INDICATOR SYSTEM, MODEL APPLICATION AND INTEGRATION IN THE REGIONAL SUSTAINABLE DEVELOPMENT DECISION SUPPORT SYSTEM ——TAKE EXAMPLE FOR ZHENGDING COUNTY HEBEI PROVINCE CHINA

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ABSTRACT:

The establish of the indicator system, the selection of evaluation forecasting model and the integration of the system are the three main problems in the regional sustainable development decision support system. A great deal of indicator systems and professional models have been put forward in many special researches and reports. How to supply the government departments with a reasonable indicator system and how to select a suitable analysis evaluation model and ultimately integrate into an intact system are in the developing. The paper has done some discuss and tries in these areas taking example for Zhengding county Heibei provice in China.

1. INTRODUCTION

The regional sustainable development decision support system should supply decision support for all kinds of problems involved in the decision process of regional sustainable development. These problems are perplexing and diversiform, which concern the cultural feature aspect, such as regional population distribution, industrial structure and town system, as well as natural feature aspect, such as regional resource background and environment. And the series of problems dealing with the population, resource, environment etc. in the process of regional sustainable development incarnate the interactional character between cultural feature and natural feature. So the regional sustainable development decision support system needs a series of indicator system and an ample model system. Then the models are integrated into the system, which can satisfy the decision-making needs.

In the past researches and reports, many indicator system and models have been put forward for regional sustainable development. The system integration has also been researched quite a few. Most of the indicator systems in the research findings pursue the versatility and cannot take the regional particularity into account. So the adoptive evaluation models are strongly professional, and have a difference from practical applications.

According to above existing problems, how to select sustainable development indicator system suitable to local areas, how to select sustainable development analysis assessment models, and integrate into a sustainable development decision support system are three aspects discussed in the paper aim at North China Plain taking counties as subject investigated. The remainder of this paper is organized as follows: In Section 2, the authors put forward the sustainable development indicator system suitable to local area. Then in Section 3, we selected suitable analysis assessment model for population, land, water resource, structure adjust and comprehensive evaluation

involved in sustainable development. Finally, the integration of the model library based on com is presented in Section 4.

2. ESTABLISH OF INDICATOR SYSTEM

Zhengding county locates in the east of TaiHang mountain pluvial fan, from $37°58'$ to $38°22'$ in north latitude and from $114°23'$ to $114°43'$ in east longitude. The area of Zhengding county is 585 sq.km, and the population was 560,000 in 1998. It is an executive county major in agriculture industry. In 1994, Zhengding was ranked a Sustainable Development in National Sustainable Development Experiment Regions. Establishing the evaluation indicator system for Zhengding is meaningful for the other places in North China plain. This indicator system describes and evaluates the Sustainable Development of Zhengding county in six aspects: population, economy, society, resource, environment and calamity.

1. Population: includes quantity/scale distribution composition growth total 5 aspects and 16 indicators.
2. Economy: includes economic development level, economics of scale, economy composition total 3 aspects and 15 indicators.
3. Society: includes resident standard of living, traffic and communication, culture education, science and technology, medical treatment and health, policy and law total 6 aspects and 34 indicators.
4. Resource: includes land, water, biology, sunlight, junketing and minerals total 6 aspects and 20 indicators.
5. Environmental pollution and protection: includes atmospheric pollution, water pollution, solid rejectamenta, noise, radioactive contamination, environmental protection and human habitation environment total 6 aspects 23 indicators.
6. Calamity: includes meteorologic calamity, geological calamity, biologic calamity, flood and fire 5 aspects.

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None of the indicator systems is suitable for everyplace, because of the regional character of environment and human culture factors. Only the opening indicator system has actual application value. The indicator system in this paper is mainly established according to the features and acquired data from Zhengding county.

3. ESTABLISHMENT OF ANALYSIS AND EVALUATION MODEL SYSTEM

It should obey the following principles when a regional sustainable development model system is established.

1. The purpose to establish models is to offer an auxiliary mean for constituting development strategy and guiding public policy and behaviour.
2. Models should reflect resources use and environmental change describe the influence for developing process and environment during the process of resource development and utilize. They indicate the functionary laws that environment changes influence economic behaviour and human survival, too.
3. Models should not be too complex, and they should be as simple as possible and can reflect the main factors and main process of sustainable development.
4. For regional sustainable models, they have given geographical frontier and are influenced by the regions outside. The two should be considered when you establish models.
5. It is required that the models should have recursion of time and selectability of target sequence.
6. Regional models should reflect the character of the region, as well as be suitable to any generic region.

3.1 Population Forecast Model

Leslie matrix is based on the corresponding life table and the fecundity schedules, which appeared in 1940's is widely applied to demology and ecology. It is mainly used to describe the distributing of female individual quantity. Leslie matrix has been recognized to be the efficient method to forecast the population. It may establish harvest model of farming and herding production. It has very important applied cost on the protection and management of endangered species.

Linear regression model has higher forecasting precision in a short time, so it may be applied to forecast the population in a short time.

Leslie model lies on fertility rate and survival rate in the matrix. But survival rate is mainly determined by medicinal level, and it is difficult to under control of human. But fertility rate can be controlled. In a word, organic combination between linear regression model which can obtain better precision of prediction in short-term and Leslie model which has the prediction advantage in mid or long-term is the optimal way.

3.2 Water Resource Evaluation Model

A grey system is the one in which a part of information is known, and a part of information is unknown. The grey system theory explains that the system in which some parameters are known and other parameters are unknown is the grey one, such

as a society system, an economic system, and an ecosystem etc. The theory can more accurately describe the state and the action of social and economic systems. A grey forecasting model is called GM model, and GM (1, N) shows a first-order differential equation forecasting model containing N variables.

We can get the future information through this model. This method has been used for various foretelling such as output of coal, of grain, and of food.

We use gray prediction model in environment, hydrology and geology, such as the variational prediction of annual mean rainfall or evaporation, the variational prediction of annual mean groundwater exploitation and so on.
1. Create grey module
2. Construct data matrix
3. Calculate undetermined parameter a and b
4. Establish differential equation
5. Set up grey model
6. Test the precision of the model

3.3 Environment Quality Evaluation Model

PCA(Principal component analysis) is one of the most widely used of multivariate techniques. The basic idea is to describe a set of multivariate data in terms of a few uncorrelated variables. The common objectives of this type of analysis are to summarize the most important components of the data with little loss of information, reduce the dimensionality and simplify the later analysis.
1. PCA can reduce the dimensionality of the data set.
2. Few PCs may capture most of the variation in the original data set.
3. PCs are uncorrelated and ordered.
4. We expect the first few PCs may 'extract' the cluster structure in the original data set

PCA. can serve as comprehensive assessment of multi-index environment and social development. Here it is applied to assess air pollution, water quality etc.

3.4 Change Prediction of Landuse

Regional land use change forecast adopts the gray system models. Through foregoing simulation of gray system models, predictive equations about plowland, orchard, woodland, habitation and industrial estate can be achieved. Then these will be used to analyze and forecast the landuse changes for the future period of time.

3.5 Structure Adjust Model

Goal-programming model provides optimization design plan for structural readjustment of important industry- plant production in agriculture. It chooses optimization decision-making plan to realize sustainable development goal according to scientific quantizing mathematical model. It also may be popularized for optimization design plan of wholly agriculture sustainable development, so it has more practical significance and popularizing value.

During the structural readjustment of Zhengding county's cropland production, the authors use aforesaid models to argument optimum planting scheme and maximize the cropland planting benefit by considering

comprehensively the restriction on economy, society, resource availability etc. from different object optimization statuses. The realization flow chart on multi-object decision of Zhengding county's cropland production structural readjustment is shown in figure 1.
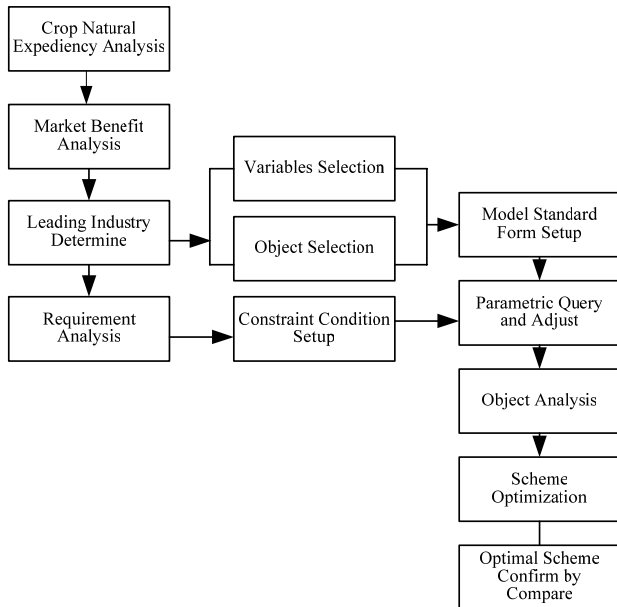

Figure1. The realization flow chart on multi-object decision

3.6 Comprehensive Evaluation for Sustainable Development Model

The Fuzzy Set theory is developed to improve the oversimplified model, thereby it develops a more robust and flexible model in order to solve real-world complex systems involving human aspects. It would classify or distinguish things by means of analyzing fuzzy information as much as possible. We use Fuzzy evaluation model to evaluate the level of sustainable development.

1. Allot weighting to each level of index
2. If the weighting inputted is wrong, the system will prompt to input again
3. Endow the last level of index with score marked by expert
4. Save the weighting and score, and then calculate the final estimate score

Figure 2 depicts the effect using fuzzy comprehensive evaluation model to assess comprehensively sustainable development.

Figure2. Comprehensive evaluation model

4. INTEGRATION OF MODELS AND SYSTEM

The regional sustainable development decision support system sets up on the GIS system, so the combination problem of model is the combination problem with GIS in effect.

Currently, most of GIS systems take data base software system as drive kernel, and models are located dependence in the system. Integrating professional applied models into the system will buildup the analysis function and advance reapplication rate of existing models. Realization of slitless integration of GIS and models has been close attended by a good many experts. The integration mode between applied analysis models and GIS has many types, but the integration between models supported by model library and GIS is perfect, which is also considered to have the most outlooks.

The model library supplies two kinds: foundation model and applicable models. Foundation model supplies the calculating model of usually statistic math. Application model is divided into spatial analysis model and application math model. The former settles the structure problems, and the latter is used to settle the half-structure and non-structure problem. The two types of model connect by the tools of model.

Model dictionary is the kernel of model library management system, and it contains the description and stored information of all the models in the model library. Model dictionary is the information tool for model library design and model management during the process of design, realization, run, maintenance and expansion of model library system. Model management function of model library is mainly realized by model dictionary. The models are stored in model dictionary, which has an aggregation relation with model dictionary and takes charge for the storage, initialization and modification of model basic information.

The data interface between model library system and application is a bottleneck problem in model library system

design. The system offers uniform standard data interface by setting up data exchanger to resolve data exchange problem. The advantage is that each model attends its algorithm so that the data exchange is complicated unitedly by data exchanger, which can reduce code redundancy and enhance the efficiency of the system.

The basic structure of model base is shown in Figure 3.
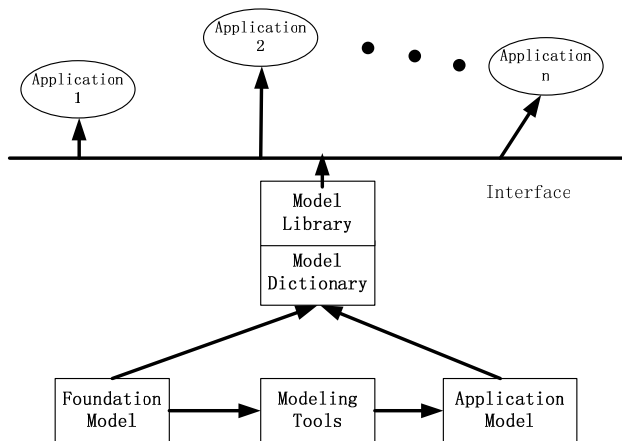

Figure 3. Basic Structure of Model Base

The model library of this system is impacted by the com. All kinds of model supply the interface for all the analysis and forecast work. The other advantage of based on com model library is its compatible, which can be applied to the other system conveniently.

5. CONCLUSION AND PROSPECT

The regional sustainable development indicator system and the dynamic evaluation model integration system achieved successful application in the area of Zhengding. It can be popularized to the other areas. It has important scientific and economic values for the research and application of town sustainable development.

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