Synopsis

Combating the Fragile Karst Environment in Guizhou, China

Karst landscapes—regions characterized by sinkholes, caves, springs, underground rivers, and slowly dissolving bedrock—constitute about 25% of the world's land surface (1). Although some karst landscapes are attractive and of aesthetic value, most of them are recognized as fragile zones unsuitable as human habitats—mainly due to extremely poor soil cover, or a complete lack of soil, and rapid water loss.

China is one of the countries featuring extensive karst areas, with about 23% of its land area, nearly 2 000 000 km^2, covered by open and covered karst rocks (2). These areas of China are mainly concentrated in the southwest, in the provinces of Guizhou, Yunnan, and Guangxi (Fig.1). About 73.6% of the total area of the province of Guizhou is made up of karst landscapes. For this reason, Guizhou has been named the "Karst province" of China (3).

Due to the extremely fragile environment and the existence of a large number of underground caves, it is much more difficult and expensive to build roads and highways in karst areas than in other areas. This has confined Guizhou province in an almost closed state for a long time in history. Development of the province has therefore been seriously limited. On the other hand, there is a large human population in the karst areas of the province, with a population density as high as 185 persons per km^{-2}. In contrast, karst areas in other regions of the world are seldom populated (4). There is thus great population pressure on the karst environment in Guizhou. As a result, Guizhou province has long been one of the poorest provinces in China. In many counties of the province, the per capita income has been below 1000 Chinese yuan (8 Chinese yuan ≈ USD 1.00) (5). As a result, the Chinese have a saying about Guizhou; "There is no one piece of flat land that is wider than 3 inches, and there is no one people whose money is more than 3 fen (1 Chinese yuan = 100 fen)."

In addition there has been an occurrence of detrimental human activities, e.g. over-logging and steep-slope farming, in the province. This is mainly due to overpopulation and extreme poverty. As a consequence there has been a decrease in vegetation cover, forest and shrub in the karst areas; surface soil has deteriorated due to intensified soil erosion; and larger and larger surface areas have become nearly naked. The stones seem to "have grown," as the local people say. This process of degradation of karst ecosystems is called "rock-desertification" (Shi Mo Hua) in Southwest China (3). Owing to the enormous difficulty in managing and controlling this phenomenon, rock desertification in karst areas is also called the "cancer of the earth"(3).

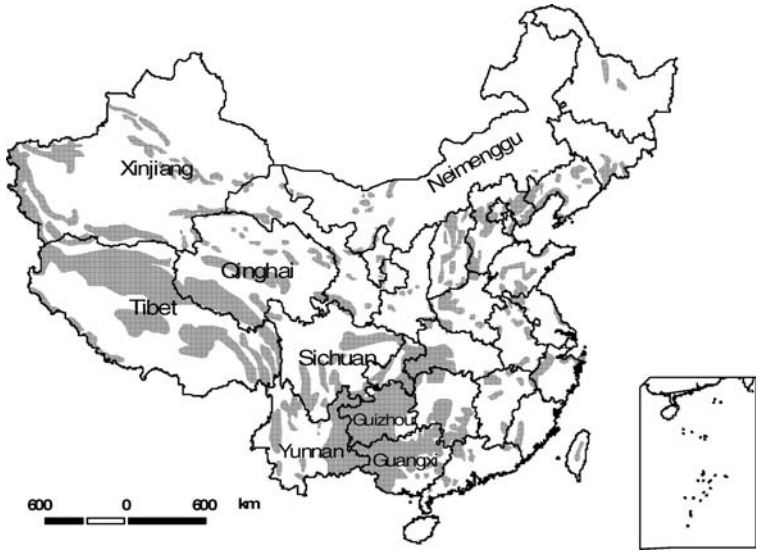

Figure 1. A sketch map of karst distribution in China.

In recent years, ecologists and geographers, together with the local people, supported mainly by various levels of government, have undertaken work to combat further degradation of the fragile karst environment; e.g. selecting adequate tree species, forest plantations, and developing models in order to control rock desertification as well as promoting development of the local economy. Some progress has been made and is described in what follows.

SELECTION OF TREES AND FORESTS

Due to the high proportion of bare rocks, scattered and thin soil cover, and frequent technical drought, vegetation restoration is extremely difficult in karst areas (6–10). Selecting suitable tree species is a major key to environmental reconstruction. The principal being that the species selected can grow and thrive in karst areas and that they can provide income for local people. Native tree species should be given priority. Experiments show that honeysuckle (*Lonicera japonica*), Chinese prickly ash (*Zanthoxylum chaffuniani*), Amomum fruit (*Amomum villosum*), walnut (*Juglans regia*), Chinese chestnut (*Castanea mollissima*), etc., are relatively ideal and provide environment protection together with the possibility for local economic development (5).

Honeysuckle (Fig. 2) has been shown to grow well in barren karst areas. This species has multiple functions, and it generally has well-developed roots and can effectively conserve water. According to experiments in Dewo town in Southwest Guizhou Prefecture, one honeysuckle plant can conserve about 200 kg of water. One mu (15 mu = 1 ha) of honeysuckle, ca 70 plants per mu, can thus hold 14 tonnes of water (11); it also has flourishing branches and leaves and can effectively protect karst slopes against erosion. In addition, its cultivation needs only simple techniques and management; it is a low cost species and proliferates readily. It also has high value as one of the most important ingredients in Chinese medicines and some hygiene products. More

Figure 2. Honeysuckle

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Figure 3. Chinese prickly ash

than one third of the Chinese medicine dosages approved by the state contain honeysuckle, and many Chinese medicines are even made mainly from honeysuckle. Thus, the species has a very important role in the development of Chinese medicines. As a result, its economic benefits are obvious. Dewo town planted 1200 mu of honeysuckle and produced 30 tonnes of dried honeysuckle in 1998, generating an income of 400 000 Chinese yuan (11). The 1200 mu of degraded karst landscape in the area was covered with green vegetation. During the eventful period of April-August 2003, in which SARS prevailed in China, honeysuckle was treated as the main ingredient in a Chinese medicine considered to be effective against SARS, and its price soared from 16–20 to about 200 Chinese yuan kg^{-1}. In addition, dried honeysuckle can serve as a tea to strengthen human health.

Chinese prickly ash (Fig. 3) can grow well in small holes, gullies, troughs and even cracks in the karst landscape. Usually, one plant of Chinese prickly ash can be grown in a small hole with soil. The fruit of the Chinese prickly ash is a very important condiment in many Chinese foods, and is widely used nationwide and even in other Asian countries. Subsequently, the species has a promising market. In 2000, 13 700 mu of Chinese prickly ash was grown in the Dintan District of Zhengfeng County, producing about 60 000 kg of Chinese prickly ash fruits, with an income of some 1.8 million Chinese yuan. At the same time, soil erosion decreased considerably in the experimental areas (5).

The Amomum fruit tree (Fig. 4), walnut, Chinese chestnut, etc. have all proved to be useful trees, both as economic species and as ecologically protective for forests (4, 5).

Figure 4. Amomum fruit tree

DEVELOPMENT MODELS FOR GUIZHOU KARST AREAS

Environment and development are closely related, and together constitute an integral complex whole. This is especially true for the karst areas of Guizhou. The selection and growth of economic and protective trees alone is far from enough to solve the problems of environment and development for these areas. The problems must be tackled comprehensively. Based on experiment and practice, the following integrated models have evolved and proved to be effective in both fighting ecosystem fragility and in alleviating poverty in most of the karst areas of Guizhou.

Chinese-Prickly-Ash Based Comprehensive Development Model

This model includes planting high quality, high-efficient economic forests—mainly Chinese prickly ash—on the karst slopes, building small water cellars, and developing courtyard economies including pigs, methane-generating pits, and economically viable fruit forests. It also involves collecting water on the roofs, and fencing the slopes steeper than 30° with honeysuckle and Chinese toon (*Toona sinensis*). This model is also called "the Dingtan model" because it was formed in the Dingtan district of Zhengfeng County. It was initiated in 1993. By 2000, the vegetation cover had increased from 14% to 32%; a total of nine water ponds were constructed, with a storage capacity of 16 860 m^3. About 13 700 mu of Chinese prickly ash were grown; 15 160 mu of mountain slopes were fenced; and soil erosion decreased on some 63% of the slopes that suffered soil erosion. The per capita income accounted for about 2000 yuan for the demonstration villages, and 3200 yuan for demonstration households. The income of the well-off households amounted to 40 000–50 000 yuan per year (4).

Vertical Multi-Layer Eco-Economic Model

Although the relative slope height is not very high in the karst areas, the ecological conditions change enormously from the low-lying depressions to the tops of karst hills. This requires different types of agricultural activity for different altitudes, and it becomes necessary to regard the lowlands, slopes, and highlands as an integral identity (12–14). A five-layer eco-economic model has been formed: planting trees on the top parts of mountains to protect the mountain tops; growing forage grass or green manure on steep slopes to conserve soil and water; planting economic forests on the middle mountain slopes as both protective and economic forests; developing courtyard and or diversified economies in the lowlands or depressions; and carrying out intensive grain production on the farmlands to provide harvests. The emphasis is on conserving soil, cultivating forests, and storing water. Engi-

Figure 5. Hybxid giannapie

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neering, biological and cultivating measures are all necessary. Mountains, water, forests, farmland, and roads, are managed comprehensively. This model helps to form a rural eco-economic system with a rational structure and multiple functions.

The Controlling-Grass-With-Grass Model

In recent years, a species of grass, crofton weed (*Eupatorium coelestinum, E. adenorphorum*), has been found to grow well and spread quickly in the karst areas, This species provides a thick ground surface cover with developed branches and leaves. This plant appears to greatly facilitate ecological rehabilitation in the seriously "rock-desertified" karst areas. However, one serious problem is that it harms large areas of native vegetation. In addition, other plants can no longer invade and establish in karst areas if E. corlestinum, E. ademorphorum is present. This species is also a toxic grass. If livestock feed on it, they often cannot reproduce or may die. There is no doubt that crofton weed severely threatens the local environment and development in the karst areas. The local people name it "destroying grass." Artificial and chemical measures have proved efficient in controlling the weed. Experimentation shows that hybxid giannapie (*Pennistum hydridum*) (Fig.5) grow in ecologically similar habits to those of crofton weed, but have growth advantages. When planted in areas invaded by crofton weed hybrid giannapie can effectively reduce growth of the weed (5). In addition, hybrid giannapie is also a good-quality grass species for livestock. This is the so-called "controlling-grass-with-grass" model.

Environmental Migration and Development-Based Poverty Alleviation Model

There are about 2.74 million extremely poor peasants in Guizhou. Their annual per capita income was below 400 yuan (about USD 50) in 1998 (4). About 200 000 of them lack the basic living conditions, i.e. shortage of drinking water and farmland. To be free from poverty they need to move from their present living areas. The province has carried out some migration efforts in the typical karst counties, including Ziyun, Libo and Anlong. Up to 1998, a total of 21 new migration villages were built near eight towns with comparatively favorable conditions, and 257 households including 1114 peasants moved into the new villages. The local governments allocated 1337 mu of farmland and more than 3000 mu of non-farmland for use by the immigrants for future development. The costs were borne by the government and partly by the immigrants themselves, with some social aid. Measures were also taken to develop the economy after migration, e.g. planting economic crops and forests, with a view to helping immigrants adapt to the new areas as quickly as possible and help lift them out of poverty.

CONTROVERSIAL ISSUES

At the very start of activities to control rock desertification, efforts were made to terrace the karst slopes to grow economic forests. But this strategy was criticized by some scientists and private companies. It was considered a waste of money and manpower. It was argued that terracing the karst slopes destroys karst ecosystems and that there is not enough soil to fill in the "room" created by the man-made embankment and to provide flat fields for cultivation. It was seen as more practical and profitable to plant trees directly in the small holes, gullies, troughs, and even cracks of karst landscape with some soil.

Even in Guizhou province, ecological conditions change greatly from place to place and from altitude to altitude. Undoubtedly, the choice of tree species and development models should be in line with local conditions.

Some scientists hold that the karst landscape in Guizhou is the typical representative of cone karst landform and of worldwide value. Application for entry on UNESCO's list of World Natural Heritage Sites should be considered (15). In which case, the karst landscapes in Guizhou should be strictly protected in order to keep their natural uniqueness and integrity, or at the very least they should be prevented from further environmental degradation.

References and Notes

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