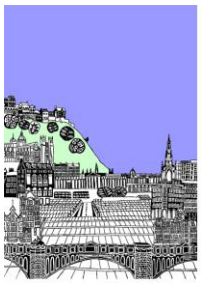

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China's Urban Wind Corridor Plan: The Story behind Climate Change Adaptation and Eco-Planning in Chinese Cities

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Abstract: By the end of 2017, more than 300 cities in China are required to develop and finish their urban wind corridor plan assigned by the central government. However, given the limited time and resources, this turns out to be a big challenge for city governments. Firstly, the paper reviews the environmental problems caused by fast urbanization in the past half a century to understand urbanization's impact on local urban climatic conditions. Secondly, for a better understanding of the public's concerns and social needs, relevant news articles from Wisenews Database are investigated and analyzed. Thirdly, a review on relevant policy documents, action plan, and guidelines is conducted to understand the political task and practice requirement, which is the basis of the implementation mechanism of wind corridor plan. Fourthly, both governmental consultancy projects and research projects are reviewed to summarize the methods and implementation of urban wind corridors into the urban planning systems in Chinese cities. Finally, learnt lessons and existing implementation problems will be discussed and summarized. The paper will provide an insight into China's urban wind corridor plan for a more comprehensive understanding of the limitations and problems of current projects and studies in Chinese cities.

Keywords: urban ventilation assessment, wind corridor, urban planning, Chinese cities

1. Introduction

Since 1978, China has been dramatically developed and urbanized. It is not doubt that Chinese people's living standard have been improved a lot. However, behind a mythic high-speed economic growth over last 30 years, her environmental conditions have been changed a lot or even deteriorated. According to the report published by Asian Development Bank in 2012, one-seventh of China suffers haze events, heavy air pollution and intensified urban heat island problems[1]. Thus, urban ventilation assessment has become a matter of great concern among the general public, planners and both the central and local governments in China. Urban wind corridor plan is considered an effective measure for climate change adaptation and eco-planning by the Central Government of China. By the end of 2017, more than 300 cities in China are required to develop and finish their urban wind corridor plan assigned by the central government. However, given the limited time and resources, this turns out to be a big challenge for city governments. Thus, there is an urgent need for a critical overview of the problem and challenges in Chinese

cities' urban ventilation assessment and their urban wind corridor plan, so the feasible strategies of science-policy implications can be developed accordingly.

2. Current Environmental Issues

Generally, air temperature has gradually increased, urban wind speed in general has decreased. It cause more calm wind situations. Due to high air pollution emission from heavy industry and also coal burning, especially in winter time, heavy air pollution and haze events turns to be more often. All these affects public health directly and indirectly.

2.1 Temperature

According to local weather records, Fig. 1a shows a spatial distribution map of average annual temperature anomaly of China between 1951 and 2001[2]. A prominent temperature rise can be found from the mid 1980's[2]. Latest research results show that actually 44% of temperature rise is contributed by urban heat island[3].

2.2 Wind Environment

Fig. 1b shows a spatial distribution map of annual wind speed anomaly of China between 1951 and 2001[2]. Apart from some minor parts, especially major northwest areas, Inner Mongolia areas, central and southern part of northeast areas, and as well as central part of mainland China experienced decreasing wind speed situation between 1956 to 2002[2]. It can expected that wind environment of urbanized areas is getting worse in these parts of China.

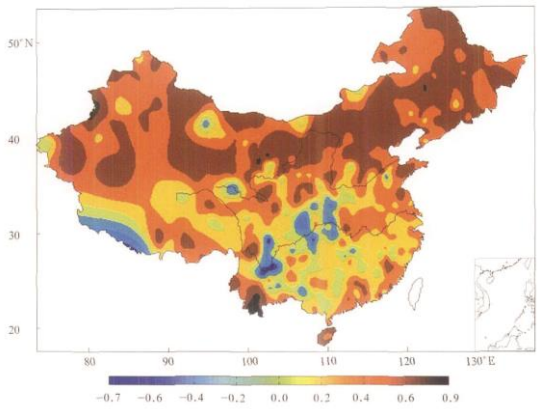

Fig.1a average annual temperature anomaly of China (1951 - 2001) [2]

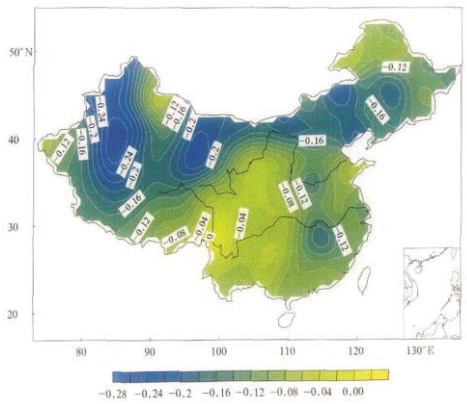

Fig.1b annual wind speed anomaly of China (1956 - 2001) [2]

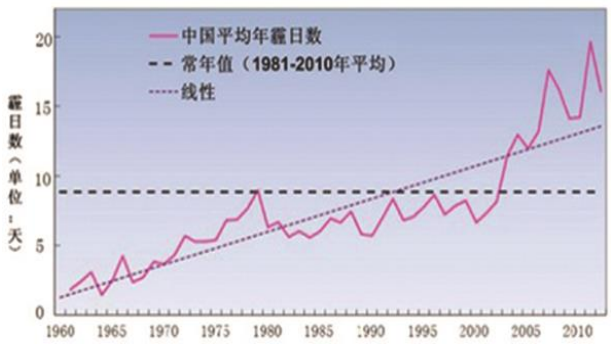

Fig.2a numbers of haze events per year (1960-2010) (pink line: numbers of haze events per year (1960-2010); black thick dash line: average value (1981-2010); pink dash link: linear trend over 1960-2010 [4]

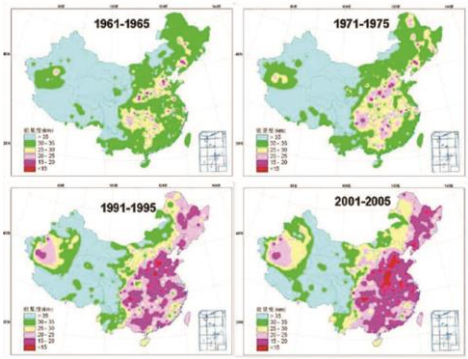

Fig. 2b Spatial distribution maps of visibility distance in Chinese cities for4 periods (1961-1965, 1971-1975, 991-1995, 2001-2005) [5]

2.2 Haze events

Due to fast urbanization, apart from the landscape transformation, the associate human activities especially industry have modified cities' urban meteorological and climatic conditions. From Fig. 2a, it shows a linear trend of increasing numbers of haze events per year from 1960 to 2010[4]. Recent studies also demonstrate that haze events happen mostly in winter and spring seasons, especially from 2000, there has been an explosive growth. For some extreme haze cases, affected areas was about up to 15% of land areas in China [6]and the visibility distance can be reduced to less than 1km[7].

2.4 Visibility Distance

According to the report by China Academy of Engineering and Ministry of Environmental Protection of China, it concluded there is a worsen trend of mixed air pollution situation in Chinese cities and regions over past half century based on local weather records (Fig. 2b)[5]. From Fig.2b, it seems that higher urbanized areas are coincidently associated with a shorter visibility distance.

3. Review on Media and News Articles

Since people in mainland China breathe such heavy polluted air, what is public concern and is there any social engagement? It is needed to explore through reviewing historical media reports and news articles. According to the database of Wisenews (01/01/1998 to 01/04/2016), Chinese news articles relevant to wind corridor have been searched.

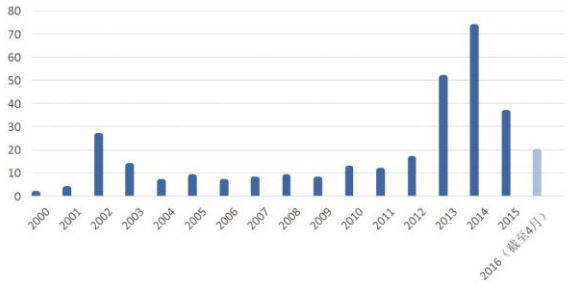

Fig. 3a annual numbers of relevant news articles (01/01/2000-01/04/2016)

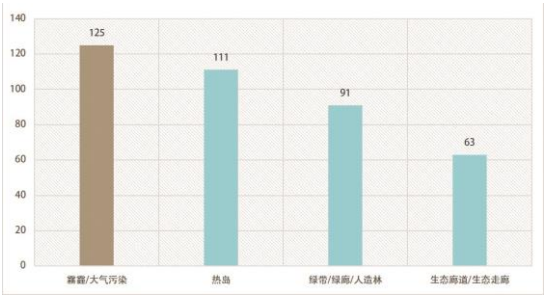

Fig. 3b numbers of new articles on 4 main thematic topics (Colum 1: haze/air pollution; Colum 2: urban heat island; Colum 3: green belt/green corridor/artificial woodland; Colum 4: ecological corridor/ecological pathway)

Tab. 1 shows annual numbers of relevant news articles (01/01/2000-01/04/2016). It found that from 2000 to 2012, yearly numbers are stable and relatively small and turning point is happened in 2013. Probably there are two reasons: 1) in Jan 2013, there was a national heavy air pollution event heavily reported by mainland media which caused a high public attention; 2) from 2013, the updated air quality index calculation includes PM2.5 data and also both 2013 and 2014 Report on the State of the Environment in China introduce haze, urban air quality and also officially release various air pollutants 'concentration data and other relevant information to the public.

However, in those news articles about wind corridor there are four main thematic topics: 1) haze/air pollution; 2) urban heat island; 3) green belt/green corridor/artificial woodland; and 4) ecological corridor/ecological pathway. It found that due to frequent reprints, one news article or similar content can be repeated again and again not in different media, but

also in different years. This also potentially cause public misunderstandings about urban ventilation and air pollution, and as well as about wrong concept and function of wind corridor. Consequently these leads to a social argument among the public, researchers and government on wind corridor and relevant implementation strategies.

4. Review on Policy and Official Documents

Premier Xi Jinping in his opening address at the Asia-Pacific Economic Cooperation (APEC) November 2014 meeting in Beijing reminded delegates of Beijing's air pollution and urban climate problems. He hoped that, as part of his "Chinese dream", one day China will see "blue sky, green mountains and clean water". The directive set off a chain reaction.

The address was preceded by the National Plan on Climate Change 2014–2020 published in September 2014 [8]. The paper mentions, for the first time, policies related to urban climate and urban living. Keywords such as urban heat island, heat stress prevention, building design, transportation planning, open space provision, urban greenery, and water body have been included.

Almost immediately after Xi's address, China finally passed its 2009 draft Design Standard for Thermal Environment of Urban Residential Areas (Ministry of Housing and Urban-Rural Development [MOHURD], 2013). It specifies that the urban heat island effect will be limited to 1.5°C.

In May 2015, the 2011 draft Technical Specifications for Climatic Feasibility Demonstration in Urban Master Plan by the China Meteorological Administration was passed. As a major basis of city planning, the document mentions the need to calculate and quantify human thermal comfort, air pollution index, urban heat island intensity, mixing height, and so on.

In June 2015, the Ministry of Housing and Urban–Rural Development (MOHURD) published a draft policy paper titled National City Environmental Protection and Development Policies[9]. It highlights the importance of Xi's "blue sky, green mountains and clean water". The key strategies are "urban wind corridors" and "urban greening". It recommends that China's major cities – and there are 291 of them – need to complete their Greening Masterplan and Air Corridor Masterplan by 2017. Dovetailing urban climate and climate change considerations, the MOHURD's paper was followed by a joint MOHURD/NDRC paper in February 2016 on Climate Change Adaptation Action Plan for Cities [10]. It requires results to be realised by the local governments of 30 key cities.

National City Environmental Protection and Development Policies [9] stipulates that city officials and planners need to take on the city's air ventilation corridor planning seriously. Work must include (A) an investigation of the city's air mass movement and its clean air sources, (B) a mapping of the air ventilation functions of its green spaces, (C) an understanding of the city's urban heat island characteristics, (D) an understanding of the city's urban air temperatures, and so on. Based on the above understandings, the city officials and planners must develop a strategic plan for the layout of the city's air corridors and a conservation plan of its green spaces.

The MOHURD policy document requires the above to be achieved by all district level cities by 2017. The document highlights three mega-areas: the Beijing region, the Shanghai region and the Pearl River Delta region. The cities within these three regions need to be considered together. To do that, mesoscale studies covering an area with a radius of a hundred kilometers must first be needed. Initial studies have been conducted [11-14]. These and many others to follow would provide the needed atmospheric boundary conditions for further fine scale studies that would provide useful data for policy makers and planners operating at the city, district urban and neighborhood scales of development planning [15, 16].

The initiative for the Chinese Government moving towards planning its cities based on climate and urban climatic knowledge is further demonstrated by the publication of Technical specifications for climatic feasibility demonstration in urban master plan (Beijing Meteorological Office, 2015). The guideline highlights a number of considerations for planners at the master planning and urban planning scales of development. Meteorological data needed includes wind speeds and directions, air temperature, humidity, short wave and longwave radiations. Demographical data, planning and urban morphological data, anthropogenic heat data, as well as air pollution data are also needed. The human thermal comfort model is used to evaluate the model simulation results, and various planning options would then be compared.

Another yet-to-be drafted guideline by MOHURD, which is still at the consultation stage (as of June 2016), tentatively titled Green Eco-city and Building Design Guideline provides further guidance to planners and architects. The guidelines hope to bridge understandings of UHI at the urban scale and the building design and system design scales of property development.

5. Local Government Reports and Academic Research Projects

Based on the collection of local governmental reports, academic papers and published Chinese journal papers from 2002 to 2016, it found that there are about 63 urban ventilation projects for 36 cities and regions and 17 provinces in China. About 2/3 is academic studies and the rest are governmental consultancy projects. Since 2013, numbers of studies has been increased dramatically (Fig 4a). At the same time, cities or regions with higher economic condition are more eager to conduct such kind of projects and very often initiated by local government.

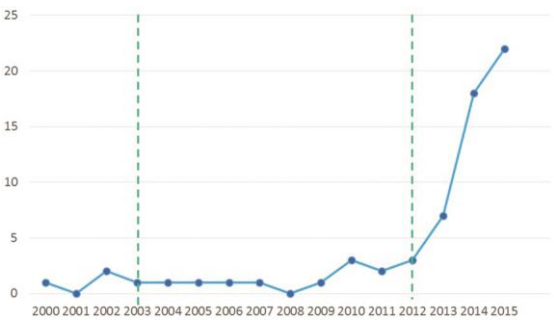

Fig. 4a annual numbers of projects on wind corridor in China (01/01/2000-31/12/2015)

Fig. 4b the distribution map of urban wind corridor studies

6. Discussion and Conclusion

Although literature shows around the late 1970's to the early 1980's, some meteorologists and geographers called for an implementation of wind direction and air pollution consideration into urban planning, with fast urbanization, in fact real applications and considerations are limited and very often planners and government officials totally ignored urban climatic elements and environmental factors in urban development. Thus, for future studies on urban ventilation assessment and implementation of wind corridor plan, it is suggested:

1) scientific-based and data-supported planning is needed;
2) cross-disciplinary collaboration is encouraged inter government; and
3) Mind-set change is required to deal with air pollution and environment problems in near future.

Acknowledgment

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