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Beijing tianjin hebei city cluster multi water cycle system coordinated development planning modeling and empirical study reach on the perspective of sustainable development

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ABSTRACT

Regional development plans of Beijing, Tianjin and Hebei Province are included in the national overall development strategy. A series of water problems such as water shortage, ecological degradation and water pollution faced by the city cluster greatly restrict the economic and social development of the region. The shortage of water resources, the ecological environment deteriorated and serious water pollution have become important factors restricting the Beijing-Tianjin-Hebei region economy and social sustainable development.

Multi water cycle system is a complex system, whose construction, operation and development relate to environment, economy, population, geography, management, infrastructure, etc. Uncertainty is an important characterizer of complex city cluster water cycle system. Many parameters of complex city cluster system in water cycle system are uncertain, such as city cluster regional water demand, water resource price and city social life, production and other activities. On the other hand, with the accelerating process of city and city industry structure adjustment, water resources system's scale, structure and characteristics of the inevitable will change for time, space and the evolution. With the development of water circulation system, the uncertain information change from beginning to the end, as well as other features, constituting the multi water cycle system. Grasping and reflecting the uncertainty are necessary for studying water circulation system planning. It is also an important component of overall planning of city cluster. Under certain aggregate conditions, how to realize the optimization of water resources between different regions and industries, has become the key urgently problem to be solved. The water quality and quantity coupling plan multiple target teamwork model construction of city cluster multi water cycle system, and the improvement of the model to solve the mechanism of protein secreted dissemination evolutionary game algorithm, in order to improve the efficiency of development and utilization of water resources in Beijing Tianjin Hebei city cluster.

KEYWORDS

City cluster;
Multi-object planning;
PSEGA;
Multi water cycle system;
Water quality and quantity.

THE GENERAL SITUATION OF RESEARCH AREA AND THE METHODS OF RESEARCH

Beijing-Tianjin-Hebei region is in the middle and lower reaches of Haihe River. Shown in Figure 1. With the rapid development of social economy, the contradiction of water resources supply and demand becomes more and more intense, resulting in serious deterioration of the ecological environment. The formation of Beijing-Tianjin-Hebei region is developing rapidly, resulting the characteristics of water resources shortage and water environment pollution problems converging in the same region[1]. Therefore the water cycle system planning and water pollution controlled research and management should break administrative division limit[2]. It is necessary to strengthen the entire region (or region basin) collaborative governance and system research.

Secreted protein is the protein secreted to the extracellular after synthesizing in cells[3]. This paper presents self-organizing evolutionary game algorithm based on the behavior mechanism of protein secretion signal peptide[4], drawing lessons from signal peptide in the cell matrix secretes protein synthesis of self-organization evolution sequence process description as the algorithm. Shown in Figure 2.

THE PRESENT SITUATION OF MULTI WATER CYCLE SYSTEM RESEARCH IN BEIJING-TIANJIN-HEBEI REGION

Solving the water pollution problem in the sustainable development perspective

First of all, taking macro-control means to adjust distribution of the Haihe river basin industrial structure. Then, study and formulate corresponding policies, improve market access threshold. Prohibit the introduction of heavily polluting projects. Clamp down the serious pollution of small and medium enterprises.

Collaborative allocation research of water resources

Realizing the multi-objective coordination between supply and demand is a strong timeliness problem in practice which need to solve in the water real-time scheduling. Collaborative allocation of water resource need respectively embodied in the following aspects: First is coordination level of water resources administration management. The second is the government behavior and the market function coordinated the development of water resources. The third is to synergy economic and social benefits in the allocation of water resources. Finally is to synergy multifarious water resources development target utilization[5].

MODEL CONSTRUCTION OF COOPERATIVE MULTIPLE TARGET PLANNING AND WATER COUPLING PLANNING IN CITY CLUSTER MULTI WATER CYCLE SYSTEM

The construction of objective function

The city is divided into I water area. $i = 1, 2, 3, ..., I$, The whole city has J kinds of water supply. $j = 1, 2, 3, ..., J$. The use of water resources is di-

Figure 1 : Administrative haihe river basin

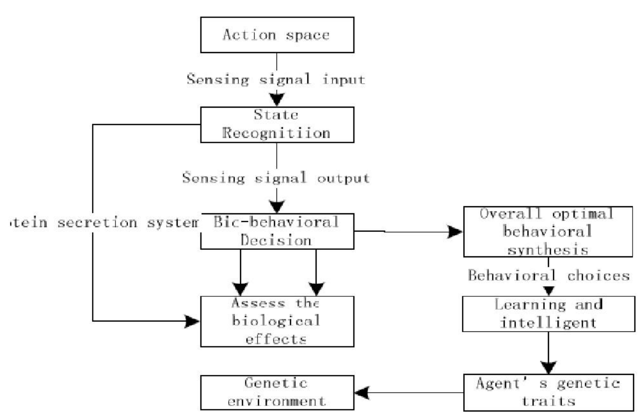

Figure 2 : Population structure PSEGA algorithm

vided into K types in each water areas, $k = 1, 2, 3, ..., K$. Make the x_{jk} water that j source distribute to k use as the decision variable. The i sub district of decision variables is: $X^{(i)} = \begin{bmatrix} x_{11}^{(i)} & \cdots & x_{1K}^{(i)} \\ \vdots & \ddots & \vdots \\ x_{J1}^{(i)} & \cdots & x_{JK}^{(i)} \end{bmatrix}$. On the other hand, in i sub region, k use demand for water is $d_k^{(i)}$,The water demand for the i sub region is: $D^{(i)} = \left[d_1^{(i)} \cdots d_K^{(i)} \right]$ The objective function can be stated as: $F = \min\left\{ f_1(\ ), f_2(\ ), f_3(\ ), f_4(\ ) \right\}$ The objective function 1 represents the principle of supply and demand of water resources system balance. The city's total water minimal representation:

$$\min f_1(X, D) = \min \sum_{i=1}^{I} \sum_{k=1}^{K} \left(d_k^{(i)} - \sum_{j=1}^{J} x_{jk}^{(i)} \right) \quad (1)$$

Among it, $d_k^{(i)}$ is the requirement of k use of water in i region, $x_{jk}^{(i)}$ is the water supply that j water resource distribute to k use in region.

Constraint conditions of water coupling planning and cooperative multiple target planning

The total water consumption of water supply is to ensure the sum of water that different water supply distribute to every user on region can not exceed the water can supply.

$$\sum_{j=1}^{J(N)} x_{ij}^{N} \le W_i^{N} \quad (2)$$

W_j^N is the water supply that water resource i distribute to the N sub district.

(2)The water quality constraints

$$\sum_{i} q_{kit} \le q_{kt}, \sum_{j} q_{kjt} \le q_{kt}, \forall i, j, t \quad (3)$$

q_{kit}, q_{kjt} ——The water quality requirements to k waterworks in t Time by water department i、j.

q_{kt} ——Water quality of k waterworks in t time.

(3)Nonnegative constraints:

$$x_{ij}^{N} \ge 0 \quad (4)$$

BASED ON THE MECHANISM OF PROTEIN SECRETED DISSEMINATION EVOLUTIONARY GAME ALGORITHM, SOLVING THE PROBLEMS ABOUT THE WATER QUALITY AND WATER QUANTITY COUPLING PLAN MULTIPLE TARGET TEAMWORK MODEL CONSTRUCTION OF CITY CLUSTER MULTI WATER CYCLE SYSTEM

Envisaged the protein secretion system state is discrete, proteins secreted use state, behavior, emotion value such a collection of 3 d sequence to express, and rememberand, game matrix, said:

$$\begin{bmatrix} I_{at}(t+1) \\ I_t \\ 1 \end{bmatrix} = \begin{bmatrix} I_{11} & -\omega & I_{13} \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} I_t \\ I_t(t-1) \\ 1 \end{bmatrix}$$

Under the state recognition behavior evolution after return status action selection rules described in formula, a state of * all possible actions:

$$A = A\text{function}(I*t) = \max(I*t) \quad (5)$$

(2) Get the state of the emotion factor on emotion evaluation rule formula:

$$I_t = I\text{function}(I*t) = \max(I*t) \quad (6)$$

(3) Emotion learning rule described in formula, * indicates vector:

$$(I*_t(t+1)) = U\text{function}(I*, I*_t) = (1-\omega)I*_t(t) + \omega I*_t \quad (7)$$

In this paper, the design based on the mechanism of protein secreted dissemination evolutionary game algorithm follows:

(1) Randomly generated initial population

(2) Select the paired state populations and carry the emotional evaluation of the game, getting their emotional factor. Population 1 in TABLE 1, population 2 and TABLE 2 are calculated as income.

(3) Repeat step 2 until the game reaching the maximum number of repetitive game.

(4) Learn rules and intelligent formula described by the formula:

$$\begin{cases} G_1(V_i, V_i') = G_1((x_i, y_i), (x_i', y_i')) = f_1(x_i, y_i) - f_2(x_i', y_i') \\ G_2(V_i, V_i') = G_2((x_i, y_i), (x_i', y_i')) = f_1(x_i, y_i) - f_2(x_i', y_i') \end{cases} \quad (8)$$

(5) According to individual fitness, the two populations

TABLE 1

classify	V_1'	V_2'	...	V_k'
V_1	$G_2(V_1, V_1')$	$G_2(V_1, V_2')$	...	$G_2(V_1, V_k')$
V_2	$G_2(V_2, V_1')$	$G_2(V_2, V_2')$	...	$G_2(V_2, V_k')$
...	...	...	...	...
V_k	$G_2(V_k, V_1')$	$G_2(V_k, V_2')$		$G_2(V_k, V_k')$

TABLE 2

classify	V_1'	V_2'	...	V_k'
V_1	$G_2(V_1, V_1')$	$G_2(V_1, V_2')$	...	$G_2(V_1, V_k')$
V_2	$G_2(V_2, V_1')$	$G_2(V_2, V_2')$	...	$G_2(V_2, V_k')$
...	...	...	...	...
V_k	$G_2(V_k, V_1')$	$G_2(V_k, V_2')$		$G_2(V_k, V_k')$

were produced offspring through the use of individual diffusion parameters adjusted probability distribution evolution.

$$\begin{cases} F_i = 100 \times \dfrac{G_1((x_i, y_i), (x_i', y_i'))}{\omega} \\ F_{i'} = 100 \times \dfrac{G_2((x_i, y_i), (x_i', y_i'))}{\omega} \end{cases} \quad (9)$$

(6)Repeat (2) to (5) until the entire group to achieve maximum ESS or evolution algebra.

CONCLUSIONS AND COUNTERMEASURES

Data processing and forecasting

Influenced by water supply and industrial structure, beijing-tianjin-hebei region exists obvious difference on the dynamic change of internal water.

Predicted by fitting the data to matlab finishing, under the conditions of coordination in urban planning resources, environment and economic development, predictions are obtained. As shown in Figure 3. Data in this article are quoted from China's statistics bureau official website after finishing for calculation.

Examples for Beijing-Tianjin-Hebei city cluster of complex water cycle system to solve multi-objective collaborative planning

Calculation process

First multi-objective problem of three benefits objectives transform into a single objective problem to solve model. For each objective function, $\mathbf{m}_j(\mathbf{x})$ predetermined a target value $\mathbf{m}_j^0$(The target is generally the optimal solution when considered alone as the basis of a target). Remember the ideal point of $\mathbf{m}_0(\mathbf{m}_1^0, \mathbf{m}_2^0, \ldots \mathbf{m}_{nl}^0)$. Then solving single-objective optimization problem $\min_{x \in d} \left\| m(x) - m^0 \right\|_\alpha$ by using the penalty method constraint problem to transform into multiple unconstrained optimization problem: $\mathbf{p}(\mathbf{x}, \sigma) = \mathbf{m}(\mathbf{x}) + \boldsymbol{\sigma}(\mathbf{c}(\mathbf{x}))$

Formula: $m(x)$ is the objective function of the original problem; $\sigma(c(x))$ is a penalty term; $c(x)$ is the constraints of the original problem. At this time getting the following continuous object optimization problem $:\min \mathbf{m}(\mathbf{x}_1, \mathbf{x}_2, \ldots \mathbf{x}_n), \mathbf{x}_i \in [\mathbf{a}_i, \mathbf{b}_i], \mathbf{i} = 1, 2 \ldots\ldots \mathbf{n}$

Analysis

Using the above model and 4th algorithm, calculating the amount of water in different level years optimization scheme. Listed below are the results about optimal allocation of water recommended solutions calculated at 75% frequency. As shown in TABLE 6.

From TABLE 3 can be seen the configuration the results of the collaborative evolutionary game algorithm based on PSEGA, Beijing and Tianjin in the water supply increased, Hebei water showed a trend of decrease.

By configuration results, water demand has an increasing trend in 2000, 2010, 2020 and 2030. There is urgent need through strengthening water saving, water diversion plan, science, water distribution and other measures to reduce invalid demand. At the same time, expanding water, improving water use efficiency and

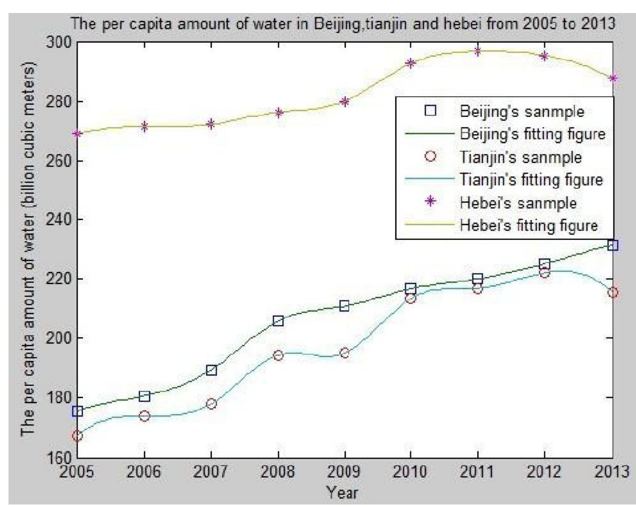

Figure3 : Beijing-Tianjin-Hebei in 2005 ~ 2013 the water consumption per capita figure fitting

TABLE 3 : Multi water cycle systems optimize the allocation outcomes of water resources in cooperative game in Beijing, Tianjin and Hebei city cluster. (P=75%)

Year	Per capita water demand			Total quantity of people required(m^3)
	Beijing(m^3)	Tianjin(m^3)	Heibei(m^3)	
2010	189.38	177.93	272.25	639.56
2020	284.87	255.46	323.47	863.8
2030	365.24	338.62	359.96	1063.82

effectiveness, improving recycling rate of industrial water and wastewater treatment and reuse dosage· increasing surface water supply capacity in the region are all on demand.

This section put 4.2 PSEGA based collaborative evolutionary game algorithm apply to multi-objective optimization of allocation of water resources. When solving problems, transforming multi-objective problem into a single objective problem, transforming multiple constraints into unconstrained and establishing a multi-objective problem collaborative evolutionary game analysis of the technical route and calculating steps. The method adjust the action by biological emotion quality factors in the progress where is signal skin guide in the matrix of cells secreted protein synthesis of self-organization evolution sequence. Since then adjusting the behavior of the body to adapt to the behavior of the environment, to avoid the search process into local minimum point, to overcome the continuous, differentiable difficulty in solving the objective function and constraints[6]. After example calculation, the results show that this algorithm is easy to realize, it has stable performance and has a good solving performance. It is feasible and effective to solve multi-target configuration on water resources.

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