An Urban Heat Island Mitigation Based on Analyses of Green Space and Land Surface Temperature in Jakarta, Indonesia

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1. INTRODUCTION

Urban heat island (UHI) phenomenon is considered as one of the major problems found in cities throughout the world. Urban areas tend to experience relatively higher temperatures compared to the surrounding suburban or rural areas due to the relatively high thermal absorption. Therefore, one of the most common UHI mitigations is the development of green space. Green space represents a fundamental component in urban ecosystems and offers significant potential for moderating UHI through the reduction of land surface temperature (LST). Several researches have conducted the cooling effect of green space, however, researches on the cooling effect of different shapes of green space or land cover fraction has been merely focused. Taken Jakarta province as a case study, this research aimed at; (1) to quantify the impact of land cover fraction on land surface temperature (LST); (2) to quantify the vegetation cover in green spaces zone defined by the spatial plan 2011-2030 of Jakarta; and (3) to quantify the cooling effect of green spaces found in areas with higher LST than the average.

2. MATERIALS AND METHODS

Land cover fractions of vegetation, impervious, and soil were modeled by linear spectral mixture analysis using Sentinel-2 image. Meanwhile, the LST was estimated based on the thermal band of Landsat 8 OLI/TIRS (band 10). The relationship between land cover fractions and LST distribution was quantified by linear regression analysis. The estimated vegetation covers were compared with the green space zone of spatial plan 2011-2030 of Jakarta to quantify the area of vegetation covers inside the green space zone. Finally, the cooling effect of five green spaces that consisted of polygonal and linear shape, were analyzed by regression analysis between zonal mean LST and the distance from green spaces.

3. RESULTS AND DISCUSSION

Land cover fractions in Jakarta consisted of 69% of impervious surfaces; 22.9% of vegetation and 5.85% of soil. Further analysis showed that the vegetation cover fraction in the green space zone of spatial planning was only 40.74% (3666.47 ha). It means that most of the area within the zone was impervious surfaces or soil. Therefore, there is a chance to improve the quality of the green space by increasing the vegetation cover fraction inside the zone. The result indicated that increased vegetation cover fraction would reduce the LST. A negative relationship was found between vegetation cover fractions and LST. On the contrary, a positive relationship was found between impervious surface fractions and LST. Regarding the shape, polygonal types of green space showed a more effective cooling effect compared to the linear type. The cooling effect of green space is found such that a positive relationship between the logarithmic distance from green space and land surface temperature.

4. CONCLUSION

Developing a large green space to mitigate the UHI in a large city such as Jakarta is difficult because of land availability. The case study of Jakarta suggests that LST can be reduced by increasing the vegetation cover fraction especially in areas that have been designated as green space zones in the spatial plan. Developing polygonal green space with a high fraction of vegetation can effectively reduce LST. This study also suggests that the cooling effect of a green space diminishes as being farther away from the green space. Therefore, the distribution of green space should be designed evenly.