Environmental Impacts of Congestion Management Strategies

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Issue

New approaches for improving mobility, accessibility and safety are beginning to challenge conventional approaches to transportation system design and operation and change planning processes. Local agencies in California and elsewhere are implementing innovative strategies to manage traffic congestion. Research and development on new transportation technologies point to large-scale change in the mid- to long-term.

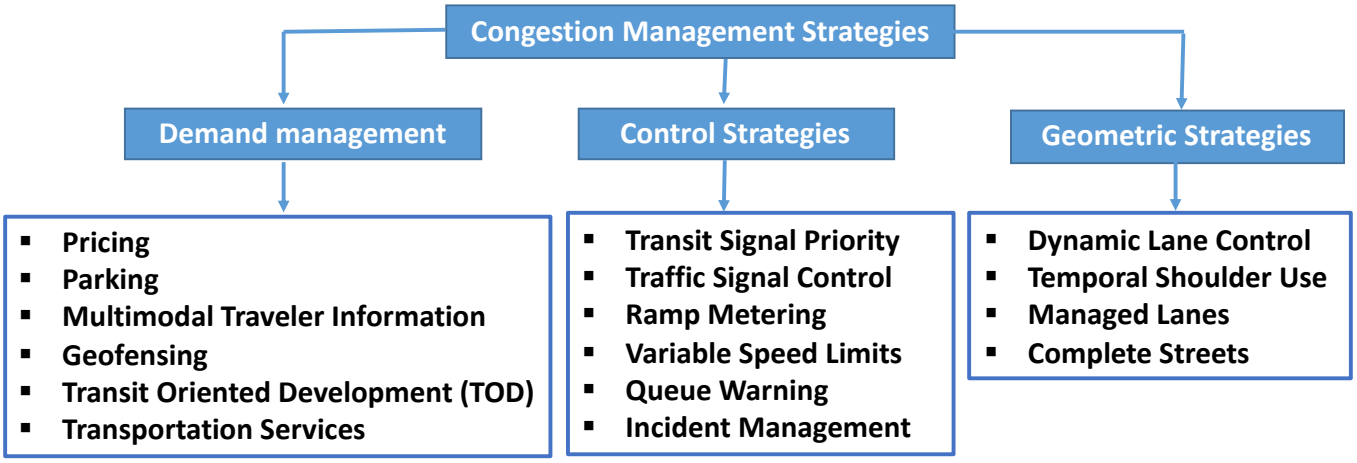
This white paper describes congestion management strategies implemented in or relevant to California and their environmental impacts based on a critical literature review, supplemented by interviews with key staff members at agencies that are implementing new strategies and pilot projects to address traffic congestion. Figure 1 shows a functional classification of the congestion management strategies investigated.

Key Research Findings

The review placed emphasis on the interaction of traffic operating conditions and the time spent in driving modes and the quantitative impacts of operational strategies based on the selected performance measures (MOEs):, greenhouse gas (GHG) pollutant emissions, vehicle miles traveled (VMT) and travel time. The review also addressed the data requirements and tools for estimating the MOEs, and the emerging transportation technologies such as connected and automated vehicles (CAVs) and the challenges to accurately assess their environmental impacts.

The congestion management strategies investigated typically can reduce GHG emissions in the range of 5% to 15%. The amount of benefits depend on the type of improvements, traffic patterns and driver and vehicle characteristics (e.g., lower benefits are expected with the prevalence of electric and hybrid vehicles on the network). Greater benefits may be achieved when a combination of measures are implemented as currently pursued by the Integrated Corridor management (ICM) program.

Figure 1. Classification of Congestion Management Strategies



Key Research Findings (continued)

Operational strategies consisting of temporal capacity additions (re-allocation of travel lanes, temporal shoulder use) are cost effective to congestion and safety problems, compared to capacity expansion projects (new highways or additional lanes). More important the temporal lane addition does not generate induced demand, which typically occurs after permanent lane additions. However, their environmental impacts following implementation have not been documented. This is also the case for managed lanes involving lane use restrictions.

Strategies aiming on travel demand reduction including shared mobility, dynamic parking pricing, geofensing and improved pedestrian and bicycle facilities have potential to reduce VMT but their emission impacts have not been yet documented.
A significant amount of research focuses on the impacts of CAVs. Simulation results indicate that CAVs operating under existing traffic management strategies may further reduce fuel and emissions by 2 to 22%. There is limited empirical evidence regarding the behavior and impacts of CAVs on traffic performance. Further uncertainties in the predictions are due to behavioral changes that may lead to VMT increases.

Recommendations for Future Research

Existing research underscores the need for technology to support implementation of advanced strategies, analysis tools for assessing strategy effectiveness, and improved understanding of the connection between environment, mobility, and safety performance of any congestion reduction program.

- **Technology Requirements:** There is a need for Comprehensive evaluation studies are needed to determine the type and function of the infrastructure required for the deployment of advanced strategies and the associated lifetime costs. Examples include emerging non-intrusive surveillance of traffic conditions, upgrade of traffic signal systems and their interconnections, and dedicated short range communications (DSRC) for CAV applications.
- **Estimation of Fuel Consumption and Emissions:** Accurate emissions and fuel consumption estimation requires the time spent in each driving mode. Currently, new technologies and algorithms provide field collection of vehicle trajectory data and clustering at various traffic states. There is a need to develop methodologies that utilize the real-world trajectory data for emissions estimation.
- **Traffic Analysis Tools:** Existing traffic analysis tools are not well suited for evaluating CAVs and other emerging technology applications. Agencies need specific guidance on the application of existing tools and their limitations for modeling CAV equipment, modeling driver behavior, modeling CAV applications and the driver responses.
- **Framework for Environmental Assessment of Congestion Management Strategies:** There is a need to develop a framework for evaluating the performance of congestion management projects that accurately models the interactions of traffic flow improvements and emissions. The proposed framework should include a land use model that is sensitive to changes in transportation network conditions, an activity-based travel demand model and a dynamic traffic assignment. The framework should be able to present the impacts in the form of benefit-cost analysis to facilitate communication of the benefits of strategies to decision-makers.

Further Readings

This policy brief was drawn from the "Environmental Impacts of Congestion Management Strategies," a white paper Prepared by Alexander Skabardonis (University of California, Berkeley) for the State of California Air Resources Board. The Report and this policy brief can be found at https://ww3.arb.ca.gov/research/single-project.php?row_id=68590.

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