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Analysis on application points of multi-agent mode in land use planning

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ABSTRACT

As the key measure to realize sustainable development and utilization of land resource, the importance of optimal allocation of land use can not be ignored, and its effective application has been widely focused by all sectors of the society in recent years. As far as concerned, with the continuous progress of society, the extensive form of land use not only caused massive waste of land resource, but also resulted in overexpansion of urban and further induced some other problems, such as serve land loss, ecological destruction and so on. Thus, it is feasible to make optimal allocation of land use planning by multi-agent mode and pay more attention to the application point, which are aim to save the land resource maximally and realize the beneficial cyclic use of land.

KEYWORDS

Land resource evaluation; Urban growth management; Multi-agent mode; Land use planning.

INTRODUCTION

With the rapid promotion of urbanization in recent years, land resource is facing a serious challenge. What's more, the resource development is entrusted with two tasks, such as, development and protection, which undertake pressures from coordination of resource utilization, environment protection and supply & demand relationship. Therefore, it is necessary to make good optimal allocation of land, strengthen and improve the land utilization efficiency, promote sustainable development and utilization of land resource. Specifically, the optimal allocation of land use is a complicated problem of multi-objective space optimization, which should be effectively resolved by focusing on land allocation between each department and fully combining with the natural attribute of land and the actual social and economic situation in the region. Meanwhile, reasonable spatial arrangement must be implemented for relative land used by each department, which has outstanding application advantages to use multi-agent mode system in the simulation of relative spatiotemporal dynamics of the complicated land use spatial system. What's more, multi-agent has good adaptability, intellectuality and interoperability, so the land use optimal allocation mode will not only have strong adaptability but also can finish the joint decision among subjects based on the utilization of the adaptability and interoperability if the multi-agent system was introduced actively, which can strengthen and improve the practical rationality of mode. Thus, the development of land use planning mode based on multi-agent is able to achieve the optimal allocation of land resource, which is aim to save the resource and promote the sustainable use of land resource.

ANALYSIS ON RELATIVE CONTENT OF LAND USE PLANNING

Concept

"Land management law" of China definitely specified that, land planning including the overall planning of land use, town planning, rural planning, comprehensive treatment of river and comprehensive development and utilization planning of river. In general, the land planning in China can be divided into five levels, such as, country, province, city, county and township. Country planning is the macro guidance for all plans, which can positively lead the planning for other levels and fully played its directional role. The essential purpose of implementing land planning in China is to reasonably forecast the future land use and development orientation and then try best to make optimal application of land resource through legal, administrative, economic and other types of measures.

As the key space carrier of ecological civilization construction, the importance of land can not be ignored. Actually, land use planning has strong comprehensiveness, so it is necessary to obey the principal of balanced economic and ecological benefit and harmonious population resource in the practical work, try best to leave good land resource for younger generation, so that make sure the food safety in future and keep the earth staying young forever.

The existing problems of land use planning in China

At present, the land use planning in our country is still on the stage of developing and not very matured. In order to promote the improvement of land use planning, existing problems can be found by referring the advanced theory in foreign countries and relative practical experience based on the actual situation of China.

Backward method

Qualitative research method is commonly used for land planning, such kind of traditional planning method has a certain degree of static characteristic, and the new round of overall land planning tested from 2002 is just the embodiment of immature.

Plan is disjointed with practice

The land planning in our country is lacking of restraining force all the time, especially the poor monitoring system in township. In order to attract more enterprises to locate in the relative regions, some of the leaders often obey the forecast and plan, which caused the plan disjointed with practice, so the planning adjustment is always on a passive status.

Conflict between plans and economy

The execution deadline involved in overall static land plan is very long, which is conflicted with the strong dynamic and economic development trend in our country. The failure of seriousness of plan may be caused if changed the current plans to adapt the economic development. Conversely, the economic development will be constrained once the plan is seriously disjointed with practice, and it will be hard to give full play to the plan.

Countermeasures

In order to enhance and improve the social and economic benefits, it is necessary to take effective countermeasures for the existing problems and make good planning and utilization of land.

Improving method

On one hand, change the traditional qualitative analysis used by land use planning into the method combined with advanced qualitative analysis and quantitative method. On the other hand, use dynamic analysis method instead of static analysis method reasonably.

Sound mechanism

Compared to the developed country, people's enthusiasm of participating the land planning is poor in China, and they often take part in the important decision passively or hardly participate it based on the lower transparency of

government's implementation of land planning. In this case, the government and masses are required to work together to establish a sound and perfect public participation mechanism and enhance the awareness of public to take part in the land planning establishment actively by virtue of network, media, social organization and other platforms.

Reinforcement management

It is necessary to firmly conduct the land management system because the land planning can supply the relative orientation for the utilization of land. Land is constituted by three parts, such as, agricultural land, unused land and construction land. Actually, land management is aim to prevent the farmland from destroying, ensure the quantity of agricultural land and avoid it being changed into construction land unlimitedly. In order to ensure the sustainable development of resource, the unit or individual person who uses the land must obey to the requirement of planning strictly. The core concept of implementing the land planning management is make good management carefully, develop the relative comprehensive guarantee system and carry out each work effectively by scientific management and social monitor based on administrative management, legal restriction, economic constrain.

Emphasize on development

And for now, China's conduction of land planning didn't pay more attention to the sustainable development. However, sustainable development is the cornerstone of land planning and utilization. In order to carry out a compound planning involves policy and design, the comprehensive coordination of ecological economy is required as the key purpose. At the same time, the sustainable development of land resource is also required by economic cyclic development.

THE APPLICATION OF MULTI-AGENT MODE IN LAND USE PLANNING

Relative concept of multi-agent mode

The research shows that, the typical manifestation of land use and cover change based on land use structure and space arrangement is the change of land utilization. In recent years, the complexity of land use change becomes prominent gradually in the process of actual regional development. As far as concerned, the representative land use and cover change simulation mode are mainly including System Dynamics, CLUE-S, Cellular Automaton, Multi-agent System and so on. The construction idea of multi-agent mode is from up to down, then the analogue simulation will be conduct after a series of complicated calculations among the construction subjects. This kind of mode not only has good flexibility but also has strong feasibility during the simulation of spatiotemporal dynamic change in land utilization. Therefore, compared to other types of mode, multi-agent mode is relatively capable to use in the simulation of land use change for those diversified area which involves many affecting factors and has rapid economy growth and big change.

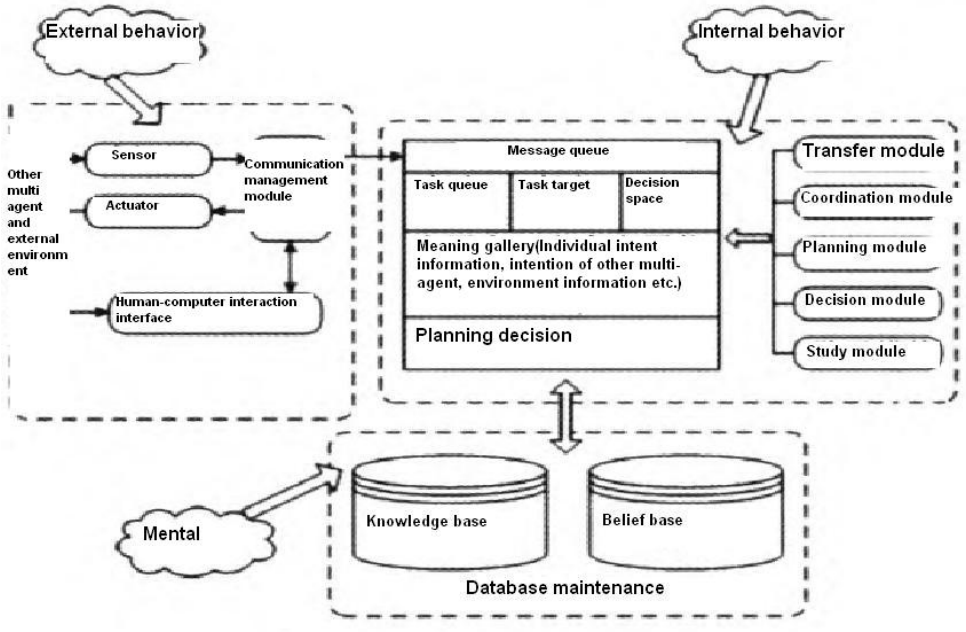

Figure 1 : Unit multi-agent mode structure

The Figure above is unit multi-agent mode structure. Specifically, the real-time status of multi-agent is mainly showed by belief base, which including the multi-agent, surrounding environment, relative knowledge about multi-agent and other content. Knowledge base means that multi-agent realize the application of knowledge condition and complete the task knowledge under the certain circumstances and then properly express it through rule mode. Task target refers to system expectation, which is the relative behavior expected by system. Belief base concludes the tasks specified by system, which

need to be accomplished at present or in future. The awareness triggering event is stored in the task list, which contains environment event, internal event and communication event.

It is feasible to make plans, confirm behavior and achieve the optimization and update of individual status during the implement of decision by combing relative knowledge of multi-agent with intention, belief, target and event. Planning decision is the core of the whole system.

Syntax definition

As the basic structure of unit multi-agent mode is based on 7 tuple, the organizational structure entity mode of the described multi-agent is as following.

OS=<O_Name,O_Interface,O_State,O_Knowledge,O_Task,O_Role,O_Relation>.

O_Name : the name of multi-agent, which has uniqueness.

O_Interface: the human-computer interface and communication port showed to the user.

O_State: the collection of multi-agent status, which is aim to describe the collection of internal and external status of multi-agent. The behavior of multi-agent is just a process to change from one status to another.

O_Knowledge: the knowledge resource of multi-agent to describe the necessary knowledge, data, inference rule and some other resources, which is mainly reflected as database, knowledge base, multimedia database and component base.

O_Task: the transaction set of multi-agent, which is to define the behavior of multi-agent, embody the function. (Inference mechanism is involved.)

O_Role: the organizational role.

O_Relation: the collection of binary relation of roles, which is able to link all the roles in organization.

Decision option

The decision option process is classified to be fuzzy decision process with multiple factors and levels by using the following option mode. Providing n decision options $A_i=(i=1,2,...,n)$ are made to form an optimal optional set, which including M factors $\mu_k=(1,2,...,m)$ to make up a factor set. The relative weight for each factor is $\varpi_k(k=1,2,...,m)$, which meet the formula of $\sum_{k=1}^{m}\varpi_k=1$ at the same time. According to the attribute of each factor, M factors can be divided into m sub-systems, and each sub-system has its own evaluation factor, such as $m_1,m_2,...,m_m$. Meanwhile, m_i indicates the factor set of sub-system i, which should meet the conditions in the formula of $\begin{cases} M=\sum_{i=1}^{m} m_i \\ m_i \cap m_j=\Phi(i\neq j) \end{cases}$.

First, establish priority relation matrix and m single factor fuzzy priority relation matrix $B_k=\left(b_{ij}^k\right)_{n\times n}(k=1,2,...,m)$, in this formula, b_{ij}^k means the priority relation coefficient of A to A_j under the factor of μ_k, the value is as below.

$$b_{ij}^k=\begin{cases} A_j \text{ is superior t o } A_i \text{ if 0 is under the factor of } \mu_k \\ A_j \text{ is as important as } A_i \text{ if 0.5 is under the factor of } \mu_k \\ A_j \text{ is superior t o } A_i \text{ if 1 is under the factor of } \mu_k \end{cases}$$

Second, Transform $R_k(k=1,2,...,m)$ to be matrix.

$$R_k=\left(r_{ij}^k\right)_{n\times n}$$

$$r_{ij}^k=\frac{r_i^k-r_j^k}{2n}+0.5; r_i^k=\sum_{i=1}^{n}b_{il}^k$$

$\forall l=1,2,...,n$, $r_{il}^k-r_{jl}^k+0.5=\frac{r_i^k-r_l^k}{2n}+0.5-\left(\frac{r_j^k-r_l^k}{2n}+0.5\right)+0.5=\frac{r_i^k-r_j^k}{2n}+0.5=r_{ij}^k$

After a series of transformation, we can get known that $R_k(k=1,2,...,m)$ is a fuzzy consistent matrix.

Third, single factor priority value s_i^k of scheme A under the factor of μ_k can be properly calculated as per root method.

$s_i^k=\frac{\overline{S}_l}{\sum_{l=1}^{n}\overline{S}_l}$, and $\overline{S}_l=\left(\prod_{l=1}^{n}r_{il}^k\right)^{\frac{1}{n}}$.

Fourth, make reasonable order arrangement for comprehensive optimal membership degree of multi factor and calculate the relative optimal membership degree for each scheme effectively. $S_i = \sum_{k=1}^{m} \varpi_k \bullet S_i^k (i = 1,2,...,n)$, the quality sequence formed by S_i getting n schemes from small to big under the influence of m factors.

Fifth, for the k sub-system, set the weight of m factors, such as, $k\varpi_1, k\varpi_{2,...,} k\varpi_m$, which meet the conditions of $\sum_{k=1}^{m} \varpi_i$ then the comprehensive priority value under the n sub-system can be calculated. $kS_i (i = 1,2,...,n; k = 1,2,...,m)$.

Sixth, take each system as one factor on a higher level, then the comprehensive priority value of each scheme on the higher level can be got as below.

$$T_i = \sum_{k=1}^{m} \varpi_k \bullet kS_i (i = 1,2,...,n).$$

In this formula, $\varpi_1, \varpi_2, \varpi, ..., \varpi_m$ refer to the weight of m sub-systems respectively. Meanwhile, $\sum_{i=1}^{m} \varpi_i = 1$, system will carry out decision option according to the value of T_i.

Example analysis

This is a megacity located on the middle reach of Yangtze River. Take its land use and spatial layout optimization as an example, this article made analogue simulation and reasonable analysis for land use planning based on multi-agent.

Main flow

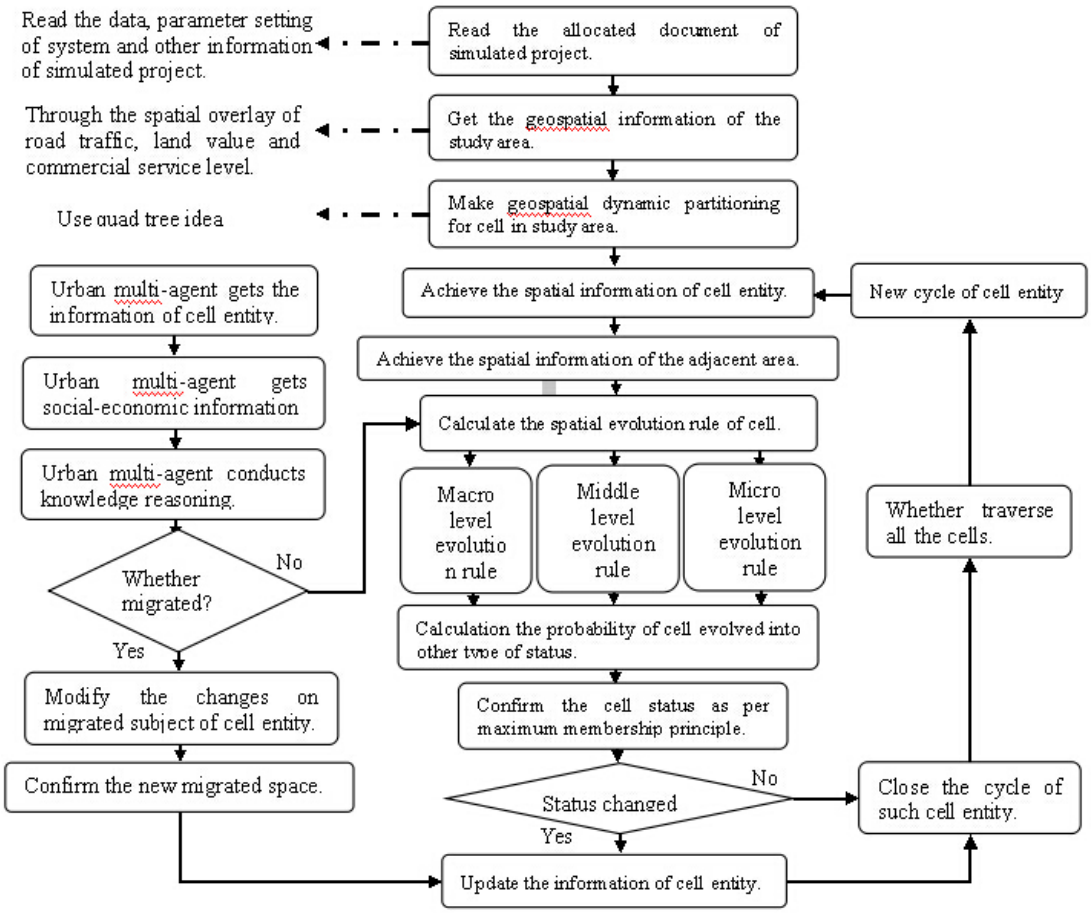

Figure 2 : Mode simulation running flow chart

The above Figure is the mode simulation running flow chart. Specifically, the urban resident, government, enterprise and other types of intelligent subjects should collect the space information in their region at first, and then create an urban multi-agent decision information data source by the reference of socioeconomic information of individual subject, finally, choose and confirm the behavior option carefully by utilizing fuzzy multiple factors and levels decision mode according to the relative knowledge and communication information between the concerning multi-agents.

Analogue simulation

Transform the drawing data needed by experiment into digital Figure with attribute through projection transformation, coordinate registration and other steps. The attribute data and spatial data can be properly linked together by utilizing the ID of space target keyword.

1990 data was taken as the basic year. Regarding the simulation of land use arrangement in 2010, it is necessary to calculate the relevance Kappa coefficient of data between simulation and practice through the below formula and check the mode carefully.

$$K = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r}(x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^{r}(x_{i+} \times x_{+i})}$$

From the above formula, x_{ii} refers to the element in the main diagonal of error matrix. x_{+i} means the sum of column i of error matrix while x_{i+} is the sum of row i of error matrix. After a series of calculation, the value relevance coefficient K of data between the simulation and practical data in 2010 is 0.8053, which certificate that such mode has higher spatial correlation relatively.

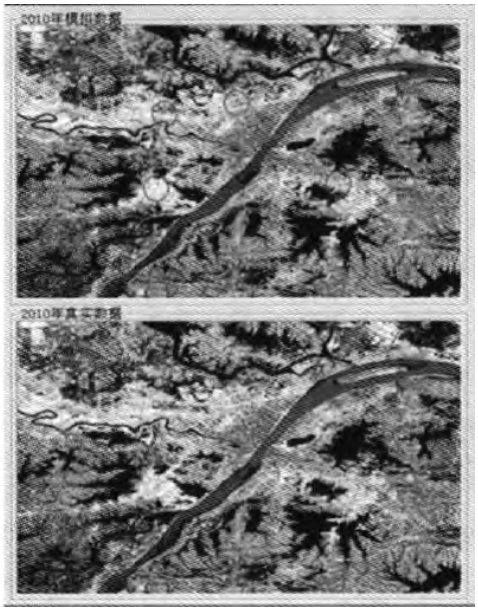

Figure 3 : Comparison chart between current status and simulation result

Taken 2010 data as the basic year, the land use spatial arrangement situation of 2020 is reasonably predicted based on the simulation mode. Therefore, a brief analysis of the development trend of land use arrangement in the next decade is carried out by combing the detail systematic simulation result. Firstly, the land use intensity in the center of city will be greatly increased. From the view of spatial form, the axial promotion is still going on, but the enforcement is reduced gradually, besides, the infill development is decreased rapidly and there is almost no room for development. Secondly, the change of land use in the center of city and surrounding area is growing to be fierce because the suburb adjacent to the main area of the city owns the superior ability to bear the economic radiation. Thus it can be seen that, the economic center will be gradually transfer to the edge zone that connected with city. Thirdly, during the process of urban land use spatial development, road traffic still occupies the important position. The land closely to the traffic corridor is obviously changed to be construction land. Fourthly, urban land space will be changed from progressive axial promote infill development to leaping dispersed development, and a lot of land resource (such as, water, forest, lake) in the scope of region will be used for construction of residential areas.

Based on the construction of land use spatial arrangement mode based on multi-agent, it is possible to make an effective expression of macro space structure in the microstructural evolution process by combining with example mode and reference of relative partial decision of government, resident, enterprise, each active individual and nonlinear interaction effect.

CONCLUSIONS

In conclusion, the economic development decides the superstructure, which will promote the progress of urbanization development inevitably. Thus, it is necessary to make sure the sustainable development and application of land resource in the land use planning. In order to obtain much more benefit, the numerous macro and micro subjects involved by land use spatial development process expressed their own expectation for utilizing the optimal region of the city one after another, so that the organizational behavior under macro control can be reflected consequently. The dynamic mode of urban land and space utilization based on multi-agent theory comes out and gradually promoted for use. However, the land use spatial arrangement is very sophisticated, so how to realize the optimal construction with a level equal to the inference rule of realistic urban subject behavior still need to be explored actively. At present, most of the parameters of multi-agent mode come from the practical experience and knowledge from experts, which lead to big subjectivity of mode establishment, so it is necessary to make deep research on it in future.

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