Using Thermal Remote Sensing to Quantify the Impact of Traffic on Urban Heat Islands during COVID

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Introduction

In 2019, a novel coronavirus was identified as the etiological agent with human-to-human transmission of the virus (SARS-CoV-2). Social distancing and public interventions were imposed to control the epidemic, including a three-month lockdown in the U.S. at the beginning of the outbreak in 2020. During that lockdown, traffic volume greatly reduced in most large cities, especially bigger metropolitan areas such as the San Francisco Bay Area. Research and case studies have shown that lockdowns were generally effective at reducing the spread of COVID-19 and flattening the curve. Significantly, this lockdown also provided a unique opportunity to quantify the impact of transportation on urban climate change by studying heat intensity in the Bay Area urban heat island.

Study Methods

This research explores the impact of transportation on climate change by using remote sensing technology and statistical analysis during the COVID-19 lockdown. The research team used thermal satellite data that measures the intensity of the urban heat island of the Bay Area, the main driver for climate change during the urbanization process. An urban heat island (UHI) is a phenomenon where the metropolitan area has a temperature significantly higher (from 2 to 11°C) than surrounding rural areas. We acquired morning and afternoon MODIS data in the same periods in 2019 before the pandemic and 2020 during the pandemic. Also, we derived in situ meteorological data to build urban surface energy budgets and construct statistical models between net radiation and both extent and intensity of heat dynamics. We built a multi-variable regression model based on the UHI intensity from remote sensing LST data and solar radiation data during 2019 and 2020 with the COVID-19 lockdown. The lockdown was included as a dummy variable in the statistical model to evaluate traffic reduction on the UHI intensity quantitatively. During the COVID-19 lockdown in 2020, the traffic volume was regulated and reduced by 30–50% according to the UC Berkeley TIMS traffic dataset. Statistical models have been constructed using a dummy variable to indicate the COVID-19 lockdown. We implement this urban heat budget in six counties in Northern California.

Use thermal remote sensing to quantify the traffic impact on the climate change take advantage of COVID-19 Lockdown in Northern California.

Findings

The analysis results suggest that the decrease in urban traffic volume can significantly reduce the intensity of the UHI. The afternoon group has a greater decreased temperature and a larger decreased extent than the morning group. When the traffic volume was cut by the COVID 19 lockdown, the UHI intensity was reduced by an average of 1.52°C and 2.54°C for the morning and afternoon, respectively. The reduction in UHI intensity through the implementation of the COVID 19 lockdown is more effective in the East Bay than in the western peninsula area. The South Bay shows a contrary pattern for LST reduction.

Policy/Practice Recommendations

Despite the global scale warming caused by greenhouse gases, the human impact on climate on a local and regional scale is much more significant. The COVID-19 lockdown has provided a unique opportunity to quantify the impact of transportation on urban climate change, as transportation accounts for the largest share of the greenhouse emissions (28.9%) according to statistics from the US Environmental Protection Agency. Taking advantage of the twice-daily surface temperature measurements and ground meteorology measurements, we retrieved the urban surface energy budget and construct statistical models between net radiation and both extent and intensity of heat dynamics. The quantitative results obtained in this study provide critical information for analyses of climate change on a global scale.

About the Authors

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