

Traffic Congestion Mitigation as an Emissions Reduction Strategy

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Traffic congestion mitigation does not inevitably reduce total emissions. Capacity-based strategies are unlikely to be the most efficient approach to reduce traffic emissions.

Problem Statement

Policy-makers, transportation researchers, and activists often assume that traffic congestion mitigation results in reduced vehicle emissions without proper justification or quantification of the benefits. If congestion mitigation is going to be tied to air quality goals, a better understanding of the impacts of traffic congestion on motor vehicle emissions is needed. This research addresses that need by investigating under which circumstances the commonly held assumption linking congestion mitigation to emissions reductions is valid.

Objectives

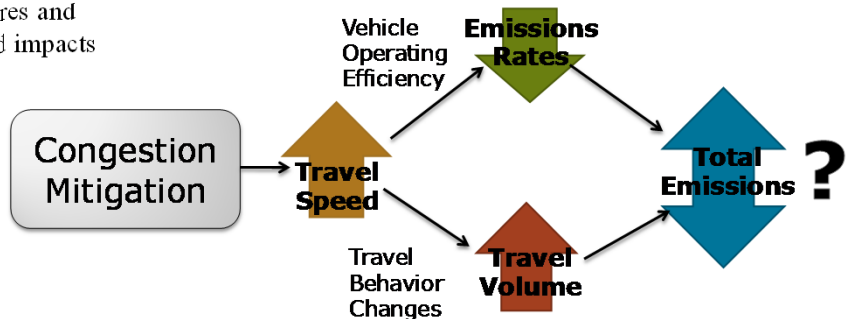
- Present a unique conceptual framework for assessing the impacts of congestion on emissions with minimal location specificity
- Develop generalized relationships between travel speed and total vehicle emissions – taking into consideration elastic travel demand
- Describe situations in which capacity-based traffic congestion mitigation is likely to reduce motor vehicle emissions – with particular attention to the role of different vehicle classes
- Compare capacity-based congestion mitigation with other emissions reduction strategies
- Assess congestion performance measures and their applicability for emissions-related impacts

Research Description

This research aims to alleviate some of the uncertainty about the relationship between traffic congestion and emissions and the potential for congestion mitigation as an emissions reduction strategy. As illustrated in the figure below, capacity-based congestion mitigation that increases average travel speed can influence total emissions both through emissions rate reductions and increased travel volumes. Understanding the balance of these two effects pathways is the purview of this research.

We develop and apply a mathematical framework to study the trade-offs between vehicle efficiency and travel demand volume that accompany travel speed changes. Emissions break-even conditions are estimated for five pollutant types (greenhouse gases, carbon monoxide, fine particulates, nitrogen oxides, and gaseous hydrocarbons) over a range of speeds for different vehicle fleet types. While the exact relationships among emissions, travel speed, and travel demand vary with location, fleet, and pollutant, several consistent results arise.

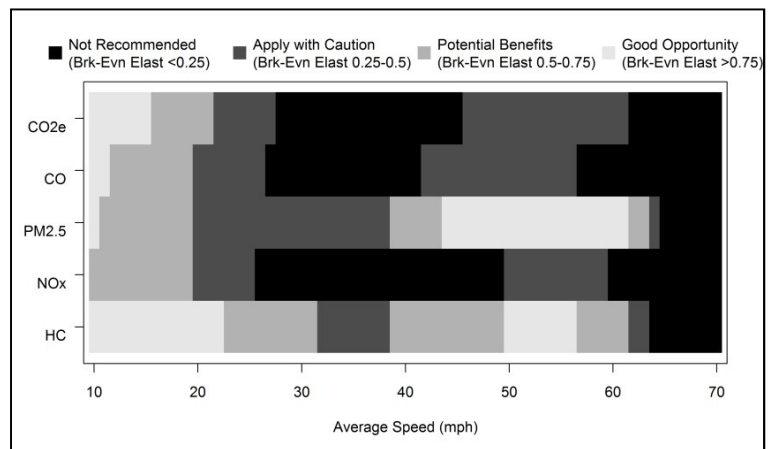
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Congestion-Emissions Influence Paths

Key Findings

- The potential for emissions *rate* reductions through average travel speed adjustments is small for speeds between about 25 and 70 mph.
- Emissions rate sensitivity to speed *increases* with the fraction of heavy-duty vehicles and for certain local pollutants (fine particulates and gaseous hydrocarbons), and *decreases* with the fraction of advanced-drivetrain vehicles, such as electric and gas-electric hybrid vehicles.
- For capacity-based congestion mitigation, total emissions are only expected to decrease under initial conditions of both low demand elasticity and low average speed. In the figure to the right, the darker-shaded areas indicate pollutant/speed combinations where capacity-based congestion mitigation is more likely to *increase* total emissions in the long run because of induced travel demand.
- For reflecting emissions trends, vehicle-miles traveled (VMT) is an essential component of system performance measurement; speed and mobility-based performance measures poorly reflect emissions changes.

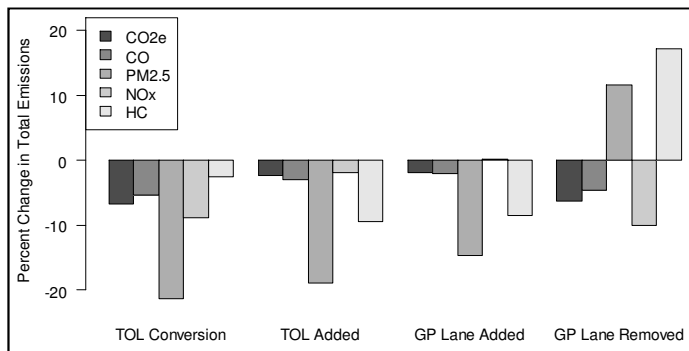


Characterization of Capacity-Based Strategies for Reducing Emissions

Conclusions

Considering elastic travel demand and vehicle efficiency, higher levels of congestion do not necessarily increase emissions, nor will congestion mitigation inevitably reduce emissions. This result includes projects that seek to increase vehicle throughput from existing roadways through traffic management. Congestion mitigation through reduced vehicle volumes, on the other hand, presents the opportunity for additive emissions benefits through vehicle efficiency improvements and travel volume reductions.

Comparing capacity-based congestion mitigation strategies with alternative emissions reduction strategies, we show that where emissions reductions are possible through speed increases, the emissions benefits are likely to be more easily and cost-effectively attained by other strategies. The largest potential emissions reductions through congestion mitigation are found on heavily congested arterials and by targeting heavy-duty vehicle efficiency. The figure to the left shows that under certain conditions, strategies such as Truck Only Lanes (TOL) that target heavy-duty vehicle efficiency are more effective in reducing total emissions than General Purpose (GP) lane management strategies. Finally, an analysis of congestion-related performance measures shows that for reflecting emissions trends, vehicle-miles traveled (VMT) is the essential component of performance. Speed and mobility-based congestion performance measures poorly reflect emissions trends.



Change in Total Emissions with Managed Lane Strategies

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Contributions

The unique contributions of this research include:

- Developing generalized relationships between congestion and emissions that are comprehensible, expedient, and broadly applicable – and include emissions sensitivity to both travel speed and volume
- Providing simple sketch-planning tools that can be applied anywhere with some simple assumptions and parameter estimation
- Producing quantitative support for the decoupling of congestion and emissions mitigations.