STUDY ON DEVELOPING STRATEGIES OF REGIONAL WATER RESOURCES SYSTEM

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ABSTRACT

This article is based on the study of comprehensive utilization of water resources in an area of East China. The problems of coordinated growth of socio-economy and water resources were studied with SD method. The SD models consisted of the functions of diversion across the basin and the effects of investments. The results in research were submited as one part of regional economical developing strategies.

1. INTRODUCTION

Water is necessary resources for the development of the society, economy and culture to human beings. With the social and economic development, there is a contradiction of water resources supply with demand that has come to show. Common problem is water shortage which keeps economy from progressing faster. Therefore, it has been a subject for study in every region to make rational use of water resources, to meet the demand of the user as much as posible, so that the economy can progress at full speed.

This hydroeconomic system consists of three subsystems: wate supply, water demand and social economics. In the subsystem of water supply, two factors are responsible for the deficiency of wate supply; one is the nonuniform distribution on time and space on the part of natural water resources; the other is the limitation of available water capacity. These two problems can be improved by taking technical measures, such as building reservoirs, pump stations, and channels to improve the nonuniform distribution on time and space on the part of natural water resources, digging wells for drawing ground water or diverting across the basin to supplement available water. But it is costly to take these technical measures.

In the system of water demand, water resources are used for agriculture, industry, towns and shipping. On the one hand, the developments of users make increasing demand of water. On the other hand, they supply necessary finance for improving water supply and increase the wealth of the society. Morever, technical measures also can be taken to save water, such as changing the crops breed, irrigation system and method to save agricultural water, and improving technologies in industrial production and the rate of reutilizing water to save industrial water.

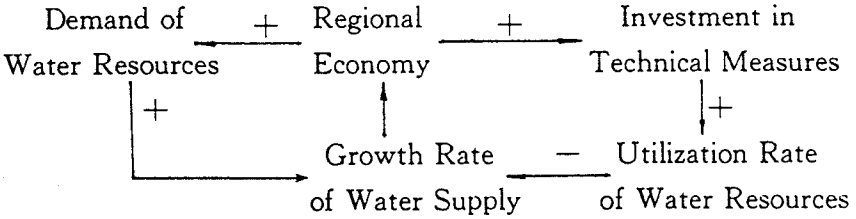

Fig. 1

In this hydro-economic system, some factors make causal relation as fig. 1.
The above-mentioned causal relation shows that the development of regional social economics has linked to the economic policy, the amount of investment and technical measures. Besides, in making the strategies of developing and utilizing water resources, the development of the regional economy must be predicted. Because the development rate of the economy does not only depend upon how much water is supplied, instead it decides how much water is demanded. Therefore, the system is nonlinear, fussy, multi-feedback and time-lag.
The research is based on Nansihu in East China, where is short of water resources.

2. SYSTEM STRUCTURE AND MODEL

As mentioned above, hydroeconomic system consists of water supply, water demand and economic development. Its SD model shows the balance between supply and demand of water resources in the region, and the relation among the economic development and water supply and demand.
The system can be divided into 10 subsystems when anralysed specifically, Detailed are the following:

SUPPLY

· Surface water

(1)**Storage** Mainly analysed are the effects of storage investment and capaoility on the actual water supply, the rate of utiliging surface water and the water shortage coefficient.

(2)**Raising** Mainly concerned with the research are the effects of raising investment and capability on the actual water supply, the copacity of raised water available, and the water shortage coefficient.

(3)**Diversion across the basin** Major factors are diversion investment, diversion capability, actual water supply, diverted water quartity available and water shortage coefficient.

· ground water

(4)**Pumping and diverting ground water** It is mainly concerned with the relation between pumping investment, the number of wells, and the actual water supply, the rate of utilizing ground water, the water shortage coefficient.

WATER DEMAND

· Agriculture

(5)**Agriculture water** Included in it are irrigation water, cattle water, and rural living water. Major factors are hydrosystem investment, valid irrigation area , irrigation water quantity, irrigation assurance factor, agricultural income; the number of cattle, actual water supply, income from cattle, population, water shortage intensity.

(6)**Agricultural water-saving** Included in it are composition of crops, irrigation methods, irrigation management. It is mainly concerned with agricultural investment, irrigation quota, sprinkling irrigation area, water quantlity saved , sprinkling irrigation area available, mangement ability, growth rate of benefit, utilization coefficient of water resources.

· Industry

(7)**Industrial water** Mainly analysed are the relations between industrial investment, industrial water demand. growth rate of industrial output value and water shortage intensity.

(8)**Industrial water-saving** Mainly concerned are on the part of industrial technology, the effect of technological improvement on water supply, the reutilization of the water resources by processing waste water.

· Others

(9)**Urban living water** Mainly analysed are the effect of population imigrated into urban areas and natural growth of population on the demand of water resources, due to industrial and commercial development.

(10)**Water demand of shipping** Analysed is the water resources demand of shipping in terms of increases of transport caused by industrial and agriculturial development.

3. THE ANALYSIS OF FUNDAMENTAL BEHAVIOR OF SYSTEM

Based on the historic statistical data of the regions concerned, through statistical analysis, the quantitative relation has been obtained between the variables in the system model, and the system model has been examined and verified. In this model, dynamic behavior and the trend of economic development are simulated from 1985 to 2030, under the varius investment policies.

Under the present investment policy, the behaviors of regional hydroeconomic system and the trend of economic development are called fundamental behavior of system. The truth of thar system is that most hydrostructures were set up over 20 years ago, have been now in need of repairs, whose supply capability is very low. If there is an initial shortage of hydro investment, the capability will be lower. The current investment poilcy is, agricultural investmant holds only 3% of the total investment of industry and agriultare combined, while hydro investment does 75% of agriculture investment.

Simulated by the above-mentioned SD Model, the main results are shown in Tab. 1.

Tab. 1 **Water supply**: $10^9 M^3$ **Output value**: 10^9 **Yuan**

INDEX	1985	2000	2015	2030
Surface Water supply	2.985	2.845	3.194	3.425
Ground Water Supply	2.592	2.287	2.520	2.908
Diversion across the Basin	1.727	1.650	1.908	2.045
General Water Supply	7.262	6.782	7.622	8.378
Agricultural Water %	87.4			49.6
Industrial Water %	10.6			47.5
General Output Value of Agriculture	11.51			9.6
General Output Value of Industry	11.33			174.8
Total Output Value of Agriculture and Industry	22.84			184.4

As is seen from the simulated results, water supply is reduced by 2000 year, so that the economic development is hindered, due to the hydrostructures in need of repairs for years and the deficiency of agricultural investment. Besides, importance attached to industrial development, the ratio of industrial water is on the rise year by year, while that of agricultural water is on the decline. Therefore the total agricultural output valne decreases though the total output value of industry and agriculture increases. But the agricultural production must pledges to supply foods enough for the region. So something must be done to transform the agricultural structure.

4. STRATEGIC ANALYSIS

To speed up regional economic development, we suggest that regional strategy of investment should be adjusted. We propose that three programs should be simulated, and their trends of economic development be compared.

PROGRAM Ⅰ

The ratio of the regional agricultural investment is raised from present 3% to 6%.

PROGRAM Ⅱ

The ratio of agricultural investment remains unchanged, but the investment of diversion across basin should be increased by 20 million RMB per year form 1990.

PROGRAM Ⅲ

The ratio of agricultural investment is raised to 6%; and the investment of diversion across basin is increased by 20 million RMB per year from 1990.

The major data of 2030 predicted by the system simulation can be obtained in Tab. 2.

Tab. 2

Water supply: $10^9 M^3$
Output value: 10^9 **Yuan**

INDEX	CURRENT INVESTMENT PROGRAM	PROGRAM Ⅰ	PROGRAM Ⅱ	PROGRAM Ⅲ
Surface Water Supply	3.425	3.561	3.463	3.495
Ground Water Supply	2.908	3.001	2.910	3.001
Diversion across the Basin	2.045	2.213	3.248	3.460
General Water Supply	8.378	8.775	9.621	9.956
General Output Value of Agriculture	9.6	12.0	9.7	10.6
General Output Value of Industry	174.8	185.1	202.6	214.5
Total Output Value of Agriculture and Industry	184.4	197.1	212.3	225.1

By comparing of the simulated results of the current investment program and three tested programs, we propose as follows.

(1) The increase of water resources conduces to the regional economic development. In particular, industrial development is in urgent need of industrial water.

(2) The ratio of agricultural and hydraulic investments should be raised in the region concerned to improve the rate of utilizing surface and ground water, for lack of hydro-structures, while which are in need of repairs for years.

(3) The increases of agricultural and hydraulic investments are somewhat effective though, the surplus of water supply is limited in a region not rich in water resources, therefore water showld be diverted across other regions.

(4) We must attach importance to water-saving techniques, because of the limited supply and high cost of water, such as charging crops composition, using sprinkling irrigation in agricultual production, developing water-saving enterprises, improving the rate of reutilizing water to keep control over the water demand.