Examining the relationship between tree removal and land surface temperature change in Austin, Texas

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Introduction

Across the United States, cities are losing urban forests to rapid urbanization and are experiencing an increase in impervious surface cover. Between the years 2009 and 2014, tree canopy cover decreased from 40.4% to 39.4%, while impervious surface cover increased from 25.6% to 26.6% (Nowak and Greenfield 2018). At the same time, United States urban areas have experienced some of the hottest years on record, and temperatures are only predicted to rise (Smith et al., 2013; Wobus et al., 2018). This rise in temperature coupled with the loss of urban forests contributes to a decline in benefits provided by trees. Trees provide a range of ecosystem services, including flood mitigation, pollutant removal, and microclimate regulation through shade and evapotranspiration (Qin, 2020; Wolf et al., 2020). The presence of trees has been linked to lower land surface temperature (LST) in urban areas, making spaces that are prone to experiencing higher temperatures more comfortable for urban residents (Ziter et al., 2019). Because of this, researchers and practitioners have promoted the preservation of trees across urban landscapes and the incorporation of new trees in urban design plans to combat the increasing urban heat island (UHI) effect. UHI is described as the temperature within an urban area being higher than that of rural areas due mainly to reduced canopy cover and excessive impervious surface cover (Greene & Millward, 2017). Being exposed to excessive heat can have negative side effects such as dehydration, heat stress, heat stroke, and organ damage (Ebi et al. 2021). The risks posed by excessive heat exposure make urban forests important in lowering the LST in urban areas and mitigating the UHI effect, in turn reducing the excessive heat effects caused by climate change by lowering temperatures in urban microclimates. The purpose of this research is to examine the influence of permitted tree removal on urban heat in the city of Austin, Texas.

Research Question

To what extent does tree removal impact LST temperature in the city?

Methods

Austin is the 10th largest city in the United States and has become a hotspot for urban growth due to its ample recreational and economic opportunities. From 2010 to 2020, Austin's population increased by 33.0%, making it one of the fastest growing U.S. cities (Austin Chamber, 2023). We created a geographic information system to analyze tree removals and LST (ESRI ArcGIS Pro, version 3.0). Tree removal data for this study was obtained from the City of Austin's Arborist Program. The available data contains approximately 47,370 tree removals or major modifications and spans the years 2007 to 2020. We used Landsat 8 OLI/TIRS images obtained from the United States Geological Survey (USGS). We calculated Land Surface Emissivity (LSE), Brightness Temperature (BT), and Normalized Difference Vegetation Index (NDVI) using ESRI ArcGIS Pro. We used these indices to calculate the LST for the study area. Next, we divided the study area into 900 m grids. For each grid, we summed the number of tree removals and calculated the minimum, maximum, and mean LST. Next, we combined the gridded layers for tree removals and LST to create a comprehensive bivariate layer, allowing for comparison of tree removals to land surface temperature. Finally, we will exported our dataset for further analysis using IBM SPSS.

Results

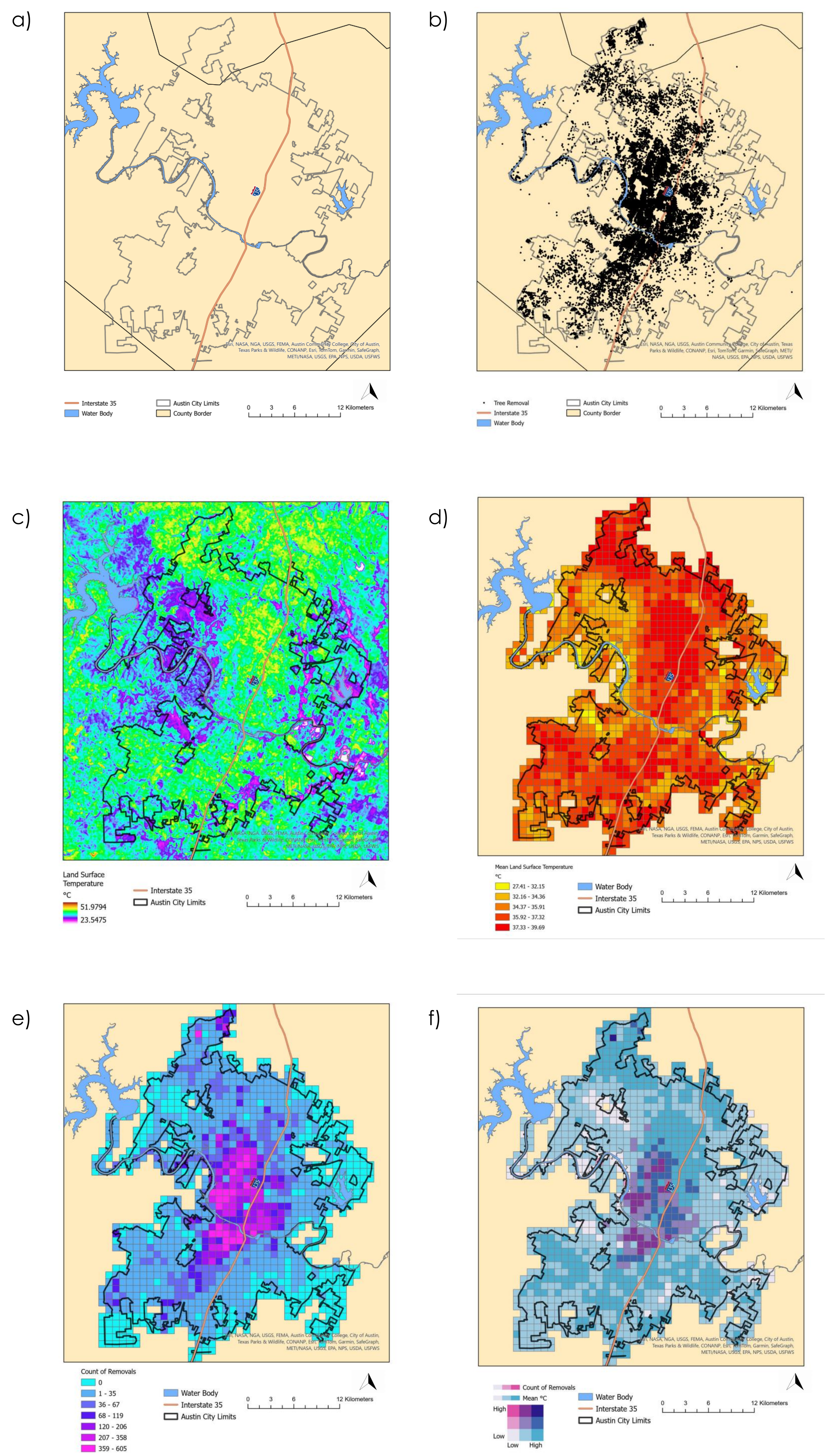

Figure 1. a) Austin city limits b) Austin tree removal points c) Austin LST d) mean LST per 900m grid block e) tree removal count per 900m grid block f) Bivariate color correlation to relate total tree removals to mean LST per 900m grid block

Variable	***Mean***	***Median***	***SD***	***Minimum LST***	***Maximum LST***	***Mean LST***
Minimum LST	32.32	32.46	2.32	--		
Maximum LST	38.91	39.09	1.63	.563**	--	
Mean LST	35.76	36.01	1.86	.812**	.812**	--
No. of Removals	37.85	6	83.24	.260**	.244**	.281**

*** indicates P value <0.001*

Discussion and Conclusions

References

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