



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Research on Functional Characteristics of Karst Eco-economic Compound System in Guizhou Province

LUO Kun-yan *

Xingyi Normal University for Nationalities, Xingyi 562400, China

Abstract Based on the eco-economy theory, this paper analyzed the characteristics of the components of eco-economic compound system of karst region in Guizhou Province. The functional characteristics of eco-economic compound system of karst region in Guizhou Province were analyzed. The functional characteristics were as follows: low biological production of Guizhou Province; weak capacity of ecosystem; slow speed of storage and accumulation of material and serious environmental pollution; low production and efficiency of energy; serious wastes of energy. On the basis of functional characteristics of eco-economic compound System in Karst region. Some views in terms of maintenance and reconstruction of compound system, were put forward, including laying stress on improving ecological system; choosing and cultivating the advanced species that suit the Karst region; improving the amount and speed of material accumulation, at the same time, introducing into advanced production technologies and management experience; reducing the energy efficiency of each section in economic system and improving the transformation efficiency of energy.

Key words Eco-economic compound system, Karst region of Guizhou Province, Functional characteristics, China

Eco-economic system is the compound system formed by the mutual combination and mutual restriction of ecological system and economic system^[1]. In the compound system, ecological system is the basis, which provides materials for economic system. The materials and energies required by economic system to maintain its survival and development all come from ecological system. Economic system is the engine for the development of compound system. With the continuous improvement of science and technology, economic system has even bigger power to change the formation and layout of natural ecological system. It changes the structure and functions of ecological system to satisfy people's need. Compound system is gradually formed by human activity, in the process of satisfying people's material & cultural demands and changing the original natural ecological system. The ecological system and economic system, which constitute the compound system, have their own ecological laws and economic laws. Only when the relevant ecological laws and economic laws are satisfied and the relations of them are well handled, then the balance between ecology and economy can be realized and the favorable ecological interests and economic interests can be obtained.

Guizhou boasts the largest area of carbonate rock and the highly developed Karst landscape in China. The area of Karst land has achieved 130 000 km², 73% of the total land area of the whole province. 83 counties and cities have Karst landscape, 95% of the total number of counties and cities in the province^[2]. The area of existing desertification land is 41 091 km², 23.3% of the total area of land in Guizhou Province, and 36.3% of the area of Karst land^[3]. The area of water erosion land takes 41.5% of the total land. The province losses 252. 154

million ton of soil every year, the average soil erosion modulus is 1 432 t/(km² · a) per year^[4]. In 2009, the total population of the whole province was 37. 93 million, among which city and town population accounted for 29. 11% of the total population, far lower than the national average level. In 2009, the length of road was 2 165 km, the area of road was 3 268 km² and the urban sewage treatment capacity is 605 000 m³, higher only than Tibet in southwest China and ranked last but one. The net income of rural households was 2 796. 93 yuan, 58. 75% of the national average level; the per capita disposable income of rural households was 11 758. 76 yuan, 74. 51% of that of the national average level; the ratio of urban and rural income was 4. 20, higher than the national average level^[5]. The situation mentioned above leads to the fragile ecological environment of eco-economic system^[6], backward urbanization, large urban and rural income gap, prominent poverty problem and lacked capacity of handling environment. The paper tried to analyze the features and mutual relations of ecological system and economic system of Karst area of Guizhou Province from the theory of eco-economic compound system. On the basis of discussing the functional characteristics of compound system, the problems that should be paid attention to in the process of maintaining and restructuring the system in future are put forward.

1 Element characteristics of eco-economic compound system in the Karst area of Guizhou Province

According to the eco-economic compound system theory, eco-economic compound system is constituted by ecological system and economic system. The ecological system mainly includes biotic factor and non-biotic factor. The former refers to the living system composed by various kinds of animals, plants and microorganism; the latter mainly refers to the environmen-

tal system composed by solar radiation, atmosphere, hydrosphere, lithosphere and pedosphere. While, economic system is composed by the production structure, circulation structure, exchanging structure, consumption structure and some ownership structure in the process of people's social material production and reproduction^[1]. Each economic system can not exist without ecological system; therefore, the ecological system and economic system are mostly the eco-economic system. There is no exception of the eco-economic system in Karst area of Guizhou Province, it is also compound system composed by ecological system and economic system. But due to the distinctive location, resource situation and the related human activity, Guizhou has typical features, which can not be found in non-karst area.

1.1 Element characteristics of ecological system

1.1.1 The element characteristics of environment. Environment elements refer to the environment system composed by solar radiation, atmosphere, water, rock and stone. Guizhou is located in the southwest China, with the position of 103°36' – 109°36' E, 24°35' – 29°9' N, besides, the annual average temperature is among 12 – 18°C, and the annual precipitation is among 850 – 1 600 mm, belonging to subtropics monsoon climate region and it is a highly Karstified plateau mountain region. It of mountain accounts for 61.7% of the total area of the whole province; the area of hills accounts for 30.8% and the area of flat land among mountains takes 7.5%^[7]. It is characterized by more mountainous land and less flat land. The area of carbonate rock in Guizhou Province is 150 000 km², 73.6% of the total area of Guizhou Province, and the area of carbonate rock is 78 669 km², 44.66% of the total area of the whole province^[8], and the aggregate thickness of carbonate rock is 6 200 – 11 000 m^[9]. Wide spread and thickness of carbonate rock laid material basis for the cultivation of Karst landscape in Guizhou Province. Except for, southeast and northwest of Guizhou Province, other areas also have the karst development to a different degree. Guizhou Province is the only karst province without the support of plane in China^[10]. Different landscapes and combination distributed in Guizhou.

The carbonate rock has strong power resisting the physical weathering, although it has high erosion but low content of water insoluble subjects, only 4% average, the residual of weathering is less, so the speed of forming soil is slow. Every 1 cm of soil needs about 8 000 a land^[9]. Affected by soil parent material and climate, the eluviation of land is serious in the process of soil formation. The formation and maturity of land is conducted under the circumstance of carbon-nitrogen cycle and rich calcium accumulation, so the lithophile in soil, such as Ca, Mg, Si, Al, etc. is rich. Thus, the limestone soil, which is characterized by rich calcium, fluffy soda and low natural fertility is formed^[11], and the distribution of this kind of land has great differences in each areas^[12]. Most of the land is red loam, yellow soil, yellow-red soil and yellow brown soil, which are mainly distributed in funnel-shape land, down bend, basin and lysogeny land. In the vast karsts area, the thickness of soil varies and the distribution of land is discontinuous and most of the

soil distributed in the cranny off rocks, so it is hard to make use of the land. In the province, 81.02% of farmland is distributed in the slope with the degree of more than 6°, among which 691 800 hm², 19.8% of the total farmland lays in the slope with the degree larger than 25°, 281 800 hm², 5.74% of the total farmland lays in the slope with the degree above 35°. The newly cultivated land will lose its value in 3 to 5 years and even turn to deserted slope with rocks^[13]. Between the carbonate parent material and the soil, there is no C transition layer, which leads to the poor adhesion between rocks and soil. In rainy days, the poor adhesion of land will result in soil erosion and block movement^[11].

The annual average precipitation is around 1 300 mm, with abundant water resources. But in the Karst area, the soil is thin in slope, the water-maintaining and storing capability of soil is poor, besides that, the existence of double layer landscape system, makes the water easy to sink into the underground of earth and flow away. Except for the storm season, the slope runoff is formed in the surface of land. The rain flows into the cranny of soil and rocks to the underground conduit and the underground water is formed. Most of the water flows to the land with lower sea level. The underground water is deep, so it is hard to develop and use it. And then the geologic-structure dry land will be formed^[14]. Moreover, due to the lack of surface drainage system, in storm season, once the underground drainage system does not work, the water will become flood. Water in some down bend land even accumulated into lake, which makes the failure of harvest.

Guizhou abounds with mineral resources and it has more than 100 minerals. There are more than 20 kinds of mineral resources, which account for above 30% of the national recoverable deposits. The minerals mainly include coal, manganese minerals, zinc ore, magnesium mineral, gold mine, navajoite and vanadium, etc. and the resource reserves are 54.9 billion t, 97.022 3 million t, 1.448 9 million t, 53.654 1 million t, 238.55 t, 0.752 6 million t, 0.546 7 million t. The backward production technology of mining and metallurgical industry and low level of management lead to the serious waste of resources and destruction of environment. For example, the reasonable recovery rate of coal is 75%, but in Guizhou Province, it is only 20%. According to the 30 million explored in 1993, the resources wasted were more than 80 million t^[15]. At present, the production of sulfur and nonferrous metal by indigenous methods and poisons plant has formed the white desert^[14]. Ecological system, after being damaged, underlying surface changes and the soil and water erosion has been intensified, which leads to the disasters such as mud and stone flow, flood, etc.

1.1.2 The characteristics of life element. Life element refers to various animals, plants and micro organism, which jointly formed the life system of ecological system. Affected by the features and distribution of soil, Karst area is characterized by stone nature, dry nature and calciphilous nature. The plants are mainly vine maquis-like shrub, dry plant grassland bush, maquis-like bush, etc. Among the plants, the forest resources have more than 2 000 kinds of woody plants; the woodland is mainly the conifer including pine and fir; the grasses are mainly

herbs and there are more than 1 800 kinds of natural pasture, so it owns the advantages in developing ecological animal husbandry; economic forest has lacquer tree, fir, China armand pine, sassafras, Chinese mahogany, oil-tea camellia, Chinese tallow tree, walnut tree, Chinese chestnut, *etc.*. According to the interpretation of satellite image, the area with high coverage of plants accounts for 15% of the total area; the area with medium coverage of plants takes 28% of the total area; and the area with low coverage of plants occupies 35% of the whole area^[13]. This kind of coverage of plants is of no benefit to adjusting stream flow and maintaining water and soil. The vegetation grows slowly, the absolute quantity of grow is low and the structure of coenosis is simple, which makes the circulation among producers, consumers and decomposers small and slow, and the energy consumption is high^[16]. The disturbance-resistance capability of the system is poor and after being damaged, it is hard to recover. Many experiments indicate that, in Karst area, implementing strict forest conservation and promoting the refreshment of forests from grassland shrub to vine and thorn shrub to copse shrub to open forest and forest needs 8–10 a, 6–7 a, 7–10 a, 8–9 a respectively, all together 30–35 a^[17].

1.1.3 The characteristics of population. Man is the most active element in the compound system, as well as the strongest destroying element^[18]. Man owns the complex natural quality and social quality. For one thins, man is a members of nature, so his existence and development can not separate from natural environment. Any behavior of man can not disobey the rule of ecological system and any behavior should be reflected and adjusted by natural condition^[18]; for another thing, man is the master of social economic activities. He can use scientific technology to launch production and reproduction activities of social materials to raise the level of material and cultural life. Therefore, man is analyzed as a single element.

Guizhou Province has a large population, with low quality and great density. In 2009, the aggregate population of the whole province was 37.93 million, among which, urban and town population was 11.041 4 million, accounting for 29.11% of the aggregate population; rural population was 26.888 6 million, accounting for 70.89% of the aggregate population. The natural growth rate of population was 6.72‰, ranking ninth of the country. The density of population was 215.51 people/km². In terms of regional distribution, the people mainly distributed in northwestern Guizhou Province; in terms of sea level above, the people mainly concentrated in middle sea level above^[19]. The illiterate people at the age of 15 years old or above in Guizhou Province accounts for 14.58% of the total population 1.88 times more than that of the average level. The poverty-stricken population in rural areas was 5.853 8 million; the rural poverty rate was 17.4%.

1.2 The characteristics of economic system Economic system is the system composed by productive force and productive mode in the process of production and reproduction of material goods. Besides, it is the cycling process of the four sections including production, circulation, exchange and consumption. Therefore, economic system can be understood as

the system composed by productive structure, (including certain industrial structure, technical structure, employment structure, economic organization structure and economic regional structure, *etc.*), circulation structure (including certain market structure and price structure, *etc.*), distribution structure (including certain accumulation and consumption structure and investment structure, *etc.*), consumption structure (including personal consumption structure and public consumption structure) and certain ownership structure^[1]. The characteristics economic system in Guizhou Province is analyzed from the aspects of industrial structure, employment structure, investment structure.

1.2.1 From the perspective of industrial structure. In 2009, the GDP of Guizhou Province was 333.340 billion yuan. Among which, the output of the primary industry was 54.785 billion yuan, 16.44% of the total GDP of Guizhou Province; the output of the secondary industry was 140.871 billion yuan, 42.26% of the total GDP of Guizhou Province, the output of the tertiary industry was 137.684 billion yuan, 41.30% of the total GDP of Guizhou Province. The industrial structure is the type of the secondary industry, the tertiary industry and the primary industry, which realized the qualitative leap. The industrial products produced by industries with large scale including mine run coal, electrical energy, fertilizer, cement were 117.98 million t, 119.229 billion kwh, 2.622 1 million t, 20.50 million t respectively; the major agro-products were grain, rapeseed, cured tobacco, fruits, with the yields of 11.58, 0.603 7, 0.377 1, 0.034 9 and 1.143 million t; the major forestry products were raw lacquer, bancoul nuts, tea seed, tallow seed oil, Chinese gall nut, palm sheet, walnut seed, Chinese chestnut, the yields were 1 641, 73 395, 16 233, 2 874, 1 739, 4 510, 12 316 and 16 707 t.

1.2.2 From the perspective of employment structure. In 2009, the number of practitioners in urban and township units of Guizhou Province was 2.110 3 million, 9.52% of the total practitioners; the number of practitioners in rural area was 20.064 million, 90.48% of the total practitioners. The number of practitioners in urban and township units employed in the primary, secondary industry and the secondary industry was 0.027 4, 0.771 7 and 1.311 3 million, which account for 1.30%, 36.57% and 62.14% respectively; in the rural practitioners, the number of people employed in agriculture, industry, architecture, wholesale and retail was 12.020 7, 0.993 9 and 0.480 9 million, which account for 59.91%, 8.27%, 3.38% and 2.40%. The employment structure in urban and township area was the tertiary industry, the secondary industry and the primary industry, and the employment structure in rural areas was the primary industry, the secondary industry and the tertiary industry, which was in accordance with economic demand.

1.2.3 From the perspective of investment structure. In 2009, the total financial income of Guizhou Province was 67.458 billion yuan, 21.11% higher than the previous year. The financial expense was 105.539 billion yuan, 32.7% more than that of the previous year. Among which, the financial expenses of general public service, education, social security and agriculture, forest and water were 18.421 billion, 22.977 billion,

10.746 billion and 12.171 yuan, which accounts for 17.45%, 21.77%, 10.18% and 11.53% respectively of the aggregate financial expenses. The investment in permanent assets of each city (province and districts) was 14.576 billion yuan, among which, the investment in basic construction, renovation and the development of real estate was 80.002, 29.739 and 31.126 billion yuan, which accounted for 54.89%, 37.17% and 21.35% respectively. The fiscal income was mainly used for education, the construction of public infrastructure and agriculture, forest and water. The urban and township investment in permanent assets was used in terms of the construction of infrastructure, renovation and the development of real estate.

1.2.4 From the perspective of consumption structure. In 2009, the per capita disposable income of urban and township residents was 11 759 yuan, 74.5% of the national average level; the per capita consumption expenses of urban and township residents was 8 349.21 yuan; the Engel coefficient of urban and township residents was 43.1%, 5 percent higher than that of the national average level (the Engel coefficient of urban and township residents of the whole nation was 37.9%); the net income of rural residents was 2 797 yuan, 58.8% of the national average level; the per capita living expenses of rural residents was 2 166; the Engel coefficient of rural families was 51.70%, 8 percent higher than that of the national average level (the Engel coefficient of Chinese rural families was 43.7%). Although the Engel coefficient was higher, comparing with the national average level, the coefficient was descending comparing with the previous years of Guizhou Province, which indicated that the overall social living standard of Guizhou Province has been improved.

2 The characteristics of the function of compound system

2.1 Low productivity of biology and poor ability of ecological carrying capacity Biological production refers to in the process of metabolizing of energy and materials, the living organism reorganize the energy and materials to form the new outcomes (carbohydrate, fat, protein)^[20]. In a certain period of time, the aggregate quantity produced by biology is called the biological production volume. It is used to explain the productivity of individual biology or biological groups, as well as an important index for evaluating the structure and harmony of ecological system. Biological productivity is restricted by climate, soil, water and plants and directly affects the carrying capacity of ecological system. According to the research conducted by GUO Chun-qing *et al.*, the ecological carrying capacity of Karst environment equals to "water-soil-rock" (the carrying capacity of basic resources) + "climate-Karst landscape – human activities" (carrying capacity of environment) + "plants in special Karst area" (ecological elasticity). Karst area of Guizhou area is characterized by widely distributed carbonate rock, thin soil, discontinuously distributed land, "geological structure" drainage of water resources, slow growth speed of plant, so the biological production in the area is obviously lower than that in other moist heat subtropical area. Carrying capability of ecological

system in Karst area is poor and the conflicts between people and land are prominent^[21]. For example, the productivity of arborous layer, woodland shrub and grassland shrub of Karst area in Guizhou Province is 5.61, 2.86 and 3.10 t/hm² · a respectively, only 57.48%, 28.04% and 47.10% – 66.13% of that of the national average level. The biological production of arborous layer in the virgin forest of Maolan, Guizhou Province is 89.2 t/hm², comparing with the non-Karst area with the same climate, the figure is only 32.45% of the 56 a of Chinese fir forest in Hunan Province and 25.58% of lithocarpus in Shanmujie of Ailao Mountain. Under the natural condition, the output of economic forest (mainly vernicia fordii) was only 540 yuan per hm² (the price in 1987); under the conditions of human operation, the profits of unit area of timber stand can support 1.56 people per hm² under the standard of food and clothing^[22]. The mountainous areas in Guizhou take a large proportion of land, 77.8% of the aggregate land area of Guizhou Province. The quality of farmland is poor and most of the farmlands are slopes, but the population there accounts for 66.4% of the total population of Guizhou Province. And the per capita quantity of grain is under the warning line of 300kg. The reasonable capacity of population of Guizhou Province is about 2.95×10^7 people (at present, Guizhou has the population of 3.79×10^7)^[22], the number of population has excessively surpassed the capacity. In order to satisfy the basic living needs, people is forced to damaging forests. The newly opened slopes will lose their cultivation value in three or five years, and the farmland even will turn to deserted land. The ecological system will evolve backwards, and the evolvement will soon achieve the climax state-stony desertification.

2.2 Slow storage and accumulation of materials and serious environmental pollution Materials circulate according to a certain ways among each element and sub-system to realize the material cycle of compound system of ecological economy. The cycle includes the natural material cycle of ecological system and the material cycle of social economic system. The former circulation mainly includes great geochemical cycle and small biological cycle. The cycle is realized through the mutual functions of producers, consumers, disintegrators and the environment; the latter is process of production and reproduction of social materials through the interference of human economic activities and using certain science and technology. It obtains material resources from ecological system and enters each section of social economy including production, exchange, distribution and consumption, and then comes back to natural environment to realize the material circulation of economic system. The two circulation can realize the organic cooperation and mutual transformation through agriculture, energy and mining production section (Fig. 1).

The material basis of ecological system in Guizhou Karst area is carbonate rock and it is a geochemical environment dominated by strong exchange of carbon and calcium^[22]. The fundamental situation of the whole province is more mountainous area, less flat land and serious stony desertification. The fertile farmland is mainly distributed in down bend and basin,

the rest are mainly the slope farmland. The situation for agricultural production is bad (Table 1). The main agricultural products are grain and the gain is mainly rice and corn. The yield of rice and corn accounts for 39.82% and 33.78% of the aggregate yield of grain. The grain can only or can not satisfy the basic needs of daily life, so they can not bring any economic income for farmers. The main cash products are oil crop, peanut, cured tobacco, vegetable, *etc.* As an effective way of solving the problems of ecological construction and farmer' income increase, the developmental momentum of animal husbandry is good. The output of animal husbandry accounts for 30%

around the total agricultural income. Guizhou boasts rich resources and it is an important component of the south channel of West-East electricity transmission project. In 2009, the electricity had achieved 119.208 billion kwh (Table 2); the major electricity was thermal power generation, which accounted for more than 95% of the total energy use. The major industrial products of mining production section were mine run coal, pig iron, aluminum, oxide of alumina, phosphorus ore and *etc.* (Table 2). The mining is an important component of industries in Guizhou Province, and it has pushed forward the development of the secondary industry to a large degree.

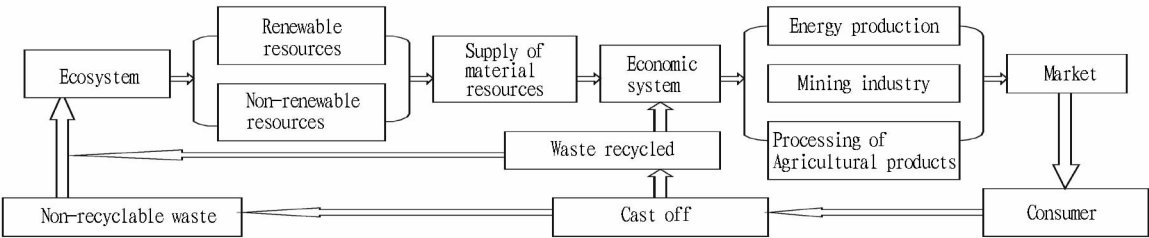


Fig.1 Material recycling of eco-economic compound system

Table 1 Basic Conditions of agricultural production of Guizhou Province (2009)

Index	Index value	Index	Index value
Area of cultivated land (year-end) // $\times 10^3$ hm ²	1 754.05	Total agricultural machinery power // $\times 10^4$ kw	1 537.5
Paddy fields // $\times 10^3$ hm ²	754.01	Consumption of chemical fertilizer // $\times 10^4$ t	83.09
Effective irrigation area // $\times 10^3$ hm ²	987.41	Consumption of pesticides // t	12 920

Note: The data come from Guizhou Statistical Yearbook 2009^[3].

Table 2 Major agricultural and industrial products and their Output in Guizhou Province (2009)

Index	Index value	Index	Index value
Output of grain // $\times 10^4$ t	1 158	Aluminum // $\times 10^4$ t	58.15
Output of oil-bearing // $\times 10^4$ t	68.39	Alumina // $\times 10^4$ t	144.28
Output of cured tobacco // $\times 10^4$ t	37.71	Phosphate rock // $\times 10^4$ t	1 317.18
Output of fruit // $\times 10^4$ t	114.28	Liquor // $\times 10^4$ t	18.35
Output of meat // $\times 10^4$ t	161.46	Cigarettes // $\times 10^4$ carton	226.74
Total aquatic products // $\times 10^1$	7.8	Chemical fertilizer // $\times 10^4$ t	262.21
Coal // $\times 10^4$ t	11 798.46	Electricity // $\times 10^8$ kwh	1 192.08
Pig iron // $\times 10^4$ t	331.01	Hydropower // $\times 10^8$ kwh	380.86

Note: The data come from Guizhou Statistical Yearbook 2009^[3].

Restricted by natural environment situation, the material productivity of ecological system in Guizhou Karst area is low, the speed of material accumulation is slow and the quantity of material accumulation is small, but the production of material in economic system relies on changing the chemical, physical and geometrical features of nature to transport them to the sections of circulation and consumption, so the varieties and quantity of material accumulation in economic system will be inevitably affected. Besides, the acquirement and accumulation of materials in economic system depend on the technical and economic situation in the area. In essence, it is the process of transforming economic materials to natural materials. However, the technical and economic level of Guizhou is low, especially in the aspects of using mineral resources; the problem of wastes is still very serious. For example, the reasonable recovery ratio is 75%, but Guizhou has only achieved 20%; the recovery ratio of bauxite is 95%, but Guizhou has only achieved 20%^[15].

Through the sections of production, circulation, exchange and consumption in the food chain and economic system of ecological system, the materials of the compound system will remit to the environment by the simple physical form through natural and chemical decomposable process, to participate in the material production process of compound system again. However, with the energy production and mining development, a large amount of hazardous substances will be released to the environment. The waste residue left in the circulation process of mineral substances will be left to the environment, which will do harm to atmosphere, water, pedosphere, ecosphere, *etc.* and lead to environmental pollution and ecological damage. For example, with the exploitation and use of coal, a large amount of sulfur dioxide is discharged to the air, which may cause acid rain. In the central Karst area of Guizhou Province, the average rate of acid rain is 80% and the rate of strong acid rain is 30%^[15]. The environmental pollution and ecological damage

will affect the normal economical structure and inhibit the efficiency of cycling and transformation of natural materials and economic materials in compound system.

2.3 The low efficient and grave wastes of energy production and use In compound system, any material circulation accompanies energy flow, which includes the energy flow in ecological system and energy flow in economic system. The former flow accompanies the single way flow of energy from the green plants producing primary products to be adsorbed by creature at various nutrition levels; the later energy flow also accompanies energy flow from the exploitation of mining, to the primary use of energy resource and to the transformation of various industrial products and secondary energy sources. No matter accompanies biologic chain or production chain, the energy will be wasted. And the energy is wasted grade by grade. The energy in the ecological system passes on its energy to the next trophic level by the ratio of 10%, which is regarded as "one-tenth law". The energy in the economic system is also descending gradually when transferring from one production chain to the next one, but there is no definite ration of the usage efficiency of energy, and it depends on the current economic technology, which is the energy use efficiency. Part of the heat in the transference of energy will be discharged to the environment, and will no longer participate in the energy flow.

Affected by natural environment, the productivity of green plants in Guizhou Karst area is limited. In 2009, the grain yield was 11.58 million t, and the per capita average grain yield was only 305.30 kg, lower than the average level of the whole country. With small per capita farmland, dispersed land and thin soil surface, the Karst area in particular, has even lower per unit of grain yield and the energy produced by ecological system is far lower than satisfying people's basic demands. Therefore, the cultivation on slope and damage of forests happen frequently, which greatly threaten the balance and stability of ecological system. In the sectors of energy production and mining, grave wastes still exist. According to the studies of QIU Ling, *et al.*, Guizhou belongs to one of the provinces in China with the lowest efficiency of energy use. Each ten thousand yuan local GDP will consume more than 3.70 t standard coal, 6.57 times more than that of Guangdong Province, which has the highest energy use efficiency. Guizhou Province is in the middle stage of industrialization, the energy-intensive industries take a large proportion. The industrial sectors are characterized by high consumption and low efficiency. The proportion of the added value of the secondary industry has negative effect on the energy use efficiency in the region. Every one percent growth of added value will increase the 0.002 t standard coal of per ten thousand yuan local GDP^[23-24]. In 2009, the gross production of the secondary industry in Guizhou was 140.871 billion yuan, 22.68% higher than that of the last year, so the relevant wastes of energy were larger.

3 Conclusions

Guizhou Karst area, with low productivity of ecological system and economic system, slow speed of storage and accumulation of material and low efficiency of energy production and energy use and large population, requires huge materials and

energies to maintain its survival. When people's demands have surpassed the carrying capability of the system, the balance and stability of the system will be broken inevitably. Due to the low efficiency of materials and energies, the great wastes will be caused in the circulation of materials and energies. Therefore, in the process of maintaining and restructuring the system, the productivity of ecological system should be considered and the advantaged species should be cultivated to improve the quantity and speed of material accumulation. At the same time, the production technology and management experiences should be introduced into to reduce the wastes of energies at each section; enhance the transformation efficiency of energy. Only by those ways the structure and function of compound system could be optimized and the sustainable healthy development of eco-economic system in Karst area could be realized.

References

- [1] MA CD. Ecological economics[M]. Jinan: Shandong People's Publishing House, 1986: 60-80. (in Chinese).
- [2] HUANG XY. Thinking of the policy of the development in phase between zoology and economy at karst area in Guizhou Province[J]. Science of Science and Management of S & T, 1999, 20(8): 40-41. (in Chinese).
- [3] CHEN QW, XIONG KN, LAN AJ. Analysis on karst rocky desertification in Guizhou based on "3S"[J]. Carsologica Sinica, 2007, 26(1): 37-42. (in Chinese).
- [4] People's Government of Guizhou Province. The proclamation of soil and water loss in Guizhou Province[EB/OL]. (2006-07-06) <http://www.gzzb.gov.cn/zc/ShowArticle.asp?ArticleID=3888>. (in Chinese).
- [5] National Bureau of Statistics of China. China statistical yearbook [M]. Beijing: China Statistics Press, 2009. (in Chinese).
- [6] SU WC. Eco-environmental fragility in Guizhou karst mountain region and its ecological rehabilitation[J]. China Environmental Science, 2000, 20(6): 547. (in Chinese).
- [7] WANG CW, ZHANG YH. Regionalization of agricultural landscape in Guizhou Province [M]. Guiyang: Guizhou People's Publishing House, 1989: 1. (in Chinese).
- [8] ZHANG DF, WANG SJ, ZHOU DQ, *et al.* Intrinsic driving mechanism of land rocky desertification in karst regions of Guizhou Province[J]. Bulletin of Soil and Water Conservation, 2001, 21(4): 4-5. (in Chinese).
- [9] WANG SJ, JI HB, OUYANG ZY, *et al.* Primary study on roles in the genesis of soil from carbonate rock weathering[J]. Scientia Sinica Terrae, 1999, 29(5): 441-449. (in Chinese).
- [10] XU Y. Research for the sustained development evaluation of ecological economy in the karst area in the Guizhou Province [J]. Journal of China West Normal University: Natural Science, 2002, 23(1): 79-82. (in Chinese).
- [11] YANG MD. Studies on karst: selected papers Yang Mingde [M]. Guiyang: Guizhou Ethnic Publishing House, 2003: 226-237. (in Chinese).
- [12] LONG J, LI J, DENG QQ, *et al.* Soil properties and fractal features in the rocky desertification process of karst regions, Guizhou Province [J]. Chinese Journal of Soil Science, 2006, 37(4): 635-638. (in Chinese).
- [13] ZHANG DF, WANG SJ, LI RL. Study on the eco-environmental vulnerability in Guizhou karst mountains[J]. Geography and Geo-Information Science, 2002, 18(1): 77-79. (in Chinese).
- [14] YANG HK. Karst desertification and assessment of its disasters [J]. Marine Geology & Quaternary Geology, 1995, 15(3): 137-146. (in Chinese).
- [15] ZHANG DF, OUYANG ZY, WANG SJ. Population resources envi-

- ronment and sustainable development in the karst region of Southwest China[J]. China Population Resources and Environment, 2001, 11(1): 77–79. (in Chinese).
- [16] CAO H, SU WC, FAN XR. A preliminary discussion on the karst of ecosystem health factors and evaluation—a case study in Bijie[J]. Environmental Science and Management, 2008, 33(10): 143–149. (in Chinese).
- [17] WANG SJ. The most serious eco-geologically environmental problem in Southwestern China: karst rocky desertification[J]. Bulletin of Mineralogy, Petrology and Geochemistry, 2003, 22(2): 120–125. (in Chinese).
- [18] MA SJ, WANG RS. The social-economic-natural complex ecosystem[J]. Acta Ecologica Sinica, 1984, 4(1): 1–6. (in Chinese).
- [19] LI XD, ZHANG SY. Quantitative analysis of relationship between population distribution and natural environment in Guizhou karst plateau[J]. Population Journal, 2006(3): 51–54. (in Chinese).
- [20] LIU BP, CAI YL. An introduction to earth science[M]. Beijing: Higher Education Press, 2000: 263. (in Chinese).
- [21] GUO CQ, WANG L, WANG HT. The research of karst ecological geology in China[J]. Ecology and Environment, 2005, 14(2): 275–281. (in Chinese).
- [22] SU WC. Characteristics and its regulation of karst ecosystem in Southwest China; in the case of Guizhu Province[J]. Bulletin of Soil and Water Conservation, 2004, 24(2): 55–59. (in Chinese).
- [23] QIU L, SHEN YM, REN WB, *et al.* Analysis on regional disparity and its influential factors of energy utilization efficiency in China[J]. Journal of Natural Resources, 2008, 2(5): 920–927. (in Chinese).
- [24] Guizhou Bureau of Statistics, Survey Office of the National Bureau of Statistics in Guizhou. Guizhou statistical yearbook[M]. Beijing: China Statistics Press, 2009. (in Chinese).
- [25] CHEN H. Difference analysis on the sustainable development of eco-city—a case of 14 cities in Gansu Province, China[J]. Asian Agricultural Research, 2009, 1(6): 24–28.
- [26] JIAN X. Optimization discuss of evaluation system in urban ecological community[J]. Journal of Anhui Agricultural Sciences, 2011, 39(7): 4395–4397. (in Chinese).
- [27] ZHAO GT. Sociological consideration on the development of ecological agriculture in western china[J]. Asian Agriculture Research, 2009, 1(7): 21–24.
- [28] WANG WJ, LIN T, ZHAI WB. Research on business model of ecological forestry test base in Bagua Islet in Nanjing[J]. Journal of Anhui Agricultural Sciences, 2010, 38(29): 16631–16632. (in Chinese).

(From page 112)

of farmers' clustering degrees. The second is that at present, almost all of farmers' lack of professional knowledge about professional economy. And the shortage of confidence and information is another bottleneck constraining the development of professional cooperatives. In general, the two routines in promoting the development of farmers' professional cooperatives are: one is to promote the clustering of agricultural resources to advanced farmers and strengthen the scaled degree of agricultural management; the other one is to accelerate the clustering of information and techs to the professional farmers and strengthen the cognition and confidence of farmers.

References

- [1] ALFRED HANEL. The concept and types of cooperatives. Type of self-help cooperatives and social structural change[M]. Marburg: The Cooperative That Promoting Self-help Advice in Marburg, 1995. (in Chinese).
- [2] YING RY. Study on he growth path of professional self-organized cooperatives of farmers[J]. Chinese Rural Economy, 2006(6): 18–23. (in Chinese).
- [3] TORGERSON R, REYNOLDS B, GRAY T. Evolution of cooperative thought, theory and purpose[J]. Journal of Cooperatives, 1998, 13: 1–20.
- [4] SUN YH, ZHOU L, YING RY. Performance for income-increasing of rural specialized cooperation artel; a case study of layers and broiler households in Jiangsu Province[J]. Journal of Nanjing Agricultural University: Social Sciences Edition, 2007, 7(2): 66–71. (in Chinese).
- [5] NIU RF, XIA Y. An introduction to the development of rural cooperative economic organizations[M]. Beijing: China Agricultural Science and Technology Press, 2000. (in Chinese).
- [6] COOK M. The future of US agricultural cooperatives: a neo-institutional approach[J]. American Journal of Agricultural Economics, 1995, 77: 1144–1152.

About Asian Agricultural Research

In 2009, WU CHU(USA-China) Science & Culture Media Co. (Cranston, USA) and American Gene C T LLC (Cranston, USA) issued the journal *Asian Agricultural Research* (ISSN 1943-9903). The main content is agricultural development, rural development, resource allocation, market and trade. The journal covers many research areas including rural management system, agricultural structure and allocation, peasants' income and poverty relief, rural infrastructure and social undertakings, employment of rural labor force, agricultural science and technology application, finance and banking, international trade of agricultural products, agricultural information, agricultural standards and quality, *etc.* Currently, its full-texts have been embodied by the AGE (Research in Agricultural & Applied Economics) database, CAB International (CABI, an international authority of the search tools), Library of Naresuan University (Thailand), Participatory Rural Development Foundation (India), and Royal Tropical Institute (Amsterdam). In addition, the editorial office has been in contact with many international well-known databases.