Role of culturally protected forests in biodiversity conservation in Southeast China

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Abstract Culturally protected forests (CPFs), preserved and managed by local people on the basis of traditional practices and beliefs, have both social and ecological functions. We investigated plant species richness and diversity within the tree layer, shrub layer and herb layer in three types of CPFs (community forests, ancestral temple forests, cemetery forests) as well as nearby forests without cultural protection (NCPFs) in Southeast China. A total of 325 species belonging to 85 families and 187 genera were recorded in CPFs, including 17 protected species in China Species Red List and IUCN Red List, which accounted for 17 % of counties' endangered species. Compared with NCPFs, the tree layer of CPFs had larger DBH and lower species density, especially in the cemetery forests. CPFs had higher alpha diversity values generally, particularly in the tree layer. The differences in tree layer were substantial, and CPFs covered nearly 85.4 % of the tree species in the surveyed sites. The similarities between CPFs and NCPFs were higher in the herb and shrub layers than in the tree layer. These differences of species diversity may be attributed to differences in resource use and management between CPFs and NCPFs. Our field investigation results suggested that local CPFs harbor many plant species, high biodiversity, and contribute to the conservation of a substantial proportion of the local species pool.

Keywords Culturally protected forests · Community structure · Species composition · Species diversity · Southeast China

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In response to the growing threat of biodiversity loss in the world (Pimm et al. 1995; Loreau et al. 2001; Achard et al. 2002), scientists and conservationists are seeking effective ways to improve biodiversity conservation. One of the approaches which has received great attention recently is to acknowledge and include the role of traditional cultural practices and beliefs in protecting and managing biodiversity (Byers et al. 2001; Infield 2001; Fabricius 2004; Berkes and Davidson 2006; Garnett et al. 2007). Culturally protected forests (CPFs), which have been preserved and managed by local communities on the basis of traditional culture, practices and beliefs, have largely been spared from severe deforestation since hunting and deforestation are forbidden. They have usually been preserved and maintained for several decades or even centuries. CPFs are reported to have both social functions and ecological services (Jim 2003; Bhagwat and Rutte 2006; Wassie et al. 2010; Hu et al. 2011). These forests often harbour spiritual, cultural heritage and aesthetic values for local community, and contribute to the local air quality, water provision and micro-climate regulation (Soury et al. 2007; Xu et al. 2009; Yuan and Liu 2009). In recent years, CPFs' management and their role in biodiversity maintenance have been widely discussed, under names such as sacred forests or sacred groves (Jamir and Pandey 2003; Mgumia and Oba 2003; Soury et al. 2007), sacred sites (Salick et al. 2007; Ceperley et al. 2010), fengshui forests (Hu et al. 2011) and church forests (Wassie et al. 2010), particularly in Africa and Asia (Wadley and Colfer 2004; Chun and Tak 2009; Luo et al. 2009; Yuan and Liu 2009; Page et al. 2010).

In traditional Chinese culture, CPFs are widespread, most of them being located besides or around the villages or temples. They can generally be divided into three types: community forests, cemetery forests and temple forests (Guan 2002). Community forests, the most common type of CPFs, are protected by local communities and are reported to play an important role in conserving and regulating the local environment (Hu et al. 2011). Villagers consider them as a natural shelter around the village, creating a physical barrier between inside and outside, thereby having the function of protection and defense (Zhong and Boris 2007). People bury ancestors, and often hold annual ceremonies in cemetery forests, which were normally managed by large families or clans (Xu et al. 2009). Temple forests are often located around temples, in which sacrificial ceremonies are held on the most important festival occasions in honor of families' ancestors. During the last few years, the CPFs in ethnic minority areas have attracted great interest in China, including the role of holy mountains in protecting species diversity (Ai and Zhou 2003; Yang and Zhao 2004; Xu et al. 2005; Zou et al. 2005; Mo et al. 2011), and the significance of traditional culture and traditional knowledge in managing forest resources in the southwestern ethnic minority area (Long et al. 1999; Fang et al. 2007; Xu 2008). Only a few studies, however, have addressed the issue of CPFs in areas of Southeast China, where the mainstream Han culture prevails (Liu et al. 2002; Liao et al. 2008). This is a caveat, because many CPFs have been protected for long periods under the traditional management of Han people, and almost every village in rural Southeast China has CPFs (Guan 2002; Lü et al. 2008). Furthermore, most of the previous studies have focused on the species composition for one patch or one type of CPF (Cui et al. 2008; Liao et al. 2008), but lack quantitative descriptions and comparisons of community structure and species diversity with the forests that do not have cultural protection (NCPFs).

In this study, we investigated three types of CPFs—community forests, ancestral temple forests and cemetery forests—in five villages in Southeast China. We compared the

features of the tree, shrub and herb layers with those in NCPFs in the same area to test the differences in community structure, species composition, alpha and beta biodiversity. Based on the field investigation results and information from social surveys in the five villages, we put forward some considerations on the role of cultural protection in the conservation of local biodiversity.

Study area and methods

Study area

The study was carried out in five villages with traditional Chinese Han culture in Southeast China, two of them in Fujian Province and three in Jiangxi Province (Fig. 1). The climate in the studied region belongs to subtropical humid zone with plentiful sunshine and abundant rainfall. Most of the land is mountainous and the slopes of sample forest plots varied from 5 to 40 degrees (Table 1). The elevation ranged from 87 to 721 m. Zonal vegetation was evergreen broad-leaved forest dominated by *Fagaceae*, *Lauraceae* and *Theaceae* (He et al. 1998; Lan 2003). Longtan, Jiangwan and Fenshui villages are all more than 100 years old with lush community forests which existed for at least the same period. Ancestral temple forests are located in Xibei village, and according to a local forest ranger existed there before the Liao's ancestral temple, which was built in 1848. The cemetery forests in Datang village date from Jiaqing of the Qing Dynasty (1796–1820).

Plots setting and vegetation sampling

The forests were surveyed between May and September 2010. Semi-structured interviews were carried out with key informants about the history, ownership, location and boundaries of the CPFs. Key informants were five venerable old men, six current or former village leaders and one forestry worker. Twelve key informants in total were interviewed, two in each of the villages with community forests, and three in both Datang and Xibei. In this study, we established a total of 50 plots in five different sites for CPFs and NCPFs. Efforts had been made to allocate the plots evenly along the village and to cover most of the distribution area of CPFs and NCPFs. The CPFs were natural forests and ranged from 0.3 to 9 ha in area. The main vegetation was evergreen broad-leaved forest, and appeared to represent almost intact original habitats with limited human disturbance, which is similar to regional climax vegetation (He et al. 1998; Lan 2003). The NCPFs investigated were selected within a range of 1.5 km from the village. Patch area ranged from 3 to 31 ha. In Fenshui, Longtan and Datang villages they were natural secondary forest and in Jiangwan and Xibei villages they were planted forests.

In each village, five plots of 20 m × 20 m were set within the patches of CPFs or NCPFs. Each plot was evenly divided into four subplots of 10 m × 10 m ($n = 200$). The minimum distance from the forest edge was 5 m to avoid edge effects. In the plots, all tree stems with diameter at breast height (DBH) >3 cm were identified to species, and DBH and height were measured. All shrubs (including saplings) were identified within a 5 m × 5 m sampling area ($n = 200$) in each subplot, and species, number, average crown and height were recorded. Number, species, coverage and height of herbs were also recorded within a sampling area of 1 m × 1 m ($n = 200$) in each subplot. Plot elevation,

Fig. 1 Locations of the five villages in Southeast China

Table 1 Basic attributes of study area

Village	Location	Mean annual temperature (°C)	Mean Annual precipitation (mm)	Altitude (m)	Slope (°)
Longtan	N: 25°06′29″ E: 116°55′27″	18.7–21.0	1031–1369	348–490	15–40
Xibei	N: 25°06′24″ E: 116°49′08″	18.7–21.0	1031–1369	700–721	15–40
Fenshui	N: 29°13′04″ E: 117°36′19″	16.7–18.3	1600–1800	87–130	5–35
Jiangwan	N: 29°22′03″ E: 118°03′14″	16.7–18.3	1600–1800	128–185	8–40
Datang	N: 29°29′29″ E: 115°53′41″	16.0–17.0	1300–1600	135–153	5–10

slope, aspect, latitude and longitude, and degree of disturbance of sampled forests were also measured. The same vegetation sampling methods were used for both CPFs and NCPF.

Data analyses

Importance value

Importance value (IV) was calculated to determine the dominant species (Zhang 2004).

$$IV_i = (a_i + b_i + c_i)/3$$

where IV_i represents the importance value of species I , a represents the relative density which equals density of species i /density of all species $\times 100\%$, b represents the relative dominance which equals basic area of species i /basic area of all species $\times 100\%$, c represents the relative frequency which equals frequency of species i /appearance frequency of all species.

In the above formula, relative dominance values were calculated from cross-sectional area at breast height for trees, crown for shrubs and coverage for herbs.

Species diversity indices

Species richness (S), Simpson, Shannon-Wiener and Pielou evenness indices were calculated using the following formulas:

Simpson indices: $D = 1 - \sum_{i=1}^i P_i^2$ (Simpson 1949).

Shannon–Wiener indices: $H_i = -\sum_{i=1}^i P_i \ln P_i$ (Shannon and Weaver 1949).

Pielou evenness indices: $JSW = -\sum_{i=1}^i (P_i \ln P_i) / \ln S$ (Magurran 1988).

where S is species number; $P_i = n_i/N$, n_i is individual number of species I , N is individual number of all species.

Beta diversity is a key concept for understanding ecosystem functions, biodiversity conservation, and ecosystem management (Legendre et al. 2005). Bray–Curtis index which takes into accounts species abundances was used to measure the similarity between CPFs and NCPFs (Magurran 2005).

The Bray–Curtis index was calculated by EstimateS Win8.20 software (R. K. Colwell, <http://purl.oclc.org/estimates>). Instead of species abundance, coverage was used to analyze the herb layer. SPSS 18.0 was used to calculate independent sample t -tests. Arc GIS 10 and SigmaPlot 11.0 were used to produce the figures.

Results

Community structure and species composition

Vertical structure

CPFs had been preserved for a long time, and were generally at the middle to late successional stages. They could be clearly divided into tree layer, shrub layer and herb layer. Tree height and DBH were higher in CPFs than in NCPFs (Fig. 2). In the tree layer, there were two sub-layers; the first was 12–25 m high with a range of DBH of 30–60 cm. The dominant species were broad-leaved trees, including *Castanopsis carlesii*, *Castanopsis sclerophylla*, *Tsuga longibracteata*, *Cinnamomum camphora* etc. (Table S1). The second sublayer was 7–12 m high, dominated by *Schima superba*, *Castanopsis fargesii*, etc.

Fig. 2 Average distribution of frequency of DBH (cm) in CPFs and NCPFs

NCPFs had only one tree layer with a height range of 6–11 m; the dominant species were *Cunninghamia lanceolata*, *Pinus massoniana* and *Phyllostachys heterocycla* cv. *pubescens*.

In the shrub layer, the species in CPFs were relatively richer, and were dominated by *Eurya muricata*, *Ardisia japonica*, *Pleioblastus amarus* and *Camellia oleifera*. The dominant shrub species of NCPFs were *Pleioblastus amarus*, *Camellia sinensis*, *Adinandra millettii* and *Loropetalum chinense* (Table S1). The difference in the herb layer between CPFs and NCPFs was location-dependent, and the dominant species were *Woodwardia japonica*, *Dryopteris crassirhizoma*, and *Dicranopteris dichotoma* (Table S1).

Species composition

A total of 325 species belonging to 187 genera and 85 families were found in CPFs while 281 species belonging to 162 genera and 77 families were recorded in NCPFs. The most common families were *Fagaceae*, *Lauraceae*, *Theaceae* and *Aquifoliaceae* in CPFs, and *Fagaceae*, *Theaceae*, *Lauraceae* and *Euphorbiaceae* in NCPFs (Table S1). In total, the CPFs had 105 species in the tree layer, 219 species in the shrub layer and 86 species in the herb layer, while the corresponding layers in NCPFs have only 63, 197 and 70 species respectively.

The dominant plant families of the tree layer in community forests CPFs in Longtan, Fenshui and Jiangwan were *Lauraceae*, *Fagaceae*, and *Theaceae*, and the dominant species were *Castanopsis sclerophylla* and *Castanopsis carlesii*. In NCPFs, the dominant tree families were *Fagaceae*, *Euphorbiaceae* and *Theaceae*, and the dominant species were *Cunninghamia lanceolata* and *Pinus massoniana* (Table S1). In the shrub layer, the most common families were similar in both CPFs and NCPFs, and were the same as the tree layer in CPFs (Table S1). In the herb layer, the most common families were *Liliaceae* and *Dryopteridaceae* in CPFs, and *Poaceae* in NCPFs.

For the ancestral temple forests in Xibei village, the main families of the tree layer were *Ericaceae* and *Fagaceae*, and the dominant species was *Tsuga longibracteata* (Table S1).

Table 2 Species composition of CPFs and NCPFs

Site	Type	Tree layer		Shrub layer		Herb layer	
		CPFs	NCPFs	CPFs	NCPFs	CPFs	NCPFs
Longtan village	Families	17	15	26	28	15	21
	Genera	26	22	46	49	19	31
	Species	33	26	72	68	25	36
	Density	0.20	0.23	0.31	0.28	–	–
Fenshui village	Families	22	19	32	28	10	11
	Genera	34	29	57	47	13	13
	Species	48	40	87	72	15	14
	Density	0.18	0.22	0.97	1.38	–	–
Jiangwan village	Families	23	7	27	24	18	13
	Genera	32	10	44	39	24	16
	Species	38	10	59	56	28	16
	Density	0.19	0.23	0.52	0.60	–	–
Xibei village	Families	13	4	25	22	12	14
	Genera	17	4	37	38	16	18
	Species	22	4	55	58	19	19
	Density	0.14	0.23	0.39	0.49	–	–
Datang village	Families	11	12	39	33	21	13
	Genera	13	18	67	63	33	17
	Species	13	19	99	84	39	20
	Density	0.05	0.26	1.16	1.32	–	–

However, NCPFs had only four species in the tree layer (Table 2). The shrub layer in CPFs was composed of *Theaceae*, *Aquifoliaceae* and *Ericaceae*, and the dominant species were *Cinnamomum austrosinense* and *Antidesma japonicum* (Table S1). In the NCPFs, the main families were *Lauraceae*, *Theaceae*, and *Ericaceae* with the dominant species being *Adinandra millettii* and *Vaccinium carlesii* (Table S1).

Cemetery forests in Datang village had relatively fewer species in the tree layers compared with those in the NCPFs. The most common families in the tree layer were *Fagaceae* and *Lauraceae* in both CPFs and NCPFs. The dominant species in CPFs were *Cinnamomum camphora* and *Pinus massoniana*, while the dominant species in NCPFs were *Cunninghamia lanceolata* and *Camellia oleifera*. The shrub and herb layers of CPFs had more species than those of NCPFs. In the shrub layer, the dominant families were *Verbenaceae* in CPFs and *Euphorbiaceae* in NCPFs respectively.

Height, individual distribution (average frequency distribution of DBH) and density

Trees in CPFs were higher (averagely 10.8 m) and had a bigger DBH (averagely 16.4 cm) than those in NCPFs (height: 9.2 m; DBH: 10.1 cm) (Figs. 2, 3). For community forests and ancestral temple forests, 89.3 % of the trees had a DBH ranged from 3 to 30 cm. Trees with a DBH greater than 50 cm represented 4.4 % of the whole tree layer, the largest being an individual *Castanopsis carlesii* with a DBH of 171.4 cm. For the cemetery forests, only 25.7 % of the trees had a DBH between 3 and 30 cm, the rest were very large trees with

Fig. 3 Average distribution of frequency of DBH (cm) in three types of CPFs

43.8 % of them having a DBH greater than 50 cm. The largest tree in cemetery forests was a *Pistacia chinensis* with a DBH of 120.0 cm. In NCPFs, the distribution of DBH from 3 to 30 cm was 98.4 %, with only 0.1 % greater than 50 cm. The stand density in CPFs was relatively low compared with the NCPFs (Table 2).

Alpha and beta diversity in CPFs and NCPFs

Alpha diversity

The Simpson index, Shannon-Wiener index and Pielou evenness index of the tree layer in CPFs were higher than those in NCPFs with a significant difference for all sites except for the cemetery forests in Datang village (Table 3). Most of the indices for the shrub layer and herb layer in CPFs were higher than those in NCPFs, and 20 out of 45 index values showed a significant difference (Table 3). The only exceptions to this overall pattern were the index values for the Xibei and Longtan herb layer, which were slightly (though not significantly) lower in CPFs.

Beta diversity

CPFes harboured most of the species in the local area, and 80.0 % of the species found in three layers around five villages presented in the CPFs. There was low similarity (Bray–Curtis index) between the tree layers of CPFs and NCPFs. Compared with natural NCPFs, the planted NCPFs had less species similarity with CPFs (Table 4). Particularly for the tree layer, the differences between CPFs and NCPFs were substantial where CPFs harboured 85.4 % of all tree species found in total and the species only presented in CPFs were on average 52.4 % in each village (Fig. 4). The similarity of the shrub layer was relatively high (Table 4), and the ratio of species presented in each type of forest was almost the same. The proportion of common species was 57.6 % of all species found and from 32.2 to 67.4 % in the shrub layer of each village (Fig. 4). Of the species in the shrub

Table 3 Difference in biodiversity indices of CPF and NCPFs

Layer	Index	Longtan		Fenshui		Jiangwan		Xibei		Datang	
		CPFs	NCPFs	CPFs	NCPFs	CPFs	NCPFs	CPFs	NCPFs	CPFs	NCPFs
Tree layer	Shannon	2.63	1.58*	3.32	2.82*	2.34	0.60*	2.41	0.59*	1.95	1.95
	Simpson	0.87	0.68*	0.95	0.91*	0.83	0.31*	0.88	0.35*	0.82	0.81
	Pielou	0.46	0.24*	0.56	0.46	0.39	0.10*	0.43	0.10*	0.46	0.32*
Shrub layer	Shannon	3.76	3.69*	3.52	2.36	2.88	2.67*	3.19	2.50	3.46	3.29
	Simpson	0.96	0.96	0.96	0.70	0.91	0.87*	0.94	0.93	0.93	0.93
	Pielou	0.58	0.58	0.46	0.29	0.41	0.38*	0.48	0.36	0.47	0.43
Herb layer	Shannon	2.77	2.95	2.30	2.09	3.04	2.23*	2.27	2.49	3.35	2.61*
	Simpson	0.91	0.95	0.88	0.83	0.95	0.87*	0.85	0.90	0.95	0.89
	Pielou	0.64	0.63	0.54	0.54	0.67	0.52*	0.54	0.55	0.76	0.64

* Significant difference ($P < 0.05$) between CPFs and NCPFs

Table 4 Bray–Curtis index between CPFs and NCPFs

Layer	Longtan village	Fenshui village	Jiangwan village	Xibei village	Datang village
Tree layer	11.2 %	31.4 %	1.3 %	8.1 %	12.8 %
Shrub layer	24.6 %	32.0 %	25.8 %	16.0 %	25.8 %
Herb layer	19.3 %	50.7 %	14.5 %	30.5 %	14.5 %

layer of NCPFs, 37.4 % were found in the tree layer of CPFs, while only 23.9 % were found in the tree layer of NCPFs. The similarity index of the herb layer showed high variation, with on average 23.3 % common species between CPFs and NCPFs (Fig. 4).

Protected species

CPFs had significant contribution to protect endangered species for the local area. 17 protected species were found in the CPFs in China Species Red List and IUCN Red List (Table 5), and eight in NCPFs (Walter and Gillett 1998; Wang and Xie 2004). Six species in the CPFs were critically endangered (CR), two species were endangered (EN), eight were vulnerable (VU), and one was Lower Endangered (LE) in CPFs. Furthermore, CPFs included seven protected species which occurred in NCPFs, with only one species near threatened—*Liparis nervosa* occurring in NCPFs.

Discussion and Conclusions

The results of our research imply that CPFs can play a significant role in biodiversity conservation. Biodiversity in the CPFs was higher than that in NCPFs. Similar findings were found in other research, such as for fengshui forests in Pearl Delta (Hu et al. 2011), traditional forests in Southwest China (Liu et al. 2002; Mo et al. 2011) and sacred forests in Mozambique (Virtanen 2002). Of the three types of CPFs, community forests and ancestral temple forests sheltered large proportions of local biodiversity. About half of the indices

Fig. 4 Unique species and common species ratio of CPFs and NCPFs (1 Longtan village, 2 Fenshui village, 3 Jiangwang village, 4 Xibei village, 5 Datang village)

Table 5 State protected species in CPFs and NCPFs

ID	Families	Latin name	Protected level	Evaluation grade	CPF	NCPF
1	Leguminosae	<i>Pterocarpus indicus</i>	II	CR	✓	
2	Rubiaceae	<i>Mussaenda shikokiana</i>		CR	✓	
3	Araliaceae	<i>Schefflera octophylla</i>		CR	✓	
4	Daphniphyllaceae	<i>Daphniphyllum oldhami</i>		CR	✓	✓
5	Lauraceae	<i>Machilus pingii</i>	II	CR	✓	
6	Euphorbiaceae	<i>Sapium discolor</i>		CR	✓	✓
7	Taxaceae	<i>Taxus chinensis</i> var. <i>mairei</i>	I	EN	✓	
8	Araliaceae	<i>Aralia chinensis</i>		EN	✓	✓
9	Lauraceae	<i>Cinnamomum camphora</i>	II	VU	✓	✓
10	Leguminosae	<i>Ormosia henryi</i>	II	VU	✓	✓
11	Orchidaceae	<i>Cymbidium goeringii</i>	I	VU	✓	
12	Theaceae	<i>Camellia japonica</i>	II	VU	✓	
13	Araliaceae	<i>Dendropanax dentigerus</i>		VU	✓	✓
14	Staphyleaceae	<i>Euscaphis japonica</i>		VU	✓	
15	Magnoliaceae	<i>Magnolia denudata</i>		VU	✓	
16	Pinaceae	<i>Tsuga longibracteata</i>		VU	✓	
17	Orchidaceae	<i>Liparis nervosa</i>		NT		✓
18	Dicksoniaceae	<i>Cibotium barometz</i>	II	LC	✓	✓

tested were significantly higher for the CPFs than for the NCPFs. Cemetery forests, while they had fewer species in the tree layer compared with NCPFs within the same local area, were important for biodiversity protection as they harboured very old trees with a large DBH, a structural feature absent from other forest types studied. Moreover, the composition of the dominant tree community provided clues for the effectiveness of CPFs in conserving biodiversity. CPFs had experienced an extended period of succession and regeneration, which had resulted in a stable forest structure with a clear stratification of layers. The attributes of the forest communities found in CPFs are comparable to

well-developed evergreen broad-leaved forests in the region, and the dominant families of CPFs recorded in this study are congruent with reports from main types of evergreen broad-leaved forests in the eastern part of middle subtropical China (He et al. 1998), from Wuyi Mountain National Natural Reserve in Fujian Province (Lan 2003; Kong and Li 2011), and from Lu Mountain National Natural Reserve in Jiangxi Province (Luo and Li 1996). These similarities suggest that CPFs can be considered as patches of well-developed broad-leaved forest in Southeast China.

In addition, the CPFs not only protect local biodiversity, but also conserve indigenous species and preserve the physiognomy of the community. Most of the dominant species in the tree layer were indigenous broad-leaved species in the late stage of succession. In NCPFs, the dominant species were easily cultivated and form conifer dominated mixed broadleaf-conifer forests. The dominant tree species in CPF patches could be valuable for the restoration of forests, and may also provide a standard for evaluating its effectiveness, in line with the suggestion of Ren et al. (2007). For example, *Schima superb*, *Cinnamomum austrosinense*, *Cyclobalanopsis glauca* are key species for restoration (Peng 1996). Moreover, since 85.4 % of the local trees species identified were found in CPFs, these forests may act as seed (species) pools to neighboring forests and areas.

With regard to protection of endangered species, 17 species were found in CPFs that were listed as endangered species in IUCN Red List and China Species Red List. According to recent investigations on the biodiversity of Fujian (Fujian Provincial Academy of Environmental Science, 2011) and unpublished results of biodiversity evaluation research in Jiangxi Province by Environmental Protection Department, there are 100 endangered plant species in the four counties where the five villages are located. This means that the investigated CPFs harbour 17 % of their counties' threatened species, even when these CPFs are less than 0.02 % of the total forests area of the four counties.

The relatively high levels of biodiversity in CPFs were plausibly caused by the differences in management and resource use between CPFs and NCPFs. The historical resource use in these CPFs was and still is limited to collecting non-timber products, including dead wood and leaves for fuel, fruits and mushrooms for food, and Chinese herbs for medicine. However, cutting economically valuable trees and shrubs was permitted in the NCPFs. Examples of trees that were cut in NCPFs were *Cunninghamia lanceolata* in Xibei village and *Camellia oleifera* in Datang village. Although China has been crafting a Western-style rule of law since the late 1970s (Li 2010), traditional beliefs and village rules or regulations are still important for restraining the behavior of residents and the way they managed the forests (Yuan and Liu 2009). In the social survey of the same villages (Gao et al. unpublished), it was reported that anyone who destroyed CPFs would be punished under village rules and informal regulations, maintained by the village committee. For instance, the committee might kill an offender's family pig and distribute the meat to other villagers. Other punishments mentioned were insisting on self-criticism in front of villagers, replanting trees, or paying a fine. Such findings are in line with other research demonstrating that local communities can be actively engaged in maintaining biodiversity in the forest landscape for future populations and fulfilling livelihood needs (Wiersum 2003).

According to the social survey of CPFs, most villagers considered forests as natural protective screens to defend villages from disaster and ensure safety and well-being. In their perception, CPFs provided not only clean air and water, and improved the local climate, but also cultural value to the community, related to their beauty, cultural heritage, and spiritual meaning. Also recreation and tourism were mentioned as an important benefit, particularly in the case of the ancestral temple forest.

Taken together, our findings suggest that there are good reasons for seriously investigating the potential roles of local motivations and traditional customs and village rules in protecting biodiversity in Southeast China. The positive attitudes towards CPFs and the informal rules to protect them are still effective today, as is demonstrated by our biodiversity investigation and social survey.

Without support from government and NGOs there is a serious risk that the effectiveness of local rules and the significance of CPFs for biodiversity conservation will diminish in the years to come. Governments in Fujian and Jiangxi Provinces have tried to support to establish small protected area protecting small ecosystems with special ecological values and areas of cultural importance for local communities, and some of these small protected areas were based on CPFs (State Environmental Protection Administration 2000). Furthermore, local preservation of CPFs should not be seen as an alternative that stands apart from government regulation, but rather as a complementary strategy within a supportive regulatory framework. The merits of informal regulations need to be recognized, encouraged, and integrated into existing policy frameworks of government. Additionally, both provinces surveyed have undergone forest tenure reform. In the reform, collectives have the option of reallocating forest rights to individual households but they can also keep patches of forest as collectively owned (Xu et al. 2010). The CPFs investigated were designated by the village committees for collective usage and ceremonial activities, while the other local forests, including the NCPFs investigated, were allocated to households. The community owned status of CPFs and the legitimate application of local rules would need acknowledgement and support from government. It is also plausible that as a large network of forest patches, CPFs can preserve a sizeable portion of the biodiversity in local area and a region.

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