

中国南部石灰岩地区生物保护和综合治理生态村模式*

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AN ECOLOGICAL VILLAGE APPROACH TO ENVIRONMENTAL CONSERVATION IN SOUTHERN CHINA LIMESTONE AREAS

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摘要 中国南部的石灰岩纯岩出露面积约 198 000 km², 位居世界各国同类面积之首, 主要分布在广西, 贵州, 云南东部, 广东北部, 湖南和湖北的西部, 以及四川南部, 尖削的石峰和美丽的岩洞是游人的胜地, 也为生物和人类提供了多种多样的生态位。石灰岩地区已记录到 4 000 多种维管植物和丰富的动物区系, 被世界自然和自然资源保护组织 (IUCN) 列为国际植物多样性中心之一, 区内居住人口约四千万, 包括我国半数以上的少数民族, 和少数民族中人口最众的壮族。

保护石灰岩地区森林已经迫在眉睫。我国人口在近四十年内增长了一倍多, 东部人口密度达到每平方公里 249 人。人口压力和对自然资源过度的开发已经毁灭了 80% 以上的原生性石灰岩森林, 令大多数石山成为全裸或半裸的光头山。森林消失后, 很多生物种失去藏身之处, 濒临灭绝; 受威胁石灰岩植物已记录到近三百种。石灰岩森林涵养水源, 是区内人民生活的一项基本保障。森林被毁后, 石灰岩地区即面临缺水问题; 没有森林覆盖, 土壤流失严重, 生产条件恶劣, 人民生活普遍贫困。例如广东地区年均国民收入超过二仟美元, 接近或达到了小康水平, 但粤北石灰岩地区不足壹佰美元, 温饱仍然未解决。

传统的生物保护方法, 以设立自然保护区为主, 虽然为一些生物种的延续提供局限性的保护, 但没有根本改善大范围内的生态平衡。而且, 零星的自然保护区缺乏足够的缓冲地带来确保区内生物种基因的有效延续。此外, 现有的石灰岩自然保护区对改善居住在石灰岩地区的几千万人民的贫困生活没有实质性的帮助, 有时甚至和当地人的利益有冲突。本文提出一个石灰岩生态村综合治理模式, 即, 以恢复石灰岩森林带动生态学, 生物保护学和经济生产, 达到综合治理石灰岩地区和生物保护的长期目标。

石灰岩生态村是一个长期的试验。它要求政府、当地民众和大学三位一体, 合作开发一片石灰岩地区。生态村模式的宗旨是使石灰岩地区内几千万人民安居乐业并和其它生物群体和谐相处, 它主要向四个方面发展: 1) 营林保水和发展林业; 2) 建立天然博物馆保护生物多样性; 3) 发展地方经济, 以树木类粮食和果品为主, 但不鼓励种植草本类作物; 4) 发展旅游业。

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本文讨论了生态村的地点选择, 它的基本设定和操作要点, 以及它可能的经济来源, 论证了科技力量和财政方面的可行性, 为行政和科技决策者在石灰岩地区开展综合治理和生物保护提供一个理论基础。

Introduction

China has a large limestone area and a diverse limestone landscape, which is best represented in the southern provinces of Guangxi, Guizhou and eastern Yunnan, as well as part of northern Guangdong, western Hubei and Hunan, and southern Sichuan (Lu, 1965; Ren, 1983). Pure limestone outcrops in this region total 198 000 km², accounting for 70% of that in China (Xu, 1995). Beautiful karst landscapes, including numerous towerlike karst hills and fantastic caves, have been a great source of tourism as well as various ecological niches for the biodiversity.

Associated with the limestone landscape are diverse flora, fauna and human ethnic groups. More than four thousand two hundred specific and infraspecific taxa of vascular plants have been reported (Xu, 1993a). In this rich flora, about 300 taxa are recognized as threatened or endangered (Wen et al., 1993), about 5 % of the genera are endemic in China and a large number of Tertiary or Quaternary refugee plants are identified (Xu, 1995). International Union for Conservation of Nature and Natural Resources has recognized the region as a center of botanical diversity (IUCN, 1990). The diverse fauna are demonstrated by Tang (1987), Zhao et al. (1990) and Zhor (1987). It is estimated that there are more than 40 million people living in the limestone areas in southern China, which include half of the minority ethnic groups in China.

Conservation of the forest on limestone landscapes or limestone forests is important. Forest is the primary producer and the host for the diverse fauna. Human being is also a dependent on the forest. In the limestone area, forest is an effective retainer of water source. Once the forest is destroyed, barren limestone hill cannot keep springs alive. Without water source, neither animals nor human beings can survive. Before 1950's, more than 50% of the limestone landscapes in southern China were covered by forests, but in 1990's, no more than 10% of virgin forests survive and few succeeded limestone forests have been reported. Since 1980's, several nature reserves have been established to protect limestone forests and their associated ecosystems, including Longgang Nature Reserve in southwestern Guangxi and Maolan Karst Nature Reserve in southern Guizhou.

My involvement in the conservation of limestone forests in southern China began in 1990 when World Wide Fund for Nature International (WWF) began to fund my studies in 1990~1992 and 1993~1994 and the Smithsonian Institution (U. S.) provided additional funds in 1990. With the above support, a comprehensive report about the botanical diversity of Chinese limestone forests was produced (Xu et al., 1993). This result helps identify priority and targets in the conservation of limestone forests in southern China, but is far from the ultimate goal. The ultimate goal of conservation is to protect the existing biodiversity and even-

tually to establish a harmonious relationship between plants, animals, human beings and other components in an ecosystem. Resulted from a previously WWF-funded project (WWF/CN 0029), an ecological village approach to environmental conservation is here presented, and the experiment is designed for formulating a long term plan for environmental conservation in the limestone area in southern China.

Long Term Environmental Conservation versus Sustainability of Human Society

Conservation of the limestone forests in southern China has become an urgent subject because human population growth in China has caused the destruction of most limestone forests. From 1950 to 1990, the Chinese population has more than doubled, 540 million in 1950 versus more than 1.1 billion in 1990 (by the end of 1994 the Chinese population exceeding 1.2 billion). Now, the average population density is 114 people per square kilometer; but it is even more alarming that the eastern coastal area of the country that accounts for 43% of the land supports 94% of the total population, which means density of 249 people per square kilometer (Zhao et al. , 1990: 13~14). Limestone areas in southern China were relatively underpopulated before 1950, and many virgin forests existed. In 1950's to mid-1970's China encouraged population growth after years of wars in the country. As a result of that policy and improvement of health care, developed areas become over-populated. Sichuan basin presents an extreme example, having more than 100 million people or almost 10 000 people per km². A general rule of human migration is from the over-populated to the underpopulated and from the poor to the rich areas. As a matter of fact, many Sichuan immigrants are found in adjacent limestone areas in western Guizhou and eastern Yunnan. In the developed areas of China a strict birth control policy known as "one child per couple" was in effect in early 1970's, but in the limestone mountainous area birth control has been less successful. Immigration and lack of birth control have made many limestone areas crowded. New settlers bring the traditional agriculture into the limestone areas; they cut down forests to plant crops, including corn, soybean and rice. Life for those new settlers were easy because forest soil was fertile, but most virgin forests were then destroyed. In southeastern Yunnan and southwestern Guizhou, prior to 1950 around 50% of the limestone landscapes were covered by virgin forests, but today no more than 10% have forest cover. Even in very remote limestone mountains in eastern Yunnan, southwestern Guizhou, northwestern Guangxi and northern Guangdong, few primary forests can be found. Gone with the forests were the dreams of those settlers.

Forests are critical to the ecosystem in limestone area (Xu, 1986) because water source depends on forests and other organisms depend on water. It is extremely difficult for limestone hills to form a soil layer that can retain water. Without erosion, it may take 13 000 years for limestone hills to form a one-cm-thick soil layer (Wei, 1983). Without the involvement of vegetation, barren limestone hills almost cannot form any soil layer because southern China has heavy rain fall and the speed of soil formation cannot possibly counteract soil erosion. Forests can retain water and they help the formation of surface soil. Therefore, in limestone forests, above-ground streams and springs exist. But once the forest is removed, soil is

washed away, surface streams disappear and springs dry. In many limestone areas in eastern Yunnan, Guizhou, Guangxi and northern Guangdong, local people have difficulty in getting enough drinking water, not to speak of agricultural irrigation. With rapid economic growth in China, these days Chinese enjoy a reasonable life with \$ 2 000 GDP per capita according to purchasing power parity (UN, 1994), but most people in the limestone mountainous area are under poverty with GDP per capita no more than \$ 100 and they cannot even feed their belly. Indeed, "limestone area" becomes a synonym of "poverty".

Many limestone areas in southern China have become impossible for people to live on, and people have to flee them. Some may move out of the limestone areas, and some may go to find an oasis within the limestone area. In general, the abandoned villages have no more than barren hills around. After human being moves away, vegetation may succeed to those deserted hills, but succession is slow because limestone hills have little soil to support plant seeds. On the other hand, people's new settlement in a limestone forest may destroy that oasis soon. Attracted by the economic growth in coastal areas more people are fleeing out than getting in the limestone area. To reduce poverty in the limestone area, the people's government of Guangdong Province has financed to help some 100 000 people voluntarily move out of the poor limestone areas in northern Guangdong. The result is satisfactory because many people found a reasonable life after they moved out of the limestone area. However, taking southern China as a whole, the majority of 40 million people in the limestone area cannot be moved away, and most of them have to live with the poverty there. It is clear that a long term plan is needed to reduce the level of poverty in a large limestone area without threatening the remaining forests and the ecosystem there. To formulate such a plan, an ecological village experiment is proposed.

A conceptual ecological village

AN ECOLOGICAL VILLAGE is an experimental field station that will achieve economical sustainability and that will build a harmonious community including human society, fauna, flora and other components of the ecosystem in and around the village. The ecological village has conservation components because it will encourage recovery of forests and protect the biodiversity. But it is not a conventional nature reserve because conventional nature reserves protect the biodiversity in the cost of human being himself without returning benefits to him. In the ecological village, human community will make sustainable usage of natural resources. The primary goal of the ecological village is to recover the vanished forests and by maintaining forests to create sustainable water sources. The ecological village will experiment ways to achieve the best result in reforestation through operation research modeling. Various plant species will be tested for pioneer man-made vegetation, and such pioneer man-made vegetation should provide the quickest path to succession of limestone forests. Both germplasms from local and from foreign areas will be tested, and modern technologies will be employed.

The second goal of the ecological village is that it will be a natural museum of living

plants, living animals and other living organisms. Rare limestone plants will be introduced into a designated area in the ecological village as *ex-situ* conservation. Government will invest to the natural museum in exchange for the protection and propagation of *ex-situ* rare germplasm. And the ecological village may distribute rare germplasm through propagation for economic benefits.

The third goal of the ecological village is to develop local economy without imposing negative impacts on the ecosystem. Traditional agriculture of herbal crops, such as corn, rice and soybean will not be encouraged in the limestone area because these herbal crops cannot protect soil from erosion. As a matter of fact, traditional agriculture has left numerous limestone areas in southern China barren or semibarren. Therefore, in the ecological village, woody crops, including starch, fruit and medicinal trees or shrubs will be cultivated. There are many woody crops preferable to limestone substrate and they produce quality foods (Xu et al. 1993: 34~40). For examples, *Aleurites fordii* yields higher percentage of industrial oil when planted on limestone soil than on acid soil; *Citrus grandis* produces quality fruit if grown on calcareous soil; found in limestone outcrops in northwestern Guangxi *Cleidocarpon cavaleriei* produces excellent starch fruit; and *Excentrodendron hsiemu* is an excellent timber. In addition, there are many medicinal plants that are exclusively distributed in limestone areas, and they can be introduced into cultivation in the ecological village.

The fourth goal of an ecological village is to develop tourism. The natural museum in the village can be a good source of tourism; limestone landscapes are attractive to tourists; and many limestone plants are good for gardening. For examples, *Camellia* sect. *Chrysantha* has beautiful golden flowers; many gesneriads and orchids that grow on limestone present beautiful flowers and it is easy to propagate them.

There are other goals that an ecological village can achieve, such as public education for environmental conservation. To conclude, the ecological village will be a multifunctional community that takes the role of environmental conservation, economic growth, education and a model of sustainable human society.

Creation and Operation of an Ecological Village

In order for an ecological village to become a general model for sustainable development of limestone area, we need to select a site that best simulates the large limestone area in southern China. At least the following factors should be considered in site-selection: (1) **Habitat:** The area has typical limestone landscape. (2) **Geography:** The site is on similar latitude, elevation and climate to most limestone areas in southern China. (3) **Humanity:** The area is not crowded in order that unwanted disturbance from human communities can be avoided. (4) **Economy:** The local government has proven leadership and can commit certain finance. And (5) **Transportation:** Convenient transportation is needed to allow the ecological village accessible to the outside world.

A successful ecological village will require combined efforts from a government, a local community and a university. The three parties will be bound together by legal contracts for

operating an ecological village. The government will coordinate the overall operation of the village; the university will supply scientific force in planning and long term operating the ecological village; and the local community will be residents of the village and they will be the labor force in economic production and in cooperation with the university.

At the initial phase of implementation (estimated duration of five years), government will vommit funds to ensure a basic living standard for the local community in the ecological vilage. Through contracts with the government, local community members will have legal responsibility to stay in the village for a minimum amount of years. The government will help build minimum infrastructure, including residential construction, transportation, water and power supplies and communication.

The local community will receive governmental funds as contracts rather than as grants. In building the infrastructure, they earn income for their living. After the infrastructure is built, residents will pursue economic sustainability through various economic activities with involvement of a university in the planning. In long term operation of the ecological village, local community will receive continuous contracts from the university as a source of income.

Involvement of a university in the ecological village experiment assumes that the university will take major responsibility of fund-raising to support this long term project. The university will establish long term partnership with both the local government and the local community that resides in the ecological village. The university will not take the responsibility to build the village's infrastructure, but will own the scientific facilities. The university will contract with villagers to perform day to day observation of scientific experiments or labor-intensive projects. Frequent contacts of university professionals and students with the local community will bring diverse cultures and knowledge to the local community, and long term cooperation between villagers and the university will transfer scientific knowledge to local people. Various educational workshops and courses will be organized by the university to transform the village into an educational unit. Subsequently, the local community will enjoy a better chance of education and they will contribute to the conservation of biodiversity as a return benefit of their education.

There are funding sources for initiating the ecological village experiment. One source will be from the Central People's Government by reversing some budget for nature reserves to the establishment of ecological village. In recent years, the Central and provincial governments have invested a large amount of money to nature reserves. If some of the nature reserves are selected for the ecological village experiment, no major increase of budget will be needed before this experiment is possible. In some existing nature reserves, basic infrastructure has already been established, and the transformation of a nature reserve to an ecological village will involve more planning but not much more finance. Local governments can be another source of funding. In these years, the Guangdong Provincial Government has financed and will continue to finance the voluntary migration of people out of the poor limestone area. In stead of financing them to move out, the government can finance to help them to stay on where they are if the area is selected as an ecological village site. Since the ecological village experiment is

to find a way for people to live a sustainable life and a successful ecological village model will return benefits for the human society in a vast limestone area, governments should welcome this experiment. Because an experiment is in a small scale, governments will not suffer major loss even the experiment fails.

After an ecological village experiment is initiated, the involved university will seek funding to support continuous operation of the ecological village. Various funding sources may support the ecological village experiment because of its economy, environment and humanity components, and following are some possible sources:

In China:

- Central People's Government. Ministry of Forestry (MOF) and Environmental Protection Agency (EPA) administer nature reserves and biodiversity conservation in China; National Natural Science Foundation supports creative experiments. The ecological village experiment involves the benefits of more than 40 million people, and it deserves support from the Central Government.
- Provincial and local governments. They have interest in the economic growth in limestone areas and they should support the ecological village experiment.
- Private funding. In China, Private funding is currently minor, but it can be an important source in years to come.

Outside China:

- WWF International. This private international organization supports conservation activities. Since there is a large limestone area on the earth in addition to that within the Chinese border, the ecological village experiment deserves international attention. As a matter of fact, the current study was funded by WWF International.
- The World Bank. The World Bank is making a long term commitment to the environmental conservation in China. The ecological village experiment will be one of the most appropriate projects that deserve the World Bank's investment because the experiment has potential economic, environmental and scientific influence.
- Other Funding Sources from foreign governments and private organizations or individuals. Funds can be raised from entrepreneurs and governmental agencies because the ecological village experiment involves both humanity and science.

Conclusions

- Human population growth has caused the destruction of most limestone forests in southern China and is threatening the survival of remaining limestone forests. A long term plan is needed for both the conservation of limestone forests and the sustainability of human community in the limestone areas. Conventional nature reserves emphasize on the conservation of biodiversity without adequate attention to the sustainability of human society.
- An ecological village experiment is proposed for testing a new approach in biodiversity conservation. An ecological village will combine the efforts from the government, the local community and the scientific institution to build a multifunctional community that encourages economic growth, better education and

environmental conservation. A successful ecological village will be a model of a sustainable human society that has a harmonious relation to the fauna, the flora and other parts of the ecosystem.

It is feasible to implement the ecological village experiment because funding sources, man power and experiment sites are there. What we need are a careful plan, high level coordination and commitment to the long term benefits of the biodiversity and human society.

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