

# Research on Comprehensive Assessment Method of Ecological Security in Urban New Area Oriented to Planning - Qinhan New Town in Xixian New Area for Example

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**Abstract.** In the light of the characteristics of urban construction activities guided by planning index, this paper puts forward a research method of ecological security which is suitable for the assessment of urban new area planning, and builds the index system of the ecological security assessment of urban new area with the “Driving force - Pressure - State - Response” model. Taking the Qinhan new town in Xixian new area as an example, this method is adopted and the planning plot control indicators are used as the main data source. Ecological security assessments are conducted on 318 planning plots in the new town, and the evolutionary trend of ecological safety after the implementation of the new town planning is assessed. From the perspective of ecological security, it puts forward control opinions for the planning of the new town and provides scientific basis for the decision-making of the planning and management departments of the new town.

## 1. Introduction

Urban new area is an important form of urban space expansion in China <sup>[1]</sup>. It has the characteristics of large construction intensity, rapid spatial expansion, and rapid land use change, resulting in its fragile and unstable ecosystem, and poses a threat to regional ecological security. Scientifically assessing the current status and trends of ecological security in new area and using them to guide planning is of great significance for maintaining the security of ecological environment and ensuring the sustainable development of the region.

## 2. Comprehensive Assessment Method of Ecological Security in New Urban Area

### 2.1. Assessment Procedure of Ecological Security in Urban New Area

The ecosystem of urban new area is a compound ecological system that integrates nature, society, and economy. The assessment of the ecological security of urban new area can be categorized into the category of systematic evaluation. In the process of ecological security assessment, the assessment subject adopts a systematic assessment method according to certain working procedures, undergoes a series of assessment steps, and obtains the assessment results and uses them for decision-making. The ecological security assessment procedure is shown in Figure 1.



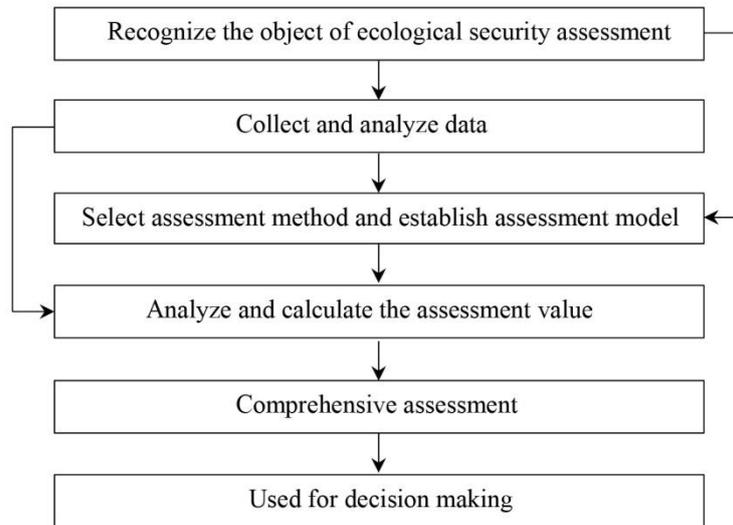


Figure 1. Ecological Security Assessment Procedure for New Urban Area

## 2.2. Ecological Security and Ecological Security Assessment

The concept of ecological security has a broad and narrow sense. The former was represented by the definition proposed by the International Institute of Applied System Analysis (IASA, 1989): referring to human life, health, well-being, basic rights, sources of livelihood security, and necessary resources, social order and the ability of humans to adapt to changes in the environment and other aspects are not threatened, including natural ecological security, economic and ecological security and social ecological security, to form a composite artificial ecological security system. The latter refers to the safety of natural and semi-natural ecosystems, the overall level of ecosystem integrity and health [2].

Eco- security assessment is the identification and analysis of the integrity of ecosystems and their sustainability to maintain their health under various risks. Ecological risk and ecological health assessment are the core contents, and the dominance of human security is reflected [3]. Ecological security studies have different scales and levels. Xiao Duning believed that the ecological safety research scale can vary from natural individuals to individuals and populations to the entire ecosystem, while the human ecology includes individuals, communities, localities, and countries [4]. Yu Mouchang pointed out that the research on ecological security has hierarchical features and forms a “global-continental, ocean-regional” multi-level ecological security system [5].

The eco- security refers to in this paper is the broad concept of eco- security, referring to the natural, economic, and social complex artificial ecosystems that are neither dangerous nor ecologically threatening. The assessment scale belongs to the mid-level regional hierarchy scale.

## 2.3. Determination of Ecological Security Assessment Index System

Ecological security assessment is the core issue of ecological security research [6], and the key link of assessment is the selection and determination of assessment index system [7]. At present, there is no universally recognized ecological security assessment index system, and the relevant literature materials are summarized, which can be classified as four types of ecological security assessment systems: including to “Pressure-State-Response” (PSR) assessment system and its derivative assessment system, ecosystem classification assessment system and “Exposure-response” assessment index system. The mainstream ecological security assessment model is the “Pressure-State-Response” ecological security framework model proposed by the UN Economic Cooperation and Development Agency. Since the PSR assessment model is a general one, it is too difficult to accurately analyse the ecological security problem in urban new area. Based on the model, Zuo Wei proposed the “Driving Force-Pressure-State-Response” (DPSR) framework model [8], adding a conceptual module for the driving force of eco-environmental system change, emphasizing on the driving forces that lead to

changes in environmental pressure and state [9]. Compared with other types of ecosystems, the changes in the ecological environment of new urban area are directly and clearly driven by the construction activities. DPSR model is more suitable for constructing the new urban area ecological security assessment system than others.

The DPSR model framework is used to construct an assessment system, which reflects the characteristics of environmental changes in new area controlled by planning indicators and constructs an ecological safety assessment index system suitable for assessing urban new area (Figure 2).

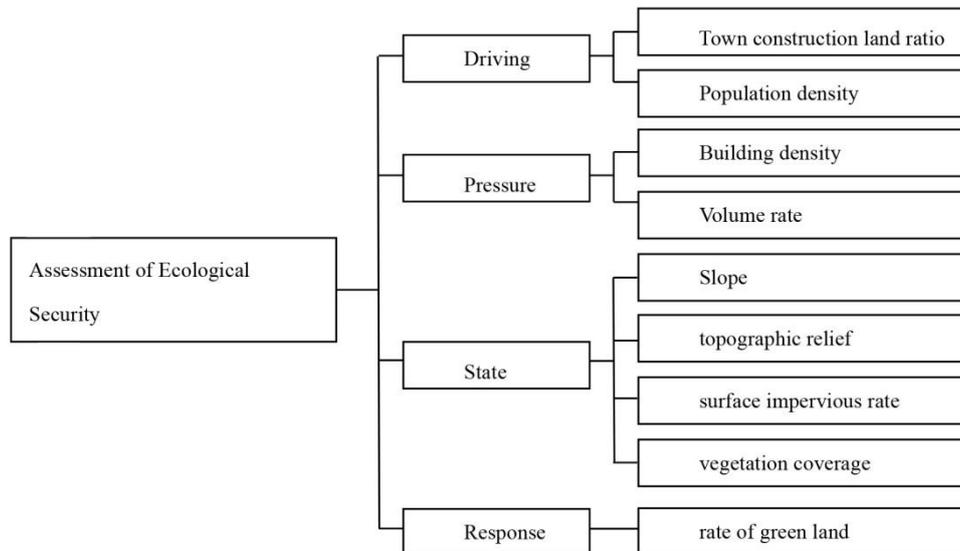


Figure 2. Assessment of Index System of Ecological Security in Urban New Area

In terms of index selection, highlighting the impact of the construction of urban new areas on regional ecological security, selecting planning and control indicators related to ecological security as important assessment indicators, making it possible to quantify urban new area planning from the perspective of ecological security. Finally, 9 indicators are selected to assess the impact of planning implementation on regional ecological security. Among them, there are 2 driving forces indicators, 2 pressure indicators, 4 status indicators, and 1 response indicator. In the assessment index system, the driving force represents the driving force for the change of the ecosystem in urban new area, including the ratio of urban construction land, population density and other indicators; the pressure represents the ecological pressure that causes changes in the structure and function of the ecosystem in urban new area and is the result of driving forces, including building density, volume ratio and other indicators; the state refers to the change of urban natural environment caused by pressure, including slope, topographic relief, surface impervious rate, vegetation coverage and other indicators; the responsiveness represents the feedback of ecosystem changes, including indicators such as the rate of green land.

#### 2.4. Eco- security assessment index selection and rating criteria.

Eco- security level refers to the extent of ecological security within the scope of research and is a comprehensive manifestation of ecosystem security. Based on the research results of existing ecological security, it is divided into 5 levels based on the degree of ecological environment [10]. The index characteristics and scores represented by various ecological security levels are shown in Table 1. The ecological safety assessment indicators are graded and the thresholds are determined according to the following principles (Table 1). Priority shall be given to the use of international and national standards as the basis for the classification of indicators; secondly, the experience of typical urban construction at home and abroad should be used for reference; for those indicators that do not have relevant research, they should be determined by consulting experts.

Table 1. Ecological security single assessment index grade division standard

assessment index	unit	assessment level				
		very unsafe	more safe	critically safe	unsafe	very unsafe
town construction land ratio	%	<15	15-20	20-30	30-40	>40
population density	population /km <sup>2</sup>	<1000	1000-2000	2000-4000	4000-5000	>5000
building density	%	<20	20-25	25-35	35-40	40-50
volume rate	—	<1.5	1.5-2	2-2.5	2.5-3.5	>3.5
slope	%	<3	3-10	10-25	25-50	>50
topographic relief	—	<0.05	0.05-0.1	0.1-0.3	0.3-0.5	>0.5
surface water impermeability	%	<10	10-20	20-30	30-70	>70
vegetation coverage	—	1	0.75	0.6	0.4	0.2
green area rate	%	>50	40-50	30-40	20-30	<20

### 3. Ecological Security Evaluation of Qinhan New Town in Xixian New Area

Using the above method and assesment index system, taking Qinhan New Town as an example, the potential environmental impacts of planning implementation will be assessed and used to guide planning, which will provide a scientific basis for ensuring regional urbanization and ecological environment coordination.

#### 3.1. Research area overview

Qinhan New Town is located at the junction of Xi'an and Xianyang, and is one of five new cities in Xixian New Area. Qinhan New Town is adjacent to Kong-gang New Town and Jinghe New Town in the north, Xi'an Jingwei Industrial Park in the east, Xianyang City in the west, Xi'an Feng-dong New Town across the Weihe River in the south. With a total area of 302.2 km<sup>2</sup>, a planned population of 660,000 people, and 50 km<sup>2</sup> of construction land, it is one of the core areas for the expansion of Xi'an's international metropolis to the north.

There are a large number of historical relics in Qinhan New Town, and the foundation of the culture is profound. Relics of important sites such as Zhou, Qin and Han dynasties exist here, including the remains of Qin Xianyang Palace and the mausoleum of the Western Han Dynasty. Ensuring that the construction of the new town is compatible with the site's ecological environment is one of the important reasons for the research of the ecological security of Qinhan New Town.

#### 3.2. Assessment data source

Land use maps of the Qinhan New Town from 2010 to 2020 and planning and control indicators are used as data sources<sup>[11]</sup>, and data is collected from the driving force, pressure, status, and response required for the assessment and processing of ecological security assessment by using land plots as evaluation units, which provides basic data support for quantitative assessment and GIS visualization.

#### 3.3. Assessment results

In the specific assessment process, firstly, according to the plots of Qinhan New Town control planning, the data needed for the regional assessment (a total of 368 plots) were collected and statistically calculated. Secondly, the ecological security assessment values for each plot are calculated. In the calculation process, according to the value of the determined single indicator ecological security threshold, the indicator values in each ecological security level interval are assigned 1 (very unsafe), 2 (unsafe), 3 (critically safe), 4 (more safe), 5 (very safe), you can get the ecological security index of each individual indicator. Then, the above 9 items of standardized ecological security raster data are summed and summed to obtain the comprehensive ecological security index for all plots. Finally, according to the determined ecological security assessment grades, the graded expression can be used to obtain the ecological security classification results after implementation of the planning.

The assessment results show that of the 368 planning plots in Qinhan New Town, 29 are very unsafe, 23 are unsafe, 93 lands are critically safe, 65 lands are more safe safe, and 158 parcels are very safe (Figure 3).

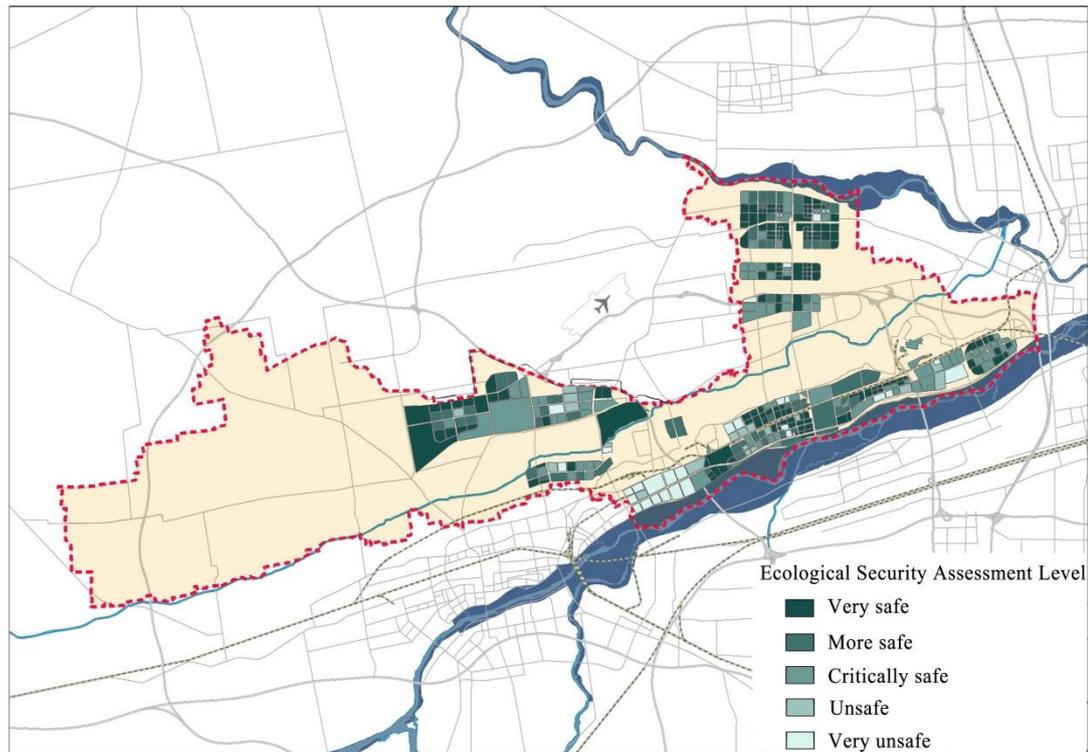


Figure 3. Ecological Security Assessment Chart of Qinhan New Town in Xixian New Area

### 3.4. Eco- security based planning land ecological regulation and planning proposal

Ecological security classification is conducted for all planning plots, and corresponding ecological regulation and planning proposals are proposed in order to achieve regional eco-system security. For very safe plots, it is recommended that the plot ratio be controlled below 2, the building density below 25%, and the green area rate 40%~50%; for more safe plots, it is recommended that the plot ratio be controlled below 2.5, the building density below 35%, and the green area rate between 30% and 40%; for critically safe plots, it is recommended that the plot ratio be controlled below 2.5, the building density below 35%, and the green space rate between 30% and 40%; for unsafe plots, it is recommended that plot volume rate be controlled below 3.5, building density below 40%, and green space rate from 20% to 30%; for very unsafe plots, it is recommended that plot volume rate should be controlled below 4 for buildings. The density is less than 50%, and the green area rate is 10%~20%.

## 4. Conclusion

Large-scale construction activities pose a threat to the ecological security of urban new area, and there is an urgent need for scientific methods to assess the impact of construction activities on the ecological security of urban new area and guide planning. Based on the characteristics of planning guidance for the urbanization of urban new area, this paper proposes an ecological security analysis and method that is suitable for the assessment plan, which provides research ideas and technical routes for scientific assessment of the impact of planning and implementation on regional ecological security.

This assessment method is used to assess and measure the ecological security of 368 planned plots in Qinhan New Town. The results showed that after the implementation of the planning, 29 plots were very unsafe, and 23 plots were unsafe. It shows that if the construction is carried out according to the

current planning, the ecological environment in some areas of Qinhan New Town will be damaged and difficult to recover, and active and effective response measures need to be adopted to change this trend. Therefore, it is imperative to adjust the planning in a timely manner and propose corresponding revision opinions and control measures for the planning control indicators, so as to provide scientific basis for ensuring the suitability of the construction of Qinhan New Town and the ecological environment.

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### **References**

- [1] Zhu Mengjue, Zhou Chunshan. The Evolutional Course, Character, and Mechanism of Chinese New Urban District Since 1978 [J]. *Modern Urban Research*,2012,19(9):80-85.
- [2] Chen Xing, Zhou Chenghu. Review of the Studies on Ecological Security [J].*Progress in Geography*,2005,24 (6) : 8-20.
- [3] Wang Genxu, Cheng Guodong, Qian Ju. Several problems in ecological security research[J].*Chinese Journal of Applied Ecology*,2003,1 (9) : 1551-1556.
- [4] Xiao Duning, ChenWenbo, Guo Fuliang. On the basic concepts and contents of ecological security [J].*Chinese Journal of Applied Ecology*,2002,13(3): 354-358.
- [5] Yu Mouchang. About the Concept of Ecological Security and Its Main Characteristics [J].*Journal of Tsinghua University (Philosophy and Social Sciences)*,2004,19 (2) : 29-35.
- [6] Wei Bin, Yang Xiaosheng, Wu Ming. Research review on assessment methodology of ecological security [J]. *Journal of Hunan Agricultural University (Natural Sciences)*,2009,35(5): 572-579.
- [7] Liu Shiliang, Cui Baoshan, Wen Minxia, Dong Shikui. Ecological effects and ecological security index system of major engineering project [J]. *Ecology and Environment*,2007,16(1): 234-238.
- [8] Zuo Wei, Zhou Huizhen, Wang Qiao. Conceptual framework for selection of an indicator system for assessment of regional ecological safety [J]. *Soils*, 2003, (1) : 2-7.
- [9] Liu Hong, Wang Hui, Zhang Xingwei. Research review on ecological security assessment[J]. *Chinese Journal of Ecology*,2006,25(1):74-78.
- [10] Zuo Wei, Wang Qiao, Wang Wenjie. Study on Regional Ecological Security Assessment Index and Standard [J]. *Geography and Territorial Research*,2002,18(1):67-71.
- [11] Divisional Planning Specification for Qinhan New Town in Xixian New Area [R]. Beijing Tsinghua Urban Planning and Design Institute,2012,20.