Reflection

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Urban metabolism

The air pollution is a problem that must be considered in healthy city planning and construction. It threatens the health of citizens. As a central city in southwestern China, Chengdu has been under tremendous pressure in air pollution in recent years, so that its image of livable cities is declining. This graduation project has the aim of understanding the relation between air pollution and the built environment through urban microclimate mechanism. To this extent, the main objective is that of investigating how to mitigate air pollution through microclimate design in the city of Chengdu in order to provide a better urban environment.

The relationship between the graduation lab (UM) and the graduation project

The project requires a morphological method related to the urban microclimate, and a method based on research and design is required. Meanwhile, the urban microclimate (wind and heat) and air pollution can be considered as a part of urban metabolism. And it can be used to shape the urban environment in a more sustainable way. In urban metabolism, creating an effective urban microclimate environment and reflecting the impact of the urban built environment on the urban microclimate and air pollution is a challenge. To this extent, the graduation lab gives the necessary tools, approaches needed and techniques to carry out a thorough project.

In the field of urbanization, urban microclimate is one of the important components of the urban ecological environment. Together with air pollution, it affects many city performance indicators such as livability and sustainability. At present, scholars in China have less research on microclimate strategies that can be used to guide urban planning. Microscale often lacks the interaction with large- scale regional environment in a large- scale study. To this extent, the graduation project can contribute to the field of urbanism by providing more physical and cross-scale interventions to mitigate air pollution towards urban microclimate design.

The relationship between research and design

Air pollution can be discussed through different disciplines and different perspectives. It is very complicated to use microclimate as an intermediate mechanism to connect air pollution with the urbanization field.

The main research can be divided into two parts. The first part focuses on the relationship between the three systems of air pollution, microclimate and urbanization. The knowledge gained can define the theoretical and analytical framework of the project. At the same time, for more consideration of ethic, this thesis uses the risk mapping method in environmental risk management (which includes population vulnerable map) and using areas of population exposure and the most polluted areas as priorities. Then density is selected as the main indicator of urban morphology to find the intervention sites and discover comprehensive

solutions.
The second part of the research is helpful to discuss the joint reaction of the wind and heat environment as well as air pollution mitigation plans. This section focuses more on discovering design principles which cope with air pollution. This stage from research to design is not linear and needs to make decisions based onsite characteristics, so the relationship between research and design can be seen as continuous parallelism.

The role of density

As mentioned in the development of theoretical and analytical frameworks, the parameters of density and morphology are highly correlated with the urban microclimate and are indirectly related to the spread of air pollution. This phenomenon has led to the emergence of a typology, which helps to define different types of density and different corresponding microclimates. For this type of generation, two main indicators FSI and GSI are selected.
First of all, for the built area, it is not necessary to change the physical density for every intervention. The project is more concerned about the impact of different types of the physical environment and the existence of microclimate phenomena on air pollution.
In short, Density typology in this article has not played a real role in relation to air pollution. Instead, it explores different physical built-up characteristics and microclimate types through density. For instance, lower FSI may increase the potential for direct solar irradiation, which related to the ventilation (heat wall effect) and the urban thermal environment.

Limitations of Transferability

When discussing the possibilities to generalize the results of research, first, The design interventions have mostly been based on maximum air pollution mitigation principles. Social factors will be integrated to shape the spatial interventions after applying the principles, these factors sometimes play a greater role in defining the design intervention.
Second, as mentioned earlier, density typology is to initially explore urban physical morphology and microclimate typology, and due to the complexity of urban microclimate systems, revealing that urban microclimate patterns that can reduce air pollution still require a lot of simulation and measured work.
Third, more factors need to be taken into account. For instance, beyond the diffusion and dilution of air pollution, it is also worthwhile to consider the implications of density regarding emissions of air pollution.
Therefore, the conclusion of the transferability is that the degree of transferability of the intervention is only partial. Some guidelines can be widely used. The typological research in this study is aim to select the intervention area. The intervention measures for the site are combined through a variety of design principles, as the result of the conflict or coupling effects between different principles, site characteristics determine the trade-off between measures.

Methodology

Throughout the methodology, there are a large number of references on the study of wind and heat separately with urban morphology, but it is difficult to draw more accurate

conclusions due to its complexity, but it still provides the possibility to study wind and heat coupling optimization measures on air pollution mitigation. On the one hand, the analysis matrix are from the literature review. On the other hand, in the environmental risk assessment method, the population vulnerability map reflects the distribution of the population that is more likely to be affected when exposed to pollution. Contributed to the consideration of social justice. Finally, considering the feasibility aspects of the intervention, stakeholder analysis will help identify investors, decision-makers, or implementers involved in urban planning or urban design. Help predict the extent to which the project can be implemented. Therefore, through the above-mentioned multiple methods, the three systems of urban form, urban microclimate, and air pollution can be interconnected. In the design stage, the main concern is that air pollution may lead to the limitation of the design plan. In the design stage, design by research and research by design become the biggest challenges, and the main focus on air pollution and the complexity of research may lead to design limitations. In this part, the best plan will be selected using the method of maximization and comparison combined with the site characteristics.

Societal and Scientifical Relevance

The air pollution is a problem that must be considered in healthy city planning and construction. Its impact on the city is mainly reflected in the comfort of public space, urban air quality and building energy conservation. Air pollutant accumulation caused by static wind frequency will induce respiratory diseases. It limits outdoor activities and causes great harm to people's health. Excessive urban climate due to dense super-tall buildings can also cause damage to cars and pedestrians. As a central city in southwestern China, Chengdu has been under tremendous pressure in air pollution in recent years, so that its image of livable cities is declining. This project would bring a better urban environment to Chengdu
by improving in combination with microclimate and air quality.

The urban microclimate is one of the important components of the urban ecological environment, which directly affects many performance indicators and livability of the city, and is closely coupled with other environmental factors (such as thermal environment, pollutants, etc.). At present, scholars in China have less research on microclimate strategies that can be used to guide urban planning. Micro scale often eliminates the interaction with large-scale regional environment in a large-scale study (Mingyuan, 2018). To this extent, the graduation project can contribute to the field of urbanism by providing more physical and cross-scale interventions to mitigate air pollution towards urban microclimate design.

Ethical considerations

In designing interventions, while reducing pollution, it also brings about social and spatial externalities that are worthy of reflection. By changing the external space of the city, new functions and values can be added to the space, providing citizens with a new way of life . In addition, related urban programs may change the structural order between social neighborhoods and bring higher population exchanges and economic income to the region. In short, when addressing air pollution by creating a better urban microclimate, the impact of changing and modifying the urban form is not only reflected in one aspect, but a comprehensive consideration of society and space.

Limitation

1. Due to the lack of data, some easier methods need to be adopted. For example, when calculating the frontal area index (FAI), since the data of local wind conditions are missed, consequently, this thesis uses the method of agglomerating adjacent buildings (aggregation distance is 1m), to relatively simplify the calculation process. Another example is that in the population vulnerability map, Baidu heat map is used to represent the exposed areas of the population. It does not take into account that the vulnerable population (old and young) use mobile phones less frequently than young people, so there are certain limitations.
2. When some parameters from urban form, microclimate and air pollution are extracted, they may not be comprehensive enough. For instance, in microclimate research, wind and thermal environment are only a part of it, there are other factors that have important effects on air pollution such as humidity and seasonal changes. On the other hand, air pollution is only one of the factors that need to be studied when designing urban spaces.
3. In addition to the above limitations, the simulation limitations (site size, for the large-scale site, huge simulation time may be spent) and reliability of the Envi-Met program still need to be considered. When testing for conflicts or couplings between interventions, the final decision depends on the simulation results of the program. But due to the unfeasible of simulating and analyzing on an urban scale, it may not be possible to pass simulations to ensure continuity and mutual feedback at various scales after defining the scope and scale of the study. When the street canyon model is built, the cube is often used as a model, the actual street canyon form is difficult to restore; therefore, its reliability is influenced by simplification of the model and parameters.

Further study

Air pollution often associates with not only urbanization and climate factors, but also many other socio-economic factors, such as population growth, economic development, traffic density, and commuting transition. In future studies, beside the aforementioned research area, researchers could also continue to find out the determinants of patterns of air pollution and microclimate in terms of expansion of land can be also considered. In addition, urban design lacks the consideration of microclimate, especially temperature and ventilation. There is little information that can be queried during the evaluation stage of the relevant urban design. However, monitoring the impact of existing projects on the urban microclimate will play a great role in design decisions. Therefore, more practice and monitoring are necessary.

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