

Ecological Strategy of Green Urban Design In Urban Renewal

The Specific Ecological Measures for the Existing Urban Ecological Problems in China

Boya Jiang, Southeast University, China

Since the 20th century, with the development of human economy and technology, the pace of modern cities' change is amazing, compared with that in the past few centuries; however, the development is so rapid that people have ignored the capacity of the natural environment. In the late 20th century, humans began to realize the importance of the interdependence between people and the natural environment after experiencing a series of ecological problems, such as urban heat island effect, urban air pollution, water pollution, etc. and began to attach focus on the eco-comfort of the urban environment and sustainable development of cities. This paper attempts to summarize the past experience and lessons in urban construction, analyze their deeper reasons and propose green urban design approaches that are suitable for China's national situation with reference to the eco-design cases in the old areas of Beijing, Shanghai and Nanjing.

1. Ecological Problems in Cities of China

The basic conditions of ecological environment in the cities of China are: Overall deterioration and local improvement, but the governance capacity lags far behind the speed of damage to the environment. There are many kinds of reasons that result in the current deterioration of environment in China, which mainly include outdated urban morphology and fragmentation of natural patches caused by human activities.

1.1 Outdated Urban Morphology

Outdated urban morphology is not conducive to relieving the discomfort under specific climatic conditions. Nowadays, the development and construction in many new areas of China is flowering without order within cities, and planning is out of control. Besides causing significant waste in land resources, this status has also caused serious damage to urban environment, has increased a large number of post-operational expenses and is more likely to lead to the urban heat island effect.

1.1.1 Unreasonable urban planning strategy

During the course of urbanization, unreasonable planning is the problem that is ignored during the process of pursuing faster and a larger scale of development blindly in China. Xu Zongwei, an officer of Housing and Construction Department pointed out: "When China makes great achievements in the development of urbanization, there are also some problems, such as traffic problems, unsatisfactory environmental quality, weak interpersonal exchange and estrangement between humans and nature." At present, new areas of cities continuously extend to the suburbs surrounding the heart of old areas and a large number of new projects and expanded transportation system are occupying a lot of arable land to meet the requirements of new areas' development, which, however, continuously reduces the urban green ecological regions, thus not in favor of regulating urban air environment.

Take Beijing as an example: With the acceleration of urbanization process in recent years in China, the urban planning strategy performed has been in the pattern of "baking pie". It has its reasonableness at specific stages in urban development, but it also caused a certain degree of environmental and ecological problems. Especially when the "pie" is baked into a certain degree (for example, after the Third Ring, the Fourth Ring, even the Fifth Ring in Beijing are built), pollution and congestion problems become increasingly serious. Since this urban planning strategy was carried out, urban green space is mainly concentrated around ring traffic areas at external parts of the city, lacking contact with the green environment within the city, which causes worsening of ecological and environmental effects. What is more, the green space within the city is scattered among buildings, which makes it

impossible to shape its own green space system and more difficult to form healthy micro-climate environment in the downtown of the city. That is also the direct reason for a sharp deterioration of ecological environment and serious pollution of atmosphere in Beijing in recent years.

1.1.2 Distribution pattern of high-density buildings

Relevant searches suggest: Urban building density is directly proportional to urban thermal field and the thermal field increases more obviously with the increase of building density. In 2009, an officer of China Housing and Construction Department pointed out: The urban building density in China is too high to meet livable standards. With gradual increase of building density in the downtown in recent years, there are significant differences in temperature values between urban area and suburbs. Take Shanghai as an example: Just in the past ten years, high-rise buildings are throughout the urban areas of Shanghai, with the number increasing by more than four times. High-density buildings lead to the standing of "wall buildings" in great numbers which have a serious impact on bio-climatic conditions of the surrounding environment, lead to inadequate natural ventilation and day-lighting, sultriness and little wind and deterioration of air quality, and restrict the improvement of living environment levels.

China is an ancient civilized country with thousands of years of cultural history. In order to protect the cultural heritage in the downtown, newly built areas have to be arranged in the suburbs surrounding the old areas of a city at planning the new areas to be built. Therefore, skyscrapers erect in turn surrounding the downtown and forming ring barriers, which block natural ventilation between the downtown and the suburbs, make it difficult for the dirty gas from automobile exhaust emissions in daytime to have convection with the fresh air in suburbs, and lead to serious pollution and low air quality in the downtown. Take Beijing as an example: Most of old houses in the downtown of Beijing are very low. In order to protect the scene of ancient capital, the height of newly built projects within the old areas of the city is restricted and high-rise buildings can be only spread outside the Third Ring. Therefore, it forms a low river basin surrounded by high-rise buildings, which leads to heat accumulation in the downtown and causes serious heat island effect and air pollution (Fig.1).

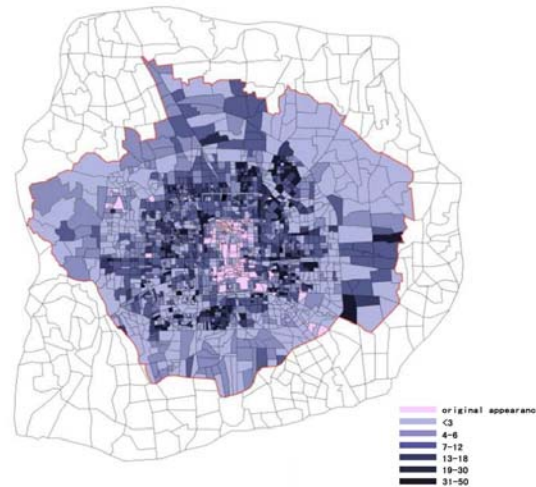


Figure 1: Building Height in Beijing

Seen from the above, in order to avoid adverse environmental effects, it is required to strictly control the density of buildings at urban design and not to lay out a large number of high-rise buildings in the upwind direction of a city or at waters edge regions of a city so as to avoid forming a wind wall, affecting the air exchange rate of a city.

1.2 Intensification of Fragmentation Degree of Natural Patches

With the intensified disturbance of human activities, the trend of fragmentation and separation is continuously taken on in the habitats of living creatures. Especially at the early stages of China's rapid economic development, owing to a large population in a small area and the principle of Economy Supremacy, there is a widespread lack of knowledge of open space, which leads to a varying degree of natural fragmentation of green patches in urban construction land, green patches in woodland, waters patches and farming land patches, among which, the fragmentation degree of natural patches in urban construction land is largest. Contiguous distribution of functional areas with high population density and building density leads to disperse distribution of green space and significant decrease of green space area. The fragmentation of woodland is the smallest, because it suffers from the least disturbance of human activities, but certain degree of damage did exist in the past time. The fragmentation of waters patches increases dramatically. For the needs of a large number of rural water and urban water, and the growth of industry, waters pollution degree increases, some lakes and rivers shrink, waters area is reduced and the fragmentation of waters patches increases. Fragmentation degree of Natural patches in farming land is also increasing compared with that in the past. With the increasing needs of land for various construction projects, more and more rural farming land is occupied, and there is a trend of increasing fragmentation in land resources due to the damage of human activities. According to relevant researches, the number of patches in the downtown of Beijing increased by 106.6% from 1997 to 2002, with the average size of patches decreasing by 51.6% and with the index of separation increasing by 94.3%. A large number of natural patch residues and native vegetation are rooted out from the city, which led to the reduction of habitat area of living creatures in the city, as well as a significant decline in the quality of habitats.

At the same time, the amount of green space in the old areas of cities is in a serious shortage. During the process of each round of urban renewal, in order to make an urgent solution to the living problem of urban population, the density of most reconstructed buildings is relatively higher, leaving very limited construction land. It is proposed to build green space within 5 years in the way of "seize every opportunity to afforest", mainly based on demolishing squatter buildings, reconstructing squatter settlements or combing the integration of historical and cultural resources in the old areas of cities. Therefore, according to the green space distribution figure in each region, it can be found that the green space distribution is uneven in the old areas of a city, with most of it scattering in the downtown of the city. For example, in the old areas of Nanjing city, 37% of the old areas are green blind zone, while almost all those areas are populated densely. Therefore, considering the problem of inadequate grass-roots green space, it is proposed that about 80% of the newly built green space be the grass-roots green space less than 4000 m² within 5 years.

A city is always in continuous evolution and development. Unreasonable urban morphology, fragmented urban green patches make it uneasy to organize such green space with eco-environmental regulation functions as systematic urban "wind channel" "green lung", etc. Therefore, reasonable planning of urban morphology and appropriate increase of green area are the key issues to be addressed.

2. Ecological Strategy of Green Urban Design in Urban Renewal

In response to the eco-environmental problems existing in the old areas of cities during urban renewal, this paper tries to propose ideal ecological strategies for green cities so as to achieve synchronized planning of eco-environmental construction and urban construction. The details are as follows:

2.1 Adjustment of Industrial Structure in the Old Areas of a City

The renewed geographical features, surface environment and humanistic environment in the old areas of a city are significant different from those in the new areas. Factories, offices and

residential areas are mixed on layout. The proportion of land constitution is unreasonable with infrastructures lagging behind. The loss of historical outlook and landscape features is aggravated. During the process of urban modernization, it is required to protect the community structure formed in the history of old areas of a city, and ensure the continuation of history & culture and the improvement of natural ecological conditions in a city.

First, the old areas of cities change from single center (Fig.2) to multi-center and from centralization to organic decentralization. Divide various functional blocks in the downtown of cities, and decentralize organically the functions and population to the surrounding areas; extend space for urban development so as to form the diversified and interactive urban development system that is not only independent but also with division of labor, i.e. “non-centralized” mode (Fig.3). Compared with the urban planning in the mode of “baking pie”, this mode may better solve problems like crowded urban housing, tense traffic, environmental deterioration, etc.

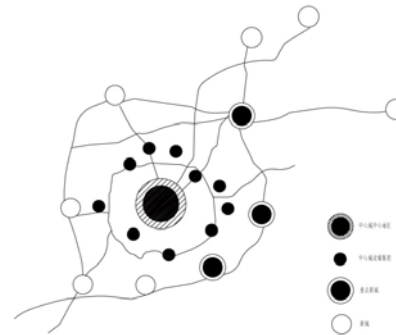
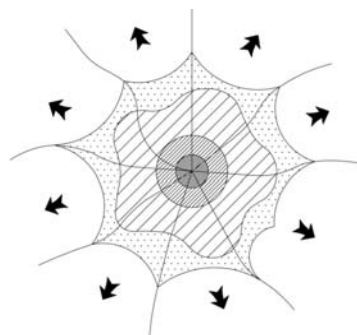


Figure 2: The Urban Planning with Single Center Figure 3: The Urban Planning with Multi-center

Adjust the height, spacing and density of buildings moderately to meet the requirements of adaptability in building functions. In an ideal urban spatial morphology (Fig.4), high-rise buildings should be laid out in the heart of a city moderately while low buildings are distributed in the surrounding areas so as to avoid forming an “artificial basin” surrounded by high-rise buildings with a low-lying center (Fig.5). And buildings with too high density may easily lead to heat island effect. According to relevant researches, when the building coverage rate increases by every 10%, urban temperature will increase by about 0.14-0.46°C”. Contiguous layout of dense population and dense building areas should be avoided and the scale of an city should be controlled strictly.



Figure 4: Spatial Layout of Urban Buildings with Poorer Ecological Effects

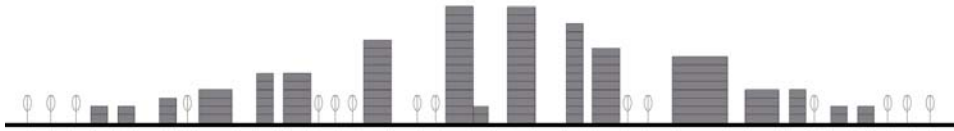


Figure 5: Spatial Layout of Urban Buildings with Better Ecological Effects

Second, re-plan and renovate old industrial sites. The adjustment should be focused on some heavily polluting projects in old areas of cities, and convert some industrial projects that seriously influence urban environmental quality, such as chemical industry, electrical power, papermaking, metallurgy and other industries and remove them from the main areas of cities, whose location should be far away from urban dominant wind direction and sensitive areas. For example, the eastern part of China is generally influenced by East Asian monsoon with Northwest wind in winter and Southeast wind in summer. Therefore, the industries with air pollution should be built in Northeast or Southwest direction. Besides removing polluting enterprises, it is needed to promote clean production and actively develop tertiary industries with high-tech content, high efficiency, low energy consumption and low pollution.

Maintain and repair the streets and buildings in the old areas of cities. With the passing of time and changes in history, the environmental quality in the old areas of cities gets worse and worse, which is unable to meet the requirements of the current urban development. Phenomena like bumpy road surface, damaged building walls, proliferation of illegal ads, facilities occupying the sidewalk unlawfully, mixing of residential, business and office buildings, etc. are very serious, which requires to optimize urban spatial structure morphology, strengthen the urban road maintenance, allocate green space and prevent pollution, as well as improving street air quality based on local cultural characteristics.

2.2 Repair and Reconstruction of Green Ecology in the Old Areas of Cities

In response to the status of serious natural patch fragmentation degree in the old areas of cities, it is needed to effectively organize systematic urban “green lung” or “wind channel”, and supplement a certain area of green space and waters opening space within the range of reconstruction in the old areas of cities. In such old areas, buildings are densely distributed and the area that can be planted on or greened is not very much, therefore, it is needed to focus on building small-scale green space or dot like green space. Such green space is not great in area, but it can provide fundamental green space and activity sites for the residents in surrounding communities, as well as moderately considering the building of the third facade.

2.2.1 Buildings of green public space in the old areas of cities

Effective means to reduce the heat island effect include increasing green space area, increasing waters area and promoting urban ventilation, among which, greening ranks the most important. The most fundamental and direct method of promoting greening is to increase green space area in public space so as to reduce the local temperature in the downtown of cities.

The practice of building green space in the mode of “seize every opportunity to afforest” for a long time has made the later generations pay more expensive social, economic and environmental costs. Before the 1980s, the urban structure of Nanjing was relatively more reasonable. However, since the 1990s, the green space in public space in the old areas were rooted out for the rise the real estate industry and its massive construction. The greenway between Purple Mountain and Qingliang Mountain was devastated, which results in abnormal climatic and environmental changes in Nanjing in recent years. In order to improve

urban ecological environment, Nanjing Government spent huge sums of money building centralized open space after demolishing a large number of buildings. According to its planning, it is required to remove those incongruous buildings to restore green space, maximize the restoration of ecology, make the landscape of Yingpan Mountain be presented and open up the landscape channel between Purple Mountain and Xuanwu Lake (Fig.6). This practice of spending a huge amount of money on green space is the experience in urban renewal and reconstruction, as well as a painful lesson.



Figure 6: Important Landscape Corridor in Nanjing

Urban green space is a main natural factor in a city, and it is also a key measure to reduce urban heat island effect. The green space in urban space can absorb solar radiation and absorb heat from environment continuously through plant transpiration so as to reduce the temperature of ambient air. A hectare of green space can absorb 81.8 MJ of heat from the surrounding environment on average each day, which is equivalent to the cooling of 189 sets of air conditioners. While a hectare of green space can absorb 1.8t carbon dioxide on average each day through photosynthesis so that the greenhouse effect is weakened. Besides, urban green space may detent dust in the air. A hectare of green space may detent 2.2t dust and reduce the atmospheric dust content by about 50%, which further inhibits atmospheric heating. Therefore, coverage of a large area of urban green space in the old areas of cities can effectively reduce air pollution of cities and lower the temperature in the downtown.

2.2.2 Buildings of green corridors

Green patches are scattered among various regions of the old areas, so it is needed to integrate urban green space resources, connect the scattered green patches and build urban green corridors so as to provide channels for air to flow from low density regions to high density regions. Southeast wind prevails in summer in eastern China, so it is required to plan a large area of green space and waters at urban planning and design, and set a certain number of green corridors in Southeast or Northwest direction at the junction of town and country to make wind channel parallel with the dominant wind direction. Doing those, fresh air in suburbs can be brought into the downtown of cities, heat island effect reduced and urban pollution relieved.

Specific measures: Make the existing rivers and roads in the old areas of cities as green corridors and connect the surrounding “green belt” to urban high-density centers so as to

make the area of “green belt” reach 40% of the areas needed to be cooled. Widen boulevards to 100m or more, which may cool cities at night. Green corridors connect all the already built regions and scattered patches, building a good ecological environment for cities. In recent years, Beijing attaches great importance to ecological protection and has carried out a reasonable ecological planning. Taking the western and northern mountains and large wetlands in Beijing as important ecological sources, and woodlands and wetlands as patches, based on the ecological corridors, cultural heritage corridors and recreation corridors built along river system, forest belt, cultural heritage lines and other linear elements, constitute an ecological infrastructure network in the mosaic pattern of matrix-patch-corridor. It is not only an ecological foundation for Beijing’s sustainable development and building a livable city, but also a rigid boundary for urban expansion (Fig.7).

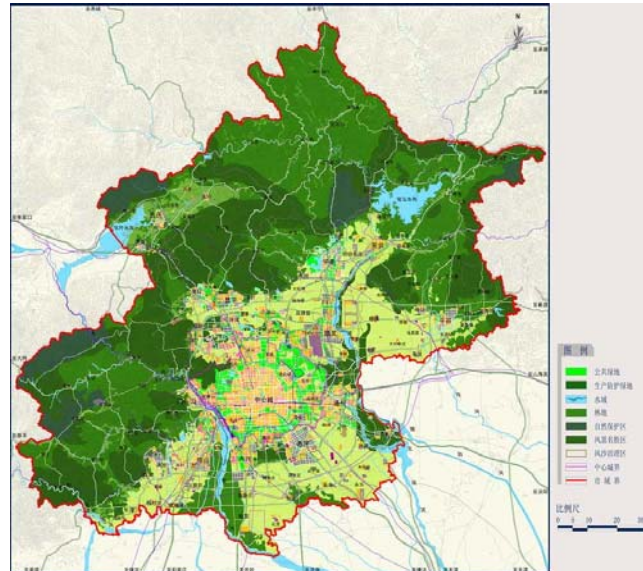


Figure 7: Reasonable Ecological Planning in Beijing

2.2.3 Increase of green coverage rate

According to relevant researches, urban green coverage rate is inversely proportional to the heat island intensity. The higher the urban green coverage rate is, the lower the heat island intensity is. When the coverage rate is higher than 30%, the heat island effect should be weakened greatly; when the coverage rate is higher than 50%, the weakening effect of green space on heat island is extremely obvious. The temperature in the centralized green space with the scale more than 3 hectares and green coverage rate higher than 60% is equivalent to that in suburbs, which means that the heat island effect is eliminated and low temperature areas with green space in the center are formed in cities, becoming an excellent environment for people’s outdoor recreation and activities.

There are more and more problems in urban environment that trouble us. First, continuous increase of population leads to skyscrapers standing in great numbers, dense population and increasingly reduced areas for greening; second, serious urban population and the heat island effect cause very high temperature in the downtown in summer. However, there is not much land for greening in the downtown during the process of urbanization. Therefore, besides planting more trees and grass on the streets of cities and increasing green coverage rate in parking lots and some squares by grass planting bricks, some other measures, like roof greening and vertical greening now are effective means to solve the problem of the heat island effect in old areas of cities. Among those new buildings currently, 90% of them are with terraced roof. Those cement roofs have large heat capacity, so accumulating a lot of heat will lead to temperature rise in the downtown. Roof planting and greening or building

roof garden not only can collect rainwater, but also may effectively weaken the heat island effect and reduce the temperature of roofs.

Vertical greening is also an effective means to reduce urban temperature. Plant vines through walls, bars, poles and other buildings to build vertical greening, which can save land and expand greening rate. Vines climbing on walls may play a role of shading and lowering temperature in hot summers, and also may isolate noise, absorb dust and reduce pollution. The temperature of walls with vertical greening is about 5°C lower than that without greening. Vertical greening may also beautify the environment.

With the promotion of energy saving and environmental protection and low carbon city, the improvement of the fifth facade landscapes in Shenzhen has being accelerated. Shenzhen has the climatic conditions for promoting roof greening which can ensure good growth of green plants. Currently, authorities in Shenzhen have made relevant policies including how to reconstruct old buildings to make it able to bear the weight of roof greening; roof greening is a must for new buildings and so on to promote the development of green roofs actively.

2.2.4 Reconstruction of green wind channel

The air with higher density and lower temperature will move downwards and the air flow triggered by this gravity plays a leading role in the air exchange at night. Therefore, it is better to build a large area of green space at higher altitudes and substitute the air in the dense downtown at lower altitudes with the cool air provided based on air flow principle; unimpeded green passage is used to connect cool air supply areas with urban dense areas so as to achieve air exchange.

Take Nanjing as an example: In recent years, Nanjing attaches more and more importance to reconstruction and repair of the damaged ecological landscapes and more attention to those constructions with bio-climatic buffer space and green corridors. The terrain of Nanjing belongs to the hills in eastern China, so Southeast wind prevails in summer and Northwest wind prevails in winter in the whole year. Green corridors in west-east direction can be opened up at design and planning to continually introduce the fresh air and oxygen from Purple Mountain, a valuable land in the eastern part of main areas of Nanjing to the downtown, and carry in the air over Yangtze River through green corridors in north-south direction. Rationally develop rich natural landscape resources along the River and the riverside landscape features integrating mountains, water, city and forests so to achieve further optimization and integration and shape a green corridor network system in the direction of north-west. And then with combination of the green opening space formed during the process structural adjustment in the old areas of the city, improve the effect of ventilating and oxygen conveying, air cleaning and pollution discharging and relieving the heat island effect.

Nowadays with rapid economic development, construction activities of humans pose a negative impact on natural ecology. Luckily, China has strengthened its awareness of this. However, it is deplorable that some constructive destruction is irreparable. Just like Aswan Dam, the negative effects of Three Gorges Reservoir Project have emerged gradually; as time goes by, the damage of the dam to ecology and environment will be increasingly serious, such as continuous deterioration of the ecology and environment of the coastal watershed, temperature rise in the surrounding areas, reduction of rainfall, etc. Repair and reconstruction of the green ecology in the old areas of cities is a correct measure that must be taken during the process of urbanization. While ensuring economic development, we should also protect our natural ecological environment.

3. Conclusion

According to the concept of sustainable development, green urban design in urban renewal should be started from the overall city as local environmental improvement measures can not build a pleasant environment in general. By taking the above integrated measures, build a better green ecological space within the old areas of cities; create appropriate green public space; control the density of buildings within a reasonable range; properly handle the convergence between the ecosystems of old and new areas of cities; connect the city, landscapes and nature so as to build a comfortable urban environment.

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