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REPORT

Economic Development, Rural livelihoods, and Ecological Restoration: Evidence from China

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Abstract This article uses a case study in Southeast China to demonstrate how the substantial changes in rural livelihoods have been driven by a combination of "pull" forces from external economic development, and "push" forces from local areas, leading to a shift in rural household economic activities: household outmigration and de-population of the countryside, changes in energy consumption, and most importantly, changes in land uses and eventually, ecological restoration. Such dramatic changes are becoming common across the Chinese countryside. It is pointed out that economic development has generally caused a deterioration of the environment at least at the early period of economic growth, but the positive impacts, especially in some ecosystem in rural areas, have become more apparent.

Keywords Ecological restoration · Household livelihoods · Economic development · Changting County

INTRODUCTION

Poverty is often associated with ecological degradation in the form of a vicious circle known as the "poverty-environment trap" in which rural poverty leads to ecological degradation, and ecological degradation further accelerates poverty (Finco 2009). Apart from poor resource endowments and residing in a fragile ecosystem, many rural households are also lacking in other forms of capital such as human, financial, and social capital. Consequently, the combination of poor environment and economy accelerates the poverty-environment trap (Reardon and Vosti 1995). Therefore, how to break the vicious circle and integrate poverty alleviation with ecological restoration has been an important issue in rural sustainable development study.

While the links between ecological conservation and poverty reduction have been a subject of intense debate among academics and practitioners for several decades, consensus on how to reconcile these two disparate goals is far from being reached (Kepe et al. 2004). Related researchers and practitioners still strive to achieve ecological restoration and poverty reduction simultaneously (Salafsky and Wollenberg 2000). It is hoped that poverty eradication and ecological restoration could be achieved simultaneously by some top-down projects sponsored by governments at all levels or by various non-governmental organizations (NGOs) (Marcus 2001). Moreover, it is believed that once local households participate in the projects and obtain alternative livelihoods (such as ecotourism, environmental services, rural industry, and new crops), local sustainable development can be achieved, and conservation and poverty reduction can be tackled together by the same project (Kramer et al. 1997; Wild and Mutebi 1997; Brandon et al. 1998).

In reality, most projects that seek to integrate conservation and development tend to be too ambitious (Brown 2003; Adam et al. 2004), and success with integrated strategies is elusive (Adam et al. 2004). A recent report of World Bank projects focusing on the integration of poverty reduction and biodiversity conservation revealed that only 16% made major progress on both objectives (Tallis et al. 2008). Barrett et al. (2005) even claimed that integration is still the exception, and synergies did not emerge naturally. More importantly, we should pay attention to additional circumstances of those successful cases, including the socioeconomic change outside the project-areas. Due to globalization and increasing trans-regional economic interaction, external influence outside local communities, such as the rapid economic growth of external regions, is of great importance to the outcome of integration. However,

few studies have interpreted the typical cases of integrating ecological restoration and poverty eradication from a broader perspective.

There are two widespread perceptions: (1) The rapid economic growth in China comes at the expense of its environment; and (2) The primary contribution of government initiated projects and programs to the current improvement of ecosystem and environment. The first thought forgets the general improvement of rural ecosystems, while second thought neglects the important contributions made by outmigration and improvement of rural economy. To mitigate the degradation of the environment, and to eliminate environment-induced poverty, China has implemented a number of large-scale national conservation programs, including the Natural Forest Conservation Program (NFCP), Grain to Green Program (GTGP), Forest Eco-Compensation Program, as well as numerous local projects (Loucks et al. 2001; Xu et al. 2006; Liu et al. 2008). While the literature on Chinese ecological restoration and rural poverty reduction is extensive, a majority of them overemphasizes the function of ecological projects (Liu et al. 2001; Liang et al. 2006; Zhang 2006), but neglects the function of economic development and rural livelihood improvement. There is still a dearth of holistic and rational interpretation, which this article aimed to contribute to.

To address the misperceptions with regard to status of China's environment (especially the difference between rural and urban areas) and more objectively assess the contribution of the government-initiated projects, we use Changting County as a case study. Characterized by a high population density, high extent of non-farm employment such as casual employment in manufacturing, construction industry, service sector and self-employment in small business, and increasing opportunities for non-farm employment, the interaction between the economy and environment in Changting County is intense. Significant number of studies in the previous literature focused on the research hot-spot, mainly analyzing from the perspectives of natural sciences and tremendous efforts of local governments (Zheng et al. 2002; Wang et al. 2005; Cao et al. 2009). Evidently these studies are also characteristic of over-evaluating the function of engineering measures, overlooking active response and adjustments of farmer households, and failing to clarify its local peculiarity and differentiation. Moreover, little research has been carried out to comprehensively combine natural factors and anthropogenic disturbance.

In this article, our major goal is to analyze how changes in the economy and rural household livelihoods impact the environment. It is argued that while economic development has caused many environmental problems in urban areas and some specific problems, such as air and water pollution in China, increasing evidence shows positive impacts on the rural areas and some ecosystems such as vegetation and soil erosion as more people migrate to cities and de-populate rural areas, especially those poor, remote, and environmentally fragile areas. Even within the rural areas, rural labors are transferring to non-agricultural sectors, resulting in substantial and distinct changes in land use, such as reducing the human disturbance on marginal land. More importantly, the growing economy and increasing income from non-agricultural sectors, either locally or from other regions, allows farmers to use more coal, gas, and electricity instead of fuelwood. The significant reduction in fuelwood consumption largely eases the pressure on the ecosystem and promotes ecological recovery.

It has been reported that some outmigration farmers return home bringing in some capital and skills, and become the leaders of local economy in rural industries and business which are often more capital intensive but less land intensive. Therefore, the gradual integration might be called, and the break of the poverty-environment trap is made. The policy implication is that our traditional thoughts on integrated ecological conservation and poverty reduction need to be broadened outside the rural regions. Alternative policy and support need to be provided to promote rural sustainable development. Changting County used in this study in Fujian Province provides good evidence of common circumstances in China.

METHODS

Conceptual Framework

Before proceeding to the empirical analysis, we conceptualized the change of farmer household livelihoods with a "pull–push" framework. The ecological succession in ecologically fragile areas depends on many natural and anthropogenic factors. We hypothesized that anthropogenic factors, i.e., farmer livelihoods, were the primary drives of ecological succession. With the "pull–push" perception, reasons for the transfer of livelihood activities within farmer households could be understood easily (Fig. 1). The "push" factors may include closing hillsides to facilitate afforestation, restoring the reclaimed land to forest and less disturbed ecosystem, under-employment in crop farming, fish breeding, and poultry raising with comparatively low earnings. The former two, belonging to important parts of water and soil conservation projects, exerted an important influence on farmer traditional livelihood activities (e.g., herb gathering, hunting, fuelwood collecting, farmland reclamation, and cultivation on steep slopes) immediately. The "pull" factors included ecological compensation to farmers for their economic losses, casual wages of

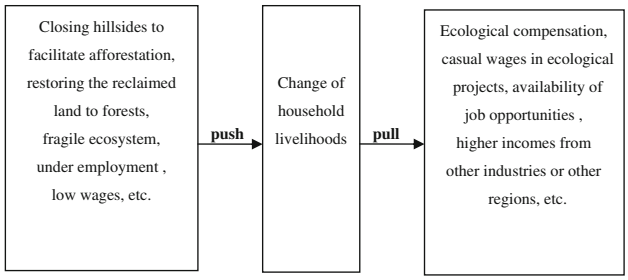

Fig. 1 Conceptual framework of influencing factors for the evolution of farmer household livelihoods

employment in ecological projects, and the availability of job opportunities and higher incomes from other industries or other regions. The change of farmer household livelihoods was motivated and sustained by the integrated effect of "pull" and "push" factors. In addition, the importance of "pull" and "push" factors can change over time. If household livelihoods change toward a more steady and sustainable state, with increasing efficiency of household resources, then it is a progressive livelihood evolution (or strengthening livelihood sustainability).

Moreover, the change in the livelihoods of farmer households would be significant in integrating ecological restoration and poverty eradication, gradually propelling human disturbance from ecosystem-destructive to nearly ecosystem-neutral, and even ecosystem-friendly conditions. On the one hand, farmer household incomes are greatly increased by boosting the economic efficiency of household resources (such as labor force, land, and fund). Then the rural poverty eradication is gained. On the other hand, the land use activities of farmer households become markedly pro-environment by decreasing human disturbance extent and ecological pressure. As a result, ecological restoration in some ecologically fragile regions, especially the forest ecosystem and grassland ecosystem of mountainous and hilly regions, is also achieved. In brief, reconciling conservation and poverty reduction in some rural areas could be realized, to some extent, by the progressive change of farmer household livelihoods (Fig. 2).

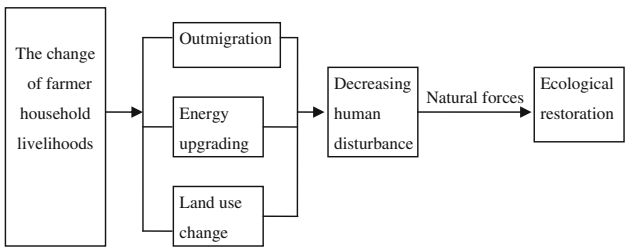

Fig. 2 Dynamics of the evolution of farmer household livelihoods in integrating ecological restoration and poverty eradication

Study Area

Changting County is located in western Fujian Province in Southeast China (25°18′40″ to 26°02′05″N, 116°00′45″ to 116°39′20″E) (Fig. 3). Situated on the southern part of WuYi Mountain of low hills and uplands, Changting is characterized by a humid, subtropical monsoon climate with high mean precipitation (1730.4 mm year^{-1}) and warm annual temperature (a mean of 18.3°C and a minimum temperature of 7.9°C) (Yang et al. 2005), and it is primarily covered by granite red soils. Historically, it was covered by luxuriant vegetation with light soil erosion. However, a half-century period of human destruction increased the intensity and scale of soil erosion, leading to extreme decreases in biodiversity and soil fertility (Chen 1998; Zeng and Zhong 2002). The area experiencing serious erosion increased by 5.1% annually, from 47 870 ha in 1966 to 97 470 ha in 1985 (Yang et al. 2005).

Changting County was well known as one of the most poverty-stricken counties of China. Primarily mountainous (Per capita arable land about 0.042 hectares in 2008) and poor in natural resources, Changting was characterized by a fast-growing population and low levels of urbanization, with poor transportation infrastructure and industrial tradition (Yang et al. 1996; Chen 1998). Moreover, the combination of these disadvantages further accelerated the extent of rural poverty, forming subsistence and low productivity agriculture. Traditionally, rural households usually relied on fuelwood for heating, cooking, and livestock feed preparation. Their income mainly came from crop-plantation and raising courtyard livestock, such as pigs and chickens, with great vulnerability and instability for environmental and market fluctuation, leading farmer household livelihoods with poor resilience. As a result, it had slipped into, and remained in the poverty and ecological degradation trap for many decades since the 1950s. Therefore, Changting was becoming increasingly well known and receiving more media exposure.

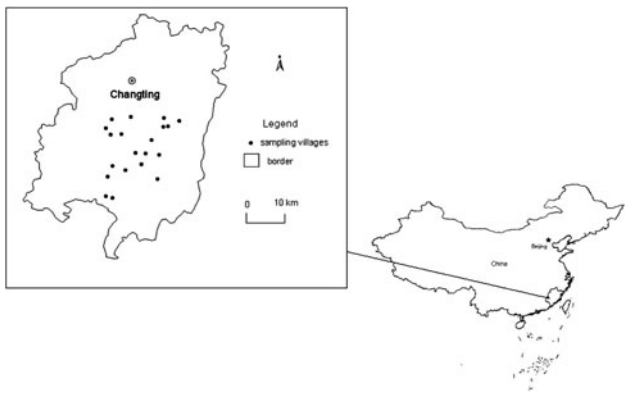

Fig. 3 Geographic location of the study site

To mitigate ecological degradation, the county's government has made great efforts in soil and water conservation since the 1950s, such as artificial afforestation and closing access to hillsides for natural regeneration. Some limited and phased ecological restoration was achieved under those efforts and policies in the 1970s. However, the phased ecological restoration was gained at the cost of farmer household livelihoods, with comparatively low household net income. Following the general economic reform of agricultural and forestland, reform of property rights of forested land was started in 1985, with 90% of village forested lands being allocated to individual farmer households in a few years. Unfortunately, the county's impoverished farmer households did not manage the forests in a sustainable way as the governments had hoped. On the contrary, driven by impoverished livelihoods and a fast-growing population, they cleared most forest immediately and reclaimed many slope lands, seeking to fulfill more immediate interests. These activities destroyed the land vegetation seriously, resulting in heavier soil erosion of large area. Thus, the governments' policies failed again to prevent environmental destruction and actually led to rapid decreases in vegetation cover and more serious soil erosion, causing most hills to become bare and infertile (Chen 1998). During this period, both vegetation and forest covers decreased, and the area affected by severe soil erosion increased by 100.88% (Cao et al. 2009). Therefore, ecological restoration always alternated with ecological degradation, and overall the governments' policies in different periods before 2000 failed to prevent ecological deterioration (Cao et al. 2009).

As economy situation at provincial level is getting better, the provincial government was able to implement a larger project called, "Soil erosion comprehensive treatment program of Changting County" since 2000, allocating RMB 10 million (about 1.47 million US dollars) annually to Changting for environmental conservation and poverty reduction. These funds have been used to combat severe soil erosion and to compensate for farmers who lost access to some traditional economic activities, such as slope-land cultivation and fuelwood collection. The program has been focusing on four towns: Hetian, Cewu, Sanzhou, and Zhuotian (Lu 2002). Propelled by these funds, the Changting government implemented some complementary measures, mainly including two major parts: closing hillsides to facilitate afforestation, and conservation-with-development (Wang et al. 2005). Under this project, the farmer households obtained some living subsidies for their labor in ecosystem restoration and some compensation for their loss of access to the firewood. So far, it seems that the environment situation and farmer household livelihoods have been evolving in a good direction since 2000.

Moreover, the change in environment and development was in coincidence with trans-regional connection with coastal areas of Southeast China. While Changting was in very much the same situation, the coastal areas of China have experienced tremendous socioeconomic development since the late 1970s, with rapid development of industrialization and urbanization in great need of a labor force. Changting was not far away from the coastal areas. A few medium cities southeast of Fujian Province (such as Xiamen, Shishi, Zhangzhou, and Quanzhou) were booming by taking advantage of both the in-flow of capital by overseas Chinese who had accumulated abundant capital and market access after China opening the door to foreign investment. The distance between Changting and those cities is only about 300-400 km. Moreover, the fast development of transportation and communication infrastructure propelled the connection of both regions. The total length of highways open to traffic increased from 684 km in 1982 to 2063 km in 2008. Key to open up the area to further development, the national highway 319 (the part between the Changting and Longyan City) and Longyan–Changting Expressway effectively promoted the connection between Changting and the coastal areas of southeastern Fujian province; in addition, the completion and operation of Longyan–Ganzhou Railway (starting from Longyan City in Fujian Province to Ganzhou City in Jiangxi Province) in 2005 connected the southeast coastal areas of Fujian Province and inland regions of Fujian Province. At the same time, both the comparative economic cost (the non-farm income to transportation costs) and trip time decreased markedly. Therefore, the remarkable economic disparity, the great dissymmetry of labor supply and demand in both regions, and the decreasing trip cost, jointly stimulated the emergence of the rural–urban migration or migration to coastal areas.

Data Collection

In order to examine the ecological restoration resulting from the change in farmer household livelihoods, two kinds of data were collected: the socioeconomic data of Changing County, and a survey of five representative villages in the four towns (Cewu, Hetian, Sanzhou, and Zhuotian) with serious soil erosion (Fig. 3).

All secondhand socioeconomic information of Changting County was collected from official data of related administrative departments, such as Bureau of Statistics, Agricultural Office, Bureau of Agriculture, Bureau of Forestry, Bureau of Water and Soil Conservancy, and the Population and Family Planning Committee of Changting County. These data mainly include two parts: the two Agricultural Surveys of China, performed by Changting County Bureau of Statistics in 1996 and 2006; and

Changting County Statistics Yearbook, Statistics Bulletin of the Economic and Social Development of the Changting County, Statistics Bulletin of the Ecological Treatment of the Changting County. All prices have been converted to comparable prices. In addition, we interviewed key leaders of these administrative sectors to enhance our overall understanding of the real conditions.

The survey data were collected from November 15, 2009 to April 3, 2010. Selection of respondents proceeded according to a two-stage cluster sample. In the first stage, five villages in each of the four towns (Cewu, Hetian, Sanzhou, and Zhuotian) were randomly chosen. In the second stage, 20 households in each village were selected randomly for investigation after an inventory of households was enumerated. As a result, a total of 400 households were selected. Then 40 in-depth interviews and 400 questionnaires were completed according to investigation plan. First, we conducted about two-hour, face to face interviews with village leaders or accountants. Village-leader questions were designed for open answers. Owing to the relatively open structure of the interviews, new issues of particular interest to the respondents could arise during interviews according to a semi-structured methodology (Brogaard and Zhao 2002; Stringer et al. 2007). Through these interviews, information on rural socioeconomic evolution was collected, such as arable land, land use/land cover change, population and households, household livelihoods, the development of rural labor outmigration, the scale and characteristics of labor flowing out and staying at home, the change of the quantity and structure for general household income, policies of governments at all levels closely related to farmer livelihoods, the development of labor and other economic factors in rural market, and other associated socioeconomic and demographic aspects in the past 20 years. In general, the main aim of village-leader interviews was to collect information about how rural socioeconomic and demographic characteristics were evolving.

Sampled households were interviewed with a questionnaire that included 45 questions, primarily about the household labor assignment in different sectors, household total income and income structure, agricultural activity, land use, and the characteristics of household energy (such as quantities, structure, preference, and economic acceptability) used for cooking and heating water. These questionnaires were carried out by our professional investigators through a question-and-answer format to ensure the accuracy of the survey. In rural households where it was difficult to isolate a respondent, a collective household interview was conducted (Dovie 2003). The majority of questions were answered by the household head; the other family members complemented some questions. Follow-up interviews were conducted with select respondents to assure survey reliability and to provide explanations for unclear responses. After eliminating 12 invalid records, we gained 388 effective questionnaires. The characteristics of these rural households are listed in Table 1. Finally, we input all of the data from the questionnaires and analyzed the links between the progressive evolution of household livelihoods and ecological restoration.

To ensure a comparative analysis, the households were classified into four types according to the proportion of nonfarm income to total household income: pure farm

Table 1 The characteristics of sampling farmer households according to different types

	PFH	MFH1	MFH2	NH
Number (household)	56	99	213	20
% of total households (%)	14.4	25.5	54.9	5.2
Household size (person household^{-1})	4.25	4.04	4.02	4.35
Labor per household (person household^{-1})	2.37	2.58	2.45	2.7
20–40 years old (person household^{-1})	1.13	1.58	1.82	1.93
More than 9 years of education (person household^{-1})	1.07	1.33	1.38	1.84
Casual laborers (person household^{-1})	0	1.05	1.15	1.02
Cropland (hectare household^{-1})	0.758	0.136	0.084	0
Householder age (year)	47.62	45.75	44.56	42.2
Householder formal education (year)	4.35	6.24	7.78	8.5
Net income per farmer (RMB farmer^{-1} year^{-1})	3250	4018	5133	6426
Nonfarm income of total (%)	5.3	33	71.43	95.6
Energy cost per household (RMB household^{-1} year^{-1})	893	1005	1116	1228
% of total net household income	6.47	6.19	5.41	4.39

Note: Data in value terms are calculated at current prices; *PFH* pure farmer household, *MFH1* mixed farm-business household (type I), *MFH2* mixed farm-business household (type II), *NH* Nonfarm household

Source: Authors' survey, 2010

households (PFH) with nonfarm income proportion less than 10%, mixed farm-business households (type I) (MFH1) with nonfarm income proportion between 10 and 50%, mixed farm-business households (type II) (MFH2) with nonfarm income proportion between 51 and 90%, and nonfarm (NH) households with nonfarm income proportion more than 90%. Then, all the investigated households were stratified for further analysis according to non-farm extent (the percentage of non-farm income to total household income).

RESULTS

The rural household livelihoods have experienced great improvement since 2000. For the improvement in living standards, from 2000 to 2007, net income per farmer increased from RMB 2588 to RMB 3650 (calculated at comparable prices in 2007), growing by 41%; annually common consumption expenditure per farmer increased from RMB 1923 to RMB 3068, growing by 59.5%; the average housing area per farmer increased from 27.3 square meters to 43.9 square meters, and the proportion of multi-storey buildings grew from 39.6 to 69.4%; the number of color TV set users for every household increased from 0.46 to 1.04; the number of those owning a motorbike in every household increased from 0.41 to 0.90; mobile telephone users in every household increased from 0.02 to 1.07 (Changting County Statistics Bureau 2000, 2008).

Meanwhile, the ecosystem experienced great improvement in many aspects (Table 2). More specifically from 1999 to 2007, the vegetation and forest cover rates increased by 78.57 and 37.78% respectively, and the annual timber growth also increased from 1.06 to 5.1 m^3 hm^{-2}, indicating rapid improvement of the landscape (Yue 2008). Moreover, the biodiversity also improved substantially: the number of plant species increasing from a mean of six species per hectare to 38 species, showing the improvement in the function of ecosystem. The improvement in land cover further mitigated the soil erosion. The soil erosion decreased greatly during the same period, the area of soil erosion declined by 37.7% and the area of land experiencing heavy soil erosion (5,000 to 8,000 t km^{-2} $year^{-1}$) decreased by 53.69%. Then the mitigation of soil erosion promoted the improvement in properties of soil, such as the soil organic matter content growing from 3.57 to 6.78 g kg^{-1}, indicating the increase of soil fertility. In addition, the microclimate conditions also showed obvious improvement, becoming milder. For example, the relative humidity of the atmosphere increased from 55.70 to 63.50%. Moreover, evidence revealed that areas outside the project areas also experienced remarkable ecological restoration (Cao et al. 2009). In brief, the improvement in all ecological aspects of Changting County revealed the substantially ecological restoration and succession.

As for the driving forces of ecological restoration, besides a series of ecological measures, the change of rural outmigration and in household energy sources for cooking and farmland use, induced mainly by the evolution of farmer household livelihoods, were the principal factors which effectively promoted ecological restoration.

Table 2 Ecological improvement in areas with serious soil erosion of Changting County

	1999	2007	Change (%)
Vegetation cover (%)[a]	42	75	78.57
Forestry cover (%)[a]	45	62	37.78
Area in which soil erosion was occurring (km^2)[b]	382	238	–37.70
Light soil erosion (<2,500 t km^{-2} $year^{-1}$)	235	130	–44.68
Moderate soil erosion (2,500 to 5,000 t km^{-2} $year^{-1}$)	45	70	55.56
Heavy soil erosion (5,000 to 8,000 t km^{-2} $year^{-1}$)	69	32	–53.62
Severe soil erosion (>8,000 t km^{-2} $year^{-1}$)	33	6	–81.82
Total soil erosion (Mt $year^{-1}$)[b]	306	97	–68.30
Erosion modulus (t/km^2 $year^{-1}$)[b]	8000	4100	–48.75
Runoff proportion of precipitation (%)[c]	65	28	–56.92
Vegetation species (no. per ha)[c]	6	38	533.33
Soil organic matter content (g kg^{-1})[c]	3.57	6.78	89.92
Relative humidity of the atmosphere (%)[c]	55.70	63.50	14.00

Note: The areas refer to four towns including Hetian, Cewu, Sanzhou, and Zhuotian

Source: [a] office of water conservancy in Fujian province. Special report on comprehensive treatment in serious soil erosion regions of Changting County, 2008, [b] Cao et al. 2009, [c] Yue 2008

The Rural Household Outmigration

There were 59,860 rural labor forces migrating to cities and coastal areas in 1996 in Changting County (Agricultural Survey of China 1996). The number increased to 89,630 in 2006 (Agricultural Survey of China 2006). The percentage of migrant labor to the total number of rural increased from 25.18 to 56.09% (Table 3). As a result, the rural out-migrants have gradually become the primary component of the total rural labors. There were not only great changes in the quantity of the rural out-migrants, but also in the labor structure for migrant labors and those staying home—younger and more educational rural labor, who may exert the highest impact on the environment, were leaving from the rural areas (Table 3).

Apart from temporary migration in rural areas, urbanization of the population was another important type. Differing from that seasonal job-driven migration, many rural households moved to urban areas and settled down permanently, completely converting into urban households with local registration (*hukou*). The rate of urbanization increased from 14.50% in 2000 to 29.05% in 2008 (Bureau of Statistics in Changting County 2000, 2009). Meanwhile, nearly 75 thousand rural inhabitants moved to urban areas. Evidently, household outmigration promoted the ecological restoration of mountains and uplands by decreasing rural resident population density. Moreover, those households completely breaking away from agriculture had a larger ecological restoration effect than temporary migrating households.

The Transition of Rural Household Energy for Cooking

As the traditional source of fuel in rural areas, fuelwood accounted for 63.14% of energy consumption for cooking in Changting County in 1996 (Agricultural Survey of China 1996). The majority of households collected fuelwood from hillsides during the slack seasons. Like in other developing countries (Ravindranath and Hall 1995), this process generally induced tremendous ecological degradation, such as soil erosion, frequent flooding disasters, reducing output of crops, and increasing poverty due to excessive deforestation of small and young trees. In last two decades, the sources of rural household energy used for cooking in Changting County gradually shifted from fuelwood to other energies, such as coal, Liquefied Petroleum Gas (LPG), electricity, and methane (Fig. 4).

The transition was driven by many factors, mainly by non-farm employment and government policies. Local governments compensated the affected households in ecological restoration project areas of Changting County. For example, after removing the accessibility to harvest fuelwood, the government provided RMB 0.04 per lump of coal for farmer households who stopped cutting vegetation and replaced their fuelwood consumption with coal consumption for three years (Cao et al. 2009).

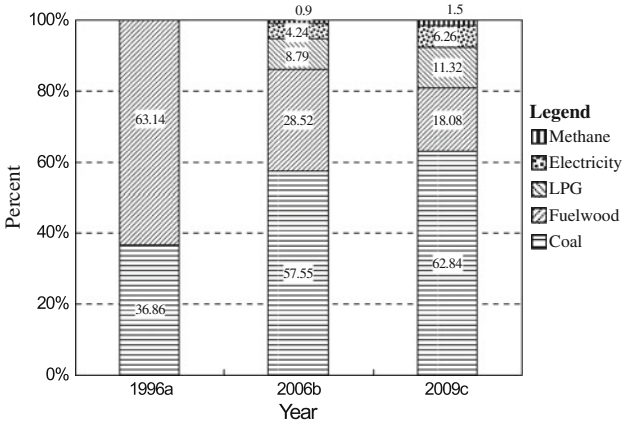

Fig. 4 The structure of rural household energy for cooking in Changting County. *Note: LPG* Liquefied Petroleum Gas. *Source:* a, Changting County Statistics Bureau 1996. *Agricultural Survey of China*. Longyan: Longyan Press; b, Changting County Statistics Bureau. 2006. *Agricultural Survey of China*. Longyan: Longyan Press; c, Authors' survey, 2010

Table 3 The change of labor structure in rural areas of Changting County (%)

	Out-migrating labor		Agricultural labor		Change (%)	
	1996[a]	2006[b]	1996[a]	2006[b]	Out-migrating labor	Agricultural labor
% of total labor	25.18	56.09	74.82	43.91	30.91	−30.91
Female	26.7	43.9	59.11	54.7	17.2	−4.41
16–20 years old	21.7	18.8	14.12	2.2	−2.9	−11.92
20–40 years old	62.47	71.3	47.16	30.7	8.83	−16.46
>40 years old	15.83	9.9	38.71	67.1	−5.93	28.39
More than 9 years education	62.67	73.3	23.09	30.1	10.63	7.01

Source : [a] Changting County Statistics Bureau. 1996. *Agricultural Survey of China*. Longyan: Longyan Press, [b] Changting County Statistics Bureau. 2006. Agricultural Survey of China. Longyan: Longyan Press

However, the corresponding subsidies were not adequate to compensate for the increased expense to households as coal price rose significantly. For example, the price of coal briquette rose from RMB 0.16 (about 0.019 US dollars) per lump in 2000 to RMB 0.62 (about 0.091 US dollars) per lump in 2010. Moreover, evidence from a 2005 survey showed that the net household income of more than half of respondents declined, due to a series of water and soil conservation measures (He 2007). In addition, there was little disparity between project areas and outside project areas in the rural energy transition. As a result, government policies were not the principal driving force behind rural energy transition.

Thanks to the increase in non-farm employment, non-farm income gradually became a crucial income source for rural households, becoming the principal source of the steady rise in the total net income for most rural households. The increasing non-farm income partly offset the increasing energy costs, due to soaring coal price.

For PFH, MFH1, MFH2, and NH, the cooking energy costs accounted for 6.47, 6.19, 5.41, and 4.39%, respectively of total net income (our survey in 2010). That is to say, for different types of farmer households, the burden of energy consumption was lower with the rise of non-farm income ratio. Moreover, the households with a high proportion of non-farm income tended to utilize the more convenient and commercial energy, such as Liquefied Petroleum Gas (LPG) and electricity. In addition, with the development of the rural labor market and gradual increase in non-farm income, the opportunity cost (labor) of fuelwood collection became so high that general farmer households actively upgraded their cooking energy from fuelwood to commercial energy. The process might play more important role than the project-oriented force in ecological treatment and promoted ecological restoration. Therefore, rural non-farm transfer was the key driving factor of rural energy transition.

The Change of Farmland Use Activities

Our survey overwhelmingly indicated that households with high rates of outmigration would conduct less cultivation. They tended to transfer farmland to others, and even abandon some marginal land. As a result, significant amounts of farmland were abandoned in many villages with high labor migration, especially marginal land, mountainous land with steep slopes, and muddy land. At the same time, the farmland with fertile soils, less steep slopes, and easy accessibility was usually transferred to other households with more labor staying home.

The evolution of farmer household livelihoods from traditional subsistence agriculture to more non-farm employment makes transfers of farmland cultivation right more frequent. It is interesting to note that the rent of transferred land between individual households practicing small-scale agriculture decreased steadily from 1,500 kg paddy ha^{-1} $year^{-1}$ in 2003 to 450 kg paddy ha^{-1} $year^{-1}$ in 2009 because fewer households were dependent on agriculture as their main source of income. This decreasing land rent is the best indicator of the general economic improvement and the increasing opportunity cost of labor. Consequently, only the best land is economically cultivable, and the rest of the land is abandoned to leave for ecological restoration. In other words, the project-oriented program is becoming possible largely thanks to the increasing income and non-farm opportunities.

DISCUSSION AND CONCLUSIONS

China has become a "world factory" and has achieved tremendous socioeconomic development in the process of globalization. The total GDP increased from 3.556 trillion RMB in 1990 to 30.067 trillion RMB in 2008 (calculated at comparable prices in 2008), with annual average growth of 13.38%. GDP per capita has also grown from 3360 RMB (about 484 US dollars) in 1990 to 22640 RMB (about 3263 US dollars) in 2008. The urbanization rate increased from 17.92% in 1978 to 45.68% in 2008, with an annual growth rate of 9.25% (Chinese National Bureau of Statistics 2009). Such rapid growth has been criticized by many people for its negative effect on the environment, especially in air and water pollution, and energy consumption. For example, during the recent decade of economic boom, China promptly became the largest emitter of fossil-fuel CO_2 into the atmosphere, with the fossil-fuel CO_2 emissions climbing from 0.4 Pg Cyr^{-1} in 1980 to 1.5 Pg Cyr^{-1} in 2006 (Gregg et al. 2008). Moreover, China had the largest area of soil erosion, accounting for the 19% of China's land area (Liu and Diamond 2005). In addition, 15–20% of China's species—including the giant panda—are now endangered (World Bank 2001). In brief, Chinese environmental degradation has continued to accelerate since the 1980s. Of the 142 countries for which environmental sustainability has been evaluated, China ranked 129th, higher only than Nigeria among countries in a comparable stage of development (Liu and Diamond 2005).

Less apparently and much less noted, the economic growth and prosperity in the coastal regions and cities provide some hope for ecological restoration in large rural areas and less developed regions. First, economic prosperity allows government, or more precisely the developed regions, to afford to increase their own local environmental quality, and also support the ecological restoration of other regions. The best examples are the Natural Forest Conservation Program (NFCP) and the Grain to Green Program

(GTGP). Second, but more importantly, the disparity between urban and rural areas, between coastal and interior areas, promoted the rural–urban migration, including permanent and temporary migration. It was reported that the number of floating population in China reached about 180 million in 2009. As a consequence, the rural household livelihoods changed tremendously, from simple farming and rural–urban isolation to diversified economy and rural–urban integration. A lot of fragile ecosystems that we have been fighting for over many decades are currently recovering; wild animals are coming back, and mountains are getting greener.

It seems "pull" forces of coastal regions and cities were larger than rural "push" forces of the ecological restoration. Varying from previous research which owed the success in conservation only to ecological projects (Cao et al. 2009), this study demonstrated that rural ecological restoration mainly resulted from economic development of external related regions, such as coastal regions and cities, instead of rural own efforts or government efforts. The research provides further evidence that humans and natural systems cannot be treated independently. On the contrary, the change in anthropogenic activities may have great significance for ecological restoration in mountain and upland regions (Folke et al. 2002). It is very important to pay attention to the changes taking place outside the local communities which might have significant impacts as well. This is especially true when society is more integrated by good transportation, communication, and market forces. China has never been lacking in government- or non-government-initiated ambitious projects nor the "push force" for ecological restoration in the past half century, but until very recently, when it has had its "pull force" available.

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