Urban climate adaptation in urban planning and design processes: Exploring the current situation in China

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[1] Tag cloud based on the interview summary

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List of Abbreviations

UHI	Urban heat island
DTR	Diurnal temperature range
MHRUD	Ministry of Housing and Rural-Urban Development
MODIS	Moderate Resolution Imaging Spectroradiometer
SUHII	Annual mean surface UHI intensity
PET	Physiological equivalent temperature

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Abstract

Abstract: With increasing urban population and size of cities, climate change impact in urban areas provides urban planners and designers in every city with new challenges and opportunities. China is urbanizing rapidly and has started to pay attention to the impact of climate change in recent years. The current situation of the urban climate adaptation in urban planning and design process in China is studied in this report. Urban heat island effect and wind dynamics are two selected urban phenomena in this study. The sense of urgency and awareness about the urban climate phenomena and relevant adaptation measures, of citizens, politicians, urban climate experts and urban planners and designers, are the first part of the research and the knowledge and opinions on the current urban climate adaptation strategies are the second part. Interviews, document and literature study are applied in this research. In-depth interview results in this research have revealed rather low awareness and attention about current urban climate adaptation strategies, while documents and literatures study has shown the progress of urban climate adaptation strategies implementation in China.

Key words: urban climate adaptation, urban planning, China, current situation

1. Introduction

1.1. Problem statement

Urban areas are particularly vulnerable to climate change. First, because urban population growth across the world remains an overwhelming phenomenon. By 2050, global urban population will be 66% of the total population (United Nations, 2015). This is equivalent to the accumulated urban population growth in the entire civilizational history of these continents (UNFPA, 2010). Besides urban population growth, the size of urban areas also increases significantly. Totally, the rapid urban growth contributes to anthropogenic global climate change due to higher consumption of energy and materials as well as associated pollution and waste generation. Second, urban environments magnify climate change effects through the highly concentrated presence of buildings and the specific concentration of socio-economic activities (Voskamp & Van de Ven, 2015). Climate change effects such as heat stress, extreme precipitation, coastal flooding, drought, and water scarcity pose risks for people, assets, economies, and ecosystems in urban areas in particular. For instance, climate change increases both the severity and duration of heat waves, especially more strongly in urban areas due to the Urban Heat Island (UHI) phenomenon. Urban areas could be 3.5°C - 4.5°C warmer more than surrounding rural areas (Hammer, Kamal-Chaoui, Robert, & Plouin, 2011).

Accordingly, growing urban populations, increasing city densities as well as their impacts on the urban/rural environment all call for the application of urban climatic knowledge in urban planning and design processes by academics, advocates and practitioners. Adapting urban environment to climate change in urban planning is a vital method. According to Whitehead, one of the two key challenges facing urban authorities attempting to achieve effective forms of adapting climate change is to develop a planning system that is able to deal with the complex land use barriers such as the economy benefits of the private sectors and the need of climate adaptation that are likely to inhibit urban climate adaptation measures (Whitehead, 2013).

The current concern for global climate change and the growth of cities offer a fresh opportunity for integrating urban climate into urban planning (Mills, 2011). Urban planning from the urban climatic point of view has been a topical issue for urban planners and policy makers. There are needs to deal with various urban challenges such as the scarcity of land, need of a viable public transport system, re-built communities of our inner cities, etc. (Ng & Chau, 2014). For all stakeholders, for example policymakers, public and private sectors, citizens, etc., sense of urgency and constant information update are essential for developing and implementing strategies and measures to adapt to climate change. However, compared to mitigation measures, adaptation to climate change has received less

attention. Currently, countries such as China have started to pay attention to scientific researches on climate change phenomena and formulation of climate change strategy for both adaptation and mitigation to climate change. It is still in an early stage for implementing specialized urban climate adaptation strategies. Urban climate adaptation as a specific domain of research effort has rarely been focused in various countries. This research aims to fill this knowledge gap. Therefore, it is important to study and compare the current situations of different countries particularly about the urban climate adaptation in urban planning and design processes.

This thesis report seeks to provide an overview of the current urban climate adaptation situation in urban planning and design processes in China. Taking UHI and wind dynamics as study objects, this report looks into four urban climate adaptation measures. It examines the sense of urgency and awareness of the phenomena and analyzes the urban climate adaptation strategies in China. Recommendations to improve the urban climate adaptation strategy in the urban planning field are presented in the end of the report.

1.2. Objective and research questions

The research objective is to analyze the state of art of urban climate adaptation in China. The main research questions and 4 sub research questions are as follows:

Main research question: What is the current situation of urban climate adaptation in urban planning and design processes in China?

Sub research questions:

Awareness and basic knowledge

- What is the sense of urgency to adapt the urban environment to climate change amongst citizens, politicians, planners, designers and urban climate experts?

- How aware are the people involved in planning and design processes of urban climate phenomena and urban climate adaptation measures?

Planning and design process for implementation

- Which urban climate adaptation strategies are used in the planning and design process and how successful are these strategies?

- Which concrete urban climate adaptation measures or interventions are used in urban climate adaptation strategies?

1.3. Research approach

In order to reflection on the current situation of urban climate adaptation in urban planning and design processes in China, three research methods have been applied in this research. First, literature about urban climate phenomena and measures was studied. Based on knowledge on urban climate phenomena and relevant measures, semi-structured interviews were designed. The interview questions were designed in cooperation with Joram van de Schans, another LUP master student. In order to provide an overview on relevant laws and regulations, some documents were studied before the interviews and after the interviews. Relevant national plans were studied before the interviews, and some regulations mentioned by the interviewees were summarized after the interviews.

There are six chapters in this report. The introduction of research background, objectives and research questions are in Chapter 1. The theoretical contexts about urban climate phenomena, adaptation measures and urban planning are in Chapter 2. Research methods applied in the data collection and data analysis phases are explained in Chapter 3. Results are in the following Chapter. The summary of the documents is an additional remark about the planning instruments section. Interview results are the other main results of this research. The answers to the sub research questions in this research are in Discussion chapter. In the end, the main research question is answered in Chapter 6 and the suggestions for future research are provided after the conclusion.

2. Urban climate and urban planning

In this chapter, some relevant literature about urban climate phenomena and urban planning are presented. Introduction to the urban climate phenomena studied in the research and the relevant urban climate adaptation measures are presented in the first and second parts of this chapter. The overview of urban climate adaptation measures focuses especially on the contribution on the studied phenomena. The urban planning part in this chapter is about urban climate responsive planning.

2.1 Urban climate phenomena

Two urban climate phenomena were selected for this study: urban heat island (UHI) and wind dynamics. In addition to these phenomena, there are other urban phenomena such as air pollution, which are not the subject of the study. There is no emphasis on air pollution because it is expected that due to changing energy patterns and the use of other modes of transport, the problem will be solved eventually (Hunt et al., 2012). First in 2.1.1 UHI is described in more details and in 2.1.2 wind dynamics is explained afterwards.

2.1.1. Urban Heat Island

The UHI effect refers to an increase in urban air temperatures as compared with surrounding suburban and rural temperatures (Oke, 1982; Quattrochi et al., 2000). Figure 1 below illustrates how UHI effect occurs in cities. Main influence factors of the UHI effect include: population shifts, urban and suburban growth, land-use change, and production and dispersal of anthropogenic emissions and pollutants interact with regional climate and the frequency and intensity of specific weather events (Rosenzweig, et al., 2005). The reflectivity and emissivity in the urban environment are different from in the rural environment because of the use of construction materials for roads and buildings. The characteristics of the land use in cities are different, which causes a change in energy balance. In comparison with green areas in the rural areas, construction materials in urban areas absorb the shortwave radiation of the sun (Eliasson , 2000). The absorbed heat during day time is released as long wave radiation, and therefore heats the urban environment. The presence of buildings traps the long wave radiation and causes additional heating. Because wind dynamics are changed by city structures and the cooling effect could be lower, higher temperatures occur in the urban areas

(Eliasson , 2000). The UHI effect is maximal on calm and clear nights after a day with similar conditions (Smith & Levermore, 2008).

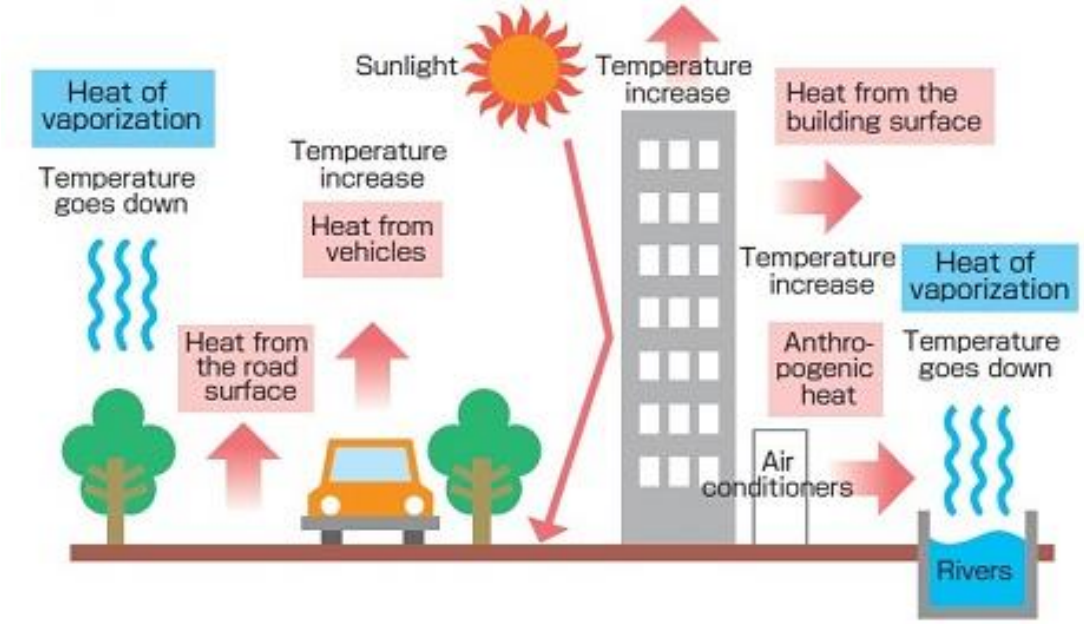


FIGURE 1 HOW UHI OCCURS**(GREEN RIBBON CASANDRA, 2014)**

Oke has already demonstrated that temperature differences occurred with a maximum intensity of 1.8°C in cities with just 1,000 inhabitants (Oke, 1973). For cities with 12,000 people a maximum UHI phenomenon of 5.1°C was observed. Therefore, Oke concluded that there is a relationship between the population size of a city and her UHI effect (Oke, 1973). There are different relations among different continents because the types of urban areas are different: European cities mostly have lower buildings, while East Asian cities consist of skyscrapers which generally lead to the higher temperature differences (Oke, 1973).

Different studies have been conducted to find out how the UHI will develop in the future. A study for London showed a maximum increase of 0.5°C in 2050 (Wilby, 2008), while a study for Tokyo found an average increase of 0.55°C (Adachi, Kimura, Kusaka, Inoue, & Ueda, 2012). However, other studies do not show a significant increase of UHI intensity (Rosenzweig, et al., 2005; Hoffmann, Krueger, & Schlünzen, 2012). It can be expected that the development of UHI depends on the trends of urbanization in cities. While urbanization trends for developed countries is different than urbanization trends for developing countries (Smith & Levermore, 2008; Carter, 2011) , which means the UHI effect will have different patterns between developed countries and developing countries (Adachi, Kimura, Kusaka, Inoue, & Ueda, 2012). The amount of hot days will grow and heat waves will occur more

frequently (Rosenzweig, et al., 2005). It was during the heat wave in 2003 that more than 15,000 people died in France and that heat-related death rates increased within the United Kingdom (Grimmond, et al., 2010).

2.1.2. Wind dynamics

Apart from the UHI effect, wind dynamics are caused by human development and are affecting the livability of cities. There is a close relation between UHI and wind dynamics as the wind chill effect can decrease the felt temperature significantly. However, it is also true the other way around as the temperature differences trigger the wind flows (Park, 1986; Britter & Hanna, 2003)

In general, it can be stated that the mean wind speed in cities is lower than in surrounding rural areas (Wilby R. L., 2008; Britter & Hanna, 2003; Wamsler, Brink, & Rivera, 2013; Eliasson , 2000). The deceleration of the wind is caused by obstacles which could be a mountain ridge, a city or just one tree. In literature, this is referred to an increase in roughness by which the wind is blocked (Britter & Hanna, 2003; Coceal & Belcher, 2005). Although the average wind speed is lower, it does not mean that peak wind speeds are absent. You might have experienced this phenomenon yourself when walking in a city, because on certain locations the wind is always blowing. In particular, the comfort for pedestrians is influenced by the wind patterns present in cities (Reiter, 2010).

From the wide variety of researches done on the wind dynamics in cities, it can be concluded that especially around tall buildings the wind has an influence on the comfort of pedestrians and cyclists. Tall buildings are those whose height is at least double the average height of the surrounding buildings. From the simulations conducted for different types of urban environments, in the case of a tall building surrounded by smaller buildings (see Figure 2), the average wind speed at pedestrian level depends essentially on the ratio between the height of the tall building and the average height of the surrounding buildings. The presence of a tall building modifies completely the air flows in the surrounding streets. The wind speed can be at least twice high as in the neighbourhood of these types of buildings (Blocken & Carmeliet, 2004; Reiter, 2010). The wind speed increases around tall buildings because of pressure differences.

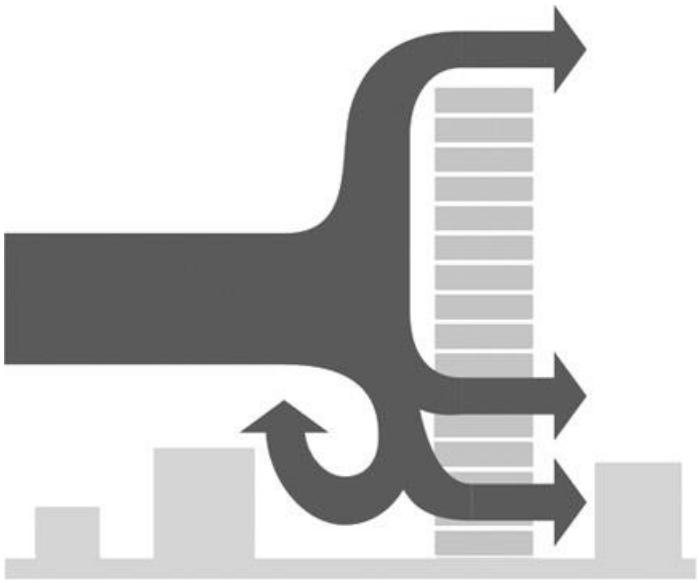


FIGURE 2 THE HIGH-RISE BUILDING EFFECT IN A DENSE URBAN ENVIRONMENT(REITER, 2010)

It is difficult to harmonise high-rise buildings and pedestrian comfort around them (Reiter, 2010). Most interventions improve wind protection at a specific location but generate unpleasant wind flows in other zones (Reiter, 2010). The boundary wind flow collides with the tall buildings and is deflected downwards, which creates a pressure difference and intensification of the wind on their way to streets. In addition to areas around tall buildings with downwash flows, the orientation of streets and openings between buildings can also generate high horizontally accelerated flows. This is especially true when there are pressure differences between the windward side (high pressure) and leeward side of buildings or streets (low pressure). However, on places where the density of the urban geometry is changing wind patterns might become uncomfortable (Coceal & Belcher, 2005). Furthermore, characteristics of the wind patterns in urban areas are important for another reason, because it is responsible for the ventilation of the city. When the wind is blocked by buildings, trees or other obstacles the city is not ventilated and both heat and pollution are trapped in the urban area (Park, 1986). Wind patterns can be changed by the appropriate design of buildings and grouping of them. Trees, windbreaks and small additions to buildings like balconies will change the wind patterns (Kramer, Gerhardt, & Scherer, 1979).

Wind nuisance depends on the type of activities people want to do and the wind speed at that specific moment. For stationary activities such as sitting, a lower wind speed is desired than for walking. For sitting the wind speed should not be higher than 2 – 3 m/s for 80% of the time, for walking this increases to 5 – 7 m/s, while the wind gets dangerous when the speed is higher than 20 m/s (Soligo, Irwin, Williams, & Schuyler, 1998). Taking these different criteria into consideration can help with the planning and design of the urban area.

2.2. Urban climate adaptation possibilities

There are different ways of adapting to the urban climate phenomena in this research. In this research these measures include **city structure**, **vegetation**, **use of materials** and **anthropogenic heat**. In accordance with these categories different urban climate adaptation possibilities are going to be presented.

2.2.1. City structure

The structure of the city has an important influence on the extent of the UHI and prevailing wind patterns. The size of the city determines a significant extent the intensity of UHI (Oke, 1973), however it is difficult to change the size of the city. Therefore, other adaptation measures should be found. Both the wind and solar orientation, of buildings and streets, could be used for the adaptation strategies.

First, the ventilation has an especially high adaptation capacity. Results show that ventilation can lower the physiological equivalent temperature (PET) by a maximum of 15K(Müller, Kuttler, & Barlag, 2014). Another study done in Melbourne, Australia shows that real temperature decreases 0.8°C when wind speed increases from 0 m/s to 0.5 m/s (Morris, Simmonds, & Plummer, 2001). The city structure can also help with cooling by increasing the mix of air from the canopy layer with the boundary layer. The mixing depends on the height / width ratio of streets, and the best mixing is acquired when the ratio is around 0.5. If the ratio is higher than 2.0, the mixing is not taking place anymore. Slanted roofs also promote mixing of the layers because air is forced up (Kleerekoper, 2011).

Second, the city structure also effects the amount of solar radiation received by buildings. Although it seems logical to lower the sun exposure in order to lower the UHI, it has negative effects as well. As the increase of the height of buildings leads to the decrease of sun exposure for other buildings, air ventilation becomes more difficult. In additional, more shadows during the winter might create uncomfortable conditions and higher energy consumption (Gago, Roldán, Pacheco-Torres, & Ordoñez, 2013). Because of the potential negative effects, it is important to design buildings on an individual scale in such a way where they collect enough sun but do not create too much shadow for the other buildings (Martin & Keeffe, 2007).

Third, an analysis for the city of Atlanta shows that the land use changes can have a big influence on the UHI phenomenon. What is special about this result is the fact that they simulated land use outside the city to see the influence. Changing an area outside of the city to 100% forest reduced temperatures by 0.1°C, while 100% asphalt would increase temperatures by 0.4 – 0.7°C (Stone, Vargo, Liu, Hu, & Russel, 2013).

In all, different city structural possibilities should be applied to different scales. Promoting ventilation is done on a neighborhood or city scale, while sun exposure is most efficient when done on an individual building scale. Land use changes can be done on different scales but is most effective on a city scale. Ventilation and land use changes are planning measures while sun exposure and wind protection are design measures. The implementation of policies that promote studies to sun exposure and wind protection can help significantly.

The design of cities and in particular buildings depends on the local climate conditions. Local wind dynamics that are caused by city design can have positive and negative effects. When the wind is too weak, it will lead to additional air pollution; while when the wind is too strong, it can create dangerous and uncomfortable conditions for pedestrians.

Horizontally accelerated wind flows can be lowered by using different orientations for streets. The wind canalization will work on the scale of streets. When a long street lies parallel to the prevailing wind direction, there is a chance the wind will be canalized along the street. This is especially the case when the street is getting narrower. By preventing long one-directional street layouts, the chance for wind canalization will decrease accordingly. The general formula for the length of the street is that the street should not be longer than 10 – 20 times of the average building height. Of course a street can go on, but it should change direction. High wind speed through small gaps between high buildings are lower when the orientation of the gap is not parallel to the prevailing wind direction (Wu & Kriksic, 2012).

After the street orientation is determined, combinations of different heights buildings should be strategically arranged along streets. The adaptation measures of the wind dynamics should be focusing on a building scale or a small cluster of buildings. Tall buildings can be strategically placed in context with prevailing wind directions. If a taller building is located downwind of a smaller building, the wind will be blocked (shown in Figure 3-a); while when a tall building is located upwind of a smaller building, the wind will pass over the street (shown in Figure 3-b).

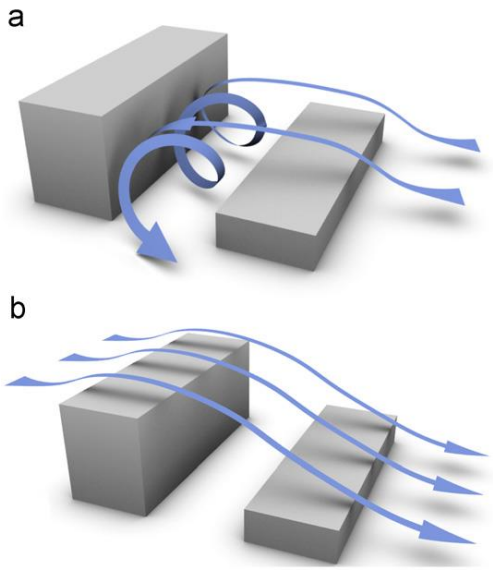


FIGURE 3 BUILDING HEIGHT COMBINATIONS TO CONTROL WINDS (A), (B) ALONG STREETS(WU & KRIKSIC, 2012)

Depending on different local climates and prevailing wind speeds it can be beneficial to construct a large, stepped podium around a tall building in a cold climate (Wu & Kriksic, 2012). As shown in Figure4 -a & b below, the podium around the building reduces the wind speed for the grade level and improves the pedestrian comfort at the street level. While for a hot climate without high wind speed, a straight façade with openings can be used (shown in Figure 4 c & d below). This feature promotes air flow through the building to reach areas that would otherwise be sheltered by a solid building base (Wu & Kriksic, 2012).

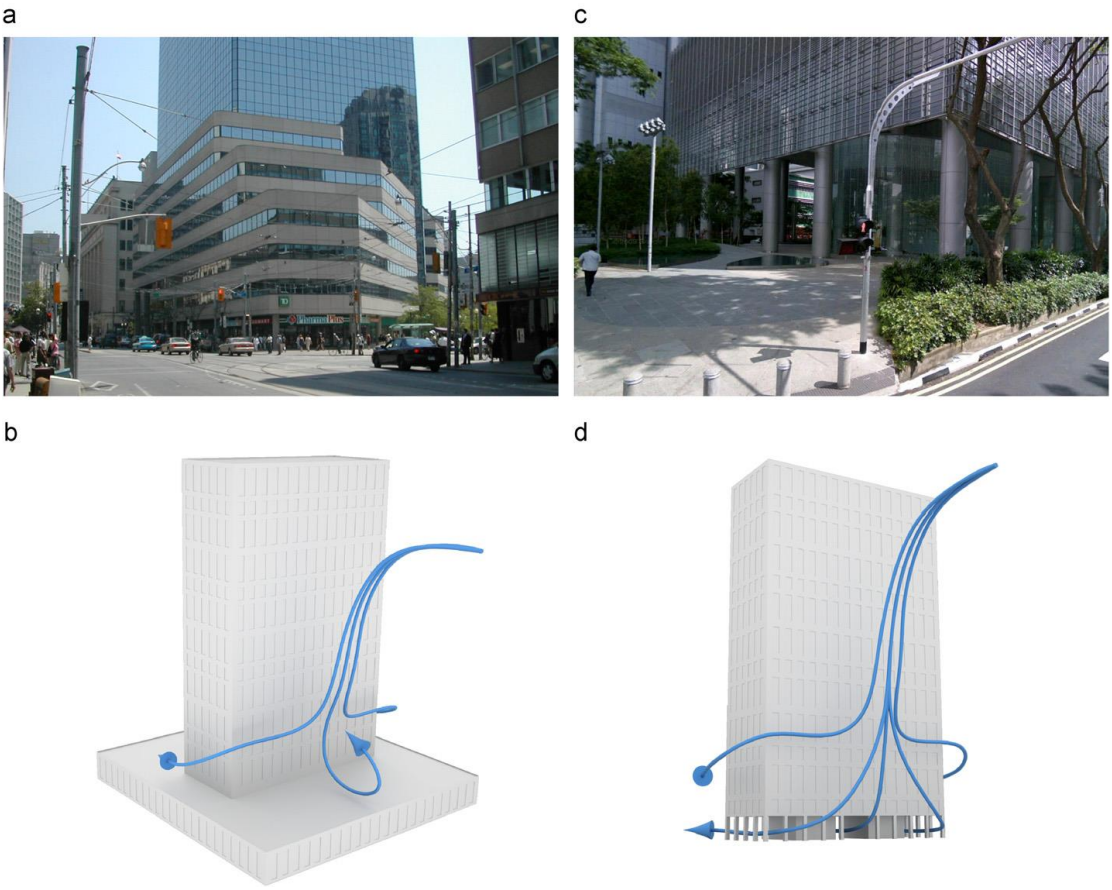


FIGURE 4BUILDING HEIGHT COMBINATIONS TO CONTROL WINDS(A),(B) AND SUN LIGHT (C), (D) ALONG STREETS(WU & KRIKSIC, 2012)

Another way to adapt to high wind speeds on the street level is to construct a large canopy above street level that deflects the wind at the second storey level (shown in Figure 5 below). Moreover, the recessed entrance of a mid-building will create more favorable winds around the entrance (shown in Figure 6 below). In the latter case in Figure 6, it may not be necessary to include a base or canopy and therefore is not deflecting the wind before it reaches the street level (Cochran, 2004). However, such a recessed entrance will not work when it is in a corner because the corner streams will neglect the effect (shown in Figure 7 below).

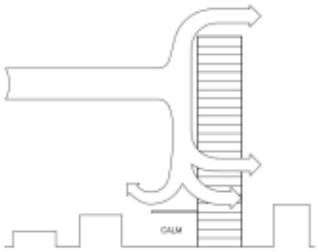


FIGURE 5 A LARGE CANOPY IS A COMMON SOLUTION TO PEDESTRIAN WIND PROBLEM AT STREET LEVEL(COCHRAN, 2004)

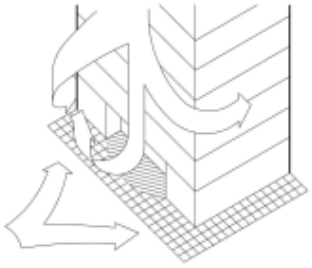


FIGURE 6 A MID-BUILDING ALCOVE ENTRANCE USUALLY RESULTS IN AN INVITING AND CALM LOCATION(COCHRAN, 2004)

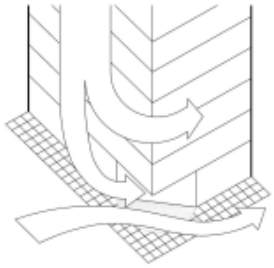


FIGURE 7 ACCELERATED CORNER FLOW FROM DOWNWASH OFTEN YIELDS AN UNPLEASANT ENTRANCE AREA(COCHRAN, 2004)

2.2.2 Vegetation

To lower UHI

Increasing vegetation can influence the UHI phenomenon in multiple ways. The addition of a couple of trees can already lead to a somewhat lower temperature for individual buildings because of the created shadow. Moreover, a study for typical one-story buildings in the United States showed that the addition of three trees per house can lead to energy savings up to 57%, half of which could be due to shadow (Vasilakopoulou, Kolokotsa, & Santamouris, 2014). The remaining savings are caused by evapotranspiration of the trees (Vasilakopoulou, Kolokotsa, & Santamouris, 2014). It could be implemented on a scale of single building but also for a whole neighborhood.

Also green roofs influence the temperatures of an individual building (Vasilakopoulou, Kolokotsa, & Santamouris, 2014; Gago, Roldán, Pacheco-Torres, & Ordoñez, 2013; Müller, Kuttler, & Barlag, 2014). The potential of implementing green roofs is big, because 20 – 25% of the city is covered by roofs (Santamouris, 2014). Roofs are called green roofs when the ordinary black roof is replaced by a roof with vegetation. Just like the addition of trees green roofs change the temperatures in two ways. First it cools down the building in summer time which can lead to a lower demand of air-conditioning in a way which reduces the energy usage of the building (Takebayashi & Moriyama, 2007). The lower temperature in the building is caused by the higher albedo values of a green roof in comparison with the black roof. Exact values depend on the type of vegetation used for the roofs. Results from Susca et al. (2011) found values of 0.2 instead of 0.05 for black roofs (Susca, Gaffin, & Dell'Osso, 2011), while results from Getter et al. (2006) found maximum values of 0.7 – 0.85 (Getter & Rowe, 2006). Temperatures inside buildings are lowered with 2 -4 °C when the outside temperature is between 25 °C and 30 °C. Every decrease of the internal building air temperature by 0.5 may reduce electricity use for air-conditioning up to 8% (Getter & Rowe, 2006). In the summer, green roofs reduce heat flux through the roof by promoting evapotranspiration, physically shading the roof, and increasing the insulation and thermal mass (Oberndorfer, et al., 2007). The second way of cooling the environment is evapotranspiration. Green roofs are also able to retain water better and are thus capable of reducing storm runoff (Oberndorfer, et al., 2007). The effect of cool roofs is not limited to the roofs themselves but also the surroundings. The bigger the roof is, the stronger the effect for the surroundings becomes (Gago, Roldán, Pacheco-Torres, & Ordoñez, 2013).

A good overall efficiency is observed near the maximum layer thickness of extensive green roofs, which is between 15 cm and 20 cm. Since the substrate thickness of an intensive green roof usually exceeds 20 cm, its behavior does not change when further increasing layer thickness (Van Renterghem & Botteldooren, 2008). On a roof in Chicago which is a leading city in green roof, temperatures at 19:00 – 23:00 were 2-3K cooler comparing to the situation with the conventional

roofs (Santamouris, 2014). A simulation for New York shows that the peak temperature is lowered by 0.37 – 0.86K (Santamouris, 2014). The height of the building with a green roof is important, but when the building is taller than 10m the cooling effect on the street level temperature is negligible (Santamouris, 2014).

Besides the application of green roofs, green spaces on the street level can have a significant effect on the UHI as well. The adaptation methods are the same as with green roofs: shading, evapotranspiration and albedo differences. Different studies have found different effects of parks on temperatures. One study shows that the effect could be as big as 4°C and cool islands are created (Gago, Roldán, Pacheco-Torres, & Ordoñez, 2013). While another study finds temperatures to be lower on average 1 - 2°C and maxima of 7°C, based on field-base measurements (Santamouris, 2014). The size of the park matters significant in the capacity of adaptation. This relation, however, is not linear and multiple smaller parks cool the city more than one big park (Vasilakopoulou, Kolokotsa, & Santamouris, 2014; Gago, Roldán, Pacheco-Torres, & Ordoñez, 2013). Temperatures in surrounding areas of parks are influenced as well. A study for New York shows that within 1.5km downwind of a park temperatures were measured 1.5°C lower (Ca, Takashi, & Eusuf Mohamad, 1998). Whereas for Gothenburg, Sweden, effects were found at a distance of 1.1 km (Kleerekoper, 2011).The scale of implementation of urban parks is at the neighborhood or city level. It will need urban planners and designers to think about the location and size of green areas. This could be forced by policies but also could also be done in a more informal way.

The character of a green infrastructure is a key factor for the exact results of the measure. While trees are providing shade to lower the surface temperature, grass is lowering the surface temperature by a lower albedo and evapotranspiration. During the day the PET can be lowered by more than 20°C while grasslands are lowering the PET by a maximum of 12°C. At night this relation is exactly the other way because trees are blocking ventilation and long wave radiation (Müller, Kuttler, & Barlag, 2014).

To influence wind dynamics

Strategically placing trees and shrubs can change the wind dynamics in cities. This can have an effect on the thermal conditions, positive and negative, but also on the uncomfortable wind flows around buildings and open spaces. As blocked by vegetation, the wind will have to find other routes to keep flowing. In general, it can be said that blocking of the wind lowers the wind speed, and trees are responsible for decreasing 22% of the wind speed (Coceal & Belcher, 2005).Depending on the prevailing wind direction in different seasons it might be beneficial to block winds, for instance, winds

in cold winter could be blocked by trees. The implementation of trees and shrubs to change the wind dynamics are more effective when done on a street or neighborhood scale.

In the same way as city design can influence the wind dynamics, vegetation can do that as well. High wind speed at squares in cities can be lowered by strategically placed vegetation. The wind speed depends on the ratio between the height of the buildings and the width of the space between them. By adding rows of trees the width can be reduced and the wind might overshoot the open space instead of creating high. In addition, trees are able to block winds in the same way as porous screens block the wind and are useful in streets where the canalization effect is present.

2.2.3 Use of materials

Properties and configurations of buildings have a significant impact on UHI effect of urban environments. Properties of urban materials, in particular solar reflectance, thermal emissivity, and heat capacity, influence UHI effect, as they determine how the sun's energy is reflected, emitted, and absorbed (U.S. Environmental Protection Agency, 2008).Such properties and configurations influence the development of UHI, particularly when surface temperatures of exposed materials (Ts) become higher than their adjacent air temperatures (Ta) due to high solar irradiation surface UHI (Radhi, Assem , & Sharples, 2014). The increase in Ts affects the intensity of local and downwind air temperatures - atmospheric UHI, especially closer to the surfaces, due to various convective heat fluxes from the surfaces (U.S. Environmental Protection Agency, 2008). The performance of materials under the sun is related to the ability of a material to reflect solar irradiation and the ability of to release absorbed heat.

The study about the assessment of the impact of building surface materials on UHI in highly productive solar regions came to the conclusion Ts and Ta of white color materials such as white ceramic, white marbles or beige porcelain are the lowest in each surface material category. In addition, materials with reflective finishing layers such as glazed ceramic and coated concrete perform better than standard ceramic and concrete with and without standard coatings (Radhi, Assem , & Sharples, 2014). Materials with high thermal mass (e.g., concrete, stone and granite, etc.) generate higher heat storage and higher temperatures (Radhi, Assem , & Sharples, 2014).

For various climates in urban areas, the importance of the urban surfaces (e.g. building walls, pavements, roofs) are different as well. In dry climates, the temperature within a canyon depends on the density of the geometry which determines the relative surface area of the road material (which

usually has a much higher emissivity than the building walls) (Kakoniti , Georgiou, Marakkos, Kumar, & Neophytou, 2016).

2.2.4 Anthropogenic heat lowering

Anthropogenic heat is the heat generated by cars, air conditioners, industrial facilities, and a variety of other manmade sources, which contributes to the urban energy budget (shown in Figure 8 below), particularly in the winter (U.S. Environmental Protection Agency, 2008).Anthropogenic heat varies with urban activities and infrastructures, which means more energy-intensive buildings and transportation produce more heat (Voogt, 2002). Almost all anthropogenic heat enters into the environment instantly and directly (Rizwan, Leung, & Liu, 2008). Recent studies have shown that anthropogenic heat from air-conditioning facilities can increase the exterior ambient temperature and should be taken into account for a more complete UHI mitigation study (Krpo, Salamanca, Martilli, & Clappier, 2010).A decrease of 4◦C in the temperature inside the buildings, or an introduction of a more efficient air-conditioning system, can generate more than 25% of the cooling energy surplus with further negative consequences on the external temperature (Krpo, Salamanca, Martilli, & Clappier, 2010).

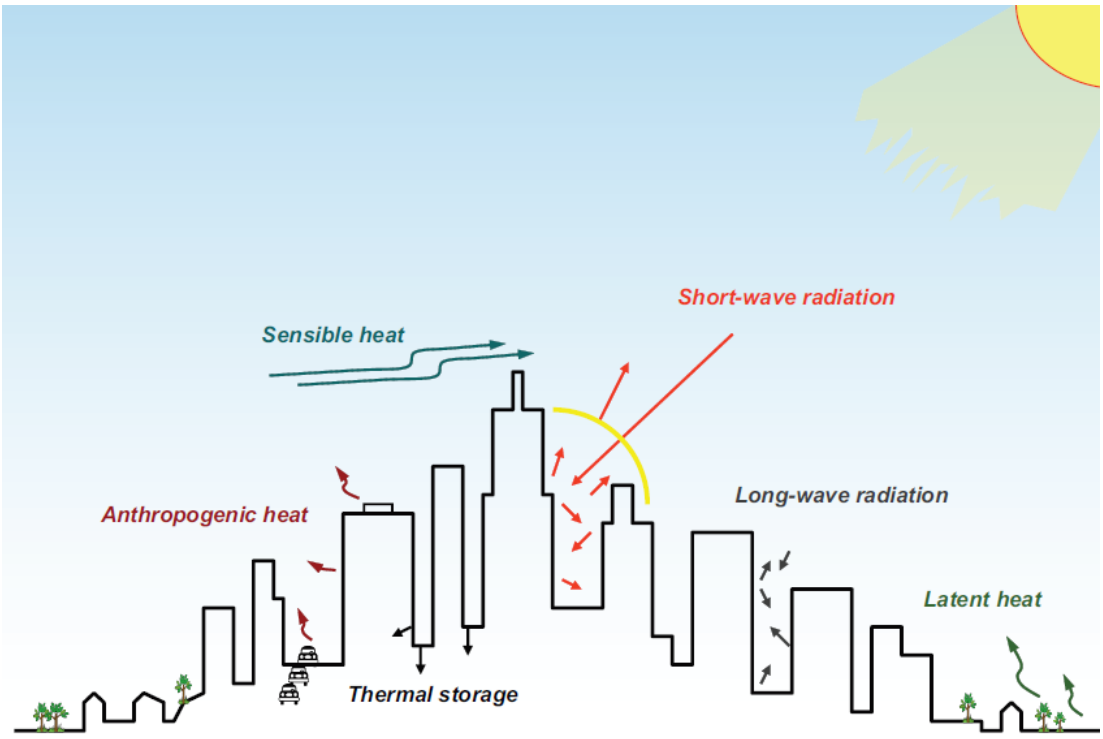


FIGURE 8 URBAN SURFACE ENERGY BUDGET(U.S. ENVIRONMENTAL PROTECTION AGENCY, 2008)

Although the anthropogenic heat is negligible on the global scale and it has smaller effect than albedo and vegetation, it still contributes additional warmth to the air and plays a role in the UHI phenomenon in the regional scale. According to Offerle et al. (2006), the anthropogenic heat is a significant factor of the UHI in winter in European cities (Offerle, Grimmond , Fortuniak, Klysik, & Oke, 2006). It seems that depending on the area and its energy consumption pattern, anthropogenic heat could be significant or negligible and it could have varying diurnal, seasonal or even weekly trends (Rizwan, Leung, & Liu, 2008).

Together with economic development and accelerated urbanization, the urban population in China has been increasing rapidly, and the anthropogenic heat released by large-scale energy consumption in cities is expected to be a vital factor affecting the climate (Feng, Wang, Ma, & Liu, 2012). The anthropogenic heat release has an apparent impact on the winter temperatures in China (Feng, Wang, Ma, & Liu, 2012).

2.3. Urban planning

Urban climate responsive planning

In general, urban planning and design has always been driven by social needs. Currently, there are convincing evidences of climate change, in most cases these evidences are urban area becoming warmer. On the other hand, sustainability is a vital task for urban planners and designers. Sustainability is about continuous function of our planet's ecological and socio-economic system. For planners and designers, addressing urban climate challenges in urban planning and design processes is a way to fulfill the needs of sustainability. In urban planning domain, it was during the 1990s that the analytical dialogue between climate change and urban studies first began (Whitehead, 2013). The significance of the urban perspective to study climate change, under the political economy of climate change context, was predicted on four premises: the role of cities as intense clusters of energy use and greenhouse gas production, the jurisdictional power of urban authorities to influence and shape policy sectors with relevance to climate protection; the role of city authorities as points of translation and transformation for national and international climate change policy; and the significant institutional memory that municipal authorities hold in the development and delivery of varied environmental policies (Whitehead, 2013). The key of urban climate responsive planning is to hold the view that urban development is a process of spatial organization under differentiated circumstances. Consequently, city should be understood as the spatial manifestation of complex economic and political processes that shape and condition the urban experience. In addition, urban climate mitigation and adaption strategies present very different opportunities and obstacles to the

marketization process; however, adaption strategies often prove very difficult to commercialize in their early stages of development.

3. Methods

3.1. Data collection

The data analyzed in this research mostly come from literatures, in-depth interviews and document study.

3.1.1. Literature review

Literature review as the starting point into this research topic has provided background knowledge and supported the preparation of the interview questions and the analysis of the results. The literatures are related to two realms: **urban climate adaption in urban planning and design process** and **background knowledge of urban climate**. As this research focuses on the current situation in China, the literatures included are either in English or Chinese.

3.1.2. In-depth interviews

- Interview questions and answers

In order to achieve the research objective, interview questions have been designed during the research preparation phase with the cooperation of two supervisors and Joram van de Schans, another LUP master student. Totally, there are 23 questions under 4 aspects which are **Awareness, Communication, Planning instruments and Implementation**. The interview questions were designed according to the main and sub research questions. The list of interview questions and its translation in Chinese are in Appendix 1.

UHI and wind discomfort are two urban climate phenomena studied in this research. The awareness of these two phenomena and urban climate adaptation measures and the corresponding measures to increase the awareness are deliberated in the section about Awareness. The questions about Communication, Planning instruments and Implementation are focused on the current situation of urban climate adaptation strategies implemented in the urban planning and design process in China.

Communication strategies are studied in different perspectives through six open questions. First, the roles of different groups in the communication process has been taken into account in two ways: the role of each group and their relationships between one another. Second, the role of communication in the implementation process is discussed. Third, relevant policies or formal guidelines are gathered from the answers from the interviewees. Finally, a strength and weakness analysis of the communication process, and future improvements to it, are the last questions in the communication strategies part.

Questions about planning instruments are intended to find out the current laws, policies, regulations about urban climate adaptation in urban planning and design process. Question about the strengths and weaknesses of the mentioned planning instruments is included as well. There are also questions about possible improvements of the mentioned planning instruments.

Questions about implementation are designed to collect and analyze the concrete measures or interventions about urban climate adaptation. There are two questions about the certain conflicts between aesthetics and current measures/ interventions and urban functions and current measures/ interventions.

All answers are translated from Chinese. Answers from the interviews (which include interviewees 1 ○, 3 △, 4 △, 5 △, 6 △, 7 △, 8 △) are summarized from voice recordings, while the answers from e-mails (interviewee 2 □ and interviewee 9 ◇) are translated directly from their written answers. The complete answers are in Appendix 2.

- Selection of interview methods

The structured in-depth interview method has been selected. The reasons of selected the structured in-depth method in this research are as follows.

The complexity of the interview questions requires knowledge of both theory and practice in the fields of urban planning and/or urban climate. The interviewees must come from diverse occupations and locations in order to fulfill the requirements of the research. It is not possible for some random citizens working in irrelevant fields to share their knowledge in the prepared interview questions. In the end, urban planning professors, civil engineers, urban planners and designers have met the requirements of the interviewees.

- Selection of interviewees

The main categories of the potential interviewees have been organized into three categories: practitioners, academic and government. Under these categories, the relevant organizations were 1) Architecture design and research institutes; 2) Meteorological Bureau; 3) Universities; 4) Research centers; 5) Government departments in the hierarchy of urban planning system. Potential interviewees were identified by online search of websites of relevant organization, Chinese authors of relevant scientific papers and personal networks.

In the end, 9 interviewees took part in the interviews. The interviewees are from different organizations and occupations. They come from cities which are located in different climate zones. All interviewees from Urumqi and Shanghai have participated in face-to-face interviews. Other interviewees from Lanzhou and Xiamen have replied to the interview questions by email after telephone contact. The general information of all interviewees is listed in Table 1 below. The code rules are explained in Appendix 4.

TABLE 1 EXPERTS GENERAL INFORMATION LIST

No.	Code	City	Position	Organization	Contact source	Code rules
1	1 ○	Urumqi (Severe Cold)	Urban planner/designer	Xinjiang Uygur Autonomous Region Architecture Design and Research Institute	Personal network	○: Severe cold climate zone; □: Cold climate zone; △: Hot-summer and cold-winter climate zone; ◇: Hot-summer and warm-winter climate zone;
2	2 □	Lanzhou (Cold)	Lecturer	Lanzhou University		
3	3 △	Shanghai (Hot -summer and Cold -winter)	Urban planner/designer	Shanghai LongiLat Architectural Design & Research Institute CO., LTD.		
4	4 △		Urban planner/designer	Shanghai LongiLat Architectural Design & Research Institute CO., LTD.		
5	5 △		Urban planner/designer	Tongji University	Personal contact intermediate	
6	6 △		Urban climate expert	Tongji University		Urban planner/designer: ○; □; △; ◇; Lecture/professor: ○; □; △; ◇; Urban climate expert: ○; □; △; ◇; Civil engineer: ○; □; △; ◇;
7	7 △		Professor	Shanghai Open University Hongkou Branch Campus		
8	8 △		Civil engineer	Shanghai New Changning(Group) Co., Ltd.		
9	9 ◇	Xiamen (Hot-summer and Warm-winter)	Urban planner/designer	Xiamen University	Online search	

➢ Relevant information about the interviewees

FIGURE 9 INTERVIEWEES LOCATION

9 interviewees were involved who came from four different climate zones (shown in Figure 10). The general information of these four cities are summarized in Table 2 below. The cities are located in different climate zones in China according to China Building Climate Division[2] shown in Figure 11 (Ministry of Construction of the People's Republc of China, 2005). Because the climate conditions in China differ greatly from northern China to southern China, it is more representative to invite participants from different climate zones than one climate zones only.

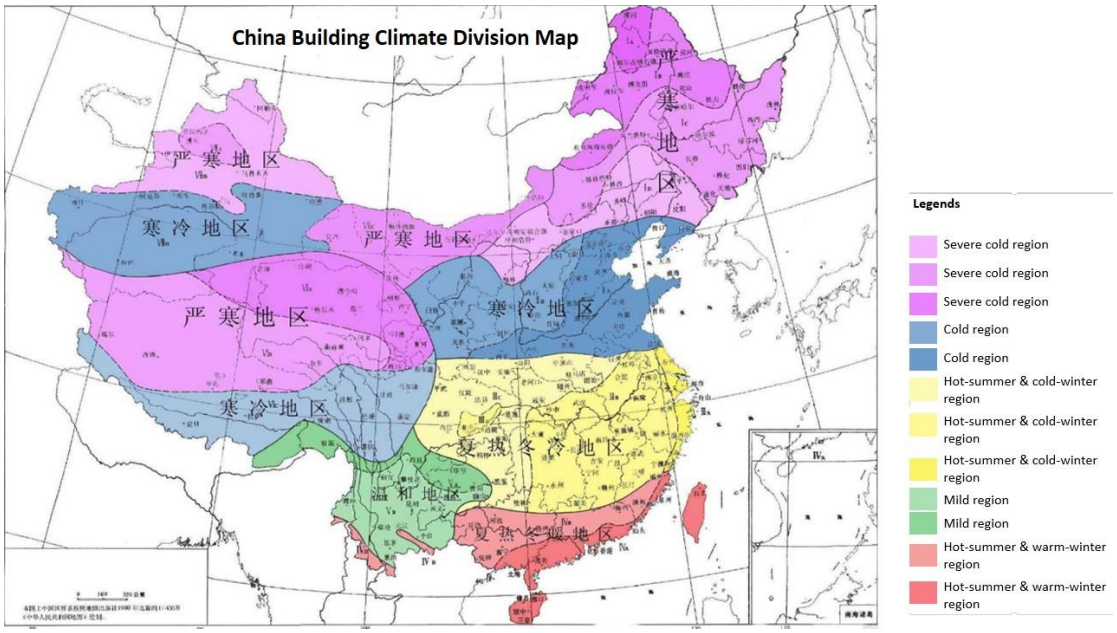


FIGURE 10 CHINA BUILDING CLIMATE DIVISION MAP[3]

[2] The detailed information of each category in China Building Climate Division shown in Appendix.

[3](Ministry of Construction of the People's Republc of China, 2005); Edited by author.

TABLE 2 GENERAL INFORMATION OF 4 SELECTED CITIES

City	Region	Area[4]	Year-end residential population	Climate characters
Urumqi **(43°49′30″N 87°36′00″E)**	Xinjiang Province	Total: 14,577 km^2 Build-up area: 251 km^2	3,530,000[5]	-Severe cold; -January average temperature: -15.2℃; July average temperature: 25.7℃;
Lanzhou **36°02′N103°48′E**	Gansu Province	Total:13085.6 km^2 Build-up area: 137 km^2	3,664,900[6]	-Cold; -January average temperature: -5.3℃; July average temperature: 22.4℃;
Shanghai **31°12′N 121°30′E**	Direct-controlled municipality	Total:5800 km^2 Build-up area: 1563 km^2	24,151,500[7]	-Hot-summer and cold winter; -January average temperature: 4.2℃; July average

[4](China Statistics Press, 2014)

[5](Statistic Bureau of Xinjiang Uygur Autonomous Region, 2015)

[6](Lanzhou Municipal Bureau of Statistics, 2015)

[7](Shanghai Statistic Bureau, 2014)

				temperature: 27.9℃;
Xiamen **24°28'47.41"N** **118°05'21.91"E**	Fujian Province	Total:1638 km^2 Build-up area: 245 km^2	3,810,000[8]	-Hot-summer and warm-winter; -February average temperature: 12.4℃; July average temperature: 27.8℃;

3.1.3. Document study

In the data collection phase, relevant policy documents have been studied as main reference and background knowledge. The documents are listed as follows (see Table 3 below). Relevant contents about urban climate adaptation in urban planning and design process in these documents are summarized in Appendix 5.

TABLE 3 URBAN CLIMATE ADAPTATION DOCUMENTS

Year	Document	Promulgated by
2015	China's Policies and Actions for Addressing Climate Change 2015	National Development & Reform Commission
2014	China's National Plan on Climate Change (2014-2020).	National Development & Reform Commission
2014	China's Policies and Actions for Addressing Climate Change 2014	National Development & Reform Commission
2013	China's Policies and Actions for Addressing Climate Change 2013	National Development & Reform Commission
2012	China's Policies and Actions for Addressing Climate	National Development &

[8](Xiamen Municipal Bureau of Statistic, 2015)

	Change 2012	Reform Commission
2011	China's Policies and Actions for Addressing Climate Change 2011	Information Office of the State Council of the People's Republic of China
2009	China's Policies and Actions for Addressing Climate Change 2009	National Development & Reform Commission
2008	China's Policies and Actions for Addressing Climate Change 2008	Information Office of the State Council of the People's Republic of China
2007	Urban and Rural Planning Law	Standing Committee of the tenth National People's Congress

3.2. Data analysis

After the data collection phase, qualitative research methods have been carried out in order to analyze the interview answers. The word frequency in answers to the open questions were analyzed by using NVivo 11 software. NVivo is a qualitative data analysis (QDA) computer software package produced by QSR International. It has been designed for qualitative researchers working with very rich text-based and/or multimedia information, where deep levels of analysis on small or large volumes of data are required. In the data analysis phase, the answers to the closed interview questions were analyzed and summarized into graphs using Microsoft Excel. The complete interview answers are summarized in Appendix 2.

4 Results

This chapter presents the results of the document study and interviews. The documents listed in Table 3, in section 3.1.3 above, are analyzed in the first part of this chapter. The results of 23 interview questions are presented afterwards. The interview results have two sections, which are 4.2 'Awareness of and basic knowledge about urban climate adaption', and 4.3 'Planning and design process for implementation'. Finally, explanations of unclear answers to interview questions are given in 4.4. The list of interview questions is attached in Appendix 2 and the original answers to each question are gathered in Appendix 3.

4.1. Results of document study

The main goal of the document study was to analyze the contents relevant to urban climate adaptation in urban planning and design process.

- **Urban and Rural Planning Law**

  This law was passed in 2007 and was revised once, in 2015. It determines how the urban planning process should work. There is no specific clause concerning urban climate adaptation yet. Only adaptations to economic or technological development are included.

- **China's National Plan on Climate Change (2014-2020)**[9]

  This national plan is focused on climate change issues, however, contents related to urban planning are limited. This national plan focuses on mitigation and adaptation, scientific research, and public awareness. Because the plan's main goals concern greenhouse gas emissions and China's energy structure until 2020, urban climate adaptation in the urban planning and design

[9]China's National Plan on Climate Change (2014-2020) includes the following chapters: Status and Prospects, Guidelines and Main Objectives, Controlling Greenhouse Gas Emissions, Adapting To The Impacts of Climate Change, Implementation Of Pilot Demonstration Projects, Improving The Regional Response To Climate Change, Incentives And Restraint Mechanisms, Strengthening Scientific And Technological Support, Capacity Building, Deepening International Exchanges And Cooperation, and Performance And Evaluation (LSE, 2014).

process is mentioned only very briefly. However, three aspects of it that are related to climate adaptation in urban planning and design are outlined below.

First, urban and rural planning should fully consider climate change impacts. When selecting new city sites and urban expansions, planners and designers need to conduct assessments of the risk of climate change. Urban planning and design projects should deal with potential risks such as floods and other extreme weather conditions. UHI should be actively coped with. There is no further discussion about concrete adaptation measures or intervention regarding UHI. Land devoted to urban vegetation should be protected from unauthorized occupation.

Second, pilot projects are planned, with detailed numbers. The three kinds of pilot projects are industrial parks, business parks, and communities. By 2020, there will be 150 industrial parks, 1000 business parks, and 1000 communities, all of which are to be climate-concerned projects. In these communities, green buildings will be designed and built. Relevant policies, regulations, and detailed rules about green buildings have already been formulated in various provinces. The main target of the industrial parks and business parks is to lower carbon emission by installing mitigation techniques. Adaptation measures are not mentioned in the plans for these industrial and business parks. In this national plan, and other climate change policies, mitigation and adaptation are usually discussed together, and mitigation measures are more common.

Third, climate adaptation research will be supported by more financial investment.

- **China's Policies and Actions for Addressing Climate Change 2015, 2014, 2013, 2012, 2011, 2009, 2008**

According to the first annual report, published in 2008, climate adaptation and climate mitigation should be treated with equal importance in a coordinated and balanced way, because urban climate adaptation is a more present and imminent task (The Information Office of the State Council, 2008). There is no more content related to urban climate adaptation in the 2008 report.

According to the 2009 report, the potential impacts of planning and construction projects on local climates have been avoided or reduced. However, climate change impact assessments for key areas and special industries were not carried out until 2015. The wind power assessment was also first mentioned in the report from 2015. The meteorological

departments released and implemented some research plans in 2011, two years after 2009. It is therefore unclear which impacts on local climate had been reduced.

The 2013 report claimed that the public had gained a deeper understanding of climate change and have participated in mitigation measures more widely and consciously. But urban climate adaptation issues are not included in the education and training of citizens.

According to the report from 2014, the Ministry of Housing and Urban-Rural Development and the Ministry of Industry and Information Technology both advocated the use of environmentally friendly construction material, and released the *Management Method for Assessing and Labeling Green Construction Material*. The use of environmentally friendly construction materials is often aimed at energy conservation and emission reduction.

In the 2015 report, cooperation with international organizations about urban climate adaptation occurs for the first time. China signed the Memorandum of Understanding on Bilateral Cooperation on Climate Change with the Asian Development Bank, and jointly organized the 'International Workshop on Urban Adaptation to Climate Change' (NDRC, 2015).

All in all, urban climate adaptation gradually gained more attention in this series of reports. The main focus of urban climate adaptation content is to prepare for extreme weather conditions and air pollution in cities. The Ministry of Housing and Urban-Rural Development works towards meeting the requirements of energy conservation and emission reduction in construction processes, for instance by planning low-carbon communities and implementing thermal construction materials.

- **Evaluation standards for green building**

A civil engineer mentioned about the evaluation standards for green buildings while being interviewed. In China's National Plan on Climate Change (2014-2020), green buildings as well as passive building design are encouraged. As Figure 12 below, from the research of Ye et al., suggests, it is understandable that one interviewee alone cannot explain how the structure of the evaluation standards for green buildings works. In Appendix 6, there are two lists given which include all Chinese documents for green building, except the enterprise standard: 17 national and trade standards and over 50 local standards (Ye, et al., 2015). According to the National New-type Urbanization Plan (2014-2020), the proportion of new buildings that will be

green buildings will be 50% by 2020, while the proportion in 2012 was only 2%. The assessment criteria for green buildings do not only include climate adaptation measures and interventions, but also focus on land saving, energy saving, water saving, material saving, and indoor environment. Energy efficient measures are implemented much more often than climate adaptation measures in green buildings.

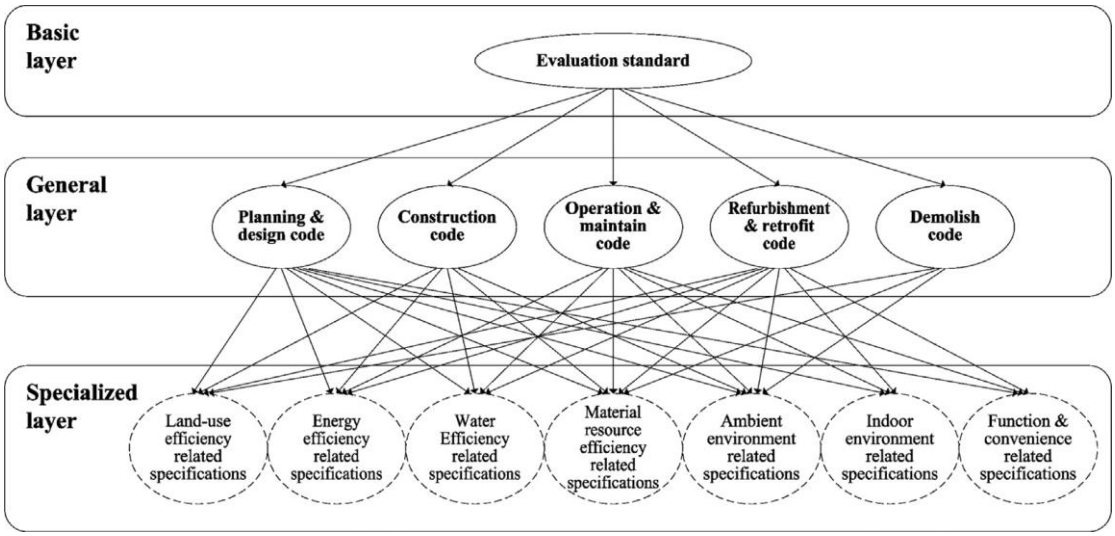


Figure 11 Structure of the green building standard system in China.(Ye, et al., 2015)

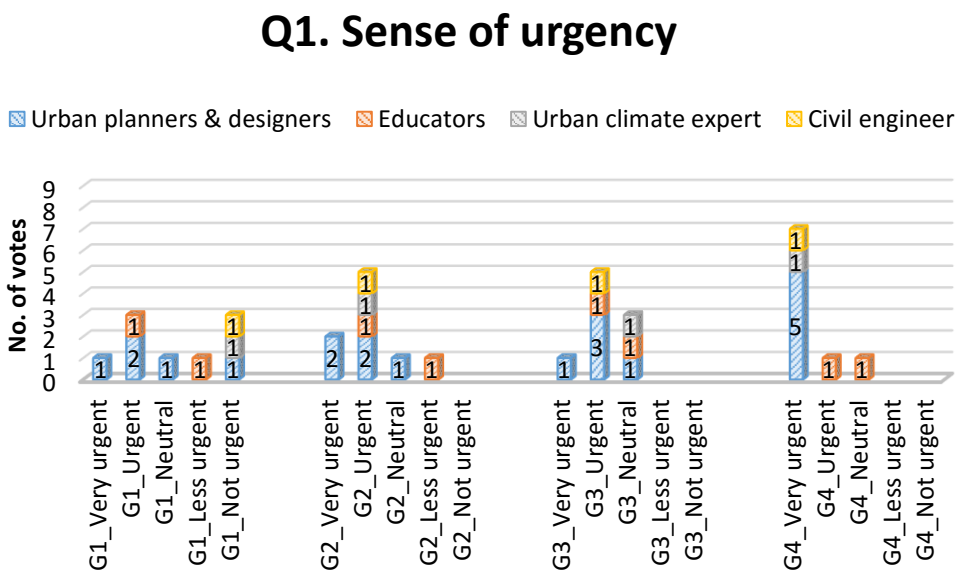
4.2. Interview results: Awareness and basic knowledge

This first section addressing the interview questions has three parts. The sense of urgency to adapt the urban environment, the awareness of urban climate phenomena, and the awareness of urban climate adaptation measures were each addressed with a closed question and the responses are then represented in histograms. A further open question is related to each closed question in order to collect ideas about how to increase low senses of urgency or awareness. This research focuses on two urban climate phenomena: urban heat islands (UHIs) and wind discomfort. There are four adaptation measures selected, which are city design, urban vegetation, use of materials, and anthropogenic heat.

4.2.1. Sense of urgency

Interview question 1. What is the sense of urgency to adapt the urban environment to climate change amongst the following groups in the future in your city?

Based on the responses to the interviews, the sense of urgency among four groups, including citizens, politicians, urban planners and designers, and urban climate experts, to adapt the urban environment to climate change is summarized into the clustered column chart in Figure 13 below.



G1: citizens; G2: politicians; G3: urban planners and designer; G4: urban climate experts;

FIGURE 12 SENSE OF URGENCY FOR URBAN CLIMATE ADAPTATION

As shown in Figure 13 above, most of the urban planners and designers believed that the sense of urgency about climate adaptation is quite high among all four groups. Interviewee (7 △) from the education field held different opinions. He did not think any of the four group have high sense of urgency about urban climate adaptation. Urban climate professors and civil engineers thought that citizens have a low sense of urgency about climate change. In general, the urban planners and designers and the urban climate experts are assumed to have higher sense of urgency about climate change. Citizens are considered to have a low sense of urgency according to the results.

4.2.2. Measures to increase the sense of urgency

Interview question 2. In case the sense of urgency in groups is low, what is needed to increase the sense of urgency to adapt the urban environment?

In order to raise their senses of urgency, different measures were suggested by all interviewees for each group. In general, the measures to increase senses of urgency have different emphasis on each group. According to NVivo statistic results, the three words or phrases most frequently mentioned by the interviewees were 'propaganda', 'communication', and 'information updates'.

Firstly, as citizens are seen as the most passive group among all groups, media propaganda methods were suggested by all interviewees. The propaganda methods included public service advertisements, for example short videos and lectures by urban climate experts. These measures would enhance citizens' understanding of the relationship between urban climate change and their daily lives.

Secondly, the common measures recommended for the other three groups were communication and urban climate information updates. In order to increase the sense of urgency, the first step is to get a clear understanding of urban climate adaptation. Through communication and information update measures new concepts and experience about urban climate adaptation will be introduced.

4.2.3. Awareness of two urban climate phenomena

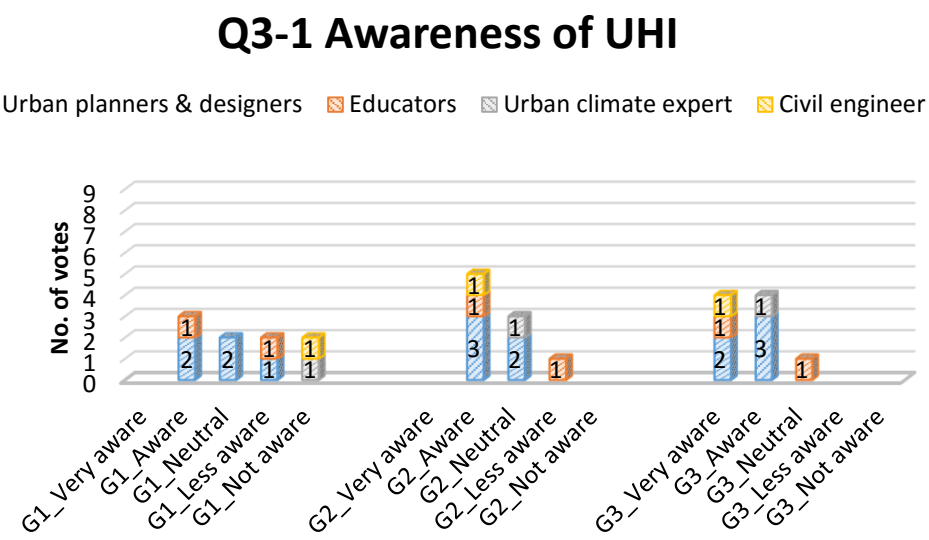
Interview question 3. How aware are the groups of the following two urban climate phenomena?

3-1 Urban Heat Islands

3-2 Wind Discomfort

The awareness of the UHI effect and wind discomfort in citizens (G1), politicians (G2), and urban planners and designers (G3) were studied in two closed questions during the interviews. The urban climate experts group is excluded in these two questions because of their authority and expertise in urban climate fields. The results are summarized into clustered column charts in Figure 14 and Figure 15.

UHI phenomenon

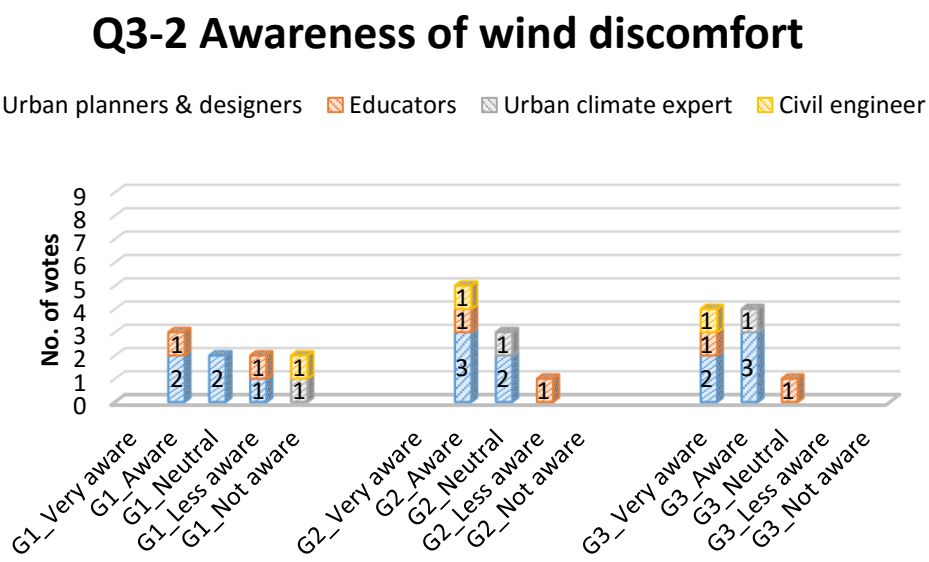


G1: citizens; G2: politicians; G3: urban planners and designer;

FIGURE 13 THE AWARENESS OF UHI AMONG 4 GROUPS

Interviewees believed that urban planners and designers are more aware of the UHI phenomenon than the other two groups, and citizens are considered less aware of this phenomenon by the interviewees who are not urban planners and designers. The 5 urban planners and designers believed UHIs are familiar to all three groups.

Wind discomfort



G1: citizens; G2: politicians; G3: urban planners and designer;

FIGURE 14 THE AWARENESS OF WIND DISCOMFORT AMONG 3 GROUPS

Compared to the UHI phenomenon, wind discomfort is less known to the interviewees themselves. However, as shown in Figure 15 above, interviewees believed that urban planners and designers were more familiar with wind discomfort. Urban planners and designers did not agree with the other interviewees, and most of them did not think politicians were aware of wind discomfort. Citizens group (G1) are assumed to be unfamiliar with this phenomenon.

4.2.4. Measures to increase the awareness about urban climate phenomena

Interview question 4. In case awareness in groups is low, what is needed to increase their awareness of the two urban climate phenomena mentioned in question 3?

In order to increase the awareness of the urban climate phenomena, the most frequent recommendations in the interviewees' answers were training (7 times), propaganda (7 times), lectures (5 times), media (4 times), cooperation (2 times), according to a word frequency inquiry on the answers from the interviewees using NVivo software. Base on the NVivo results, the frequency of each measure as mentioned by each of the interviewee profession categories is displayed in Figure 15 below.

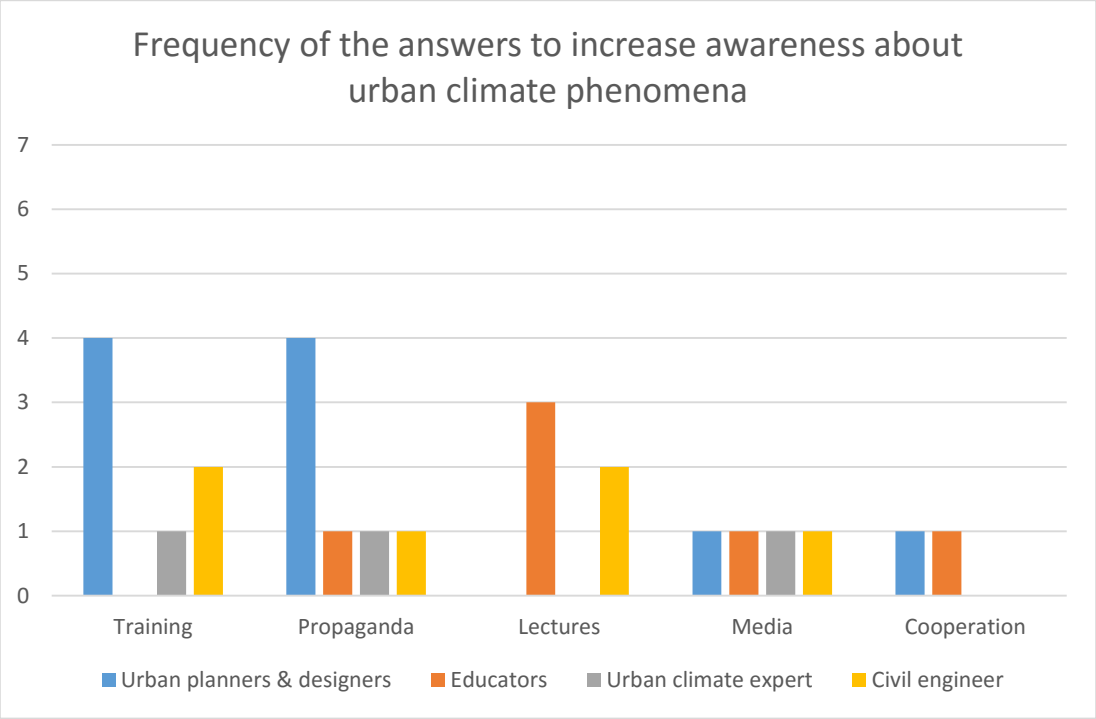


FIGURE 15 FREQUENCY OF THE ANSWERS TO THE MEASURES TO INCREASE AWARENESS ABOUT URBAN CLIMATE PHENOMENA

Citizens are regarded as the group with the lowest awareness of urban climate phenomena, and the measures suggested for citizens were similar to the measures recommended to increase their sense of urgency. Propaganda methods were the most frequently suggested for citizens. Print media and TV media can be used to provide information to citizens in their daily lives. Lectures and various activities were the main methods recommended to citizens.

Training and international and cross-field cooperation were two methods recommended to enhance the politicians' and urban planners' and designers' understandings of urban climate phenomena. Through training activities, politicians and urban planners and designers are able to acquire the basic knowledge about urban climate phenomena, and the knowledge about urban climate phenomena is definitely required when they encounter urban climate adaptation measures in their work.

4.2.5. Urban climate adaptation measures

Interview question 5. How aware are the groups of following urban climate adaptation measures?

5-1 City design (e.g. street orientation, adapting to the wind and solar orientation of buildings and streets, land use in the surrounding areas)

5-2 Urban vegetation (e.g. green roofs, urban forestry, parks, strategically placed trees and shrubs, vegetated walls, vegetated rails and roads)

5-3 Use of materials (e.g. low albedo and longer cooling time-lag materials)

5-4 Anthropogenic heat (e.g. less air conditioners, lower car use)

The interview results indicate that in general people are most familiar with urban vegetation and the anthropogenic heat lowering measures. Urban planners and designers have knowledge about city design measures and the use of materials due to their professions, while citizens and urban climate experts do not know much about city design measures or the use of materials as they do not actively participate in the current urban planning system in China. Interviewees' views diverged on politicians' awareness of urban climate adaptation measures. Some interviewees trusted that the politicians were aware or even very aware of these measures because they need the knowledge to formulate relevant policies and regulations. Other interviewees did not agree that the politicians were highly aware because they assumed that the politicians' awareness would be represented by the planning instruments which they have promulgated and implemented and, at present, mitigation measures are more popular than adaptation measures in climate change policies. The results of the awareness of these four adaptation measures are shown in Figure 16-19.

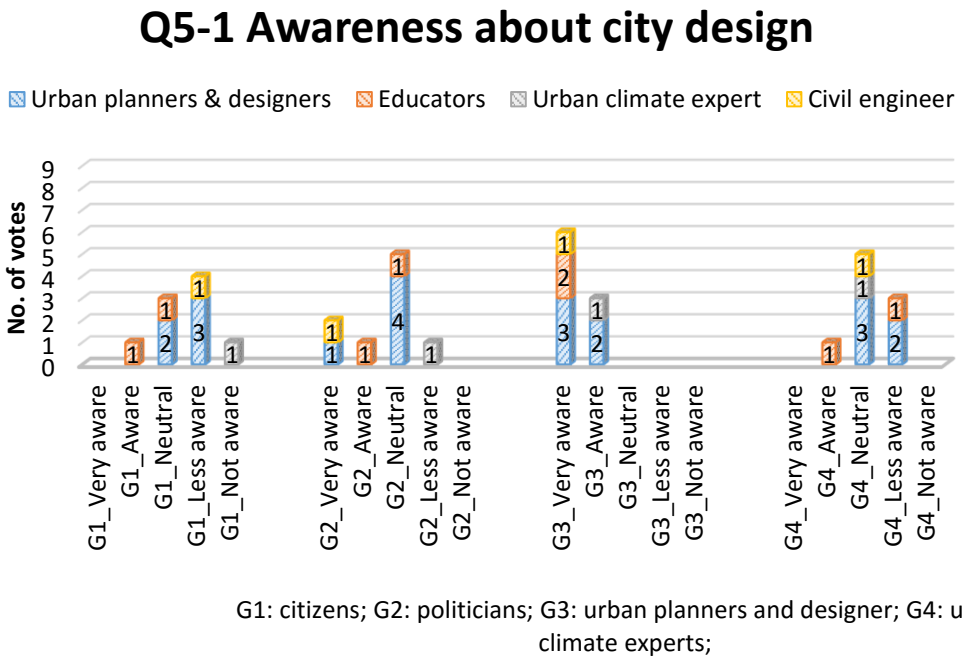


FIGURE 16 THE AWARENESS OF CITY DESIGN AS AN URBAN CLIMATE ADAPTATION MEASURE AMONG DIFFERENT GROUPS

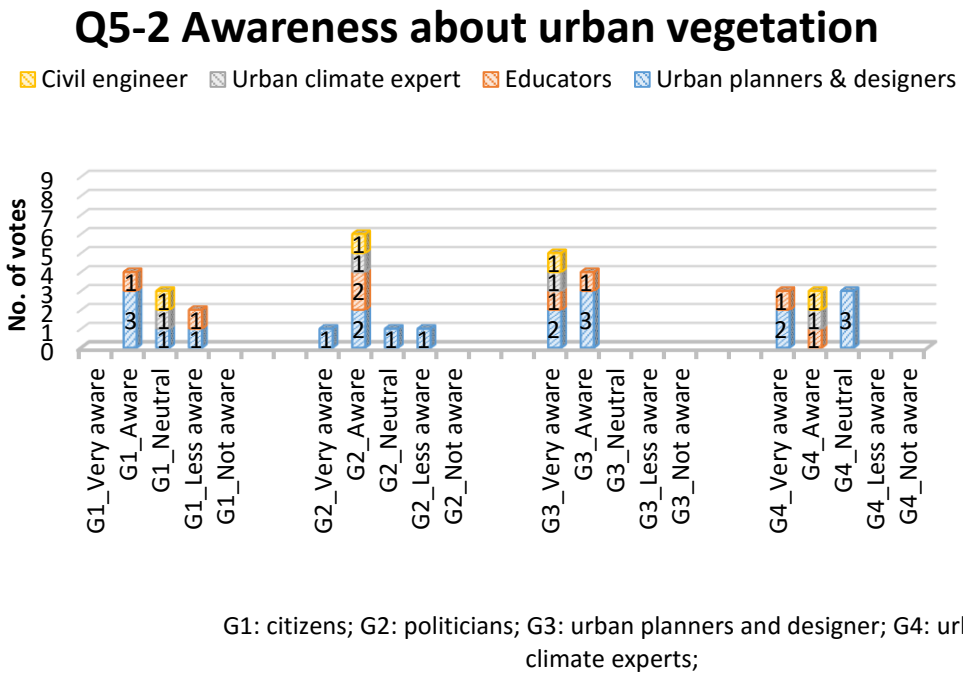


FIGURE 17 THE AWARENESS OF URBAN VEGETATION AS AN URBAN CLIMATE ADAPTATION MEASURE AMONG DIFFERENT GROUPS

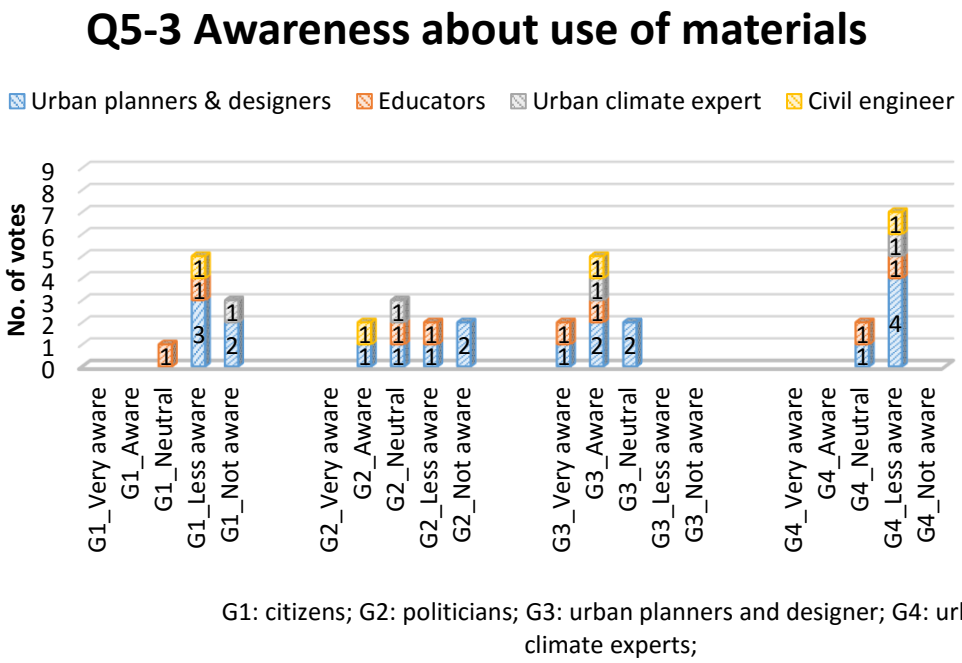


FIGURE 18 THE AWARENESS OF THE USE OF MATERIALS AS AN URBAN CLIMATE ADAPTATION MEASURE AMONG DIFFERENT GROUPS

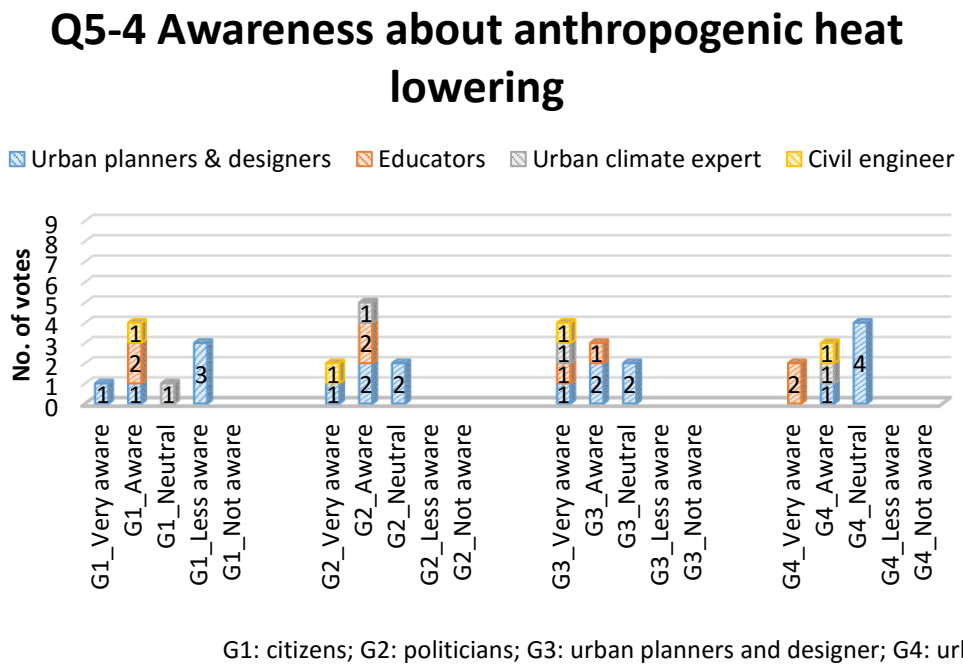


FIGURE 19 THE AWARENESS OF THE ANTHROPOGENIC HEAT LOWERING AS AN URBAN CLIMATE ADAPTATION MEASURE AMONG DIFFERENT GROUPS

4.2.6. Measures to increase the awareness about urban climate adaptation measures

Interview question 6. In case awareness in groups is low, what is needed to increase their awareness of four urban climate adaptation measures mentioned in question 5?

In order to increase the awareness of the urban climate adaptation measures, the most frequent recommendations in the interviewees' answers were training (12 times), education (5 times), policy making (5 times), media propaganda (5 times), conference (4 times), cooperation (4 times), lectures (4 times), according to a word frequency inquiry on the answers from the interviewees using NVivo software. Base on the NVivo results, the frequency of each measure as mentioned by each of the interviewee profession categories is displayed in Figure 20 below.

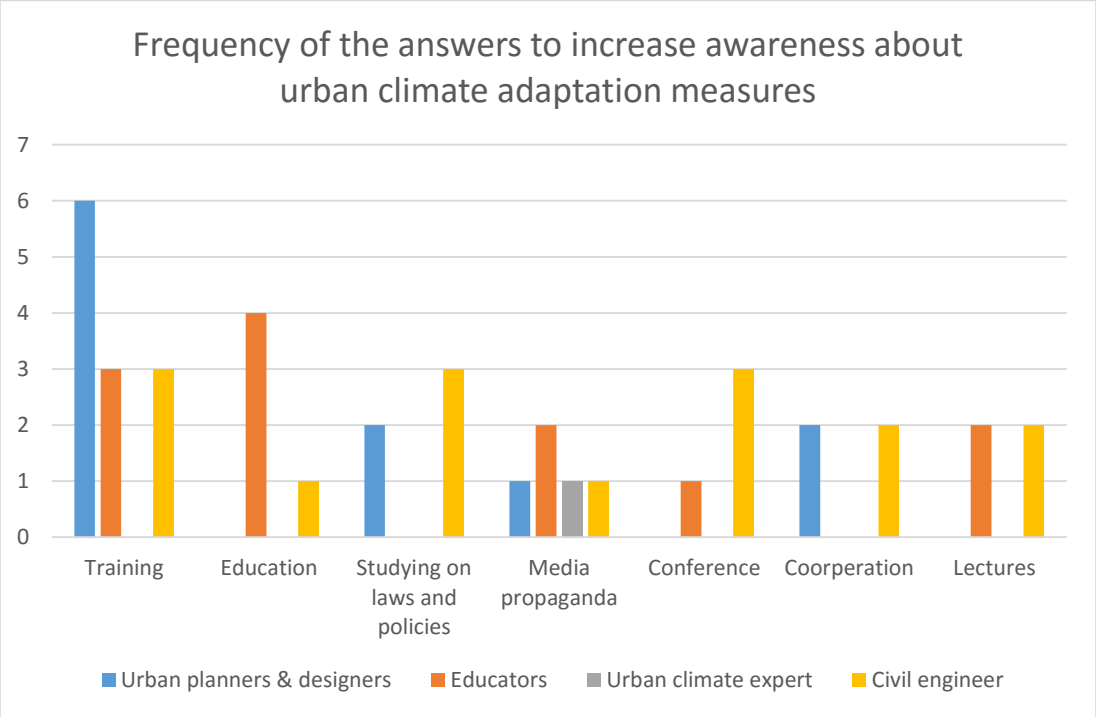


FIGURE 20 FREQUENCY OF THE ANSWERS TO INCREASE AWARENESS ABOUT URBAN CLIMATE ADAPTATION MEASURES

Citizens are regarded as the group with the lowest awareness of urban climate adaptation measures (as shown in Table 4 below). Various media propaganda methods were the most frequently suggested for citizens. Print media and TV media can be used to provide information about urban climate adaptation measures to citizens in their daily lives. Lectures and various activities were the main methods recommended to citizens. Simple introductions to some easily applied adaptation measures are efficient ways to increase citizens' awareness. Showing examples of buildings which have applied urban climate adaptation measures is also recommended by urban planners.

Training and studying on laws and policies, international and cross-field cooperation, and holding conference about urban climate adaptation measures were three methods recommended to enhance the politicians', urban climate experts', and urban planners' and designers' understandings of urban climate adaptation measures.

TABLE 4 AWARENESS OF URBAN CLIMATE ADAPTATION MEASURES

	City design	**Urban vegetation**	**Use of materials**	**Anthropogenic heat**
Highest awareness group	Urban planners and designers	Urban planners and designers	Urban planners and designers	Politicians
Lowest awareness group	Citizens	Citizens	Citizens	Citizens

4.3. Interview results: Planning and design process for implementation

There are three parts in this section: communication strategies, role of planning instruments, and concrete urban climate adaptation measures. Each part covers the results of six open questions.

4.3.1. Communication strategies

Interview question 7. What roles do citizens, politicians, planners and designers, and urban climate experts have in the process of planning, designing, and implementing urban climate adaptation measures?

Citizens are passive receivers (4 △, 5 △, 2 □, 7 △, 8 △) and participants (1 ○ and 9 ◇). They can give feedback and empirical data to other groups based on their daily experiences with urban climate-responsive planning projects (1○ and 6 △). For instance, they can share their experience of microclimate information, such as wind and heat environments, and usage data such as the usage of air conditioners. Citizens in China also play the main role in public supervision, which is important in the policy implementation process (9 ◇). Citizens are vulnerable to climate change and they focus on self-interest (3 △).

Politicians take the most powerful and active role in the communication process. In China, politicians are state leaders and cabinet members, and as policy makers and decision makers can encourage and offer communication opportunities to the other three groups. Their awareness of and interest in urban climate adaptation influences the development and implementation of urban climate adaptation strategies. Politicians are the decision makers (1 ○, 4 △, 7 △, 8 △, 2 □). For example, the government's orientation determines governmental investments in relevant researches and pilot projects. Politicians focus on the feasibility and operability of the urban planning plans in short terms (3 △).

Urban planners and designers focus on realizing planning goals within the framework of laws and policies (1 ○, 3 △, 2 □). They are responsible to carry out concrete urban planning projects (4 △, 5 △, 9 ◇, 8 △). They know the deficiencies in the planning and design process and the current planning instruments.

Urban climate experts play the role of knowledge providers (1 ○, 7 △, 8 △). They provide professional information and analyze urban climate conditions (2 □, 6 △). They are important in the policy making process as well. They offer feasible suggestions to politicians and to urban planners and designers (3 △, 8 △).

Interview questions 8. What are the relationships between these actors in the communication strategies?

In order to explain the relationships between each role clearly, a diagram (Figure 21 below) is made based on the interviewees' answers. The detailed answers to this question are in Appendix 3.

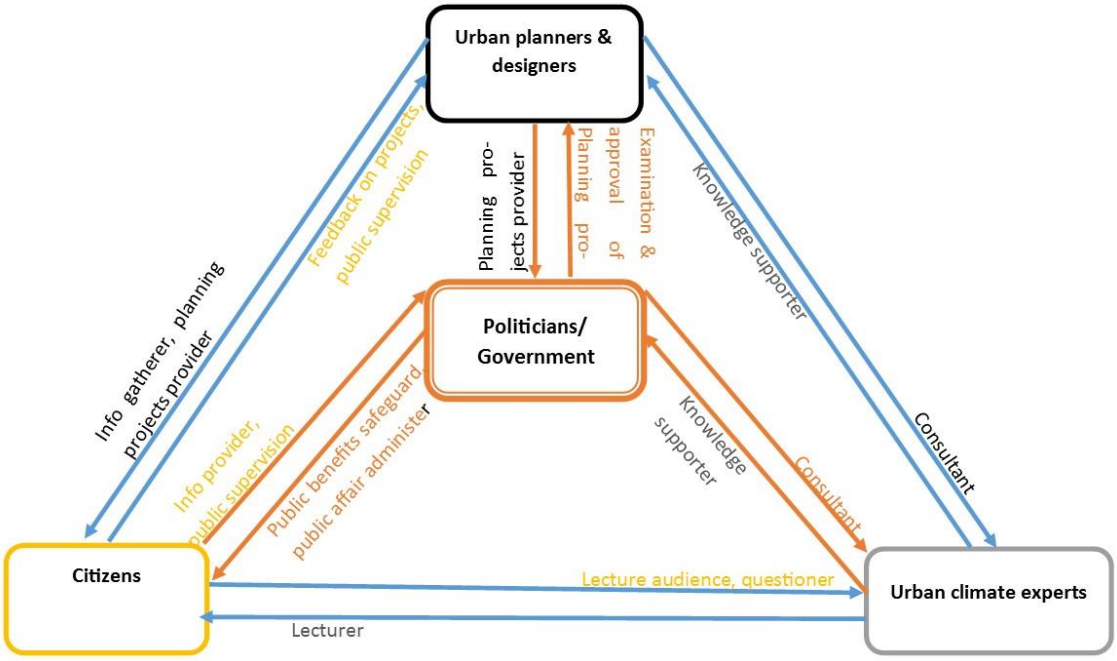


FIGURE 21 ROLES OF DIFFERENT ACTORS

Interview question 9. What is the role of communication in supporting the planning, design, and implementation of adaptation measures?

Because of the complexity of urban climate adaptation issues, communication plays an important role in the planning, design, and implementation of urban climate measures. The role of communication in supporting the planning, design, and implementation of adaptation measures has been discussed with the interviewees, and the answers are listed below.

Communication makes the urban climate adaptation measures more rational, scientific, and practical (1 ○, 5 △). Communication plays the key role in every step of the planning and design process. Communications between each actor are important, especially with the citizens (8 △). Communication measures make citizens acquire more knowledge about urban climates and their living places (4 △). As urban climate adaptation has a close relationship with land use, local wind systems, and local climate conditions, appropriate adaptation strategies depend on specific situations in individual cities. Therefore, communication strategies are required to work out concrete measures for planning and design practices (6 △). Furthermore, urban climate adaptation is a long-term and dynamic process based on information that is continually revised. Communication is needed to evaluate the progress of the adaptation process as well. In all, communication ensures that the planning, design, and implementation of urban climate adaptation strategies fits to current circumstances. Communication between urban climate experts and urban planners and designers makes urban climate adaptation measures more scientific and practical. There should be more communication with citizens and across fields, because lack of communication can easily cause misunderstandings and has negative impacts on planning projects.

Interview question 10. Are there formal guidelines or policies that drive the use of communication in the planning, design, and implementation of adaptation measures?

If yes, can you please name them?

There are no specific formal guidelines or policies about communication strategies on a national level or a municipal level. The interviewees tried to name some documents about urban planning or climate adaptation, but no specific content about urban climate adaptation was mentioned by the interviewees. In such documents, urban climate adaptation is usually mixed up with climate change mitigation, energy conservation, and emissions reduction.

There were two answers concerning national-level instruments: the Urban and Rural Planning Law and China's National Climate Change Programme. At the municipal level, some government work arrangements and action plans were mentioned by the interviewees from Shanghai. Except the interviewees from Shanghai, no interviewees gave an answer.

Three regulations about urban planning in Shanghai were mentioned by interviewees, which are: Urban Planning Administration Regulations, Regulations of Shanghai Municipality on Urban and Rural Planning, and Regulations on Urban Planning and Development Control. No contents which is relevant to urban climate adaptation have been found in these three regulations.

Other answers given were: the 2015 Key Work Arrangement on Energy Conservation and Emission Reduction and Climate Change (SPMG G 2015-41), the Action Plan of Clean Air (SPMG G 2013-83), the 2015 Key Work Arrangement on Industrial Structure Adjustment (SMPG GO G 2015-14), the Action Plan of Solar Energy Development and the Energy Conservation Regulation. These work arrangements and municipal plans mainly focus on energy conservation and emission reduction. Content related to urban climate adaptation in the urban planning and design process is very limited. UHI and wind discomfort are never mentioned in any of the documents. Content about urban planning is only mentioned in the Action Plan of Clean Air (SPMG G 2013-83). Research on the relation between air pollution and urban planning was planned by the government in this action plan. According to the 2015 Key Work Arrangement on Energy Conservation and Emission Reduction and Climate Change (SPMG G 2015-41), the Shanghai government has started to formulate urban climate adaptation strategy and the main goal of the strategy is to adapt to extreme weathers. There are no details about how this strategy will be formulated.

Interview question 11. What are the strengths and weaknesses of the communication process?

Interviewees think communication will encourage citizen participation in urban planning and design processes. Communication also provides opportunities for different stakeholders to express their opinions. However, communication with different stakeholders means long discussion times. Interest conflicts among stakeholders will be difficult to solve.

Interview questions 12. Is there need to improve the communication process? If yes, how can it be improved?

There are eight answers to this question, gathered from nine interviewees. One interviewee (7 Δ) chose to skip this question during the interview due to time restrictions. The eight interviewees who answered this question all agree that there are improvements needed in the communication process. The main improvements suggested by the interviewees were:

*1) Taking initiatives by the government in the communication process (**1** ○);*

*2) Setting up clear communication rules and providing communication opportunities for all groups (**3** △);*

*3) Encouraging citizens to participate in urban climate adaptation measures (**4** △);*

*4) Inviting urban climate experts to join the government consultancy team (**6** △);*

*5) Increasing the transparency of climate data (**6** △).*

4.3.2. Planning instruments

In this section, six questions focus on legally binding instruments and policy instruments. However, due to multiple reasons (discussed in section 4.4), the role of instruments section received only a few answers from the interviewees.

Interview question 13. Are there legally binding instruments (e.g. zoning plans) used to implement urban climate adaptation measures?

Legally binding instruments listed by the interviewees were: Urban and Rural Planning Law (2□ and **5** △) and China's National Plan on Climate Change (2014-2020) (8 △).

Interview question 14. What are the strengths and weaknesses of the legally binding instruments used?

The answers to this question are also quite limited. As for strengths, the answers were: 1) legally binding instruments are led by the government (8 △), and 2) the legally binding instruments are comprehensive and general (**5** △).

As for weaknesses, the answers were: 1) poor binding effect (**3** △), 2) less freedom for citizens, enterprises, and public institutes (8 △), 3) poor implementation (8 △), 5) still in the early development phase (8 △), and 6) lack of urban climate research and basic climate data (**6** △).

Interview questions 15. Are there certain chances or opportunities missed when using legally binding instruments or other policy instruments (e.g. coupling with other policies)?

Because interviewees showed very low interest in the policy instruments section during the interviews, the third question, regarding certain missed chances or opportunities when using instruments, did not receiving any answers.

Interview question 16. Are there other policy instruments used to implement urban climate adaptation measures? If yes, please explain how they work.

The other policy instrument listed by the interviewees was the Evaluation standard for green building (**5 ∆**). One interviewee (**8 ∆**) mentioned that there is not a comprehensive policy for urban climate adaptation in the urban planning and design process.

Interview question 17. What are the strengths and weaknesses of the other policy instruments used?

Only weaknesses of current policy instruments were indicated, by two interviewees. Firstly, the policies cover a wide range of urban climate issues while they still need more detailed criteria (**5 ∆**). Secondly, the relevant policies are not complete and comprehensive enough, for example, there is not a policy that focuses on improving living quality such as indoor thermal comfort (**6 ∆**).

Interview questions 18. Are there certain chances or opportunities missed when using legally binding instruments or other policy instruments (e.g. coupling with other policies)?

Because interviewees showed very low interest in the policy instruments section during the interviews, the third question, regarding certain missed chances or opportunities when using instruments, did not receiving any answers.

4.3.3. Concrete urban climate adaptation measures

Interview question 19. Which concrete urban climate adaptation measures/interventions are currently being implemented or have been implemented in your city?

The concrete measures named by the interviewees include seventeen measures (shown in Table 5 below). Urban greenery was mentioned by the interviewees from all three occupation groups. The civil engineers, and urban planners and designers contributed most of the answers. Not all the measures named by the interviewees are urban climate adaptation measures; some mitigation measures were taken for adaptation measures by mistake.

TABLE 5 CONCRETE URBAN CLIMATE ADAPTATION MEASURES

Occupation category	Concrete measures
Urban planners/designers	M1) Winter heating system improvements; M2) Impact analysis of wind dynamics and architectural style; M3) Architectural bionics design; M4) Urban greenness; M5) Urban design and use of building materials;
Civil engineer	M6) Rain water gathering instruments for urban greenery; M7) Encouraging citizens to plant trees; M8) Sustainable thermal construction materials for all buildings' façade, roofs; M9) Light colors for the façades of the building; M10) The orientation of and distances between buildings, ventilation hole performance, and lighting performance should be designed according to the designing codes. M11) Encouraging green roofs and vertical landscape in the city;
Educators	M2) Urban greenness

Interview question 20. What are the strengths and weaknesses of these mentioned urban climate measures/ interventions?

The strength of the concrete urban climate adaptation measures and interventions is to improve the air quality in winter (1 ○). The weaknesses of these concrete measures are poor performance of the measures implementation process and low awareness of the policy makers.

Interview questions 21. Are there conflicts between aesthetics and these mentioned urban climate adaptation measures?

Currently, the aesthetics of cities and architecture is not a common concern in most circumstances in China. Economic interests and environment demands are more important than the aesthetics in most current situations in China. When talking about the conflicts between aesthetics and urban climate adaptation measures, all interviewees hold the same attitude that there is no conflicts so far between the aesthetics and the concrete urban climate adaptation measures.

Interview question 22. Are there conflicts between urban functions and these mentioned urban climate adaptation measures?

The conflict between city development and the mentioned urban climate adaptation measures is that there is too much emphasis on economic development and neglect of environmental protection and living quality (**3 △**). Therefore, measures and interventions with high economic value would be more easy to be implemented by municipalities than those which are most suitable.

Most of the interviewees did not see conflicts between the urban function and the concrete urban climate adaptation measures.

Interview question 23. Are there certain chances or opportunities (e.g. coupling with other interventions or 'no regret' measures) missed when implementing these mentioned urban climate adaptation measures?

Unfortunately, no clear answer was obtained for this question.

4.4. Reasons for little response

Of the 23 interview questions, there are 10 questions that show little response. Most of questions with little response are in the planning instruments section and the concrete measures section.

The first situation is that the participants did not know the answers to those questions. Some interviewees stated that they knew little about the topics such as relevant planning instruments, so they were not capable of answering some questions during the interviews. Others left blanks in their written answers through e-mails without any explanations.

All legally binding instruments or policies are formulated and implemented by government departments. Currently, there is not a specific policy about urban climate adaptation at any level of the urban planning system, and urban climate adaptation is always mixed with urban mitigation. All interviewees did not have opportunities to participate in the policy making or implementation process. Without participation in this process, it is understandable that they were not aware of relevant content of documents when they do not even have a clear idea of what urban climate adaptation is. To pick up such specific terms in a large amount of documents seems to have been too difficult for the interviewees.

Another reason to little response is because of the time required by the questions during the interviews. The planning instruments and implementation sections were the last two sections of the interviews. After more than 13 questions, the time and patience of the interviewees were consumed to a large extent. Interviewees often had lost interest in answering every question after the first hour discussion. Even one open question could take half an hour to explain. It is not feasible to give complete answers to every open question in one to two hours, and interviewees would say they did not know the answers in order to refuse to answer such time-consuming questions. Chinese people would rather say they have no idea about certain questions than say they lose their patience and interest to answer. Because in Chinese culture it is not very polite to refuse others directly.

5 Discussion

In this chapter, the results of the interviews will be discussed in order to arrive at answers to the research sub-questions. The first part of the discussion chapter discusses the sense of urgency about and awareness of urban climate adaptation issues. The next part of the discussion chapter focuses on the urban climate adaptation strategies implemented in urban planning and design. This part includes communication strategies, relevant planning instruments, and concrete urban climate adaptation measures and interventions.

5.1. Sense of urgency to adapt urban environment to climate change

Research sub-question 1. What is the sense of urgency to adapt the urban environment to climate change amongst citizens, politicians, planners, designers, and urban climate experts?

Citizens feel it is urgent to cope with climate change (Yu, Wang, Zhang, Wang, & Wei, 2013), but they could not distinguish between urban climate adaptation and urban climate mitigation. As citizens do not know what exactly urban climate adaptation is about, it is understandable that they have low sense of urgency to adapt the urban environment to climate change.

Dealing with urban climate adaptation requires integrated policies, systematic approaches, close cooperation, and coordination with all stakeholders. The role of politicians influences not only the policy making process but also the policy implementation process. The urban climate adaptation content in documents is very limited compared to that regarding climate mitigation. In general, politicians' sense of urgency about urban climate adaptation is at least lower than about urban climate mitigation. Politicians prefer the measures that can lead to direct decreases of emission and energy consumption to adaptation measures.

In China, researchers and practitioners in urban planning and urban climate fields are greatly influenced by the government's behaviors. As soon as the government pays more attention on urban climate adaptation, urban planners and designers and urban climate experts will see higher urgency regarding urban climate adaptation. Currently, there is not even a specific law or legislation about urban climate adaptation. Urban climate adaptation contents can only be found in a few chapters of documents about climate change. Urban planners and designers are not aware of documents about

climate change because they are usually not relevant to urban planning and design. Urban planners and designers do not feel urgent to urban climate adaptation. While urban climate experts have more chance to work with documents about climate change for instance as knowledge supporters in the policy making process, they are more familiar with urban climate adaptation than urban planners and designers. Therefore, urban climate experts feel more urgent to urban climate adaptation than planners and designers.

5.2. Awareness of the urban climate phenomena and adaptation measures

Research sub-question 2. How aware are the people involved in the planning and design processes of urban climate phenomena and urban climate adaptation measures?

In China, scientific research on the UHI phenomenon has started earlier than on wind discomfort. The general awareness of the whole society about UHI is higher than the awareness of wind discomfort. Currently, citizens have good knowledge of climate change phenomena. Citizens know some measures to cope with climate change, but they cannot distinguish those measures between urban climate adaptation and mitigation. urban climate adaptation Citizens are apt to confuse urban climate adaptation and mitigation. It is easy to communicate a new phenomenon or a new phrase to the public, while it is not that easy to introduce or implement a new measure or intervention into their daily lives.

In the interview results, the measures suggested to increase the sense of urgency or awareness are similar. The reasons behind this similarity are not only that these measures are practical, but also due to the centralized governance system and economic benefits. Propaganda and training measures are usually governmental behaviors. Training for politicians, civil servants, and urban planners and designers must be hosted by government departments. There will be training when new policies or regulations are to be implemented. Besides commercial behaviors such as real estate advertisements, propaganda measures to increase awareness are usually planned by government departments. For instance, the civil engineer in the interview works in a state-owned construction company, and the latest training he took part in was about the Green Building Standard Evaluation System, which was hosted by the Urban Construction Department. This training corresponds to the request for a large amount of green buildings, according to the national plan. The training and education of professionals can be regarded as a way to implement new policies or regulation, and they are planned by government departments. Commercial advertisements contents about climate

adaptation focus on the strengths of certain urban climate adaptation measures implemented in residence communities and commercial housing. For example, urban greenery measures as one of the most common adaptation measures are emphasized about the contribution on lowering surrounding temperature of the residence communities. Use of some thermal insulation materials to reduce the use of air conditioners can also be found in some commercial advertisements. In China, apartments and closed residence communities are most common. Citizens mostly care about their daily living environment which are indoor environment and their residence communities.

5.3. Urban climate adaptation strategies

Sub research question 3. Which urban climate adaptation strategies are used in the planning and design process and how successful are these strategies?

5.3.1. Communication strategy

Citizens in the communication process are passive receivers. They are receivers in the propaganda measures. They give information and feedback to the other three groups. However, the communication channels for the citizens group mainly rely on the needs and arrangements of the other groups, and it is not easy for the citizens group to actively communicate with the other groups.

Politicians in the communication process are the decision makers and policy makers. Politicians in China are state leaders and cabinet members, who also come under the civil service in China. The politicians are the organizers of the communication activities.

Urban planners and designers in the communication process are the executors of planning and design projects in their own cities. They are responsible for implementing urban climate adaption instruments, which are made by the politicians. The advice from urban climate experts can support their planning and design work and show the possibilities for adapting the urban area to the urban climate. In the current urban planning system, relations between citizens and urban planners and designers are not frequent.

Urban climate experts in the communication process are the data providers and consultants. They are as passive as the citizens.

All in all, top-down communication supports every step of the urban climate adaptation process. Considering the different situation of each city, the urban climate adaptation process in each city should have its own characteristics. Communication in the preparation phase helps to collect detailed information because urban climate experts are invited to join policy making process. Communication also helps to raise the sense of urgency of those who are not familiar with urban climate adaptation (9 ◇). Urban climate adaptation is a long-term and dynamic process, which depends on constant information updates. Feedback on the adaptation measures by urban climate experts and urban planners and designers offers opportunities to improve the adaptation measures and relevant instruments.

Considering the tremendous difference in economy, culture and nature conditions of Chinese cities, the urban climate adaptation strategies for each city or region should be formulated based on its own situation. Good communication helps to clarify the current situation of each city or region. In order to balance the demands of different stakeholders and guarantee the fairness and transparency of the process, the communication process will need quite a long time. Communication also requires expertise of the stakeholders. However, currently people cannot even differentiate between urban climate adaptation and urban climate mitigation. The lack of public participation and low transparency of the communication process, especially the policy making process, are two big concerns in the current communication process.

5.3.2. Planning instruments

Knowledge about planning instruments of the interviewees is very limited. Interviewees show low interest in and knowledge of planning instruments about urban climate adaptation. Because the interviewees are not involved in the policy making process or in any urban climate adaptation projects, they do not have the opportunity to familiarize themselves with relevant planning instruments about urban climate adaptation. Furthermore, based on the documents study, content about urban climate adaptation in the planning instruments is very rare.

Based on the results of the documents study, the weaknesses of current planning instruments are analyzed below.

First, the content concerning urban climate adaptation in national plans is too general. Besides the statement ‘urban and rural planning should fully consider the impacts of climate change’ in China’s National Plan on Climate Change (2014-2020), there is no explanation about how and what to consider. In the annual national reports, *China’s Policies and Actions for Addressing Climate Change*

from 2008 to 2015, the main content about urban planning and design is the annual work summary of the Ministry of Housing and Rural-Urban Development (MHRUD). The key points of the work of MHRUD are new and revised policies, regulations, design codes, etc., and targets such as numbers of new green buildings for the next three or five years. Mitigation measures and interventions in urban planning and design process are a lot easier to find in the climate reports than adaptation measures and interventions. Although urban planning and design content has increased over the years, there is still no specific chapter about urban planning and design in the climate reports.

Second, the implementation process of the planning instruments needs improving. The structures of the planning instruments are too complex to be implemented, which also explains why the answers to the whole planning instruments section in the interviews were limited. Advisory detailed instruments are sometimes not really implemented in the urban planning process at present. For instance, the majority of the green building standards are voluntary. The only mandatory evaluation standard is the Evaluation Standard for Green Building for Sino-Singapore Tianjin Eco-City (DB29-192-2009) (Ye, et al., 2015). If relevant policies, regulations, standards, codes, etc. are only published but not mandatorily implemented in planning practice, planners and designers could choose to ignore them.

On the other hand, the weaknesses of the instruments outweigh the strengths of the instruments. Based on the document study, the urban climate adaptation strategies in the urban planning and design process have gradually started to attract attention. Public participation, academic cooperation, and adaptation measures have been involved in the national plans more often.

5.4. Concrete urban climate adaptation measures

The concrete urban climate adaptation measures can be summarized into urban greenness, use of construction materials and green buildings. The concrete measures collected in the answers are only a few, because interviewees have a low awareness of concrete urban climate adaptation measures in their cities. Furthermore, interviewees do not know the difference between adaptation measures and mitigation measures. They considered some mitigation measures to be adaptation measures by mistake. Even in the national plans, climate adaptation contents are sometimes found in climate mitigation sections.

Various urban climate adaptation pilot projects are going on in different parts of China. Some adaptation measures even appear without policy support. For example, green roofs first appeared in

Sichuan province in the 1960s, which was a totally spontaneous behavior by residents. But the development of green roofs in its early development phase was very slow because of low awareness and low support from the government. At that time, neither those residents nor the government realized the relationship between impact of green roofs and urban climate adaptation. It is necessary to provide everyone with open access to urban climate adaptation interventions and planning instruments, such as an online platform especially for urban climate adaptation. The guidance and financial or technical support by the government is necessary to the implementation of urban climate adaptation measures and interventions.

Considering the short history of urban climate adaptation in China, comprehensive and systematic information needs to be summarized and reflected upon. The strength of these concrete adaptation measures is their diversity. Even only within the measures collected from the interviewees, there are already many different categories. Spontaneous development of some adaptation measures by individuals may happen in China as well.

6 Conclusion

China is currently in the process of rapid industrialization and urbanization, confronted with multiple challenges such as climate change, economic development, poverty eradication, etc. Although urban climate adaptation strategies in China have only started very recently and the cooperation with urban planning is still not frequent yet, there have already been experiences and lessons to sum up for the improvements in the future. After analyzing and discussing the research data (interviews, literatures, documents), below is the answer to the **main research question: What is the current situation of urban climate adaptation in urban planning and design processes in China?**

- Sense of urgency and awareness

Although the awareness of citizens to climate change have increased with the education and training activities by the government, the sense of urgency of urban climate adaptation and awareness about urban climate phenomena and adaptation measures are still low. Besides citizens, politicians, practitioners in urban planning and design field and civil servants from local government all need to increase their sense of urgency and awareness. Education and training activities need to be continuous considering rapid increasing urban population and large population base in China. If urban climate adaptation keeps gaining emphasis in the policy system, the sense of urgency and awareness of the whole society will increase gradually. The sense of urgency and awareness of the politicians influence the development of urban climate adaptation significantly.

- Communication strategies

The communication between government departments and the rest of stakeholders needs more attention, frequency and openness. The role of politicians in policy making process is much more significant and dominant than others in the centralized governing structure in China. The passive role of citizens in the urban planning and design process is not easy to change in a short period of time. The sense of urgency and the awareness of the citizens have been increased by the public propaganda measures, but the opportunities for citizens to participate in urban planning projects or policy decision-making processes are still limited. As the consultants, urban climate experts are more passive than urban planners and designers in the communication process. The cooperation with urban planners and designers is not frequent and no regular communication channel has been established yet. Urban planners and designers are passively manipulated by the planning instruments.

Their interests and attempts on urban climate adaptation greatly depend on the government orientation.

- Planning instruments

Both formulation and implementation process of the planning instruments need improvements. Especially the review on the instruments in the city level needs more attention because those instruments directly influence the effectiveness of the adaptation measures and interventions. Contents overlap, complex system and lack of linkage between different levels are the weaknesses of the planning instruments.

Good urban climate adaptation strategies definitely need communication, cooperation and expertise of different stakeholders together with the support of comprehensive planning instruments. Currently, the policy support in this top-down planning system is especially urgent and important. There is no specialized instrument about the urban climate adaptation up until now. There is little content relevant to urban climate adaptation in planning instruments. Furthermore, compared to mitigation contents, contents about urban climate adaptation in documents from different hierarchies only accounted for a small proportion. Groups such as local governments, urban planners and designers and citizens which have not been involved in the policy making and implementation process are not aware of the existing contents about urban climate adaptation. Besides the need of new specialized instruments, it is also necessary to increase the awareness of the existing instruments which are relevant to urban climate adaptation.

As the development of the urban climate adaptation strategies is in the starting phase, relevant instruments about the urban climate adaptation are particular important. In the formulation process, the role of politicians or the role of government departments should be relatively marginalized, and the role of other stakeholders should be intensified, especially the citizens. The government should encourage stakeholders besides experts to actively participate in the policy making and implementation process.

- Concrete urban climate adaptation measures

For urban planners and designers involved in the interviews, their knowledge of concrete measures and interventions are not as informative as expected. The main reason to explain their poor performance is that they have not been involved in any pilot projects about urban climate adaptation.

Their lack of knowledge of urban climate adaptation does not definitely imply the lack of concrete measures or interventions. For instance, strict targets of green buildings and pilot cities etc. can be found in some national level plans as well as municipal level ones. More and more concrete measures and interventions will be imported and implemented in China in the future.

To implement suitable urban climate adaptation measures on municipal level, the assessment of the current vulnerability and the future risks should be made for each city. And there should be the different adaptation strategies for different cities considering the diverse climate conditions and social, economic and culture backgrounds.

Limitations

The aim of this research is to study the current situation of urban climate adaptation in urban planning and design processes in China. When rethinking the whole field work and thesis writing period, there are some shortcomings in the process and some improvements for future study are going to be noticed as well.

First, neither politicians or citizens took part in the interviews. The selection of interviewees was limited to the very few responses from the practitioners in urban planner and designer group and urban climate group. The absence of politicians and citizens is such a pity in this research. Both politicians and citizens play significant role in urban climate adaptation. The questions about the planning instruments are found not easy for the practitioners in the urban planning and design field. The major reason to explain the difficulty is the less involvement in the policy making process. Politicians are expected to have the knowledge of planning instruments as they play important role in not only the policy making process but also the implementation process. Their sense of urgency and awareness about urban climate adaptation weigh quite much in the top-down planning system. Citizens carry out the urban climate adaptation measures at local level. Unlike mitigation measures, urban climate adaptation measures are most appropriately implemented at the local level where the specific realities of climate change occur (Laukkonen, et al., 2009).

Second, more cities in each climate zone need to be analyzed in the future study. Because of the time and effort limit, there were only several interviewees in one city of each climate zone in this research. However, considering the large size of each climate zone in China, the number of the interviewees to represent each climate zone is not enough.

Future research

All in all, the outcomes in this research aim to shed the light on the current situation of urban climate adaptation in urban planning and design processes in China based on the in-depth interview results and documents and literatures. Many important practices about urban climate adaption are going on in China now. The purpose of this research is to raise the awareness of more Chinese researches and to share the knowledge with foreign researches as well.

The researches on different orientations about urban climate adaptation should be encouraged. First, the answers to the planning instruments questions are expected from the politicians and local governments in further study. Second, the experts in urban climate field and practitioners in urban planning field should cooperate in the academic sector first and the research results should be applied in practice. Third, the role of citizens in the implementation process needs more attention in the future research. Under the reality of lack of citizen participation in the policy making process in China, it will be a big challenge in the implementation process whether citizens are willing to implement new adaptation measures in the daily life. In addition, for further researches on the similar research objectives in China, several cities in one climate zone are recommended to be studied. With similar climate conditions, different cities may have implemented different adaptation measures which are worth to compare and learn from. Last but not least, the relationship between urban climate adaptation and ancient urban planning principals in Chinese cities is a unique research objective for future research. Before the modern Chinese urban planning began since World War Two, the main principal of ancient urban planning in China was to maintain the harmony and balance between people and nature. There must be some concepts in ancient urban planning rules which are relevant to climate adaptation. Although those relevant concepts might not be clearly regarded as urban climate adaptation strategies at that time, the further study on those ancient concepts can still be inspiring.

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Appendix

1. Urban Climate Adaptation Interview Questions

Awareness

What is the sense of urgency to adapt the urban environment to climate change amongst the following groups in the future in your city?

In case the sense of urgency is low, what is needed to make those groups to increase sense of urgency of adapting to the urban environment?

How aware are the groups of the following two urban climate phenomena?

-Urban Heat Island

-Wind Discomfort

In case awareness is low, what is needed to increase the awareness among those groups of two urban climate phenomena mentioned in question 3?

How aware are the groups of following urban climate adaptation measures?

-City design

(e.g. street orientation, adapting to wind and solar orientation of building and streets, type of land use in the surrounding areas)

-Urban vegetation

(e.g. green roofs, urban forestry, parks, strategically placed trees and shrubs, vegetated walls, vegetated rails and roads)

-Use of materials

(e.g. low albedo and longer cooling time-lag materials)

-Anthropogenic heat

(e.g. less air conditioners, lower car use)

In case awareness is low, what is needed to increase the awareness among those groups of four urban climate adaptation measures mentioned in question 5?

知晓度及基本知识普及度部分

1. 在您所在的城市，以下各组就未来开展城市环境适应气候变化研究的紧迫程度是？

组别	非常紧急	紧急	中立	不太紧急	不紧急	不清楚
市民						
政府公职人员						
城市规划/设计人员						
城市气候专家						

2. 如果紧迫感太低，有哪些举措有助于增加各组别人员对城市环境对气候变化适应性研究的紧迫感？

组别	增加紧迫感的方法
市民	
政府公职人员	
城市规划/设计人员	
城市气候专家	

3. 以下各组人员对于各类城市气候现象的了解程度

- 城市热岛效应

组别	非常了解	了解	中立	不太了解	不了解	不清楚
市民						
政府公职人员						
城市规划/设计人员						

- 风危害(Wind discomfort)

组别	非常了解	了解	中立	不太了解	不了解	不清楚
市民						
政府公职人员						
城市规划/设计人员						

4. 如果知晓度不高，如何增进各组人员对问题 3 中所提及的城市气候现象的认识？

组别	提升知晓度的方法
市民	
政府公职人员	
城市规划/设计人员	

5. 以下组别对于城市气候适应方法的了解程度

- 城市规划设计部分（例如，建筑物和街道的风向和朝向、土地综合利用）

组别	非常了解	了解	中立	不太了解	不了解	不清楚
市民						
政府公职人员						
城市规划/设计人员						
城市气候专家						

- 城市绿化部分（例如，屋顶绿化、城市林业、公园、墙体植被等）

组别	非常了解	了解	中立	不太了解	不了解	不清楚
市民						
政府公职人员						
城市规划/设计人员						
城市气候专家						

- 材料的使用（例如，低反射率或长效衡温材料的使用）

组别	非常了解	了解	中立	不太了解	不了解	不清楚
市民						
政府公职人员						
城市规划/设计人员						
城市气候专家						

- 人为热源控制部分（例如，减少空调数量，减少私家车数量）

组别	非常了解	了解	中立	不太了解	不了解	不清楚
市民						
政府公职人员						
城市规划/设计人员						

城市气候专家						

Communication

Which roles do citizens, politicians, planners and designers and urban climate experts have in the process of planning, designing and implementing urban climate adaptation measures?

What are the relationships between these actors in the communication strategies?

What is the role of communication to support the planning, design and implementation of adaptation measures?

Are there formal guidelines or policies that drive the use of communication in the planning, design and implementation of adaptation measures?
If yes, can you please name them?

What are the strengths and weaknesses of the communication process?

Is there need to improve the communication process? If yes, how to improve?

Instruments

Are there legally binding instruments (e.g. zoning plans) used to implement urban climate adaptation measures?

If yes, please explain how they work?

What are the strengths and weaknesses of the legally binding instruments used?

Are there certain chances / potentials missed when using the legally binding mentioned instruments (e.g. coupling with other instruments)?

Are there other policy instruments used to implement urban climate adaptation measures?

If yes, please explain how they work?

What are the strengths and weaknesses of the other policy instruments used?

Are there certain chances/ potentials missed when using other policy instruments (e.g. coupling with other policies)?

Implementation

Which concrete urban climate adaptation measures/ interventions are currently implementing or have been implemented in your city?

What are the strengths and weaknesses of these mentioned urban climate measures/ interventions?

Are there conflicts between aesthetics and these mentioned urban climate adaptation measures?

Are there conflicts between urban functions and these mentioned urban climate adaptation measures?

Are there certain chances/ potentials (e.g. coupling with other interventions / 'no regret' measures) missed when implementing these mentioned urban climate adaptation measures?

城市规划与设计过程中的应用

一、交流合作

1. 在规划、设计以及实施城市气候适应措施的过程中，市民、政府公职人员、城市规划/设计人员以及城市气候专家在交流沟通过程中分别扮演了何种角色？

市民：
政府公职人员：
城市规划/设计人员
城市气候专家：

2. 在沟通过程中，各角色之间存在着怎样的关系？
市民与政府公职人员：

市民与城市规划/设计人员：

市民与城市气候专家：

政府公职人员与城市规划/设计人员：

政府公职人员与城市气候专家：

城市规划/设计人员与城市气候专家：

3. 沟通过程中在支持规划、设计以及实施城市气候适应措施的过程中发挥了怎样的作用？

4. 有正式的规章或政策以促进规划、设计以及实施城市适应措施吗？
如果有，请列举出相关规章政策。

5. 在沟通过程中有哪些优点和缺点？

6. 是否需要改进沟通机制？如果需要，应如何改善？

二、（政策）手段

1. 城市气候适应性举措的实施过程中有具有法律约束力的政策吗？
如果有，请说明相关政策。

2. 问题 1 提及的具有法律约束力的政策有哪些优点和缺点？

3. 城市气候适应举措的实施过程中还有其他政策法规吗？
有，请列举说明。

4. 问题 3 中涉及的政策手段有哪些优点及缺点？

三、具体实施措施

1. 您所在的城市有实施哪些具体的城市气候适应举措或干预措施？

2. 问题 1 中所提及的举措及干预措施有哪些优点和缺点？

3. 问题 1 中所提及的举措及干预措施与城市设计美学是否存在冲突？

4. 问题 1 中所提及的举措及干预措施与城市功能是否存在冲突？

2. Urban Climate Adaptation Interview Summary

➢ **General Information**

No.	Code	City	Position	Organization
1	1 ○	Urumqi (Severe Cold)	Urban planner/designer	Xinjiang Uygur Autonomous Region Architecture Design and Research Institute
2	2 □	Lanzhou (Cold)	Lecturer	Lanzhou University
3	3 △	Shanghai (Hot-summer and Cold -winter)	Urban planner/designer	Shanghai LongiLat Architectural Design & Research Institute CO., LTD.
4	4 △		Urban planner/designer	Shanghai LongiLat Architectural Design & Research Institute CO., LTD.
5	5 △		Urban planner/designer	Tongji University
6	6 △		Urban climate expert	Tongji University
7	7 △		Professor	Shanghai Open University Hongkou Branch Campus
8	8 △		Civil engineer	Shanghai New Changning(Group) Co., Ltd.
9	9 ◇	Xiamen (Hot-summer and Warm-winter)	Urban planner/designer	Xiamen University

➢ **Translated Interview transcripts**

Awareness

1. What is the sense of urgency to adapt the urban environment to climate change amongst the following groups in the future in your city?

○: Severe cold climate zone

□: Cold climate zone

Δ: Hot-summer and cold-winter climate zone;

◇: Hot-summer and warm-winter climate zone

Urban planner/designer: ○; □; Δ; ◇;

Lecture/professor: ○; □; Δ; ◇;

Urban climate expert: ○; □; Δ; ◇;

Civil engineer: ○; □; Δ; ◇;

Groups	Very urgent	Urgent	Neutral	Less urgent	Not urgent	Don't know
Citizens	4 Δ;	1 ○; 9 ◇; 2 □;	3 Δ;	7 Δ;	5 Δ; 6 Δ; 8 Δ;	
Politicians	4 Δ; 9 ◇;	3 Δ; 5 Δ; 2 □; 6 Δ; 8 Δ;	1 ○;	7 Δ;		
Urban planners& designers	4 Δ;	1 ○; 3 Δ; 9 ◇; 2 □; 8 Δ;	5 Δ; 7 Δ; 6 Δ;			

Urban climate experts	1 ○; 3 △; 4 △; 5 △; 9 ◇; 6 △; 8 △;	2 □;	7 △;			

2. In case the sense of urgency is low, what is needed to make those groups to increase sense of urgency of adapting to the urban environment?

Q2-Citizens

Measures to increase citizens' sense of urgency

1○:	-Propaganda methods such as public service ads, short videos to enhance the citizens' understanding of environment protection and climate adaptation;
2□:	-Propaganda methods in the community level;
3△:	-Increasing propaganda methods among citizens about the influence of daily performance to urban climate and proper mitigation and adaptation measures, etc.;
4△:	They are aware of urban climate adaptation.
5△:	-Organizing public lectures about the negative effect and consequences of urban climate change in the future;
6△:	-Media propaganda methods (to popularize urban climate knowledge and to provide urban climate data); - Showing citizens the influence of urban climate to their health and daily life;
7 △:	Media propaganda methods to make citizens aware of the influence of urban climate;
8△:	-Media propaganda; -Encouraging the development of NGOs; -Holding lectures by urban climate experts;

	-Fostering awareness of environment protection;
9◇:	-Media propaganda methods;

Q2-Politicians

Measures to increase politicians' sense of urgency

1 ○:	-Holding meetings to collecting the feedback from citizens; -Listening opinions from urban planners and designers; -Trainings about relevant issues and topics
2 □:	-Organizing workshops to show foreign examples; -Training;
3 △:	-Training; -Introducing relevant concepts; -Enhancing the sense of mission; -Establishing appraisal and evaluation system;
4 △:	-They are aware of urban climate adaptation.
5 △:	-Linking to the government benefit;
6 △:	-Enhancing crisis consciousness -Lectures on urban climate topics from urban climate experts; - Getting to know the urban climate data and trend;
7 △:	-Strengthening legislation;
8 △:	-Holding regular conference and workshops; -Formulating policies on national level, regulations, and long-term planning perspective; -Strengthening law enforcement of relevant governmental departments;
9 ◇:	-Holding government meetings;

Q2-Urban planners/designers

Measures to increase sense of urgency

1 ○:	-Encouraging urban planners and designers to focus on relevant topics;
2 □:	-Introducing successful examples and pilot projects; -Encouraging communication and cooperation;
3 △:	-Training; -Advocacy planning -Research on the major influence factors of daily life and industry manufacturing
4 △:	-They are aware of urban climate adaptation.
5 △:	-Increasing budgets on relevant research projects;
6 △:	-Providing advices on policies; - Setting urban climate adaptation as an indicator in law and regulation for urban planning & design; -Publishing teaching materials on urban climate adaptation for higher education
7 △:	-Enhancing International communication with foreign urban planners and designers;
8 △:	-Introducing advanced planning theories; -Learning from western experience; -International communications and cross-field cooperation;
9 ◇:	-Introducing of new and advanced planning concepts and theories;

Q2-Urban climate experts

Measures to increase sense of urgency

1 ○:	-Improving working ethic;
2 □:	-Encouraging communication with urban planners and designers; -Holding conferences with policy makers;
3 △:	-Field work to study on the major factors and reasons of urban climate phenomena
4 △:	They are aware of urban climate adaptation.
5 △:	-Increasing the knowledge on urban climate;

-Broadening their international perspectives;

6 △: -Encourage urban climate experts to publish papers about urban climate adaptation issues;

7 △: -Climate prediction researches;

8 △: -Holding conferences and workshops to encourage communication;

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9 ◇: -Holding conferences and workshops;

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3. -1How aware are the groups of the following two urban climate phenomena?

- Urban Heat Island

○: Severe cold climate zone

□: Cold climate zone

△: Hot-summer and cold-winter climate zone;

◇: Hot-summer and warm-winter climate zone

Urban planner/designer: ○; □; △; ◇;

Lecture/professor: ○; □; △; ◇;

Urban climate expert: ○; □; △; ◇;

Civil engineer: ○; □; △; ◇;

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens		1 ○; 5 △; 7 △;	4 △; 9 ◇;	3 △; 2 □;	6 △; 8 △;	
Politicians		1 ○; 4 △; 5 △; 7 △; 8 △;	3 △; 9 ◇; 2 □; 6 △;			
Urban planners &	5 △;	1 ○;	2 □;			

designers	9 ◇; 7 △; 8 △;	3 △; 4 △; 6 △;				

3-2 How aware are the groups of the following two urban climate phenomena?

- Wind Discomfort

○: Severe cold climate zone

□: Cold climate zone

△: Hot-summer and cold-winter climate zone;

◇: Hot-summer and warm-winter climate zone

Urban planner/designer: ○; □; △; ◇;

Lecture/professor: ○; □; △; ◇;

Urban climate expert: ○; □; △; ◇;

Civil engineer: ○; □; △; ◇;

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens		4 △; 7 △;	9 ◇; 8 △;	1 ○; 3 △; 2 □; 6 △;	5 △;	
Politicians	4 △;	7 △; 6 △; 8 △;	1 ○; 3 △; 9 ◇; 2 □;	5 △;		
Urban planners & designers	4 △; 7 △;	1 ○; 9 ◇; 2 □;	3 △; 5 △;			

		6 △; 8 △;				

4. In case awareness is low, what is needed to increase the awareness among those groups of two urban climate phenomena mentioned in question 3?

Q4-Citizens

Measures to increase awareness of urban climate phenomena

1 ○:	-Propaganda methods such as public services, videos, etc.
2 □:	-Media propaganda methods; -Lectures and activities to introduce the urban climate phenomena;
3 △:	-Stimulating the phenomena and explaining the cause of urban climate phenomena; -Getting citizens involved in these activities;
4 △:	-Extension of urban climate phenomena knowledge in community level; -Guide of citizens' daily actions to environment protection
5 △:	-Spreading interesting reading materials, or developing mobile apps about climate knowledge and environment;
6 △:	-Media propaganda (to provide urban climate data and knowledge); -Including relevant knowledge as teaching materials for students;
7 △:	-Providing information on TV program;
8 △:	-Media propaganda methods; -Lectures by urban climate experts and urban planners and designers; -Organizing activities and encouraging citizens to take part in;
9 ◇:	-Media propaganda methods;

Q4-Politicians

Measures to increase awareness of urban climate phenomena

1 ○:	-Propaganda methods such as public service ads, videos, etc.;
2 □:	-Holding lectures by professionals and experts; -Encouraging communications and cooperation;
3 △:	-Training; -Propaganda methods;
4 △:	-Setting reports about urban climate phenomena as compulsory assessment criteria of the year-end work
5△:	Integrating to government services content
6 △:	-Videos and films about urban climate; -Increasing the budget on urban climate adaptation research projects; -Training;
7 △:	-Being aware of the consequences of the influence of urban climate
8 △:	-Holding regular conference; -Communication with urban climate experts; -Getting aware of relevant policies and laws; -Training and exams on urban climate knowledge;
9 ◇:	-Holding government meetings about urban climate

Q4-Urban planners and designers

Measures to increase awareness of urban climate phenomena

1 ○:	-Enhancing the work ethic and urban consciousness; -Training on relevant topics/ issues;
2 □:	-Introducing new planning theories; -Studying examples and experience; -Attending lectures by urban climate experts
3 △:	-Enhancing certificate training of relevant topics;

4 △:	-More cross-fields cooperation; -Increase urban climate phenomena knowledge
5 △:	-On-the-job training;
6 △:	-Studying academic papers about urban climate topics; -Setting as indicator for planning and design practice; -Setting urban climate as a subject of certification examination;
7 △:	-Further education on relevant topics;
8 △:	-Introducing new planning theories; -Attending lectures by urban climate experts; -Learning experiences from abroad; -Training and exams;
9 ◇:	-Introducing new and advanced planning theories and concepts;

5. How aware are the groups of following urban climate adaptation measures?

- 5-1 City design (e.g. street orientation, adapting to wind and solar orientation of building and streets, type of land use in the surrounding areas)

○: Severe cold climate zone	Urban planner/designer: **○; □; △; ◇;**
□: Cold climate zone	Lecture/professor: ○; □; △; ◇;
△: Hot-summer and cold-winter climate zone;	Urban climate expert: **○; □; △; ◇;**
◇: Hot-summer and warm-winter climate zone	Civil engineer: ○; □; △; ◇;

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens		7 △;	**4 △;**	**1 ○;** **3 △;**	**6 △;**	

			9 ◇; 2 □;	5 Δ; 8 Δ;		
Politicians	4 Δ; 8 Δ;	7 Δ;	1 ○; 3 Δ; 5 Δ; 9 ◇; 2 □;	6 Δ;		
Urban planners& designers	4 Δ; 5 Δ; 9 ◇; 2 □; 7 Δ; 8 Δ;	1 ○; 3 Δ; 6 Δ;				
Urban climate experts		7 Δ;	4 Δ; 5 Δ; 9 ◇; 6 Δ; 8 Δ;	1 ○; 3 Δ; 2 □;		

- 5-2 How aware are the groups of following urban climate adaptation measures?

  Urban vegetation (e.g. green roofs, urban forestry, parks, strategically placed trees and shrubs, vegetated walls, vegetated rails and roads)

○: Severe cold climate zone	Urban planner/designer: ○; □; Δ; ◇;
□: Cold climate zone	Lecture/professor: ○; □; Δ; ◇;
Δ: Hot-summer and cold-winter climate zone;	Urban climate expert: ○; □; Δ; ◇;
◇: Hot-summer and warm-winter climate zone	Civil engineer: ○; □; Δ; ◇;

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens		4 Δ; 5 Δ; 9 ◇; 7 Δ;	3 Δ; 6 Δ; 8 Δ;	1 ○; 2 □;		
Politicians	4 Δ;	5 Δ; 9 ◇; 2 □; 7 Δ; 6 Δ; 8 Δ;	3 Δ;	1 ○;		
Urban planners& designers	4 Δ; 5 Δ; 6 Δ;	1 ○; 3 Δ;				

	7 △; 8 △;	9 ◇; 2 □;				
Urban climate experts	7 △;	5 △; 9 ◇; 2 □; 6 △; 8 △;	1 ○; 3 △; 4 △;			

- 5-3 How aware are the groups of following urban climate adaptation measures?

  Use of materials (e.g. low albedo and longer cooling time-lag materials)

○: Severe cold climate zone

□: Cold climate zone

△: Hot-summer and cold-winter climate zone;

◇: Hot-summer and warm-winter climate zone

Urban planner/designer: ○; □; △; ◇;

Lecture/professor: ○; □; △; ◇;

Urban climate expert: ○; □; △; ◇;

Civil engineer: ○; □; △; ◇;

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens			2 □;	1 ○; 3 △; 4 △; 7 △; 8 △;	5 △; 9 ◇; 6 △;	
Politicians		4 △;	1 ○;	3 △;	5 △;	

		8 Δ;	2 □; 6 Δ;	7 Δ;	9 ◇;	
Urban planners& designers	2 □; 4 Δ;	1 ○; 9 ◇; 7 Δ; 6 Δ; 8 Δ;	3 Δ; 5 Δ;			
Urban climate experts			1 ○; 7 Δ;	3 Δ; 4 Δ; 5 Δ; 9 ◇; 2 □; 6 Δ; 8 Δ;		

- -4 How aware are the groups of following urban climate adaptation measures?

  Anthropogenic heat (e.g. less air conditioners, lower car use)

○: Severe cold climate zone

□: Cold climate zone

Δ: Hot-summer and cold-winter climate zone;

◇: Hot-summer and warm-winter climate zone

Urban planner/designer: ○; □; Δ; ◇;

Lecture/professor: ○; □; Δ; ◇;

Urban climate expert: ○; □; Δ; ◇;

Civil engineer: ○; □; Δ; ◇;

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens	9 ◇;	5 △; 2 □; 7 △; 8 △;	6 △;	1 ○; 3 △; 4 △;		
Politicians	9 ◇; 8 △;	4 △; 5 △; 2 □; 7 △; 6 △;	1 ○; 3 △;			
Urban planners & designers	9 ◇; 7 △; 6 △; 8 △;	4 △; 5 △; 2 □;	1 ○; 3 △;			
Urban climate experts	2 □; 7 △;	9 ◇; 6 △; 8 △;	1 ○; 3 △; 4 △; 5 △;			

6. In case awareness is low, what is needed to increase the awareness among those groups of four urban climate adaptation measures mentioned in question 5?

Q6-Citizens

Measures to increase awareness of urban climate adaptation measures

1 ○:	-Showing examples of buildings which have applied urban climate adaptation measures;
2 □:	-Media propaganda methods; -Lectures by professionals;

3 △:	-Enhancing publicity guide through exhibitions, communications, sample buildings, etc.
4 △:	-Extension of knowledge on urban climate adaptation measures in communities; -Introduction of Do-it-yourself (DIY) measures for citizens;
5 △:	-Booklets of examples and introductions which cover the topics such as current situation, solutions, futures, etc.
6 △:	- Propaganda methods (Media, newspapers, etc.)
7 △:	- Strengthen Media propaganda methods;
8 △:	-Media propaganda methods; -Increasing budgets on organizations; -Adding education materials for students; -Fostering environmental awareness;
9 ◇:	-Media propaganda methods;

Q6-Politicians

Measures to increase awareness of urban climate adaptation measures

1 ○:	-Showing examples which have applied urban climate adaptation measures;
2 □:	-Conferences with urban climate experts and planners & designers; -Training and exams; -Lectures;
3 △:	-Increasing urban climate knowledge and environment protect issues; -Establishing appraisal and evaluation mechanism for urban climate issues;
4 △:	-Introducing the urban climate adaptation measures; -Making suggestions during assessment of the planning related work;
5 △:	-Professional knowledge training connecting to government services;
6 △:	- Setting urban climate adaptation as one main part of compulsory laws of comprehensive land planning;
7 △:	-Increase urban climate knowledge;
8 △:	-Holding conferences across different sectors, agencies, and level of government; -Training and exams on relevant laws and policies;

-Attending lectures by professionals;

9 ◇: -Holding government meetings

Q6-Urban planners and designers

Measures to increase awareness of urban climate adaptation measures

1 ○: -Improving work ethic;

-Training;

2 □: -Training and education;

-Learning from experiences;

3 △: -Increasing comprehensive knowledge;

-Organizing excursions to sustainable development examples;

-Studying current policies and making suggestions;

-Focusing on urban climate issues in urban planning and design practice;

4 △: -Understanding urban climate adaptation measures in order to implement during planning practices;

-Increasing cross-field cooperation;

5 △: -Professional knowledge training related to planning projects;

6 △: -Encouraging researches;

-Setting urban climate adaptation as the item in relevant regulations and comprehensive land planning;

7 △: -Further education on urban climate topics;

8 △: -Studying on laws and policies together with training and exams;

-Attending lectures from urban climate experts;

-Holding international conferences and cooperation;

-Knowledge update;

9 ◇: -Training on relevant topics;

Q6-Urban Climate Experts

Measures to increase awareness of urban climate adaptation measures

1 ○: -Improving work ethic;

	-Training; -Meetings with urban planners and designers;
2 □:	-Training and education; -Learning from experiences;
3 △:	-Increasing comprehensive knowledge; -Excursions to sustainable development examples; -Studying current policies and making suggestions;
4 △:	-Increasing cross-field cooperation;
5 △:	-Knowledge update;
6 △:	-Encouraging researches;
7 △:	-Further education; -Encouraging researches;
8 △:	-Studying on laws and policies together with training and exams; -Holding international conferences and cooperation; -Knowledge update;
9 ◇:	-Training on relevant topics

Communication

1. Which roles do citizens, politicians, planners and designers and urban climate experts have in the process of planning, designing and implementing urban climate adaptation measures?

Roles of citizens

1 ○:	-Citizens give feedback to other groups; -Citizens support and understand urban climate adaptation measures;
2 □:	-Passive receivers;
3 △:	-Main influenced group by urban climate; -Groups which focus on self-interest;
4 △:	-Groups which wait for urban climate improvement;

5 △:	- Participators/ receivers
6 △:	-Providing data related to microclimate such as wind and heat environment and raw data such as the usage of air conditioners;
7 △:	- Group passively accept urban planning and design projects and the laws, policies, and regulations;
8 △:	-Passive receivers of the propaganda by other groups; -Experiencers of the projects which have been implemented urban climate adaptation measures;
9 ◇:	- Public supervision and participation;

Roles of politicians

1 ○:	-Decision makers for planning projects;
2 □:	-Decision makers for laws, policies and regulations of urban climate adaption and mitigation; -Encouraging and offering opportunities for cooperation between urban planners/designers and urban climate experts;
3 △:	-One of the advocators; -Group which focuses on the feasibility and operability of the urban planning plans in short terms;
4 △:	-Approving and publishing laws, policies, regulations to improve urban climate which technique supported by urban climate experts;
5 △:	- Executors;
6 △:	-Main groups which propagandize urban climate knowledge to citizens; -Enacting policies and laws about urban climate adaptation -Implementation of city plans, regulations and comprehensive plans;
7 △:	-Decision makers;
8 △:	-Propagandizing urban climate knowledge to citizens; -Making policies with urban climate experts and implementing such as Green Building Standard Evaluation System;

9 ◇:	-Responsible for managing and implementing urban climate issues;

Roles of urban planners and designers

1 ○:	-Group which realizes the problems and finds out the solutions for the problems.
2 □:	-Planning and designing urban areas following the laws, policies, regulations by government;
3 △:	-Group which implements and gives feedback on planning theory and strategies; -Group as consultants in policy making process with the government; -Group which focuses on realizing planning goals
4 △:	-Group which does planning and design work according to laws, policies, regulations, etc.; -Indirect influence on urban climate;
5 △:	-Designers;
6 △:	-Showing and promoting pilot projects to government and private sectors; - Persuading government and private sectors to accept urban climate adaptation measures;
7 △:	-Policies/legislations followers;
8 △:	-Carrying out the policies during planning practices; -Executors and practitioners;
9 ◇:	-Making concrete planning projects;

Roles of urban climate experts

1 ○:	-Technique supporters;
2 □:	-Providing professional information and analyzing of urban climate; -Good cooperator for politicians and urban planners/designers;
3 △:	-Group which makes efforts on improving urban climate; -Group which provides possible measures and resolutions;
4 △:	-Groups which makes efforts on mitigation and adaptation measures;

5 △:	-Instructors;
6 △:	- As professional consultants for urban planners/designers and politicians;
7 △:	-Advisors;
8 △:	-Technique supporters; -Offering feasible suggestions for decision makers;
9 ◇:	- Discussing innovative planning and design theory and practices with other group;

2. What are the relationships between these actors in the communication strategies?

Relationship between citizens and politicians

1 ○:	-Source of information/ Decision makers;
2 □:	-Citizens experience the change of urban climate and the improvements by urban climate mitigation and adaptation measures; -Politicians are the decision makers of the whole process for improving urban climate;
3 △:	-Citizens are worried about the negative influence to their daily lives; -Politicians should solve their worries;
4 △:	- Interest demands party / Policy makers;
5 △:	- Being coordinated/ Coordinators
6 △:	-Citizens experience urban climate from daily energy use and living comfort condition and they want to improve the microclimate by the help from politicians; -Politicians try to find more experts to join the consultant team to carry out laws, policies and regulations .
7 △:	-Opposite relationship;
8 △:	-Citizens passively experience the urban climate adaptation measures; -Politicians carry out relevant measures by making laws, policies and regulations;
9 ◇:	- Public supervision and management;

Relationship between citizens and urban planners/designers

1 ○:	- Source of information/ Information analysts

2 □:	-Citizens are not involved in the planning and design process, they only have the opportunity to know the projects often after the construction process; -Urban planners/designers care more about the politicians.
3 △:	- Citizens are not aware of the planning practices which are related to certain policies about living quality, and property rights and citizens may complain about some of the planning practices. -Reflections about the planning practices should be done together.
4 △:	- Interest demand party/ Advisors of recommendations and suggestions;
5 △:	-Citizens have the intentions and desire to improve urban climate; -Urban planners & designers gather ideas and work out the plan.
6 △:	-Urban planners/designers invite citizens to join the explanation session of comprehensive plans and regulation plans;
7 △:	-Citizens expect urban planners/designers to improve the urban climate together with other groups;
8 △:	-Citizens might communicate with urban planners/designers in some public hearing hold by the government for some projects; -Urban planners/designers might consider those opinions from the citizens;
9 ◇:	- Advisors and designers;

Relationship between citizens and urban climate experts

1 ○:	- Questioners/ Answerers
2 □:	-Citizens seldom have the opportunity to get in touch with urban climate experts;
3 △:	-Lack of understanding between each other; -Citizens have doubts about the opinions from experts and do not understand the measures promoted by experts; -Many ideas and concepts are accepted by citizens, however feasible implementation measures are not sufficient and some experts do not correctly understand citizens' requirements.
4 △:	-Interest demand party/ Indirect advisors of recommendations and suggestions;
5 △:	-Citizens acquire urban climate knowledge from urban climate experts;

	-Urban climate experts spread knowledge to citizens.
6 △:	--Citizens join the lectures hold by urban climate experts;
7 △:	- Misunderstanding between each other;
8 △:	-Citizens learn climate knowledge from the lectures hold by urban climate experts;
9 ◇:	- Auditors and educators;

Relationship between politicians and urban planners/designers

1 ○:	-Decision makers/ Proposers
2 □:	-Urban planners/designers follows the laws, policies, regulations made by the government;
3 △:	-Politicians carry out policies/regulations for improvements of the environment which are motivated by personal principles and policies. While economy and social development is considered as a whole, it is hard to apply to a large scale; -Urban planners and designers can only put efforts under the policies, and the final decisions are still made by government.
4 △:	- Policy makers/ Advisors
5 △:	- Politicians make strategies; -Urban planners and designers do planning practice according to the strategies.
6 △:	- Civil servants are responsible for enacting policies, and urban planners and designers are responsible for implementing policies.
7 △:	- There are misunderstanding and knowledge gap between politicians and urban planners and designers.
8 △:	-Politicians carry out policies and regulations related urban climate adaptation and urban planning and design field; -Politicians guide and manage the planning projects and planning sectors; -Government are responsible for the supervision of law enforcement and evaluation of the projects as well as the evaluation and veto of the planning projects.
9 ◇:	-Politicians: guiding the urban planning and design -Urban planners and designers: implementing planning and design practices;

Relationship between politicians and urban climate experts

1 ○:	- Questioners / Consultants
2 □:	-Urban climate experts usually work on research projects funded by the government;
3 △:	- Politicians should listen feasible opinions from experts to make scientific decision.
4 △:	- Policy makers/ Indirect advisors;
5 △:	-Urban climate experts give answers to urban climate problems raised by politicians.
6 △:	-Politicians provide funding for researches on urban climate adaptation -Urban climate experts in government sector provide local climate data;
7 △:	- Misunderstanding between each other;
8 △:	-Urban climate experts help policy makers to carry out and amend the policies, regulations, etc.;
9 ◇:	- Organizers and Experts;

Relationship between urban planners/designers and urban climate experts

1 ○:	- Strategy providers/ Reviewers
2 □:	-Lack of communication and cooperation;
3 △:	-Urban planners and designers and urban climate experts should communicate their own knowledge among each other in order to improve urban environment.
4 △:	- Direct advisors/ Indirect advisors
5 △:	-Urban climate experts answer technical questions for urban planners and designers.
6 △:	-Urban climate experts coordinate to formulate policies about Urban Heat Island and wind tunnel into the comprehensive plans and regulative plans.
7 △:	-Lack of cooperation between each other;
8 △:	-Urban planners/designers do planning and design practices; -Urban climate experts offer professional supports;
9 ◇:	-Designers and planners vs tutors in the training

3. What is the role of communication to support the planning, design and implementation of adaptation measures?

Role of communication

1 ○:	-To analyze the urgency and realistic characteristics of the urban planning issues; -To make the urban climate adaptation measures more pertinence, scientific, democratic and ecologic.
2 □:	-There should be more communication with citizens and cross-fields, as lack of communication might cause misunderstanding and have negative impact on the projects.
3 △:	- To draw on each other's strength and complement each other;
4 △:	-For citizens, communication makes them know more about urban climate and their living places; -For politicians, urban planners and designers and urban climate experts, communication makes them have an active attitude towards urban climate adaption issues.
5 △:	- The communication and cooperation between urban planners and urban climate experts helps to make the measures more scientific
6 △:	-As urban climate is related to land use, aerodynamic roughness length, and local climate, it should be adapted to its own situation which requires the detailed measures and planning and design practices. -The adaptation is a long-term and dynamic procession based on information that keeps being revised. Communication is a result after measuring progress and evaluating phased objectives, to ensure the planning, design and implementation of adaptation measures are always updated and adaptable to current circumstance. It helps to allocate resources properly and avoid unexpected result.
7 △:	*No response.*
8 △:	-Communications between each role are important, especially with the citizens.
9 ◇:	- Communication plays key role in every steps in the planning and design process.

4. Are there formal guidelines or policies that drive the use of communication in the planning, design and implementation of adaptation measures?
If yes, can you please name them?

《上海市 2015 年产业结构调整重点工作安排》；

- Provisions of Shanghai Municipality

2015 Key Work Arrangement on Industrial Structure Adjustment

《上海市清洁空气行动计划（2013-2017）》；

-Provisions of Shanghai Municipality

Action Plan of Clean Air (SPMG G 2013-83)

《城乡规划法》；

-Urban and Rural Planning Law

《上海市开发利用太阳能行动计划》；

-Provisions of Shanghai Municipality

Action Plan of Solar Energy Development

《上海市节约能源条例》；

-Provisions of Shanghai Municipality

Energy Conservation Regulation

《国家适应气候变化战略》；

-China's National Programme on adaptation to Climate Change

《上海市节能和应对气候变化"十二五"规划》；

Provisions of Shanghai Municipality

Twelfth Five-Year Plan of Energy Conservation and Climate Change

《上海市城市规划技术管理条例》；

-Provisions of Shanghai Municipality

Urban Planning Administration Regulations

《上海市城乡规划条例》；

- Regulations of Shanghai Municipality on Urban and Rural Planning

《上海市城市建设规划管理条例》；

-Provisions of Shanghai Municipality

Regulations on Urban Planning and Development Control

5. What are the strengths and weaknesses of the communication process?

	Strength	Weakness
1 ○:	*No response.*	*No response.*
2 □:	-Making clear of the real desire and need from the communication; -Avoid the mistakes by information asymmetry;	-Long discussion time; -Hard to agree by all stakeholders;
3 △:	*No response.*	-Communication process is based on unequal standing, and there is lack of citizen participation.
4 △:	-Encouraging citizens to participate	*No response.*
5 △:	- To know each other's focus and attention;	- There are obstacles among different stakeholders because of the interests in different job functions.
6 △:	- To enhance understanding and feasibility and in urban climate adaptation measures in order to implement measures together.	*No response.*
7 △:	*No response.*	*No response.*
8 △:	-To get citizens involved in the planning and design process;	-Not easy to execute efficiently;
9 ◇:	*No response.*	*No response.*

6. Is there need to improve the communication process? If yes, how to improve?

1 ○:	YES	-Taking initiatives by the government;
2 □:	YES	-Legislation & training
3 △:	YES	- Setting up clear and mature communication rules and providing communication opportunities for all groups; -Making relevant policies and implementing measures should be based on opinions from different groups.
4 △:	YES	- Encouraging citizens to participate in urban climate adaptation measures;

5 △:	YES	- To strengthen the communication between government and citizens by set up discussion groups or coordination committee.
6 △:	YES	- To increase the transparency of climate data; -To invite urban climate experts to join the government consultant team;
7 △:	*No response.*	
8 △:	YES	-Multiple methods: media press conferences, online surveys; random interviews; hearing conferences;
9 ◇:	YES	*No response.*

Instruments

1. Are there legally binding instruments (e.g. zoning plans) used to implement urban climate adaptation measures?

   If yes, please explain how they work?

1 ○:	Unclear
2 □:	Yes. Urban and Rural Planning Law
3 △:	Yes. Most of the instruments are regulations from local government. The binding effect is not strong among citizens, private enterprises and public institutes.
4 △:	Yes.
5 △:	Yes. Urban and Rural Planning Law
6 △:	Yes.
7 △:	No response.
8 △:	Yes. - China's National Plan on Climate Change (2014-2020)
9 ◇:	Unclear

2. What are the strengths and weaknesses of the legally binding instruments used?

1 ○:	Unclear
2 □:	Unclear
3 △:	-Weakness: poor binding effect; less freedom for citizens and enterprises and public institutes; most of the instruments are compulsory policies.
4 △:	Unclear
5 △:	Unclear
6 △:	To enact legally binding policies need research and relevant data support, so the prerequisite of enacting the policies is urban climate research and basic climate data.
7 △:	Unclear
8 △:	-Strength: Being led by the government; -Weakness: Lack of implementation; Mentioned in the planning phrase about the urban climate adaptation issues; Still in the early phase.
9 ◇:	Unclear

3. Are there certain chances / potentials missed when using the legally binding mentioned instruments (e.g. coupling with other instruments)?

4. Are there other policy instruments used to implement urban climate adaptation measures?

If yes, please explain how they work?

5 △: Evaluation standard for green building

8 △: Not clear. There is not a comprehensive policy for urban climate adaptation issues.

5. What are the strengths and weaknesses of the other policy instruments used?

5 △: The standard covers wide range but it still needs more detailed criteria.

6 △: Relevant policies are not complete and comprehensive enough for example they have not covered living comfortability issues.

6. Are there certain chances/ potentials missed when using other policy instruments (e.g. coupling with other policies)?

Implementation

1. Which concrete urban climate adaptation measures/ interventions are currently implementing or have been implemented in your city?

1 ○:	-Improvement of the winter heating system; -Energy conservation measures of the building façade aiming at urban climate characteristics; -Influence analysis of wind dynamics and architectural style; -Architectural bionics design;
2 □:	-Urban greenness;
3 △:	Urban greenness construction; Adjusting industrial structures;
4 △:	-Energy saving and emission reduction; -Urban climate adaptation measures;
5 △:	Free bicycles in the cities
6 △:	Urban design, urban green issues, use of building materials
7 △:	Unclear
8 △:	-Rain water gathering instrument for urban greenery; -Encouraging citizens planting trees; -Sustainable thermal construction material for all buildings' façade, roof; -Light colors for buildings; -The orientation, distance between two buildings, ventilation hole performance and lighting performance should be designed by the designing codes. - Encouraging green roof and vertical landscape in the city; -Encouraging the use of sustainable energy.
9 ◇:	Unclear

2. What are the strengths and weaknesses of these mentioned urban climate measures/ interventions?

1 ○:	-Strength: Mitigation of the winter air pollution condition;
2 □:	Unclear
3 △:	-Weakness: politicians, urban planners and designers have realized the importance of urban climate but the power is not strong enough. Poor influence on citizens and public institutes
4 △:	-Unclear
5 △:	-Strength: Encouraging citizens to use bicycles rather than private transport.
6 △:	-Strength: Starting from urban greenery, basic understanding -Weakness: Lack of detailed implementation and low awareness in order to realize the real effects.
7 △:	Unclear
8 △:	Unclear
9 ◇:	Unclear

3. Are there conflicts between aesthetics and these mentioned urban climate adaptation measures?

No.

4. Are there conflicts between urban functions and these mentioned urban climate adaptation measures?

-1 ○, 2 □,4 △, 5 △, 6 △, 7 △, 8 △, 9 ◇: No conflicts

-3 △: Currently the focus of city development is still for economy development not for the livable quality.

5. Are there certain chances/ potentials (e.g. coupling with other interventions / 'no regret' measures) missed when implementing these mentioned urban climate adaptation measures?

Unclear

3. Detailed division information of China Building Climate Division[10]

TABLE 6 DETAILED DIVISION INFORMATION OF CHINA BUILDING CLIMATE DIVISION

Code		Division name	Climate main indicators	Building basic requirements
Ⅰ	ⅠA ⅠB ⅠC ⅠD	Severe cold region(includes Harbin, Changchun, Shenyang, Hohhot, Zhangjiakou, Heihe, Mohe, Nenjiang, Manzhouli,Qiqihar City, Siping, Jixi, Datong)	January average temperature≤-10℃ July average temperature≤25℃ July average relative humidity≥50%	1. Buildings should meet the requirements of winter heat preservation, cold protection and freeze-proofing. 2. ⅠA、ⅠB zones should protect the buildings from the hazard of frozen soil and snow 3.The west of ⅠB、ⅠC、ⅠD zones should protect the buildings from blowing sand and hail.
Ⅱ	ⅡA ⅡB	Cold region(including Beijing, Tianjing, Dalian, Yingkou, Chengde, Dandong, Taiping, Xi'an, Zhengzhou,Yinchuan, Yan'an, Lanzhou, Jinan, Qingdao, Zaozhuang, Shijiazhuang, Cangzhou)	January average temperature: -10~0℃ July average temperature: 18~28℃	1. In winter, buildings should meet the requirements of winter heat preservation, cold protection and freeze-proofing. In summer, building in some parts of the region should also have cooling function. 2. Buildings in ⅡA zone should have cooling function, damp and storm proof. Buildings in coastal area should prevent the salt fog corros

[10]Translated by author according to (Ministry of Construction of the People's Republc of China, 2005)

				ion.
Ⅲ	ⅢA ⅢB ⅢC	Hot-summer and cold-winter region (Chengdu, Chongqing, Shanghai, Nanjing, Hefei, Wuhan, Changsha, Guilin, Wenzhou, Hangzhou, Sanming, Pindingshan)	January average temperature: 0~10℃ July average temperature: 25~30℃	1 In winter, buildings should prevent the cold. In summer, buildings should meet the requirements of cooling, sunshade and ventilation. 2. Buildings should meet the requirements of lightening, damp and storm proof. 3、Buildings in ⅢA zone should prevent the salt fog corrosion.
Ⅳ	ⅣA ⅣB	Hot-summer and warm-winter region (includes Guangzhou,Fuzhou, Quanzhou, Baise, Nanning, Haikou, Shantou, Sanya, Taipei, Hong Kong)	January average temperature>10℃ July average temperature: 25~29℃	1. Buildings should meet the requirements of cooling, sunshade, storm proof and ventilation.2. Buildings should meet the requirements of lightening, damp and storm proof. 3. Buildings in ⅣA zone should prevent the salt fog corrosion as well as storms and typhoon.
Ⅴ	ⅤA ⅤB	Mild region (includes Xichang, Kunming, Guiyang, Lijiang, Dali, Panzhihua, Gejiu)	January average temperature: 0~13℃ July average temperature: 18~25℃	1. Buildings should meet the requirements of rain proof and ventilation. 2.Buildings in ⅤA zone should have thermal insulation, and buildings in ⅤB zone should have lightening proof.
Ⅵ	ⅥA ⅥB	Cold region(Lhasa, Xining, Kangding, Ganzi, Golmud)	January average temperature: 0 ~ -22℃	Buildings should meet the requirements of cold region and severe cold region sho

	VIA		July average temperature<18℃	wn above.
VII	VIIA VIIB VIIC	Severe cold region (Urumqi, Aqsu, Erenhot, Turpan, Kashi, Zhangye, Hami)	January average temperature: -5~ -20℃ July average temperature≥18℃ July average relative humidity<50%	Buildings should meet the requirements of cold region and severe cold region shown above.
	VIIA	Cold region		

4. Interviewees code rules

Information category	Detail	Code	Code Position
No.	1~9	1~9	1
Climate zone	Severe cold (Selected city: Urumqi)	○	2
	Cold (Selected city: Lanzhou)	□	
	Hot-summer and cold-winter (Selected city: Shanghai)	△	
	Hot-summer and warm-winter (Selected city: Xiamen)	◇	
Profession	Urban planner/designer	○; □; △; ◇;	Shown in different colors
	Educator (professor, lecturer)	○; □; △; ◇;	
	Urban climate expert	○; □; △; ◇;	
	Civil engineer	○; □; △; ◇;	

5. Contents about the urban climate adaptation in urban planning and design process in Chinas Policies and Actions for Addressing Climate Change2015-2008

Year	Contents
2015(NDRC, 2015)	➢ China actively developed green buildings, revised **Green Building Evaluation Standards**, formulated and promulgated **Green Store Building Evaluation Standards**. Beijing, Chongqing, Jiangsu, Zhejiang and Shenzhen began to enforce new green building standards in urban civil buildings, totaling nearly 400million square meters accumulatively; by the end of June 2015, a total of 3,241 green projects obtained green building rating labels, with a total construction area of more than 370 million square meters. ➢ **Carrying out climate change impact assessment for key areas and special industries.** China carried out real-time quantitative assessment of the impact of drought on agriculture and water resources, and conducted targeted a**ssessment of the climate impact of wind power**. ➢ **Conducting a wide range of practical cooperation with international organizations.** China signed the memorandum of understanding on bilateral cooperation on climate change with the Asian Development Bank, and jointly organized the "**International Workshop on Urban Adaptation to Climate Change**".
2014(NDRC, 2014)	➢ The Ministry of Housing and Urban-Rural Development and the Ministry of Industry and Information Technology advocated **the use of environment-friendly construction material** and released the **Management Method for Assessing and Labeling Green Construction Material**. ➢ In carrying out the **Opinions of the State Council on Strengthening the Development of Urban Infrastructure**, the Ministry of Housing and Urban-Rural Development revised the **Design Code for Outdoor Drainage**, which raises standards for urban rainwater canals designing and sets requirements for urban waterlogging prevention.
2013(NDRC,	➢ **Proactive Participation by the Public**

2013)	Through education and training on climate change addressing, energy saving, emission reduction and low-carbon living, the public have gained a deeper understanding of climate change and have participated more widely and consciously. Increasing numbers of people have chosen to make low-carbon lifestyle choices in transport, as well as their eating habits and housing.
2012(NRDC, 2012)	➢ **Enhancing the assessment and management of energy conservation**. The Ministry of Housing and Urban-Rural Development has released the Implementation Plan for Carrying out the Notice of the State Council to Issue the Comprehensive Work Plan on Energy Conservation and Emission Reduction During the 12th Five-Year Plan Period, the Special Blueprint of Conserving Energy in the Construction Sector During the 12thFive-Year Plan Period, and the **Implementation Opinions Concerning Accelerating the Development of China's Green Buildings**; ➢ In order to better implement urban flood control, the Ministry of Housing and Urban-Rural Development issued the **Circular on Strengthening Prevention Measures of Urban Water logging and on Carrying out Urban Flood Control in 2012.** ➢ **Carrying out green and low-carbon pilot and demonstration projects in key small towns.** In 2011, the Ministry of Finance, the Ministry of Housing and Urban-Rural Development and the National Development and Reform Commission jointly launched **the green and low-carbon pilot and demonstration project for key small towns.** Seven small towns were selected to take part in the project – Gubeikou Town in Miyun County, Beijing; Daqiuzhuang Town in Jinghai County, Tianjin; Haiyu Town in Changshu, Suzhou City, Jiangsu Province; Sanhe Town, in Feixi County, Hefei City, Anhui Province; Guankou Town in Jimei District, Xiamen City, Fujian Province; Xiqiao Town, in Nanhai District, Foshan City, Guangdong Province; and Mudong Town in Banan District, Chongqing.
2011(The Information Office of the State Council, 2011)	➢ The meteorological departments have released and implemented the **Weather Research Plan (2009-2014)**, **Climate Research Plan (2009-2014)**, **Applied Meteorology Research Plan (2009-2014)** and **Comprehensive Meteorological Observation Research Plan (2009-2014)**, and distributed the China Implementation Plan of the Climate Observation Systems, in an effort to promote the observation, pre-evaluation and evaluation of climate change. China has set up the first-generation operational system based on a dynamical climate model for short-term climate prediction, developed the new-generation dynamical climate model system, and conducted various evaluations regarding the impact of climate change on the safety of national grain supply, water supply, ecology and human health.

	➢ **Strengthening practical cooperation with developed countries cooperation on green buildings and ecological urban development** with Britain and cooperation on urban and rural sustainable development with Sweden.
2009(NRDC, 2009)	➢ Since 2008, China has strengthened the administration of climate feasibility study and regulated this activity, so as to reasonably develop and utilize climate resources and **avoid or reduce the potential impacts of meteorological disasters and climate change on the planning and construction projects after their execution or the potential impacts on the local climate**.
2008(The Information Office of the State Council, 2008)	➢ **To place equal emphasis on both mitigation and adaptation.** Mitigation and adaptation are integral components of the strategy for coping with climate change. Mitigation is a long and arduous challenge, while **adaptation is a more present and imminent task**. The latter is of particular importance to developing countries. The two must be treated with equal importance in a coordinated and balanced way.

6. Green Building standards lists

TABLE 7 NATIONAL AND TRADE STANDARDS FOR GREEN BUILDING(YE, ET AL., 2015)

Title	Scope	Category	Enforcement date	Note
Evaluation Standard for Green Building (GB/T50378-2006)	National	Engineering	1/06/2006	Design or operation stage evaluation of all buildings
Evaluation Standard for Green Construction of Building (GB/T50640-2010)	National	Engineering	1/10/ 2011	Specific stage evaluation
Evaluation Standard for Green Refurbishment of Existing Building	National	Engineering	Under development	Specific stage evaluation
Evaluation Standard for Green Industrial Building (GB/T50878-2013)	National	Engineering	1/10/ 2014	Specific building evaluation
Evaluation Standard for Green Industrial Building of Tobacco Industry (YC/T396-2011)	Trade	Product	15/07/ 2011	Specific building evaluation
Evaluation Standard for Green Office Building (GB/T50908-2013)	National	Engineering	1/05/2014	Specific building evaluation
Evaluation Standard for Green Store Building	National	Engineering	Under approval	Specific building evaluation
Evaluation Standard for Green Hospital Building	National	Engineering	Under approval	Specific building evaluation
Evaluation Standard for Green Hotel	National	Engineering	Under	Specific

Building			development	building evaluation
Green Hotels (GB/T21084-2007)	National	Product	1/03/ 2008	Partial correlation
Evaluation Standard for Green Exhibition Building	National	Engineering	Under development	Specific building evaluation
Evaluation Standard for Green Railway Station	Trade	Engineering	Under development	Specific building evaluation
Evaluation Standard for Green Campus	National	Engineering	Under development	Specific building evaluation
Evaluation Standard for Green Eco-District	National	Engineering	Under development	Specific building evaluation
Code for Green Design of Civil Buildings (JGJ/T229-2010)	Trade	Engineering	1/10/ 2011	For building design
Code for Green Construction of Building	National	Engineering	Under development	For building construction
Code for Operation and Maintenance of Green Building	National	Engineering	Under development	For building O&M

TABLE 8 LOCAL STANDARDS FOR GREEN BUILDING(YE, ET AL., 2015)

Provincial-level Region	Title and number (if possible)	Enforcement date	Note
Anhui	Evaluation Standard for Green Building in Anhui	Under development	For evaluation
Beijing	Management Specification of Green Construction in Beijing (DB11/513-2008)[a]	1/05/2008	For construction
	Evaluation Standard for Green Building in Beijing (DB11/T825-2011)	1/12/2011	For evaluation
	Design Standard of Green Building in Beijing (DB11/938-2012)[a]	1/07/2013	For design
Chongqing	Green Building Standard (DBJ/T50-066-2007)	1/10/2007	For design, construction and O&M
	Technical Specification for Eco-Residential Building Construction (DBJ/T50-039-2007)	1/02/2008	For evaluation
	Evaluation Standard for Green Building in Chongqing (DBJ/T50-66-2009)	1/02/2010	For evaluation
	Design Code of Green Building in Chongqing (DBJ50/T-135-2012)	1/03/2012	For design
	Code of Green Construction Management in Chongqing (DBJ50/T-166-2013)	1/06/2013	For construction
Fujian	Evaluation Standard for Green Building in Fujian (DBJ/T13-118-2010) 1st March, 2010	1/03/2010	For evaluation
	Technical Specification of Green Construction in Fujian (DBJ/T13-180-2013)	31/12/2013	For construction

Gansu	Evaluation Standard for Green Building in Gansu (DB62/T25-3064-2013)	1/08/2013	For evaluation
Guangdong	Evaluation Standard for Green Building in Guangdong (DBJ/T15-83-2011)	15/07/2011	For evaluation
	Evaluation Standard for Green Construction in Guangdong (DBJ/T15-97-2013)	01/12/2013	For evaluation
Guangxi	Green Building Evaluation in Guangxi (DB45/T567-2009)[b]	23/02/2009	For evaluation
	Code for Design of Green Building in Guangxi (DBJ/T45-001-2011)	1/09/2011	For design
Guizhou	Evaluation Standard of Green Construction of Small Towns in Guizhou (Trail)(DBJ52/T060-2012)	1/09/2012	For evaluation
	Evaluation Standard for Green Building in Guizhou (Trail) (DBJ52/T065-2013)	1/12/2013	For evaluation
Hainan	Evaluation Standard for Green Building in Hainan (Trail) (DBJ46-024-2012)	1/08/2012	For evaluation
Hebei	Evaluation Standard for Green Building in Hebei (DB13(J)/T113-2010)	1/03/2011	For evaluation
	Technical Standard for Green Building (DB13(J)/T132-2012)	1/05/2012	For design, construction and O&M
	Management Specification of Green Construction in Hebei (DB13(J)/T154-2013)	1/04/2014	For construction
Heilongjiang	Evaluation Standard for Green Building in Heilongjiang	Under development	For evaluation
Henan	Management Specification of Green Construction in Henan	1/05/ 2011	For construction

	(DBJ41/T107-2010)		
	Evaluation Standard for Green Building in Henan (DBJ41/T109-2011)	01/02/2012	For evaluation
	Evaluation Standard for Green Indemnificatory Houses in Henan (DBJ41/T116-2012)	1/01//2013	For evaluation
Hong Kong	Evaluation Standard for Green Building in Hong Kong	December, 2010	For evaluation
Hubei	Evaluation Standard for Green Building in Hubei[d]	June, 2010	For evaluation
Hunan	Evaluation Standard for Green Building in Hunan (DBJ43/T004-2010)	01/01/2011	For evaluation
Jiangsu	Evaluation Standard for Green Building in Jiangsu (DGJ32/TJ76-2009)	01/04/2009	For evaluation
Jiangxi	Evaluation Standard for Green Building in Jiangxi (DB36/J001-2010/T)	01/05/2010	For evaluation
Jilin	Evaluation Standard for Green Building in Jilin (DB22/T1591-2012)	16/10/2012	For evaluation
	Liaoning Evaluation Standard for Green Building in Liaoning (DB21/T2017-2012)	1/10/ 2012	For evaluation
Neimenggu	Evaluation Standard for Green Building in Neimenggu	Under development	For evaluation
Ningxia	Evaluation Standard for Green Building in Ningxia (DB64/T954-2014)	01/04/2014	For evaluation
Qinghai	Evaluation Standard for Green Building in Qinghai (DB63/T1110-2012)	15/08/2012	For evaluation
Shandong	Evaluation Standard for Green Building in Shandong (DBJ/T14-082-2012)	1/03/2012	For evaluation
Shanghai	Evaluation Standard for Green	01/03/2012	For evaluation

	Building in Shanghai (DG/TJ08-2090-2012)		
	Management Specification of Green Construction in Shanghai (DG/TJ08-2129-2013)	01/10/2013	For construction
	Green Design Standard for Residential Building (DGJ08-2139-2014)	01/07/2014	For design
	Green Design Standard for Public Building	Under approval	For design
Shanxi	Standard for Green Design of Public Buildings in Shanxi (DBJ61/T80-2014)	30/04/2014	For design
	Standard for Green Design of Residential Buildings in Shanxi (DBJ61/T81-2014)	30/04/2016	For design
	Evaluation Standard for Eco-Residential Building in Shanxi (DBJ61/T83-2014)	01/06/2014	For evaluation
	Evaluation Standard for Green Building in Sichuan (DBJ51/T009-2012)	01/11/2012	For evaluation
	Design Standard of Green Schools in Sichuan (DBJ51/T020-2013)	01/03/2014	For school design
Tianjin	Evaluation Standard for Green Building for Sino-Singapore Tianjin Eco-City (DB29-192-2009)[a]	11/09/2009	For evaluation
	Green Building Design Standard for Sino-Singapore Tianjin Eco-City (DB29-194-2009)[a]	27/01/2010	For design
	Technical Specification for Green Construction for Sino-Singapore Tianjin Eco-City (DB/T29-198-2010)	01/08/2010	For construction

	Green Building Construction Management Technical Specification in Tianjin (DB29-201-2010)[a]	15/09/2010	For construction
	Evaluation Standard for Green Building in Tianjin (DB/T29-204-2010)	01/01/2011	For evaluation
Yunnan	Evaluation Standard for Green Building in Yunnan (DBJ53/T-49-2013)	01/08/2013	For evaluation
Zhejiang	Evaluation Standard for Green Building in Zhejiang (DB33/T1039-2007)	01/01/2008	For evaluation
	Green Design Standard of Civil Buildings in Zhejiang (DB33/1092-2013)	01/01/2014	For design

[a] Besides these mandatory standards, all other standards in the table are voluntary.

[b] Besides this product standard, the category of all other standards in the table are engineer standard.

[c] It's a normative document jointly issued by China Green Building Council and China Green Building (Hong Kong) Council.

[d] It's an approved normative document issued by local government.