

Sustainable Land Management in China

Application of the ECCO Methodology

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1. Sustainable Land Management in China

As a result of long time development and adjustment in history, China's land use has a well-founded structure, which is generally reasonable. Much experience has been won on sustainable land use. "Mulberry field with fishpond" in the Pearl River Delta is a good example. Ecological agriculture has been developed rapidly over the last decade. China has managed to feed 22% of the world population on less than 7% of the arable land of the world. However, the following issues are of significance to China's sustainable land use in the future: clarifying the character of china's land; finding out problems to sustainable land use and subsequently finding out the needed action and countermeasures to be taken.

1.1 The situation and character of China's land use

According to the statistics of 1985, China's total land area of 960 million hectares was divided into 126 million ha farmland, 6 million hectares garden, 123 million hectares forest land, 263 million hectares grassland, 27 million hectares of construction land for urban, rural, industry, mining and transportation purposes, 36 million hectares inland water, 302 million hectares uncultivated land.

The table below is shows that China is relatively short of land resources with land per capita being far less than the world's average.

Table 1. Land per capita in China

	Total Land	Farmland	Forest Land	Grassland
China (hectare/capita)	0.90	0.12	0.12	0.25
World (hectare/capita)	2.76	0.26	0.84	0.65
China/world (%)	32.6	41.00	14.30	32.30

The area of mountains and plateaus accounts for 60% of the total land, and is larger than the area of plain that just accounts for 31%.

The regional distribution of every kind of land is uneven, and utilization is varied. For instance, the 400 mm precipitation isopleth cuts the country into two parts: the southeast monsoon region and the northwest inland region. Although the areas of the two parts are almost equal, 90% of the country's arable land is in the southeast region. Forest is mainly found in the northeast, southern and northern regions, very little forest is in the northwest. 80% of all grassland is in the northwestern arid and semi-arid areas

and on the Tibet Plateau. Dry and large land is highly developed in the southeast and underdeveloped in the northwest.

The Yangtz River basin and its southern area constitute 80% of the country's water resources, but its arable land area is only 36%. The Huai River basin and its northern area have less than 20% of all water but 64% of all arable land.

1.2 Some Problems of Sustainable Land Use

A sharp conflict exists between land supply and demand. Because of the rapid growth of the economy, land is seized by different sectors, such as construction, transportation, agriculture etc. In addition there is a need for ecological environmental protection and biodiversity protection areas.

Likewise there is a sharp conflict between the long-term shortage of arable land and the immediate need of maintaining grain production. China's arable land accounts for 13.8% of the total global land area. Per capita, arable land holdings are only two fifths of the world's average. With the increasing population and decreasing arable land, it is very difficult to maintain the amount of grain per capita.

Due to a lack of the necessary macro control of land use, especially legal regulations and economic adjustments to a market economy, and also due to unsuccessful micro management, China has been seen a serious occupation of arable land for construction purposes and structural adjustment of the agricultural sector. Due to the very low price of land, if any, enterprises and government agencies occupy much land, and waste of arable land is serious.

The land area is not clear by administered and management measures are backward. Although China has investigated its land resources many times, the backward system of information collection, processing and transmitting failed to guarantee that the information collected is true and scientific. Of course, such information cannot satisfy the needs of land use management, let alone of sustainable land use. A land resource management system compatible with the marketing economy must be set up without delay.

There is an ongoing degradation of arable land. For a long time, the increasing population posed a bear heavy burden to farmland which was intensively used without sufficient protection. As a result, arable land (fertility) degradation, agro-ecological imbalance and disasters are all getting worse. There are 130 thousand hectares of arable land damaged or lost because of disasters. In southern China, 20-40% of all paddy fields are found on clay soils. Moreover, land contamination is becoming more and more serious as discharge of industrial wastes and pesticide increase. The area of contaminated land is becoming ever larger.

The percentage of forest cover is low. China is one of the least forested countries in the world. In the year 1991, there were 128 million hectares of forest, i.e. a percentage of forest cover of 13.4%. The per capita forest area is 15% of the world average or less.

Serious water loss and soil erosion. China ranks first in the world, with its 1.79 million square kilometers of land suffering from water loss and soil erosion. 5 billion tons of soil are eroded every year.

Ever expanding desertification. China is one of the countries with large areas of desert land. China has a total desert area of 1.53 million square kilometers, i.e. 15.9% of its total land area. The area of desert land has increased from 1560 square kilometers per year in the period of 1950-1970 to 2100 square kilometers per year in 1970-1980.

1.3 Policies and Measures for Sustainable Land Management in China

1.3.1 To improve the legal system of land management, to protect land and promote sustainable use of land

To legalize the system of land management, the Land Management Act (LMA) should be adapted. Some regulations should be formulated to coordinate with LMA, such as the Land Regulation Rules, Farmland Protection Rules, Land Estimation Rules, Land Appreciation Tax Rules, Rules for Sale and Transfer, Detailed Implementing Rules for Land Sales, Transfer, Land and Mortgage and so on. In the future, all management and guidance activities should be bound to use laws and regulations. Land marketing should have a good basis.

Accelerate institutional reform. Many administrative sectors are committed to institutional reform, such as state planning, marketing management, urban construction, tax revenue, and price management. In order to avoid chaos in the real estate sector, we should do more than just adapt regulations. For example, land use planning and detailed planning, including city development and urban construction, villages and towns development planning, land use planning for agriculture. All of these facilitate the reasonable use and optimal allocation of land.

Setting up basic arable land reserve regions. This is an important measure of arable land protection and conservation. Basic arable land means arable land that satisfies the need for agricultural products of the whole population. The basic arable land is subject to basic arable land protection planning. Administrative, economical legal, technological measures are needed to protect a minimum quantity of arable land for sustainable development.

Last but not least establish and improve land resource information management systems and initiate detailed investigations of land resources, with tools such as GIS, GPS, RS, etc.

1.3.2 Improving The Quality Of Land

Improve land fertility, enlarge irrigation, prevent land contamination, especially arable land contamination, ameliorate middle-and-low-yield arable land that constitutes two thirds of China's arable land. Ecological agriculture will have to be popularized to improve soil fertility by using compost made of stalks, reasonably use of fertilizers, more farmyard manure, and less chemical fertilizers. Investments in irrigation and drainage facilities should be increased with high priority, so as to enlarge the irrigation areas. Industrial pollution, especially that from village and town enterprises, should be prevented and cured by taking measures.

Plant trees and protect the forest. Forest is the main part of terrestrial ecology. We should mobilize more and more people to plant trees and afforest the whole territory.

Shelter-forest is an important measure to improve the ecological environment. New shelter-forest should be established by artificial planting, closing hillsides to facilitate afforestation, and using airplanes to sow tree seeds. We are committed to construct a "Tree-North" shelterbelt, Yangtze River upper and middle reach shelterbelt, and a coastal shelterbelt. Perfect forest administration, and a supervision and monitoring system should be established in order to implement the tree planting and deforestation quota plans.

Prevent, monitor and cure water loss and soil erosion. The increasing population and becoming economy have made the situation of water loss and soil erosion worse. Water and soil conservation system should be established and perfected on the basis of the Water and Soil Conservation Act. The government should withdraw funds from infrastructure construction, agricultural development and relief programs to support the national priority of water and soil conservation areas, such as in the middle reach of the Yellow River, and the upper and middle reaches of the Yangtze River.

Continue to combat desertification. We should set up a system to prevent and cure desertification, to choose priority areas and to construct demonstration areas.

Popularize ecological agriculture. Some ecological demonstration projects have been started in the last decade. This new matter came first from the villages, then spread to the towns, and to counties. To develop ecological agriculture is a necessary choice to realize China's agricultural modernization and also proved a successful approach to the development of sustainable agriculture in line with China's characteristics. In the future, we should first consolidate, reinforce and improve the present ecological agricultural demonstration projects and then build a set of 'ecological agricultural' counties, in coordination with regional development, improvement of low-and-middle-yield-field and 'agriculture commodity base construction'.

Strengthen wetland protection. Wetlands are an important habitat for many plants and animals. China's 25 million hectares of wetlands suffer from long term neglect. In the future, we should formulate wetland protection planning and regulations, so as to maintain the wetland resources.

2. Application of the ECCO Methodology

2.1 An Introduction to ECCO

ECCO (Evolution of Capital Creation Options) is a new procedure for identifying strategies and technologies that can satisfy both economic and environmental long-term aspirations, thus leading to sustainable development (SD). It is a holistic quantitative scientific policy tool based on the concept of natural capital and the link between its depletion and creation of human-made capital (HMC).

ECCO is a dynamic macro-economic physical simulation model. The ECCO model determines the equilibrium between supply and demand, taking account of time lags between the time of decision to invest in HMC, and that HMC becoming functional. Because it comprises some fifty sectors, it is in effect a dynamic input-output facility, which also accounts for capital accumulation and consumption. It uses as its reference the quality of oil, coal and natural gas.

An ECCO model considers the economy in two parts: wealth production and wealth consumption. The ECCO computer program draws its data principally from three sources: national accounts, financial statistics and energy use and resource statistics. Technology, energy, economy, resources, environment interactions are obtained from literature.

Capital stocks in financial terms have to be converted to the primary energy embodied in their creation. As the model is itself an aggregated dynamic input-output device, once the energy data is entered and the structure considered satisfactory, the model endogenously generates the energy intensity of capital stock in the initial year of simulation, using an iterative technique.

Once the modeled is initiated, no money term enters the model, except at the discretion of the user. The simulated outputs are expressed in embodied energy of reference quality or in certain cases like water or food products in other physical units. Thus

- capital stocks are expressed as GJ (10^9 joules)
- output rates are expressed as GJ/Year
- investment rates are expressed as GJ/Year

Output can always be restored to monetary units of a given year, but in general it is simpler and just as informative to express them as a proportion of initial values.

After model validation, a reference profile is simulated, based on the current policies in place. This simulation also produces a number of familiar indicators of economic and social performance, and will form a background against which alternative policy options may be tested. The model does not create any criteria of success. There is no optimization routine. The desired criteria of success are expressed by the user, who can ask for appropriate indicators to be inserted into a particular version of the model.

Once the model structure has been developed and sound data inserted, the range of issues that may be quickly, cheaply and accurately examined by ECCO is vast, and can replace cost-benefit analysis in many circumstances. The model can be run on a desktop computer. Depending on the computer it takes from 30 seconds to five minutes to simulate 40 years. One can compare the outcome of new policies with old, and print the results as graphs or tables.

An ECCO model is a tool for those involved in corporate strategy, local authorities, government, interest groups, environmentalists; indeed anyone concerned with the future development/environment interactions in their country.

2.2 ChinaEcco

As an application of ECCO, the author constructed a dynamic simulation model of China: ChinaEcco, which integrates biophysical and socio-economic analyses. The model includes 30 sub-models, such as population, land use, industry, agriculture, energy, water, environment and so on. The initial year is 1990, and simulating is done for 40 years. The table below shows some indicator trends for China.

Table 2. Predictions after simulation using the ChinaEcco model

Year	1990	2000	2010	2020
Population (billion)	1.143	1.289	1.431	1.564
Arable Land (million ha)	95.67	93.87	92.10	90.00
Forest Land (million ha)	267.4	272	276.6	281.3
Grass Land (million ha)	400	380.5	361.9	344.3
Industrial Output (GJ)	2392	37500	587900	9215000
Energy Supply (GJ)	28.17	44.56	70.5	111.5
Energy Consum (GJ)	28.92	47.23	77.13	126
SO ₂ (million tons)	14.94	24.84	41.3	68.66

3. References

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