

Effect of Urbanization on Local Climate in Changzhou City in Recent 60 Years

YU Wen-zheng², Zhu Hong-xia², Qi YingXiang¹, Chen Tianliang¹,
Shao Li and Wang Lin²

¹College of Environmental Science and Engineering, Nanjing University of
Information Science & Technology, Jiangsu Nanjing, 210044, China

²College of Applied Meteorology, Nanjing University of Information Science &
Technology, Jiangsu Nanjing, 210044, China;)

Abstract

Based on the meteorological data from the weather stations of Changzhou for the period 1952-2011 and the statistical yearbook, the change trends of the mean temperature, min-mean temperature, max-mean temperature and precipitation of Changzhou are analyzed. Then the data about the development of the city such as the population, ecology, arable land and build-up area are analyzed. The results show that: the effect of urbanization on temperature is more obvious. The differences between gross production, arable land at the end of year, build-up area, road area at the end of year and temperature are highly significant. Through analyzing the trend of climate change and the data of urbanization over the past 60 years in Changzhou, the effects of the rapid development of urbanization on local climate change are noticeable.

Keywords: Changzhou; urbanization; climatic effect

1 Introduction

In the past twenty years, China's urban population increased rapidly with the expanding city scale. Statistics show that the level of the eastern coastal urbanization reaches 55%, formed the coastal city belt composed by the Yangtze River Delta, Pearl River Delta and Beijing-Tianjin-Hebei, three super-large urban agglomerations. As the influence of human activities on the natural environment deepening, the effects of urbanization on the climate are also increasingly prominent. The IPCC Fourth Assessment Report 2007 states that human activities are likely to be the main cause of global warming. This possibility is above 90%. Currently there are a large number of studies about the impact of urbanization on local climate. Wei et al preliminary revealed the impact and variation of urbanization of Nanchang on local climate by analyzing the characteristics of climatic factors of Nanchang during 1971-1979 such as annual temperature, wind, precipitation, solar radiation and so on. Ji et al studied the effects of urbanization on temperature of cities along the Yangtze River downstream such as Anqing, Wuhu and Nanjing. The results show that: the development of medium-sized cities is rapid in recent decades. As the economy growing and the rate and intensity of consumption of resources and energy increasing, the annual average maximum temperatures of these cities are also rising. Yin et al identified that urbanization in Shanghai was speeding up and the local climate characteristics were changing, particularly the significant changes in precipitation, by studying the effects of urbanization on rainfall in Shanghai. Che et al investigated the influence of urbanization in Xi'an on the local climate. Research found that there's a rising trend in temperature and a declining trend in precipitation, relative humidity and sunshine percentage in Xi'an. The benefits of urbanization had a significant impact on local climate in Xi'an.

Urbanization will be a trend of the development of our country in future. With the

development of urbanization, the original natural surface is substituted by the intensive buildings, industrial areas and road blocks and viaducts. In addition, the lives of dense urban population and production activities bring about the consumption of a large number of energy and the emission of anthropogenic heat source and pollutants. Thus, urbanization is a place where the intervention of human activities on the natural environment is the most intense and the change in the natural environment is greatest. Urbanization must have an important impact on local climate.

2. Data and Methods

2.1. Study Area

Changzhou is a city along with perennially humid climate, adequate rainfall and four distinct seasons, which is situated in the transition zone of northern tropical and subtropical. Changzhou belongs to the boom Taihu plain of the center of Yangtze River Delta, inside are mountains, hills, plains and lakes with the undulating and dependent terrain. Changzhou is a traffic hub of the Yangtze River Delta and eastern China, which joints Wuxi and Suzhou, forming the three cities in the southern of Jiangsu in the traditional sense(Wu cultural area, Jiangsu province), namely Suzhou, Wuxi and Changzhou metropolitan area.

2.2. Data

2.2.1. Meteorological Data

This paper analyzed the year and month data of mean temperature, mean minimum temperature, mean maximum temperature and precipitation from the weather stations of Changzhou during 1952-2011.

2.2.2. Urban Development Data

Urbanization is a subject which refers to study the changes of urban population, architecture and urban land use in a period of time. According to the Changzhou 60 years statistical data, selecting 1952-2011 Changzhou data of total population, GDP, industrial production and arable land as the urban development data and combining with meteorological data, the effects of urbanization on local climate are analyzed.

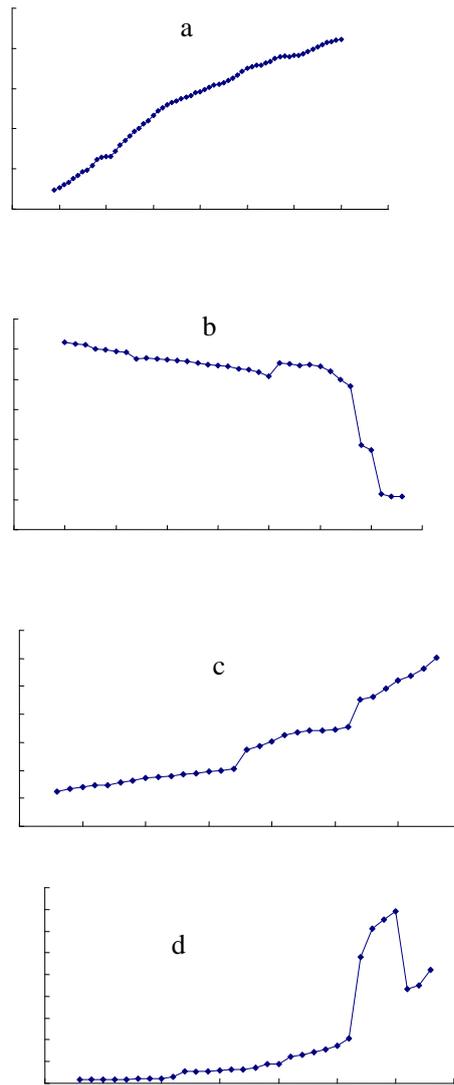
2.3. Methods

The average annual values of various climatic factors are calculated. Using the moving-average method, five-year moving average value is researched. Correlation analysis is performed with SPSS software.

3 Results

3.1. The Process of Urbanization

The process of urbanization in a region is mainly manifested in the local changes of population, economy, buildings and urban land. In the figures it can be observed that the trends of the total population, build-up area and the road area at the end of year are on the rise, while the trend of the arable land at the end of year is on the declining (see Figure 1).



**Figure 1. Annual Variations of Four Urbanization Indexes in Changzhou
(a)Total Population (b)Arable Land at the End of Year (c)Build-up Area
(d)Road Area at the End of Year**

The urbanization level is 16.9% in 1951. After the fluctuation of 30 years, the urbanization level is 17.6% in 1979, and then continues to rise, reaching 74.9% in 2008. The certain differences exist in the pace of the development of urbanization in Changzhou over the past 60 years (see Figure 2).

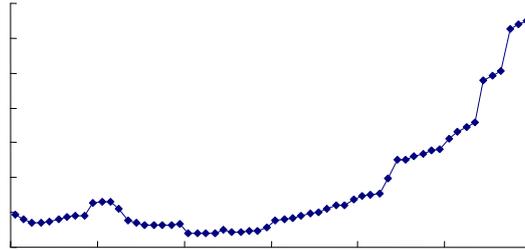


Figure 2. Urbanization Level of Changzhou in the Past 60 Years

3.2. Climate Change

3.2.1. Annual mean precipitation

As can be seen from Figure 3, the variation of the annual mean precipitation in Changzhou is regularly fluctuant. The linear trend equation of the annual average rainfall from the selected data is computed as $y=0.5662x-34.858$.

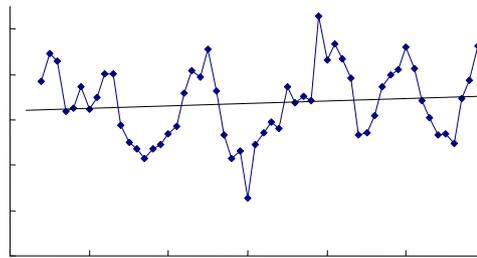


Figure 3. Trends of Annual Mean Precipitation

3.2.2. The Annual Mean Temperature, Min-mean Temperature and Max-mean Temperature

From Figure 4, Figure 5 and Figure 6, it can be observed that there are increasing trends in the time series of the annual mean temperature, min-mean temperature and max-mean temperature. In the 1970s and 1980s the trends of the annual mean temperature, min-mean temperature and max-mean temperature are significant with a declining rate but an increasing rate in the 1990s, while the trends are slight with a decreasing rate in the 2000s. In general, the trends are gradually rising.

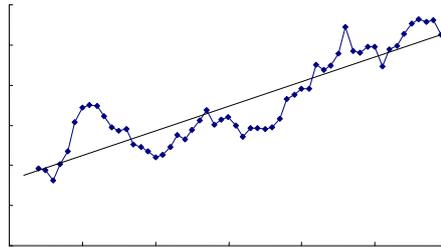


Figure 4 Trends of Annual Mean Air Temperature

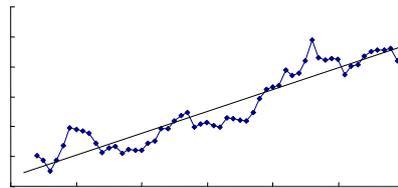


Figure 5. Trends of Annual Min-mean Air Temperature

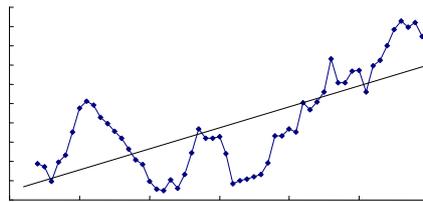
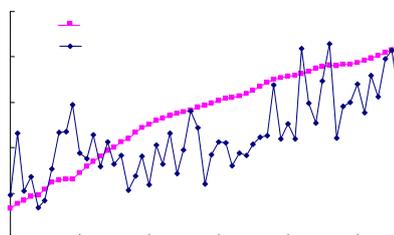


Figure 6. Trends of Annual Max-mean Air Temperature

3.3. The Relationship between Urbanization and Climate Change

Figure 7 demonstrates that the fluctuations of the total population, road area at the end of year and GDP are regular with the mean temperature increasing year by year and tend to become large over time.



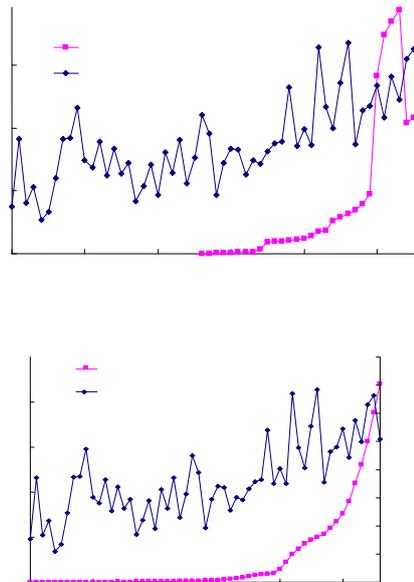


Figure 7. Trends of Annual Change of Mean Air Temperature, Total Population, Road Area at the End of Year and GDP

The differences are highly significant between the total population, GDP and industrial production, arable area at the end of year, build-up area and road area at the end of year and temperature through correlation analysis. The correlation coefficients are 0.670, 0.656, 0.654, -0.593, 0.687 and 0.513, respectively. The specific reasons are analyzed as follows:

(1)The correlation coefficient between temperature and the total population is 0.670. The increase of population contributes to the addition of the consumption of resource and energy and the total economy without any changes, and the correlation with temperature is positive.

(2)The correlation coefficient between temperature and GDP is 0.656 with industrial correlation coefficient of 0.654. Maybe it is because the phenomena that the total economy is increasing and the industrial development will consume more resources result in the addition of emission of heat so that the temperature is rising.

(3)The correlation between temperature and arable area is negative with a correlation coefficient of -0.593. Currently, China is in the developing stages of the process of urbanization and the rapid transformation from agricultural society to industrial society by analyzing reasons. With the development of industry and the expansion of the cities, arable land is occupied continuously. The conversion from arable land to other types of land use will lead to the change of carbon cycle. In addition, the reduction of arable land is actually the result of industrial development, which is consistent with the foregoing analysis.

(4)With the development of urbanization, the scale of cities continues to expand, land cover changes and green land decreases, which will lead to the local warming. The correlation coefficient between temperature and build-up area is 0.687. Thus, urbanization and the expansion of urban will have greater impacts on the temperature.

4. Conclusions and Discussion

According to the analysis of the climatic trends and the urbanization data over the past 60 years in Changzhou, the results show that: the advancement of urbanization brings

about the rising trends of the population in Changzhou, build-up area and road area at the end of year. There are highly significant differences between the total population, GDP, industrial production, arable area, buildings area and road area at the end of year and temperature. The effects of the rapid development and advancement of urbanization on local climate change are great. In order to protect our increasingly fragile environment, the impact of human activities on the environment needs to be minimized while developing economy such as strictly controlling the emission of greenhouse gas, saving energy, speeding up the industrial transformation and promotion and adopting lower energy consumption and high-tech industrial development. This can realize the sustainable development and the harmony between man and nature.

Acknowledgments

This work is supported by the Dynamic mechanism of desertification in response to climate change in Qinghai Lake (41375160), evaluation of solar energy resources and the related studies of efficiency and effectiveness of photovoltaic (1213013) and effect of urbanization on climate change—a case study of Yangtze River delta (2010JDXM027). Prof. Wenzheng Yu is the corresponding author.

References

- [1] JIANG Zhihong, TANG Zhenfei. Urbanization effects on precipitation over the Yangtze River Delta based on CMORPH data. *The Meteorological Science*, 2011, 31(4):355-364.
- [2] WEI Hong, YU Di, ZHENG Hongxiang. “Impact of Urban Development on the Local Climate in Nanchang” [J]. *Journal of Nanchang Hangkong University (Natural Science Edition)*, 2008(4):53-59.
- [3] JI Zhonghui, GUO Yongfang, ZHA Liangsong. Comparison about impact of Urbanization on Urban Temperature in the downstream of the Yangtze River—a case study of Anqing, Wuhu and Nanjing [J]. *Resources and Environment in the Yangtze River*, 2011, 20(5):559-565.
- [4] YIN Jian, LIANG Shanshan. “Influence of Urbanization on Regional Precipitation in Shanghai” [J]. *Journal of China Hydrology*, 2010, 30(2):66-72, 58.
- [5] CHE Huizheng, ZHANG Xiaoye, LI Yang, et al. Effect of urbanization on local climate in Xi’an City in recent 50 years [J]. *Arid Land Geography*, 2006, 29(1):53-58.
- [6] HUANG Zongchu, ZHENG Xiangmn, CAO Xiqiang. “Impact on Ecological Environment of Agricultural Industry of Changzhou and Administration Countermeasure” [J]. *Yunnan Geographic Environment Research*, 2004, 16(3):42-46.

Authors



Yu Wenzheng, male, Ph.D. and professor, mainly engaged in climate change, the evolution of regional environment and the sustainable utilization of resources (including land and climate resources). E-mail: ywzheng519@126.com



Chen Tianliang, male, master candidate, mainly engaged in effect of urbanization on climate change. E-mail: g1z217@163.com



Qi Yingxiang, female, master of China University of Political science and Law, associate professor, mainly engaged in the research about policy of resources and environment.



Shao Li, male, master candidate, mainly engaged in effect of urbanization on climate change. E-mail: shaoli20081317@163.com

Zhu Hongxia, female, lecturer, mainly engaged in the research about climate change.
E-mail: yqzhx@nuist.edu.cn