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Sustainable Development Model and Simulation for Yellow River Delta Based on Land Use Information

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Abstract: Along with the rapid development of the Yellow River delta's economy, the contradiction between population, environment, and resource is highlighted, the land problem has more and more influence to the human survival, and the sustainable use of the land becomes necessary for the coordination and getting along with the human and the natural environment. Based on the land information, we analysis and simulate the sustainable development of the Yellow River delta area. By analysis the system structure of land use and the relationship between each subsystem, we construct a dynamic model of regional sustainable development based on land information. Then put the yellow triangle area of Binzhou city as a case to simulate the development models under different constraint conditions of land use. Using the principle of system dynamics to simulate the dynamic change of land using under study area, account for the regional sustainable development system, quantify the influence from the land using change on the sustainable development of the yellow triangle area, and predict the evolution trend of studying regional land using in the future.

Keywords: Distortion the yellow river delta area, land information, predict, regional sustainable development, system dynamics.

1. INTRODUCTION

The development history of human is a historical process which is the improvement of the cognitive of human to the natural environment, the increase of the use of it and the reform of it. However, with the continuous development of economy, population is an exponential growth and its density is a growing tendency. The contradictions between population, environment and resources are increasingly highlighted. The regeneration of resources can not meet human demand for natural resources. Land issue has more and more influence to human existence. The sustainable use of land becomes an important and necessary qualification, which makes human beings and the nature get along well with each other [1-3].

The challenge in the 21st century, the opportunities of era, the rapid development of our country's economic and social steady stability in our country's sustainable development and land use are closely related. In recent years, our country regards tide of sustainable development view, pay attention to the comprehensive consideration of the natural environment, social and cultural, etc. On the basis of robust to maintain rapid economic growth, the land is one of the most important natural resources, is a very important part of the form of compound ecosystem. It is also the foundation of human life, economic activity. At the same time, the land use is an ecological city and environment friendly city and the development important foundation. Land use change will play a decisive role to the sustainable development of economy and society [4-7].

The aim of this paper is to elucidate how sustainable development of Yellow River Delta, special in land use. Since the system dynamics (SD) model can deal with dynamical processes with feedback and predict the complex system change under the different "what-if" scenarios, it has been widely used in different fields of natural science, social science and engineering technology. Recently, powerful ability of SD model to reflect complexity of land use driving forces has also been concerned and demonstrated. However, SD model's ability to represent the spatial process is weak because it cannot deal with a mass of spatial data well and cannot describe the distribution and situation of those spatial factors in the system [8-10].

So, how to develop the land development planning to improve the regional competitiveness is essential to promote the efficient ecological development of economy and the improvement of the national coastal economic drama. In order to elucidate the sustainable development of Yellow River Delta in land use, we construct the system dynamics model of land use.

2. POSSIBILITY OF SYSTEM DYNAMICS APPLICATION IN REGIONAL SUSTAINABLE DEVELOPMENT

This paper introduces the system dynamics to study the sustainable development of regional land information based on mainly because of the sustainable development of regional land based information has the following characteristics:

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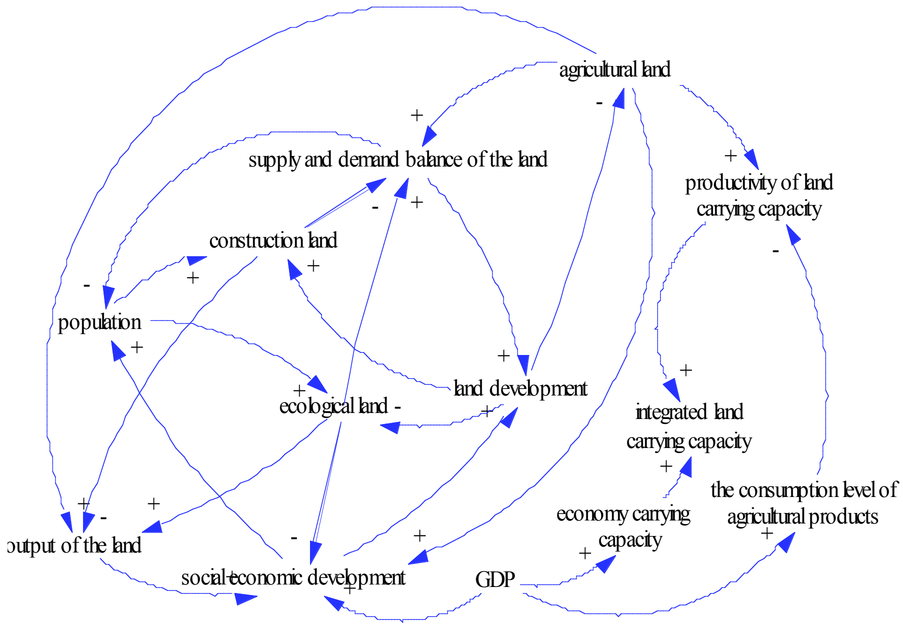

Fig. (1). Sustainable development model of land information area of the yellow river delta causal feedback.

(1) Due to the limited resources of land use, and there is an increasing demand for land resources and human resources to maximize and the allocation of resources of the conflict between the larger and larger.

(2) The regional sustainable development based on the land information system is a complex dynamic nonlinear relationship, there are many variables and parameters, and a table function, general function and so on, can deal with the complex and dynamic issues.

(3) The system of regional sustainable development of basing on land information in the material, information flow have nonlinear clear organizational structure, have an inseparable relation with organizational structure system. Therefore, it cannot use a linear system to describe the regional sustainable development of basing on land information system. In addition, system dynamics can be solved, which exists in the system of regional sustainable development of basing on land information in constant time delays and multiple feedback problems.

(4) Insufficient data and difficult to quantify the data is often difficult problem encountered in the study, the model of system dynamics is based on the feedback loop for infrastructure, which is good at solving problems existing system of multiple feedback loops [12-14].

3. REGIONAL SUSTAINABLE DEVELOPMENT MODEL BUILDING BASED ON SYSTEM DYNAMICS

The system border is one of the variable factors of system, which is used to determine the scope of the study object of study. It is generally believed that all the factors that have a significant impact on system performance should be pack inside the system the system environment is outside the boundary and related parts In this paper, within the system boundary effect based on the land information of all the important factors for the sustainable development of Yellow River delta are included, this article proposed the subsystems of population, resources, land use structure and the transformation of subsystem and economic subsystem, by these subsystems around the Yellow River delta regional sustainable development system based on land information, not only can compare to the sustainable development of comprehensive analysis, can also check the correctness of the sustainable development [3, 11].

According to principle of SD need to establish a variable set of each subsystem design model, we select the main variable system of sustainable development of Yellow River Delta regional based on land information as shown in (Fig. **1**): Construction land, cultivated land, garden land, water, forest land and unused land connected between each subsystem, jointly safeguard the sustainable development of the Yellow River delta area. Build based on the information of land use dynamic model for the sustainable development of Yellow River delta area, to be able to influence factors for the sustainable development of Yellow River delta area and variables as a whole to study and intuitive and comprehensive is its main characteristic. The following is based on the sustainable development of land information area of the Yellow River delta causal feedback:

Basing on the analysis of the whole structure about the Yellow River Delta Region's sustainable development, combining with the connections between different factors and according to the demand of systematical dynamic's model [15, 16], we need to establish sub-system of the overall system for further step. The overall system can be divided into many parts, for instance, sub-system of resources, population, economy and the structure of land transform. It's necessary for us to set different sort of models with variables to satisfy the needs.

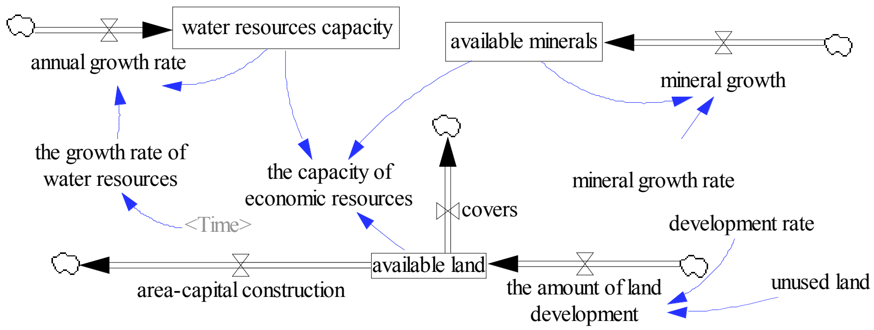

Fig. (2). Changes in resource subsystem flowchart.

3.1. Sub-System of Resources

Resource is made up of land, water, mineral nature resources and their exploitation and utilization system. Meanwhile, the human social and economic constantly develop, which their own continually provide material and energy circulation. However, the total resources are limited, the unreasonable use of resources will lead to insufficient resources and ecological environment is destroyed [16]. It has negative effect on the sustainable development of social economy. Capacity of water resources, mineral and available land, is respectively determined by water annual increment, mineral resources in growth and land construction, capital construction elements. Set capital construction and cover the land as constant, mineral growth, the growth rate of water resources and land development rate combine the data of former years.

The following equation subsystem resources changes as shown in (Fig. **2**):

Available Land=INTEG(The amount of land development-Area-capital construction, based on available land area) (hectares)

The amount of land development=Unused land ×Development rate

Available minerals=Available minerals×Mineral growth

Water volume growth=Water resources capacity×The growth rate of water resources

The capacity of economic resources=Available Land+ Available minerals+ Water resources capacity

3.2. Population Subsystem

Population and the quality is the most important factor in regional development. In the sub-population, the number of population is determined by the amount of population the amount determined by birth and death, the amount of labor is determined by the amount of labor to move to vacate the decision, labor immigration rate and quit rate and population birth and death rates are obtained by fitting the data by the calendar year in which the population of the birth and death rates in line with the normal distribution.

Total population = (birth population-mortality population, based on the total population) (million)

Mortality population=total population × death rate (million)

Birth population= total population × birth rate (million)

Amount of labor=(Labor migration quantity-Labor emigration quantity + birth population ×its proportion of population- mortality population × its proportion of population, based on labor force)

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Labor emigration quantity=amount of labor × Labor emigration rate (million)

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3.3. Economic Subsystem

Economic subsystem is the material basis of sustainable development. In Figs. (**3** and **4**), the state variables GDP are determined by growth in GDP. And instrumental variable such as GDP growth rate is based on historical data fitting.

The subsystem of economic change's equation as follows:

GDP=INTEG (GDP variation, base period's GDP summation) (billion yuan)

GDP variation=GDP*GDP growth rate (billion yuan)

per capita GDP=GDP/ total population (Million yuan)

Economy carrying capacity=(GDP- investment in the fixed assets)/ the average consumption expenditure

The average consumption expenditure= Per capita consumption expenditure of rural residents + Per capita consumption of urban residents

The Engel coefficient of urban residents = The per capita living consumption expenditure of urban residents/ The food consumption of urban residents per capita expenditure

The Engel coefficient of rural residents= the per capita living consumption expenditure of rural residents/ the food consumption of rural residents per capita expenditure

Investment in the fixed assets=GDP* Investment in fixed assets ratio.

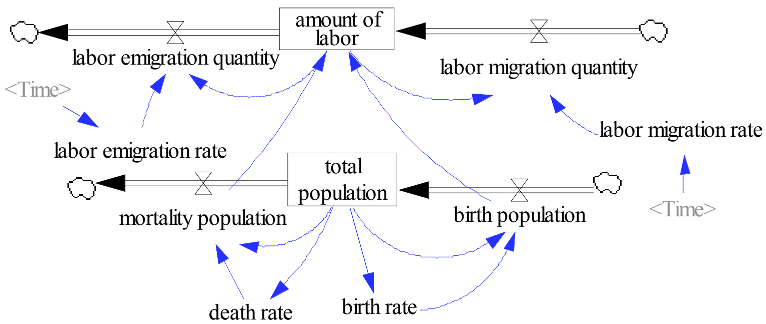

Fig. (3). Changes of population subsystem.

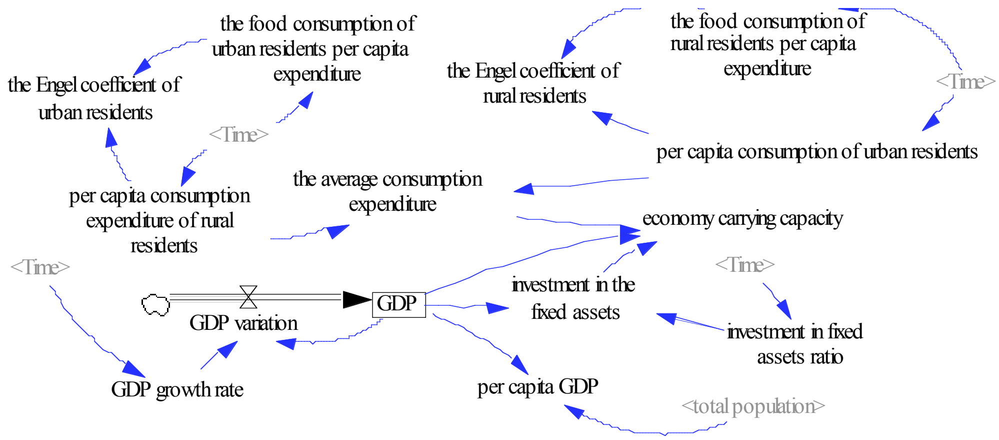

Fig. (4). Flow chart of economy subsystem.

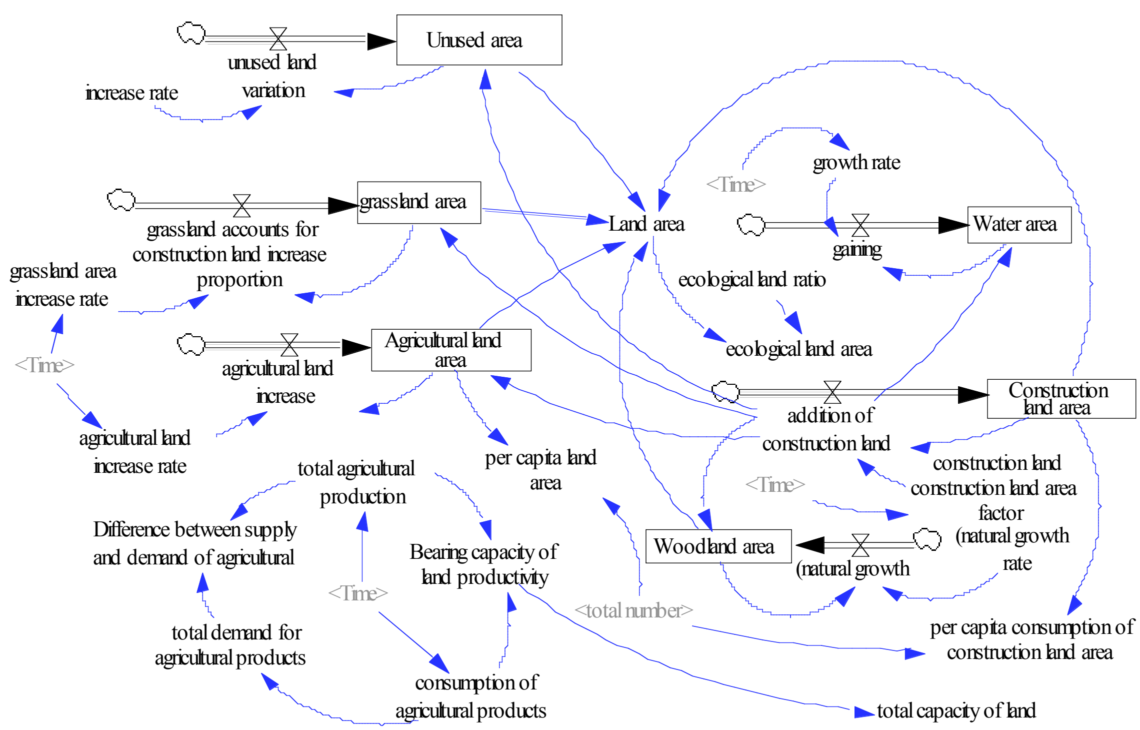

Fig. (5). Land use structure and transformation subsystem flow chart.

3.4. Land Use Structure and its Optimization Subsystem

The main contain of the general land use planning is land use structure optimization [19, 20]. Modeling with a sense of purpose, prepared as in Fig. (**5**) transformation of land use structure and subsystems such as the structure of the flow chart. This subsystem is the key to regulating circuits used in all kinds of conversion factors, And by controlling the size of these factors to balance various area. State variables obtained by its variation and fitting the growth rate from the previous data obtained.

Land use structure and conversion subsystem equations as follows:

Bearing capacity of land productivity = total agricultural production/consumption of agricultural products= agricultural land area of agricultural production by agricultural single output (ten thousand tons)

Difference between supply and demand of agricultural = total agricultural output - total demand for agricultural products (ten thousand tons)

Construction land area = INTEG (base of addition of construction land, construction land area) (ha)

Construction land gaining = Construction land area x construction land construction land area factor

Woodland area = INTEG (natural growth - the increase of construction land proportion of x, base of forest land area) (ha)

Woodland natural growth = area x growth rate(ha)

Water area = INTEG (gaining - water area of construction land increase proportion of x, base water area) (ha)

Agricultural land area = INTEG (agricultural land increase - the increase of construction land proportion of x, base of farmland area) (ha)

Gaining= INTEG (grassland area, grassland accounts for construction land increase proportion of x, grassland area of base) (ha)

Unused area = INTEG (-unused land variation - the increase of construction land proportion of x, base unused area) (ha)

Land area = agricultural land area + area of construction land, unused land area + woodland area, grassland area (ha)

4. SIMULATION MODEL

Taking Binzhou city as an example, to study the regional sustainable development, according to the number, population in this area in the birth rate, mortality rate, the amount of labor and immigration and emigration area distribution of each land type, variation of GDP, urban and rural Engel coefficient data, determine the basic parameters required for the model, simulation was carried out with the analysis of the regional system based on the sustainable development of Yellow River Delta regional land information.

4.1. Basic Simulation Model Assumptions and Calculation of Parameter

In the process of building regional sustainable development research simulation system model based on land use information in this area, our several primary simplify and hypothesis are as followings: The land type of this area has mostly land and water, among them, the land can be divided into agricultural land, field of graze, forest land, the land of not take advantage of as well as construction land. The total amount of population is only relevant to the population of born and measure and the death amount. Most of us only consider the change of each type of land, but we don't take into account the situation of transform of each type of land.

According to the nature of the parameters, the selected proportion of different types of formulas derived by using the expertise of statistical data in previous years, based on the use of statistical methods, forecasting techniques, accounting methods and other mathematical methods to estimate the parameters of the model to the Yellow River Delta sustainable development forecasting system simulation analysis, and through the analysis of the model, with a better policy recommendations on issues of sustainable development in Binzhou. This model system Yellow River Detal region boundary in BinZhou city.

4.2. The Imitative Operation and Analysis of Model

The boundary of time is 2010 to 2030 years, a total of 20 years. The main historical data is 2006 to 2011 data, taking 2009 as the basic year simulation. By adjust the parameters of the model, we divide the development model into natural development model, coordinated development model and rapid economic growth model. we get the predit value. See Table **1** in detail.

From the various types of land area changes, we can see

Table 1. The center coordinates of each layer of ancient pagoda.

	Natural Development Model			Coordinated Development Model			Rapid Economic Growth Model		
	2010	2020	2030	2010	2020	2030	2010	2020	2030
Unused area	32701.6	24536.6	14890.7	32459.8	22287.5	11408.2	32367.1	21470.6	10219
Land area	759899	785321	814362	759350	778588	799479	758886	773122	788222
Water area	208152	185521	166355	208152	185521	166355	208152	185521	166355
forest area	23185	29997	39380	22877	25514	27979	22507	20864	17911
Usably land area	556725	555873	553875	557006	558343	557439	557461	562439	563555
fixed asset investment (unit: 10^8 Yuan)	159.06	506.33	1200.08	477.18	1519	3600.2	715.76	2278.5	5400.4
Land comprehensive carrying capacity	1.3411	1.5718	1.9399	1.1603	1.166	1.3723	1.0141	0.9166	1.0405

that between 2009 and 2030 the total area of land type have a tendency to change in Binzhou, the construction land is increasing, the unused land and water area are continuous decreasing. Agricultural land areas are always unstable, wood land and meadow are steadily rising. The construction land has the rapid speed to development, a net increase of 75122 hectares, adding 45%. Reflecting a obvious tendency that Binzhou will development the urbanization in the future 30 years, during that time, the agricultural land area have a tendency to decline, but the increasing population makes people to widen the demand for agricultural product, and technology is become more and more important. People are having a large demand for living environment, making the green environmental protection to the agenda, the country take the returning farmland to forest and grassland policy, the area land of wood land and meadow are increasing, but the total area of the land is certain in Binzhou, there are area of growing demand, but we must also have reduced demand, with the explosion of unused land, unused land area decreased rapidly, and continuously reclaiming land from lakes caused the decrease of water area.

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According to the model prediction, all population capacities present a growth trend, while the quantity of labor force grows in a slow speed. Bin Zhou city has a large population base, and due to the birth control population shows a growth tendency. With the rapid development of economy, people's living standards has been improved continually, resulting in declining emigration. By contrast, people who immigrate to Bin Zhou city provide abundance labor force. The old age are going to continues to increase, so that aged in the total proportion of the population continues to expand causing lack of labor force, As time goes on, the gross GDP developed continually and economy expands rapidly. The policy of the green GDP was proposed. Steady state based on the social economy development strategy of control excessive growth, GDP and GDP growing base, make the GDP growth rate and decreases. With the rapid development of the national economy, average income and people' living standards have a sustainable growth. Per capita consumption expenditure proportion of food consumption by decreasing. It means that Engel coefficient taper off. Because of the different of consumption concept between rural residents and the town residents' Engel coefficient has reduced solely and compared to town, it has a large Engel coefficient at the same time.

4.3. Policy Suggestions

From the point of the simulation prediction, We can see environmental and economic social system of contact is very close, only in improving population quality and improving the structure of the land, on the basis of through the GDP growth of resource utilization to improve environmental quality and GDP growth.

(1) In the future economic development, we should put the construction of the ecological environment in the first place.

(2) The increase of unused land reform, increase the area of woodland and grassland, improving Bin Zhou city ecological environment.

(3) The adjustment of economic structure, promote economic growth and improve the green GDP; Adjust the wage policy, increase residents per capita income, and makes people have sufficient income to supply consumer spending, promote rural residents consumption idea change, reduce the Engel's coefficient.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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