目木兰	Magnolia amoena Cheng
shrub-86	黄山木兰	Magnolia cylindrca Wils.
shrub-87	厚朴	Magnolia officinalis Rehd.et Wils
shrub-88	白背叶	Mallotus apelta (Lour.) Muell.
shrub-89	柔毛泡花树	Meliosma myriantha var. pilosa (Lec.) Law
shrub-90	蝙蝠葛	Menispermum dauricum DC.
shrub-91	香花崖豆藤	Millettia dielsiana Harms
shrub-92	华桑	Morus cathayana Helms.

shrub-93	南天竹	Nandina domestica Thunb.
shrub-94	求米草	Oplismenus undulatifolius (Arduino) Roem. & Schult.
shrub-95	牛矢果	Osmanthus matsumuranus Hayata
shrub-96	中华山蓼	Oxyria sinensis Helms.
shrub-97	北亚稠李	Padus racemosa (Lam) Gilib. Var. asiatica (Kom.) Yu et Ku
shrub-98	鸡矢藤	Paederia scandens (Lour.) Merr.
shrub-99	山芍药	Paeonia obovata Maxim.
shrub-100	金星蕨	Parathelypteris glanduligera （Kze.) Ching
shrub-101	爬山虎	Parthenocissus tricuspidata (Sieb. et Zucc.) Planch.
shrub-102	疏花山梅花	Philadelphus laxiflorus Rehd.
shrub-103	浙江楠	Phoebe chekiangensis C.B. Shang
shrub-104	小叶石楠	Photinia parvifolia (Pritz.) Schneid
shrub-105	青灰叶下珠	Phyllanthus glaucus Wall.
shrub-106	黄槽竹	Phyllostachys aureosulcata McClure
shrub-107	水竹	Phyllostachys heteroclada Oliver
shrub-108	金毛竹	Phyllostachys nigra var. henonis (Mitf.) Stapf ex Rendle
shrub-109	多花黄精	Polygonatum cyrtonema Hua
shrub-110	长梗黄精	Polygonatum filipes Merr.
shrub-111	玉竹	Polygonatum odoratum (Mill.) Druce
shrub-112	黄精	Polygonatum sibiricum Delar ex Redoute
shrub-113	豆腐柴	Premna microphylla Turcz.
shrub-114	枫杨	Pterocarya stenobtera C. DC.
shrub-115	葛藤	Pueraria lobata (Willd.) Ohwi
shrub-116	光竹	Qiongzhuea luzhiensis Hsueh et Yi
shrub-117	麻栎	Quercus acutissima Carr.
shrub-118	猫乳	Rhamnella franguloides (Maxim.) Weberb
shrub-119	卵叶鼠李	Rhamnus bungeana J. Vass.
shrub-120	长叶鼠李	Rhamnus crenata Sieb.et zucc
shrub-121	满山红	Rhododendron mariesii Hemsl. et Wils.
shrub-122	映山红	Rhododendron simsii Planch.
shrub-123	软条七蔷薇	Rosa henryi Bouleng
shrub-124	金缨子	Rosa laevigata Michx.
shrub-125	野蔷薇	Rosa multiflora Thunb.
shrub-126	腺毛莓	Rubus adenophorus Rolfe
shrub-127	周毛悬钩子	Rubus amphidasys Focke ex Diels.
shrub-128	寒莓	Rubus buergeri Miq.
shrub-129	掌叶复盆子	Rubus chingii Hu
shrub-130	山莓	Rubus corchorifolius L.f
shrub-131	中南悬钩子	Rubus grayanus Maxim.
shrub-132	蓬蘽	Rubus hirsutus Thunb.
shrub-133	覆盆子	Rubus idaeus L.
shrub-134	木莓	Rubus swinhoei Hance
shrub-135	鄂西清风藤	Sabia campanulata subsp. ritchieae (Rehd. et Wils.) Y.F.Wu
shrub-136	清风腾	Sabia japonica Maxim.

shrub-137	雀梅藤	Sageretia thea (Osbeck) Johnst.
shrub-138	地榆	Sanguisorba officinalis L.
shrub-139	大血藤	Sargentodoxa cuneata (oliv.) Rehd. et Wils.
shrub-140	虎耳草	Saxifragga stolonifera Meerb.
shrub-141	木荷	Schima superba Gardn. et Champ.
shrub-142	五味子	Schisandra chinensis (Turcz.) Baill.
shrub-143	华中五味子	Schisandra sphenanthera Rehd et Wils.
shrub-144	六月雪	Serissa japonica (Thunb.) Thunb.
shrub-145	白马骨	Serissa serissoides(DC.) Druce
shrub-146	菝葜	Smilax china L.
shrub-147	小果菝葜	Smilax davidiana A. DC.
shrub-148	土茯苓	Smilax glabra Roxb.
shrub-149	黑果菝葜	Smilax glauco-china Warb.
shrub-150	缘脉菝葜	Smilax nervo-marginata Hayata
shrub-151	中华绣线菊	Spiraea chinensis Maxim.
shrub-152	粉花绣线菊	Spirarea japonica L. f
shrub-153	省沽油	Staphylea bumalda DC.
shrub-154	野木瓜	Stauntonia chinensis DC.
shrub-155	野珠兰	Stephanandra chinensis Hance
shrub-156	金线吊乌龟	Stephania cepharantha Hayata
shrub-157	紫茎	Stewartia sinensis Rehd. et Wils.
shrub-158	白化龙	Styrax faberi Perk.
shrub-159	水蒲桃	Syzygium samarangense (Bl) Merr. Et Perry
shrub-160	香椿	Toona sinensis (A. Juss.) Roem.
shrub-161	香榧	Torreya grandis cv. Merrillii
shrub-162	野漆	Toxicodendron succedaneum (L.) O Kuntze
shrub-163	长花络石	Trachelospermum cathayanum Schneid. var. tetanocarpum (Schne
shrub-164	络石	Trachelospermum jasminoides (Lindl.) Lem
shrub-165	栝楼	Trichosanthes kirilowii Maxim.
shrub-166	油点草	Tricyrtis macropoda Miq.
shrub-167	江南越桔	Vaccinium mandarinorum Diels
shrub-168	饭汤子	Viburnum (Linn) setigerum Hance
shrub-169	荚蒾	Viburnum dilatatum Thunb.
shrub-170	宜昌荚蒾	Viburnum erosum Thunb.
shrub-171	合轴荚蒾	Viburnum sympodiale Graebn.
shrub-172	山葡萄	Vitis amurensis Rupr.
shrub-173	刺葡萄	Vitis davidii Foex
shrub-174	华东葡萄	Vitis pseudoreticulata W.T Wang
shrub-175	水马桑	Weigela japonica var. sinica (Rehd.) Bailey
shrub-176	紫藤	Wisteria sinensis (Simg) Sweet.
shrub-177	NI-shrub-1	NI-shrub-1
shrub-178	NI-shrub-2	NI-shrub-2

shrub-179	NI-shrub-3	NI-shrub-3
shrub-180	NI-shrub-4	NI-shrub-4
shrub-181	NI-shrub-5	NI-shrub-5
stratum	**Chinese name**	**Latin name**
tree-1	青榨槭	Acer davidii Franch.
tree-2	建始槭	Acer henryi Pax
tree-3	鸡爪槭	Acer palmatum Thunb.
tree-4	异色猕猴桃	Actinidia callosa var. discolor C. F. Liang
tree-5	臭椿	Ailanthus altissima (Mill.) Swingle
tree-6	毛八角枫	Alangium Kurzii Craib
tree-7	合欢	Albizzia julibrissin Durazz.
tree-8	山合欢	Albizzia kalkora (Roxb.) Prain
tree-9	光皮桦	Betula luminfera H. Winkl.
tree-10	灯台树	Bothrocaryum controversum (Hemsl.) Pojark.
tree-11	小构树	Broussonetia kazinoki Sieb. et Zucc.
tree-12	构树	Broussonetia papyrifera (L.) Vent.
tree-13	老鸦糊	Callicarpa giraldii Hesse ex Rehd.
tree-14	雷公鹅耳枥	Carpinus viminea Wall.
tree-15	山核桃	Carya cathayensis Sarg
tree-16	锥栗	Castanea henryi (Skan) Rehd. et Wils.
tree-17	板栗	Castanea mollissima Blume
tree-18	茅栗	Castanea seguinii Dode
tree-19	甜槠	Castanopsis eyrei (Champ. ex Benth.) Tutch
tree-20	朴树	Celtis sinensis Pers.
tree-21	三尖杉	Cephalotaxus fortunei Hook. f.
tree-22	浙闽樱桃	Cerasus schneideriana (Koehne) Yu et Li
tree-23	香槐	Cladrastis wilsonii Takeda
tree-24	浙江大青	Clerodendrum kaichianum P.S.Hsu
tree-25	四照花	Cornus kousa subsp. chinensis (Osborn) Q.Y. Xiang
tree-26	野山楂	Crataegus cuneata Sieb. et Zucc.
tree-27	柳杉	Cryptomeria fortunei Hooibr. ex Otto & Dietrich
tree-28	杉木	Cunninghamia lanceolata (Lamb.) Hook.
tree-29	柏木	Cupressus funebris Endl.
tree-30	青冈	Cyclobalanopsis glauca (Thunb.) Oerst.
tree-31	青钱柳	Cyclocarya paliurus (Batalin) Iljinsk.
tree-32	黄檀	Dalbergia hupeana Hance
tree-33	浙江柿	Diospyros glaucifolia Metcalf
tree-34	柿树/野柿	Diospyros kaki Thunb.
tree-35	木半夏	Elaeagnus multiflora Thunb.
tree-36	微毛柃	Eurya hebeclados Ling
tree-37	野鸦椿	Euscaphis japonica (Thunb.) Kanitz
tree-38	牛鼻栓	Fortunearia sinensis Rehder & E.H.Wilson

tree-39	白蜡树	Fraxinus chinensis Roxb.
tree-40	苦枥木	Fraxinus insularis Hemsl.
tree-41	银杏	Ginkgo biloba L.
tree-42	算盘子	Glochidion puberum (L.) Hutch
tree-43	枳椇/拐枣	Hovenia acerba Lindl.
tree-44	光叶毛果枳椇	Hovenia trichocarpa var.robusta (Nakai et Y. Kimura) Y.L.Chen et P.
tree-45	伞形绣球	Hydrangea chinensis Maxim.
tree-46	小果冬青	Ilex micrococa Maxim.
tree-47	月桂	Laurus nobilis Linn.
tree-48	山胡椒	Lindera glauca (Siebold & Zucc.) Blume
tree-49	红脉钓樟	Lindera rubronervia Gamble
tree-50	枫香	Liquidambar formosana Hance
tree-51	豹皮樟	Litsea coreana var. sinensis (C.K. Allen) Yen C. Yang & P.H. Huang
tree-52	山苍子	Litsea cubeba (Lour.) Pers.
tree-53	刨花润楠	Machilus pauhoi Kaneh.
tree-54	马鞍树	Maackia hupehensis Takeda
tree-55	玉兰	Magnolia denudata Desr.
tree-56	野梧桐	Mallotus japonicus (L.f.) Müll.Arg.
tree-57	红柴枝	Meliosma oldhamii Miq.
tree-58	鸡桑	Morus australis Poir.
tree-59	蓝果树	Nyssa sinensis Oliv.
tree-60	中华石楠	Photinia beauverdiana C.K. Schneid.
tree-61	毛竹	Phyllostachys edulis (Carrière) J.Houz.
tree-62	高节竹	Phyllostachys prominens W.Y.Xiong
tree-63	苦木（苦树）	Picrasma quassioides (D.Don) Benn.
tree-64	马尾松	Pinus massoniana Lamb.
tree-65	黄山松	Pinus taiwanensis Hayata
tree-66	化香树	Platycarya strobilacea Siebold & Zucc.
tree-67	响叶杨	Populus adenopoda Maxim.
tree-68	金钱松	Pseudolarix amabilis (J. Nelson) Rehder
tree-69	小叶白辛树	Pterostyrax corymbosus Siebold & Zucc.
tree-70	槲栎	Quercus aliena Blume
tree-71	白栎	Quercus fabrei Hance
tree-72	短柄枹栎	Quercus serrata Murray
tree-73	圆叶鼠李	Rhamnus globosa Bunge
tree-74	马银花	Rhododendron ovatum (Lindl.) Planch. ex Maxim.
tree-75	盐肤木	Rhus chinensis Mill.
tree-76	檫树	Sassafras tsumu Hemsl.
tree-77	小齿钻地枫	Schizophragma integrifolium var. integrifolium
tree-78	青皮木	Schoepfia jasminodora Siebold & Zucc.
tree-79	中国旌节花	Stachyurus chinensis Franch.
tree-80	野茉莉	Styrax japonicus Siebold & Zucc.

tree-81	白檀	Symplocos paniculata Miq.
tree-82	椴树	Tilia tuan Szyszyl.
tree-83	榧树	Torreya grandis Fortune ex Lindl.
tree-84	毛果漆/毛漆树	Toxicodendron trichocarpum (Miq.) Kuntze
tree-85	漆树	Toxicodendron vernicifluum (Stokes) F.A. Barkley
tree-86	榆树	Ulmus pumila L.
tree-87	珊瑚树	Viburnum odoratissimum Ker Gawl.
tree-88	蝴蝶荚蒾	Viburnum plicatum var. tomentosum Miq.
tree-89	榉树	Zelkova serrata (Thunb.) Makino
tree-90	NI-1	NI-1
tree-91	NI-2	NI-2
tree-92	NI-3	NI-3
tree-93	NI-4	NI-4

NI: Non-identified species.

ANNEX 6. Eco-tourism Farmers' questionnaire, delivered in 2007 (summer)

社会经济变化调查（农户部分）

日期 Date：　　时间 Hour：　　地点 Place：　　天气 Weather：

第一部分 **First Part**：1990 年的一些情况 – **Household Socioeconomic background in 1990.**

1. 农户家庭的基本情况（户主-**Household head___**）

家庭成员 **Household member**	年龄 **Age**	性别 **Sex**	学历 **Education**	政治面貌 **Political affiliation**	职业 **Occupation**	社　团 **Village Committee**

2. 林业收入（两年）- **Forestry Income** (1989-1990)
竹林收入 (**Bamboo)_______**　山核桃收入 (**Hickory)________**　茶叶收入 (**Tea**) __________

3. 林业帮工 (**Forest 'help' labour**):
经常(**often**)　有时(**sometimes**)　很少(**rarely**)　没有 (**Inexistent**)
林业雇工(**Forest hired labour**):
经常(**often**)　有时(**sometimes**)　很少(**rarely**)　没有 (**Inexistent**)

4. 林业雇工/(林业帮工+林业雇工+自家林业劳动力)
Forest hired labour/Total Forest labour：__________
自家林业劳动力 / 总林业劳动力
Total Household Forest labour/Total Forest labour：__________

5. 林业收入/总收入 **Forest income/total income**，非大农业收入/总收入 **Off-farm income/ total income**，（大农业收入：林业收入，农业收入，渔业收入，捕猎收入）**(Farm income: forestry, agriculture, fishing, hunting)**

6. 非大农业雇工 **Off-farm hired labour**
长久 **Constant**　经常 **often**　有时 **sometimes**　很少 **rarely**　没有 **inexistent**
非大农业雇工（人数）**Number of off-farm hired employees**：_________

第二部分 **Second Part**：第三产业产值变化 **Changes in the Third sector**

1. 何时开始经营餐饮业 / 一些重要的变更 **When did your business/job start**
   小店 **Small shop**

   餐馆 **Restaurant**

   旅店/宾馆 **Hostel**

   工作人员 **Employee**（小店/餐馆/旅店、宾馆/景点）

2. 何时开始接待外来的顾客或游客 **When did visitors start to come to your business**
3. 如何开始经营生意？（第一笔资金来源）**How were you able to open your business**
   自己的储蓄 Savings（储蓄主要来源：林业收入，非大农业收入）

   贷款 **Loan from**：银行 (**Bank**)，村委会 (**Village committee**)，合作社 (**Cooperative**)，天荒平政府 (**Tianhuangping government**)，其它 (**Others**)

4. （稍后）开始经营生意时，第一笔投资资金估计有多少？**How much money did you invested in your business for the first time?**

第三部分 **Third part**：林业雇工的变化 **Changes in forest hired labour**

从你开始经营第三产业时/一些重要的变更 **Since you started to manage your third sector business…**

竹林雇工 **Bamboo Forest hired labour**：

增加 (**increased**)　没有变化(**did not change**)　减少 (**decreased**)

山核桃雇工 **Hickory Forest hired labour**:

增加 (**increased**)　没有变化(**did not change**)　减少 (**decreased**)

茶叶雇工 Tea **Forest hired labour**:

增加 (**increased**)　没有变化(**did not change**)　减少 (**decreased**)

第四部分 **Fourth Part**：

1. 农户家庭 2006-2007 年的基本情况 **Household Socioeconomic background in 2006-2007**:

家庭成员 **Household member**	年龄 **Age**	性别 **Sex**	学历 **Education**	政治面貌 **Political affiliation**	职业 **Occupation**	社　团 **Village Committee**

2. 林业收入（两年）- **Forestry Income** (2006-2007)
   竹林收入(**Bamboo**)_______ 山核桃收入(**Hickory**)________ 茶叶收入(**Tea**) _________

3. 林业雇工/(林业帮工+林业雇工+自家林业劳动力)
   Forest hired labour/Total Forest labour： _________
   自家林业劳动力 / 总林业劳动力
   Total Household Forest labour/Total Forest labour： _________

4. 林业收入/总收入 **Forest income/total income**，非大农业收入/总收入 **Off-farm income/ total income**，（大农业收入：林业收入，农业收入，渔业收入，捕猎收入）**(Farm income: forestry, agriculture, fishing, hunting)**

5. 非大农业雇工 **Off-farm hired labour**
   长久 **Constant** 经常 **often** 有时 **sometimes** 很少 **rarely** 没有 **inexistent**
   非大农业雇工（人数）**Number of off-farm hired employees**： ________

6. 您认为您对已经发生变化的生活满意么？（从 1990 年到现在）
   Since 1990, do you feel satisfied with these changes?
   a 生活有很大的改善(**Big improvement**)

   b 收入提高(**Income increase**)

   c 跟以前一样(**no significant changes**)

   d 生活变的不如以前 (**Past times were better than present times**)

   e 没进步或变穷了而其他人生活改善的很快 (**our lives did not improve or went poorer while others improved very fast**)

ANNEX 7. Eco-tourism Visitor Survey, delivered in 2007 (summer)

旅游资源调查（游客部分）

日期 Date： 时间 Hour： 地点 Place : 天气 Weather：

1. 目前所在的居住地方？**Where do you live?**

   省市（国外）： 城镇：

2. 您所选择的旅游交通工具？**How did you come here?**

   （1）私家车(**car**) （2）公共汽车(**bus**) （3）旅游团体车(**tourist company**)

   （4）其它 (**other**)

3. 直接到达目的地所需要的时间？**How long did it take you to get here?**

   （1）少于或等于半个小时 (**around half-an-hour**)

   （2）少于或等于一个小时 (**one hour**)

   （3）一个到两个小时 (**1-2 hours**)

   （4）两个到五个小时 (**2-5 hours**)

   （5）多于五个小时 (**more than 5 hours**)

4. 在大溪旅游期间选择的住宿方式：(**Accommodation**)

   （1）当天回去 (**do not stay, go back in a while**)

   （2）自家所在景点的房子 (**we have a house in the village**)

   （3）朋友家里 (**at friends' home**)

   （4）当地所在的宾馆 (**hostel**)

5. 到大溪旅游的次数？**How many times did you come to Daxi?**

   （1） 第一次 **First time**

   （2）最多每年一次 **Once a year at most**

   （3）一年一次 **Once a year**

   (4）一年两到三次 **Once to three times a year**

   （5）最少每年四次（包括四次）**At least four times a year**

6. 在旅游期间内大溪是否是主要旅游的地方？

   Within your trip, is Daxi your main destination?

   （1）唯一旅游的地方 **Main destination**

   （2）除了大溪之外，还有其他地方（大溪:______ 天；其他:______天）O**ther places**

7. 通过何种途径获知大溪的旅游景点? **How did you know about ecotourism in Daxi?**

   （1）朋友和亲戚 **Friends and relatives**

   （2）旅行社 **Tourist company**

   （3）安吉政府的宣传 **Advertisement by Anji government**

   （4）报纸、杂志、宣传小册子 **Newspaper, magazine, pamphlets**

   （5）电视、收音机 **TV, radio**

   （6）网络 **Internet**

8. 来安吉之前，您是否了解以下这些是否是安吉的称号或景点？

   Before coming Anji, did you know the following symbols of Anji?

   Are they true or not?

   （1） 中国第一生态县 **The First Ecological County in China**

   是（**True** ） 否（**False** ）不清楚（**Not sure** ）

   （2） 电子电器工业强县 **A High-tech County in China**

是（**True** ） 否（**False** ）不清楚（**Not sure** ）

（3） 黄埔江源头 **The Source of Huangpu River**

是（**Yes** ） 否（**False** ）不清楚（**Not sure**）

（4） 道教胜地 **A Daoist Sacred place**

是（**Yes** ） 否（**False** ）不清楚（**Not sure**）

（5） 中国大竹海 **A Bamboo Home-town in China**

是（**Yes** ） 否（**False** ）不清楚（**Not sure**）

（6） 天荒平水电站 **Tianhuangping Hydroelectric station**

是（**Yes**） 否（**False** ）不清楚（**Not sure** ）

9. 在最近一年中，你有没有去一些自然保护区

Within the last year, have you visited any natural protected areas?

（1） 没有 **No** （2）有 **Yes**（地点：______ ）

10. 在这次旅游期间，您在大溪会逗留多久？

In this trip, how long are you planning to stay in Daxi?

（1） 少于两个小时 **Less than two hours**

（2）两个小时到五个小时 **From two to five hours**

（3）一天 **One day**

（4）两天到四天 **From two to four days**

（5）五天到七天 **From five to seven days**

（6）多于一个星期 **More than one week**

11. 在这次旅游期间，您在大溪计划中的一些活动和一些景点？

In this trip, are you planning to visit/do the next places/activities

（1） 天荒平水电站 **Tianhuangping hydroelectric station**

已经参观过（ **already**）将要参观（**planning to/will** ）不在计划内（**not planned** ）

（2） 九龙峡（景区） **Nine Dragons' Waterfalls**

已经参观过（**already** ）将要参观（**planning to/will**）不在计划内（**not planned** ）

（3） 九龙峡（度假村）**Nine Dragons' Waterfalls' Cottages**

已经休闲过（**already** ）将要休闲（**planning to/will** ）不在计划内（**not planned** ）

（4） 藏龙百瀑 **Hidden Dragon's Hundred Waterfalls**

已经参观过（**already** ）将要参观（**planning to/will** ）不在计划内（**not planned**）

（5） 农家乐 **Nongjiale (The Farmers' Family hostel)**

已经消费过（**already**）将要消费（**planning to/will** ）不在计划内（**not planned** ）

（6） 当地特产 **Local Products**

已经购买过（**already** ）将要购买（**planning to/will** ）不在计划内（**not planned** ）

（7） 在景区之外的一些爬山活动（野外）**Some hikking out-of the tourist sites**

已经爬过（**already** ） 将要计划爬（**planning to/will** ） 不在计划内（**not planned**）

12. 在这次旅游期间，您估计的开销？

How much money are you planning to spend?

（1）燃料汽油（自家车）___________ （元）**Car petrol (for your own car)**

（2）公交车、巴士__________ （元）**Public transportation**

（3）在大溪购买的特产：**Local Products**

笋干 **Dried Bamboo shoots**___________（元）

山核桃 **Chinese hickory**___________（元）

茶 **Tea**_____________（元）

手工艺品 Handicrafts__________（元）

13. 在以下的这些选择中，大溪的哪些改变会使您的旅游更满意？

Among the next options,
which changes in Daxi's eco-tourism would you recommend?

（1） 停车场 **Car Parking**
多些 **More** 保持原样 **Ok** 少些 **Less**

（2） 自然景点 **Natural areas**
多些 **More** 保持原样 **Ok** 少些 **Less**

（3） 农家乐 **Nongjiale (The Farmers' Family hostel)**
多些 **More** 保持原样 **Ok** 少些 **Less**

（4） 专业导游 **Specialised Tourist guides**
多些 **More** 保持原样 **Ok** 少些 **Less**

（5） 生态资料 **Ecological information**
多些 **More** 保持原样 **Ok** 少些 **Less**

（6） 特产专卖店 **Local Product Shops**
多些 **More** 保持原样 **Ok** 少些 **Less**

（7） 环境干净 **A cleaner environment**
需要改进 **Needs to be improved** 保持原样 **Ok**

（8） 餐饮业服务质量 **Restaurant/hostel service quality**
需要改进 **Needs to be improved** 保持原样 **Ok**

（9） 对景点的客流量进行适当的限制 **Control the amount of arriving tourists**
多些 **More control is needed** 保持原样 **Ok** 少些 **Less control is needed**

14. 对大溪的旅游总体上是否满意？

Concerning your visit at Daxi, are you satisfied?

（1）非常满意 **A lot**
（2）满意 **Satisfied**
（3）没感觉 **So-so**
（4）不满意 **Not satisfied**
（5）很不满意 **Very unsatisfied**
（6）还没来的及感觉 **Have not an opinión yet**

15. 您如何认为在这次旅游中大溪游客的数量？

How do you feel about the amount of visitors arriving at Daxi?

（1）过多 **Too many** （2）刚刚好 **Ok** （3）有点少 **Still Little**

16. 您愿意介绍您的亲戚朋友来大溪旅游吗？

Are you willing to introduce Daxi to your relatives and friends?

（1）愿意 **Willing** （2）不愿意 **Unwilling** （3）无所谓 **Don't care**

17. 您认为大溪的生态保护的程度如何？

How do you feel about the degree of ecological protection at Daxi?

（1）很差 **Very bad**
（2）有点差 **Bar**
（3）一般 **So-so**
（4）一般好 **Good**
（5）很好 **Very good**
（6）不知道 **Don't know**

18． 您和谁一起来大溪旅游？**Who are you coming with to Daxi?**

（1）家庭成员或亲戚 **Family and relatives**

（2）朋友 **Friends**

（3）一个人 **Alone**

和您一起来旅游的人是属于以下的哪个年龄层次及人数？

How many of you have the following ages?

（1）**Under five year-old** < 5 ___ （人）

（2）**Between 6 —17** ____（人）

（3）**Between 18 — 30** ____（人）

（4）**Between 31 — 40** ____（人）

（5）**Between 41 — 50** _____（人）

（6）**Between 51 — 65** ____（人）

（7）**> 65** ____（人）

总人数_______ （人）

19. 您在以下选项中处于哪个年龄层次？**How about your age?**

（1）**18——30** （2）**31——40** （3）**41——50**

（4）**51——65** （5）**> 65**

20． 您的性别 **Sex**: 男 **Male______**, 女 **Female_______**.

21． 请选择您的学历？**Education**

（1）小学 **Primary**

（2）中学 **Secondary**

（3）高中 **High school**

（4）中专 **Professional training**

（6）大学 **University**

（7）没有上过学 **Did not receive formal education**

22． 您在以下选项中属于哪个月收入范围**? Income range in yuan**（元）

（1）**< 800** （2）**800 — 1500** （3）**1500 — 2500**

（4）**2500 — 3500** （5） **3500 — 4500** （6）**4500 — 5500**

（7）**5500 — 6500** （8）**6500 — 7500**（9） **> 7500**

23． 您现在的职业? **Occupation**

（1）学生 **Student**

（2）老师 **Teacher**

（3）公务员 **Civil servant**

（4）公司职员 **Employee**

（5）个体户 **Self-employed**

（6）经商者 **Manager**

（7）家庭主妇 **Housework**

（8）退休者 **Retired**

（9）自由职业者 **Entrepreneur**

（10）目前待业者 **Looking for employment**

（11）其它 **Others**

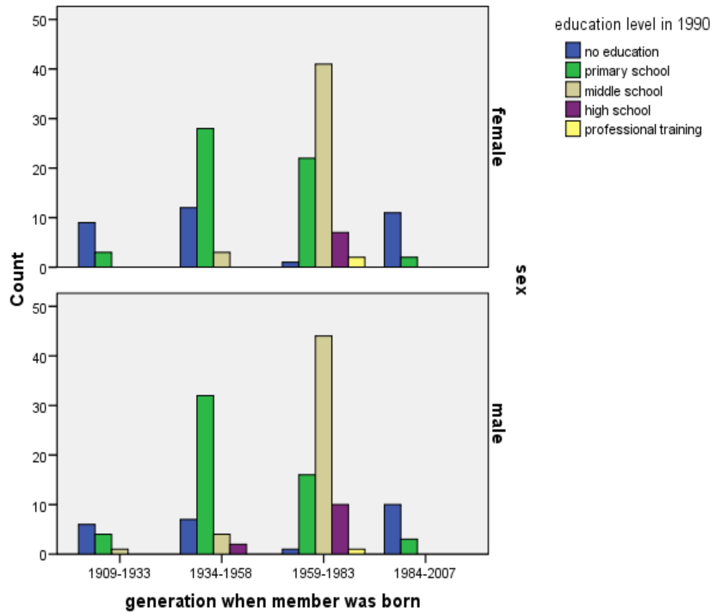
24． 如果您有什么意见或建议，我们很乐意接受

Would you please have any suggestions concerning eco-tourism at Daxi village?

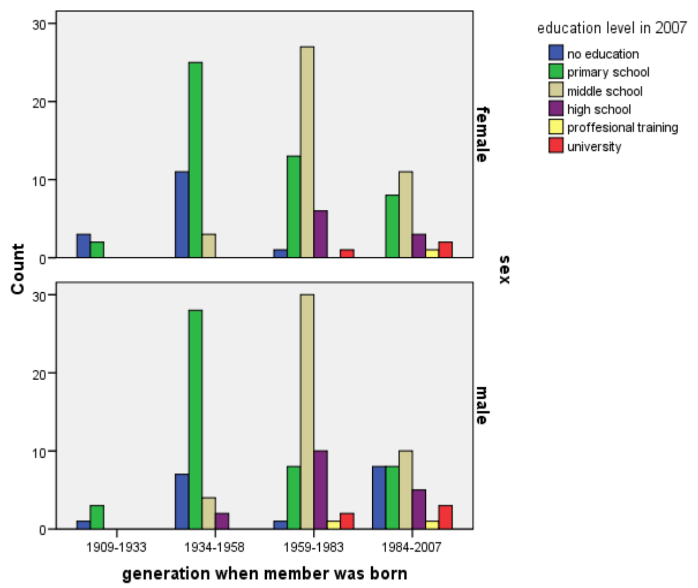
非常感谢您的合作 **Thank you very much for your cooperation.**

ANNEX 8. Educational attainment by Sex and Generation (1990-2007).

Daxi's Educational Profile distribution between sexes and across generations in 1990



Daxi's Educational Profile distribution between sexes and across generations in 2007



ANNEX 9. Occupation by Sex and Generation in 1990.