Journal of Trends in Life Sciences
ISSN: 2960-0200

STUDY ON THE INDEX SYSTEM OF ECOLOGICAL ENVIRONMENT INTEGRATION OF RAPID URBAN DEVELOPMENT

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Abstract: My country's urbanization has entered a period of rapid growth. At the same time, urban environmental degradation and ecological damage have become one of the bottlenecks restricting urban development. In terms of conceptual understanding, "ecology" and "environment" have certain differences and overlapping parts, which leads to certain confusion or overemphasis in the selection of urban ecological indicators and environmental indicators, which affects the urban ecological indicators. A comprehensive reflection of the overall characteristics of the environment. Starting from the status quo of ecological and environmental index research at home and abroad, this paper puts forward the basic principle of the integration of urban ecological and environmental indicators, integrates the indicator system with quantitative methods, and then designs the four aspects of status, progress, capacity, and early warning. The urban ecology and environment integration index system aims to strengthen the effectiveness and practicability of the index system in the stage of rapid urban development.
Keywords: Urban development; Integration of ecology and environment; Index system

1 INTRODUCTION

With the long-term and rapid economic and social development in the past 20 years, my country's urbanization has entered a period of rapid growth, and urban development has made significant contributions to the economy and society. But at the same time, in many cities in our country, environmental deterioration, ecological destruction, resource depletion, etc. have become bottlenecks that restrict urban development and limit cities to play a greater role [1-3]. The research on urban ecology and environment index system is an essential basic work to solve such problems. A relatively reasonable, comprehensive and effective urban ecological and environmental index system can provide an important theoretical basis and regulatory basis for urban development and development planning research.

In terms of conceptual understanding, "ecology" and "environment" have certain differences and overlapping parts, which leads to confusion or overemphasis on certain aspects in the selection of urban ecological indicators and environmental indicators, thus It is not easy to fully reflect the overall characteristics of urban ecology and environment. This paper analyzes the development of ecological and

environmental research and its integration trend in the application of the index system. From the perspective of combining ecological and environmental indicators, it proposes an integrated index system for urban ecology and environment, and discusses it based on the concept of sustainable development and systematic research models. The method of establishing the indicator system is explained, and a system framework is established for Chinese cities.

2 A REVIEW OF THE RESEARCH STATUS OF URBAN ECOLOGY AND ENVIRONMENTAL INDICATORS

Traditionally, environmental science has focused on the study of specific natural environmental elements, especially abiotic elements, and its intersecting parts with ecology (such as environmental biology, pollution ecology) also focus on the study of abiotic factors that affect ecosystems Mainly. Ecology, on the other hand, developed from the study of ecosystems. The theories guiding ecological research mainly include hierarchical view, holism, system theory and co-evolution. Its intersecting part with environmental science is mainly to study the impact of abiotic factors on ecosystems. But recently, the research fields of these two types of disciplines have been continuously expanded, and there has been a trend of integration in some aspects [4-8].

Reviewing the research and application of urban index systems at home and abroad, we can also find the trend of the integration of ecological and environmental indicators.

The research on the ecological environment index system in foreign countries is earlier and more [6, 7, 9, 10]. Japan carried out the evaluation and application of the urban environmental index system in Osaka in 1974, and its index consisted of only six key factors (SO2, floating dust, product of SO2 and floating dust, noise, BOD and traffic volume intensity). In recent years, many environmental index systems oriented towards sustainable development have emerged. A typical example is the urban index system developed by the European Commission and the International Institute of Urban Environment in 1993. This index covers a wide range, including environmental quality, green space, resources, green economy, social justice and health.

Domestic research on ecological and environmental index systems started relatively late, but a large number of studies have emerged in recent years. It is also characterized by relatively weak research on urban ecology. The typical urban ecological index system includes the research of Shen Qingji in recent years, who put forward the concepts of urban production niche and living niche [10]. In recent years, my country has also begun to try to apply a large-scale urban environmental index system. In 1999, Zhang Kunmin combined the World Bank's "Real Savings Rate" method in the research and application of the urban environmental index system in Sanming City and Yantai City, which is very systematic and directional.

Since the 1990s, the research on sustainable development index system at home and abroad has increased year by year, which includes some ecological and environmental aspects, and it is often called "environmental index" or "environmental and resource index". In 1996, the initial framework of core indicators for sustainable development led by the United Nations Commission on Sustainable Development (CSD) and the United Nations Department of Policy Coordination and Sustainable Development (DPCSD) took the driving force-

state-response (DSR) as the basic framework, and the environment On the other hand, fresh water and the atmosphere account for a relatively large proportion, and indicators such as the density of hydrological networks and the expenditure for reducing air pollutants are proposed.

Generally speaking, in recent years, the research and application of urban ecological and environmental index systems at home and abroad are increasing, and there is a trend of focusing on comprehensiveness and expanding to socio-economic aspects; Tendency to globalize means and governance capabilities. However, there are still some areas to be improved. For example, the research on the urban special index system is mainly based on the design of a single ecological or environmental specialty, especially environmental pollution; and recently, it is more common in the sustainable development index system. The ecological environment indicators are relatively rough; the consideration of early warning indicators in the research is also relatively weak.

This study tries to draw lessons from the subject basis of ecology and environmental science, put the two in an equally important position, and integrate them into a comprehensive index system. In the indicator classification of this preliminary study, we can still see the imprint of separating "ecology" and "environment". This is not only because this paper intends to show equal emphasis on the two, but also to take into account the difference between the two traditional concepts.

3 DISCUSSION ON THE BASIC PRINCIPLES OF THE INTEGRATION OF URBAN ECOLOGICAL AND ENVIRONMENTAL INDICATORS AND THE PRIMARY SELECTION OF INDICATORS

The optional indicators of urban ecological environment are more complex. In addition to the usual principles of systematicness, representation, and hierarchy, the research on the indicator system also explored the following five methods, and based on this, the primary selection of indicators for evaluating the ecology and environment of Chinese cities was carried out. .

3.1 Integration of Ecology and Environment

In the study, ecological and environmental factors were considered and integrated. On the premise of paying equal attention to the two, combined with the characteristics of China's development, this paper believes that the importance of the two should be slightly tilted in terms of timing. Under the current conditions of our country's cities, there are many urgent and serious environmental problems, which directly endanger the urban ecology and social economy. The focus of ecological environment protection and construction should be on pollution prevention and control, so the indicators of environmental protection are more important; however, with the improvement of environmental conditions and living standards in the future, the demand for ecological construction will increase day by day. Among the more than 60 pre-selected indicators based on this research, there are slightly more indicators related to the environment. Among the 49 indicators that finally formed the indicator system, 23 indicators are biased towards ecology, and indicators are biased towards environment. There are 26 of them.

3.2 Combination of Correlation and Independence

In the primary selection of many alternative indicators and the subsequent re-selection, correlation inspection and independent analysis are important means for index screening. Based on some available urban ecological environment data in recent years, this paper calculates the correlation coefficients among the indicators. Taking the overall average correlation coefficient among the indicators as the standard, the indicators with low correlation are regarded as independent indicators, and those with high correlation are regarded as correlation indicators. . Then, based on the principle of eliminating overlapping factors in the correlation indicators and pursuing the independence of the indicators, the correlation indicators are merged, and the indicators with less overlap with other independent indicators and strong comprehensive elements are given priority in the merger. The specific methods are shown below.

3.3 Current Status and Dynamic Cooperation

The urban ecological environment not only has obvious spatial differences, but also a process with large changes in the time dimension, so it cannot be measured only by static state indicators. Although the changes in the indicators can be seen by comparing the current indicators in different periods, the degree, acceleration and characteristics of the indicator changes, as well as the differences in the changing trends among cities are difficult to find. And these sometimes better reflect the progress of the rapidly changing ecological environment, such as changes in the annual concentration of SO2 in the atmosphere. Therefore, the selection of the indicator system focuses on selecting some indicators that reflect changes and trends, and later classifies the static state and dynamic progress as two types of functional groups.

3.4 Stitching with Ability

The ability to build and maintain the ecological environment is the key guarantee for the coordinated and sustainable development of the urban ecological environment. If there is a lack of this ability, then no matter how good the state is today, it will collapse sooner or later in the future. Therefore, the focus of urban ecological environment construction should be on the cultivation of capabilities. This study selected many indicators to measure the improvement of ecological environment functions and reflect its capacity building, such as centralized gas supply rate and environmental protection investment/GDP, etc., and listed capacity building as one of the four functional groups of the index system.

3.5 Aggregation of General Measurement and Qualitative Change Early Warning

The basic principles of ecosystems show that when some factors change beyond the critical threshold, the system will suffer from imbalance and mutation, which will destroy the ecological balance. In the context of rapid economic and social transformation and rapid urban development in my country, the ecological environment of cities in my country will undergo major changes in the next stage. Therefore, it is urgent to establish an early warning mechanism in the indicator system as an evaluation and monitoring tool. This study preliminarily set early

warning values for some key indicators, such as per capita green area and surface water quality. If these indicators are lower than or higher than a certain critical interval, it may cause serious damage to the urban ecological environment. Therefore, Boolean algebra is used here to deal with the early warning indicators: when the threshold is not reached, these indicators will not affect the indicator system, that is, a full score of 1 is taken; and when the threshold is exceeded, the most serious impact value is directly taken, that is, 0 marks. In the indicator system, an early warning function group has been specially established.

Under the guidance of these principles, more than 60 ecological and environmental evaluation indicators were initially selected in the study.

Core indicators are indicated by double underlines, important indicators are indicated by single underlines, general indicators are indicated by normal fonts without underlines,Reference indicators are indicated in italics without underline.

Figure 1 Index System of Urban Ecology and Environment Integration

Fig.1 The integrated index system of urban ecology and environment

4 MAIN METHODS OF INTEGRATING URBAN ECOLOGY AND ENVIRONMENTAL INDICATORS

4.1 Importance Simulation and Screening of Indicators

After preliminarily selecting more than 60 indicators to measure China's urban ecological and environmental indicator system, it is necessary to analyze the rationality, importance and completeness of the indicators, so as to screen the indicators and classify different indicators' importance levels to apply to Applications with different requirements and degrees.

In this paper, factor analysis method is used to analyze and reduce dimension according to the correlation between the selected preliminary evaluation indicators.

Therefore, it helps to obtain indicators of different importance levels that can fully reflect the information of the original evaluation indicators. Through factor analysis on the ecological and environmental data of some cities, the four largest common factors were obtained, and their cumulative contribution rate (that is, the degree of containing the original index information) reached more than 80%. It can be considered that they basically reflect the original index information. Indicator information. These common factors are not some primary indicators themselves, but contain the most important four aspects of information among many indicators.

The first common factor has the closest relationship with environmental pollution and involves the most indicators, so it can be called the environmental pollution factor.

son. The remaining three common factors are factors with ecology, water resources and energy efficiency as the main information respectively.

On this basis, the indicators can be simplified according to the aforementioned principles of handling the relationship between correlation and independence. When streamlining, take into account the availability of data, the comprehensive balance judgment of experts, and the balanced distribution of indicators in reflecting the ecological and environmental status, progress, capabilities, and early warning functions. For relatively independent and important indicators, four levels of indicators with different degrees of importance are screened out:

There are 13 core indicators (indicated by double underline in Figure 1), 14 important indicators (indicated by single underline in Figure 1), and 13 general indicators (indicated in general font without underline in Figure 1), and reference indicators A total of 9 (shown in italics without underline in Figure 1).
These four indicators with different levels of importance are combined to become the basic evaluation indicators in this urban ecology and environment indicator system, with a total of 49 indicators.

4.2 The Function and Hierarchical Framework Construction of the Indicator System

When evaluating things with the index system, there must be an evaluation result in the end. The most quantifiable and comparable results are the single
Value and scalar data, that is, many indicators should be synthesized into a comprehensive indicator.
In the research, the indicators are divided into four categories according to the functional attributes contained in the indicators themselves, that is, four functional groups. They respectively reflect the state level, change progress, governance capacity and critical early warning of the urban ecological environment.
Afterwards, the classification of indicators is refined with a multi-layer structure, and each functional group is divided into indicator types that focus on ecological aspects and indicator types that focus on environmental aspects. Contained in each type is the most basic index.
The top of this 4-tier index system is the final comprehensive index, which is called "urban ecology and environment integration index" here.

4.3 Standardization and Synthesis of Indicators

Before obtaining the final comprehensive index, each basic index needs to be standardized. The most direct and effective method is to make dimensionless processing for each index. Among many dimensionless processing methods, this paper adopts a non-negative [0, 1] interval processing method:
For a certain index (X), the standardized index value (D i) of a certain city is obtained from its real value (X i), the maximum value (X max) and minimum value (X min) of the index in each city.
This index system can be used not only for the dynamic comparison of the ecological environment of a single city in each period, but also for the static horizontal comparison of multiple cities in a certain period and the dynamic comprehensive comparison of multiple cities in multiple periods. For the dynamic comparison of a single city, the reference maximum and minimum values are taken from the maximum and minimum values in each reference base year; for the multi-city dynamic comparison, the reference maximum and minimum values are taken from the reference base year Maximum and minimum values across all cities.
The calculation formula of the standardized index value is as follows:
$D i = (X i - X min)/(X max - X min)$ $0 \leq di \leq 1$
If the increase of the index value has a restrictive effect on the urban ecological environment, the calculation formula of the standardized index value is
$D i = (X max - X i) / (X max - X min)$ $0 \leq di \leq 1$

For the indicators belonging to the early warning category, the standardized indicator values are calculated by the Boolean algebra method, and the values are 0 or 1 as mentioned above.

Thus, for each indicator, the normalized value is 1 for the best in each city (or city for each period) and 0 for the worst. Therefore, the weighted total index value of each index is between [0, 1]. The larger the normalized value, the better the ecological environment level of the city (while the better cities in foreign countries are calculated by this method, the value may be greater than 1). After the base year of the first application of this method, the standardized value of the base year can still be used as a benchmark to calculate the ecological environment index of each city (or each period of the city). In this way, the total index of each city and the standard value of each index after the base year may be greater than 1—indicating that it is better than the best city in the base year, but it may also be less than 0—indicating that it is worse than the city in the base year Not bad.

Since the importance of each basic index and each layer index is different, comprehensive processing is required when index synthesis. This study adopts the commonly used weighting treatment. The weights of functional groups and types were finally determined by AHP. The weight of the basic indicators is determined by the Delphi method. However, due to the limitation in the number and scope of evaluation experts, the weight obtained is only a very preliminary result, which is not listed here as a result. Finally, through the weighted summation method, the comprehensive value of urban ecological and environmental indicators can be obtained.

5 DISCUSSION

(1) Ecology and environment are two distinct but overlapping concepts, and the disciplines studying both are moving towards more abundant.

Rich and comprehensive development, and there is a trend of partial integration; and these two concepts have similar references in practical applications. This is the basis for the integration of the two indicators in this study.

(2) In previous research on the application of urban index systems, special index systems were often developed based on single disciplines of environment or ecology, which was related to the existing discipline system and management system [14]. For example, in my country's urban construction and In terms of management, the ecological construction is mainly managed by the gardens and construction departments, while the environment is mainly managed by the environmental protection department. The comprehensive sustainable development indicator system developed rapidly in recent years often analyzes ecology and environmental factors together, but they are part of the overall indicator and do not require completeness. Therefore, it is necessary to conduct integrated research on ecological and environmental index systems.

(3) In order to strengthen the effectiveness and practicability of the indicator system in urban development, this research focuses on the use of some methods in combination with the requirements of sustainable development and systematic viewpoints, such as emphasizing the ecological environment recovery ability on the basis of analyzing the urban ecological environment , Emphasize the establishment of a system early warning mechanism on the basis of measuring general changes, and appropriately combine qualitative evaluation on the basis of

quantitative analysis. It is found in the research that the application of these methods does not necessarily conflict with the quantification required by the indicator system and the availability of indicators.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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