

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

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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.

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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. Ambrose-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 *versus* 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 Criterion 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 constraints 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 straight 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.

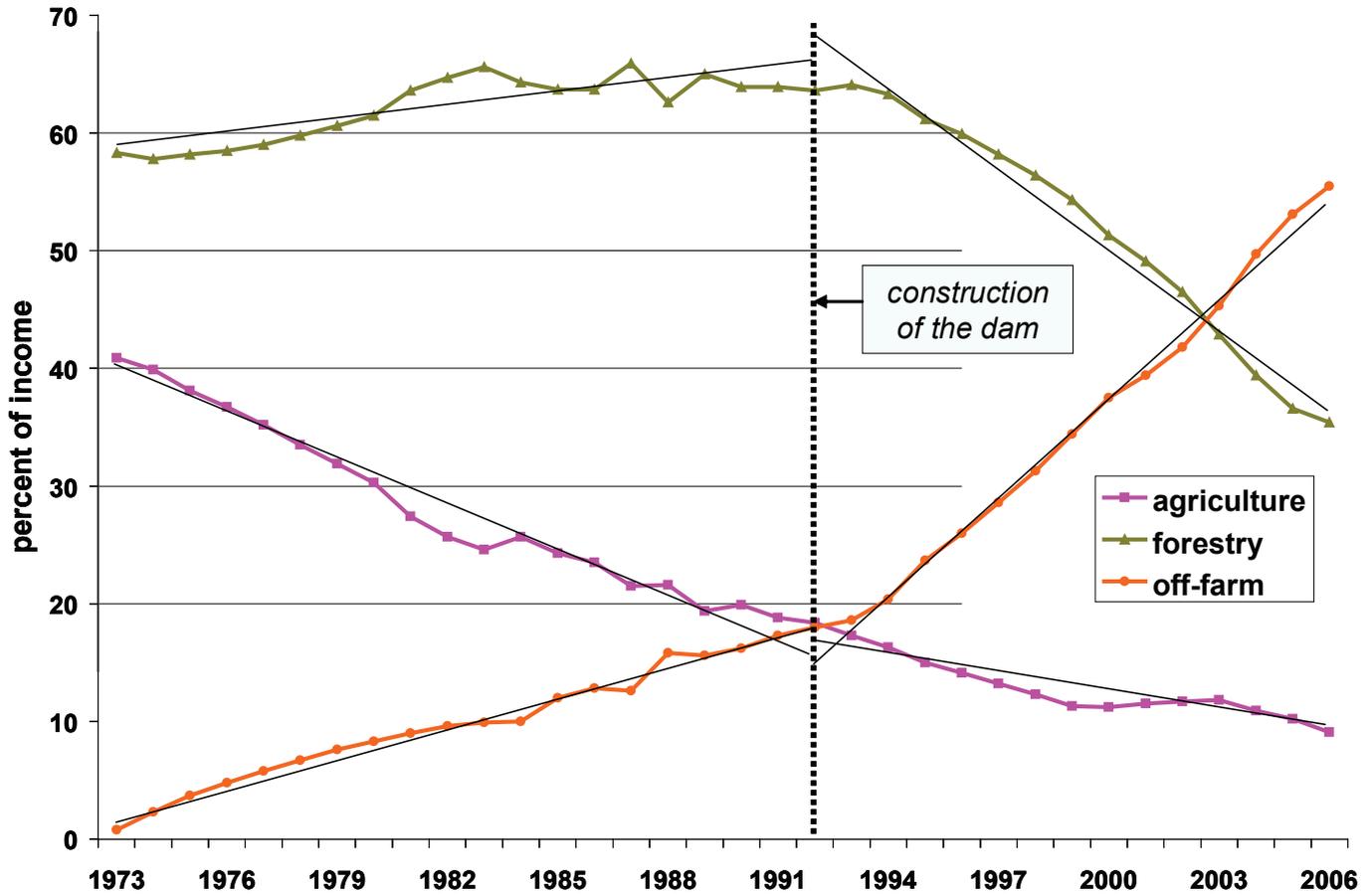


TABLE 1 Changes in percent of income from different activities in Daxi village between the 1990 National Rural Survey Panel (n=16) and the 2005 field survey (n=92)

	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,

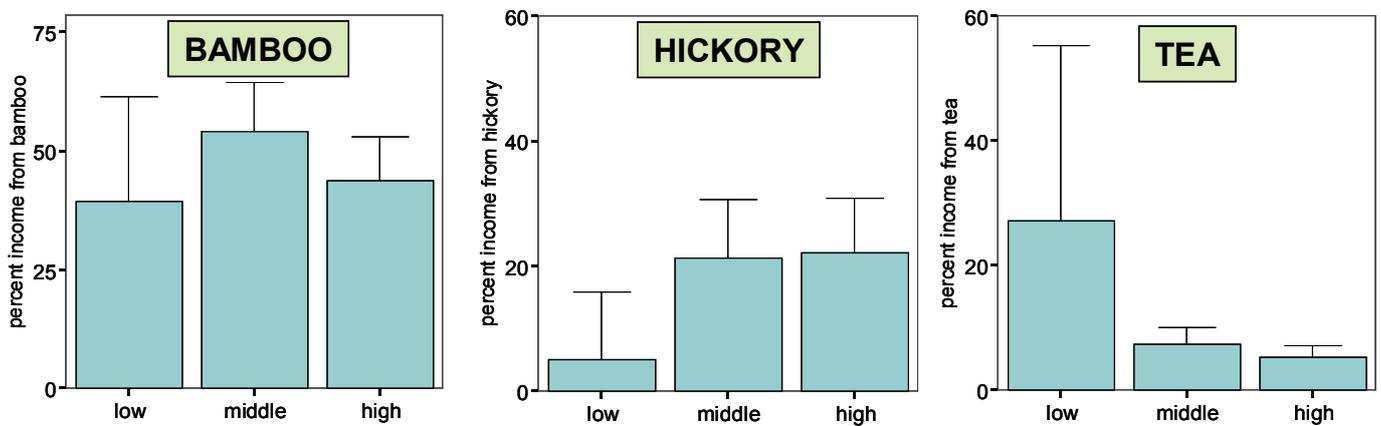
which was at that time still rather egalitarian, with a Gini coefficient of 0.21. While farm-based income showed a fairly equitable distribution (Gini 0.19), the still small but fast growing off-farm income showed strong differences (Gini 0.53) indicating a specialization trend. Among the forest-based 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

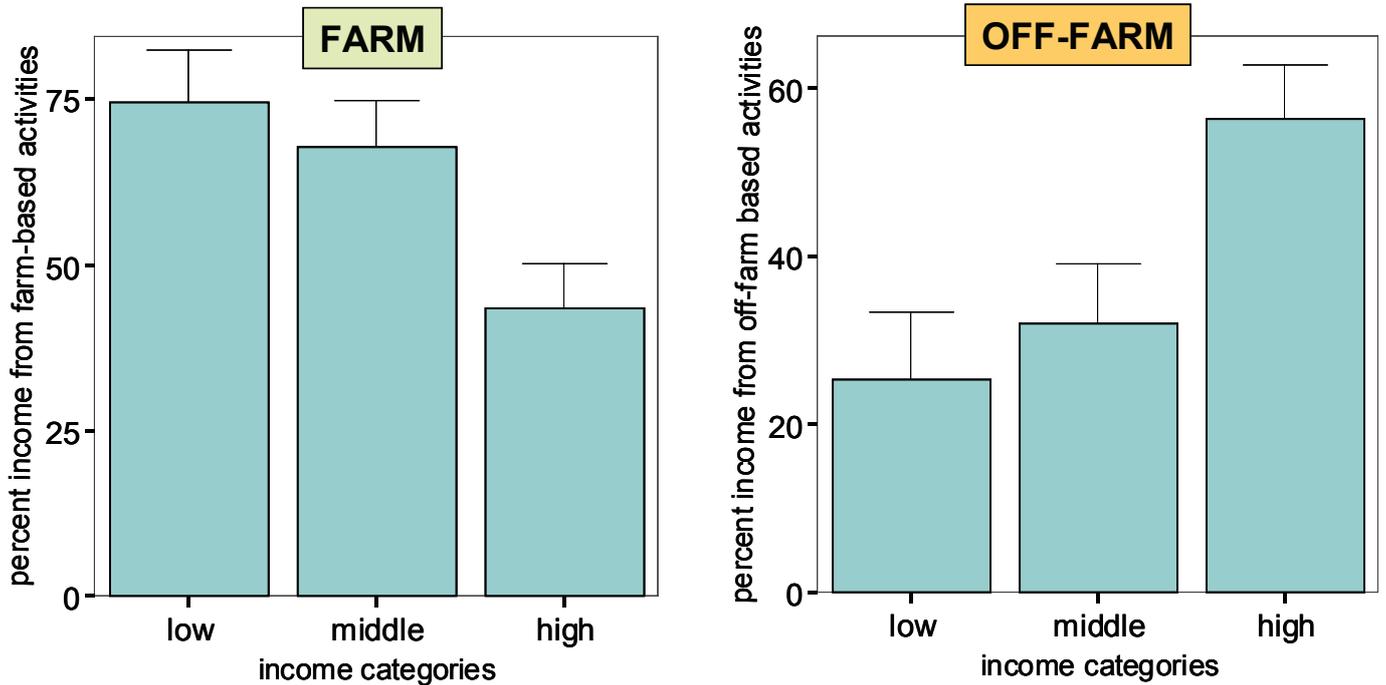


FIGURE 4 Relative contribution of bamboo, hickory and tea income for different income categories in the 2005 panel. Their relative contribution has changed significantly when compared with the 1992 panel of figure 2. Bamboo has become relatively more important for low income farmers, and tea for high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

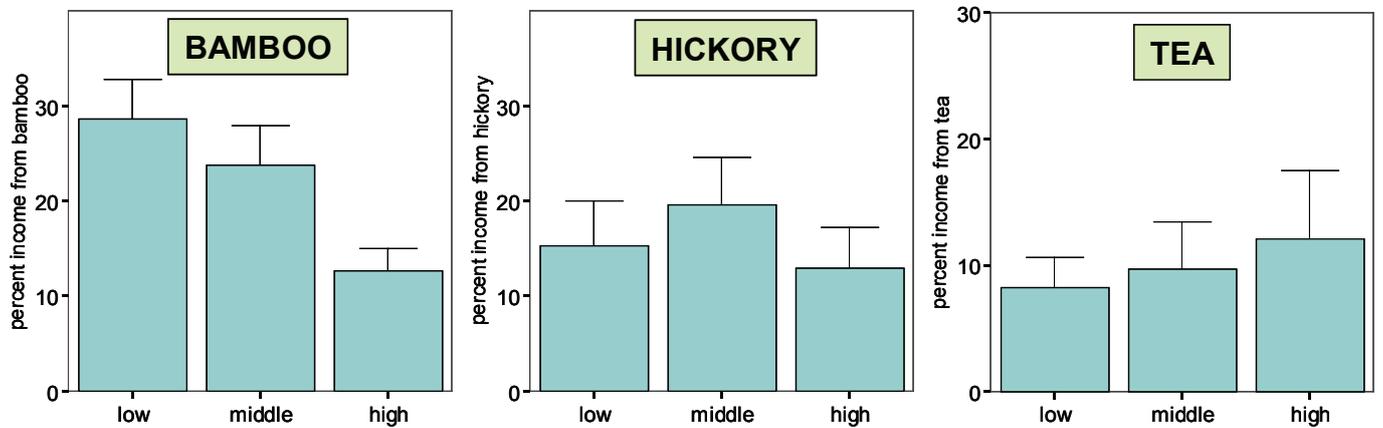


Table 2 present the summary statistics of the variables entered in the multiple regression models used to assess the factors with greatest influence on per capita income. The best model selected using the parsimonious Corrected Akaike Information Criterion that optimises the trade-offs between model 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 Criterion

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).

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