

# Analysis of Urban Ecological Vulnerability and prospects under the Impact of Urban Expansion

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**ABSTRACT.** Currently, urban expansion has been an important means of urban economic development, but the coercive impact of its rapid expansion on the ecological vulnerability of the region has become an increasingly important issue that restricts sustainable urban development. This paper uses a SWOT analysis method to analyze this phenomenon, and then proposes solutions based on the problem in order to better grasp the future and lead the development of a new type of city that is low-carbon and ecological.

## 1 BACKGROUND (INTRODUCTION)

The transformation of Chinese cities in the process of urbanization is the general background of this era [1]. Urbanization is an important initiative to promote regional socio-economic development, and is a necessary path for China to achieve modernization. Since entering the 21st century, China has made remarkable progress in the level of urbanization, which has greatly contributed to the development of regional socio-economics [2]. The expansion of land for construction is one of the main signs of rapid urbanization [3]. The ecological vulnerability of China's urban sprawl is not a new topic, from the initial cries of stifling the blind expansion of cities to the present sighs of helplessness over the loss of ecological territories, the criticism of which is sometimes strong and sometimes weak, accompanying the main theme of China's rapid urbanization and becoming a hot topic for urban and architectural workers to discuss urban development issues. According to statistics, between 1978 and 2019, China's urbanization rate increased from 17.92% to 60.60%. And the urban built-up area expanded from 7438 km<sup>2</sup> in 1981 to 146,102 km<sup>2</sup> in 2017, an increase of 19.64 times.

In the past decades, human activities have caused a large amount of habitat loss, habitat fragmentation and habitat quality degradation with various adverse consequences on human well-being [4-5]. Since the early 20th century, when the famous American ecologist Clement first proposed the "ecotone" [6], this theory has evolved into the study of ecological vulnerability [7], especially in the 1980s. Since the 1980s, in the wave of reform and opening up, the level of urbanization in China has been increasing, and the resulting ecological and environmental problems have become increasingly prominent, and the public has gradually become aware of the fragility of the ecological environment. For example, the Outline of the Beijing-Tianjin-Hebei Cooperative Development Plan released by the state in April 2015 clearly states that how to

balance the contradiction between social and economic development and ecological environmental protection is a key issue in realizing the Beijing-Tianjin-Hebei Cooperative Development Plan [8].

## 2 Analysis of the current situation of urban expansion (SWOT analysis method)

### 2.1 Advantages

#### 2.1.1 Development of economic level

The large-scale construction carried out during urban expansion absorbs surplus rural labor to participate in urbanization and makes it transfer to secondary and tertiary industries, which better drives the development of our economy. Urban expansion can also drive the development of rural areas in all aspects, improve the regional industrial structure, facilitate urban-rural exchanges, and narrow the gap between urban and rural development. When the economy is developed and people's material and spiritual life is satisfied, they will have more energy and money to pay attention to and improve the ecological problems caused by urban expansion.

#### 2.1.2 Mass quality improvement

As far as education is concerned, China's rural population base is large, the total number of people is more than the urban population, the urbanization process has increased the connection between rural areas and towns, even the direct transformation of rural areas into towns, the education of children is guaranteed [9]. Urban development has led to the spread of education, raising the quality level of the general public, making it easier for the public to accept the

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ecological problems caused by urban expansion and will be more concerned about the ecological problems of the city.

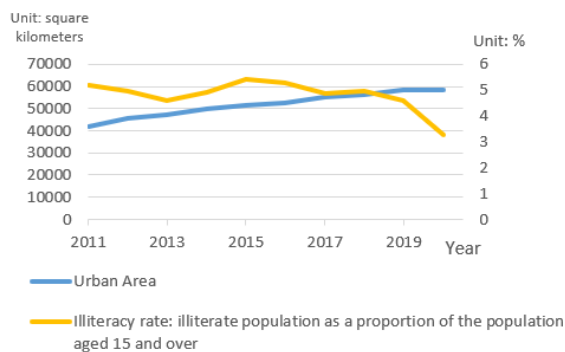


Fig. 1. Urban built-up area and illiteracy rate [owner-draw]

## 2.2 Disadvantages

### 2.2.1 Urban sprawl creates stress on ecological service functions

Wind and sand control is one of the major ecosystem services, which is mainly influenced by vegetation cover, local climate factors (wind, soil moisture), and soil erodibility.

Soil conservation is one of the important regulating service functions provided by ecosystems and is influenced by local vegetation cover, climatic conditions, topographic factors, etc[8].

The water-holding function of ecosystems is mainly manifested in intercepting precipitation, regulating runoff, influencing precipitation, and purifying water quality, and also plays a key role in improving hydrological conditions, preventing silting of rivers and reservoirs, and regulating the regional water cycle [10].

### 2.2.2 Urban expansion leads to weakening of ecological territories

The first thing caused by the urban expansion process is the reduction of natural habitat area. Due to the reduction of habitat area, the migration of many animals will be affected, while the competition between plants and animals will be enhanced, which can easily lead to the disappearance and extinction of species. For example, Erdao Baihe in Antu County, Jilin, which was also a lush temperate forest, has now become a prosperous town in the Changbai Mountain area, with no native forest left. Another example is the development of the city of Wuhai in Yimeng, Inner Mongolia, in the midst of endless grasslands, which resulted in the endangerment of the endemic *tetraena mongolia* [11].

Secondly, urban expansion has facilitated the construction and expansion of urban infrastructure, resulting in the isolation of many natural green spaces and urban water habitats into "islands" in artificial buildings, resulting in severe fragmentation and islanding of urban habitats. For animals, according to the species-area principle, it is difficult for many large animals or animals requiring large activity areas to survive in urban patchy habitats; for plants,

islanded habitats are not conducive to pollen and seed dispersal, causing genetic decline or even extinction of many species. Therefore, islanded habitats are very unfavorable to the survival of organisms and can easily cause a decrease in biodiversity.

### 2.2.3 The urban artificial system causes heat island effect and pollution

Due to the low heterogeneity of urban environment, there is little space for the development of biodiversity, which leads to its simple food chain composition and small share of participation in biogeochemical cycles [11], and a large number of urban artificial systems, such as factories, buildings, businesses, roads, etc., are incomplete artificial systems and fragile systems.

Moreover, with the conversion of a large amount of vegetation into impervious surfaces of artificial construction such as asphalt and cement, the green areas such as grass and woodland are greatly reduced, which inevitably leads to an increase in surface heat capacity, a decrease in heat absorption rate and evapotranspiration, and triggers the heat island effect (UHI), which in turn hinders the sustainable development of cities and the normal life and health of the public [3]. Many studies have shown that urban sprawl significantly enhances urban surface heat island intensity, but its variation varies significantly from day to night and from season to season [12].

According to the seventh national census, the urbanization rate of China's resident population reached 63.89% in 2020, compared to less than 50% (49.68%) in the sixth national census in 2010 and 36.09% in 2000, maintaining a high rate of growth in China's urbanization rate over a 20-year period. This horizontal spread of "big pie" and the expansion of low-density cities have brought about a very serious "big city disease". Cities can not control and control pollution in time, thus causing a series of environmental problems [13].

## 2.3 Opportunities

### 2.3.1. Strong support from government policies

As early as 2010, the National Development and Reform Commission (NDRC) launched the pilot low-carbon provinces and cities, national low-carbon cities (towns), the construction of ecological civilization demonstration zones, the creation of circular economy demonstration cities (counties), and the pilot kitchen waste resource utilization and harmless treatment cities. Electricity demand-side management city comprehensive pilot.

The Ministry of Housing and Urban-Rural Development (MOHURD) has also carried out the demonstration of renewable energy building application cities, the construction of green ecological urban areas, the continuous assessment of water-saving cities, and the cooperation with Guangdong, Hebei, Shenzhen and Wuxi to carry out a number of low-carbon ecological city demonstrations.

China is paying more attention to this area and there are endless possibilities.

### 2.3.2. Development requirements of major national strategies

The Proposal of the "Central Committee of the Communist Party of China on Formulating the Fourteenth Five-Year Plan for National Economic and Social Development and the Visionary Goals for 2035" sets out the main goals of achieving new progress in ecological civilization construction, specifically including optimization of the pattern of territorial space development and protection, significant green transformation of production and lifestyle, more rational allocation of energy resources and significant improvement in utilization efficiency, sustained reduction in total emissions of major pollutants, and The ecological environment will continue to improve, the ecological security barrier will be more solid, and the urban and rural living environment will be significantly improved.

## 2.4 Threats

### 2.4.1. Weak concept of residents' initiative to protect ecology

Although the country has put the ecological environment on the same level as the economy and society, the public has not established the consciousness of protecting the environment for a long time, and still ignores the fragility of urban ecology and destroys the ecological environment with reckless pollution. In China's cities in general, the public's ecological concept is weak, and domestic sewage is discharged at will, and the sewage is not filtered and processed and flows into the urban water ecosystem.

### 2.4.2. Urban ecological environment problems have a long way to go

To really develop the city well, urban ecological and environmental problems will become a huge challenge for the government and society as a whole. How to effectively achieve the coordinated development of urban economy and urban resources and environment, as well as how to strengthen urban resources and environmental protection and take strong measures are the current challenges for the development of each city. The old urban areas are dependent on resources for development, and this process will inevitably cause irreversible damage to the urban ecosystem. When building and expanding new urban areas, ecological issues will directly become the first element that cities need to consider.

## 3 SWOT matrix analysis

Combined with the above SWOT analysis of the impact of urban expansion on urban ecological vulnerability, this

study uses the SWOT matrix to make further analysis and recommendations for urban ecological development planning.

① "Strengths-Opportunities" (SO) strategy: urban expansion is guided by policies and financial support, and more financial resources are available for environmental restoration and pollution control

② "Disadvantage-Opportunity" (WO) strategy: to regulate the contradiction between urban construction land and ecological land, the "cluster" development mode of cluster-type multi-center can be adopted, and the coordinated development of the main urban area and the new area should be strengthened, following The city should make efforts to promote the transformation of resource-based cities, improve the long-term mechanism of sustainable development of resource-based cities, cultivate and strengthen succession replacement industries, actively develop new industries, promote the optimization and upgrading of industrial structure, and improve the capacity of sustainable economic development [15].

③ "Strength-Threat" (ST) strategy: the state and government establish and improve laws and regulations, and make efforts to build people's awareness.

④ "Disadvantage-threat" (WT) strategy: according to the spatial pattern of urban space, economic industry, land resources, water resources, transportation network system, etc., guide the construction of polycentric compact ecological cities [16]; in the direction of smart, low-carbon, sponge, and forest cities, make efforts to promote green buildings, the development of three-dimensional farms, in the face of drastic changes and transformations, urban space also faces the fate of survival and death, therefore, urban space must also be sustainable, like the growth of an organism, both to maintain the essential characteristics and to have the ability of self-renewal and adaptability [17].

## 4 Summary and Prospect

Sacrificing much or more land for construction does not necessarily achieve the goal of ecological protection, nor does it have to be at the expense of the economic value of land use. Instead, it can be ensured by using as little land as possible through scientific and reasonable spatial pattern design. The basic urban ecosystem services and their security patterns, while still meeting the requirements of urban development; The spatial pattern and scale of a city should be defined by the ecological bottom line of the city, and should not be planned and defined by an image of the urban space [18]. Therefore, when we expand the city, we should also consider the ecological problems brought about by it, not to develop the economy at the expense of ecology, and truly implement the idea of "green water and green hills are the silver mountain of gold" of General Secretary Xi Jinping, and strive to establish a low-carbon city,

a forest city, and a resilient and sustainable ecological city. We will truly realize the harmony between human and nature.

In the process of expanding new urban areas, it is necessary to continuously explore ecologically compatible development models and develop new environmentally friendly urban ecosystems in order to fit in with the ecosystems native to urban expansion. Turning around, the formation of new ecosystems in the process of urban expansion is something that can contribute to the improvement of old urban ecosystems. The new city and the old city ecosystem will form a positive and negative relationship with each other, reversing the symbiosis.

As Patrick Geddes, an urbanist, said, the relationship between nature and man is not a decorative backdrop for the human stage, but needs to be maintained as a source of life, a social environment, a teacher and a sacred place.

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