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Examining the Externalities of Highway Capacity Expansions in California: An Analysis of Land Use and Land Cover (LULC) Using Remote Sensing Technology

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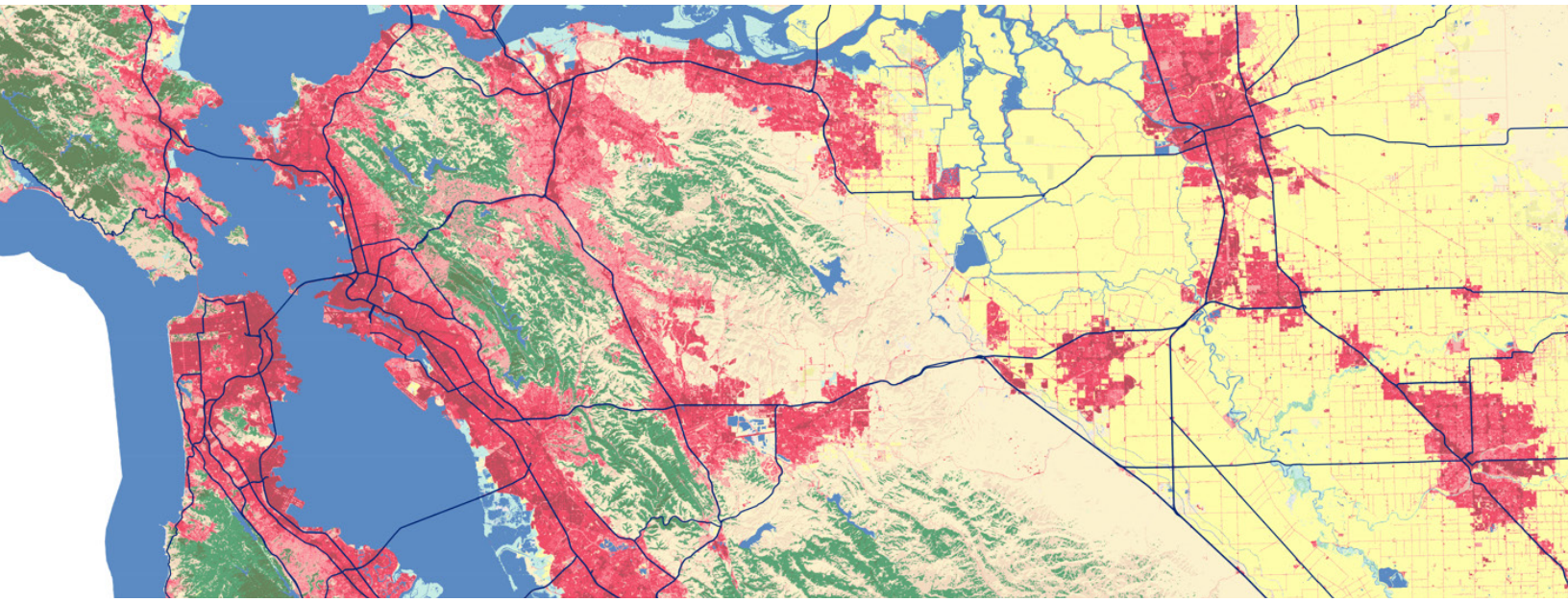

Introduction

Reducing Vehicle Miles Traveled (VMT) is at the center of climate planning efforts in California. Yet, VMT impact mitigation presents an incomplete picture of the negative externalities of highway expansion. Most importantly, constructing additional highway lanes has wide impacts on land use and land cover (LULC). The significant and far reaching environmental impacts of LULC change are often not fully captured through the current environmental review processes. This oversight can lead to overestimating the benefits of these projects at the expense of potential habitat or vegetation loss.

Access to satellite remote sensing data can help us better understand and examine the broader LULC impacts of highway capacity expansions and develop new methods and metrics for environmental impact assessment. The goal of this research was to explore the use of satellite remote sensing data to help modernize and expedite current environmental review practices for transportation infrastructure projects.

Study Methods

The research methods involve two phases: (1) an analysis of the relevant literature and current practices of environmental review for highway projects; and (2) a geospatial analysis examining land cover changes—measured through Normalized Difference Vegetation Index (NDVI) data and directly associated with highway expansion—in California, as well as the relationship between land use and the vegetation impacts of highway projects using satellite remote sensing data.

To determine if NDVI can be used as an indicator for environmental review, the research team first conducted a literature review and a review of current environmental review practices. The second phase of the research involved gathering NDVI data surrounding over nineteen highway expansion project sites in California. To analyze the impacts of these highway expansion projects on surrounding NDVI values, we implemented one-, two-, and three-kilometer buffers and collected NDVI data using Google Earth Engine for a year leading up to the project's conclusion and

a year following the construction's completion date. We then calculated statistics of the findings for three buffer zones and mapped the results using ArcGIS Pro to determine if there was a significant correlation in the changes observed in the NDVI values.

Findings

The results of the literature review and geospatial analysis of the highway expansion projects provided new insights into the potential benefits of using NDVI for environmental review processes. The study offered several key findings. First, the patterns of the impacts of highway expansion on changes in NDVI are diverse, indicating that the environmental context of the project plays a significant role in determining the extent of the impact. For example, sites located near less-developed areas with more extensive vegetation (e.g., sprawled areas or exurbs) show larger changes in NDVI values. Conversely, sites located in urban areas or otherwise near large expanses of bare, non vegetated earth exhibit insignificant vegetation impacts. Also, NDVI values near cropland/farmland were not necessarily impacted by highway expansion because these areas are not covered by naturally growing vegetation, but rather artificially maintained crops, and are therefore less affected by external environmental factors. Lastly, project sites that experienced multiple types of construction/renovation (e.g., adding more lanes, widening sections, bridge renovation, etc.) were more likely to exhibit decreasing NDVI values compared to project sites that only experienced one type of construction. This suggests that aside from project types, the number and combination of projects are important in determining the significance of environmental impacts.

These findings provide significant evidence of the benefits of using wall-to-wall remote sensing data sources such as NDVI to comprehensively measure the impacts of transportation infrastructure development. While current environmental review practices do account for changes in land use, they only account for land use changes that are directly attributed to the project and do not fully cover land use and land cover changes that can be anticipated over time.

Policy/Practice Recommendations

- Decisions about highway construction and capacity expansion should consider the full environmental impacts, including land use and land cover changes over time.
- New guidelines should further emphasize the importance of context in the environmental review processes and infrastructure decision making.
- Using remote sensing technology and new sources of big data can inform the environmental review processes and decision making about infrastructure projects.

About the Authors

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To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/2251

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