MANAGEMENT OF MATSUTAKE IN NW-YUNNAN AND KEY ISSUES FOR ITS SUSTAINABLE UTILIZATION

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ABSTRACT

Matsutake is a group of economically important wild mushrooms. It contributes greatly to local economy and livelihoods in many places of the world. The management and sustainable use of this resource is gaining increasing attention in NW-Yunnan, one of the most productive areas for Matsutake in the world. In the paper, we provide an overview to the value, nature of matsutake and its distribution, collection, and current management in NW-Yunnan. We also identify key issues and challenges to for the sustainable utilization of this valuable resource.

Keywords: matsutake mushroom, management, Northwest Yunnan

1 INTRODUCTION

1.1 SOCIAL AND COMMERCIAL VALUE OF MATSUTAKE MUSHROOM

Matsutake mushroom is an autumn delicacy favored by Japanese since ancient times. Autumn is season of harvesting (*minori no aki*) and hearty appetites (*shokuyoku no aki*) in Japan. Several foods are associated closely with autumn in Japanese tradition: new rice (*Shinmai*), mushrooms (*Kinoko*) including Matsutake and Shimeji, wild vegetable (*Yasai*), fish (*Sakana*) and fruit (*Kudamono*) including grape, pears, chestnuts, persimmons. Amongst of which, matsutake is prized as the "King of mushroom". Matsutake gathered in groves of *akamatsu* or red pine in Japan are considered the finest in flavor and fragrance and command such a high price that most people can only afford to eat once a year, if at all. The subtle flavor of this delicacy is often enjoyed by cooking a single *matsutake*, sliced into small pieces, with rice (*matsutake gohan*) (Anonym, 1999). More than seasonal delicacy, matsutake also symbolize fertility, and by extension, good fortune and happiness (Hosford *et al*., 1997). In ancient, Matsutake is mainly used by nobles and priests; now it becomes a public consumable (Hosford *et al*., 1997).

Matsutake have become a commercially important wild mushroom. Depending upon the quality, the wholesale price in Japan varies from US$ 27 to US$ 560 per kilogram (Wang *et al*., 1997). Consumption in Japan is approximately 3000 tonnes per year, of which Japan produces 1000 tonnes in a good year (Van On, 1993). The remainder is imported mainly from Korea, China, and North America. Matsutake collection can generate significant income, for example, in Canada, the British Columbia wild mushroom industry harvests 250-400 tonnes per year, with a value of US$ 25-45 million (Wills and Lipsey, 1999). Collection of Matsutake has recently become more and more important in northwest

Yunnan, China as other income streams (e.g. timber extraction) are lost. In Shangri-La County, up to 80% of local revenue used to be generated from logging, but a commercial logging ban was imposed in 1998 in an attempt to conserve watershed integrity (Yeh, 2000).

1.2 NATURE OF MATSUTAKE MUSHROOM

"Matsu-take" translates literally as "pine-mushroom" from the Japanese. Originally, matsutake referred to *Tricholoma matsutake*, but subsequently the name refers to a group of similar mushrooms related to *T. matsutake* (Hosford et al., 1997). There are about 15 species (and one variety) distributed worldwide (Zang, 1990; Liu et al., 1999). They occur in Asia (mainly *T. matsutake*), North America (mainly *T. magnivelare*, also known as American matsutake), Europe (mainly *T. caligatum*, also known as European matsutake) and Oceania (Wang *et al*., 1997). In China, five species (and one variety) were found in at least eight provinces (Liu *et al*., 1999), of which *T. matsutake* is the most valuable and intensively exploited. Matsutake mushrooms are soil-borne and perennial mycorrhizal fungi. They develop a symbiotic association with the roots of specific trees (Ogawa, 1976; James, 1998). In NW Yunnan, these trees are mainly *Pinus spp*. and *Qucuer spp*.

1.3 NORTHWEST YUNNAN

Located in the southern mountain region (Hengduan Mountains) of the Eastern Himalayas, northwest Yunnan is in a transitional zone between the Qinghai-Tibet and Yunnan-Guizhou Plateaus. Three major rivers, the Lancang (Mekong), Jinsha (upper reaches of the Yangtze) and the Nu (Salween), run parallel in a southerly direction. High mountains and deep gorges dominate the regional landscape, with the elevation ranging from 6740m at the summit of Kawagebo to about 500m in the lower parts of the Nujiang valley. The variation of topography and latitude results in a high diversity of microclimates. Consequently, northwest Yunnan contains 40% of the province's 15,000 plant species and is recognized as a global biodiversity hotspot (Myers *et al*., 2002).

1.4 MATSUTAKE DISTRIBUTION, PRODUCTION & TRADE IN YUNNAN

As noted in Table 1, Japan annually imports 2300-3500 metric tonnes of matsutake (Gong and Wang, 2004), 1/3 to nearly 2/3's of which comes from China. Southwest China (mainly northwest Yunnan and southwest Sichuan provinces) accounts for almost 80% of the Chinese total; the second most productive area for matsutake in China is the Northeast (Heilongjiang and Jilin provinces).

Table 1. Matsutake importat of Japan (in tonnes), adopted from (Gong and Wang, 2004)

	1995	1996	1997	1998	1999	2001
Total Importation	3515	2703	3059	3248	2935	2394
From South Korea	633	170	249	355	515	181
From North Korea	1141	541	615	1086	307	210
From China	1191	1152	1076	1313	1292	1531
Percentage from China	33.88	42.62	35.17	40.42	44.02	63.95

In Yunnan, the income from matsutake ranks number one among all exported agricultural products and NTFPs. In 2005, more than U.S. $44 million was generated by the export of Matsutake. The distribution and abundance of matsutake in Yunnan is shown in Fig 1. The most productive areas of Yunnan are located in the northwestern and western parts. For example, in 2005 the total exportation from Yunnan was around 1300 metric tonnes. Diqing Prefecture (which includes Shangri-la, formerly known as Zhongdian) accounted for 47% of Yunnan's matsutake exports, while Dali, Chuxiong and Lijiang prefectures accounted for 21%, 18% and 12% respectively (Fig 2).

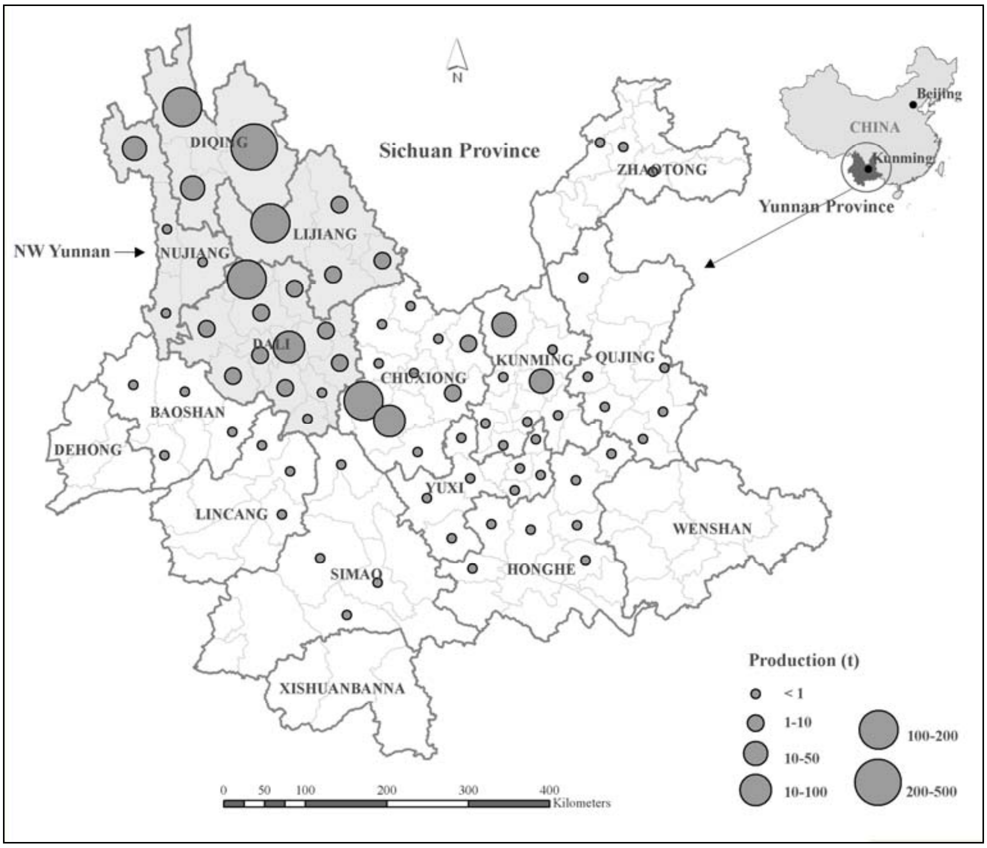

Figure 1 Distribution of Matsutake Production in Yunnan (Data based on year 2005)

The trend of matsutake production in Yunnan is difficult to evaluate in the limited time frame for which data is available. Data for Shangri-La County between 1998 and 2005 is shown in Fig 3. As can be seen, there are great year-to-year differences in amounts of matsutake harvested. The factors determining this fluctuation are weather (especially temperature and precipitation), price, and possibly the impact of previous harvests though this has not been substantiated. It is generally agreed upon by local mushroom pickers, traders and researchers that weather is the most significant factor contributing to crop fluctuations. While methods of harvest and habitat management are also considered important, it is difficult to quantify their impacts, if any, with the information available. Continued monitoring over the long term is necessary before a trend can be established.

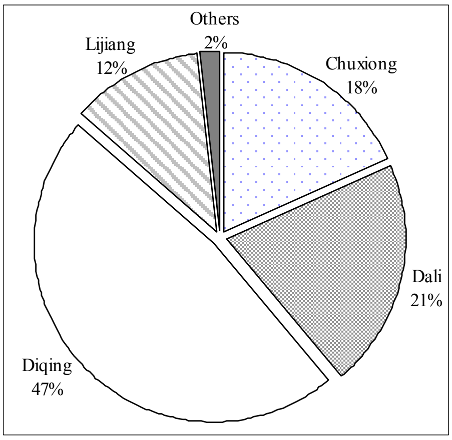

Figure 2. Matsutake Production in Yunnan Province in 2005 with a total production of 1300 metric tons.

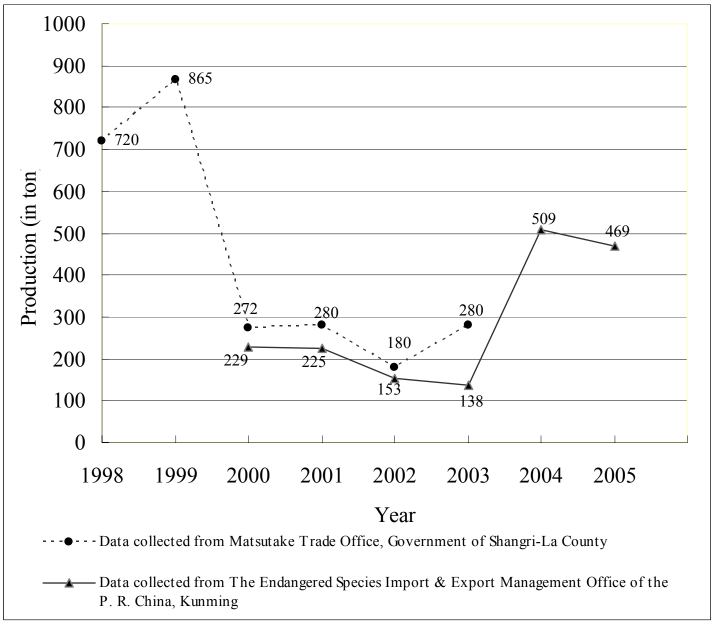

Figure 3. Matsutake production of Shangri-La (formerly Zhongdian) County. The data collected from the CITES-Kunming is slightly lower than that from Shangri-La Matsutake Office of the same year. The difference could be due to two reasons: 1, domestic consumptions and 2, export via Sichuan Province (e.g. preserved products). Moreover, the total amount of Matsutake trade in Shangri-La city mainly from Diqing Prefecture (mainly Shangri-La and Deqin Counties), part from Gangzi Prefecture of Sichuan Province and part from Changdu Prefecture of TAR (Tibetan Autonomous Region).

2 MANAGEMENT OF MATSUTAKE IN YUNNAN

2.1 POLICY ENVIRONMENT AT THREE LEVELS

In year 1999, the State Council enlisted *T. matsutake* as a protected wild plant - National Grade II. Based on the *Regulation of Wild Animal and Plant Protection*, the CITES Chinese office is authorized and started to implement a management system to control the matstuake export in 2000 by issuing the permit for exportation. This system is firstly executed in Yunnan and Sichuan Provinces and then extended to all the production area. With this system, it predefines the upper limit of total export of a year at national level; mandates the provincial forest authorities to administrate the registration of Matsutake Export Company and to allocate the export quota; and mandates the CITES local offices to issue the export permit. The custom processes the export procedure based on this permit.

At provincial level, the Forestry Department implements the administrative duties as mandated by the state. At prefecture or county level, three different governmental authorities tax the matsutake: *Special Agro-Forestry Products Taxation, Business Administration Taxation and Plant Quarantine Taxation*.

At local level, the local communities establish regulation, so called *Xiangguiminyue* to define the resource boundary, allocated resource user right and regulate harvesting methods or patterns.

2.2 RESOURCE TENURE AND ACCESS

Generally the tenure system for non-timber forest products is vague. In Yunnan, forestland tenure is broadly divided into three categories: state forest, collective forest and household or freehold forest in 1981 (Xu and Ribot, 2004). Although NTFPs are considered an attached attribute of the forestland tenure, there is no particularly tenure arrangement for specific forest products. However the right to harvest NTFPs can be negotiated based on customary institution and statutory forestland tenure arrangement among traditional users.

In customary practices, NTFPs had been harvested across administrative and forest tenure boundaries in northwest Yunnan either as open access resources or common property when they were consumed locally with small amount. With increasing marketing value and large-scale commercialization of NTFPs, such as the matsutake, conflicts occurred. New regulations are formed at community or township level to solve the inter-and-intra-village conflict, in which boundaries for matsutake harvest are demarcated, usually corresponding to administrative boundaries and customary access i.e. (*Xiangguimingyue*). Within each community, all villagers have equal access rights. In places of rich production, outsiders also can buy the harvesting permit for matsutake from local community authorities.

Harvesting practices various from village to village. For instance, in many villages of Deqin County, it is up to each individual where he or she wants to harvest each day, while in A'dong village a "rest day" is declared at least once a week during which no harvesting is allowed. But in Jidi village in Shangri-la County, a system of harvest rotation has been developed whereby matsutake production areas are divided into sections and villagers are divided into groups. Each group harvests one section in a day and then moves on to another section the next day, and so on. Where there is a great deal of variation in productivity from one part of the forest to the next, this rotation system ensures that each villager can access the most productive areas equally (but not every day) while mitigating pressure on the most productive areas by controlling the number of harvesters per day.

2.3 MARKET ARRANGEMENT AND ACTORS

Four levels of matsutake markets (see Table 2) can be recognized in Yunnan based on their size (number of buyers and total amount of matsutake exchanged), location, function, transportation infrastructure, and their degree of regulation and information flow. Actors in the market chain include mushroom pickers, local community authorities, middle-men, trading companies, exporting companies, and government authorities. As one move up the chain of markets from the small scale (town or village) markets to intermediate and regional scale markets, there is better transportation and information flow, and more regulation. However, the involvement of local people is becoming less.

In northwest Yunnan, mushroom pickers are mainly Tibetan, as well as Yi, Naxi, Lisu and Bai. Middlemen, or those who buy matsutake directly from the pickers, are comprised of small, usually local independent buyer-sellers as well as local agents and representatives of larger trading companies. The small buyer-sellers typically buy up matsutake from a small area. A primary grading of the matsutake usually takes place during the initial sale; the matsutake are then sold to bigger buyers or directly to the domestic market. During harvesting season, trading companies normally send their agents to village level and small scale markets as well as to intermediate scale markets in commercial centers. These company agents are usually Han Chinese from outside the area, but in most cases local villagers are employed to act as translators and for the purpose of gaining local trust.

In the largely Tibetan Diqing Prefecture, which accounts for nearly half of all the matsutake production in Yunnan (Fig 2), there are around 150 trading companies set up at the intermediate scale Matsutake Market of Shangri-La County. Exporting companies (50-60) with the legal right to export are generally based in Kunming. Each of the big trading companies has its own matsutake exportation quota determined by the CITES-Kunming office.

3 CHALLENGES IN SUSTAINABLE UTILIZATION OF MATSUTAKE

3.1 LACK OF HABITAT MANAGEMENT AND PRODUCTION MONITORING

That habitat is important to matsutake existence and production is well acknowledged. In the local village, in order to protect the forest hence to keep the production, some activities are not allowed such as timber extraction and grazing. However, there is a lack of habitat management in the real sense - for instance to purposely manage the forest density, age structure and species composition, soil characteristics, light condition and liter depth and coverage etc. - that is to optimize the environment for Matsutake production. Nevertheless, we cannot expect the local villagers to understand the ecology of the mushroom with a scientific manner and develop a systematic habitat forest management system. This needs the efforts of the government and the researchers. Indeed, many such researches have been carried out in Japan, Korea North America and China (Hosford et al., 1997; Amaranthus *et al.*, 1998; James, 1998; Gong *et al.*, 2000; Eberhart *et al.*, unknown), some of the knowledge and management experiences can be further tested and adopted locally.

Table 2. Market categories and characteristics in NW Yunnan

	Location and Activities	Function of the market	Number of Buyers	Daily Exchange	Transportation infrastructure	Information flow	Market Regulation
Village level sporadic primary market	Usually a remote village near the origin of the matsutake; buyer often mobile	exchange	1-3	<200kg	Poor, footpaths	Poor	Poor
Small scale market	Village road side, village market, or local established market for matsutake	Primary grading, exchange,	3-10	200-1000kg	Country road connect to outside market	Okay	Primary
Intermediate scale (regional) Market	Regional economic center of the production area, normally the capital of prefecture or county , e.g. Shangri-La Matsutake Market	Simple grading, exchange, preparing trading document, storage, transportation	Several dozen to hundreds, e.g. 150 in Shangri-La	1000-20000kg	Good networks connect with large scale market	Good	Good
Large scale Market	Normally capital city of province or strategic exporting point, in this case, Kunming	Fine grading, packing , process, storage , export	50-60 (20-30 have exportation right)	>20000kg	Large airport	Good	Good

As matsutake is a protected as well as highly commercialized mushroom. It's critical to understand the resource dynamics. However, we cannot clearly show how the resource has changed over time since lack of data. Started from 2000, CITES started to record the annual amount exported at county level, which forms as a fundamental base for matsutake monitoring. However, this data are generally not accessible by public. An open, systematic and finer monitoring mechanism should be in place for managing important NTFPs.

3.2 COLLECTING IMMATURE AND OVER-MATURE FRUITING BODY – FROM THE POPULATION ECOLOGY AND ECONOMIC POINT VIEW

We frequently found restrictions on collecting immature fruiting bodies in many of the local regulations, and it is involuntarily related with protection of the mushroom. Collecting of immature fruiting bodies is nothing related with resource protection but indeed economic important. However, the prohibition of over matured mushroom collection makes sense to conserve the resources. From the population ecology point view, collection should not influence the reproduction of the matsutake. There are mainly two ways for matsutake mushroom reproduction: vegetative growth of hypha and dispersal of spores produced by sexual reproduction cycle. Murata *et al.* (2005) showed that sexually reproduction through spores is very important in the propagation and distribution of *T. matsutake*. This implies that excessive collection or collection without leaving matured fruiting bodies to disperse the spores will impair the reproduction ability and eventually threat to the population itself.

However, at what extent this influence works and at which percentage of population should be collected are kept unknown.

From the economic point view, collecting baby matsutake is non-economic practice. As we know the price of matsutake varies greatly with grades which are determined by size, odor, degree of openness, status of bug-affected. For immature pieces (normally shorter than 5cm), it only cost USD 38/kg (based on whole sale export price of China in 2000). One kilogram requires 58-60 pieces of this size. While for matured ones (7-14cm, not fully open and damaged) the price is USD 58-80/kg and one kilogram only requires 6-34 pieces. Theoretically, if we only collect matured ones, the total income should at least double. Similarly, the price of over matured fruiting bodies is also relatively low. It should be left for regeneration.

3.3 FROM “QUANTITY” TO “QUALITY”

Obviously, China especially Yunnan is the major supplier of matsutake in terms of quantity. Presently, the increasing gain of the income is based on the increasing exploiting of the resource. This is somehow dangerous to the sustainable utilization of the resource. Though the quantity is big, the price for Chinese matsutake is generally low (See Table 3). The price can be determined by many reasons, such as freshness, odor, openness, and status of damage and bug-eaten. Although to some extent, Chinese matsutake cannot fully compete with Japanese and Korea matsutake, since latter countries have an advantage in transportation time, but they also have a superior product because of the greater care taken in harvesting and transporting the mushrooms. However, there are still many options for adding up the value of Chinese matsutake, for instance, focus on providing high quality products instead of providing everything, good packing, shorten the transport time and natural food certification.

Table 3. Average Wholesale Price (per kg) of Matsutake in Japan from Different Countries Modified from (Gong and Wang, 2004) Exchange rate was taken as 1USD= 118.94 Japanese Yuan

	From China	From South Korea	From North Korea	From Canada
In Japanese Yuan	7459	17074	7935	4914
In USD	62.71	144	67	41

3.4 KNOWLEDGE AND POLICY GAP

Although there is a body of knowledge available of matsutake, many still are kept unknown. These knowledge gaps impede the wise use of this resource. It includes artificial cultivation, the relationship with host plant, the impact of harvesting methods, population dynamic and ecology of the mushroom. Moreover, the gaps also exist between the knowledge itself and practice. For instance, very few management plans incorporate existing scientific and indigenous knowledge on matsutake ecology. Hence, more action researches are needed to bridge the existed knowledge with the management practice.

We introduced the policies related with matsutake at three levels. The legal policies mainly focus on the control of export while the customary regulations regulate the resource allocation, access and method of harvest. Policy is lack to clearly define the tenure and harvesting of the matsutake (and generally NTFPs). Although, the local regulations perform as a supplementary instrument to manage the resource, it is poorly implemented. For instance, most of the regulations prohibit the harvesting of matsutake shorter than 5 cm; but it is rarely controlled.

4 SUMMARY

It is well known that Yunnan is one of the most important areas for matsutake production in the world. The free market system and customary institutions are in place that has developed works well in many respects but some problems persist. There are many local regulations on harvesting, but there has been little attempt to restore the degraded habitats after logging, protect current matsutake habitat or to enhance matsutake reproduction. From the market point view, the collection and sale of baby fruiting bodies is also poorly controlled. There is also a lack of strategy plan improving the quality of matsutake exports. Aside from taxation and quota control, the government should play more importance roles on supplementing relevance policies of NTFPs management, monitoring the resource dynamics and develop and advocate a “quality” based exportation strategy. More researches and management approaches also should be in place to support the sound management of matsutake. In a word, to properly manage matsutake is a holistic approach that needs to take policy, research, market trade and local practice into account.

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WILD EDIBLE FUNGI OF THE HENGDUAN MOUNTAINS, SOUTHWESTERN CHINA

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ABSTRACT

The Hengduan Mountains make up the core region of the "Mountains of Southwestern China", one of the World's 34 Biodiversity Hotspots. This region is extraordinarily rich in fungi. Significant progress has been made in field investigations and the studies of the mycobiota in this area in the last thirty years. Over 4,000 species of fungi have been identified in this region, representing about 40% of China's known fungal taxa. Among them, about 600 species belonging to about 120 genera are wild edible fungi. These fungi are an important natural product providing food, traditional Chinese medicine, and other goods for the local people. In this paper, the use and value of some common wild fungi of the Hengduan Mountains region are summarized. Our recent work shows that many fungi in the region (including some edible and medicinal fungi) are still very poorly known and need to be documented.

Keywords: natural resources; food; medicinal fungi; non-timber forest products; sustainable utilization

1. INTRODUCTION

The Hengduan Mountains are located in southwestern China. The region of the Hengduan Mountains, in the broad sense, extends from the western edge of the Sichuan Basin to eastern Xizang (Tibet) including the southern slope of southeastern Tibet, and southeastern Qinghai. The northern boundary reaches southern Gansu. The southern boundary reaches down to the Yunnan plateau (Fig. 1).

There are a series of parallel mountain ranges and rivers from running north to south in this region. For example, the famous Three Parallel Rivers of Yunnan Protected Areas lie in this region. The highest mountain reaches 7,756 meters above sea level, while the elevation in some hot-dry valleys is only about 1500 meters. The average altitude of the Hengduan Mountains is around 3,000 meters above sea level.

Due to the complicated topography, geography, diverse environments and many other ecological, geographical and geological conditions, the Hengduan Mountains make up the core of the "Mountains of Southwestern China", one of the World's 34 Biodiversity Hotspots (Boufford & van Dijk 2000; Myers et al. 2000; Conservation International 2005; Yang 2005).

Visitors travelling in the region during the mushroom season from June to October are impressed by the variety and the delicacy of fungi available in markets and restaurants (Schmid 2002; Yang & Piepenbring 2004). However, scientific knowledge of the diversity of the wild edible and medicinal fungi in the region is still scanty. A detailed and systematic survey needs to be conducted.

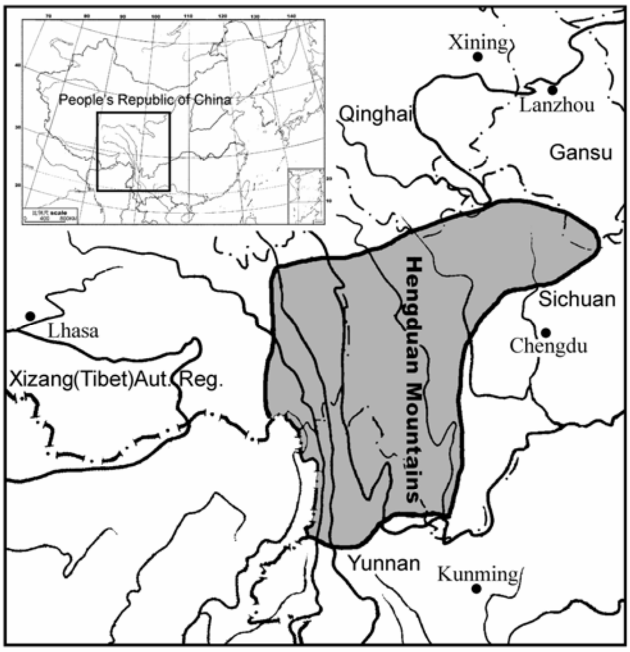

Figure 1. Location of the Hengduan Mountains, the core region of the "mountains of southwestern China", one of the world's 34 biodiversity hotspots

2. MATERIALS AND METHODS

Academic taxonomic reports on fungi from the region, especially on wild edible mushrooms, were collected and analyzed. Whenever possible, doubtful identifications were checked through re-examination of relevant original specimens. In order to expand the inventory of fungi in the region of study, several field trips were conducted. Fresh fungal materials were collected, annotated, and photographed, or otherwise illustrated. Possible ectomycorrhizal hosts were recorded at the time each collection was made. Fresh materials were dried using an electric or a kerosene mushroom drier. To learn more of the traditional uses of wild mushrooms, local people were interviewed. Examination and identification of the collections was conducted in the laboratory. Anatomical studies of fruit bodies were conducted using light microscopy (Yang 1997, Yang et al. 2004).

3. RESULTS

In the last thirty years, several important field investigations and significant progress in the study of fungal resources of the Hengduan Mountains region have been made. According to our research, over 4,000 species of fungi have been identified in this region (Teng 1963; Tai 1979; Wang et al. 1983; Mao et al. 1993; Dai & Li 1994; Ying 1994; Ying & Zang 1994; Yuan & Sun 1995; Teng 1996; Zang 1996; Wang et al. 2004; Yang 2005). Among them, nearly 600 species belonging to about 120 genera are wild edible fungi.

Some wild edible mushrooms, such as *Boletus griseus*, *B. reticuloceps*, *Cortinarius emodensis*, *Floccularia luteovirens*, and *Leccinum aurantiacum*, are quite common during the rainy season. Some of them, like *Aureoboletus thibetanus*, *Gomphus orientalis*, *Pisolithus tinctorius* and *Suillus pinetorum*, are rare, not commonly used as food, and not sold in markets. While most of the wild edible fungi are collected from July to October, *Cordyceps sinensis*, *Lentinula edodes*, and species of the genus *Morchella* can usually be found earlier in the year (during April to June). Fruit bodies of *Tuber indicum* and a few other species of the genus do not become mature until October to the February of the year following the beginning of fruiting body development (Yang & Piepenbring 2004). The most common and economically important wild edible and medicinal fungi in the region are listed in Table 1.

Table 1 The most common wild edible and medicinal fungi of the Hengduan Mountains

Scientific name	Utility
Amanita chepangiana Tulloss & Bhandary	Food
Amanita hemibapha var. *ochracea* Zhu L. Yang	Food, medicine
Amanita manginiana sensu W. F. Chiu	Food
Amanita pseudoporphyria Hongo	Food
Amanita sinensis Zhu L. Yang	Food
Auricularia auricula (L.) Underw.	Food, medicine
Boletus aereus Bull.: Fr.	Food
Boletus brunneissimus W. F. Chiu	Food
Boletus edulis sensu W. F. Chiu	Food, medicine
Boletus griseus Frost	Food
Boletus magnificus W. F. Chiu	Food
Boletus reticuloceps (M. Zang et al.) Q. B. Wang & Y. J. Yao	Food
Boletus speciosus Frost	Food, medicine
Cantharellus cibarius Fr.	Food, medicine
Cantharellus minor Peck	Food, medicine
Catathelasma ventricosum (Peck) Singer	Food
Cordyceps sinensis (Berk.) Sacc.	Medicine
Cortinarius emodensis Berk.	Food
Cortinarius tenuipes Hongo	Food
Engleromyces goetzii Henn.	Medicine
Floccularia luteovirens (Alb. & Schwein.) Pouzar	Food
Ganoderma lucidum (Fr.) P. Karst.	Medicine
Hericium erinaceus (Bull.) Pers.	Food, medicine
Hygrophorus russula (Schaeff. : Fr.) Quél.	Food
Laccaria laccata (Scop.: Fr.) Berk. & Broome	Food
Laccaria vinaceoavellanea Hongo	Food
Lactarius akahatsu Tanaka	Food
Lactarius deliciosus (L.: Fr.) Gray	Food
Lactarius hatsudake Tanaka	Food, medicine
Lactarius volemus (Fr.) Fr.	Food, medicine
Leccinum aurantiacum (Bull.) Gray	Food
Leccinum extremiorientale (Lar. N. Vassiljeva) Singer	Food
Lentinula edodes (Berk.) Pegler	Food, medicine
Lyophyllum decastes (Fr. : Fr.) Singer	Food
Lyophyllum fumosum (Pers.: Fr.) P. D. Orton	Food
Lyophyllum shimeji (Kawam.) Hongo	Food
Morchella conica Pers.	Food, medicine
Morchella elata Fr.	Food, medicine

Table 1 *continued*

Morchella esculenta (L.) Pers.	Food, medicine
Morchella smithiana Cooke	Food, medicine
Oudemansiella furfuracea s. l.	Food, medicine
Polyozellus multiplex (Underw.) Murrill	Food
Ramaria asiatica (R. H. Petersen & M. Zang) R. H. Petersen	Food
Ramaria hemirubella R. H. Petersen & M. Zang	Food
Ramaria linearis R. H. Petersen & M. Zang	Food
Ramaria sanguinipes R. H. Petersen & M. Zang	Food
Russula cyanoxantha (Schaeff.) Fr.	Food, medicine
Russula nigricans (Bull.) Fr.	Food, medicine
Russula virescens (Schaeff.) Fr.	Food, medicine
Sarcodon aspratus (Berk.) S. Ito.	Food, medicine
Schizophyllum commune Fr.	Food, medicine
Scleroderma citrinum Pers.	Food
Termitomyces bulborhizus T. Z. Wei *et al.*	Food
Termitomyces eurrhizus (Berk.) R. Heim	Food, medicine
Termitomyces striatus (Beeli) R. Heim	Food
Thelephora ganbajun M. Zang	Food
Thelephora vialis Schewein.	Food, medicine
Tremella aurantialba Bandoni & M. Zang	Food, medicine
Tricholoma bakamatsutake Hongo	Food
Tricholoma matsutake (S.Ito & S. Imai) Singer	Food, medicine
Tricholoma saponaceum (Fr.) P. Kumm.	Food
Tuber indicum Cooke & Massee	Food
Tylopilus eximius (Peck) Singer	Food
Wolfiporia cocos (F.A. Wolf.) Ryvarden & Gilb.	Medicine

4. DISCUSSION

4.1 DIVERSITY OF WILD EDIBLE FUNGI

The Hengduan Mountains region is extraordinarily rich in fungi. Over 4,000 species of fungi have been identified in this region, representing about 40% China's known fungal taxa (Teng 1963; Tai 1979; Ying et al. 1982; Wang et al. 1983; Ying et al. 1987; Mao et al. 1993; Dai & Li 1994; Ying 1994; Ying & Zang 1994; Yuan & Sun 1995; Teng 1996; Zang 1996; Wang et al. 2004; Yang 2005). Among them, nearly 600 species belonging to about 120 genera are wild edible or medicinal fungi. These species account for about 75% of the total species of edible and medicinal fungi in China as a whole. The Hengduan Mountains may be the richest center of biodiversity for edible fungal species in China.

Most of the wild edible or medicinal fungi in the Hengduan Mountains belong to the *basidiomycota*, while a few belong to the *ascomycota* (Table 1). About 50 species are probably endemic to the region of study and adjacent regions. For example, both *Boletus reticuloceps* and *Cortinarius emodensis* are popular edible mushrooms and are usually found in the subalpine to alpine regions at 3000 - 4700 meters altitude in ectomycorrhizal association with *Abies* and *Picea*. *Engleromyces goetzii*, a well-known medicinal fungus that parasitizes alpine bamboos, occurs in eastern Africa (Uganda, Kenya, Tanzania and

Malawi) and Asia (Nepal and southwestern China). This fungus is most likely a relict of mycobiota that existed at least as long ago as the Tertiary.

4.2 FUNGI AS FOOD AND MEDICINE

As in other regions of China, wild fungi have been widely collected and used as food and medicine by the people of the Hengduan Mountains region. Wild edible fungi are one of the important natural resources on which the local people of all nationalities rely heavily, and these mushrooms certainly play a role in improving the food nutrition (Yang 2002). Species of the genus *Boletus*, such as *B. edulis, B. griseus* and *B. magnificus* and species of *Termitomyces* like *T. bulborhizus*, *T. eurrhizus* and *T. Striatus*, are sold in most of the local markets.

The Chinese caterpillar fungus, *Cordyceps sinensis*, is perhaps the most popular medicinal fungus in the region, and can only be found in the subalpine to alpine regions at 3000 - 4700 meters altitude. It is a very famous traditional medicine in China due to its well-known healing properties (Liu 1984; Ying *et al* 1987). In the mid-1990s, one fruit body of the caterpillar fungus could be bought for 1-2 Chinese Yuan. However, the price has sharply risen to 15-20 Chinese Yuan in the last four years. Apparently demand is outstripping supply, and the question of sustainable management of this fungus may rise. Other important medicinal fungi to be mentioned are *Ganoderma lucidum*, *Hericium erinaceus* and *Wolfiporia cocos* (Liu 1984; Ying *et al* 1987). These fungi are not uncommon in the region of Hengduan Mountains, and are often collected and sold in traditional Chinese medicine markets.

4.3 EXPORT OF WILD EDIBLE FUNGI

Both wild and cultivated edible fungi have been exported as food and for medicinal use from China to Europe (e.g. Italy, France, and Switzerland), North America (USA), East Asia (Japan and Korea), Southeast Asia (e.g. Singapore, Malaysia, Indonesia, and Thailand) and many other countries where the fungi are used as food and for medicinal purposes. Today, China is the most important country for the export of both wild and cultivated mushrooms (e.g. Schmid 2002; Wang & Liu 2002; Yang 2002). Among the exported fungi, perhaps the most prominent is matsutake or pine mushroom, *Tricholoma matsutake*. In the last 10 years, over 1000 tons annually of fresh fruit bodies of matsutake have been exported from this area (Fig. 2).

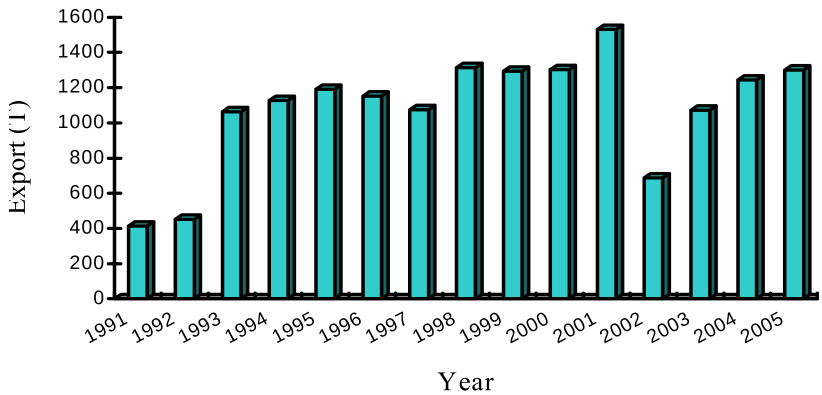

Figure 2 Annual export of fresh goods of *Tricholoma matsutake* from Yunnan, southwestern China to Japan

The foreign exchange income produced from this exportation is over 100 million US dollars every year. *Tricholoma matsutake*, and a few additional species, such as *Cordyceps sinensis, Tuber indicum,* and *Boletus edulis*, have become so important in local economic development in the last 10 years that the local governments have paid much attention to the marketing of them. Since the economic and transport conditions of many communities in the region of the Hengduan Mountains are still relatively underdeveloped, marketing of wild edible and medicinal fungi has significantly improved the local economy in the last few years.

5. CONCLUDING REMARKS

Wild edible fungi play important roles not only in the local ecosystems in terms of decomposition of organic material and formation of ectomycorrhizae with forest trees, but also in social systems as non-timber product from forests in the region of study. Wild edible fungi are an important natural product supporting local economies of the region. Most of the species, such as *Tricholoma matsutake, Boletus spp., Termitomyces spp.,* and *Tuber spp.* have developed a symbiotic relationship with plants or animals during their evolution and still cannot be cultivated under artificial conditions. These fungi can only be collected from natural environments. This is one of the dominant factors controlling the rising price of regional fungi in both local and overseas markets.

The commercial harvest of fungi in forests can damage forest habitat through the effects of repeated entry of mushroom collectors and compacting of the soil by their travel. Over-harvest may lead to gradual degradation and even loss of the mushroom resources. For example, the natural production of *Tricholoma matsutake* has decreased dramatically in the last 10 years in central Yunnan. In the early 1990s, matsutake was usually collected in the areas surrounding Kunming, the capital city of Yunnan Province, and then exported to Japan. However, by the mid-1990s merchants had to move westwards to Chuxiong in order to purchase fresh matsutake for export. By the early 2000s, a few major merchants moved farther to Shangri-la, in northwestern Yunnan, in order to get enough fresh stock of this delicacy.

With the development of the regional mushroom industry, it is becoming more and more clear that sustainable utilization and effective conservation of fungal resources will require regulation and management of future harvests on public or state-owned lands. A key to wise management of edible mushroom resources is a common understanding among resource managers, mushroom collectors, mushroom buying merchants, and the concerned public with regard to these key areas: (1) the biology of the region’s unique forest organisms, (2) the ecological importance of mushrooms in forest ecosystems, (3) the effects of forest disturbance on the survival of fungi, and (4) the need to establish best practices for sustainable harvest (Molina et al. 1993).

Local governments can play vital roles in the areas of education, development of management practices, and deployment of these practices. In some mountain villages, local regulations created and implemented by the local governments have succeeded in helping create sustainable production and harvest methods for these communities.

On the other hand, our recent collections and studies indicate that many fungi of the region, including edible and medicinal species, are still very poorly known. For example, *Chroogomphus pseudotomentosus*, *Simocybe centunculus*, *Leucopaxillus rhodoleucus*, and others are widely distributed in the region. However, they have not been previously recorded from the region. Furthermore, some species are new to science, and their values to human life and commerce are still unknown. Such fungi need to be documented in the near future before we are left in ignorance their potential when they become extinct.

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PROSPECTIVE STRATEGIES ON BIODIVERSITY CONSERVATION IN BAMBOO-BASED FOREST ECOSYSTEMS IN TROPICAL AND SUBTROPICAL CHINA

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ABSTRACT

To address current problems on increasingly degrading biodiversity in bamboo-based forest ecosystems in China, it is recommended that the strategies on policy development and integration, training and capacity building, and on-site demonstrations on sustainable management of biodiversity of the forest ecosystems in tropical and subtropical China should be taken as priorities in development of policies and technologies for sustainable forest management in China as follows:

1. Sectoral policy development in partnership to build the linkages between bamboo development for local economic benefits and biodiversity conservation at different levels of the government; 2. On-site demonstration on eliminating threatening impacts on biodiversity and ecosystem stability caused by shifting natural mixed bamboo forests into monocultured bamboo forests; 3. On-site demonstration on rehabilitation of the degraded biodiversity in monocultured bamboo forests in subtropical moso bamboo forests; 4. Biodiversity conservation of indigenous endangered Chinese bamboo species; 5. Development of a national network and partnership of biodiversity monitoring by incorporating this in existing forest ecosystem monitoring management systems; 6. Demonstration on livelihood development through bamboo resource utilization to benefit biodiversity conservation; 7. Application and documentation of the impact of participatory and co-management approaches to community level biodiversity conservation activities and incentive mechanisms in the project area for replication, upscaling and policy integration.

Keywords: bamboo-based forest ecosystem, biodiversity conservation, policy, awareness raising, capacity building, strategy

1. INTRODUCTION

Bamboo is a perennial species, and when annually harvested on a selective harvesting scheme, maintains a perennially green canopy. It is a pioneer plant for afforestation and vegetation recovery. It is a multipurpose resources and income generator, growing in remote mountains and rural poor areas where severe poverty exists, in China as well as in developing countries elsewhere in the world. There is plenty of indigenous knowledge on traditional bamboo stand management, as well as modern technology available for bamboo industry development in rural areas (Fu, Xiao and Lou, 2000). A rapid developing bamboo industry demands and consumes huge amount of bamboo materials from both plantations and natural bamboo forests. In many areas, the rate of harvesting bamboo is bigger than the growth rate of the bamboo forests because of the huge marketing demanding to the resources and people depending on the resources.

As a result, natural bamboo has been intensively harvested and over-exploited in past two decades because of its advantages as the best means for quality products to substitute timbers and for poor farmers to generate income from local resources. For short-term financial return, more than four million hectares of the natural mixed bamboo and broad-leaved or coniferous evergreen forests were cleaned up by removing all trees, shrubs and even underground vegetations to achieve maximum short-term bamboo productivity according to long-term productivity monitoring (Lou, 1998). Despite of increase in bamboo productivity, this practice has also resulted in serious degradation of ecosystem functions and biodiversity in bamboo-based forest ecosystems in tropical and subtropical China (Lou and Sheng, 1999). Furthermore, the danger of extinction of animal-inhabiting bamboo forests due to habitat destruction and massive bamboo flowering also poses great threats on not only the giant panda and the red panda, but also for example the endangered golden takin (*Budorcas taxicolor bedfordi*) and *Rhizomys sinensis*, the Chinese bamboo rat, who are mainly relying on bamboo for their foods in tropical and subtropical zones. Some endangered bamboo species, e. g. *Qiongzhuea tumidinoda* in Yunnan and Sichuan provinces listed in China Plant Red Data Book and Red List of IUCN, have been seriously over-exploited and destroyed for their commercially valuable culms and edible shoots. Evidence shows that intensive harvesting and use of commercially valuable bamboo forests are causing biodiversity lose in tropical and subtropical China (Lou, 1998). Besides the significant negative impacts on biodiversity on the forest ecosystems, all management practices currently applied for high-yielding pure bamboo forest through central government approved high-yielding standard such as cleaning up trees and shrub, loosening soil, pesticide and chemical fertilizer application, over-harvesting has also seriously resulted in soil erosion and declining of site and bamboo productivity in the managed monocultured bamboo forests, without any considerations on biodiversity conservation and ecosystem management for maintaining long-term site productivity.

Within this context, conservation of bamboo-based forest ecosystems is one of the keys to the effective conservation of the tropical and subtropical terrestrial ecosystem biodiversity in China. Should conservation of forest ecosystem biodiversity be achieved in a sustainable manner, it is imperative and critical to reconcile biodiversity conservation and economic benefits from bamboo-based natural forests in tropical and subtropical China, particularly in recognizing the fact that bamboo has become a major income source for huge rural population and a local core industry in more than 30 counties and much more townships and villages in rural and mountainous areas of tropics and subtropics. Actions are needed to protect the bamboo-based forests for biodiversity conservation and long-term productivity and the habitats for the many animals living in and on bamboos, and also to secure livelihoods of local farmers dependent on bamboos.

2. MAIN ISSUES ON DECREASING BIODIVERSITY OF BAMBOO-BASED FOREST ECOSYSTEMS IN CHINA

Over the past decades, China's tropical and subtropical forests have severely deteriorated in productivity, ecosystem functions, and biodiversity. This is largely due to a lack of knowledge and capacity at the national, provincial, and local legal infrastructure to safeguard biodiversity in forest management.

China possesses 7.2 million hectares of bamboo-based forests which comprise no less than 10% of the country's tropical and subtropical forests. The country's bamboo ecosystems symbolize a distinctive national resource and provide for the livelihoods of the local rural population. A forest is categorized as a bamboo forest if bamboo plants are dominant in number among the upper canopy species. Typically, natural bamboo-based forests in China contain a rich diversity of flora and fauna (Ma, Zhang and Lou, 1996). However, bamboo's fast growth and versatile use has led to over-exploitation of the resource and loss and fragmentation of habitats for the other plants and animals in bamboo based ecosystems. The most serious threats to the loss of biodiversity in bamboo based forests are described below.

The fragmentation and extinction of bamboo forests which provide food and shelter to the giant panda is a wide known threat to biodiversity. At present, numerous projects in nature reserves exist to protect the last remnants of these forests and animals.

However, the threat of mono-culture bamboo forests resulting from pressures at the local level to prioritize short term economic and production targets is largely misunderstood and mistaken. Over 4.2 million out of a total of 7.2 million hectares of natural mixed bamboo and broad-leaved or coniferous evergreen forests have been exploited and turned into monoculture forests (Jiang, 2003). In these forests, all trees, shrubs, and underground vegetations are removed to achieve maximum bamboo productivity.

As a result, short term economic returns have occurred at the cost of ecosystem long term biodiversity conservation and loss of long term site productivity. INBAR and its partners demonstrated the negative repercussions of monoculture forests in Anji of Zhejiang Province and Jianyang of Fujian province. In this study, an 11 year old monoculture bamboo forest declined in productivity by 25% and diversity of shrub and grass species was reduced from 58 to 31 species. Moreover, the number of bacilli and fungi in the soil declined by as much as 45% and 90%, respectively. Nitrogen fixation in the monoculture forest was less than 10% compared to mixed bamboo forests. This research illustrates how bamboo monoculture significantly and negatively affects the biodiversity of bamboo ecosystems, as well as, the long term sustainability of production (Lou, Ph. Dissertation, Chinese Academy of Forestry, 2001).

Furthermore, the possible extinction of native Chinese bamboo species also constitutes a considerable threat to the biodiversity of bamboo based forests in China, e. g. *Qiongzhuea tumidinoda* in Yunnan and Sichuan provinces (Dong, 2006). These species are listed in the China Plant Red Data Book and the Red List of IUCN. The Qiongzhuea species have been seriously overexploited because of their commercially valuable culms and edible shoots. The conservation of Qiongzhuea bamboo species is integral for biodiversity conservation in rich forest ecosystems.

3. GOALS OF STRATEGIC TECHNOLOGY AND POLICY DEVELOPMENT TO MINIMIZE LOSE OF BIODIVERSITY

The goal of strategic technology and policy development to minimize lose of biodiversity should well fall under the China National Biodiversity Action Plan (NBAP) of 1994 to prioritize the protection of forests ecosystems in tropical and subtropical regions in China, in particular Objective 5 (*In Situ* Biodiversity Conservation outside Reserves) –*"Adopting Forest Management to be Propitious to Biodiversity Conservation"*. (China State Environmental Administration, 1994). Moreover, the project falls under the policies set forth by the national and institutional framework of the 11th fifth year National Plan, for example under paragraph 3 in chapter 20, which call for *The protection of ecological functions and biodiversity of forests and genetic resources of rare and endangered plants and animals in Yunnan and Sichuan provinces"* and the 12th Special Focus in Chapter 23 on *'Protection and rehabilitation of natural ecology by key engineering projects of* *ecological protection in the upper reach of the Yangtze River'*. These close and strong linkages show that this project has very well addressed some national priorities environmental protection in the national economic development plan and biodiversity conservation action plan (Chinese State Environmental Administration, 2002).

The designed national projects on strategic technology and policy development to minimize declining of biodiversity should focuses on direct and indirect threats taking place outside nature reserves. Specifically, the project concentrates on the effects of over management and over exploitation of bamboo-based forest ecosystems in sub-tropical and tropical forest of China. In the past, biodiversity conservation policies have not been developed nor incorporated in any national, provincial, and local forestry management plans to address these issues. In China, few research and demonstration projects on forest biodiversity conservation have been used as a basis for policy and technology development in the forestry sector. Thus, there is an imperative need to build capacity of government institutions and local farmers to implement biodiversity policies as part of management practices for bamboo bamboo-based forest ecosystems.

The main goals on strategic technology and policy development to minimize declining of biodiversity should be: to determine and show the optimal reconciliation between biodiversity conservation and economic return; to adequately strengthen the capacity of local, provincial, and national governments and farmers to create government policies and awareness; and to develop a strategy to up scale appropriate policies and experiences beyond the pilot project areas, as well as integrate policy in national initiatives on sustainable forest biodiversity management.

4. RECOMMENDATION ON STRATEGIC APPROACHES TO HANDLE THE BIODIVERSITY DECLINING IN BAMBOO-BASED FOREST ECOSYSTEMS

To address the current problems, policy development and integration, training and capacity building, and on-site demonstrations on sustainable management and conservation of bamboo ecosystem biodiversity in tropical and subtropical China are taken as priorities in strategic research and policy development of sustainable bamboo-based forest management described as follows:

4.1 SECTORAL POLICY DEVELOPMENT IN PARTNERSHIP TO BUILD THE LINKAGES BETWEEN BAMBOO DEVELOPMENT FOR LOCAL ECONOMIC BENEFITS AND BIODIVERSITY CONSERVATION AT DIFFERENT LEVELS OF THE GOVERNMENT

In many cases, local governments see bamboo resource development as a major means for local economic development without consideration of bamboo forest biodiversity. To sustainably use bamboo resources for local farmers' livelihoods by maintaining biodiversity of bamboo forests for long-term benefits, significant efforts to be made are:

1. To assess, demonstrate and assemble an adequate information base as a foundation for policy development and management decisions affecting bamboos biodiversity and to ensure the richness of biodiversity;
2. To work with the government at national, provincial, county, and township levels to formulate bamboo development policies that reconcile biodiversity conservation and income generation by incorporating relevant policies into their overall economic development and land use plan to mainstream the biodiversity conservation policies;

3. To develop and incorporate integrated, coherent and systematic policies for bamboo resource management, industrial development and product trade which is dispersed in different government agencies at different levels, to promote integration of bamboo biodiversity concerns into local development processes.
4. To conduct training and demonstrations to build the capacity of stakeholders at different levels to implement economic and land use policies with biodiversity concerns.

4.2 ON-SITE DEMONSTRATION ON ELIMINATING THREATENING IMPACTS ON BIODIVERSITY AND ECOSYSTEM STABILITY CAUSED BY SHIFTING NATURAL MIXED BAMBOO FORESTS INTO PURE BAMBOO FOREST.

Bamboos are used traditionally by many Chinese nationalities for example Han, Yi and Miao nationalities. The economic advantages for industrial utilization have also led to overexploitation of bamboo resources in many areas of China. To explore high bamboo productivity with short-term high profits, intensive management, over-harvesting, tree and shrub clearance, and pesticide and fertilizer application in natural bamboo forests and traditional bamboo plantations have occurred. This has very significant and negative impacts on maintenance of the biodiversity richness and ecosystem stability of mixed bamboo forests with other species. The following efforts should be taken to address the problems.

1. To improve the technological elements in traditional bamboo use practices and other cultural characteristics of rural people and minorities on bamboo resource in terms of biodiversity conservation in Yunnan and Sichuan provinces.
2. To develop appropriate sustainable and economically viable bamboo management technologies, which are certified as a national standard and with criteria for technology approved by the SFA. Current criteria in China that provide economic incentives for bamboo production should be adapted for sustainable management technologies that address bamboo biodiversity concerns in the China National High-Yielding Standard.
3. To demonstrate bamboo forest biodiversity conservation approaches in species selection and plantation plans in large scale bamboo afforestation and plantation programmes such as in Land Conversion Programme and the resource base for bamboo pulping projects in Guizhou, Yunnan and Sichuan provinces to promote biodiversity conservation in presently biodiversity unfriendly projects.
4. To build demonstration sites for the application of sustainable bamboo management technologies for natural mixed bamboo forests.
5. To conduct training and technology dissemination on policies for different stakeholders for capacity building on sustainable management of bamboo forests in terms of biodiversity concerns.
6. To disseminate the lessons learned and experiences from Sichuan and Yunnan to other areas with bamboo forests in China.

4.3 ON-SITE DEMONSTRATION ON REHABILITATION OF THE DEGRADED BIODIVERSITY IN PURE BAMBOO FORESTS IN SUBTROPICAL MOSO BAMBOO FORESTS.

1. To evaluate and document the impacts of the practices on biodiversity and site productivity.
2. To set up project sites to demonstrate the management practices to rehabilitate degraded biodiversity and site productivity of managed pure bamboo forests.

4.4 BIODIVERSITY CONSERVATION OF INDIGENOUS ENDANGERED CHINESE BAMBOO SPECIES

Not only the biodiversity of the bamboo forest ecosystems, but also the diversity of Chinese bamboo species is coming under serious threat. Although China is very rich in species, most of the bamboo research and conservation activities have been concentrated on collection and *ex-situ* conservation of the subtropical bamboo species which are widely used in industry such as Moso. However, preliminary data show that several important other subtropical and tropical species are under threat of extinction due to deforestation and/or overexploitation, and it is likely that other species are also endangered, but no data are available as yet. Examples of threatened species are *Qiongzhuea tumidinoda*, *Chimonobambusa granditolia, Brachystachyum densiflorum* and *Fargesia acaduca* in Yunnan and *Bambusa multiplex* cv. *Alphonse-Karr* on Hainan, etc. These species are important for the livelihoods of local people, often ethnic minorities, and also provide important habitat for rare and endangered animals (Dong, 2006). Future efforts should include:

1. To establish demonstration areas for *in situ* conservation of indigenous endangered tropical bamboo species *Qiongzhuea tumidinoda* in mountainous areas in the Yunnan and Sichuan provinces and to develop management technologies for the sustainable use of the bamboo resources as a reliable source of off-farm income for local communities where they traditionally use the endangered bamboo as a livelihood means.
2. To develop methodology, including the criteria for endangered species, and manuals for the collection and in-situ and if needed also ex-situ conservation of endangered bamboo species and establishment and maintenance of the reserve for endangered bamboo species.
3. To develop appropriate methods for assessing bamboo resources and the pressures on them and incorporating these methods into NTFP elements of national forest inventories.

4.5 TO DEVELOP A NATIONAL NETWORK AND PARTNERSHIP OF BIODIVERSITY MONITORING BY INCORPORATING THIS IN EXISTING FOREST ECOSYSTEM MONITORING SYSTEMS.

A national biodiversity monitoring network and partnership will greatly help maintain biodiversity in bamboo forests in the long run. So far, forest ecosystem monitoring in China includes neither bamboo ecosystems nor bamboo forest biodiversity. Thus the following steps should be taken:

1. To develop the monitoring technology for bamboo forest biodiversity evaluation and monitoring in China.
2. To develop national networks for evaluating and monitoring bamboo forest biodiversity.
3. To promote and incorporate bamboo forest biodiversity monitoring systems with the existing forest ecosystem monitoring system in south and southwest China.

4.6 TO DEMONSTRATE LIVELIHOODS DEVELOPMENT THROUGH BAMBOO RESOURCE UTILIZATION TO BENEFIT BIODIVERSITY CONSERVATION

Not only can these bamboo forests perform very well in biodiversity conservation and environmental protection for high rainfall catchment areas since they are perennially green and have a continuous canopy cover but well-managed bamboo forests can also continually generate income for farmers. Since bamboo is the fastest growing plant in the world and rapidly renews itself with versatility of utilization at a low cost investment for rural industry, bamboo has specific advantages in income generation for rural farmers. The efforts to demonstrate livelihoods development through bamboo resource utilization in terms of biodiversity conservation should be as follows:

1. To develop demonstration project sites on livelihood sustainability through bamboo development by training and capacity building on bamboo resource management, utilization and marketing bamboo products in relation to biodiversity conservation.
2. To conduct a series of trainings to disseminate livelihood development technologies that take into account biodiversity concerns.

4.7 APPLICATION AND DOCUMENTATION OF THE IMPACT OF PARTICIPATORY AND CO-MANAGEMENT APPROACHES TO COMMUNITY LEVEL BIODIVERSITY CONSERVATION ACTIVITIES AND INCENTIVE MECHANISMS IN THE PROJECT AREA FOR REPLICATION, UPSCALING AND POLICY INTEGRATION

Bamboo grows widely in more than ten provinces such as Yunnan, Sichuan, Guangxi, Hunan, Jiangxi, Guizhou, Chongqing, Henan, Hubei, Anhui, Zhejiang, Jiangxi, Fujian, Guangdong, and Tibet. Although they are the richest in bamboo forest resources and biodiversity in species, genetic and ecosystem levels, most of the provinces are also among the least developed and most disadvantaged areas. Any projects shall aim to employ and document the application of the participatory and co-management approaches during project implementation for future replication at different levels. For this purpose, the project should

1. To collect the best practices in participatory and co-management of natural resources, particularly with biodiversity conservation components and apply at the community level during project implementation.
2. To conduct trainings to disseminate the bamboo biodiversity conservation policies and technologies as well as best practices for alternative livelihoods at the community level to benefit biodiversity conservation through participatory and co-management approaches.
3. To promote and upscale the findings and policy recommendations to be included in national and local policy frameworks and forestry programmes and plans.
4. To promote policy integration to national initiatives on sustainable management of forest biodiversity

5. PROSPECTIVE OUTCOMES ON BIODIVERSITY CONSERVATION FOR BAMBOO-BASED FOREST ECOSYSTEMS IN CHINA

The guiding principle on strategic technology and policy development to minimize declining of biodiversity is to ensure lasting results in the biodiversity conservation of bamboo forests ecosystems. The goal of the project is to provide local, provincial, and national actors with a sustainable development approach to guide economic, land use and biodiversity planning in the various provinces.

It is recommended that tentative projects should be designed to have two main outcomes. Through the use of pilot projects, the first expected outcome should be to increase capacity building and raise conservation awareness among local government and citizens. The second outcome should bring local government and business actors together to adopt, integrate, and implement economic and land policies compatible to biodiversity conservation. In turn, these policies will help instigate regional and national level policies.

The expected outcomes will be based on following research outputs.

- ***Output 1***. On-site community level demonstration in mixed bamboo forests and strategies to halt the biodiversity decline, environmental degradation, and productivity instability resulting from a shift to monoculture forests.
- ***Output 2***. On-site community level demonstration on monoculture bamboo strategies to rehabilitate degraded biodiversity and restore ecosystem productivity.
- ***Output 3***. On-site community level demonstration on biodiversity conservation of indigenous endangered native bamboo species in Chinese forests.
- ***Output 4.*** Based on outputs from the pilot sites, a portfolio of current and new policies and strategies to combine biodiversity conservation in bamboo forests will be created. The portfolio will include short and long-term economic benefits, as well as, incentive systems for biodiversity conservation, e. g. payments for environmental services and certification scheme.
- ***Output 5.*** A national partnership network to monitor and promote biodiversity conservation in bamboo forests will be established. The goal of the network will be to monitor and incorporate knowledge from pilot sites into existing forest ecosystem management systems.
- ***Output 6***. Government officials and farmers will be trained in participatory approach to community level biodiversity conservation inside and outside project sites.

Any projects' pilot sites, training workshops, and partnerships should demonstrate that biodiversity conservation provides greater economic and social returns in the long-term. Awareness of the long-term threats to bamboo forest productivity will give local government and farmers higher incentives to conserve and utilize biodiversity for sustainable development. This, in turn, will strengthen local land and economic policies. Capacity building, public awareness, and government policies on biodiversity conservation will guarantee that new policies and technologies be implemented after the completion of the project. The national partnership network will significantly extend output results to other regions in China under prospective national initiatives on sustainable management of forest biodiversity in the country.

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BARRIERS AND SUCCESS FACTORS FOR IMPLEMENTING MECHANISMS FOR THE SUSTAINABLE USE OF BIODIVERSITY

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1 INTRODUCTION

Biodiversity faces many types of threats to its ecological integrity and cultural significance. Although many factors are responsible for the ongoing decline in biodiversity, its root causes are invariably some forms of human activities, such as habitat destruction and fragmentation, over-harvesting or pollution, linked with the absence or failure of management and governance structures and processes to deal with these developments (Brooks et al. 2002; Myers 1993; Myers and Knoll 2001; Novacek and Cleland 2001; Pimm and Raven 2000: Singh 2002). This paper presents results from the interdisciplinary research project GoBi (Governance of Biodiversity), which evaluates the success or failure factors of biodiversity management, especially in protected areas. Its main hypothesis is that the ecological outcome of biodiversity management in protected areas including sustainable use mechanisms depends on the appropriateness of the selected governance and management systems with regard to the local context, and on broader economic and political issues.

Protected areas are one of the principal options to establish alternative resource use regimes or to restrict human activity altogether in the aim to stop - at least locally - biodiversity loss. The UN 2003 List of Protected Areas counts more than 102.100 protected areas world wide, covering about 18,8 mio km2, or close to 10% of the earth‘s terrestrial surface. This constitutes a sharp increase from the 48.388 protected areas counted in 1992, covering about 12,8 mio km2. Unfortunately, many of them do not meet their stated objectives of protecting biodiversity (Oates 1999; Terborgh 1999). Putting land under special legal protection might be a precondition for its effective conservation, but it is not sufficient. Pressures rise on forest products, arable land and drinking water, to name just the most prominent examples. At the same time global spending pungently mismatches the costs of conservation in terms of protected area budget and staff (James, Green et al. 1999; Balmford, Gaston et al. 2003). Consequently, the effective implementation of functioning management systems in already existing protected areas will be the foremost challenge for in situ conservation and also for sustainable use in their buffer zones in the years to come. The linkages between biodiversity conservation and the sustainabe use through local livelihoods are diverse and their framing at policy level ranges from separation to competition to symbiosis between the two issues (Adams et al. 2004). We observe an increase in the establishment of combined approaches.

To include the need for sustainable human livelihoods into conservation planning is widely recognised as a requirement for protected area management in general. Biosphere reserves are one such approach; the biosphere reserve concept combines a zoning scheme and participatory management requirements with a research-oriented world network (Batisse 1997; Chape et al. 2003). Biosphere reserves constitute a set of trans-sectional natural landscapes and ecosystems, many closely intertwined with human settlements and forms of use. Biosphere reserves are experimental places and vanguards for sustainable development‘, as declared in the Seville Strategy of UNESCO in 1995. This ambitious claim is nonetheless difficult to put into practice. As with ‘paper parks’ [1] , many biosphere reserve authorities, neither have the capacity nor the resources to meet this mandate.

2 BARRIERS AND SUCCESS FACTORS FOR IMPLEMENTING MECHANISMS FOR THE SUSTAINABLE USE OF BIODIVERSITY

Setting aside areas for conservation and sustainable use is favoured as a feasible and relatively fast strategy to slow down biodiversity loss. But this reasoning is only as valid as protected areas are actually capable of maintaining biodiversity. In other papers of the GoBi Research Group it has been explained how in particular conservation success of a protected area in the sense of fulfilling conservation functions can be assessed (Stoll-Kleemann & Bertzky 2005a-b).

Protected area management seeks to intervene in a complex social-ecological system to achieve conservation and sustainable resource use. The success of a protected area is hence determined by the impacts of this system and by the adequacy of the management intervention to mitigate these impacts. The probability of successful biodiversity protection and sustainable use is much higher if sound protected area management meets enabling governance conditions at local and regional levels.

Governance aspects affecting successful sustainable use of biodiversity in protected areas can be divided into the dimensions of “political embedding, institutional structures and related conflicts” (Stoll-Kleemann et al. 2006).

Political Embedding

Protected areas and their management differ substantially in their dependency on the political environment. Protected area management is subject of political interests and has to adapt to changing conditions in a highly politicised environment. Generally, an enabling political environment is required. Important factors are the financial situation, supporting (political) actors, effective networking, prestige, conflicting interests (pipelines, mines, etc), the national conservation discourse, the constellation of actors and the general political situation (*ibid*).

Furthermore, in many cases, the political arena for protected areas is closely connected to other issues such as indigenous politics, rural development programmes or industrial exploitation of natural resources (e.g. wood, minerals). Together they make up a complex and dynamic web of concurring and opposing interests (ibid).

Institutional Structures

To date, inadequate attention has been paid to the importance of institutions and analysis is required of the compatibility of conservation policies with the institutional setting within which they operate. Incorporating institutions increases the chance that policies once implemented will have the intended consequences of promoting conservation and sustainable use (Stoll-Kleemann 2005b). Research on common property institutions and sustainable governance of resources specifies the conditions under which groups of users will self-organise and sustainably govern resources upon which they depend (Agrawal 2001, Ostrom 1990). Agrawal (2001) provides a useful list: resource system characteristics, group characteristics, institutional arrangements, and external environment. This approach can be taken further: Institutions govern the relationships between the resource system, the user group and contextual factors. They are therefore highly responsible, as a proximate cause, of the sustainability of these relationships (Wood et al. 2000).

Conflicts

In order to avoid unsustainable exploitation of resources in or around protected areas the management has to determine and enforce rules and use restrictions up to zonation of the area with 'no-go' or 'no-take' zones. This often implies conflicts. But the closer these restrictions are to the traditionally practised forms of resource use in that area, the less the risk of conflict. Nevertheless, traditional use regimes are challenged by in-migration of people and new forms of resource use like commercial exploitation or access to new markets outside the area. The increased competition for resources enforces further potential for conflict.

Biodiversity conflicts can either focus on different preferences, values and objectives of actors, on the options and instruments they choose for action, or on a combination of both (Scheffran and Stoll-Kleemann 2003). Conflicts can be found in a variety of actor relationships and in the pattern of linkages between managing institutions, e.g. conflicts among the local population (access and use of resources, use and property rights, tourism, ethnic groups); conflicts between local population and protected area management or state authorities (conservation against resource use activities like agriculture, poaching, logging, fishing or collection of medicinal plants), and conflicts about the legal status and financial compensations. In many cases biodiversity governance and management policies have failed to solve these kind of conflicts and therefore to establish efficient protection or real sustainable use of biodiversity (*ibid*).

Protected Area Management

Protected area management consists of different responsibilities and fields of work. Protected area managers regularly have to deal with divergent requirements such as ecological and development needs. They often face contradicting interests (e.g. individual vs. common), and need to handle uncertainty of developments (Stoll-Kleemann 2005b).

Protected area management needs the support of the local and neighbouring population (Stoll-Kleemann and O'Riordan 2002 a-b). "Sharing Power", a recent guide to co-management of natural resources, identifies the synergetic character of collaborative natural resource management arrangements: Traditional management systems, instead of vanishing at the advent of modern resource use forms, evolve into 'hybrid' forms of management drawing on the strengths of the different (i.e. local and non-local, modern and traditional) actors (Borrini-Feyerabend et al. 2004). However, this requires a strong recognition of the diversity of views and interests involved and a disposition to follow the much more dynamic and hence less predictable road of collaborative management. This kind of integrative approach emphasizes the social and political implications of protected area politics: Wilshusen et al. (2002) point out that biodiversity conservation is essentially a political issue of distributing costs and benefits. Conservation should not happen on the backs of the already poor rural populations that have little economic alternatives to the use of natural resources for their living.

Therefore, it is important not only to have people participating in management processes but also to respond to their livelihood needs. Stable livelihoods around a protected area are the best pre-condition for acceptance of use-restrictions inside the park. The development of alternative sources of income can take very diverse forms, e.g. new cultivation techniques, better access to nearby markets but also tourism related services. They are certainly preferred to compensation payment schemes which promote dependence, conflict and corruption. Promoting or securing stable local livelihoods is a long-term task which requires considerable capacity and resources (Stoll-Kleemann 2005b).

A further main challenge to protected areas is the lack of financial sustainability (e.g. de la Harpe et al. 2004). In general, lack of resources strongly inhibits protected areas activities. Poor infrastructure, unpaid staff and missing outreach cannot be compensated by political support. High financial insecurity makes planning obsolete and causes serious conflicts in itself: For inhabitants of protected areas it can be more than disappointing to see their hopes smashed, which had prior been generated by protected area officers (Stoll-Kleemann and O'Riordan 2002a).

Earmarked funding is a further difficulty: Though conditions linked to money may have a steering function, protected areas are often in a situation where they have to respond first to the requirements of their various governmental and non-governmental donors, and only in second place to their acute needs. Of course, cases can be found in which some protected areas are managed to function well even without money while others fail to reach their conservation goals despite important funding, due to adverse circumstances (e.g. corruption) or weak management (Stoll-Kleemann et al. 2006).

Empirical Results

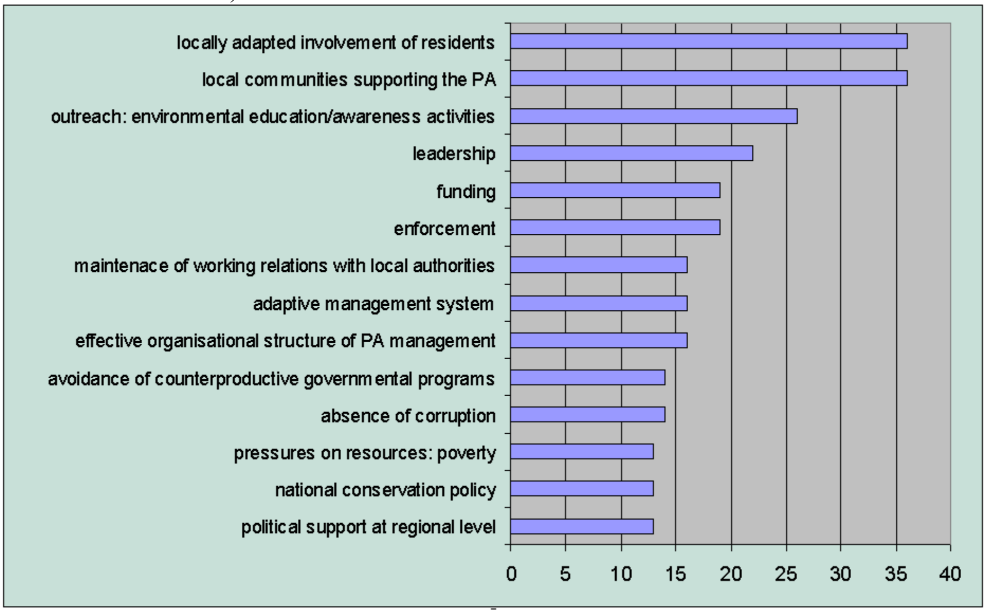
The results of the GoBi Factor Ranking Survey (Stoll-Kleemann et al. 2006) show what experts consider particularly relevant for successful protected area management. More than 160 persons have been asked to rank 41 factors with regard to their importance for the overall protected area success. Professional positions ranged from conservation professionals, government officials, and scientists to representatives of indigenous groups; most respondents had a university degree.

To differentiate among varying conceptions, we asked respondents to first give their definition of a successful protected area. Then they could choose among four ranks to describe each factor with regard to its relevance for protected area success (from relevance "very high" to "no relevance at all"). Respondents were asked to state whether their evaluation was in reference of a specific protected area, country, region or whether it was general in outlook. Finally we asked them to identify the top three factors according to their experience. While going through the ranking sheet, we commented on the different factors clarifying our understanding of them and asking the experts to name further aspects that deemed important to them.

Table 1 shows part of the top three factors selection. The results are surprising: The two factors attracting the highest score refer to the necessity of good relations between the protected area management and the local population as described above. Almost 20% of the respondents chose them; this is especially interesting because the distribution of chosen factors is quite large with many factors receiving between 10 and 15 votes. The issues of funding and of enforcement, typically emphasized in literature, do rank high but attract less than 20 votes each, whereas participation and local support attract more than 35 votes each. Leadership and environmental awareness raising also rank high, again emphasizing a people-oriented approach (Stoll-Kleemann 2005b, Stoll-Kleemann et al 2006).

The results are even more surprising if we consider the strong presence of people with ecological (and not anthropological) backgrounds, and if we take into account the diverse understandings of what is a successful protected area. Definitions range from 'conservation first', via 'reconciliation between preservation and use' of resources, to 'pro-people' concepts – notwithstanding these differences, the necessity of working closely and in trust with the local population is recognized as central to conservation efforts.

Table 1: Top factors influencing protected area success. 163 experts selected among 41 factors their top three. The table presents only the 14 factors with the highest scores (Stoll-Kleemann et al. 2006)



3 CONCLUSIONS

The results show that typical imperfections of governance and management institutions such as enforcement problems, insufficient political support, lack of stakeholder involvement, corruption, lack of capacity and leadership play an important role in determining success or failure of protected areas including implementing mechanisms for the sustainable use of biodiversity. The empirical material raised shows correlations between singular success and failure factors and allows deriving reasons for the continuance of governance and management failures. Adaptable institutional arrangements including responsive leadership and capacity building are necessary to manage biodiversity and ecosystems that have complex social, political, cultural and ecological dimensions.

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DEVELOPMENT OF PLANNING SYSTEM OF CLOSE-TO-NATURE FOREST MANAGEMENT FOR MULTIPLE BENEFITS ECOLOGICAL FORESTRY IN CHINA

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ABSTRACT

The recent forestry development in China has tended to shift emphasis from timber production to ecological rehabilitation and environmentally sustainable services. The planning system of forest management is therefore facing challenges of adjusting development goals, updating guide theory, and modifying planning methods for the multiple beneficial objectives of sustainable forestry. The concept of close-to-nature forest management is a possible way to meet the needs of multi-benefit sustainable forestry. Under the principles of close-to-nature forest management, a variety of technical elements and tools can be developed for localized implementation. This paper introduces a preliminary study of a close-to-nature forest management planning system which aimed to meet the needs of these new development trends. The main improved technical elements of this planning system include four formatted techniques: inventory and identifying of the basic management units characterized with biotope mapping, goal analyzing and designing with the support of the so called Target Forest Development Type concept, stand operation shifting from a timber volume oriented system to a target tree oriented operation, silvicultural planning changed from a rotating scheme to natural succession and a vertical structure oriented temporal flexible form. With experimental examples from different forest types, the new planning scheme and techniques characterized by the Close-to-Nature concept are implemented in several model areas in China for transforming plantations into near-natural forests. The first results and the future application for Chinese ecological rehabilitation are discussed.

Key words: Close-to-nature forest management, Biotope mapping, target forest development type, target tree operation, silvicultural planning.

1 INTRODUCTION

Sustainable Development is an urgent issue of modern forestry, and the basic questions of sustainability are: (1) What should really be sustainably developed? and (2) How can we perform this in practice? The first question is about the target, and the second concerns the implementation methods and application techniques (Aplet et al. 1993). The answer to the first question is clearly that the forest as an ecosystem should be sustainable and a close-to-nature forest is a sustainable forest ecosystem. For the second question it is clear that techniques and supporting tools of close-to-nature forest management will help to realize the goal of sustainable development.

Since the 1950s, the Dauerwald-movement and the attempt to introduce close to nature forestry by law led to a large set back for close to nature forestry in Germany. Arbeitsgemeinschaft Naturgemässe Waldwirtschaft (ANW) was founded first with only 46 foresters as a working group for close to nature forestry (Wobst 1979). The concept and implementation of Close-to-nature forestry techniques are accepted and further developed in European forestry (Ammon 1937; Assmann 1950a, 1950b; Gayler 1975; Lamprecht 1977; Hatzfeldt 1994; Knock & Plusczyk 2001). From the 1980s the ANW membership has been rising continually. The principles of close to nature forestry, as defined by ANW, have also been adopted by the Chinese State Forest Administration and we have applied them to our research project as technical support to the Natural Forest Protection Program since 2003.

Generally, close-to-nature forest means that the forest is of uneven age, is mixed with local tree species, and has a multilayer structure (Höfle 2000; Lu et al. 2004). Close-to-nature forest management is then a management model which is based on the natural stability mechanisms of the ecosystem, is supported with biological diversity, and includes economic requirements and ecological feasibility to realize the various beneficial objectives of sustainable development.

With the emphasis of forestry strategy shifting from timber production to ecological rehabilitation in China, forest management is facing the challenge of adjusting development goals, updating guide theory, and modifying planning methods to meet the needs of ecosystem construction (Lu & Zhang 2002). The planning system of forest management should represent the principles of sustainable and multifunctional ecological forestry, and develop a relevant planning model, operation technique and implementation procedure to ensure the goal of multifunctional forestry sustainability (Lu & Gan 2002). After years of study we reach an elementary planning system to implement close-to-nature forest management in China. In comparison with a timber harvesting oriented plantation model, the close-to-nature based planning system is improved in the following aspects: (1) inventory and identification of the basic management units characterized with biotope mapping, (2) management goal analysis and design with the support of the so called Forest Development Type concept, (3) shifting stand operation from a timber volume oriented system to a target tree oriented operation, and (4) changing management planning from a rotating scheme to a natural succession based and vertical structure oriented temporal flexible form. These four technical elements have been experimented in several demonstration areas (as shown in figure 1) and will be further implemented in the next 5 year research phase.

2 EXPERIMENT AREAS AND DATA

As shown in figure 1, our study on close-to-nature management has been conducted since 2003 and has been demonstrated in different forest types from the tropical province of Hainan, subtropical Yunnan and Sichuan to temperate regions in the Shanxi province and Beijing. For a simple and coherent description we use the data from the Beijing region, with some Chinese pine stands (*Pinus tabulaeformis*) as an example in this paper.

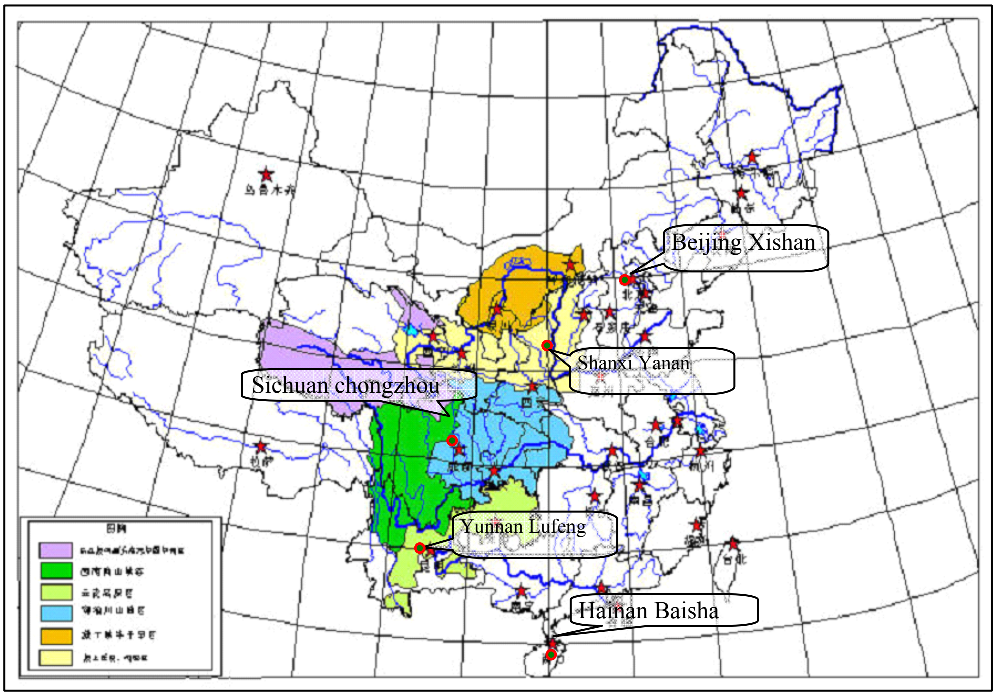


Figure 1. Study areas on close to nature management

Our investigation consists of 3 parts: forest site and environment condition, vegetation situation and soil, and stand structure and growth. Site conditions are expressed by a code system, consisting in elevation (4 levels in the Beijing region), soil nutrition (6 levels), topographical and physiognomic state (8 classes) and soil thickness with organic contents (4 classes). Each component of these parameters indicates a different site condition which should be considered in forest management planning. Results of site surveys will be presented mainly with different biotope maps and related data tables. Vegetation survey studies on the current vegetation composition should estimate present and future dominant species compositions. Investigation of stand structure and growth is conducted with different survey plots and the resulting stand parameters are shown in Table 1, including growth data for diameter, height and volume.

Table 1 shows the stand parameters out of 6 plots of 54 years old pine plantation in the Beijing region. With its average stand volume of 72 m3/ha and 9.2 m mean height after the 54-year growing period, the even aged needle tree plantation shows a clear degradation of growth and a transformation towards a close-to-natural stand is urgently needed.

Table 1. Stand parameters of a pine plantation (Pinus tabulaeformis) of Xishan forest farm in the region of Beijing.

Sample No.	(N/ha) Stems	(m2/ha) Basal area	(m3/ha) Standing volume	Mean DBH (cm)	Mean height (m)	Number of tree species	Number of family
1	400	12.11	65.71	19.64	10.85	2	2
2	1680	18.23	69.91	11.76	7.67	1	1
3	1800	17.06	60.93	10.99	7.14	1	1
4	720	17.63	105.78	17.66	12.00	1	1
5	1000	17.12	81.15	14.77	9.48	1	1
6	1440	15.76	63.18	11.81	8.02	1	1
Average	1173	15.68	72.09	13.05	9.19	1	1

3 IMPROVED PLANNING SYSTEM FOR CLOSE-TO-NATURAL FORESTRY

According to the principles of close-to-natural forestry, we understand that the first step for forest management is to understand the present situation and natural potentials of the site, and then to see what is an optimal combination on the site for human interests and the natural possibilities. This is necessary to set goals for proper management. After setting goals we should operate in the stand according to the relationship of the trees to obtain improvements or harvest with lower costs for people and fewer disturbances to nature. In the long term forest development process it is necessary to have a schedule of different operations aimed at the management goals. These are the things we need to do in management planning and they are formulated into four technical elements in an integrated planning system.

3.1 IMPROVED INVESTIGATION

The goal of investigation is to understand the present situation and its natural potential. The improvements for this step are: (1) an expansion to include the parameters of forest environment and site condition, stand structure, and tree growing data; (2) a quantitative code system to express the site condition; and (3) expressing most results in a set of professional maps by using biotope mapping.

A biotope can be understood as a typical ecosystem unit in the spatial and temporal state (Anonymous 1980). It has to be the base of a forest management plan referring to securing the ecosystem dynamics in the forest, while nature conservation in most cases refers to the conservation and advancement of biotopes and endangered species (Schulte et al. 2003; Sturm & Hanstein1986; Sturm 1989).

As shown by Figure 2, Biotope mapping means classifying the comprehensive impacts of different natural elements and indicators. With the help of coding and mapping, the site conditions can be organized into biotype classes which are elementary units with similar natural attributes for proper forest management.

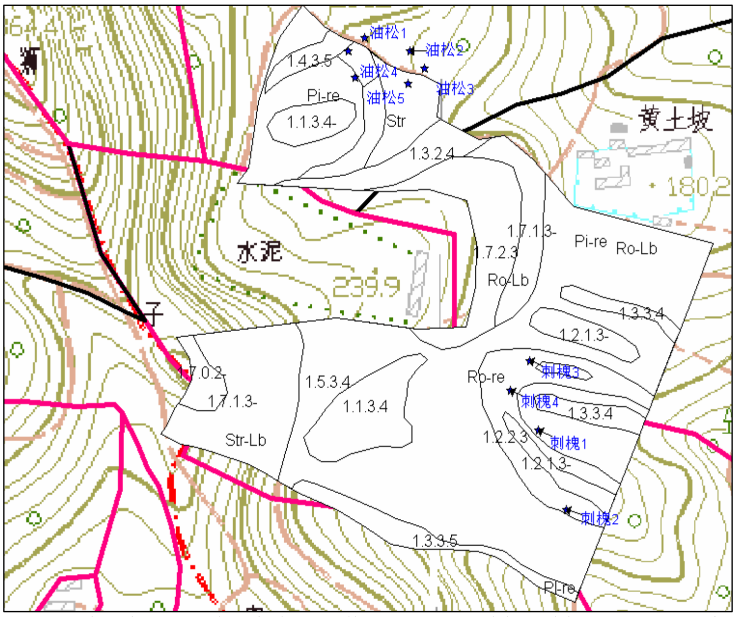


Figure 2. Investigation result of site coding presented in a biotope map of an experimental area in Beijing.

3.2 GOAL ANALYZING AND THE DESIGN OF FOREST DEVELOPMENT TYPES

Analyzing the management goal is a combination of the needs of people with the possibilities of the nature. As the Xishan experimental pine plantation is located on the joint part of an urban and suburban region in the western part of Beijing, the overall management objective is to provide recreation and landscape service functions before timber production. As this is hardly reachable with the present even-aged pure needle species plantation, it is necessary then to transform it into a close-to-nature forest with a diverse structure to meet the needs of sustainable environmental and cultural needs.

There are several ways to express management objectives; the traditional method in China is the so called Target Stand Design (TSD). Generally, TSD is usually used for new afforestation areas, it defines tree species or composition, it targets stand volume and rotation or cutting circle based on site indicators and growth parameters of tree species. Another one of the objective expression methods is Forest Development Type (FDT, or WET in German). FDT was originally developed in the LOEWE program of Niedersachsen, Germany (Anonymous 1991; Otto 1994) and it is figured with a dynamic controlling of forest and some concrete parameters such as target harvesting diameter and vertical structure.

The integration of TSD and FDT improved our management goal analysis and expression. In our experiment, areas of Target Forest Development Type (TFDT) are used to present the main characters of a close-to-natural forest in the future. TFDT is composed of a description of Forest condition, development target, service and conservation functions, ability of timber production, target diameter, mixture type, tree species composition, and regeneration possibilities as its main parts. But for optimal management planning we feel a quantitative and visualizing supporting tool for design of TFDT is still absent.

3.3 TENDING OPERATION ORIENTED BY TARGET TREES

A fundamental difference between close-to-nature forestry and plantation forestry is the decision parameters of how to cut trees in a stand, with or without the target tree design as a key element in between. A practical target tree oriented operation starts by classifying all trees in stand into four classes labeled as target trees, ecologically valuable trees, disturbing trees, and other normal trees. Classification must be done according to the biological and ecological relationships between single trees such as vigor, stem quality, and biodiversity. The second step is the felling of disturbing trees with consideration for the protection of natural regeneration.

Figure 3 shows a Pinus tabulaeformis stand which is located in a western suburb of Beijing. The management goal is defined as maintaining landscape and recreation services in combination with timber production. Based on the analysis of biotopes and the design of a Target Forest Development Type, the transformation task of this pine plantation is concluded as the following three aspects: (1) stopping the tendency of tree growth degradation; (2) improving the diameter structure to possibly a sustainable reverse J shape distribution; and (3) increase the proportion of broadleaved trees. With its single tree relationship based advantages, target tree operation will help to improve these points over and over, aimed to an unequally distributed close-to-natural forest.

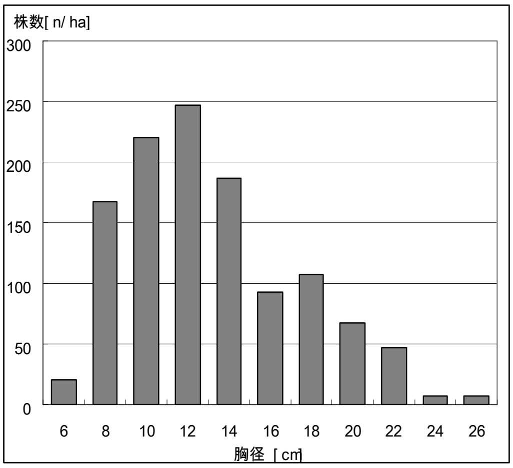
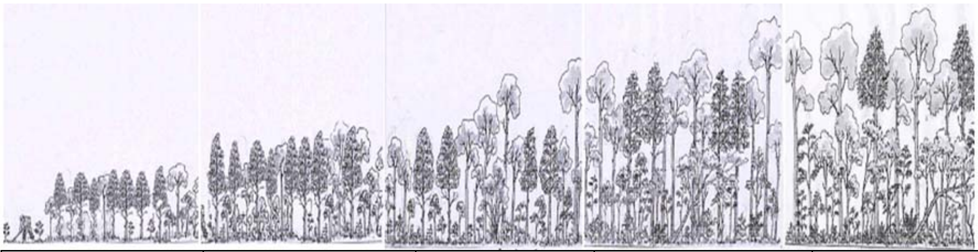


Figure 3 Diameter class distribution and forest condition in Chinese pine plantation.

3.4 OUTLINE OF SILVICULTURAL PLAN ON THE CLEW OF NATURAL SUCCESSION

A traditional silvicultural plan uses rotation-based sequences to control the process of forest growth towards economic production. In our study, this is changed to a design of silvicultural operation planning based on the natural progress of succession. The natural succession can be classified into 4, 5 or 6 phases with different ecological indicators to meet the need of understanding and management (Spurr & Barnes 1980; Whittaker 1975; Horn H S 1981). In our study, this progress is divided into 5 stages with clear differences of the structural and operational parameters, as shown in Figure 4. An operational planning table with ecological indicators and forestry parameters from forest establishment, competition differentiation, selection stage, close-to-nature (pre-mature) stage, and natural permanent forest stage are given for silvicultural measurements in the stands which aim to be close-to-natural forests.



Ⅰ．establishment	II. competition differentiation	III. selection stage	IV. close-to-nature (pre-mature) stage	V. natural permanent forest stage
Afforestation	protection	Select and tending the TT	Checking TT	Partly harvest TT in main canopy
Promoting the natural regeneration	Special TT* selection in needle stand	Cutting disturbing trees	Cutting disturbing trees	Tending TT in under canopy
tending	Special operation for degraded stand	Protecting natural seedling	Select TT in the second generation	Promotion gap regeneration

Figure 4. Classification of forest succession procedures and planning main silvicultural operation for each stage.

For an implementation outline of silvicultural operation, information on ecological indicators such as competition, species composition, canopy development, and soil development needs to be collected, and forest development parameters should be analysed to support developing a reasonable operational planning table. This table will serve as a guideline for the operational measurement at each stage of stand devolopement for vertical structure orientation and temporal flexible forms in practice.

In relation to a concrete stand, the time sequencing of each stage varies, depending on the growth rates of the tree species, the site conditions, and the different stages. It means that the period from forest establishment to a permanent, self-sustaining forest will be estimated to last from 50 to 120 years in case of the Beijing region.

4 CONCLUSION AND DISCUSSION

The planning system of close-to-nature forestry, taking demonstrative data from Beijing, is developed out of our primary study on multi-functional ecological forest management in China for different experimental areas from the tropical area of Hainan, subtropical Yunnan and Sichuan, to the temperate regions in the Shanxi province and the Beijing region. Due to the long-term process of forest ecosystem development, evaluation of influences with concrete field data is still a task for us in the future. However, the concept of Close-to-Natural Forestry is realized in China due to the efforts of the last years, and further study and implementation will continually be conducted and extended to other regions in the next five years of the national research program. We hope that this integrated planning system with its four concrete technical elements will serve as a tool for sustainable forest management strategies in China and make its contribution to biodiversity conservation and ecological rehabilitation in the future.

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COLLECTIVE ACTION FOR PROMOTING COMMUNITIES' MARKETING CAPACITY: SUSTAINABLE NTFP MANAGEMENT IN THE CONTEXT OF THE COMMUNITY-BASED NATURAL RESOURCE MANAGEMENT (CBNRM) MECHANISM

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1 BACKGROUND

1.1 UNCLEAR LEGISLATIVE ARRANGEMENT FOR NTFP OWNERSHIP

The Forest Law of P. R. China regulates that "all forest resources (including NTFPs) belong to all citizens except those parts belonging to collective entities as regulated by law" (Article 2). That means that there are two kinds of ownership for forest resources: one is state-owned and the other is collective-owned in rural areas.

However the past reforms on forest resources after the establishment of P. R. China paid much attention to the legal arrangement of forestland. The basic principle is to separate use right of forest land from ownership, which means to keep the collective-owned and allow individual households and users groups to have use rights over forest land and then to authorize the ownership for forests and timber (including bamboo and fruit trees). This implies that there is no clear legal arrangement for NTFPs.

Traditionally, NTFP is an open access to all collective members within the village and even outside the village which resulted in (1) over-harvesting and non-management for NTFP itself; (2) conflicts among different users; and (3) poor management for forest resources, including NTFP.

1.2 NTFP BECOMES AN IMPORTANT SOURCE FOR MANY RURAL HOUSEHOLDS IN YUNNAN

Yunnan has most abundant fauna and flora resources in P. R. China. Let's take eatable wild mushroom as an example, there are more than 720 species in China and 600 species in Yunnan, takes 86.7%[1]. Traditionally rural people collected NTFP for family consumption so that NTFP contributed very much for improving rural households' food sources and nutrient structure.

In the recent more than 10 years, with the improvement of economic situation for most Chinese people, more and more people paid much attention to the quality and structure of food, green food becomes the first priority for many urban residents, so that NTFP also becomes an important cash income source for many rural households.

The unclear legislative arrangement and bigger and bigger market demand resulted in poor management and over utilization for many NTFPs, especially wild mushrooms, eatable wild vegetables and many species of herbal medicinal plants. This situation also is paid attention by both governments and local communities. The former issued and implemented many policies to manage the NTFP, and the later initiated different approaches to manage the NTFP resources based upon local situation. Xiaoshao Village, Yiliang County is one good example.

Xiaoshao Administrative Village consists of 8 natural villages comprising a total of 380 households and 1,382 residents. It belongs to Goujie Township in Yiliang County, Kunming Municipality. The village is 85 km away from Kunming. The village has a total land area of over 50,000 mu (over 3,000 hectares). Its arable land area is only approximately 3,000 mu, with 700 mu of paddy land and the remainder dry land. Forestland occupies the remaining approximately 47,000 mu of village land. The net income was about 2500 RMB yuan (300 USD) of which NTFP accounted for 2/5.

2 INTRODUCTION TO XIAOSHAO VILLAGE'S TENURE SYSTEM OVER FOREST

2.1 YILIANG COUNTY

According to briefings with county agriculture and forest bureau officials, Yiliang County allocated forest land to households under the "Two-Hill" Policy in 1983. By 1987, however, severe over-cutting had occurred in many parts of Yiliang. In response, the county adopted a policy that all land that had not been reforested by households would be returned to collective management at the natural or administrative village level. Land that had been reforested by households would remain under household management under the principle that "he who plants the trees shall have rights to the land." Currently, approximately two-thirds of Yiliang's forest land is operated under collective management, with the remaining land managed by households.

County officials pointed to several reasons for the over-cutting that followed allocation of forestland to households. First, many households found forest land difficult to manage. In comparison to arable land, forestland tracts are large and often difficult to access, meaning that greater investments of time and labor are required for effective management. Second, frequent changes in forest policies made farmers feel insecure, and increased their desire to cash in on the economic benefits of the forestland they had been allocated before the next change in policy. However, county officials also recognized that in some instances, households had been able to effectively manage the forestland that had been allocated to them. These successful examples of household management were based on several factors, including: allocation of forestland in a manner that made forestland easily accessible by farm households, a secure perception among farmers that they would be able to reap the benefits of any investments they made on their forestland, and access to the capital required for such investments. On the whole, county officials felt strongly that collective forest management had been more effective than household management in protecting forest resources.

2.2 XIAOSHAO VILLAGE

Collective Forestland Management.

Village cadres in Xiaoshao reported that allocation of forestland under the Two-Hill policy in 1982 resulted in progressively severe harvesting by households. Cadres estimated that within the first two years of the Two-Hill policy, approximately 40% of village trees had been harvested, and that by 1985 village tree cover had declined to 40% of 1982 levels. Tree harvesting was pervasive throughout all of the villager small groups within the administrative village, and was primarily attributed to the desire to build new houses and to reap economic benefits from the forests while households possessed management rights. In 1988, the village decided that it would close the forests to farmers because, in their words, "the forests were bare, the water sources were dry, and the people were poor." Village cadres attributed instances of erosion, seasonal flooding, and decrease in grazing areas, all of which were prevalent between 1983-1990, to the lack of tree cover. In 1990, all forestland was formally taken back under village collective management. Cadres estimated that current tree cover in Xiaoshao had returned to approximately the same levels as existed in 1982.

Contracted Hill Policy

Xiaoshao village also provided an example of local innovation to realize the economic potential of forestland without harvesting trees. This method, called the "Contracted Hill" policy, capitalizes on the presence of a particular type of edible mushrooms that grows in village Hills. Under the policy, rights to manage specific parcels of Hill land during a designated mushroom harvesting season are auctioned to the highest bidder, who receives a contract specifying his rights and obligations on the land. Successful bidders receive the right to harvest mushrooms on the contracted land during the designated season (May 31 – October 31) and to retain any income from the sale of mushrooms. Contractors are also permitted to charge admission fees to individuals who are interested in picking mushrooms on the land. Contractors are required to pay all contracting fees, determined by auction, at the time of contracting, and are required to protect the forestland to which they have won rights. Neither tree cutting nor grazing is permitted on the contracted land during mushroom season.

Management of forestland is also contracted out during the non-mushroom season (November – May), but the contracting method is reversed. An auction process is opened to village households, with the household providing the lowest bid (that is, willing to manage an area of forestland during those months in return for that payment) earning the position in return for payment of the contracted amount by the administrative village.

The Contracted Hill policy was first introduced on an experimental basis in Da Gou Li villager small group in 1992. At that time, approximately 800 mu of forestland was contracted out for a total of 3,400 RMB. In 1993 and 1994, other villager small groups introduced the policy, but the contracted land areas remained small and collective income was minimal. During these initial years of the policy, contracting was limited to village households only.

In 1995, the village adopted a different approach to the Contracted Hill policy. The area of land to be contracted was expanded greatly, and for the first time, non-villagers were allowed to contract the land. As a result, collective revenues from contracting increased dramatically to approximately 360,000 RMB. Income, aside from a small fee retained by the administrative village, was allocated among the villager small groups occurs based on each small group's share of total village population[2]. Village policy required that contracting fees be used to cover each villager small group's annual operating expenses, including cadre salaries and any public works projects. The increased contracting revenues allowed small groups to cancel all other collective contributions, taxes, and fees that had been imposed on farmers, with additional profits distributed among all village small group members on a per capita basis. Village cadres reported that a public accounting of expenditures and profit distributions is made to farmers every year.

The policy of allowing non-villager to participate in the auction process was maintained between 1995 and 2000, with contracting revenues increasing each year to a high point of 630,000 RMB in 2000. In each year, revenues were sufficient to cover all public works costs and to distribute profits to villagers. The amount of annual profits distributed varied among villager small groups, and depended on the extent of public works that were required in any given year. Cadres told us that many villages had used the revenue to undertake basic agricultural infrastructure improvements such as improving village reservoirs.

Beginning in 2001, however, the village reversed its policy of contracting to outsiders, once again allowing only village residents to participate in the auction process. This decision was motivated by two considerations. First, village cadres reported that non-villagers presented difficulties in managing and enforcing contracting arrangements. Second, village cadres and farmers felt that the benefits from village resources should be accrued by villagers themselves, rather than outsiders. This shift in contracting led to a reduction in contracting revenue from 630,000 RMB in 2000 to 580,000 RMB in 2001, but cadres we interviewed expressed unanimous support for the decision in spite of this lost revenue.

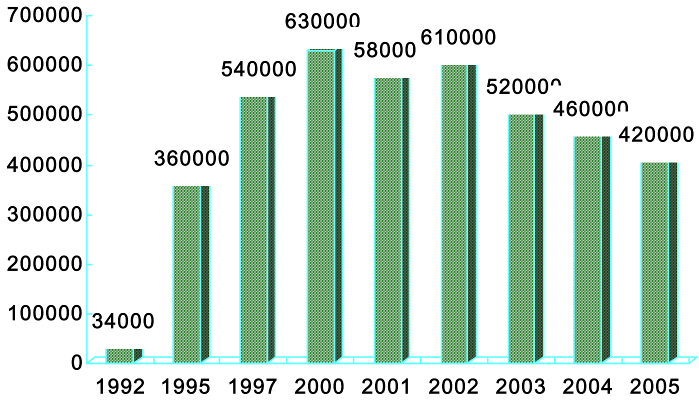

Figure 1. Shift in contracting revenue.

Following our interview with village cadres, we interviewed two groups of farmers that included three current contractors and several non-contractors of the Contract Hill land from different villager groups. All of the farmers participating in the group interviews, regardless of whether they were contractors or non-contractors, strongly supported the Contracted Hill policy. When we asked whether farmers would favor allocation of the forestland to households, they universally expressed opposition to this possibility. Non-contractors replied that they were happy to receive a profit distribution each year "without doing anything," and reported that the profit distribution in their villager small group the previous year had been 300 RMB per capita. Contractors pointed out that management by a small number of contracting households, who lived on the contracted land during the mushroom season was more efficient and ensured better forest protection while simultaneously providing the opportunity for individual profit.

They also expressed support for the policy limiting contracting to villagers, stressing that villagers should have the opportunity to reap the economic benefits from village resources. They noted that when management was contracted to non-villagers, a considerable amount of poaching of mushrooms had been done by villagers, but that poaching has declined since contracting to villagers was undertaken due to social pressure.

All three forestland contractors told us that they had obtained contracts through a competitive auction. Auction participants were required to pay 1,000-2,000 RMB for the right to bid on the land to be contracted, depending on the decision made by each villager group. For unsuccessful bidders, this deposit was returned in full. For successful bidders, it served as a down payment on the contracting fees.

One of the contractors, Mr. Zhao, had obtained rights to a parcel of 350 mu of forestland for a contracting fee totaling 38,500 RMB. Though this was the most expensive parcel of Contracted Hill land in the village, competition was intense, with nearly 20 people submitting bids for that parcel. The opening bid for the parcel was 28,000 RMB. Mr. Zhao was able to pay the contracting fee through a combination of personal savings and loans. He borrowed approximately 25,000 RMB from the township credit cooperative, and the remainder from friends and relatives. To secure the loan from the credit cooperative, the village cadre provided documentation of rights to the contracted land. Mr. Zhao reported that it is very difficult for farmers to get loans from the credit cooperative for typical agricultural purposes, but they are willing to make substantial loans to those farmers who have contracted forestland under the Contracted Hill policy. The interest rate on the loan is 0.72% monthly (8.64% annually). Mr. Zhao has already made payments to the credit cooperative totaling 27,000 RMB.

A second contractor who had successfully won the bid for three consecutive years between 1999 and 2001 also reported that the competition was keen. In 2001, for a tract of 350 mu of forestland, his winning bid was 28,950 RMB, well above the starting bid of 15,000 RMB. Seventeen farmers participated in the bidding process for that parcel. The profit was also impressive. His cash income from contracted Hill of 400 mu in 1999 was 30,000 RMB, while the contract fees were just 15,100 RMB. In 2000, he was able to make more than 40,000 RMB from half of his 800 mu of contracted Hill (the revenue collected from the other half was kept by his son) although his winning bid for all of 800 mu was only 53,000 RMB. By the time of our interview, he had almost recouped all of the contract fees he paid, and still had nearly two months to collect revenues from mushrooms before his contract expired.

3 OUTCOMES AND IMPACTS

First, existing forest resources are effectively protected. All bidders are required to submit a bidder's fee of 1,000 Yuan prior to the auction. Upon any successful bid, the contracting party is also required to pay between 100-1,000 Yuan depending on the area of forestland contracted to cover the costs of closing the forests to outsiders and forest fire prevention. In addition, the contractee also must pay a lump sum of the contracting fee for the current year. After the signing of contract with the village committee, the contractee is permitted to take over the mountain. Parcels are auctioned off once per year, but contractees may bid for management rights to the same parcel in consecutive years. Parcels are typically auctioned, and management contracts signed, every April, and the contract period ends on October 31. Upon expiration of the contract, an inspection team consisting of village leaders and residents conducts an examination of the contracted land. If no forest fires have occurred, and the forests have not been degraded through tree-harvesting or other develop, the deposit will be returned. Some village small groups even incorporate forest management and oversight into contracting terms. As a result, Xiaoshao village has not had forest fires or forest degradation crimes for the past 14 years. Villager small groups and farm households have voluntarily returned cultivated land into forests. Forest resources have been effective protected, and the mushroom production has continually increased.

Second, fees and taxes imposed on farmers have been reduced while the collective economy has been developed. Among the 8 villager small groups, 5 groups have abolished all collective contributions, and two groups have not only abolished collective contributions but also allocated a portion of the contracting fees to villagers as a distribution of profits. The Dagouhei group's average annual distribution amounts to 500 Yuan per capita. The village committee receives a management fee amounting to 3% of the collected contracting fees, equaling nearly 20,000 Yuan per year. The villager small groups no longer rely on collecting fees from the farmers to carry out public works projects. During the period of the "Ninth Five Year Plan", Xiaoshao Village Committee invested 5.1 million Yuan to establish four land parcels for tobacco cultivation construct 7 small reservoirs provide drinking water for 6 villager small groups, establishing chestnut-drying centers in 3 villager small groups, and complete electrification programs in 4 villager small groups.

Third, is the creation of mutuality between resources and the economy and a positive cycle between the environment and economic development. Since Xiaoshao began contracting out forestland for mushroom picking, not only has the economy been developed, but also forest resources were protected. It is said that nowadays in Xiaoshao, "there are forests on mountains, there are mushrooms in the forests, there are reservoirs in the semi-mountainous areas, there are grains in the valley and there is money in the home." Moreover the output of mushrooms increased by more than 1.5 times since (1) contracting households may control products and ensure harvesting undertook with the best timing; (2) mushrooms'root and production environment could be protected well. Meanwhile, the price increased by more than 15% from both good market season and mushroom quality. All these contributed to the increase of villagers'income since households who could not acquire collection rights may share benefit from distribution of profits.

Fourth, the practice has explored a new avenue for forest management and oversight. Turnover of personnel has increased and speeded the process of reform and development through open-mindedness. Influenced by Xiaoshao Village, state-owned tree farms also initiated this method of contracting out forest land this year. During the months of mushroom season, office workers from departments in Kunming and Yiliang City make the trip to Xiaoshao to breathe our fresh air and pick mushrooms – about 20 carloads on an average weekend. This has increased word-of-mouth advertising, further opening up farmers' minds to the economic opportunities. In the meantime, extensive market research by villagers has expanded visions for economic development and market expansion.

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Prior to 1999, 100% of receipts were allocated to villager small groups. Starting in 1999, the administrative village imposed a 3% service charge to cover the costs of contracting, leaving the remaining 97% for allocation to villager small groups.

CERTIFICATION OF NON-TIMBER FOREST PRODUCTS: POTENTIAL PATHWAY TOWARD BALANCING ECONOMIC AND ENVIRONMENTAL GOALS IN SOUTHWEST CHINA

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ABSTRACT

Non-timber forest products, or NTFPs, have attracted considerable interest as a component of sustainable development initiatives in recent years due to their ability to support and improve rural livelihoods while contributing to environmental objectives, including biodiversity conservation. However, systematic understanding of the role and potential of NTFPs in conservation and development remains weak and it has been realized that the utilization of NTFPs requires certain measures of planning and control to be sustainable. While domestication is one way to reduce pressure on the natural resource, certification may provide another option to ensure that wild collection is maintained at a sustainable level. Certification can offer collectors higher prices to compensate for lower harvest levels and help them to secure user rights. This paper discusses in detail the potential and challenges of organic, ecological and Fairtrade certification schemes toward balancing poverty reduction and biodiversity conservation goals in China’s Southwestern mountain regions.

Keywords: biodiversity, certification, China, Fairtrade, Forest Stewardship Council, non-timber forest products, Yunnan.

1 INTRODUCTION

Products from natural and planted forests play an important role in the household economy, especially in the more remote mountain areas of Southwest China that lack other business opportunities. With the enforcement of a strict logging ban in 2000 on all natural forests and the gradual conversion of land above 25 degrees of slope from annual into tree crops under the *Sloping Land Conversion Program*, many upland communities have lost a significant income source (from timber). Many upland households have substituted this loss by intensifying the collection of NTFPs from natural and planted forests which has lead to a severe decline of some products and, thus, poses an increasing threat to biodiversity. As most collectors of NTFPs lack basic market knowledge and rely on traders to buy their produce, they only earn a small income from NTFPs.

Domestication of NTFPs can be a way to intensify production (through higher yields, improved and/or more consistent quality, and control over timing of harvest), secure producer rights and reduce pressure on wild resources. Its risk are that domestication of products originally harvested from the wild can lead to genetic homogenization, reduce the economic value of wild systems (up to the point where natural forest land is being cleared to grow domesticated NTFPs on a larger scale) and lead to transfer of benefits from one group of stakeholders to another (Belcher, 2003).

Another potential solution that could benefit and bridge economic and environmental goals is product certification under organic, Fairtrade or sustainable forest management schemes. NTFPs that can be dried, further processed and stored, such as nuts, medicinal plants and mushrooms for example, may be particularly suited since distance to markets poses a serious logistical challenge. At present, the relatively wealthier consumers of certified products are only found in the big cities in the East of the country or abroad.

The objectives of this paper are to present initial development initiatives conducted by the *Center for Mountain Ecosystem Studies* related to the natural resource "NTFP" in mountainous Southwest China. More specifically, the paper evaluates and discusses the potential and constraints of certification for the sustainable management of NTFPs and for improving incomes among some of the poorest upland communities in China.

2 TOWARD IMPROVED NTFP MANAGEMENT IN NORTHWEST YUNNAN

The *Kunming Institute of Botany* (KIB), China's leading institution in the fields of biodiversity and ethno-botany in China, has recently intensified its applied research in partnership with the World Agroforestry Center (ICRAF) through its jointly managed *Center for Mountain Ecosystem Studies* (CMES). The two most important on-going research and development projects of CMES related to NTFP are presented and discussed below. These and the initiatives described in Section 3 represent promising opportunities to successfully address the need for improving rural incomes while maintaining the natural resource base in typical poor upland communities in Southwest China.

Domestication of non-timber forest products: reducing pressure on natural resources

One strategy to reduce pressure on NTFP resources in their natural environment and create more income opportunities for farmers is domesticating them, i.e. growing them on-farm. The *Center for Mountain Ecosystem Studies* has pursued this option together with the *Department of Forestry* in Baoshan prefecture, Northwest Yunnan. An initial participatory survey of potential NTFP in 2003 in the project site, in Yangliu township (Longyang District, 98o 50′ eastern longitudes, 25o15′ northern latitude; elevation range: 1500 – 2500 m above sea level) – one of the poorest villages in Yunnan - identified seven valuable medicinal plants species that local farmers were interested to try growing on their land, recently converted to tree crops under the *Sloping Land Conversion Program* (SLCP). Agricultural land converted in China under the SLCP to tree crops (mainly peach and walnut trees) are prohibited from being used for growing annual crops, even during the early establishment stage of the trees when there is ample space between them. To compensate for the income loss farmers receive payment for each hectare of land converted to trees, for up to 8 years. However, medicinal plants are not classified as annual crops and can thus be grown in-between the trees. It is commonly observed that trees in similar agroforestry system benefit from the more intensive land management (weeding, fertilizer application to crops) compared to leaving the land fallow (and simply slashing the weeds).

Starting from spring 2004, six farmer households (all living in the same village) participated in this action research and tried growing the medicinal plants on a total area of

2 ha. Since collection of medicinal plants from wild resource is the responsibility of women, also the action research was done by the female members of the participating households. They intercropped the medicinal plants with the existing young pear and walnut trees and applied mineral fertilizer. After 18 months most species were ready for harvesting.

Initial experience has shown that some medicinal plants have a high potential for domestication and that a major constraint is lack of knowledge among farmers in the management of growing medicinal plants on-farm. Only one species, *Dipsacus daliensis* whose root is commonly used in Chinese medicine, performed well. However, due to the exceptionally good growing conditions (no competition and fertile soil) roots were bigger than commonly found in the market and traders were concerned that these would not sell as well as average-sized roots since buyers might doubt the identity of the species.

As an outcome of the first 18 months of this action research, only three species (*Dipsacus daliensis, Foeniculi fructus* and *Pinellia ternata*) are now being tested on-farm by about 40 interested households in two villages (on about 5 ha of land) and the *Forestry Department* pays special attention to working with farmers on improving the management of the crop. Based on the findings from the first phase of the action research the time form planting to harvesting of *D. daliensis* for example, is now being reduced to one year. It is interesting to note that the male household members have also become involved in growing medicinal plants on-farm now, since it is turning out to become a more profitable farming enterprise than simply collecting plants from the wild.

The approach of this action research has also been extended to other parts of mountainous Yunnan. So has CMES started to cooperate with the extension staff of *Southwest Forestry College* in promoting the growing of medicinal plants on SLCP land more widely.

The domestication of wild plant resources requires an iterative process of action research and basic scientific studies. Now that the first medicinal plants have been ear-marked as performing well when grown on-farm, as a next step their active chemical ingredients need to be quantified and compared to those plant specimens growing in the wild. If this analysis confirms that the quality of the plants growing on-farm is satisfactory, production on farmers' fields can be confidently promoted. Conducting inventories of wild resources over time will be needed to confirm the claim that domestication is reducing pressure on the natural resource base and, thus, supports biodiversity conservation. Impact of domestication on market prices need to be examined as well.

However, since domestication of medicinal plants and other NTFP is not applicable for the majority of species, equal importance need to be placed on the development of sustainable wild collection systems. Certification of wild collection can be an option to provide incentives for conservation and sustainable use and can strengthen local economies. Yet, the rich diversity of NTFP species (among the group of medicinal plants alone) and complex ecological interactions, make certification of wild resources a far more challenging endeavor than the certification of agricultural crops (see also: http://www.floraweb.de/map-pro for more information on this aspect).

The base for improving market access: commodity chain analysis

While agricultural crops have been well researched and promoted by the Chinese government and international research organizations worldwide, non-timber forest products have not yet received the attention they deserve. A better understanding of their value in the household economy as well as in domestic and international markets (including regional cross-border trade) and is needed to demonstrate their importance for rural incomes and sustainable resource management. Under this premise a Master study is currently being conducted at CMES that focuses on commodity chain analysis of selected commercially important non-timber forest products collected and harvested in two townships in Baoshan prefecture, namely Yangliu and Shuizhai townships. Both townships represent typical upland situations in Southwest China: while the former has little forest area left and large parts of the sloping land has been converted to tree crops under the *Sloping Land Conversion Program*, the latter has a forest cover of more than 80 % in some of its mountain villages (some of which has been planted more than 30 years ago) and thus relatively rich non-timber forest resources.

Objectives of this research are to: (i) identify those NTFPs that are currently the most important commodities for farmers / collectors in Yangliu and Shuizhai or have a high potential to become important commodities in these communities; (ii) document details of the commodity chain from producer to customer for selected NTFPs; and (iii) identify opportunities and associated strategies for improving rural communities' benefits from NTFP management, harvest, processing and marketing while preventing an over-use of the resource base.

The underlying research hypothesis is that a thorough understanding of the commodity chain of NTFPs – from producer/collector, trader and processor up to retailer and consumer – is an essential base for strategic development interventions at the local level as well as a crucial source for sound policy recommendations. Findings of the research will feed into CMES' development efforts to place rural producers/collectors and village-based traders in a better market position and build the base for jointly developing sustainable collection/production methods with the communities. The study uses key informant interviews as the major tool. Target respondents are the main producers/collectors, traders/wholesalers, processors and retailers of the most important NTFPs from the study area, as well as local government staff. Interviews are complemented by the collection of secondary data from government offices, such as information on trade, export and relevant legislation.

Initial results have …

- **Confirmed the importance of non-timber forest products** in terms of cash income for the majority of smallholder households, as well as the steady market demand for all surveyed products.
  In the poorer villages (in Yangliu township), medicinal plants - mostly collected by women and commonly gathered far from the villages (up to four hours walk) - constitute a key income source for most households who can derive up to 75 % of their annual cash income from this activity. Walnuts and pine-nuts (most of which have been planted) are increasingly adding to household income as more of the planted trees start bearing fruits. A single large walnut tree (more than 20 years old) can provide as much as twice the annual average per capita income (of about 105 US $).

  A significant contribution to household income in the wealthier villages (in Shuizhai township) comes from the collection of high-value forest mushrooms, such as the Matsutake mushroom (Tricholoma matsutake) that is largely exported to Japan and truffle (Tuber sinensis) chiefly sold to Europe. A single household can earn up to ten times the average annual per capita income from collecting and selling Matsutake mushrooms. While most households have access to truffle growing areas (within and outside their own village boundaries), access to

Matsutake is restricted to a smaller number of households, those who have the use rights over the forest parcels where the mushroom can be found.

- **Identified over-harvesting as a threat to biodiversity conservation** and to the sustained supply of NTFPs as a source of cash income. Collectors and traders observed a steady decline for a range of medicinal plant species, resulting in their increased value on the market. While for medicinal plants and truffles it is a resource with free access to everyone (i.e. without any control of over-harvesting), the case is different for Matsutake mushroom. Communal forest areas are sub-dived and each household in the village has the use rights to a certain piece of the forest. In those forest parcels where the valuable Matsutake mushroom grows users guard the area well during harvesting time and do not collect the young mushrooms since they fetch a lower price from the trader. The high value of this particular NTFP has made it clear to users that a decline or complete loss of this resource would harm their household economy and an informal system of sustainable management has evolved (through privatized control over the resource).
- **Documented major constraints to maximizing income benefits from NTFP**. In general, producers and collectors do not have access to market knowledge (such as demand and price) and sell their produce individually to local (i.e. from within the village) or outside traders. At least, there are a number of traders for each product and individual households have a certain bargaining power, especially for high value products (such as Matsutake mushroom). The lack of a local production and marketing organization, however, also means that there is no processing (value adding) at the village level. Another issue is that the planting of tree crops, such as pear and walnut (resulting from heavy government promotion), is not based on well-founded knowledge of market development for the products. The large number of mature pear trees have in recent years already lead to an over-supply of fruits on local markets and a decline of prices, to the extend that fruits are not harvested. With the large number of walnut trees planted in recent years it remains to be seen whether an over-supply will result in drop-off in prices in six to eight years from now as well.
- **Pointed to some opportunities and needs for intervention, such as:** (i) building capacity among community members to access market knowledge and explore joint marketing and processing initiatives; (ii) investigating the potential benefits of group certification under organic, Fairtrade or sustainable forest management schemes to access alternative (so-called “niche”) markets and maintain valuable and ecologically important NTFP resources; (iii) building capacity within forestry extension services to promote the planting of a wider range of tree species (based on a thorough survey of market demand and prediction of future market developments) and sound management systems (including domestication of selected NTFP, such as medicinal plants); and (iv) making NTFPs more visible, i.e. draw government attention to the many important commodities that have not yet entered official statistics due to a lack of clear classification and challenges in conducting inventories and in monitoring home-use and informal trade; this would from the basis for improving legislation on sustainable management and the equitable share of revenues from NTFP resources.

Concurrently with the commodity chain analysis described above, CMES has starting working with government and NGO partners to build capacity among facilitators (extension staff and community development workers) and farmer leaders to engage communities in Southwest China in more professional marketing initiatives. Improved quality management and group certification (for organic and Fairtrade labeling) have been key topics in related training activities and workshops (see Section 3 below).

As the applied research and development initiatives initiated by CMES and presented above have identified certification as a potential option for improving upland economies and contributing to sustainable natural resource use, the Center has taken up this topic and is currently exploring this option jointly with other institutions in China. The following Section discusses these initiatives and the associated benefits and challenges in more detail.

3 CERTIFICATION INITIATIVES IN SOUTHWEST CHINA TARGETING SMALLHOLDER FARMERS: POTENTIAL AND CHALLENGES

Certified organic agricultural production began in China around 1990, after the *Rural Ecosystems Division of the Nanjing Institute of Environmental Sciences* (now the *Organic Food Development Center of China* [OFDC] under the *State Environmental Protection Administration*) became China's first member of the *International Federation of International Agricultural Movements* (IFOAM) in late 1988. Since then, organic food production in China has grown rapidly, mainly driven by demand from overseas markets in Europe, Japan and the USA. In recent years demand for organic products on the domestic market is increasing, as the wealthy middle class in China is rapidly growing (mainly in the big cities in the East of the country) and consumers are increasingly becoming aware of the health benefits of eating organic food. China's first supermarket for organic products has opened in 2005 in Shanghai.

Aside from the Chinese certification agencies, namely the Organic Food Development Center of China (OFDC; under the State Environmental Protection Administration) and the China Organic Food Certification Center (COFCC; under the Ministry of Agriculture), a number of international certifiers are now present in China (such OCIA, ECOCERT, BCS, IMO, JONA and OMIC). The certification of farms growing crops for the overseas organic market by international certifiers has started in 1995.

Unlike in many other countries, where farmers were the drivers behind organic agriculture movements (at least during the early development stage), organic food production initiatives in China were originally organized and managed by the government (state firms). While the government has moved away from direct ownership and private firms have taken over now, smaller companies and smallholder farmers in poorer and remote areas - such as those in mountainous Southwest China - will need more government support to overcome constraints to participation in the growing organic food market in China and abroad. Even today, farmers are not the primary force behind the growth in organic production, but trading companies. These typically initiate, provide technical advice, organize needed input supply, and take care of processing and marketing. This mode of operation also prevails in poorer regions and in wild collection areas. Most of the certified organic wild collection of food and medicinal plant resources is managed / controlled by a few large companies that typically also are engaged in managing a number of organic farms.

The following sections report of three on-going innovative strategies that specifically address the needs related to certification of smallholder producers and collectors of non-timber forest products and that have a direct bearing on biodiversity conservation. These few examples draw a clear picture of the scale of the challenge that most mountain farmers and the supporters of such smallholder initiatives are currently facing.

Creating more opportunities for smallholder producers of organic food products

In 2005, CMES, the *BioFach China Project* and the *Organic Food Development Center of China* (OFDC) have started their cooperation based on the assumption that the development of domestic marketing and distribution business of organic agricultural and non-timber forest products contributes to the improvement of the socio-economic situation of smallholder mountain farmers in Southwest China. Joint capacity building initiatives have specifically targeted smallholder producers and collectors of wild resources and have supported building capacity among communities and development organizations to strengthen related local initiatives, as well as raising awareness among Chinese consumers regarding the benefits of organic food production and Fairtrade.

The *BioFach China Project* is a public-private partnership project coordinated by the *Nuernberg Global Fairs* with support from and in coordination with the *Deutsche Investitions- und Entwicklungsgesellschaft* (DEG, under the KfW banking group) and accompanied by the *International Federation of Organic Agriculture Movements* (IFOAM) as the patron of *BioFach Fair*, the leading annual international product fair for certified organic products. The *BioFach China Project* aims to contribute to the domestic market development for organic and natural products in China. It does this through policy advice, establishing networks for dialogue and exchange, trainings for all actors in the commodity chain, market development, and raising public awareness. *BioFach China* offers an educational program, including a number of training seminars with agricultural producers, private companies and organizations as well as information seminars with consumers. *BioFach China* will also connect the Chinese organic sector with the international markets using the other *BioFach* events in Germany, Japan, United States and Brazil to promote the Chinese organic industry. The first *BioFach-China* conference will be conducted in December 2006 and a yearly annual *BioFach-China* product fair from mid 2007.

Two training seminars for smallholder groups and supporting organizations have been jointly realized by CMES, *BioFach-China* and OFDC, and a third one is under preparation for early 2007.

The first seminar & workshop provided a platform for people form various fields and professions (i.e. research/academe, government, business, NGO sectors) currently involved in promoting or doing organic farming and Fairtrade to exchange views and ideas on opportunities and key challenges in Southwest China. It is obvious from the facts presented and discussed that organic farming and Fairtrade have a great potential in China. Key challenges, especially in the Southwest of China where mountain farmers cultivated remote hilly lands of relatively low productivity (compared to the lowland areas in the middle and east of the country) are: (i) access to knowledge (e.g. in production technology, processing and marketing), (ii) access to markets, and (iii) cost of certification (including those associated with complying to certification requirements). The seminar-workshop also confirmed that organic food production by smallholder farmers (in contrast to large-scale farm enterprises and state-owned farms in the middle and eastern part of the country that largely produce for the export market), and more so Fairtrade, is still a relatively new concept in China. This is especially true for provinces in the southwestern part of the country.

The focus of the second training was based on the conclusion from the first seminar: community facilitators, extension workers and local community/farmer group leaders need more knowledge on the specific requirements rural producer groups need to follow and the skills they need to attain to engage more professionally in the production and marketing of their farm or non-timber forest produce. Quality awareness, internal control systems and smallholder group certification were key topics during the training. Participants were staff members of government agencies, non-governmental organizations, research institutions, certification agencies and the private business sector directly involved in supporting or collaborating with rural communities.

The IFOAM manual for setting up internal control systems, or ICS, in the context of smallholder group certification has been translated to Chinese language and used for the seminars. In addition the topic "Poverty alleviation and organic agriculture" has been presented during several events in 2005/2006. In December 2006, the topic will be presented during the first *BioFach China* Conference in Shanghai jointly by CMES and OFDC in order to create more awareness and to bring interested companies in contact with small farmer initiatives. One of the core experiences is that no functioning and successful organic smallholder project is existing in China right now. The third training may, therefore, target a small number of facilitators from government extension offices, NGO staff, as well as staff of certifying agencies who are directly responsible and committed to supporting smallholder groups successfully produce and market their products.

While certification under national and international organic labeling schemes has been the major focus of this joint initiative, also alternative ways of marketing agricultural and non-timber forest products on the Chinese market will be explored in the future. Alternative modes to market organic products could be those that forego the need to obtain the label of an accredited certifier (and thus, reduce cost and probably time) by building consumer trust, i.e. develop localized direct-marketing schemes and promote products under a unique brand name. This may build on successful examples in other parts of China, such as Hongkong, and abroad (e.g. Thailand).

Emerging Fairtrade initiatives in China

Unlike certified organic production, Fairtrade certification is a relatively recent concept that contributes to sustainable development by supporting better trading conditions for small-scale farmers in the developing world. Higher prices paid by consumers (mainly) in developed countries for a product that has been produced according to Fairtrade standards means more income for producers and development support for their entire community.

Fairtrade Labelling Organizations International (FLO) is the leading Fairtrade standard setting and certification body. FLO was established in 1997 and is an association of 20 Labelling Initiatives worldwide that promote and market the Fairtrade label in their countries. FLO members currently operate in 15 European countries as well as Australia and New Zealand, Canada, Japan, Mexico and the United States. At present, FLO regularly inspects and certifies about 508 producer organizations in more than 50 countries in Africa, Asia and Latin America. The major strategic intent of FLO is (i) to deliberately work with marginalized producers and workers in order to help them move from a position of vulnerability to security and economic self-sufficiency; (ii) to empower producers and workers as stakeholders in their own organizations; and (iii) to actively play a wider role in the global arena to achieve greater equity in international trade. (URL: www.fairtrade.net)

In China, only two pilot Fairtrade projects exist so far, but many more producer groups have approached FLO to participate in the scheme. Discussions are currently underway at FLO how to best deals with the growing interest from China. Concerns are that FLO may need to work with and train an established certifier (for organic products for example) that has been accredited by the China National Certification and Accreditation Administration and whether all parts of the standards, especially for hired labor in plantations, could be fulfilled in China.

As with organic certification, the motivation to start a Fairtrade producer group has come from a company interested to explore this market niche for Chinese tea. There is no awareness at farmers' level about the existence of a market for Fairtrade products. The export company assisted producers to form an association and develop more technical, managerial and organizational skills. Through the annual inspections and resulting recommendations for improvement given by FLO the tea associations has made great progress in terms of embracing and applying all principles of Fairtrade and their communities have benefited greatly from the extra money (Premium) received from the sale of their FLO-certified tea overseas.

As the two tea associations have been FLO certified since 2002 and have made great progress and demonstrated that the Premium money can have a big positive impact on community development, it may be time for scaling up the concept in China. This will need initiative from FLO to communicate with the Chinese government or an accredited certification agency in the country to increase the scope of operation, as well as support for raising awareness among producers and consumers about the principles and benefits of Fairtrade.

The first seminar organized by CMES, *BioFach-China* and OFDC has already raised considerable interest among NGO groups in Southwest China to know more about the concept and discuss it with the communities they work with. Recently CMES has also been approached by the *Western Academy of Beijing*, an International School, to jointly promote Fairtrade in China's capital.

Sustainable forest and NTFP management: Forest Stewardship Council certification

The Forest Stewardship Council (FSC) is an international network whose mission is to promote environmentally appropriate, socially beneficial, and economically viable management of the world's forest. It provides a system for different stakeholders interested in forest issues to work towards responsible forest management. Through the FSC system, the forest owners, managers, forest product manufacturers, local communities, non-governmental organizations and other interest groups are given equal access and voice. In short: "*FSC brings people together to find solutions to the problems created by bad forestry practices and to reward good forest management*". (URL: www.fsc.org)

In 2001, WWF-China helped establish the *National Working Group on Forest Certification* with 28 representatives from the government, NGOs, enterprises, media, research institutions and trade organizations. The main task of the *FSC Working Group* is to put forward strategies for forest certification development in China. A draft version of *Chinese Forest Certification Standard* has since been completed, and a review is in process to ensure it satisfies the requirements of national laws, regulations and policies, while also meeting *Forest Stewardship Council* requirements. (URL: http://www.forestandtradeasia. org/ guidance/China/English/7/20/). The *FSC China National Initiative* was launched in March 2006.

FSC certification can include non-timber forest resources as well (the most widely-know is Brazil nut). All NTFPs that bear the FSC logo must come from fully FSC certified forests and the management system must be evaluated for each NTFP. However, even though the *NTFP Working Group* of FSC has been attempting to put NTFP certification into practice since 1996, experience with the certification of NTFPs is still relatively small. Ecological, economic and social impacts related to controlled harvesting of the large variety of plant species in complex eco-systems and to adding value to these natural (formerly in most cases free-for-all) resource is still not well-understood. In many countries, land tenure or long-term land use rights complicate the issue. That FSC-certified NTFPs command a price premium in the market is also not yet proven for the majority of products.

The *Center for Mountain Ecosystem Studies* is currently discussing with *WWF-China* and FSC to start a pilot project on community-managed forest and NTFPs in Southwest China. So far, only forest plantations have been granted FSC certification in the country. Presumably the Matsutake mushroom that is harvested by the community from the community-owned pine forest may fetch higher prices in Japan, once it bears the FSC label. This, and the opportunities for other products (such a walnut, truffle, medicinal plants, etc.) to increase in value through FSC or any other certification, will need to be confirmed through further research.

The new initiatives started in Southwest China, as presented above (Section 2 and 3), are hoped for providing directions and alternative working models for engaging smallholder farmers and collectors more genuinely in the production and marketing business in line with organic, Fairtrade and FSC standards. Outside facilitators, such as non-governmental organizations (NGOs; especially those with solid experience in the field; possibly building on experience in other countries), can play a decisive role in moving such initiatives forward by helping communities attain the needed technical, organizational and managerial skills. Successful examples could be extrapolated and implemented with the lead of local governments and extension staff. Findings can also be shared through national and international networks which will enhance mutual learning among all involved in promoting organic agriculture and Fairtrade. Drafting of policy recommendations and discussion papers – based on thorough evaluation of initial successful cases and approaches - can enhance discussion and exchange, and scale up impact.

4 SUMMARY DISCUSSION AND CONCLUSIONS: THE CHALLENGES OF MARKET ACCESS IN MOUNTAINOUS SOUTHWEST CHINA

Non-timber forest products are an important source of household supply and cash income for the majority of smallholder mountain farmers in Southwest China. Sustainable management is possible – as the case of Matsutake mushroom shows – but it does not normally exist for the majority of non-timber forest resources, such as medicinal plants, truffle and pine-nut for example. The incentive for communities to develop a mechanism to regulate the access to natural resources does only exist when producers or collectors understand and can enjoy the economic and environmental benefits from such intervention. While resource privatization can lead to sustainable management of NTFPs - as observed with Matustake mushroom growing in Baoshan prefecture, Northwest Yunnan - it can also create or enlarge disparity in income levels within the community, as only a fraction of all households (in this concrete case: about one third) benefits from the valuable resource. Government regulation, such as taxation of the mushroom trade, could help improve the existing system so that every community member will benefit.

Domestication of NTFP is one way to reduce pressure on natural resources, it is, however, only applicable for plants that can be easily grown on-farm, such as some medicinal plants for example. Besides, if plants that demand a good price in the market can be easily domesticated, more people will grow them or even companies might start production on a much larger scale. This may cause fierce competition and is likely to change market prices.

Certification may be another option to balance income needs and biodiversity conservation goals. Certification systems relevant for NTFPs include organic agriculture, sustainable forest management (FSC) and Fairtrade. While FSC certification may be the most "natural" scheme for a forest product, it is also the most difficult certification to obtain, in terms of the evaluation process and cost. In addition FSC-certified NTFPs may initially not sell as well as products that bear a well-recognized organic certification label, since most consumers may have never heard about FSC-certified non-wood products.

Recent discussions regarding combining certification schemes (see also URL: http://www.isealalliance.org/ for more information) to reduce time and cost, have not been held in China yet since only organic certification is more widely known in the country. Combining certification schemes, i.e. organic, Fairtrade and sustainable forest management certifications, makes progressively more sense as all are moving towards holistic approaches, i.e. incorporating ecological, social and economic aspects in their respective standards. Therefore, the overlap between standards of all three major certification schemes is increasing. NTFPs have played a key role in this discussion since they can be certified under any of the three major certification schemes.

While certification has become more affordable for smallholder farmers in the developing world since group certification became available and IFOAM published a guidance manual for producer organizations applying for smallholder group certification in 2004, the challenges for smallholders in China's mountainous Southwestern provinces are still more profound. Right now, no functioning and successful organic smallholder project exists in China. The government-promoted "*Farmers plus Company Model*" has worked well and without major conflicts where it has been applied in the past. Traders and processing businesses have contributed their skills, financial resources/investments (e.g. in storage and processing facilities) and have made use of their established business connections (all of which rural communities usually do not have). This is also how the Fairtrade pilot projects were initiated (i.e. through the initiative of the export company) and is still functioning today, with a notable increase in empowerment of the producer association over time, however. In any such case, there is no fast way for communities to take over the role that the company has played and not many have the desire to do this - as it requires commitment, time and patience at the start – and, hence, are satisfied with the *status quo*.

Many NGOs, especially in the Southwest of China, are working with poor communities where no such company & farmer scheme exists to develop or advance local business models that integrate economic, social and ecological benefits. They build capacity among producers of agricultural or handicraft products or collectors of NTFP to work together and jointly market their produce to enlarge incomes. However, improved market access is the major goal, certification just one of several potential pathways. Trainings that have been initiated by the *BioFach-China* Project in cooperation with CMES and OFDC support building the knowledge base needed by community development facilitators, local leaders and certifiers to develop capacity among communities to set up and run a market-oriented association. It needs to start from the basics of organizational management, including understanding the requirements for quality assurance and internal control systems in smallholder groups. A producer and marketing group will need this fundamental knowledge, whether the group likes to pursue certification or just wants to improve its marketing power. Easily overlooked is the fact that volume matters, i.e. the market commonly demands a constant supply of consistently high quality which can be a challenge for a small producer group and needs to be thought of early during the planning phase.

Aiming for certification may not always be the best option, as the domestic market for certified NTFP may be very limited and the challenges to export beyond solution for many smallholders, and with Fairtrade still in its infant stage in China. Alternative pathways need to be explored with equal vigor. Developing a brand name for community products from sustainably-managed farm and forest land, linking with consumers and building trust are steps that need to be explored. Groups and facilitators need to learn from outside experience, such as the successful government-supported promotion of upland village products in Thailand for example.

The demand for certified products from well-managed forests and agroforestry landscapes is on the rise. That smallholder producers and collectors can benefit from this has been observed in various parts of the world. Poor communities in China' mountainous Southwest are surely going to participate in this trend. However, more needs to be done than just supporting capacity building and pursuing certification or alternative marketing schemes. NTFPs need to be duly recognized and monitored like any other commodity by the government, and use rights need to be improved. Research organizations have to support more research to understand the ecology, reproductive capacity over time and sustainable management of NTFPs. Moreover, consumer awareness need to be raised, and innovative partnerships sought with the business sector (e.g. looking at effective public private partnerships and corporate social responsibility).

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SILVICULTURE FOR WOOD AND NTFP PRODUCTION IN TROPICAL RAIN FORESTS: CONTRADICTION OR CHANCE? EXAMPLES FROM THE SOUTH PACIFIC ISLANDS

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ABSTRACT

In tropical rainforests the production of wood and – at the same time - NTFP is often seen as a contradiction: conventional logging creates severe changes to the structure and biodiversity of the forest, with the result that the growing conditions for most NTFP species are heavily disturbed. A sustainable production of the full set of naturally occurring NTFP seems to be impossible under conventional logging systems.

On a number of South Pacific Islands a sound silvicultural management system for indigenous tropical rainforests is applied, that maintains both the forest structure and its biodiversity to a large degree. This is demonstrated by the results of a simulation based on the pre-harvest inventory data from a 6000 ha management unit from the Fiji Islands. Furthermore it becomes obvious that a negative impact on NTFP tree species is, overall, very limited. Nevertheless, more specific investigations and research are still needed to further refine and improve the system, whereby in particular more detailed aspects of the ecology of different NTFP species need more attention.

1. INTRODUCTION

In tropical rainforests the production of wood and - at the same time - NTFP is often seen as a contradiction: conventional logging creates severe changes to the forest ecosystem. The **forest structure** is heavily disturbed through the removal of much of the upper canopy. In addition the remaining stand and the regeneration are damaged due to uncontrolled felling and improper skidding operations. Excessive road, skid track and landing construction leads to fragmentation and loss of forest area. Using heavy machinery results in soil compaction. Furthermore blocking of watercourses through insufficient or badly constructed water crossings and, on slopes, soil erosion is leading to negative impacts on the forest growth or even to the dying of stands.

Besides the forest structure the **biodiversity** (flora, but closely depending on this also fauna) of the forest is heavily affected: Directly through excessive removal of only few commercial species (mostly of the upper canopy species) with very low cutting limits so that the regeneration of these species is hardly possible. Furthermore the biodiversity is indirectly affected through changes in forest structure.

The abiotic and biotic ecological factors such as light, water, nutrients, wind, and competition differ before and after logging. In consequence logging leads to changed forests which results in changed growing or living conditions for flora and fauna including the NTFP species.

The following paper shall show that both sustainable wood production and NTFP production is possible in the same forest and at the same time. In this context, NTFP production is not necessarily understood as widening the scope for commercial forest use, but at least as preservation of the natural variety of NTFP needed for the subsistence of the local population. The management system used as example was developed for different South Pacific countries with main focus on the Fiji Islands.

2. MATERIAL AND METHODS

2.1 THE REGION

The countries involved are all situated in the south western Pacific Ocean. The most important applied research was carried out at Nakavu/SE Viti Levu, the largest and Drawa/central Vanua Levu, the second largest island of the Fiji Islands. But also experiences from Vanuatu, Samoa and Niue have contributed to the development of the management system.

The climate in the investigated areas is tropical with average annual temperatures of approx. 20 to 25°C and an annual precipitation of approx. 3000 to 4000 mm. A distinctive dry season is absent.

The Fiji Islands still have a forest cover of approx. 55 %. The tropical lowland rain forests are located mostly in the south eastern parts of the bigger islands. Approximately 300 tree species are found within the natural forest which has, in comparison to other tropical regions, a rather poor tree species diversity.

2.2 THE PROJECT

The natural forest management pilot project (NFMPP) was established as part of the (then) Fiji-German Forestry Project in 1989, which was supported by GTZ (DE VLETTER 1995). Later on it was extended as Pacific-German Regional Forestry Project to other countries of the region (supported by GTZ/SPC).

The goal of the natural forest management project was to enable local forest owners to manage their forest resources independently and in a sustainable way (community forestry approach). For that purpose research was carried out in a 300 ha research area at Nakavu and in a 6000 ha management unit, the so called Drawa Block. The main activities were:

Involvement of the local resource owners in all relevant steps of sustainable natural forest management.

Carrying out of reduced impact logging (RIL: pre-harvest inventory; pre-harvest planning of roads, skid trails and landings; directional felling; winching of logs; post-harvest assessment) according to international standards.

Development of a silvicultural system which makes use of sets of species-specific felling limits for three different logging intensities (Table 1) and carrying out selection and marking of trees for harvesting according to the defined limits.

In 2005 the project was selected by the FAO/APFC initiative *In search of excellence: exemplary forest management in Asia and the Pacific* (FAO/APFC 2005).

Table 1: Summarized Diameter Limit Table (acc. to MUSSONG 1992, SPC/GTZ 2003)

<table>
<tr><th colspan="2">Logging Intensity 1 „light“ (removal of 20% of standing volume >= 35 cm dbh)</th><th colspan="2">Logging Intensity 2 „medium” (removal of 30% of standing volume >= 35 cm dbh)</th><th colspan="2">Logging Intensity 3 „heavy“ (removal of 40% of standing volume >= 35 cm dbh)</th></tr>
<tr><th>DBH >=</th><th>No. of species</th><th>DBH >=</th><th>No. of species</th><th>DBH >=</th><th>No. of species</th></tr>
<tr><td>110</td><td>2</td><td>105</td><td>2</td><td rowspan="2">100</td><td rowspan="2">2</td></tr>
<tr><td>80</td><td>24</td><td rowspan="2">75</td><td rowspan="2">24</td></tr>
<tr><td>65</td><td>25</td><td>65</td><td>24</td></tr>
<tr><td>50</td><td>15</td><td>50</td><td>40</td><td>45</td><td>38</td></tr>
<tr><td>40</td><td>all others</td><td>40</td><td>all others</td><td>35</td><td>all others</td></tr>
</table>

NOT qualified for logging: - All **unknown** species/trees
- 53 species **unsuitable for timber** production
(i.e.: mature trees too small, ficus spec. with no real trunk)
- 11 species with important **non timber use** (**NTFP)**

2.3 THE ASPECT OF NTFP

For indigenous forest areas in Fiji 183 NTFP species where described from which 94 are tree species (SIWATIBAU 1992). Taking into account that approx. 300 tree species are growing in Fiji, every third tree species has to be classified as a multi purpose tree. In the management plan of the Drawa Block in total 24 species are listed as relevant NTFP species according to an ethno botanical study (KOROVULAVULA AND TUIWAWA 1999). From this 24 species there are two animal species (fresh water prawns, wild pigs) and another two palm species that will be not attractive for any logging operation. Nine other tree species are excluded from logging due to their classification in the diameter limit table as species with important non timber value. The remaining eleven species have a high wood value but are important NTFP species as well. As a compromise this species are allowed to be cut (if also the local forest owners agree) for wood production, but with relatively high cutting limits only (dbh 50 to 105 cm) so that they can fulfill their NTFP function as well.

2.4 THE SIMULATION

To test how strong a logging operation would affect the NTFP tree species population, several simulations were carried out. In the first simulation it is tested how precise the tree selection according to the diameter limit tables will work. In a second simulation it is investigated how the forest structure changes after logging. The third simulation focuses on the change of the NTFP tree species diversity.

In the first simulation all three logging intensities (light, medium, heavy logging; cf. Table 1) were tested for the Drawa Bock pre-harvest inventory data. In all further simulations the medium logging intensity (removal of approx 30 % of standing volume of all trees 35 cm and above) was chosen only. A systematic strip sampling method with plot sizes of 20 x 10 m characterizes the used inventory design. The total number of established plots is 18067.

For the second simulation, sequences of five connected plots were chosen by a systematic sampling (every 500th plot sequence) after a random start. The required information was species name of the inventoried trees, their dhb and the usable log length (about total tree height and crown diameter there were not sufficient or no data available in the inventory files). All chosen plot sequences were plotted next to each other to simulate the forest structure before logging. Subsequently, all trees which were selected according to the diameter limit table were highlighted for removal. In this way the possible change of forest structure could be made visible and underlined with the descriptiva of structure relevant stand characteristics (like number of trees, basal area and volume per hectare, average dbh and stem height, number of plots without trees >= 35 cm dbh, area of closed canopy with at least 1 tree >= 35 cm dbh/plot).

In the third simulation the impact on the tree species diversity was investigated: how many NTFP tree and tree species will disappear after a logging operation. All simulations are focusing on trees of 35 cm dbh and above. Smaller trees and regeneration is not subject of this investigation.

3. RESULTS

3.1 PRECISENESS OF THE DIAMETER LIMIT TABLES

In the first simulation the diameter limit tables are tested for tree selection in a simulated 4 ha stand. The results show very clearly that the diameter limits work quite precisely, not only on a large scale like tested before on different inventory data sets (NFMPP area (300 ha), Drawa Block (6000 ha), National Forest Inventory (250000 ha) but also on a very small scale like the simulated 4 ha stand. The target removal of 20 % standing volume for a light logging, 30 % of a medium logging and 40 % of a heavy logging are not fully reached (Figure 1) but the deviation from the targets is acceptable, taking into consideration the very small area.

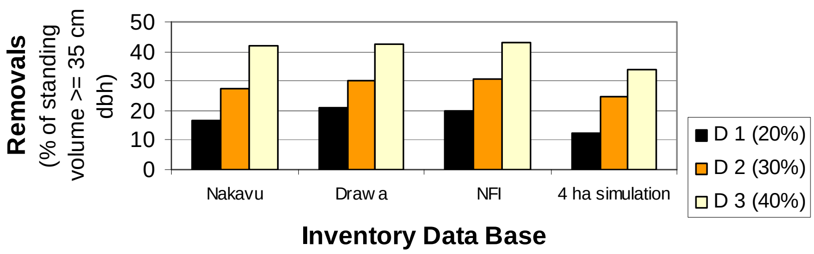

Figure 1. Simulated removals according to the Drawa diameter limit table (DE VLETTER AND MUSSONG 2001, changed)

3.2 CHANGE OF FOREST STRUCTURE

The results of the simulations show the typical unsystematic tree distribution pattern for undisturbed tropical rain forests (Figure 2). Densely stocked as well as more open parts occur, small trees grow next to big trees, sometimes also a single big or small trees without any close neighboring tree are found. In some cases plots are “empty” which means that they have no trees >= 35 cm dbh (probably smaller trees and regeneration are found in such plots).

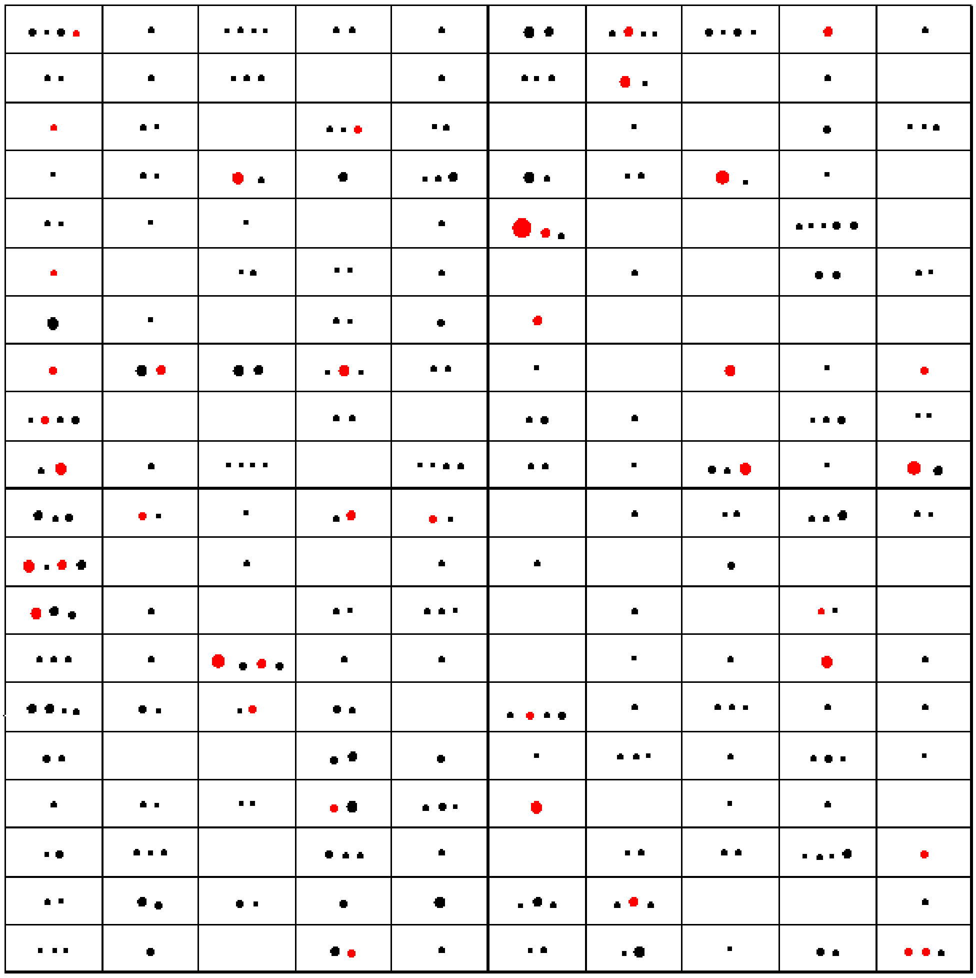

Figure 2: Simulated 4 ha stand (each indicated plot measures 20 x 10 m); each dot represents an inventoried tree; red dots are trees to be removed during logging operation; dot size proportional to dbh (35 to 130 cm)

In the second simulation step an unbiased tree selection is carried out strictly according to the diameter limit table. It becomes visible that the trees to be removed have an unsystematic distribution as well (Figure 2). In some cases a tree within a group of several trees is removed, in other cases the only tree >= 35 cm dbh in a plot will be cut. Sometimes very dense structures remain untouched whereas in other cases several trees are removed. In addition, not only the trees with large diameters are selected, but medium and small sized trees as well.

The descriptiva of forest structure related stand parameters before and after simulated logging show that both, the volume and the basal area of all trees >= 35 cm dbh is reduced after logging by approx. 27 %, whereas the number of trees after logging is only 14 % less (Table 2). The average dbh after logging is reduced with approx. 7 % only. The average stem height is almost not affected through logging. After logging, the average usable log length is reduced only by 5 cm or 0.5 %. On the other hand, the number of gaps (plots with no tree >= 35 cm dbh) is significantly increasing (by 22 %) whereas the “closed” canopy (plots with at least one tree >= 35 cm dbh) is decreasing by 6 % only.

Table 2. Descriptiva of forest structure related stand parameters before and after simulated logging (logging intensity "medium” with target removal of 30% of the standing volume of all trees >= 35 cm dbh); all figures for trees >= 35 cm dbh

	before logging	after logging	%
number of trees (n/ha)	73.50	63.25	86.1
basal area (m^2/ha)	14.10	10.40	73.8
volume (m^3/ha)	95.00	69.28	72.9
arithmetic (squared) dbh (cm)	47.7(49.4)	44.8(45.8)	93.9(92.6)
average stem height (m)	9.38	9.33	99.5
number of „gaps“/ha (>= 10x20 m without trees >= 35 cm dbh)	11.25	13.75	122.2
area of „closed“ canopy (m^2/ha covered with trees >=35 cm dbh)	7750	7250	93.5

3.3CHANGE OF BIODIVERSITY AND DIVERSITY OF NTFP TREE SPECIES

The change of biodiversity is estimated according to the change of tree species richness after logging. Remarkable is the fact that in the Drawa Block only approx. 11 % of the tree species have relevant NTFP value according to the ethno botanical survey (Table 3). This share also applies to the number of NTFP trees per ha.

Table 3: Number of tree species and number of trees per ha and share of NTFP within the Drawa Block; all figures for trees >= 35 cm dbh

	total	NTFP	%
tree species (n)	168+4?	18	10.6
inventoried trees (n/ha)	64.0	7.4	11.6

In order to estimate the loss of NTFP tree species diversity due to logging activities a simulation was carried out for the entire Drawa Block. The results show that the number of NTFP trees per ha is reduced by approx. 13 % (0.9 trees/ha), whereas the number of NTFP tree species is decreasing after logging by approx. 6 % (one NTFP tree species) (Table 4). But it has to be taken into consideration that the simulation used trees of 35 cm dbh and above so that it is very likely that this species is still occurring in the stand although with smaller diameters.

A last simulation intends to show the number and distribution of NTFP tree species in the stand and which NTFP trees will be logged according to the diameter limit table. For this purpose in the simulated 4 ha stand (cf. Figure 2) all NTFP trees are indicated (Figure 3).

Table 4. Simulated change of NTFP species richness and reduction of NTFP trees per ha after logging in the Drawa Block; all figures for trees >= 35 cm dbh

	before logging	**after logging**	**%**
NTFP tree species (n)	18	17	94.4
NTFP trees (n/ha)	7.4	6.5	87.1

It becomes visible that only 2 out of 16 existing NTFP trees will be logged. All other NTFP trees remain untouched. Both removed trees have high to very high timber value. The NTFP values (resin, latex) have less importance for the local population.

4 DISCUSSION

The chosen method of different relatively simple simulations on a huge data base (18067 plots; 23144 trees) seems to work well for an applied research approach. To reach statically reliable results in further investigations, the number of replication should be increased.

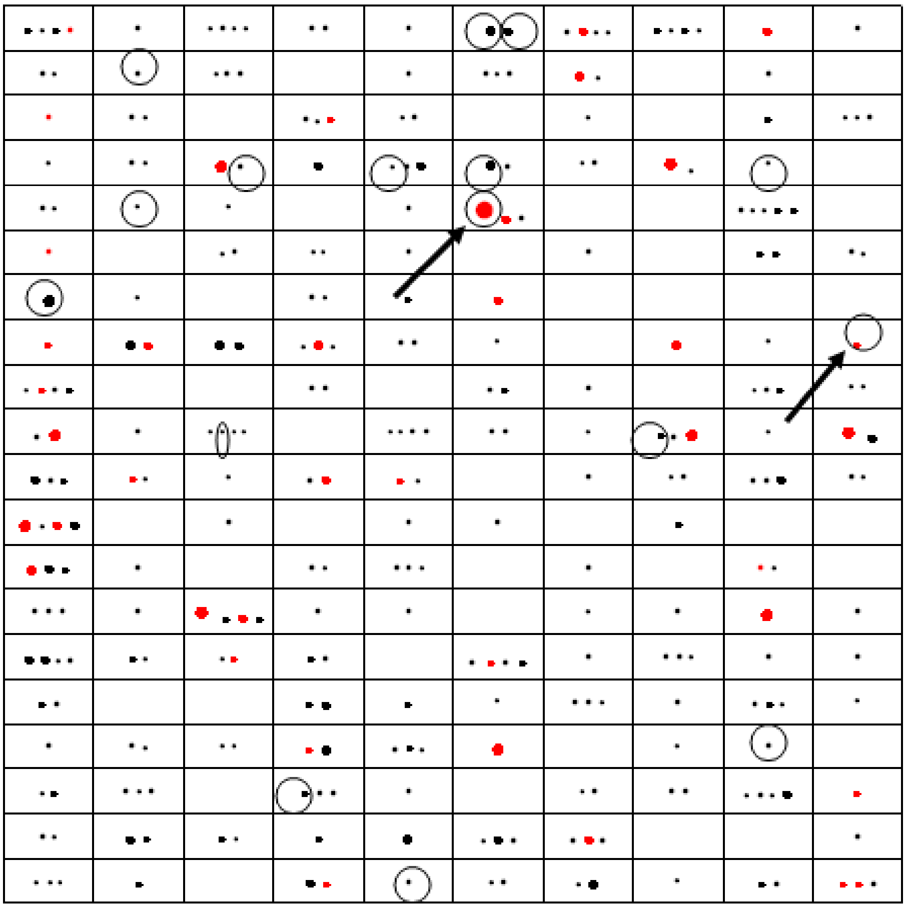

Figure 3: Simulated 4 ha stand (each indicated plot 20 x 10 m); each dot represents an inventoried tree; red dots are trees to be removed during logging operation; rings indicate NTFP trees; dot size proportional to dbh (35 to 130 cm)

The diameter limit tables were already developed and tested before, using different inventor data sets (DE VLETTER AND MUSSONG 2001). The simulation of the tree selection on a small stand (4 ha) shows that the system could work not only on a large scale but also on small scale with acceptable results. The deviation from the target removals for all logging intensities is within a tolerable range, whereas it is obvious that the smaller the area is, the bigger the expected deviations are and vice versa.

The simulation of the changes of the vertical forest structure after logging shows that, in spite of a removal of almost 30 % of the basal area and standing volume of all trees 35 cm dbh and above, the average diameter and the average stem (tree) height of the remaining stand are barely affected. Also the opening of the upper canopy is increasing by 6.5 % only. Looking at the changes in the horizontal structure, it is shown that the removal of the trees lead neither to an equal distribution nor to a concentration of removals in certain parts of the simulated stand. Combined with the fact that not only big, but also medium sized and small trees are removed, close-to-nature patterns arise which resemble unsystematic natural mortality patterns (Schroeder 1992, ULBIG 2005)

It can be concluded that if the forest structure is conserved, the growing/living conditions for other species, the biodiversity, will be conserved as well. In addition, the integration of almost all upper canopy tree species in the tree selection system (but with relatively high species-specific cutting limits) reduces the risk to loose certain tree species due to logging activities considerably.

The same holds true for NTFP species. If the changes in the forest structure through the described selective logging system are comparable to close-to-nature processes, their growing/living potential is not basically endangered. Even the possibility given by the diameter limit tables to cut a few NTFP tree species (with relatively high cutting limits) with a high timber value for wood production, apparently does not causea risk for the NTFP potential. In the simulation only 2 NTFP tree out of 40 trees (5 %) were cut. The other 14 NTFP trees remain untouched. The "loss" of one NTFP tree species in the simulation does not necessarily mean that this species does not occur any more. The simulation works only with the inventories minimum diameter of 35 cm dbh and above. If a species is not found any more in the upper canopy after logging, it is very likely that it still occurs with a dbh < 35 cm.

This investigation can not completely exclude, that logging may have a negative impact on a small number of NTFP species with very specific growing/living requirements. Information about the ecological requirements of such species is still lacking. Page: 9

The tested silvicultural management will conserve the environment required by most NTFP species, so that the sustainable production of wood and NTFP in combination seems to be possible.

5 CONCLUSIONS

- Sustainable production of wood and NTFP in the same stand and at the same time is not necessarily a contradiction but a chance for people and environment
- With a sound silvicultural system it is possible to manage tropical rainforests in such a way that the sustainable production of both wood and NTFP is feasible
- Condition is that the structure as well the biodiversity of the forest is maintained through „close-to-nature“ interventions
- The developed „diameter limit table“ is a suitable tool for such an approach

- The system can not necessarily serve to increase the NTFP production but will secure the present production
- For the further development of the system and especially the promotion of specific NFTP species, more investigations are needed.

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