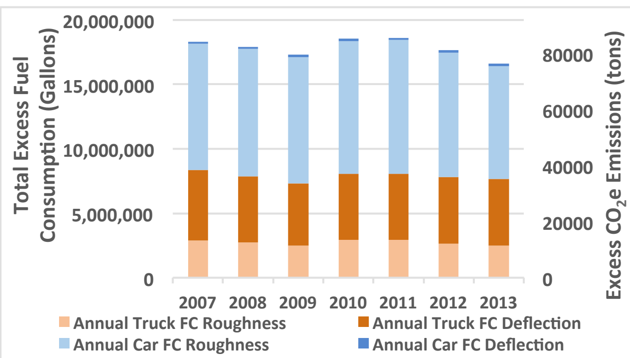
Mapping of Excess Fuel Consumption

PROBLEM

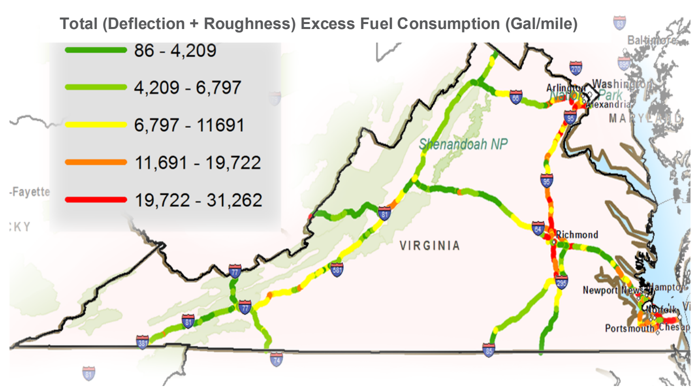
Establishing a framework for sustainable development of our nation's roadway system requires quantitative means to translate pavement condition and design into life-cycle energy use and greenhouse gas (GHG) emissions. Recent developments in mechanistic pavement-vehicle interaction (PVI) models provide such engineering estimates. Implementation of such models at the network level can provide transportation agencies with a metric for quantifying section-specific PVI impacts.

APPROACH

Pavement-vehicle interaction models were used to calculate excess fuel consumption within Virginia's interstate highway network due to pavement material and structural properties as well as pavement roughness. Data for pavement condition and design are obtained from Virginia DOT for five different pavement types. We used HDM-4 and MIT Gen II models, respectively, for estimating roughness- and deflection-induced excess fuel consumption relative to a perfectly rigid pavement with IRI=63 in/mile, for both passenger cars and trucks within the system. The results of the analysis are integrated into the Geographical Information System (GIS) allowing for illustration of fuel consumption magnitudes at different locations throughout the network.



Excess fuel consumption separated based on vehicle class and dissipation mechanism



Map of annual excess fuel consumption (Gallon/mile) within the VA interstate highways

FINDINGS

Within the network, the contribution of deflection- and roughness-induced PVI to fuel consumption is on the same order of magnitude**, with higher impact from deflection-induced PVI for trucks, and roughness-induced PVI for cars**. This suggests having stiffer pavements in roads with high truck traffic and smoother pavements in roads with high car traffic leads to the highest reduction in fuel consumption. Furthermore, higher excess fuel consumption is observed around cities with high-volume traffic. By ranking the excess fuel consumption, it is found that only 1.3% of the analyzed interstate network is responsible for 10% of GHG emissions, which means that the rehab of those few lane miles results in significant improvement.

IMPACT

Integration of pavement condition and GIS data provides a pavement management system with the capability to graphically display conditions and treatment decisions of pavements through their lifetime. The results of such analysis can serve as an additional criterion for optimal maintenance scheduling as a tool to reduce GHG emissions if used in conjunction with a full life-cycle assessment.

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Authors: Dr. Arghavan Louhghalam in collaboration with Mehdi Akbarian and Prof. Franz-Josef Ulm