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Research Results

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Project Title:
Environmental Impact Evaluation Using Sparse Mobile Data

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Environmental Impact Evaluation Using Sparse Mobile Data

This research develops a traffic-related air pollution evaluation system based on sparse mobile crowd-sourced data and traffic volume data

WHAT IS THE NEED?

Traffic congestion at arterial intersections and freeway bottlenecks degrades the air quality and threatens the public health. In California where pollution levels have been regulated for decades, there is still a surprisingly high level of morbidity and mortality attributable to dangerous particles from vehicle emissions. Conventionally, the air pollutant concentration is monitored by fixed-site quality assurance air monitoring stations. However, these stations are usually sparsely distributed and work on the average air quality of a certain region. Under the deteriorating situation of traffic congestion and air pollution today, there is a strong need to develop a high-resolution vehicle emission and dispersion monitoring and visualization system.

WHAT WAS OUR GOAL?

This research establishes a framework to evaluate the environmental impact of traffic congestion for both arterials and freeways using sparse mobile data and traffic volume data from fixed location sensors. The proposed emission and dispersion system will provide suggestions to the transportation operator and public health officials to alleviate the risk of air pollutants.

WHAT DID WE DO?

We first estimate the traffic state, e.g., link average speed and traffic volume, using both sparse crowd-sourced mobile data and fixed location sensing and survey data. To tackle the low frequency problem of mobile data, the previously developed stochastic arterial trajectory estimation model is extended to freeways. Unique features of freeway driving modal activity are also considered. In response to the low penetration problem, we fuse the sparse mobile data with PeMS and LADOT traffic count data, which provide reliable real-world traffic volume information. The traffic state information for certain time intervals (e.g., peak hours) are applied to EMFAC model to estimate vehicular emissions. For freeways, traffic volume and truck ratio records collected from PeMS are also incorporated to the model to tackle the data sparsity problem. For arterials, the traffic volume information is acquired from either historical manual count or flow estimation methods. The traffic-related emissions of each air pollutant type are applied to AERMOD to estimate the air pollutant concertation estimation. The results are visualized in the concertation contour map in ArcMap.

WHAT WAS THE OUTCOME?

The proposed methods have good performance in estimating monthly peak hour fine particulate matter (PM 2.5) concentration, with error of 2 ug/m3 from the measurement from monitor sites. The estimated spatial distribution of annual PM 2.5 concentration also matches well with the concentration map from CalEnviroScreen, but with higher resolution to clearly show the significant air pollution around congested arterials and freeway bottlenecks. Future directions include: 1) explore more updated and reliable mobile crowd-sourcing database; 2) localize the air pollutant concentration down to each community, and investigate its livability by incorporating other pollution factors; 3) improve the computational efficiency in estimation and visualization.

WHAT IS THE BENEFIT?

The proposed system will help transportation operators and public health officials monitor and alleviate the risk of air pollution. It could serve as an essential supplement of sparsely-distributed Quality Assurance Air Monitoring Stations. It provides an effective method to measure the livability of a transportation system, in term of localized emissions and environmental justice. This research will also provide a platform for other applications, such as eco-routing application which help reduce the driver and pedestrian's exposure to air pollution, and connected vehicle based eco-signal timing.

LEARN MORE

Review the complete report.

https://ncst.ucdavis.edu/project/evaluating-environmental-impact-of-traffic-congestion-in-real-time-based-on-sparse-mobile-crowd-sourced-data/

IMAGES