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ANALYZING IMPACTS OF LAND COVER CHANGES ON LAND SURFACE TEMPERATURE IN BAY AREA, CALIFORNIA

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KEY WORDS: Land Surface Temperature, NLCD Data, Land Cover Change.

ABSTRACT:

Land Surface Temperature plays a critical role in the land surface-atmosphere exchange processes. In this study, the impacts of land cover changes on land Surface Temperature in bay area, California was analyzed. The key findings of the land cover change impacts study are presented. National Land Cover Database (NLCD) data and Landsat Land Surface Temperature data were used for this study. The time period of analysis is 2001 through 2020. The results of the study indicated that with the increase in built land cover, the land surface temperature in bay area, California exhibited a significant increase.

1. INTRODUCTION

Urbanization and accompanying land cover changes has been observed to have a quantifiable impact on hydrologic cycle components (Hollis,1975; Peterson et al., 1995; Dow and DeWalle, 2000), urban microclimate (Landsberg, 1981), urban energy fluxes (Cleugh and Oke, 1981), energy usage (Akbari et al., 2001), and much more. Land Surface Temperature is an important parameter in the land surface-atmosphere exchange processes (Voogt and Oke, 2003). Relationship between LST and land cover has been explored (Amiri et al.2009; Kayet et al., 2016; Gohain et al; 2021).

In this paper, land cover changes during the period of 2001 through 2019 in bay area, California was analyzed. Further the change in Land Surface Temperature during the time period of 2001 through 2020 was analyzed. The organization of this paper is as follows: Section 2 focuses on the study area, time period of analysis, data used, Section 3 focuses on the methods, Section 4 focuses on the results and discussion, and Section 5 is the conclusion of the paper.

2. STUDY AREA AND DATA

2.1 Study Area

Three bay area counties: Alameda, Contra Costa, and Santa Clara were used for this study. The areal extent of these three counties is 7,586 sq.km. The case study area is shown in Figure 1.
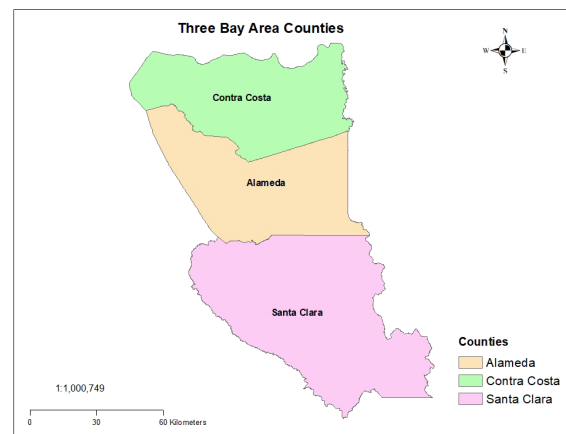

Figure 1. Study Area

2.2 Time Period of Analysis

The time period of analysis for this study was 2001 through 2020.

2.3 Data Used

National Land Cover Database (NLCD) land cover data and Landsat surface temperature data was used for this study. NLCD data was downloaded from the Multi- Resolution Land Characteristics (MRLC) Consortium Website. Landsat surface temperature data was downloaded from the U.S. Geological Survey (USGS) Earth Explorer Website. Landsat Level 2 Collection 2 Surface Temperature data was used for this project.

3. METHODOLOGY

This study consists of two phases. In the first phase, land cover change in the three bay area counties, during the time period of 2001 through 2019 was analyzed. In the second phase of the study, the variation of Land Surface Temperature (LST) during the period of 2001 through 2020, and the variation of LST across various land cover types was analyzed.

For the land cover change analysis phase, NLCD data was downloaded from the MRLC Consortium Website (https://www.mrlc.gov/data) for the following years: 2001, 2004, 2006, 2008, 2011, 2016, and 2019. Further, the land cover data was clipped to the extent of the study area in Esri ArcMap 10.7.

Further, an attribute field for area was added to the NLCD data for each year of study. The area of each land cover class for the clipped NLCD data corresponding to the seven time periods was computed in Esri's ArcMap using the formula as shown in Equation 1:

$$Area = Count * 30 * 30 \qquad (1)$$

where   Area = Area of each land cover class (in square meters)

Count = Number of Pixels in each land class

For the LST analysis phase, Landsat surface temperature data for the time period of 2001 through 2020 was downloaded from the USGS Earth Explorer Web Server. Landsat scenes for June of each year during the period of 2001 through 2020 were analysed. 1-km square grids were generated for the study area in Esri ArcMap. The land cover class in each 1-km grid cell was computed using ArcGIS Spatial Analyst - Zonal Statistics tool. Landsat surface temperature data in scaled Kelvin was converted to Kelvin using the scaling factor of 0.00341802. The mean Land Surface Temperature in each grid cell was computed using ARCGIS Spatial Analyst – Zonal Statistics tool. This process was executed for the 20 Landsat scenes during the time period of 2001 through 2020.
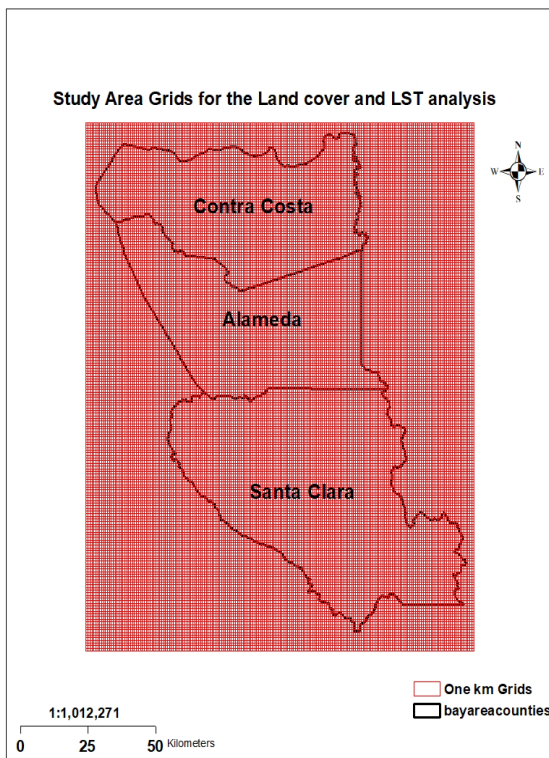

Figure 2. Grids used for the analysis

4. RESULTS AND DISCUSSION

The results of the two phases of analysis are presented in sections 4.1 and 4.2.

4.1 Phase 1 Results

Results of the land cover change analysis phase for the study area indicate a huge increase in the built surfaces and a significant decrease in the green spaces (developed open spaces), barren land, cultivated land cover (cultivated crops and pasture), and the forest land cover classes. The developed, low medium, and high intensity land cover classes which account for the impervious built surfaces has increased by 52% from 2001 through 2019. The percent change in select land cover classes from 2001 through 2019 is shown in Table 1. Red downward triangle symbol indicates a percent decrease in the area of the land cover class, and green upward triangle indicates percent increase in the area of the land cover class.

Land Cover Class	Percent Increase/Decrease
Developed, open space	▼ 16.6
Forest	▼ 25
Barren	▼ 8
Cultivated crops and pasture	▼ 17.52
Developed, low, medium, and high intensity	▲ 52

Table 1. Percent Land Cover Change from 2001 through 2019

4.2 Phase 2 Results

For the LST analysis, the following land cover classes were used: Developed open spaces (green spaces), Developed, low, medium, and high intensity (built land cover), Cultivated crops and Pasture (Cultivated land cover), Barren land cover, and Forest land cover.

The forest land cover class was found to exhibit the lowest value of LST followed by green spaces. The built land cover was found to exhibit the highest value of LST owing to the built surfaces and lack of vegetation. The barren land cover also exhibits a high value of LST owing to lack of vegetation. The values of LST and the variation of LST across the selected land cover classes for the month of June in 2001 and 2020 is shown in Figure 3.
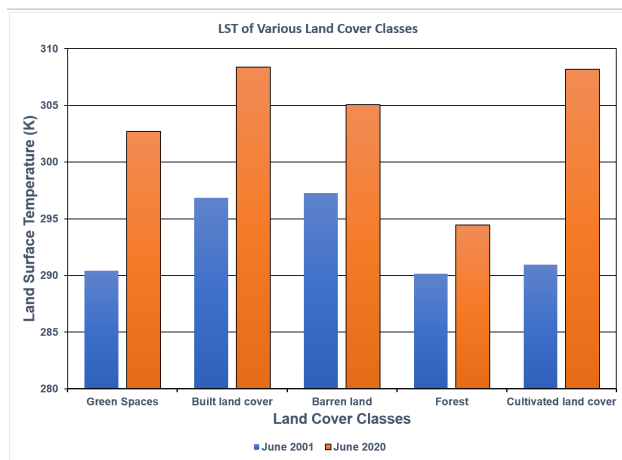
Figure 3. LST Variation across land cover classes

Further, the LST values of the selected land cover classes in 2001 and 2020 were analysed to assess the change in LST. Results of this analysis indicate an increase in LST in all the selected land cover classes. The percent increase varied anywhere from 1.5 to 6. The percent increase in LST is shown in Table 2.

Land Cover Class	Percent Increase
Green Spaces	▲ 4.23
Forest	▲ 1.47
Barren	▲ 2.62
Cultivated land cover	▲ 5.92
Built land cover	▲ 3.88

Table 2. Percent Increase in LST from 2001 through 2020

5.   CONCLUSION

The results of the study indicate that the impervious built land cover has increased by more than 50% in the past 20 years in bay area. The land surface temperature was found to vary significantly across the land cover classes. Also, the land surface temperature in all the land cover classes was observed to have increased during the period of 2001 through 2020. Future studies will extend to analyzing the relationship between LST and vegetation indices.

REFERENCES

Akbari, H., Pomerantz, M., and Taha, H., 2001. Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. *Solar Energy*, 70(3), 295-310.

Amiri, R., Weng, Q., Alimohammadi, A. and Alavipanah, S.K., 2009. Spatial–temporal dynamics of land surface temperature in relation to fractional vegetation cover and land use/cover in the Tabriz urban area, Iran. *Remote sensing of environment,* 113(12), pp.2606-2617.

Dow, C.L., and DeWalle, D.R., 2000. Trends in evaporation and Bowen ratio on urbanizing watersheds in eastern United States. *Water Resources Research*, 36(7), 1835-1843.

Gohain, K.J., Mohammad, P. and Goswami, A., 2021. Assessing the impact of land use land cover changes on land surface temperature over Pune city, India. *Quaternary International,* 575, pp.259-269.

Kayet, N., Pathak, K., Chakrabarty, A. and Sahoo, S., 2016. Spatial impact of land use/land cover change on surface temperature distribution in Saranda Forest, Jharkhand. *Modeling earth systems and environment,* 2(3), pp.1-10.

Landsberg, H., 1981. *The Urban Climate*. Academic Press, New York.

Oke, T.R., 1987. *Boundary layer climates*. Routledge, London.

Peterson, T.C., Golubev, V.S., and Groisman, P.Y., 1995. Evaporation losing its strength. *Nature*, 377(6551), 687-688.

Voogt, J. A., and Oke, T. R., 2003. Thermal remote sensing of urban climates. *Remote sensing of environment*, 86(3), 370-384.