

Effects of Different Land Use Types on Surface Temperature in the Northwest Arid Zone

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ABSTRACT

This study analyzed the spatial and temporal characteristics of surface temperature in Uttarakhand Banner, and explored the correlation between land use types and surface temperature. The results show that the surface temperature of Urumqi Banner is greatly influenced by the change of land use types, and the difference of surface temperature between different land use types is obvious; the spatial and temporal trend of surface temperature in Urumqi Banner is different from the trend of gradual warming of the global climate change, which is mainly due to the change of the land use types by human activities.

KEYWORDS

Wutian Banner; surface temperature; land use type.

1. INTRODUCTION

Land surface temperature (LST) is an important parameter for the study of surface ecosystems and plays an important role in the process of energy exchange between the surface and the atmosphere [1-2]. Accurate estimation of surface temperature helps to assess regional hydrology and energy balance, heat flux and soil moisture as well as to understand the long-term dynamics of global climate change, and has been widely used in many research directions, such as urban heat island effect [3-5], ecological environment evaluation [6-7], climate change [8], and vegetation monitoring. In recent years, global biodiversity, ecosystems and their services have undergone significant changes due to global warming and a variety of anthropogenic activities [and the quality of the ecological environment in arid and semi-arid zones has also fluctuated. Surface temperature, as an important surface parameter for evaluating ecological environment quality, has become a research hotspot for scholars at home and abroad.

The rapid development of remote sensing technology and the wide application of satellite data provide a rich data source for obtaining large-scale surface temperature. At present, for different remote sensing thermal infrared data, scholars at home and abroad have proposed surface temperature remote sensing algorithms such as single-window algorithm, split-window algorithm, etc., and obtained high-precision research results in urban areas at small and medium scale levels. The emergence of surface temperature data products has led to further development of surface temperature research based on remotely sensed data, and the accuracy of surface temperature inversion reaches within 1K under the conditions of clear weather and known emissivity, which is widely used in analyzing the urban heat island effect and spatial-temporal variations of surface temperatures in large-

scale regions. At present, the research progress of surface temperature has achieved some results, but there are still problems that need to be continued in-depth research: the time span of surface temperature spatio-temporal variation research is relatively short, and the research time lacks coherence; the research area is mainly concentrated in the economically developed areas and mountainous regions in eastern China, and there are fewer researches in arid and semi-arid regions of northwestern China. In this study, Uttarakhand Banner is taken as an example, which has an arid climate and a fragile ecological environment, and the land cover of Uttarakhand Banner has changed dramatically as a result of the influence of national policies and anthropogenic activities. The continuous monitoring of surface temperature can provide theoretical support for the rational utilization of water resources and the restoration of ecological environment in Uttarakhand Banner. Therefore, this paper explores the connection between surface temperature and land use types based on MODIS surface temperature and remote sensing monitoring data of land use types in China from 2000 to 2019, with a view to providing scientific references for environmental monitoring and ecological planning in Uttarakhand.

2. OVERVIEW OF THE STUDY AREA AND RESEARCH METHODOLOGY

2.1. Overview of the study area

Wutian Banner, a flag under the jurisdiction of Ordos City, Inner Mongolia Autonomous Region, is located in the western part of Inner Mongolia Autonomous Region and the southwestern part of Ordos City, in the belly of the Maowusu Desert, with an extreme continental climate in the temperate zone. Wutian Banner is in the transition zone between arid and semi-arid, which is the transition zone of desert grassland-steppe-forest-steppe in China, and the ecological environment is very fragile. Its climate is arid with little rainfall and uneven distribution, and the rainfall is mostly concentrated in the months of June-August, and the annual rainfall is between 250 and 440 mm, increasing from west to southeast. The precipitation ranges from 250 to 440 mm, increasing from west to south-east.

2.2. Data source and pre-processing

The data used in this study are MODIS surface temperature products, which are derived from the monthly synthesized MOSLT1M China 1KM surface temperature products from 2000-2015 provided by the Geospatial Data Cloud (<http://www.gscloud.cn/>); the 2000-2015 monthly and annual scales of Uttarakhand Banner are obtained by splicing and cropping. 2019 monthly-scale and annual-scale surface temperature data.

The land use/cover raster data were provided by the Resource and Environment Science Data Center of the Chinese Academy of Sciences (<http://www.resdc.cn/>). This database is supported by many major scientific and technological projects, such as the National Science and Technology Support Program and the Knowledge Innovation Project of the Chinese Academy of Sciences, and the data production and production are based on the Landsat series of satellite data as the data source, which is completed by image classification and manual visual interpretation [21]. In this study, five periods of land use/cover data in 2000, 2005, 2010, 2015 and 2018 were used, with a spatial resolution of 1 km, and the land use types included six level 1 types of cropland, forest land, grassland, watershed, construction land and unutilized land.

3. RESULTS AND ANALYSIS

Table 1. Average LST of different land use types in Wushen Banner

| LST/°C | 2000 | 2005 | 2010 | 2015 | 2019 | Average |
|-------------------|-------|-------|-------|-------|-------|---------|
| Cropland | 32.18 | 32.20 | 30.33 | 29.94 | 30.29 | 30.99 |
| Woodland | 33.80 | 33.52 | 31.88 | 31.57 | 31.87 | 32.53 |
| Grassland | 32.43 | 32.08 | 30.50 | 30.08 | 31.46 | 31.31 |
| Water | 30.60 | 29.69 | 29.41 | 28.66 | 30.45 | 29.76 |
| Construction Land | 34.19 | 34.21 | 32.47 | 32.32 | 33.05 | 33.25 |
| Unutilized land | 34.45 | 33.99 | 32.56 | 32.10 | 32.90 | 33.20 |

The surface temperatures of different land use types in Uttarakhand Banner from 2000 to 2019 were statistically analyzed using stacked analysis (Table 1), from which it can be seen that the differences in surface temperatures of different land use types are obvious, and the construction land and unused land are the two land types with the highest surface temperatures in the study area, which are 33.25 °C and 33.20 °C, respectively, followed by the woodland and grassland, which have the surface temperatures were 32.53 °C and 31.31 °C, respectively, and the lowest surface temperatures were found in cropland and waters, which were 30.99 °C and 29.76 °C, respectively. In the area of cultivated land and water bodies, water resources were more abundant, and the higher evapotranspiration absorbed part of the solar radiation energy, so the surface temperature was lower. The surface of construction land and unutilized land is not covered by vegetation, and the surface temperature rises faster under the action of solar radiation. The average surface temperature of all land use types showed a trend of decreasing and then increasing, and kept decreasing year by year during 2000-2015, which was related to the national policy of Uttarakhand, from 1999 to 2010, the state implemented the project of returning farmland to forest and grassland, which effectively stopped the process of desertification and increased the vegetation in the study area Coverage, so that the quality of ecological environment in Uttarakhand Banner has been significantly improved; surface temperature in 2015-2019 and rebounded, related to the global climate continues to warm.

4. CONCLUSION

Through processing, analyzing and statistics of MODIS data and Chinese land use remote sensing monitoring data, the connection between surface temperature and land use type was explored. The following conclusion was obtained: there is a certain correlation between surface temperature and land use type in Uttarakhand. Influenced by the change of land use types, the surface temperature of different land use types has obvious differences, and the surface temperature of construction land and unutilized land is the highest, followed by grassland and forest land, and lastly, cultivated land and waters. The spatial and temporal trends of surface temperature change in Uttarakhand are different from the trend of gradual warming of global climate change, which is mainly due to the change of land use types by human activities. This shows that the spatial and temporal changes in surface temperature in Uttarakhand are the result of the combined effects of human activities and climate change, and that human activities are dominant.

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