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Project Title:

Biking in Fresh Air: Consideration of Exposure to Traffic-Related Air Pollution in Bicycle Route Planning

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Task Manager:

Scott Williams,
Associate Transportation Planner
k_scott_williams@dot.ca.gov

Consideration of Air Pollution Exposure in Bicycle Route Planning

Development of a bicycle route planning tool that considers exposure to air pollution

WHAT WAS THE NEED?

Active transportation modes such as walking, and biking are key elements of sustainable transportation systems. In order to promote biking as an alternative form of transportation, a holistic approach to improving the quality of biking experience is needed. Local, regional, and state agencies in California are making efforts to increase bicycle infrastructure in the State in order to promote sustainable and multi-modal transportation. In most areas, bicycle routes are a subset of vehicle routes and new bicycle infrastructure is created by adding bicycle lane(s) to existing rights-of-way. The planning of bicycle routes typically takes into consideration available right-of-way, existing roadway infrastructure, vehicular traffic volume, safety concern, and built environment, among others. Exposure to traffic-related air pollution, on the other hand, is rarely considered in route planning, despite bicyclists being vulnerable to the harmful air pollution due to their direct exposure to vehicular exhaust and increased breathing rate during biking. Traffic volume alone is not a sufficient surrogate for the level of air pollution on the road, though; it also depends on traffic speed, fleet mix, meteorology condition (e.g., wind speed and wind direction), and terrain.

WHAT WAS OUR GOAL?

The goal of this research was to incorporate reduced exposure to traffic-related air pollution as another consideration in improving the quality of the biking experience. Specific objectives of this research included: 1) creating a streamlined process for estimating the level of near-road air pollution concentration; 2) developing a novel bicycle route planning tool that allows planners and engineers to compare the exposure of bicyclists to traffic-related air pollution among different bicycle routes; and 3) demonstrating the method for considering bicyclists' exposure



DRISI provides solutions and knowledge that improves California's transportation system

to traffic-related air pollution in bicycle route planning.

WHAT DID WE DO?

Current air quality measurement data are not available at the spatial resolution necessary for the planning of bicycle routes. In this research, high-resolution traffic-related air pollution concentrations were estimated through a modeling process that involves traffic activity, traffic emission, and air pollutant dispersion modeling. The modeling process was applied to estimate traffic-related primary fine particle (PM_{2.5}) concentrations in the City of Riverside, California, for traffic volumes in calendar year 2017 based on a total of 36 hourly average meteorological conditions consisting of three time periods of day (morning, midday, and afternoon) for the 12 months in calendar year 2012. The 36 sets of estimated PM_{2.5} concentration values were then weighted by the level of bicycle activities by time period of day and by month of year derived from the GPS dataset in the 2010-12 California Household Travel Survey. This resulted in a weighted average PM_{2.5} concentration map for the city, based on which the level of exposure to PM_{2.5} for bicyclists was estimated for each roadway link in the city.

Two case studies in the City of Riverside were used to demonstrate the consideration of traffic-related air pollution exposure in bicycle route planning. In each case study, alternative routes along the same travel corridor were analyzed with respect to 10 factors including connection to land uses, posted speed limit, total number of lanes, road shoulder width, traffic volume, terrain and road grade, roadside parking, presence of barriers, number of intersections, and total PM_{2.5} exposure. As some of these factors are qualitative, the comparison between the alternative routes was made by rank order. The use of equal, as well as different, weight of importance for each factor was evaluated. In terms of exposure to traffic-related air pollution, the comparison results

reveal that the best alternative route depends on whether this factor is taken into consideration and how important this factor is relative to other factors.

WHAT WAS THE OUTCOME?

This research has developed a method for incorporating exposure to traffic-related air pollution as another consideration in the bicycle route planning process and has demonstrated how to apply the method through two case studies. Planners and engineers may elect to adopt the presented method or use the information about exposure to traffic-related air pollution differently. For instance, both the order and the weight of importance for the different factors can be changed, which may affect the ranking results. Planners/engineers and stakeholders may jointly determine how important the different factors, including exposure to traffic-related air pollution, are relative to one another. Other factors that should be taken into consideration for a specific corridor or area may also be included.

WHAT IS THE BENEFIT?

Exposure to traffic-related air pollution has been proven to contribute to a wide range of health problems such as lung and heart diseases. A bicycle route planning tool that takes into consideration exposure to traffic-related air pollution will help to reduce the amount of air pollution exposure by bicyclists, thus improving public health. In addition, the tool has the potential to induce mode shift, from driving to bicycling. Fewer automobile drivers would, in turn, help to reduce greenhouse gases and other harmful emissions from vehicles.

LEARN MORE

The final report can be accessed at :
<https://ncst.ucdavis.edu/wp-content/uploads/2016/10/NCST-UCR-Biking-Fresh-Air-Final-April-2017-2.pdf>

The web-based application of the bicycle route planning tool can be accessed at <http://www.arcgis.com/apps/webappviewer/index>.

IMAGES

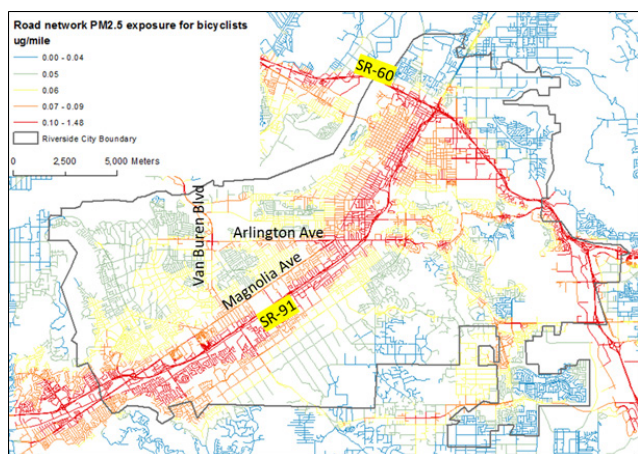


Image 1: Traffic-related primary PM2.5 exposure per mile for bicyclists on the road network in Riverside, California.

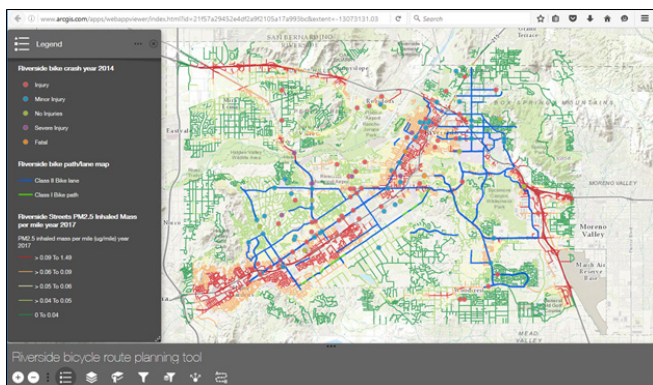


Image 2: Bicycle route planning support tool

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