

Request for Research Funding for FY 2023-2024

Project Number (Research Center Use Only): OEM-24-01

Requesting Office	Office of Environmental Management	Priority	1 of 1 (projects may not have the same ranking – no ties)
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Proposed Title
Data Driven Approach to Investigate the Nexus between Transportation-Related Emissions and Health Impacts in Central Florida

Justification

Describe the current situation, why the research is needed, and how the research affects your office’s mission critical focus areas

Air pollution is considered the fourth largest threat to human health after high blood pressure, dietary risks, and smoking. Furthermore, the effects on health arising from the use of motor vehicles pose a substantial challenge to transportation engineers as well as transportation officials and policymakers. In Central Florida, the motor vehicle dominates the mode split and, as a result, air quality suffers severely in more congested settings especially near residential, industrial, and commercial zones. A recent study published in the proceedings of the National Academy of Sciences outlines steps needed to tackle the consequences of global warming and recommends reducing CO2 emissions by 45% from 2010 levels by 2030. Transportation is a huge factor in carbon emissions and traveling smart to reduce emissions is crucial. The negative effects of air pollutants on public health have been identified with a high degree of certainty. Common pollutants found in traffic emissions such as CO, CO2, PM2.5, PM10, and NOx are recognized to increase mortality rates in the general population, as they contribute to increases in chronic and acute respiratory diseases, heart conditions, and cancer. While many studies confirm the general effects of air pollution on public health, there are ample variations between studies in the estimated impacts on the public health and the associated factors. The link between traffic-related factors, land use and public health is still vague and the correlation between traffic-related emissions from the surrounding land use context and the direct impact on individual health needs to be understood more clearly in order to influence policymaking towards a healthier, more sustainable future especially in Central Florida. However, much of the current research fails to fully capture the issue with certain accuracy for three main reasons:

(1) Models for traffic-related emissions are not accurate: there are few studies that isolate emissions sources to analyze for traffic-caused health effects and fewer that attempt an accurate assessment of traffic interactions (accounting for land-use, facility operations, driver behavior, vehicle type, etc.). One systematic review on the confounding effects of traffic-related noise and air pollution surprisingly found very low impact among studies and states the need for “using pollution indicators specific to road traffic”, which may help to overcome the shortcomings in exposure modelling (Tétreault L. et al, 2013). The most popular models used in the previously mentioned studies were macroscopic static planning models, which ignore individual vehicle behavior, leading to under-estimation of pollutant emissions.

(2) Air Pollution Measurement Technology is outdated: literature found that those that utilized high-end stationary sensors alone suffered from lack of spatial resolution and could not focus on specific areas to investigate factors such as proximity to major roadways (Clements A. L., 2017). Advancements in air pollution measurement technology is needed with proper utilization of mobile sensors that complement high-end stationary sensor capabilities to ensure accurate outputs.

(3) Data collection methods for health impacts are lacking: Many of the estimation methods for health impacts are based on models such as concentration-response/exposure-response relationships or hazard ratios. While these are useful tools, the shortcomings are obvious when reviewing the variability between outcomes. The data collection methods corresponding to more precise exposure models are mainly limited to school children and infants and many of these relied solely on parental self-reporting surveys, which are much less reliable than hospital records reviewed by medical staff. The scope of the project will require three main data collection efforts: patient data, traffic data, and air quality data. Patient data will be obtained from health departments in Central Florida, traffic data are available from the relevant transportation agencies and for air quality data, a network of low-cost mobile sensors to monitor air quality will be needed to support the data collection program.

Impact

How shall the results impact practice? Consequences of not doing the research?

(1) Improve FDOT’s method and model to predict emissions based on microscopic traffic models especially if the EPA air quality rules change as expected. The ability to model and predict the impacts of traffic related factors on health such as congestion, land use, and future interventions by using an emissions model that takes more specific traffic interactions into account, rather than simple demand inventories or GIS data on their own.

	<p>(2) This study aligns with FDOT’s mission and Metroplan’s recent Strategic Health Plan Goals and PATHS Framework specifically (a) Supporting Healthy Lifestyles, (b) Implementing Healthy Transportation Infrastructure, (c) Integrating Health Equity into Transportation Planning process by redefining the Future Land Use Map towards healthier population.</p> <p>(3) Access to detailed hospital admissions records will include data on multiple demographics and filtering to reduce bias towards effects that may not be directly caused by traffic.</p> <p>(4) Correlating the impacts of exposure models with health benefits presents a more robust argument for influencing investment and policymaking.</p>
<p>Affected Offices</p>	<p>Identify any office and names of office personnel that will need to be involved in the scoping or conduct of the research, will be affected by implementation of the results, or will need to participate in the implementation process—including OTIT, if enterprise data/network software application will be a deliverable, and district staff, as appropriate, e.g., through statewide meetings. If the requesting office will not be the implementing office, please identify which office and names of specific personnel which will have to serve in that capacity—have they been involved?</p> <p>FDOT Office of Environmental Management (Catherine Bradley, Neil Campbell). We communicated with Metroplan regarding the research idea since it aligns with their strategic health plan. We will be coordinating with Metroplan throughout the project, and they are willing to provide the necessary help and guidance along with FDOT.</p>
<p>Existing Work</p>	<p>Learning About and Using the Research in Progress (RiP) Database http://www.trb.org/main/blurbs/176215.aspx</p> <p>As a minimum, the Transportation Research International Documentation (TRID) and the Research in Progress (RIP) online databases should be reviewed by an expert in the research subject matter to assure research effort and resources shall not duplicate prior or ongoing work. TRID: https://trid.trb.org/Results RIP: https://rip.trb.org/</p> <p>There is already a well-established body of research suggesting that air pollution plays a major role in health (J. J. Bonnici, 2011). However, several studies have made a variety of estimates for the public health implications of traffic-related air pollution, which don’t seem to agree on the severity of the issue. Other studies correlated specific pollutants with specific symptoms and conditions (S.S. Yamamoto et al., 2013) but not the geographic area. The literature also found that those that utilized high-end stationary sensors alone suffered from lack of spatial resolution and could not focus on specific areas, to investigate factors such as proximity to major roadways (Clements A. L., 2017). However, recent developments in low-cost mobile sensor technology has allowed for capture of more criteria pollutants (Hagan D. and Kroll J., 2018). It was recommended that, for proper utilization of mobile sensors, sensors must be applied in ways that complement sensor capabilities and that calibration with high-end devices is necessary to ensure accurate outputs. On the other hand, there are few studies that isolated emissions sources to analyze for traffic-caused health effects and fewer that attempt an accurate assessment of traffic interactions (accounting for land-use, facility operations, driver behavior, vehicle type, etc.). This is due to outdated or simplistic strategies for traffic emissions modelling, therefore resulting in unreliable exposure models. One systematic review on the confounding effects of traffic-related noise and air pollution surprisingly found very low impact among studies and states the need for “using pollution indicators specific to road traffic”, which may help to overcome the shortcomings in exposure modelling (Tétreault L. et al, 2013). The most popular models used in the previously mentioned studies were macroscopic static planning models, which ignore individual vehicle behavior, leading to under-estimation of pollutant emissions. Integrating mesoscopic modeling (VISUM), micro-simulation (VISSIM) and the latest environmental Protection Agency’s (EPA) emissions model (MOVES) (Abou-Senna H., 2013; Sider et al., 2014; Sider et al., 2013; Tetreault et al., 2018), developed by researchers at the University of Central Florida, can simulate many more factors such as regional travel demand, vehicle type and routing decisions, individual driver behavior, and next-generation technologies. They offer the most accurate resolution for capturing emissions by considering second-by-second speed profiles while also enabling regional level decision processes (such as origin destination matrix) to impact emissions. This presents an opportunity to model emissions much more accurately for current conditions, as well as demonstrating the impacts of transportation at various spatial scales, which has never been done in a transportation-health related context.</p>
<p>Keywords Used In Existing Work Search (Cannot leave blank)</p>	<p>Emissions, traffic, health impacts, respiratory, cancer, travel demand modeling, land use, air pollution.</p>
<p>Related Contracts (Give contract numbers)</p>	<p>None</p>

Funding Request	Estimated cost: \$350,000	Anticipated Duration	Estimated length of time to complete work: 24 months
Project Manager	Proposed technical manager to oversee research: Catherine Bradley	Contracting Method	Anticipated procurement method (e.g., supplement to existing project, RFP to all registered vendors, direct contract with university) Direct contract with UCF (Hatem Abou-Senna & Naveen Eluru)
Equipment	Estimated equipment cost (or N/A): Approx \$5,000	Comments* (understanding leases are preferred, include the proposed use of the equipment, whether lease options are feasible, whether work to be done with equipment could instead be procured through service expenditure, etc.): We will utilize one or two UCF devices, but we will need to purchase another two to three low-cost air quality sensors for collecting other types of air pollutants in specific zones. These devices will be portable and will be moved around from one zone to another to reduce cost of purchasing additional sensors.	
Urgency	Score 1-5 1= highest, most immediate need: 1	Comments* (elaborate as appropriate on justification/impact comments to explain the urgency of the need . . . is a solution needed immediately, needed within a certain period of time or by a known or anticipated deadline, desired for enhancement, etc.): Desired for improving FDOT’s models and methods of predicting traffic-related emissions especially due to the anticipated changes of the EPA’s air quality rules	
Implementability	Score 1-5 1=greatest likelihood of and proximity to implementing results: 1	Comments* (consider both the likelihood of implementation and the length of time and resources required to implement the results of the research.) Identify any prerequisites to, requirements for, or barriers to implementing the anticipated results of this research (e.g., new or change to existing specifications, development of production units of prototype device, legislative change); please indicate if multiple phases of work shall be required: The developed high-resolution models can be used immediately and implemented by FDOT.	

Project Benefits (Succinct, complete explanation)

1. Develop an exposure model that can estimate emissions with higher resolution, accounting for complex factors and potential smart solutions. In order to improve the effectiveness of the findings, the research will be carried out in an accurate, cause-specific manner. That is to say we will measure the impact on public health, in a specific zone, that comes as a direct result of traffic emissions and the corresponding land use context and socioeconomic data. This exposure model will also consider different pollutants by measuring both greenhouse gas emissions and criteria pollutants with higher temporal and spatial resolution. Furthermore, simulating and measuring the benefits of smart solutions to public health is one novel aspect of the study that will be crucial in affecting transport policies and mitigation strategies.
2. Utilize the new exposure model in combination with thorough patient-by-patient analysis to reduce bias from other factors which may impact cardio-respiratory health. Using a thorough analysis of patient records is another novel aspect of this transportation study that will result in modelling outcomes more accurately than the outcomes of the current literature. While there is a general consensus that transportation emissions do have a negative impact, it is important to investigate its context and how it impacts health and ensure that this impact is not under or over-stated.
3. Measure the relative impact of emissions on health with respect to non-emissions-based risk factors. Another major objective of the study is to filter traffic related health impacts from non-traffic related ones. As mentioned, traffic emissions do contribute in some proportion to negative effects on public health. However, current methodologies did not quantify this relative impact to non-emissions-based factors which is needed to develop mitigation strategies and improve transportation policies. A major question that will be answered in the study is: how much should traffic emissions be prioritized with respect to other sources of pollution and risk factors?
4. Predicting future traffic volumes and emissions under various potential future scenarios including increasing electric vehicle (EV) adoption as well as the potential effect of another pandemic. UCF has Data from CDC by County before, during and after the Covid19 pandemic which will be utilized for the prediction models.

Project Benefits (Select all that apply and explain)	Quantifiable Benefits (units, dollars, etc...if applicable)	Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits
○ Materials Enhancement		Efficient allocation of resources.
○ Materials Savings		
○ Time Savings		Running more robust and high-resolution prediction models incorporating significant factors will help FDOT staff save time and effort.
○ Lives Saved/Injuries Prevented		Improve human health impacts from GHG emissions and other air pollutants which will expose the public to less polluted areas.
○ Other (Explain)		Supporting healthy lifestyles, implementing healthy transportation infrastructure, and integrating health equity into the transportation planning process by providing local governments the tools to redefine the Future Land Use Map towards healthier population.

*Comments should explain and support urgency, financial benefit, and implementability scores

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