

## Accepted Manuscript

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PII: S2210-6707(17)31407-5  
DOI: <https://doi.org/10.1016/j.scs.2018.01.033>  
Reference: SCS 946

To appear in:

Received date: 23-10-2017  
Revised date: 17-1-2018  
Accepted date: 17-1-2018

Please cite this article as: Li, Guodong., Zhang, Xi., Mirzaei, Parham A., Zhang, Junhua., & Zhao, Zisheng., Urban heat island effect of a typical valley city in China: Responds to the global warming and rapid urbanization. *Sustainable Cities and Society* <https://doi.org/10.1016/j.scs.2018.01.033>

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# Urban heat island effect of a typical valley city in China: Responds to the global warming and rapid urbanization

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## Highlights

- 1) UHI characteristics of typical valley city are significant and unique.
- 2) Simultaneous observation experiments between urban and rural areas are conducted.
- 3) There are significant mutation and multi-period oscillation in temperature variation.
- 4) Contribution rate of UHI effect on the regional temperature variation is 57.3%.
- 5) There is considerable correlation between comprehensive urbanization index and UHI.

**ABSTRACT:** Global warming and rapid urbanization has significantly resulted in exacerbation of the urban heat island (UHI). However, most of the previous studies neglected the impact of terrain background on the UHI effect. Lanzhou city, the second largest city of Northwest China, is chosen as the case study, the typical valley terrain, fast urbanization and serious atmospheric pollution have caused unique urban climate characteristics. Based on the observational experiments between urban and rural areas, the meteorological data of four weather stations in past 60 years, economic and social development statistical data, trends of the regional temperature and UHI characteristics in different time-scales are analyzed. Then, the contribution of the urbanization effect on the urban air temperature alteration is evaluated, and finally a potential relation between the urbanization and the UHI are examined. Results show that the temperature of Lanzhou demonstrates a rising trend in the wave curve during the past 60 years. Based on Mann-Kendall analysis, an unusual change in the annual temperature is found in 1993. There are quasi-periodic variations on the time scales of seven years in the annual mean and maximum temperature series. Furthermore, it is found that the UHI effect of Lanzhou increases year by year, especially after 1980s. The UHI intensity shows a large seasonal dependence, being strongest in winter ( $0.43^{\circ}\text{C}/10\text{a}$ ), and weakest in spring ( $0.17^{\circ}\text{C}/10\text{a}$ ). And, daily UHI intensity analyses also present the characteristics to be strong during a night and weak during a day; the difference between the maximum and minimum UHI is biggest in summers. In general, the contribution rate of the UHI effect to regional temperature is 57.3%. Eventually, Principal Component Analysis (PCA) method is used to extract the first principal component of nine urbanization indices, and construct a comprehensive urbanization index. The cubic fit regression model between the UHI

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