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Application of traditional knowledge in forest management: Ethnobotanical indicators of sustainable forest use

Shengji Pei [a,*], Guoxue Zhang [a,b], Huyin Huai [c]

[a] Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650204, China
[b] Graduate School, Chinese Academy of Sciences, Beijing 100039, China
[c] College of Bioscience and Biotechnology, Yangzhou University, Yangzhou 225009, China

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ABSTRACT

Forest management has been usefully defined in terms of production, utilization and distribution of products, and the institutional or organizational arrangements by which they are carried out. Both technical and social aspects of forest management are treated as parts of a single system. Traditional knowledge of the use and management of forests still has a vital role to play in forest management today. This is because traditional practices are believed to be often favourable towards conservation and sustainable use. It is therefore valuable to establish a framework to evaluate the contribution of traditional knowledge to forest management today. Accordingly, a framework, based on ethnobotanical information, is proposed in this paper, with quantitative and qualitative indicators suggested for different variables relating to traditional knowledge. The discussion is based on ethnobotanical case studies from Yunnan and other provinces of China in which we have been working.

1. Introduction

Forests not only provide local people with food, medicine and livelihoods, but also contribute to the maintenance of indigenous culture (Kareiva, 1994; Baird and Dearden, 2003). All over the world, societies with long-established relationships with forests have accumulated much knowledge about how to use them on a sustainable basis. The economic value of forests to local people can be very high—for example, the value of non-timber forest products collected from tropical rainforest near Iquitos, Peru is greater than that of the timber (Peters et al., 1989). Traditional knowledge of forest conservation and sustainable use is attracting increasing attention from policy-makers and scientists (Salick et al., 1995; Gould et al., 1998; Ros-Tonen, 2000; Dhillion and Gustad, 2004). Indigenous people and their knowledge about nature have assumed major importance in modern conservation practice including in relation to protected areas (Gunatilleke et al., 1993; Anderson and Putz, 2002; Rist et al., 2008). Simply stated, forests are often distributed around and maintained by indigenous communities, who know how to maintain them in a healthy condition.

Forest management has been usefully defined in terms of production, utilization and distribution of products, and the institutional and organizational arrangements through which these processes are carried out; both technical and social aspects of forest management are treated as part of a single system (Fisher, 1989). On the technical side, forest management covers harvesting, distribution, protection and regeneration (Tamang, 1990). On the social side, the traditional knowledge of local people forms a fundamental element of most forest management systems in developing countries. This traditional knowledge is, therefore, of great relevance not only to the cultural future of local societies, but also to scientists and planners striving to improve local livelihoods.

This paper describes an analytical framework and some suggested indicators for evaluating the status of forest utilization and conservation. It is based on ethnobotanical field studies carried out over recent years in China and some other Asian countries. Our objective here is not to provide definitive conclusion, but rather to stimulate discussion which will eventually result in an improved framework and reliable quantitative indicators.

2. Scientific understanding of traditional knowledge

The World Conference on Sciences (WCS) organized by UNESCO in cooperation with ICSU was convened in Budapest, Hungary in 1999 to discuss the role of science and sustainable development. At this meeting 'traditional knowledge' was defined as: 'a cumulative body of knowledge, know-how, practices and representations maintained and developed by people with extended histories of

* Corresponding author. Tel.: +86 871 5223221; fax: +86 871 5223236.
E-mail address: peishengji@mail.kib.ac.cn (S. Pei).

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interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource practices, rituals, spirituality and world-views' (ICSU, 2002). The Convention on Biological Diversity defines traditional knowledge as the: 'knowledge, innovations and practices of indigenous and local communities deriving from customary uses of biological resources and associated cultural practices and traditions; traditional knowledge is a body of knowledge and beliefs transmitted through oral traditions and first hand, observations about the local environment, and as a system of self management that governs resource use, and plays important role in sustainable development of the world today'.

Today, sustainable management of forests is a critical global issue, as global forest resources continue to decline, and global climate change accelerates. Rural poverty remains a big issue in many developing countries. At the same time, traditional knowledge about forest management is disappearing rapidly in many parts of the world. Understanding, recognizing, respecting and protecting traditional knowledge is urgently needed to save the world's forests, the environmental services that these forests provide and the people of this planet.

3. Ethnobotanical indicators of sustainable forest use

Ethnobotany is the scientific field concerned with studying human interactions with plants and their habitats, often with an emphasis on traditional use and with the management of plants viewed from an historical perspective. Forest ethnobotany, which has been a central theme in the field of ethnobotany, involves the investigation, documentation and quantitative assessment of traditional knowledge and practices relating to forest use and management. Based on many years' ethnobotanical studies in forested areas of Yunnan Province (China) and in some southeast Asian and other Himalayan countries (Pei, 2002, 1996a,b, 1995; Pei et al., 1993), we can affirm that sustainable use of forests and plant resources can be measured and monitored by ethnobotanical methods and approaches. We contend that it is possible to establish monitoring systems concerned with the sustainable use and management of forests within local communities based on traditional knowledge.

3.1. Evaluation framework for assessing sustainable use of forests based on ethnobotanical information

Based on many years research on forest resource management in different parts of China with various ethnic groups, we have found that all well-maintained forests are located in places which receive fewer impacts from outside—that is to say, the better the traditional lifestyle is maintained, the better the forest is protected (Pei, 1996a,b; Liu et al., 2000a; Xu, 2003; Pei and Huai, 2007). We contend that indicators of the likely sustainability of forest use can be developed based on ethnobotanical data and that these indicators will be useful for predicting the future and for management purposes. The indicators are related to the evaluation framework shown in Fig. 1.

The framework has five variables, each with a bearing on sustainable use. Trends in these variables over time will indicate the status of forest management. Although each of these variables is itself under complex, influences, it is postulated that it should be possible to develop this framework and establish indicators that will be practically useful for predicting the future state of a forest.

Variable 1: Traditional forest-related knowledge. If forest management is under a traditional knowledge system then (it is suggested) this will be helpful for sustainable use and management of the forest. If traditional knowledge on forest use shows a declining trend, and then this will produce a negative impact on the forest system.

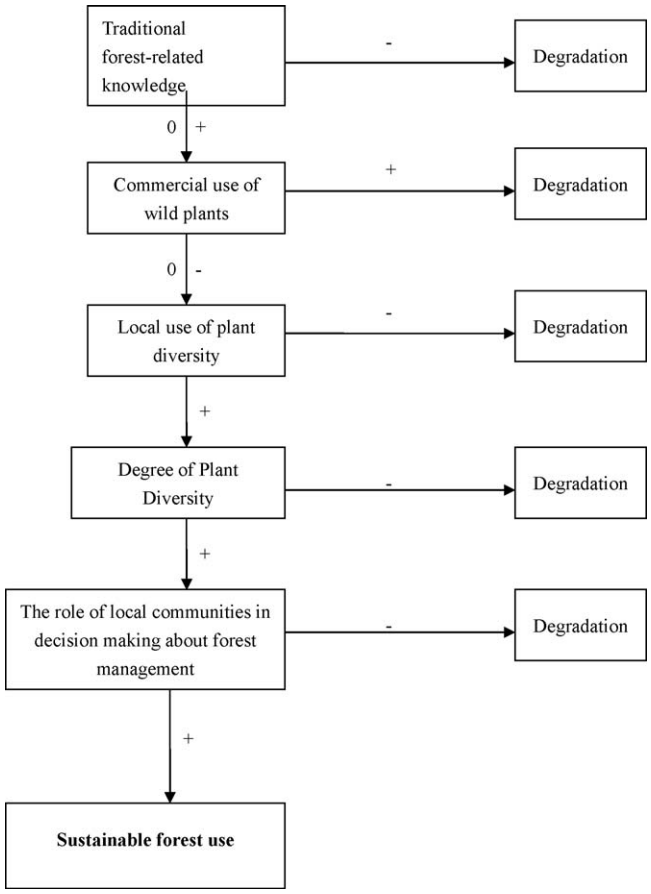

Fig. 1. Evaluation framework for sustainable use of forests based on ethnobotanical information. *Note:* + stands for the indicators increasing during a certain period, 0 stands for stable, and – stands for decreasing.

Variable 2: Commercial use of wild plants. Much research has shown that, when a forest plant has a high commercial value, then uncontrolled over-harvesting appears. So, if commercial use of wild plants in a forest is increasing, then the forest resource will be threatened and the forest degraded.

Variable 3: Local use of plant diversity. When local people use a diversity of plants from diverse habitats, then the pressure on any particular type of wild plant in any particular habitat will be reduced. This will help to maintain forest systems generally in a good condition, being good for species diversity as a whole. Although some species may suffer, overall this situation will produce more positive than negative impacts on the sustainability of forests.

Variable 4: Degree of plant diversity. A high level of plant diversity in a forest area provides more opportunities and options to local people for food, fodder, fuel, construction material, herbal medicine and non-timber forest products, which can not only reduce harvesting pressures on a more restricted number of species but also can help protection of forest being recognized as a useful ecosystem overall in local perceptions.

Variable 5: The role of local communities in decision-making about forest management. If local communities have a greater participation in decision-making regarding forest management, then this will benefit sustainable forest management, given that these are the people with the greatest interest in its long-term future.

3.2. Ethnobotanical indicators relating to the variables in the framework

A number of ethnobotanical indicators of the sustainability of forest and management can be suggested with reference to the proposed evaluation framework:

(1) *Level of traditional knowledge of the forest*: Can be assessed from people's knowledge of the classification, identification, naming and ecology of plants. Quantitative assessments are possible and can be applied to the whole community or to sub-groups, for instance based on age and gender. The following formula designed by Phillips and Gentry (1993a,b) can be used to calculate an index of ethnobotanical knowledge:

$$Mg_j = \frac{1}{n}\sum V_i \quad (1)$$

where Mg_j is the mean degree of traditional knowledge held by members of group j, n is the numbers of members in the group j, and V_i is the amount of traditional knowledge held by member i from group j.

There are other indicators of the state of traditional knowledge. One is the existence and strength of social mechanisms that enable traditional knowledge to be passed on from generation to generation. This social mechanism may concern various specialized aspects of traditional knowledge (e.g. traditional medical knowledge). Both oral and demonstration means can be used to transfer knowledge. The existence of cultural symbols and the vitality of traditional herbal medicine systems give further clues, as too does the state of agroforestry and tree-planting practices, in particular the extent of use of local tree species. Various beliefs are practices associated with traditional cultures help to preserve plant diversity. They include plant worship, taboos, sacred forests, totems, and ethical and moral restrictions. Again, Phillips and Gentry's formula can be to make a quantitative assessment.

(2) *The Purpose of Plant Use*: Plants may be used for many purposes by communities; these include commercial use and local use for food, fodder, shelter, timber, fuel, energy, medicine, income generation and cultural uses. The diversity of plant use can be measured by the Shannon–Wiener diversity index (Vandebroek et al., 2004):

$$H' = -\sum p_i \log(p_i) \quad (2)$$

where H' is the diversity index, and p_i is the ratio of the number of the species used for use type, compared with the total number of species used for all purposes. The bigger the value of H', the higher the diversity of plants used. The following index of evenness can also be used to assess the overall diversity of plant use, considering all types of use:

$$J' = \frac{H'}{\log(s)} \quad (3)$$

where J' is an index of evenness, H is the diversity index determined for a particular category of plant use and s is the total number of types of use. High J' shows that some types of use are dominant within the community.

Commercial use of wild species will lead to changes in forest structure and functioning, especially if such collection is continuous and well beyond the forest's regeneration capacity. The above formulae can be used to determine this index. Alternatively, we also can use the formula proposed by Huai and Pei (2004a,b):

$$RUI_s = \frac{SNmp}{SNp} \times 100\% \quad (4)$$

where RUI_s is an index of commercial collection for a given forest type, $SNmp$ is the number of commercial species collected, and SNp is the total number of species in the habitat.

(3) *The Degree of Plant-diversity Use:* The diversity of plant used in different components or aspects of agroecosystems can be determined; e.g. in home gardens, in crop fields, wild cultivated, in agroforests, used for intercropping, etc. The number of species (species richness) and Shannon–Wiener diversity index can be used to evaluate total plant diversity.

Phillips and Gentry's formula of diversity (see above) can be used to provide a quantitative measure of the extent of traditional forest practices. There are several variables including the number of plants harvested from the forest, the number of plant parts collected, the numbers of locations and seasons in which collection occurs, and the extent of village regulations on wild harvesting.

(4) The degree of community participation in decision-making on forest management is indicated by the amount of traditional knowledge (the basis for local decision-making), the existence and types of community organization involved, and the social norms and regulations that govern forest use and management. It should be possible to develop quantitative indicators based on interviews with local communities. It would be useful to take into account the roles of various community institutions in decision-making on forest management and land use, as well as the structure of governance related to the forest, land tenure arrangements and the impact of developmental interventions on the community and the forest.

The above ethnobotanical indicators of sustainable forest use are proposed here for development. In fact, a particular indicator often relates to more than one variable. For example, the degree of plant-diversity use can be quantified by using Phillips and Gentry's formula of diversity, this indictors are affected by many factors, such as gender, age, and cultural background of plant users. So on-site testing should be used to determine which indicators or combination of indicators are most appropriate in particular local settings.

4. Evaluation of ethnobotanical indicators in Yunnan

Cultural and biological diversity are intimately and inextricably linked (McNeely, 2003). Traditional knowledge systems are important for modern societies, not only because traditional knowledge itself is a valuable aspect of cultural heritage and should be protected in its own right, but also because it is of great value in modern development, especially regarding sustainable use of forests, ecosystem management and poverty reduction.

Yunnan (area 380,000 km^2) is well-known in China for its rich biodiversity. Highly variable, geographically, Yunnan extends over a vast altitudinal range (76–6674 m) and contains many types of forests including tropical rain forest, mountain evergreen forest, alpine dark coniferous forest and savanna-type forest-grassland. 17,000 species of plants are recorded from Yunnan, of which half are found in forest vegetation. This rich landscape and genetic heritage of Yunnan are the result of both natural biological evolution and human manipulation of ecosystems. Over time, the indigenous people of Yunnan have modified and changed the environment, adding further complexity to the landscape.

The indigenous people of Yunnan are culturally highly diverse, ranging from Himalayan to Southeast Asian-type societies. Among the 48 million inhabitants of Yunnan, one-third belonging to ethnic minorities with 25 cultural groups. They are distributed in a

mosaic pattern in this mountainous province. Many of the ethnic groups are forest people, practicing hunting, gathering and cultivation in the forest. All the ethnic groups have a high dependency on forest resources for their livelihoods, including for supplies of fuel, fodder, timber, medicine and supplementary foods. They practice harvesting of non-timber forest products (NTFP), agroforestry and shifting agriculture while engaging in the worship of sacred forests to meet their spiritual needs. Traditional knowledge of forest management is an essential part of their culture.

From a scientific point of view, the overlapping patterns of distribution of forest, plant diversity and cultural diversity in Yunnan provide an excellent geographical area in which to study people-forest interactions including the role of traditional knowledge in the utilization and maintenance of biodiversity. However, in the last half century, rapid economic development and globalization have brought about critical challenges to the environment, biodiversity and cultural traditions of this area. Natural forest is declining, biodiversity is threatened, land use for various purposes related to the monetary economy is expanding, forest land is converted for economic uses, exotic and invasive species are increasing, and traditional knowledge of forest management is being lost among all ethnic groups. Hence sustainable use and management of forest resources in not only important for biological conservation, the combating of global warming and the maintenance of traditional cultures, but is also critical for tackling rural poverty, in particular among ethnic minority communities and other marginal societies.

In the following paragraphs, we discuss the application of the proposed evaluation framework with its monitoring indicators in Yunnan:

Variable 1 concerns the level of traditional forest-related knowledge. The Lahu is a forest ethnic group which has long inhabited the tropical mountain forest area of Yunnan, engaging in hunting and gathering. The forest has traditionally provided indispensable resources for their lives. Over the last 25 years, the Lahu have become a settled agricultural community and the forests in their neighborhoods have been reduced. Studies have shown that both their traditional forest knowledge (in general) and their traditional medical knowledge are disappearing (Huai and Pei, 2004a,b). Elsewhere, we have used formula (4) to measure changes over time in the level of knowledge of traditional Lahu doctors (Huai and Pei, 2004a). In contract to the Lahu, the Hani people living in the tropical mountains of Xishuangbanna have managed to protect their rattan resources in natural forests through continuing to employ sustainable methods of harvesting. This is related to the retention of their IK, including "Sang-Pa-Ba-Wa" beliefs (Meng and Chen, 1998). Liu et al. (2000b) adopted formula (1) to analyze the status of forest-related traditional knowledge among the Yi people in the Zixishan area of central Yunnan. Here, a high level of retention of this knowledge was found, which is believed to have contributed to forest protection in this area. Overall, these examples confirm our contention that loss of traditional knowledge can be a valuable indicator of unsustainable use of forest resources and a signal that forest degradation will begin (or has already started). On the other hand, if traditional knowledge is well maintained within a community, their forest management and use will often be sustainable.

For *variable 2* and taking the example of medicinal plants, it has been shown that commercial harvesting has sometimes rapidly led to their decline and even extinction, e.g. in the cases of *Dendrobium* spp., *Cordyceps sinensis*, and *Taxus yunnanensis* in Yunnan (Walsh and Goodman, 1999; Hamilton and Hamilton, 2006; Ru et al., 2006). On the other hand, there are cases in Yunnan where medicinal plants of high commercial value elsewhere (but not commercially harvested at these particular sites) have continued to be used by local communities with the plant resources being maintained in a good condition. In fact, most medicinal plants remain available if there is no commercial harvesting. For instance, among the commonly used medicinal plants of the Lahu community, up to 84% of medicinal plants have remained sustainably available over recent years (Huai and Pei, 2003).

For *variable 3* and taking the example of traditional agricultural systems, then the evidence suggests that the higher the diversity of cultivated crop diversity, the less the pressure on wild plant resources in the local environment. This is significant for the protection of wild plants and the sustainable use of plant resources (e.g. Long and Zhou, 2001). In the case of *Eucommia ulmoides* in the southwestern provinces of China (such as Guizhou, Sichuan, and Yunnan) and of *Gastrodia elata* and *Poria cocos* in Yunnan and Guizhou, the extensive cultivation of these plants has ensured that supplies of these species are today solely sourced from cultivated rather than wild sources (Guo and Huai, 1997; Xiao and Xiao, 2006).

For *variable 4*, the argument is that any management systems that ignore local communities cannot be sustained. In the last half century, biodiversity conservation has been shifting from reliance on protected areas under the sole authority of government as the principal conservation tool to increasing consideration being given to the involvement of local communities in co-management arrangements (Wu, 2003). Community co-management is reported to have achieved its objectives to some extent (Zhang et al., 2000; Li and Zhu, 2006). We contend that the greater the role played by the local community in decision-making, the better the resources in the forest will be managed. Since 2007, two medicinal plant conservation areas (MPCAs) have been established within community forests belonging to Naxi people in northwest Yunnan. These MPCAs are rather large in area (300 ha and 330 ha) and situated in places where there is particular abundance of medicinal plants; they are managed by a community management committee. An agreement has been reached between this committee and the community as a whole to ensure that the whole community is involved. This model has been developed with the belief that strong community decision-making and management of forest resources is the most likely avenue leading to conservation and sustainable use of medicinal plants.

Traditional knowledge systems and the modern Scientific Knowledge System (SKS) are not mutually exclusive. Rather, they should be viewed as complementary. Through interaction and co-operation, they can together be powerful forces in modern initiatives in development and conservation. Respecting, maintaining and protecting intellectual property rights (IPR) associated with traditional knowledge are not only necessary, but urgently needed. IK should be documented and evaluated before it is lost, tasks in which ethnobotany is in a strong position to make significant contributions. Therefore, establishment of a legal system to protect intellectual property rights of traditional knowledge should be considered by government. Such legal protection can promote the role of traditional knowledge in forest sustainable use and management.

Another relevant issue in this regard is networking between the various stakeholders with an interest in forest resources and forest management. The fact is that many types of organization and many types of interest are relevant to the sustainable management of forest resources, which must always, of course, be implemented at the local level. Long-term collaborative partnership and equitability-based can be very supportive of local efforts.

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