

A SYSTEM DYNAMICS MODEL AND POLICY ANALYSIS
FOR RURAL SOCIO-ECONOMIC DEVELOPMENT
OF A PROVINCIAL LAKE AREA

Zhang Nai-guang Hu Cheng-hong
Shanghai Jiao Tong University, China

ABSTRACT

This paper is based on the historical and current situation of rural socio-economic development of a provincial lake area. At present, economic development of the lake area is considerably lag behind. Meanwhile, there exist rich natural resources and hidden unemployment of rural population. By describing the several facets of difficulty facing the lake area, the author addresses the issue of adjusting industry structure of the entire lake area, upon which the System Dynamics approach is employed in modeling and policy analysis.

The System Dynamics Model of the lake area rural socio-economic development consists of 8 sub-models, which are farming, fishery, animal husbandry, rural industry, forestry and side-occupation, energy, water conservancy and population. By simulating and analysing, policy recommendations are set force.

Introduction

A provincial lake area in which the cultivative condition is considerably advantageous used to be flourishing in traditional agriculture. But presently the economic development of the lake area is in the face of difficult position. Recently the reform of rural economic system in China has aroused the farmers' enthusiasm for farming, and the rural gross social product of the lake area has been increased greatly. Because the state of irrational industry structure has been varied little, the momentum of increasing rural gross social product is being weakened. On the other hand, there exist hidden unemployment of rural population, local deficit financing, water conservancy facilities in bad repair, the shortage of funds for construction, undeveloped culture and education. Meanwhile, there are 1.66 million mu unexploited aquatic water area and 2.00 million mu unexploited grassy islet by the lake. One word, the above-mentioned difficulties are almost associated with the problem of irrational industry structure. Therefore, the key to the economic development of the lake area, in detail, is exploiting natural resources of the lake area for developing animal husbandry and fishery, opening all avenues for developing rural industry, and accomplishing the transform of the labor force from farming to fishery, animal husbandry and rural industry, ect.

Because the modification of industry structure is connected with almost economic processes and multi-subsystem, among which there

exist multiplicate and complex relationships, it is very difficult to study such complicated problem with the help of quatitative analyses in a relatively long span of twenty years. So we consider it is appropriate to study the problem using System Dynamics approach.

Modeling

As figure 1 shows, the System Dynamic Model of the lake area consists of eight sub-models, which are farming, fishery, animal husbandry, rural industry, forestry and side-occupation, energy, water conservancy and population. First, there exists the problem of rational investment ratio among there subsystems. Next there exists the relationship of input-output in each subsystem of economy. The profits derived from the current year rural gross social product are partly converted into accumulation, which are added to the funds of investment from outside system, form the input funds of the next year. Then we take into consideration of the relationships among subsystems. The sub-model energy, population and water conservancy are considered as social capital and manpower capital for economic development. The effects to the farming output value from water conservancy are presented by the multipliers of effective irrigation area and cultivated land area by dykes. The economic growth will raises the demands of energy and labor force, but the satisfied level of the supplies will affect the policies for energy and labor force. Energy supplies most come from external system, the rest come from internal system. The straws used for domestic fuels will reduce the amount of those returned to the cultivated land and affect the output value of farming. Meanwhile, the grasses on the lakeside used for fuels will reduce the amount of those fed for livestock. Moreover, the growth of population will affect the level of rural gross social product per capita. Between the subsystem farming and fishery there exists a relationship --- the increase of cultivated land by enclosing the lake will cut back the lake area, further affect the output value of fishery.

In order to construct a model of economic system, at first, we have to describe the mechanism of basic economic growth. figure 2 is a graphical presentation of Harrod Domar model --- economic

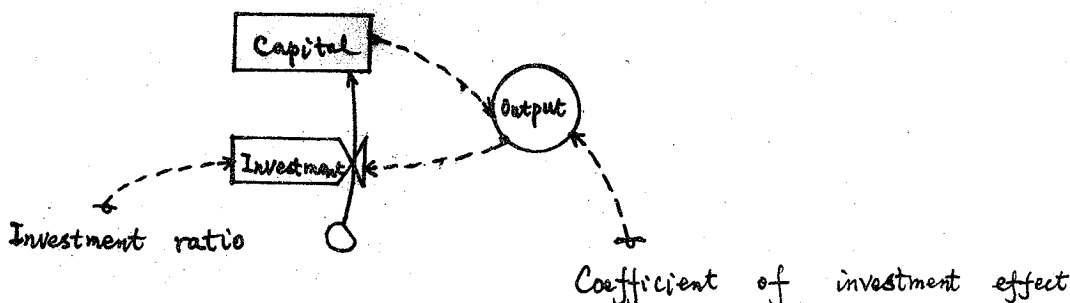


Figure 2

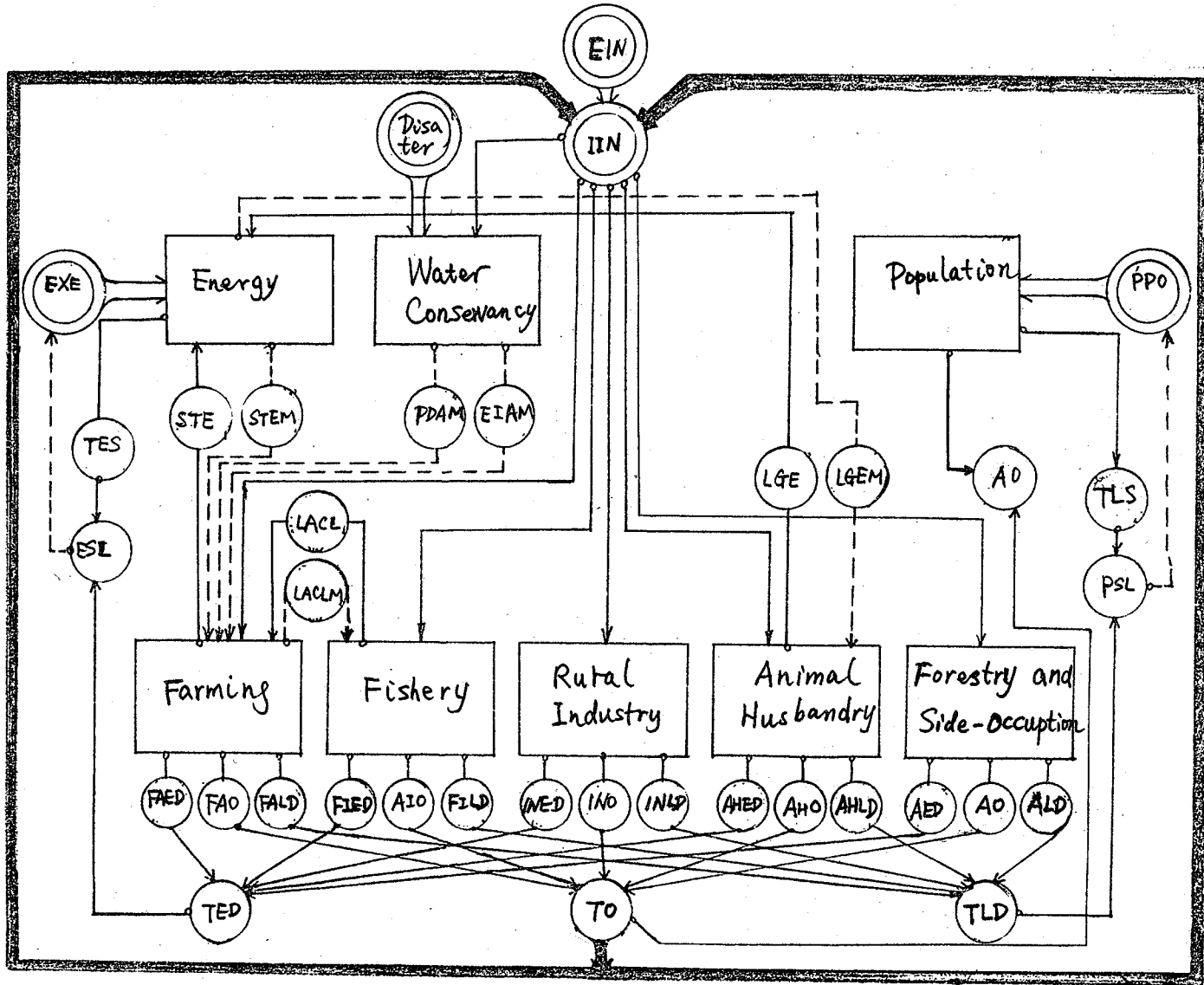


Figure 1

growth rate = investment rate * coefficient of investment effect. There is no competitive substitution between labor force and funds in the lake area because of the absolute surplus of the supply of labor force. Under this circumstances, the growth mechanism is applicable for industry and agriculture. The growth mechanism may be described as follows: the current year deposit is transformed into investment, and the productive capacity is increased --- the next year total income is increased. This income will promote more deposit, investment capital formation and more income. By simulating and analyzing, the following issues will be studied and policies recommendations will be set force.

- * Dynamic pattern of industry structure which will bring about overall and long term benefits
- * Employment structure of labor force which corresponds to the structure of industries.
- * Conditions of capital and energy for maintaining structural variation
- * Appropriate population growth policy
- * Rational proportion between the investment to water conservancy and the investment to natural resource exploitation and production
- * The requirement for transportation, education, communication, technology advancement, improving market environment

This model consists of 18 level variables, 253 variables and 373 equations. The time span of simulation is from 1980 to 2000.

Policy Analysis

in the model, the selection of policy options for the adjustment of industry structure is implemented by changing the investment structure to different sectors. Owing to the fact that conditions of the lake area are complicated in the coming fifteen years. Therefore, according to different conditions, we have designed tens options by computer simulation. The following three options are typical ones. For the three options, the common assumptions exist:

1. The birth rate of women keeps the level of 1985, i.e. 3.94 babies
2. The final energy conversion rate keeps the level of 1985, i.e. 14.08%

Table 1 is a table of comparison for investment structure variation. For option 1, the investment ratio between different industry sectors keeps unchanged from 1985 to 2000. For option 2 and 3, fairly big changes occur.

Table 2 is a comparison of industry structure variation for the three options. It indicates that different investment structure variation.

Fig.3 is the growth curve of rural gross social product for

Time	Option	Farming	Fishery	Rural Industry	Animal Husbandry
1985	Option 1	64.20%	2.830%	8.837%	20.435%
	Option 2	64.200%	2.830%	8.837%	20.435%
	Option 3	64.200%	2.830%	8.837%	20.435%
1990	Option 1	64.200%	2.830%	8.837%	20.435%
	Option 2	43.000%	9.030%	15.837%	26.435%
	Option 3	35.000%	9.030%	23.837%	26.435%
1995	Option 1	64.200%	2.830%	8.837%	20.435%
	Option 2	27.000%	15.030%	28.837%	26.435%
	Option 3	20.000%	13.030%	41.837%	20.435%
2000	Option 1	60.20%	4.830%	10.837%	26.435%
	Option 2	15.000%	15.030%	41.837%	26.435%
	Option 3	10.000%	16.030%	50.000%	20.435%

TABLE 1

Time	Option	Farming	Fishery	Rural Industry	Animal Husbandry
1985	Option1	54.76%	3.97%	25.59%	13.95%
	Option2	54.76%	3.97%	25.59%	13.95%
	Option3	54.76%	3.97%	25.59%	13.95%
1990	Option1	45.44%	3.23%	37.89%	11.96%
	Option2	35.21%	7.85%	41.48%	13.53%
	Option3	31.08%	7.57%	46.62%	12.85%
1995	Option1	39.50%	2.92%	45.57%	10.69%
	Option2	20.26%	8.71%	57.93%	12.13%
	Option3	14.54%	6.90%	68.77%	8.48%
2000	Option1	33.12%	4.28%	50.70%	10.59%
	Option2	9.92%	6.23%	72.16%	11.20%
	Option3	6.41%	4.76%	81.49%	6.37%

TABLE 2

option 1. In option 1, the output of farming has a high percentage in the rural gross social product. Hence, natural disaster has serious impact upon the output of rural social gross product, as well as output of farming. In fig. 3, the considerable fluctuation of gross output is a good example. By the year

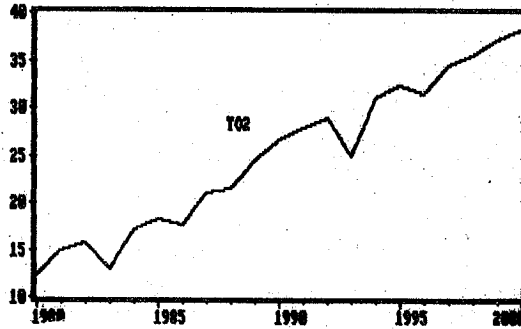


Figure 3

2,000 the rural gross social product is only 3.8 billion which is 3.094 times of that of the year 1980, and the rural gross social product per capita is 524.53 yuan. At the same time, the unemployment rate will reach 56.67%. In addition, the natural resource utilization ratio is very low for the lake area. After the year 1986, no new development of ponds for fishery will be exploited, and up to the year 2,000 only 500 thousand mu grassy islet will be exploited, which corresponds a quarter of the total grassy islet area.

Fig.4 shows the growth curve of the rural gross social product for option 2, in which there is a big industry structure variation. Therefore, the impact of natural disaster upon the gross social product will be low. By the year 2,000 the rural

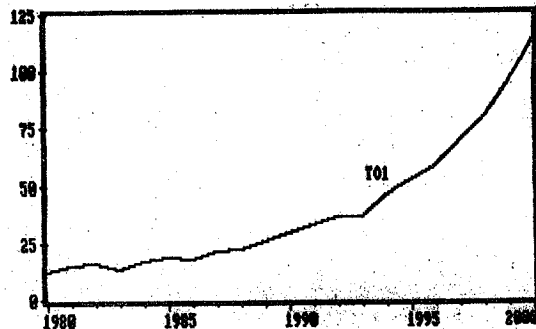


Figure 4

gross social product will be 11.377 billion yuan, which is 9.265 times of that of the year 1980. Furthermore, the employment rate will reach 86%, and 2 million mu grassy islet will be exploited. Fig.5 shows the growth curve of the rural gross social product for option 3. The industry structure variation for option 3 changes dramatically compared to option 2. The reason for this big variation is that we have made considerable adjustment of investment ratio between farming and industry. By the year

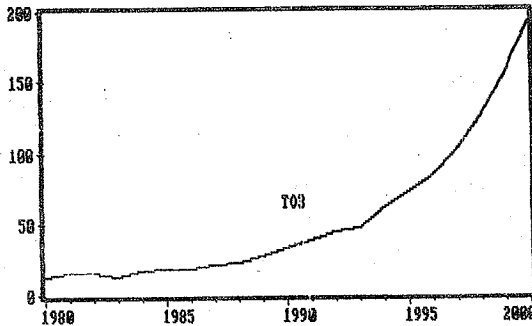


Figure 5

2,000 the rural gross social product will reach 19.319 billion yuan which is 15.732 times of that of the year 1980. Output per capita will be 2639.4 yuan. Industry will dominate the lake area, the output of which will be 81.49% of the total output. The demand for labor force supply and employment structure will be very high corresponding to the high speed growth of economy and industry structure variation.

The above-mentioned three options are based on the idea that the adjustment of industry structure will push economic growth. The variation of industry structure will lead to economic growth and the utilization of natural resource. Meanwhile, corresponding requirements for variation of employment structure, labor force supply, energy policy, funds, ect. must pay special attention resulting from industry structure variation.

In sum, the model provides a vehicle for experimentation for the decision makers of the local government of the lake area in devising socio-economic development plans and policies. The options and analyses presented will be useful for the socio-economic development of the lake area.