Monitoring the Seasonal Spatiotemporal Changes in the Land Surface Thermal Environment with Dynamics of Land Use and Land Cover Changes in Harare City, Zimbabwe

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Abstract

Abstract: This study investigates the thermal behavior of hot and cool seasons together with seasonal changes in land use and land cover (LULC) in the Harare Metropolitan Province (HMP) in Zimbabwe by using Landsat data. Although the effects of biophysical and meteoro-logical factors on land surface temperature (LST) have been well studied in previous research, less attention has been paid to examining seasonal divergence along with LULC in the HMP. In order to fill this vacuum, this study aims to monitor the seasonal changes in the land surface thermal environment (LSTE) along with the dynamics of LULC. A 20 × 20 km geographical grid was selected as the study area with a 10 km radius from the city center covering 40000 ha. The analysis was based on both radiometric-calibrated and atmospheric-corrected Landsat Level 2 data sets provided by the United States Geological Survey (USGS). In the methodology, both the hot (from mid-September to mid-November) and cool (from mid-May to mid-September) seasons of 2005 and 2019 were selected as two investigation time points. Then, emissivity corrected LST for both hot and cool seasons in each year were calculated, and LULC classification at the same time points was also done by the random forest (RF) method. Finally, LST intensity by season (Hot – Cool) was calculated, and descriptive statistical information was derived. In the results, the mean LST was 23.15 °C, 28.75 °C, 25.32 °C, and 32.28 °C in 2005-cool, 2005-hot, 2019-cool, and 2019-hot, respectively. The highest proportion of LULC was dominated by residential area (RA) at both time points, and it was observed as 43.2% in 2005 and 58.4% in 2019 with light improvement. The diminution of LULC was observed from bare lands (BL), green spaces (GS), and croplands (CL). Significant deterioration was examined from BL while second was reported by GS. Inter-seasonal changes in LULC were observed from both BL and GS at both time points. Because of growing small plants in a favorable climatic environment, the BL declined in the cool season, while GS was also inclined during the same season primarily observed. This scenario influences the dynamics of LST among the seasons, and it has been proven by the intensity calculation. The highest intensity was observed from BL at both time points; it was 5.8 °C in 2005 and 7.5°C in 2019. The discussion has been made by concentrating on the behavior of seasonal changes of LST and the

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influences of LULC on its dynamic variation in each season. This study identified significant challenges for urban planners and respective administrative bodies to mitigate and control the negative effect of LST on the long livability of HMP. The constructed model can be applied to any geographical area by calibrating the necessary data.

Keywords: LST; LULC changes; LST intensity; Seasonal changes; Harare City