

# **Sustainable Land Management: Evaluation for Social, Resource-Environmental and Economic Impacts**

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## **1. Why Evaluation ?**

Land resources are important assets with demand exceeding their supply. It is one core problem of land management to solve the conflicts between demand and scarcity. Studying the sustainable land management and evaluating its social, resource environmental and economic impacts, are effective measures to allocate land resources properly and accomplish their sustainable use.

The two aims of evaluation are: to identify the present problems of land management, and to optimize the land management and land use alternatives for land-use planning.

At present, the studies in this field have not yet produced a sound foundation. In China, the study is only in an initial stage, and is still far away.

China has begun its strategy for its sustainable social, resources-environmental and economic development in 1994. Its economic structure has being transferred from plan-oriented economy to market-oriented economy and its types of economic increase have being transferred from extensive in intensive forms. China has two major “National Policies”: one is “to use land properly and protect arable land practically”, and another is “to protect environment”. To achieve the proper strategies, it is necessary to evaluate the present land use and management, find the problems and seek methods to solve the problems. Now, China is taking its second round of land-use planning at five levels: national, provincial, civic, county and town-farm. They all pursue sustainable land use and need measures to optimize alternatives. Therefore, the study is very important for the reform of land management in China.

## **2. Goals**

The FESLM Working Party in Nairobi (1991) laid a foundation for the following definition of sustainable land management, “Sustainable land management combines technologies, policies and activities aimed at integrating social-economic principles with environmental concerns so as to simultaneously maintain or enhance production/services (Productivity), reduce the level of production risk (Security), protect the potential of natural resources and prevent degradation of soil and water quality (Protection), be economically viable (Viability) and socially acceptable (Acceptability).”

In China, sustainable land management has its own meaning in line with Chinese particular features. These features include its very large population, very scarce arable land, rapid economic growth increase with high-speed and rapidly expansion of the urban areas. Sustainable land management seeks to use land resources properly and scientifically

combined with arable land protection. It should be defined as “sustainable land management leads to use land resources properly and scientifically, combines arable land protection with the use, development and renovation of other natural resources, meets the demands of social and economic development for land, and achieves the best benefits in terms of social, resource-environment and economy.” The objectives of such SLM of China may expressed as follows:

**Protection:** the quantity and quality of arable land resources must be safeguarded. The present total amount of cultivated land must not decrease and should increase gradually with the growth of the population.

**Productivity:** the food productivity of the land must rise.

**Prevention:** the forests and grasslands must be also safeguarded. All land for agricultural use must be protected from loss and degradation. Locally, there may be additional conservation priorities to maintain genetic diversity or preserve individual plant or animal species. In eastern coast urban areas and western arid areas, water resources conservation must be given priority.

**Feasibility:** land use must be economically feasible. To create opportunities for economic development, land management and land-use planning must be geared at reaping economic benefits.

### **3. Factors**

China is a developing country. The land resources are mainly used for feeding its people. These demands are very large. So the social goals always rank first. Of course, economic and environmental successes are also important. So it is essential to balance the social and economic development and environmental protection. The following factors may be used for evaluating the impacts of social, resource-environmental and economic impacts for sustainable land management.

- **Social factors**

**Food security.** China is a country with the largest population in the world. The national government requires each provincial administrative region to provide food security. The land in a region should provide enough food and shelter to the people. A region must accommodate its people, present or projected.

**Employment.** Employment opportunities should be fully provided.

**Exchanges of land tenure.** The rights to use land should be easily exchanged among users in order to keep land use viable.

**Right of minorities.** There are 55 minorities in China. Most regions have more than one nationality. The right and customs of minorities should be guaranteed.

**Social stability.** Sustainable land use helps to mediate disputes between land user. Land resources should be divided fairly and reasonably.

**Customs.** The different customs within a region should be respected by any land use. Some unhealthy customs may be reformed by introducing advanced land use types.

Legal and civil rights. Land use should be in line with just laws and regulations.

Cultural value. Land use must protect valuable cultural heritage.

National interest. Land use must safeguard the national law and political system, territorial integrity and dignity.

- Resource-Environmental Factors

Soil degradation control. Land management or land use should not damage the soil surface and affect soil nutrient levels. Land improvement projects should not lead to soil losses and land degradation.

Water resources. Land management or land use should save water resources and safeguard water for urban and rural areas, especially for the arid area and semi-arid areas. Land use should safeguard potable water resources for people and domestic animals.

Gas Emission control. Land management or land use should not produce harmful gasses and lead to gas pollution. Land use plans should control such pollution.

Solid waste and harmful substance control. Land management and land use must not increase the emission of solid wastes and harmful substances.

Grasslands. Sustainable land management must not destroy grassland. The suitable land for agricultural use should be evaluated. Marginal land cannot be cultivated fully and a certain proportion of the area should be planted to planted grasses and trees to form a green cover.

Woodlands. Natural forests must be protected. In alluvial plains where agricultural land is located, the cultivated land may be agro-forest area. In mountain areas, the valleys can be used for development of agriculture whereas the mountains must be afforested.

Reservations. Land development should not destroy the habitat of wild animals, especially where wild animals are in imminent danger. At the same time, land use and land management may create favorable conditions to help wild animals live. Wetlands are main places where a large variety of wild animals and plants live. They, however, are easy to cultivate and suitable to agricultural uses. Land management and land use should avoid cultivating this land at a large scale.

Natural landscape and entertainment parks. Productivity not only means return of material yield from agricultural and non-agricultural uses, but also includes aesthetic values. So land use and land management may aim to preserve the beauty of the natural landscape and maintain some landscapes as entertainment places.

- Economic Factors

Total GNP. Land use and land management must contribute to economic strength. Total GNP is one of standards of that strength.

Average GNP. In some regions, the average GNP may be more important than total GNP. It also affects the economic position of the region.

Incomes of poor sections. The number of people living in poverty is one index of economic and social equity. Land use and land management must decrease the number of poor people and raise their incomes.

Input-output ratio. Sustainable land management should consume less resource and produce more returns.

Land prices. The prices of a parcel of land are often determined by land scarcity and location. Good land management, use, development and improvement can boost prices. Contrarily, changes of land prices can also affect land use.

Land utilization ratio. All lands are useful. But some lands cannot be used or protected at present due to lack of technology and funds. The land utilization ratio indicates the proportion of lands being used or protected. This reflects the degree of land development.

Land productivity. Land productivity may be expressed in terms of food, other material production or aesthetic value. It is always decided by both natural conditions and land management.

Urbanization. In China more than 70% of the population lives in rural areas. Generally speaking, the higher the urbanization, the higher land productivity.

Ratio of land-based commodities. The products (e.g. food, fiber) may be for consumption or offered for sale. The ratio of goods from land sold reflects the returns of land use to users.

Capability of attracting investments. So the capability of attracting investments, from both domestic and foreign indicates the suitability of land conditions.

#### **4. Procedure**

The procedure of evaluation of social, resource-environmental and economic impacts for sustainable land management includes the following 8 steps.

- Step1.  
Define scope. The region evaluated can be a valley, a geographical unit or an economic region. China's land management system is based on administrative divisions. Among the different levels of divisions, county, town and farm are basic levels. Therefore, evaluation should be done at these three levels.
- Step2.  
Inventory of present land utilization types. LUTs are kinds of land use conform the detailed description. Inventory of present land utilization should include land use types, products and output value, commodity ratio of products, land use system (farming system, livestock system etc.), holdings, labour, investment, technology, infrastructure etc. The purpose of the inventory is to know the real conditions of land resources, use, productivity and management.

- Step 3.  
Define promising land utilization types. Promising land utilization types are determined by the requirements of sustainable land management and land use, and real conditions in the study area. Before defining and choosing, a detailed survey may be needed, including natural, economic, environmental conditions.
- Step 4.  
Evaluate social, resource-environmental and economic impacts. Matching the present land utilization types with the promising ones, the problems of land management and land use can be found. The 30 factors mentioned above can be used for the evaluation.
- Step 5.  
Put forward alternatives of land management and land use. After finding the problems, the next step is to seek the causes of these problems and effective measures to solve them.
- Step 6.  
Conduct land use planning. Through analysis of the alternatives, sound land use planning based on sustainable land management can be conducted. In the course of land use planning, the sustainable land use alternatives should be submitted to all people, section, agencies, policy makers and experts who involve in the land use. The planning must be made in the forms of rules or regulations and laws for implementation.
- Step 7.  
Implement sustainable land management and land use planning. The land use planning is implemented by administrative authorities.
- Step 8.  
Monitoring and revise. While the land use planning is being implemented, new information can be found. The planning needs to be revised according to the changing conditions. After a period of implementation of the planning, monitoring is also needed to check if the plan is suited for the area.

## 5. Quantification of Factors

- Social Factors
  - *Food security* is expressed by the ratio of food guarantee. The information can be obtained by social survey. If the ratio is more than 100%, the value given is 1, which means that the food supply is more than needed and there is “complete security”. If the ratio is exactly 100%, the value given is 0, which means the food production is exactly enough for sustenance and there is “fragile security”. If the ratio is less than 100%, the value given is -1, which means that food production can not feed the people of the region and there is a “security risk”.
  - *Population supporting capacity* is expressed as the ratio of supporting capacity of the land over the present or project population. The information can be obtained by “land productivity assessment”. If the ratio compared with the project population is more than 100%, the value given is 1, which means the lands can not only support the present people but also the project people and the region is produces a “surplus”. If the ratio compared with the present population is more

than 100% but the ratio compared with the project population is less than 100%, the value given is 0, which means the land can only support the present people and the region is “marginal”. If the ratio is below 100%, the value given is -1, which means the land cannot support the people and the region is “critical”.

- *Employment* is expressed by the rate of unemployment. The information can be obtained from statistics. If the rate is less than 10%, the value given is 1, which means almost all labour can be employed and there is “employment security”. If the rate is around between 10-30%, the value given is 0, which means that there is “inadequate employment”. If the rate is more than 30%, the value given is -1, which means “employment risk”.
- *Exchange of land tenure* expressed by the rate of lands entering marketing. The information can be obtained from statistics. If the rate is more than 10%, the value given is 1, which means land markets are well developed and there is a “high turnover rate”. If the rate is 5-10%, the value given is 0, which means the land markets are inadequately developed and there is “mediate turnover rate”. If the rate is less than 5%, the value given is -1, which means land markets are less developed and there is a “low turnover rate”.
- *Rights of minorities* are reflected by the degree of satisfaction of minorities. The information can be obtained by social investigation. If the land uses are satisfactory to more than 90% of the minorities, the value given is 1, which means “high safeguard”. If the land uses are satisfactory to 70-80% of minorities, the value given is 0, which means, “mediate safeguard”. If the land uses are considered satisfactory by less than 70% of the minorities, the value given is -1, which means “low safeguard”
- *Social stability* is expressed by the crime rate. The information can be obtained from statistics. If the rate is less than 1/10000 a year, the value given is 1, which means “highly stable”. If the rate is between 1/10000 and 5/10000, the value given is 0, which means “fragile”. If the rate is more than 5/10000, the value given is -1, which means “unstable”.
- *Customs* are monitored through the degree of satisfaction of people. The information can be obtained by social survey. If more than 90% people welcome changes of the land uses, the value given is 1, which means “beneficial effect”. If 70-90% people agree on the changes in land use, the value given is 0, which means “normal effect”. If less than 70% of the people endorse the changes in land use, the value given is -1, which means “unhealthy effect”.
- *Legal and civil rights* are expressed in the form of “rate of safeguard of laws and regulations”. If the rate is more than 90%, the value given is 1, which means “high safeguard”. If the rate is 70-90%, the value given is 0, which means, “mediate safeguard”. If the rate is less than 70%, the value given is -1, which means “low safeguard”.
- *Cultural value* is expressed in the form of “rate of preservation of valuable cultural heritage”. The information can be obtained by social survey or statistics. If all of the heritage can be protected, the value given is 1, which means, “well protected”. If more than 80% of the heritage can be protected, the value given is 0, which means, “incompletely protected”.

If less than 80% of the heritage can be protected, the value given is -1, which means, “worst protected”.

- *National interests* is expressed in the form of “rate of safeguard”. If the rate is 100%, the value given is 1, which means “favorable effect”. If the rate is less than 100%, the value given is -1, which means “bad effect”.
- Resource-environmental Factors
  - *Soil degradation control* is expressed in the form of “rate of improvement of degenerated land”. The information can be obtained by surveying and monitoring. If the rate is more than 50%, the value given is 1, which means, “well improved”. If the rate is around 20-50%, the value given is 0, which means, “mean improved”. If the rate is less than 20%, the value given is -1, which means “less improved”.
  - *Water resources* is expressed by the form of “preservation rate of water resources”. The information can be obtained by surveying, calculation and monitoring. If the rate is more than 90%, the value given is 1, which means that the water resources are sufficient and can be believed “safe”. If the rate is 75-90%, the value given is 0, which means the water resources are insufficient and “fragile safe”. If the rate is less than 75%, the value given is -1, which means the water resources are in short supply and the situation is “unsafe”.
  - *Water pollution control* is gauged by the standard emission of waste water. The information can be obtained by monitoring. If the sewage is fully treated and the emission reaches the standard, the value given is 1, which means “well treated”. If the sewage is treated by 80-100%, the value given is 0, which means, “mediately treated”. If the sewage is treated for less than 80%, the value is given -1, which means “less treated”.
  - *Gas pollution control* is gauged by the form of degree of emission relative to the standard. The information can be obtained by monitoring. If the harmful gases are fully controlled and the emission reaches the standard, the value given is 1, which means, “well controlled”. If the harmful gases are controlled for more than 80%, the value given is 0, which means, “mediately controlled”. If the harmful gases are controlled less than 80%, the value given is -1, which means “less controlled”.
  - *Solid wastes and harmful substance control* are expressed in the form of a “treatment rate”. The information can be obtained by monitoring. If no accumulation of solid wastes and movement of harmful substances exist or the treatment is 100%, the value given is 1, which means, “well controlled”. If the rate is 80-100% and waste emission is within the environmental capacity, the value given is 0, which means, “mediately controlled”. If the rate is less than 80% and the waste emission exceeds the environmental capacity, the value given is -1, which means “less controlled”.
  - *Grassland* is judged by the rate of grassland degeneration. The information can be obtained by surveying and monitoring. If the rate is less than 10%, the value given is 1, which means “well protected”. If the rate is 10-40%, the value given is

0, which means, “mediately protected”. If the rate is more than 40%, the value given is -1, which means “less protected”.

- *Woodland* judged by the increase rate of woodlands within 10 years. The information can be obtained by surveying and monitoring. If the woodlands increase by more than 5%, the value given is 1, which means “positive effect”. If the rate is less than 5% and more than 0, the value given is 0, which means “neutral effect”. If the rate is less than 0, the value given is -1, which means that the woodlands deteriorate and there is a “bad effect”.
- *Reservations* are judged by their “good” or “bad” effect. The information is obtained by surveying and monitoring. If the conditions are improved, the value given is 1, which means “good effect”. If the conditions remain unchanged, the value given is 0, which means “no effect”. If the conditions get worse, the value given is -1, which means “bad effect”.
- *Wetland* is judged by the increase/decrease of plant and animal species. The information can be obtained by surveying and monitoring. If the number of species increases, the value given is 1, which means “good effect”. If the species remain unchanged, the value given is 0, which means “no effect.” If the number of species decreases, the value given is -1, which means “bad effect.”
- *Natural landscape and entertainment parks* are judged by the increase/decrease of people attracted by the region. The information can be obtained from statistics. If the number remains unchanged, the value given is 0, which means “no effect”, If the number decreases the value given is -1, which means “bad effect”.
- **Economic Factors**
  - *Total GNP* is judged by its rate of increase by region and per year. The information can be obtained by general investigation or statistics. If the increase rate is more than 10%, the value is given 1, which means “high benefit”. If the rate is 5-10%, the value given is 0, which means “general benefit”. If the rate is less than 5%, the value given is -1, which means “low benefit”.
  - *Average GNP* is expressed in the form of “increase rate of GNP per capita per year”.  
The information can be obtained from statistics. If the rate is more than 10%, the value is given 1, which means “high benefit”. If the rate is 5-10%, the value given is 0, which means “general benefit”. If the rate is less than 5%, the value given is -1, which means “low benefit”.
  - *Incomes of the poor section* is expressed by the number of people living in poverty. The information can be obtained by general investigation or statistics. If the number decreases by more than 10% a year, the value given is 1, which means “good effect”. If the number decreases by 5-10% a year, the value given is 0, which means “general effect”. If the number decreases by less than 5% a year, the value given is -1, which means “no effect”.
  - *Ratio of input-output* is expressed by the returns of input of land use. The information can be obtained from statistics. If returns are 50% more than inputs,

the value given is 1, which means “good effect”. If returns are 25-50% more than inputs, the value given is 0, which means “general effect”. If return is less than 25% more than input, the value given is -1, which means “no effect”.

- *Land prices* are judged by the degree of stability of land prices. The information can be obtained by appraisal. If the increment of the land price is more than 10% a year, the value given is 1, which means “good effect”. If the increment is 5-10%, the value given is 0, which means “general effect”. If the increment is less than 5%, the value given is -1, which means “no effect”.
- *Land productivity* is expressed by the proportion of recent land productivity compared with productivity potential. The information can be obtained by “land productivity assessment”. If the proportion is more than 80%, the value is given 1, which means “high productivity”. If the proportion is 60-80%, the value is given 0, which means, “mediate productivity”. If the proportion is less than 60%, the value is given -1, which means “low productivity”.
- *Urbanization* is expressed by the urbanization rate. The information can be obtained from statistics. If the rate is higher than the average rate of the country, the value given is 1, which means “high urbanization”. If the rate is same of average rate, the value given is 0, which means, “mediate urbanization”. If the rate is lower than average, the value given is -1, which means “low urbanization”.
- *Ratio of land-based commodities* can be obtained from statistics. If the ratio is 10-50%, the value given is 0, which means, “mediate effect”. If the ratio is less than 10%, the value given is -1, which means “bad effect”.
- *Capability of attracting investment* is expressed by the rate of increase of investment. The information can be obtained by surveying and prediction. If the rate increase by more than 10% a year, the value given is 1, which means “good effect”. If the rate is increase by 1-10%, the value given is 0, which means, “mediate effect”. If the rate increase by less than 1%, the value given is -1, which means “bad effect”.

## 6. Information Sources and Aggregation

In paragraph 5, the main information sources of factors were given. Generally speaking, the information of social factors is obtained through social survey, the resource, environmental factors through survey and monitoring, and economic factors are determined through statistics. Different factors have different sources of information. There are 5 kinds of sources: survey, calculation, prediction, statistics, monitoring and appraisal. Table 1 gives the 5 ways by which information can be obtained.

Through the evaluation of each factor, the individual value of the factor can be easily got. In order to evaluate the situation of sustainable land management and land use for whole region, it is necessary to aggregate the values into total index. After aggregation, the following standard may be helpful for understanding what the situation of the region is:

- sustainable land management, total index more than 25, the value of more than 20 factors is 1 and the remaining factors are 0 at least
- maintainable land management, total index more than 10, the value 20 individual factors is 1 or 0 at least

- extensive land management, total index less than 10, the value of more than 10 individual factors is 0.

**Table 1. Ways of Obtaining Information of Each Factor**

	Survey	Calculation	Prediction	Statistics	Monitoring	Appraisal
<b>Social factors</b>						
-food security	*	*	*			
-population supporting capacity		*	*	*		
-employment	*			*		
-exchanges of land tenure	*			*		*
-rights of minorities	*					
-social stability	*			*		
-custom	*					
-legal and civil right	*					
-cultural value	*					*
-national interests	*					*
<b>Resource-environment Factor</b>						
-soil degradation control	*	*			*	
-water resources	*	*			*	
-water pollution control	*				*	
-gas pollution control	*				*	
-solid waste and harmful substance control	*				*	
-grassland and wetland	*				*	*
-woodland	*				*	*
-wild animal dwell land	*				*	*
-natural landscape and entertainment	*				*	*
<b>Economic Factors</b>						
-total GNP			*	*		
-average GNP		*	*	*		
-incomes of poor section	*			*		
-ratio of input-output		*	*	*		
-land price						*
-land utilization ratio			*	*		
-land productivity		*		*		
-urbanization			*	*		
-ratio of land-based commodities			*	*		
-capability of attracting investment	*		*	*		

## 7. Example

A county in Inner Mongolia of North China is selected as example. The county, Wengnute Qi, is located in the south part of Inner Mongolia. The total area is 11,878 km<sup>2</sup>. The population is 420,000. There are 6 minorities in the county. The landforms include tableland, hills, mountains and sandy lands. The present land utilization types identified are intensive irrigated agriculture, rainfed agriculture, nomadic livestock husbandry, fenced livestock husbandry, natural forestry and processing industry. The promising land utilization types are determined as intensive irrigated agriculture, intensive livestock husbandry, protectable forestry and high benefit processing industry. The present land utilization types should be changed into the promising types. It is essential to evaluate social, resource-environmental and economic impacts for setting up sustainable land management. The 7 items of studies are made. They are evaluated for agriculture, livestock husbandry forestry, transportation, energy resources and water resources. Finally, the situation of the present land management is evaluated and summed in table 2.

The total index for the study area is 5. This implies that there is “extensive land management”. To achieve the goal of sustainable land management, the following measures must be implemented: increase food production, protect cultural heritage, control soil degradation, improve grassland, protect woodland, improve wild animal habitats, increase the land utilization ratio, increase land productivity and increase urbanization.

**Table 2. Evaluation of Social, Resource-environmental and Economic Impacts**

	<b>Results</b>	<b>Values</b>
<b>Social factors</b>		
-food security	feeding 80% present population	-1
-population supporting capacity	supporting project population	1
-employment	unemployment rate 3%	1
-exchanges of land tenure	10% per year	0
-rights of minorities	95% guaranteed	0
-social stability	crime rate 1/10000	1
-custom	no effect	0
-legal and civil right	no effect	0
-cultural value	48% production	-1
-national interests	100% guaranteed	1
<b>Resource-environment Factor</b>		
-soil degradation control	severe	-1
-water resources	95% preservation	1
-water pollution control	reached standard	1
-gas pollution control	reached standard	1
-solid waste and harmful substance control	controlled	1
-grassland and wetland	70% degradation	-1
-woodland	30% destroyed	-1
-wild animal dwell land	decreased 20% within 10 years	-1
-natural landscape and entertainment	no effect	1
<b>Economic Factors</b>		
-total GNP	8.9% increase a year	0
-average GNP	5.2%increase a year	0
-incomes of poor section	no people live in poverty	1
-ratio of input-output	1:1.5	0
-land price	no change	0
-land utilization ratio	59.5%	-1
-land productivity	55%potential	-1
-urbanization	15.3%	-1
-ratio of land-based commodities	61%	1
-capability of attracting investment	1increase 10%	1

## 8. Needs for Further Studies

The paper introduces some results of my study. In many aspects, it is necessary to improve. The following aspects may be important:

- reselecting factors;
- improving procedures;
- studying quantification;
- using new technologies.