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Research Results

Behavior in Vegetative Barriers of Aerosol Particulate Matter2.5 (PM2.5) and PM10 along Highways

This Task created a modeling tool that can simulate scenarios and recommend optimal vegetative barriers for California's transportation network.

Environmental

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Project Title: Behavior in Vegetative Barriers of Aerosol Particulate Matter2.5 (PM2.5) and PM10 along Highways

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WHAT WAS THE NEED?

There is strong international agreement that people who live, work, or attend school near major roadways face higher health risks. These risks are linked to higher levels of air pollution from traffic emissions, including particulate matter. As a result, public health concerns have increased interest in ways to reduce the impacts of traffic emissions.

Traditionally, transportation and land use planning have focused on vehicle emission standards, reducing vehicle travel, and creating buffer or exclusion zones between major roads and nearby communities. These approaches are generally considered long-term solutions because they require time to reduce emissions and often involve changes to planning, zoning, and transportation systems.

Other approaches focus on roadway design and urban planning, including road location and layout, as well as the use of solid roadside barriers and vegetation barriers. Roadside barriers offer an important advantage because they can provide a shorter-term solution. In addition, they often provide other environmental and community benefits. When properly selected and planted, roadside vegetation can help reduce concentrations of traffic-related air pollution and lower people's exposure to traffic emissions.

WHAT WAS OUR GOAL?

The primary goal of this project was to develop a modeling tool to help Caltrans practitioners evaluate different scenarios and select the most effective vegetative barriers. The tool, called the Vegetative Barrier Model (VBM), simulates how roadside barriers, with or without vegetation, affect the concentrations of vehicle-related particulate matter (PM2.5 and PM10). It provides quantitative information to support

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the planning and design of vegetative barriers that reduce air pollution and improve equity and livability in communities located near roadways.

WHAT DID WE DO?

Researchers from the University of California, Riverside (UCR) conducted this project. To develop and evaluate the Vegetative Barrier Model (VBM), they collected data during 2024–2025 along a section of SR-55 in Orange County, Southern California. The study site included three roadway conditions: a solid barrier, a vegetative barrier, and an open section with no barrier. This unique setup allowed the researchers to compare how each type of barrier affected air quality near the roadway.

The research team used a mobile monitoring platform equipped with a PurpleAir monitor and other instruments to measure air quality. They also collected data on vegetative barrier characteristics, including optical porosity, leaf area index, plant species, and barrier dimensions. These data were used to estimate pollutant deposition and volatile organic compound emissions and to develop and evaluate the VBM.

WHAT WAS THE OUTCOME?

The UCR research team developed and demonstrated the Vegetative Barrier Model (VBM). The model is based on the idea that the effect of a vegetative barrier can be estimated by combining results from two well-established conditions: a solid barrier and no barrier. The vegetation's porosity is used to estimate where the vegetative barrier falls between these two conditions.

The researchers used data collected at the SR-55 study site to evaluate this modeling approach. They also used data from a field study conducted in 2014 along I-280 in Woodside, California, to further evaluate the model.

The VBM includes two sub-models: the Dispersion Model (DM) and the Volatile Organic Compounds Emission Model (VEM). The DM estimates particulate matter concentrations at selected receptor locations, while the VEM estimates emissions of biogenic volatile organic compounds from the vegetative barrier. Both sub-models are programmed in MATLAB and are packaged into an executable VBM with a user-friendly interface that allows practitioners without specialized modeling expertise to use the tool.

WHAT IS THE BENEFIT?

This model provides quantitative information to support the planning of vegetative barriers that reduce air pollution and improve equity and livability in underserved communities located near roadways. Using this tool, Caltrans practitioners can design and build effective roadside vegetative barriers to help reduce air pollution along California's roadway system.

In addition to improving air quality, vegetative barriers can help reduce urban heat island effects, absorb carbon dioxide (CO_2), conserve water, prevent soil erosion, and improve the appearance of roadside areas.

LEARN MORE

https://dot.ca.gov/-/media/dot-media/programs/research-innovation-system-information/documents/final-reports/5-task-4051-final-report-trdp-combined-a11y.pdf

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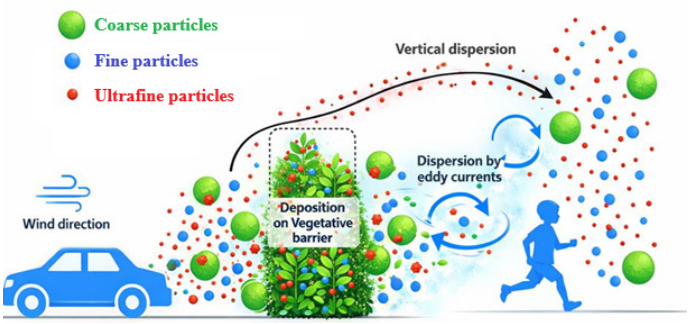


Image 1: How vegetative barriers filter vehicle pollution to protect local communities near roads. (Courtesy: Dr. Akula Venkatram, UC Riverside)

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