The Role of Pavements in Meeting GHG Reduction Targets

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Untapped Potential

To meet the targets for reducing greenhouse gas (GHG) emissions set by cities and states, several solutions have been proposed including renewable energy production, subsidies for electric vehicles, and carbon taxes. However, transportation authorities have not considered the role of pavements as a means of reaching GHG targets. In fact, apart from impacts associated with materials production and construction equipment, pavements exert a substantial environmental impact by influencing vehicle fuel consumption. To better understand the overall effect of the road network on climate change, a high-level analysis is required that investigates how pavement policymaking can help reach GHG reduction targets. Different choices in the budget assigned to road preservation and repair should be considered to find the optimal contribution of the road network to GHG mitigation and meet targets.

Quantifying the Impacts of Pavements

We propose a systematic approach to quantify the climate change impact of pavement networks at the U.S state-level. The first step evaluates network conditions using an aggregated approach. To understand the current conditions, road mileage and surface types were extracted from Federal Highway Administration (FHWA) statistics considering different road classifications (i.e. expressways, highways, arterials, and collectors) for urban and rural neighborhoods. The next

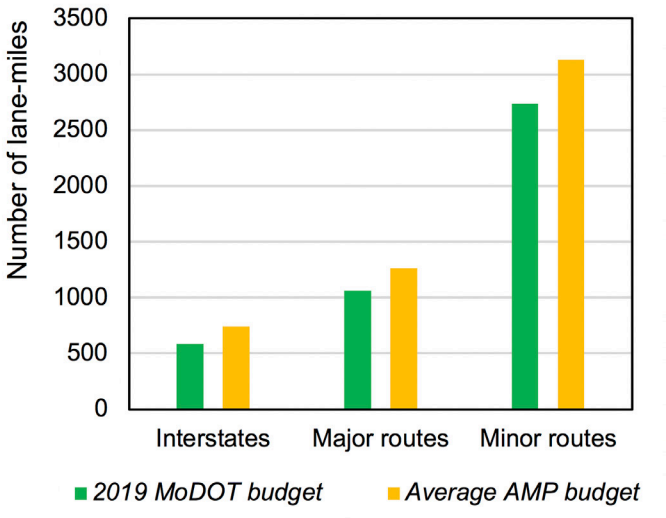

Figure 1. Missouri Department of Transportation's number of pavement lane miles repaired using the projected budget (green) versus the historical average state AMP budget (yellow).

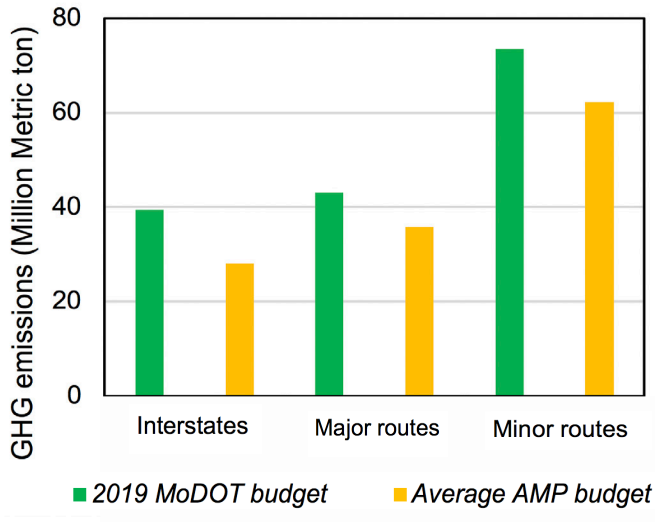

Figure 2. GHG emissions of excessive fuel consumption induced by IRI and deflection for the Missouri network with MoDOT budgets and historical average AMP budget for a 50-year analysis period.

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step involved gathering network performance data, such as international roughness index (IRI), thickness, lane number, and traffic volume, from FHWA's long-term pavement program (LTPP) database.

Then, these data were inputted into CSHub models (2,3) to estimate the future road conditions and excess fuel consumption (EFC) of vehicles from pavement surface roughness and deflection. To predict future GHG emissions associated with different road preservation and repair budget levels, researchers applied their method to a case study of Missouri's road network over a 50-year analysis period using two different budget levels (see Figure 1). The first budget level was taken from the state's historical average transportation asset management plan (AMP) budget, while the second was MoDOT's predicted 2019 budget. Additional funds enable investments in pavement treatments that can lower roughness and deflection, thereby lowering EFC.

Findings

The GHG emissions of pavements due to EFC at each budget level and for each road classification are shown in Figure 2. By increasing the budget level from the 2019 MoDOT projection to the historical average AMP values, cumulative savings would be equivalent to 1,000,000 passenger car trips of 58,800 miles each—or 29.9 million metric tons of CO2 in total. These results indicate that policymakers should consider investment in pavement repair and maintenance to reduce roughness and increase stiffness, which will mitigate climate change impacts. In the future, researchers will expand their analysis to consider the environmental impacts associated with pavement surface reflectivity and the embodied carbon associated with the materials used for reconstruction and repair of roads.

Key Take-aways

- Pavements can prove a useful tool for transportation departments to meet emissions targets by reducing the fuel consumption of the vehicles that drive on them.
- In a case study of Missouri's highway network, researchers found that increasing the state transportation budget to that of historical levels would result in significant emissions reductions.
- Researchers estimated these emissions reductions at 29.9 million metric tons of CO_2. This would be the equivalent of 1,000,000 passenger car trips of 58,800 miles each.

Citation:

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