CENTER FOR ADVANCING RESEARCH IN
Transportation Emissions, Energy, and Health
A USDOT University Transportation Center

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Signature of Submitting Official:	Marcia Walker

OVERVIEW

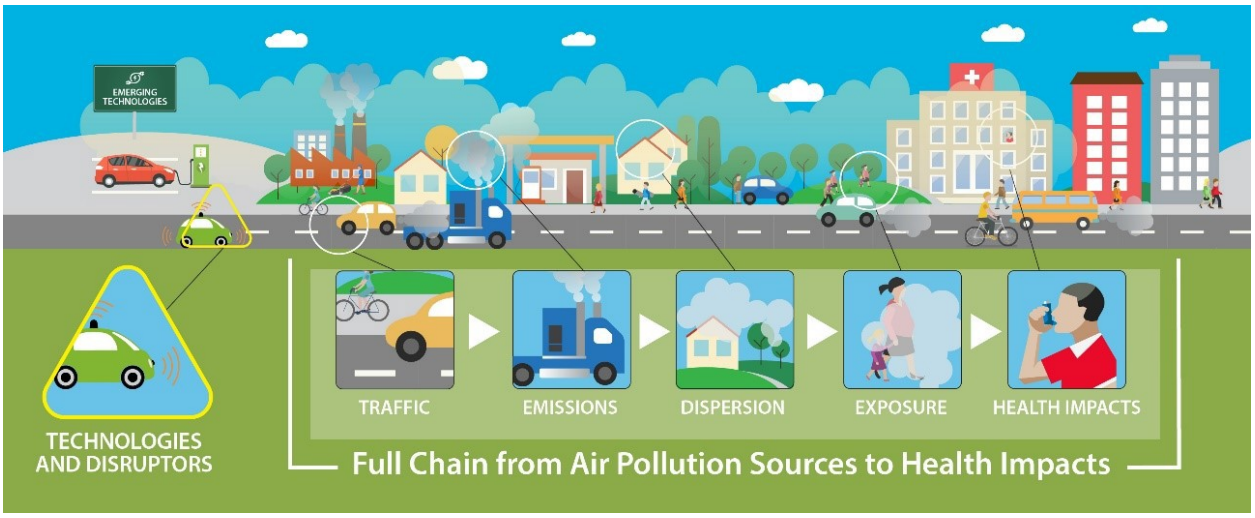
The Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH) has been highly productive during this reporting period as we continue to build on our successes of the last three and a half years. The initial cooperative projects are winding down; however, our second and third-year competitive research projects and strategic initiatives are progressing well. We have initiated several technology transfer activities, which have received extremely positive feedback. We are continuing our work despite the disruptions we faced at the end of the reporting period due to COVID 19. At the end of this reporting period, we continue to be proud of our progress and excited about upcoming activities in all our goal areas.

ACCOMPLISHMENTS

Major Goals of the Program

CARTEEH brings together experts from transportation and public health, two disciplines that have not traditionally worked together. CARTEEH's focus is to advance research on transportation emissions in a comprehensive manner, mapping the holistic tailpipe-to-lungs spectrum, as shown in Figure 1.

Figure 1: Tailpipe to Lungs Spectrum



CARTEEH's research focus areas were defined to cover this spectrum and are as follows:

- Transportation System
- Emissions and Energy Estimation
- Exposure and Health Impacts
- Data Integration
- Policy and Decision-Making

Progress in each CARTEEH goal area is detailed in the following sections:

CARTEEH Goal #1: Research Program

CARTEEH's research program includes collaborative research projects conducted jointly among consortium members, competitive program awards, and other initiatives that support our strategic research, education, and technology transfer goals. These are all included as part of our project portfolio in Table 1 below, though some initiatives are discussed further under the education and technology transfer sections of this report.

Work on the cooperative projects identified in the first-year project work plan has been completed, and final reports will be wrapped up and distributed during the next reporting period. We currently have eight final reports in the final stages of editing and submission. The consortium partners have successfully met the collaboration requirements of these projects and are discussing future collaborative projects.

The majority of the competitive research projects awarded in CARTEEH's second year have also ended at each partner institution. CARTEEH staff members are working with researchers to finalize their reports and upload their data to the CARTEEH Data Hub.

Two new initiatives were kicked off during this reporting period. The first is a project working on modeling of the "full-chain" between transportation and health, building on an advanced transportation emissions modeling platform developed by CARTEEH researchers. The second initiative involves the exploration of transportation as a disease vector, specifically the role that transportation vehicles and infrastructure plays in the spread of contagious diseases and developing a model that takes into account both people and vehicles.

Table 1: CARTEEH Project Portfolio

Project	Lead Institution	Principal Investigator
Transportation Emissions and Health Data Hub	TTI	Dr. Andrew Birt
Reconciles differences in characteristics of transportation and health data; develops a platform to house datasets		
Truck Emissions Exposure Study in Ports	GaTech	Dr. Michael Rodgers
Assesses pollutant emissions at selected major ports; evaluates the potential reduction of exposure using multiple methodologies		
Border Crossing Emissions Impact Study	TTI	Dr. Tara Ramani
Characterizes the emissions impact of border crossings and identifies population groups most affected by the emissions		
Healthy Living and Traffic-Related Air Pollution in an Underserved Community	UTEP	Dr. Wen-Whai Li

Quantifies traffic-related air pollution and the associated respiratory health for vulnerable school children in El Paso, Texas		
Development and Evaluation of Connected Vehicle Application for Alternative Fuel Trucks	UCR	Dr. Peng Hao
Evaluates benefits of battery-electric trucks and plug-in hybrid electric trucks over conventional diesel trucks		
Health Risk Characterization for Transportation Users	JHU	Dr. Mary Fox
Develops a cumulative exposure and risk profile for transportation workers and/or system users considering chemical and other stressors		
Assessing Regulatory Compliance and Community Air Pollution Impacts of Crude Oil by Rail (CBR) Transport in Baltimore City, Maryland	JHU	Dr. Genee Smith
Delivers evidence-based characterization of emissions impacts of CBR within Baltimore City, Maryland		
PM Exposure for Paratransit Transport	GaTech	Dr. Alex Samoylov
Characterizes exposure to PM faced by sensitive populations using paratransit transport		
Measuring Temporal and Spatial Exposure of Urban Cyclists to Air Pollutants Using an Instrumented Bicycle	GaTech	Dr. Kari Watkins
Develops an understanding of local cyclists' exposure to PM2.5 air pollutants in an urban environment		
Traffic-Related Air Pollution and Childhood Asthma in the United States: A Burden of Disease Assessment	TTI	Dr. Haneen Khreis
Conducts a burden of disease estimate of childhood asthma attributable to traffic-related air pollution within the US		
Characterizing In-Cab Air Quality in Heavy-Duty Diesel Construction Equipment	TTI	Dr. Phil Lewis
Analyzes air quality and driver exposure inside the cabs of heavy-duty diesel construction equipment		
Dockless Mobility: Addressing Safety, Emissions, and Gaps in Policy Making	TTI	Dr. Suriya Vallamsundar
Examines emissions exposure on dockless mobility users in Dallas, Texas		
Quantifying Bioavailable Metals and Potential Dust Emissions from Highway-Related and Desert Sediments at Lordsburg Playa, New Mexico	UTEP	Dr. Thomas Gill
Scopes the presence of bioavailable metals and potential dust emissions from highway-related and desert sediments in New Mexico		
Secondary Particulate Matter Exceed Primary Emissions from Current Gasoline Vehicles: Air Quality and Public Health Implications	UCR	Dr. Georgios Karavalakis

Assesses emissions from gasoline direct injection and multipoint injection vehicles when operated under different driving cycles		
Quantifying Traffic Congestion-Induced Change of Near-Road Air Pollutant Concentration	UCR	Dr. Jill Luo
Develops a statistical model to quantify the contribution to the ambient air quality degradation due to traffic congestion		
Transportation and Health - Conceptualization and Quantification	TTI	Dr. Haneen Khreis
Addresses the transportation-health nexus beyond air quality and emissions; develops a comprehensive conceptual "pathways" model		
Urban Policy Interventions and Their Effectiveness in Reducing Traffic Emissions and Traffic-Related Air Pollution	TTI	Dr. Haneen Khreis
Identifies policy interventions to effectively reduce traffic emissions and traffic-related air pollution from on-road mobile sources		
Technology Landscape and Future Direction for Transportation Emissions, Energy, and Health	TTI	Dr. Yanzhi (Ann) Xu
Develops a technology roadmap for transportation emissions, energy, and health		
Curriculum for Transportation Emissions and Health	TTI	Dr. Haneen Khreis
Development of a unique, cross-disciplinary course titled “Traffic-Related Air Pollution: Emissions, Human Exposures, and Health.”, which can be used for undergraduate, graduate, and practitioner education.		
Transportation Emissions and Health Literature Library	TTI	Dr. Haneen Khreis
Downloadable spreadsheet resource tabulating and categorizing literature on transportation emissions, energy, and health.		
Innovative Data Applications using CARTEEH's Data Hub	TTI	Dr. Yanzhi (Ann) Xu
Use of CARTEEH's data hub infrastructure for data integration applications, including the development of a national emissions map		
Development of an Emission-Based Selection Algorithm to Optimize Variable Message Signs Location *(student project)*	TTI	Ms. Farinoush Sharifi
Develops an algorithm to identify locations of variable message signs to maximize emissions savings in situations of nonrecurring congestion		
Real-World Data Measurement of Factors Affecting Air Quality for Nonroad Diesel Equipment Operators	TTI	Dr. Phil Lewis
Characterizes the various factors affecting equipment operators' exposure to poor air quality, using real-world data and measurements.		

Trace Metals in Airborne Particulate Matter and Genomic Characterization of Associated Microorganisms: Insights into Health Effects from an Industrialized, Near-Roadway Site in Houston	TTI	Dr. Shankar Chellam
Investigates vehicular contributions of PM10, and its elemental components and microorganisms, to understand health effects and implications.		
Making New Mobility a "Win" for Public Health	JHU	Dr. Johnathon Ehsani
Investigates the use of new mobility options as a public health intervention, through simulation of scenarios and validation with real-world data.		
Improved Vehicle Emissions and Near-Road Dispersion Modeling Tool for Project Evaluation: Integrating MOVES-Matric, the FEC, and AERMOD	GaTech	Dr. Haobing Liu
Developing a tool to streamline and integrate transportation emissions modeling and dispersion modeling for a more straightforward assessment of air quality impacts.		
Modeling Air Quality Impacts of Pollution Mitigation Scenarios at a Multimodal Inland Port	GaTech	Dr. Franklin Gbologah
Assessment of Nox and PM emissions and dispersion for various pollution control scenarios in an inland port.		
Association of Traffic and Related Air Pollutants on Cardiorespiratory Risk Factors from Low-Income Populations in El Paso, TX.	UTEP	Dr. Soyoung Jeon
Studies linkages between cardiorespiratory risk factors and levels of traffic-related air pollutants.		
Onboard Sensing, Analysis, and Reporting (OSAR): Expanded Field Demonstrations and Development of Associated Visual Aids	UCR	Dr. Kent Johnson
Develops the capability for spatial and temporal visualization of emissions from the OSAR on-board emissions measurement system.		
Development of Full-Chain Transportation Emissions, Exposure and Health Modeling Platform	TTI	Dr. Yanzhi (Ann) Xu
Models the "full-chain" between transportation and health, building on an advanced transportation emissions modeling platform developed by CARTEEH researchers		
Transportation as a Disease Vector - a Modeling Approach	TTI	Dr. Joe Zietsman
Investigates the role of transportation vehicles and infrastructure in the spread of disease.		

All the year three competitive projects were initiated during this period and are included in the table above.

Research Results Disseminated

CARTEEH researchers continued to disseminate their research results through various venues, including presentations at conferences, paper submittals to journals, and in meetings and outreach to stakeholders. Key research findings are also disseminated through the CARTEEH website. CARTEEH's success in disseminating research results was evidenced by its inclusion in the Transportation Research Board's Roadmap for Transportation and Public Health, which also mentioned the CARTEEH literature library. The report may be accessed here.

Plans for Next Reporting Period to Accomplish Research Goal

In the next reporting period, CARTEEH leadership will continue working with the new principal investigators of the year three projects to ensure the success of their projects. Plans are underway for the year four competition, where we anticipate focusing on student-led projects. We expect to leverage our research results for further education and technology transfer activities, with an emphasis on stakeholder engagement and in line with our technology transfer plan.

CARTEEH Goal #2: Education and Workforce Development

CARTEEH research projects are catalysts for CARTEEH student involvement, with the number of students involved with CARTEEH increasing each semester.

Texas A&M University College of Education Collaboration

In September of 2019, partnering opportunity discussions were initiated with Dr. Michael de Miranda, Head of the Department of Teaching, Learning, and Culture in the Texas A&M College of Education. Dr. de Miranda focuses on engineering and technology teacher preparation and engineering education, and the development of STEM educators. As a result of those conversations, CARTEEH is assisting with a Capstone project for four students, titled "Wearable Pollution Detection Device." The project aims to develop a low-cost, "wearable" device that can take samples from the air and measure particulate matter, which will be collected onto physical storage space. Once the device prototype is successful, more units will be made to be distributed to middle school students throughout Texas in the hope of increasing students' interests in STEM while spreading knowledge and awareness of pollution throughout Texas.

Curriculum Course Development

Progress continues with the development of CARTEEH's cross-disciplinary course titled "*Traffic-Related Air Pollution, Human Exposures, and Health*." The course's outline has been finalized and copyrighted and can be found posted on the CARTEEH website. A pool of primary and back-up lecturers has been identified for each of the 60 planned sessions. Currently, members of the consortium are discussing the best way forward to reach out to lecturers and securing the content of each session. This will be a collective effort led by TTI with active involvement from all partners.

The course will cover critical topics from transportation, urban planning, exposure assessment, and public health and policy domains. It is intended to set the foundation for a three-credit-hour graduate-level course offered by consortium member institutions. The course targets students and practitioners in the areas of urban planning, transportation planning, transportation engineering, geography sciences, environmental epidemiology, and public health.

Last spring, a modified version of the course was piloted to 34 Georgia Tech undergraduate students as a special topics course. Dr. Michael Rodgers served as the primary instructor and was aided by four other instructors. Based on their experiences, a modified version of the course was taught in the 2020 Spring Semester. Dr. Rogers is preparing a permanent course request over the summer with plans to complete the approval process involving the undergraduate committee, full Civil and Environmental Engineering Committee, and Institute Curriculum during the fall semester.

CARTEEH Summer Internship Program

In conjunction with two other TTI UTCs, SAFE-D, and NICR, CARTEEH began accepting applications for the summer internship program in January of this year. Four interns were initially selected, however by mid-March, it was apparent that the COVID-19 pandemic would disrupt the program. Texas A&M University canceled all its summer research undergraduate experience programs, and it was uncertain whether housing would be available for out of town students. As a result, the decision was made among the TTI UTCs to continue the internship program for local students only.

CARTEEH will have three summer interns, who have been paired with mentors for summer projects. As local students, they will be able to work remotely if necessary, and still have access to TTI facilities. Rather than participating in the university-wide poster session for undergraduate interns, a poster session will be held in the lobby of TTI headquarters at the completion of their internship.

CARTEEH Webinar Series

During this period, two partner institutions hosted webinars related to transportation and health. In November, UTEP hosted Dr. Jeffery Sarnat from Emory University and Georgia Tech. Dr. Sarnat spoke on "Traffic Pollution, Health, and the Theory of Everything.", A link to Dr. Sarnat's talk is posted here on the CARTEEH website.

The second CARTEEH webinar was held at Georgia Tech, with Andrew Dannenberg, MD, MPH, speaking. Dr. Dannenberg, is an Affiliate Professor in the Department of Environmental and Occupational Health Sciences, School of Public Health, and in the Department of Urban Design and Planning, College of Built Environments, at the University of Washington in Seattle, where

he teaches courses on healthy community design and health impact assessment. Slides and a recording of his talk may be found here.

Education Results Disseminated

In addition to the student posters that were presented at the CARTEEH symposium, papers developed as part of the summer internship program are being considered for potential expansion into journal submissions or other dissemination activities. Intern Jillian Barthelemy is currently completing an article for publication, based on her summer internship project with Dr. Haneen Khreis.

Plans for Next Reporting Period to Accomplish Education Goal

During the next reporting period, the current education initiatives will continue, and CARTEEH will look for additional opportunities for education and workforce development growth. We anticipate further progress on the curriculum course development, and a successful summer internship program, despite the initial setback from the pandemic.

CARTEEH Goal #3: Technology Transfer

CARTEEH views technology transfer as a vital part of the research process, and one that must be integrated with our R&D activities and not treated as an afterthought. We place a high value on stakeholder identification and engagement, as well as emphasizing information dissemination and the creation of open-access tools and methods that enable practical application of cutting-edge research findings.

Several technology transfer activities are underway and progressing. The CARTEEH technology transfer activities aim to make research results and knowledge available to the research community and beyond.

Transportation, Air Quality, and Health Symposium

During this reporting period, work continued on the next CARTEEH Transportation, Air Quality, and Health Symposium, which was scheduled for May 18-20, 2020, in Riverside, California. TTI and UC Riverside were to serve as event co-sponsors, with other partners supporting the program development. In late March, symposium leaders determined that the symposium must be postponed, due to COVID-19. It has been rescheduled for May 2021 at the same location.

The symposium's objective will continue to be promoting healthy transportation planning and policy by bringing together different disciplines working in the distinct areas of transportation systems, emissions, energy, air pollution, exposures, and public health. The targeted audience includes students, researchers, and university faculty or staff, as well as transportation professionals.

Transportation Emissions and Health Data Hub

Work continued on the "Innovative Data Applications Using CARTEEH's Data Hub" initiative during this reporting period. The follow-on project from the original Data Hub seeks to leverage the initial infrastructure for innovative data applications.

The goal of this project is to provide value to end-users in such a way that the data hub can sustain and expand its growth beyond the initial development funds. To the public and policymakers, the project aims to demonstrate use cases and provide value to a large body of diverse end-users. The proposed project output is a national vehicle emissions map with linkages to the existing asthma map. The map will enable the public to look up the most polluted major roadways across the US, differentiated by pollutants.

In this reporting period, the team focused on two major areas: 1) demonstrating the use of code hosted on the Datahub for a full chain model from traffic to health and 2) identifying new data sources related to energy to add to the data hub. Under area one, the team successfully reviewed and applied a Datahub entry (https://carteehdata.org/library/dataset/burden-of-disease-due-to--7e53) to a case study of health impact analysis for El Paso, TX.

Under area two, the team identified several data sources related to transportation electrification, safety, and the electric grid. The team reviewed and verified the validity of these datasets. The team also conducted exploratory analyses to confirm the value of such datasets in CARTEEH related research. The team will publish these data sets on the Data Hub in the next quarter.

CARTEEH Literature Library

The CARTEEH literature library continues to develop on the CARTEEH website. This tool is intended as a resource for students, researchers, and practitioners interested in transportation and health, especially the impact of transportation emissions and air pollution on human health. During this period, approximately 140 additional studies were added to the library, bringing the total to 940, addressing the full chain of events between transportation pollution sources and health impacts. This reference list will continue to be periodically updated to include new studies as they become available.

Technology Transfer Results Disseminated

All Center activities are posted to the CARTEEH website, with several updates made to the site following this reporting period. While earlier research projects are just coming to completion, a significant number of abstracts have been submitted, as well as presentations made.

The CARTEEH Transportation, Air Quality, and Health Symposium site remains active, and the detailed program has been supplemented with slides from each presentation, as well as videos in some instances.

Plans for Next Reporting Period to Accomplish Technology Transfer Goal

Work continues on the implementation of the Technology Transfer Plan, including incorporating revised reporting requirements. Further discussion of the implementation of the T2 plan is found in our "outcomes" section.

PARTICIPANTS AND COLLABORATING ORGANIZATIONS

CARTEEH is made up of a consortium of five institutions: TTI is a member of the Texas A&M University System and home to the Center. Faculty and students from other colleges, such as the Texas A&M Health Science Center, are also involved. Johns Hopkins University, Georgia Tech, University of Texas-El Paso, and the University of California, Riverside, complete the partnership.

Partner Organizations and Other Significant Collaborators

CARTEEH's focus areas cross multiple disciplines, bringing opportunities for a unique collaborative effort with institutions and individuals. These partners are essential to the success of the Center. Organizations and individuals in the following tables have directly supported or collaborated on Center activities.

Table 2: CARTEEH Partner Organizations

Organization Name	Location	Contribution
Air Alliance Houston	Houston, Texas	Collaboration
American Thoracic Society	New York	Collaboration
Atlanta Bicycle Council	Atlanta, Georgia	Collaboration, In-kind support
Atlanta Bike Coalition	Atlanta, Georgia	In-kind support
Atlanta Regional Commission	Atlanta, Georgia	Data, Collaboration
Breathe Easy Dallas	Dallas, Texas	Collaboration
Broadway Services	Baltimore, Maryland	Access to facilities and data
California Air Resources Board	Sacramento, California	In-kind support
California Energy Commission	Sacramento, California	In-kind support
Cherry Hill Neighborhood	South Baltimore, Maryland	Collaboration
Chesapeake Climate Action Network	Takoma Park, Maryland	Collaboration
City of Austin Department of Transportation	Austin, Texas	Collaboration
City of Carson	Carson, California	Personnel
City of Dallas	Dallas, Texas	Collaboration
City of Los Angeles	Los Angeles, California	Data
Clean Water Action	Washington, D.C.	Collaboration
Dallas Independent School District	Dallas, Texas	Access to facilities
El Paso Independent School District	El Paso, Texas	Facility and student access

El Paso Health Department	El Paso, Texas	Data sharing
El Paso Metropolitan Planning Organization	El Paso, Texas	Data sharing
Emory University	Atlanta, Georgia	Personnel, Collaboration
Environmental Defense Fund	Austin, Texas	Collaboration
George Mason University	Fairfax, Virginia	Collaboration, data
Georgia Department of Transportation	Atlanta, Georgia	Data
Georgia Ports Authority	Savannah, Georgia	Data, access to facilities, in-kind support
Georgia Tech Research Institute	Atlanta, Georgia	Data, personnel, access to facilities
Health Effects Institute	Boston, Massachusetts	Collaboration
Houston-Galveston Area Council	Houston, Texas	Collaboration
Institute for Healthy Living at the University of Texas at El Paso	El Paso, Texas	Collaboration, facility and student access
Kelly Burt Dozer	College Station, Texas	In-kind support
Larry Young Paving	College Station, Texas	In-kind support
Los Angeles County Metropolitan Transportation Authority	Los Angeles, California	In-kind support
Maryland Institute College of Art	Baltimore, Maryland	In-kind support
Metropolitan Atlanta Rapid Transit Authority	Atlanta, Georgia	Collaboration, in-kind support
Mississippi State University	Starkville, Mississippi	Collaboration
Mount Winans Community Association	Baltimore, Maryland	Collaboration, facility access
Nashville Metropolitan Transit Authority	Nashville, Tennessee	Collaboration, in-kind support
National Weather Service	Santa Teresa, New Mexico	Information/data sharing, collaboration
New Mexico Department of Environment	Santa Fe, New Mexico	Data, collaboration
New Mexico Department of Health	Santa Fe, New Mexico	Data, collaboration
New Mexico Department of Transportation	Santa Fe, New Mexico	Data, collaboration, access to facilities (field site)
North Central Texas Council of Governments	Arlington, Texas	Collaboration
Oak Ridge National Laboratory	Oak Ridge, Tennessee	Computer models
Port of Galveston	Galveston, Texas	Facilities
Port of Houston	Houston, Texas	Facilities
Port of Long Beach	Long Beach, California	Facilities
Port of Los Angeles	Los Angeles, California	Personnel
South Baltimore Go! Pilot Project	South Baltimore, Maryland	Collaboration
South Coast Air Quality Mgmt. District	Diamond Bar, California	Data, equipment, and facilities
Tampere University of Technology	Tampere, Finland	Collaboration, personnel exchange, in-kind support
TAMU Department of Construction Science	College Station, Texas	Facilities

Texas Department of Transportation	Austin, Texas	In-kind support, collaboration
The City of Dallas	Dallas, Texas	Collaboration
The Nature Conservancy	Austin, Texas	Collaboration
U.S. Department of Agriculture	Big Spring, TX and Fort Collins, CO	Collaboration, in-kind support, data, equipment, student access
U.S. Geological Survey	Reston, Virginia	Data, in-kind support, access to equipment
University of Delaware	Newark, Delaware	Collaboration
University of Miami	Miami, Florida	Collaborative research
University of Southern California	Los Angeles, California	Collaboration
The University of Texas, El Paso Department of Public Health	El Paso, Texas	Data sharing
University of Texas Houston School of Public Health	Houston, Texas	Collaboration and student access
University of Washington	Seattle, Washington	Collaboration
USDA Agricultural Research Service	Big Spring, Texas	In-kind support, equipment, collaboration
USDA Agricultural Research Service	Fort Collins, Colorado	In-kind support, equipment, collaboration
USDA Agricultural Research Service	Las Cruces, New Mexico	Equipment, collaboration
WeGo Public Transit	Nashville, Tennessee	In-kind support, access to facilities

Table 3: CARTEEH Collaborators

Name	Affiliation	Contribution	Country
Dr. Ananya Roy	Environmental Defense Fund	Collaboration	USA
Dr. Andrea Polidori	University of California - Riverside	In-kind contributions	USA
Dr. Bakeyah Nelson	Air Alliance Houston	Collaboration	USA
Dr. Cassandra Gaston	The University of Miami, Miami, FL	Contact/Collaboration/data sharing/leveraging	USA
Dr. Chanam Lee	Texas A&M University	Collaboration	USA
Dr. Daniel Tong	NOAA, Washington DC	Contact/leveraging	USA
Dr. David Cocker	UCR, Department of Chemical and Environmental Engineering	Experimental Design and Data Analysis	USA
Dr. David Dubois	Office of the State Climatologist, Las Cruces, NM	Collaboration	USA
Dr. Dongjoo Park	University of Seoul	Collaboration	Korea
Dr. Ellen MacKenzie	Dean, JHU Bloomberg School of Public Health	Collaboration	USA
Dr. Eun Sug Park	TTI – Mobility Analysis Program	Collaboration	USA
Dr. Gabriel Ibarra-Mejia	The University of Texas at El Paso, Department of Public Health	Collaboration, Data, Faculty	USA

Dr. George Delclos	University of Texas Health Science Center at Houston	Collaboration	USA
Dr. George Thrushton	New York University School of Medicine	Collaboration	USA
Dr. Jennifer Horney	University of Delaware	In-kind support	USA
Dr. Jenny Mindell	University College London	Collaboration	The U.K.
Dr. Jeremy Sarnat	Emory University	Collaboration, Faculty	USA
Dr. Joan Reibman	New York University School of Medicine	Collaboration	USA
Dr. Joao Ferreira-Pinto	The University of Texas at El Paso, Department of Public Health	Collaboration, Data, Equipment, In-kind, Faculty	USA
Dr. John Tatarko	USDA Agricultural Research Service, Fort Collins, CO	Collaboration	USA
Dr. John Wright	Bradford Institute for Health Research	Collaboration	The U.K.
Dr. Jorma Keskinen	Tampere University of Technology	In-kind contributions	Finland
Dr. Julian Marshall	University of Washington	Collaboration	USA
Dr. Kai Zhang	University of Texas Health Science Center	Collaboration	USA
Dr. Karen Lucas	University of Leeds	Collaboration	The U.K.
Dr. Kees de Hoogh	Swiss Tropical and Public Health Institute	Collaboration	Switzerland
Dr. Kent Johnson	University of California, Riverside	Data	USA
Dr. Kyuok Kim	Korea Transport Institute	Collaboration	Korea
Dr. Leah Whigham	University of Texas Houston Health Center	Collaboration, Data, Equipment, In-kind, Faculty	USA
Dr. Lixin Jin	The University of Texas at El Paso	Collaboration, Data, Equipment, In-kind, Faculty	USA
Dr. Liz York	Centers for Disease Control and Prevention	Collaboration	USA
Dr. Mark Benden	TAMU Health Science Center	Collaboration	USA
Dr. Mark Burris	TAMU – Civil Engineering	Collaboration	USA
Dr. Michael de Miranda	TAMU - College of Education	Collaboration	USA
Dr. Mark Nieuwenhuijsen	Barcelona Institute for Global Health	Collaboration	Spain
Dr. Martina Klose	Barcelona Supercomputing Center, Barcelona, Spain	Contact/ data sharing	Spain
Dr. Michael Jerett	University of California, Los Angeles	Collaboration	USA
Dr. Nicholas Webb	USDA Agricultural Research Service, Las Cruces, NM	Collaboration	USA
Dr. Nick Duffield	Texas A&M Institute of Data Science	Collaboration	USA
Dr. Qi Ying	TAMU – Civil Engineering	Collaboration	USA
Dr. R. Scott Van Pelt	USDA Agricultural Research Service, El Paso, TX	Collaboration	USA
Dr. Rashid Shaikh	Health Effects Institute	Collaboration	USA
Dr. Rob Scott McConnell	The University of Southern California, Keck School of Medicine	Collaboration	USA
Dr. Robin Autenreith	TAMU – Civil Engineering	Collaboration	USA
Dr. Roya Bahreini	UCR, Environmental Sciences	In-kind contributions	USA
Dr. Shams Tanvir	University of California, Riverside	Personnel	USA

Dr. Susan Anenberg	Environmental and Occupational Health, George Washington University	Collaboration	USA
Dr. Susan Chrysler	TTI – SAFE-D UTC Assistant Director	Collaboration	USA
Dr. Tom Durbin	University of California, Riverside	Data	USA
Dr. Wei Li	TAMU – Landscape Architecture and Urban Planning	Collaboration	USA
Dr. Yunlong Zhang	TAMU – Civil Engineering	Collaboration	USA
Mr. Brandon Feenstra	South Coast Air Quality Management District	Data, In-kind support	USA
Mr. David Ederer	Centers for Disease Control and Prevention	Collaboration	USA
Mr. Douglass Mann	Maryland Institute College of Art	Data collection access	USA
Mr. Hugh Pocock	Maryland Institute College of Art	Data collection access	USA
Mr. Iyasu Eibedingil	The University of Texas at El Paso	Collaboration, Data, Equipment, Student	USA
Mr. John Smart	Advanced Vehicles - Idaho National Lab	Collaboration	USA
Mr. Juan Aguilera	Institute for Healthy Living at the University of Texas at El Paso	Collaboration, Data, Equipment, Student	USA
Mr. Marcos Mendez	The University of Texas at El Paso	Collaboration, Data, Equipment, Student	USA
Mr. Mathew Bechle	University of Washington	Data	USA
Mr. Michael Garber	Emory University	Collaboration	USA
Mr. Zhiming Gao	Oak Ridge National Laboratory	In-kind support	USA
Ms. Niina Kuittinen	Tampere University of Technology	Collaboration	Finland
Ms. Victoria DeGuzman	University of Southern California/ METRANS UTC	Collaboration	USA
Mr. Trent Botkin	New Mexico Department of Transportation	Collaboration	USA
Mr. William Hutchinson	New Mexico Department of Transportation	Collaboration	USA
Mr. Michael Baca	New Mexico Environment Department	Collaboration	USA
Dr. Sarah Hayes	U.S. Geological Survey	Facilities, Equipment, Data	USA
Dr. Robert Wunderlich	Center for Transportation Safety, TTI	Data	USA
Dr. Jothikumar Narayanan	Centers for Disease Control and Prevention	Next-generation sequencing	USA
Stephen Paciotti	Texas Commission on Environmental Quality	Collaboration	USA

OUTPUTS

In CARTEEH's 2018 Technology Transfer Plan, several output performance measures were targeted to be tracked for our center. We have already successfully met several of our output target metrics, such as the number of conference presentations and papers based on CARTEEH research, as well as the number of public, industry, and nonprofit organizations engaged by CARTEEH researchers.

Our target metric for conference presentations and papers based on CARTEEH research is seven per year, and we have already exceeded this number in the current reporting period. Also, the

number of public, industry, and nonprofit organizations engaged by CARTEEH researchers is on target to exceed our identified goal. As shown in the previous list, we have partnered with over 65 organizations over the past year.

Presentations

Name: Meitiv. A., Xu. X., Sharifi. F., Shelton. J., Zietsman. J., Xu. Y.
Event: American Public Health Association's 2020 Annual Meeting and Expo. San Francisco, CA. October 24-28, 2020. **(**Submitted)
Title: Full-chain transportation and health modeling platform: An interactive way to explore

Name: Sharifi, F., X. Xu, A. Meitiv, J. Shelton, Y. Xu (Submitted). Regional Emission and Health Impact
Event: Assessment of Implementation of Micromobility: An El Paso, TX Case Study.
Title:2020 Conference on Sustainability and Emerging Transportation Technology (SETT). Irvine, CA. August 31 – September 2, 2020. (Submitted)

Name: Tanvir, S., Un-Noor, F., Boriboonsomsin, K., and Gao, Z.
Event: Submitted for presentation at 99th Annual Meeting of the Transportation Research Board and publication in Transportation Research Record
Title: Feasibility of Operating Heavy-Duty Battery Electric Truck Fleet in Drayage Application

Conference Abstracts, Conference Papers, and Journal Articles

Van Pelt, R. & Tatarko, John & Gill, Thomas & Chunping, Chang & Li, Junran & Eibedingil, Iyasu & Mendez, Marcos. (2020). Dust Emission Source Characterization for Visibility Hazard Assessment on Lordsburg Playa in Southwestern New Mexico, USA. 10.21203/rs.3.rs-21670/v1.

Barthelemy, J., Sanchez, K., Miller, M.R., and Khreis, H., 2020. New Opportunities to Mitigate the Burden of Disease Caused by Traffic-Related Air Pollution: Antioxidant-Rich Diets and Supplements. International Journal of Environmental Research and Public Health, 17(2), p.630.

Sohrabi, S., and Khreis, H., 2020. Burden of disease from transportation noise and motor vehicle crashes: Analysis of data from Houston, Texas. Environment international, 136, p.105520.

Sohrabi, S., Zietsman, J. and Khreis, H., 2020. Burden of Disease Assessment of Ambient Air Pollution and Premature Mortality in Urban Areas: The Role of Socioeconomic Status and Transportation. International Journal of Environmental Research and Public Health, 17(4), p.1166.

Thurston, G.D., Balmes, J.R., Garcia, E., Gilliland, F.D., Rice, M.B., Schikowski, T., Van Winkle, L.S., Annesi-Maesano, I., Burchard, E.G., Carlsten, C. Harkema, J.R., Khreis, H. et al. 2020. Outdoor Air Pollution and New-Onset Airway Disease. An Official American Thoracic Society Workshop Report. Annals of the American Thoracic Society, 17(4), pp.387-398.

Filippelli, G., Anenberg, S., Taylor, M., van Geen, A. and Khreis, H., 2019. New Approaches to Identifying and Reducing the Global Burden of Disease from Pollution. GeoHealth, p.e143.

Rojas-Rueda, D., Nieuwenhuijsen, M.J., Khreis, H. and Frumkin, H., 2020. Autonomous vehicles and public health. Annual review of public health, 41, pp.329-345.

Askariyeh, M.H., Venugopal, M., Khreis, H., Birt, A. and Zietsman, J., 2020. Near-Road Traffic-Related Air Pollution: Resuspended PM2. 5 from Highways and Arterials. International Journal of Environmental Research and Public Health, 17(8), p.2851.

Media References

None to report currently

Website

The CARTEEH website continues to be the face of our Center and is regularly updated with the latest center activities. It also provides access to the Transportation Emissions and Health Data Hub, as well as the literature library and videos from CARTEEH seminars. From October 1, 2019, through March 31, 2020, the CARTEEH website had a total of 5,668 page views and a total of 2,900 unique visitors.

Technologies

None to report for this period

Inventions

None to report for this period

Other Products

None to report for this period

OUTCOMES

We have successfully met several of our outcome performance measures, such as the number of attendees at seminar and outreach events, and the number of visitors to the website, literature library, and Data Hub. Our target measure for the number of attendees to the seminar, webinar, and outreach events is 150 per year; we are meeting that goal.

A second performance measure is the number of visitors to the CARTEEH website, literature library, and Data Hub. Our target number is 700 per year. We are continuing to exceed this goal each year.

IMPACT

We are continuing to see the impacts of our work, ranging from the successes of our students

and interns to the dissemination of our research results and technology transfer activities. We continue to engage several transportation agencies and work with them collaboratively on solutions that can maintain and enhance the functioning of the transportation system while also promoting health. Our outputs continue to impact the body of existing scientific knowledge, with publications and conference presentations reaching a scientific audience, as well as the local media. We hope to continue outreach to stakeholders with a view of increasing our impact in the coming reporting period.

CHANGES/PROBLEMS

None

SPECIAL REPORTING REQUIREMENTS

No special reporting requirements.