



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

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OVERVIEW

The Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH) has been very successful during this reporting period, building on our achievements over the past several years. Our research projects and strategic initiatives are progressing well, and we have continued to emphasize technology transfer and stakeholder outreach and education as we aim to maximize the impacts of our activities.

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, which cover the tailpipe-to-lungs spectrum, 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 CARTEEH's project portfolio, shown in Table 1 below, which includes over 45 initiatives that are either ongoing or have been completed.

In this reporting period, work continues with current projects. In addition, six projects were published to the [CARTEEH website](#). The newly published reports address important and emerging areas of transportation research, including four that focus on the topic of vehicle electrification.

Jaqueline Kuzio from the Texas A&M Transportation Institute (TTI) completed a project titled, "[Economic Impacts of Electric Vehicle Infrastructure Expansion on Texas Metros](#)" in December 2021. This project focused on creating an economic benefit tool that aids the user in communicating the benefits of investing in EV charging infrastructure. The economic benefit tool for Electric Vehicle (EV) infrastructure provides planners and policymakers with an overview of the economic benefits associated with investing in charging stations for EVs.

TTI's Suriya Vallamsundar also finalized a project titled, "[Personal Exposure to Air Pollution in the Vicinity of U.S.-Mexico Border Crossings](#)" focused on the evaluation of personal and ambient monitoring of particulate matter (PM) in El Paso, Texas. The findings from this study contribute to the body of literature on air quality and microenvironmental exposure. The methods developed in the study can be used by city planning and air quality organizations to screen highly impacted neighborhoods and develop targeted strategies to improve air quality.

The University of Texas at El Paso led a project under the directive of Dr. Thomas Gill titled, "[Quantifying Bioavailable Metals and Potential Dust Emissions from Highway-Related and Desert Sediments at Lordsburg Playa, New Mexico.](#)" This study combined USDA's SWEEP wind erosion model and EPA's AERMOD air dispersion model to quantify dust emission from a playa environment. The field testing and modeling methodologies performed in this study can be adopted to assess the potential intensity of wind erosion and dust emission and identify areas for mitigation at other playas and desert dust hotspots that threaten transportation corridors and infrastructure.

Farinoush Sharifi, who recently completed her Ph.D. at Texas A&M University, was the lead researcher of a CARTEEH-funded study titled "[Drayage Truck Electrification Feasibility and Benefit Analysis.](#)" The goal of this study was to assess the feasibility of the electrification of drayage truck fleets operating at and around the Port of Houston. The feasibility assessment includes the commercial availability of the technology, the practicality of truck operations considering range and charging, and the economics of transitioning to an electric fleet.

The University of California – Riverside recently published a final report led by Dr. Peng Hao titled "[Evaluation of Battery Electric Trucks and Connected Vehicle Technologies for Drayage Application](#)". The report focuses on answering questions related to the feasibility of heavy-duty truck fleet electrification by analyzing real-world operation data of a typical drayage operator. To achieve this project objective, second-by-second activity data was collected from 20 drayage trucks from an operator in Southern California. These data were used to estimate the corresponding electric energy consumption and the state of charge of the battery using a microscopic electric energy consumption



model. An algorithm for generating tours of drayage activity from the collected data was developed and implemented.

TTI’s Ann Xu finalized a report titled “[Technology Landscape and Future Direction for Transportation Emissions, Energy, and Health](#)”, which presents a roadmap for technology development and implementation in transportation emissions, energy, and health—in the context of emerging transportation sector trends. Specifically, the project focuses on vehicle electrification. The report identifies technologies currently available or under development in both software and hardware. Further, the report notes transition partners and stakeholders in private and public sectors. The technology landscape also reveals gaps in research and development as well as in technology transfer. The report concludes with an action plan for modeling, testing, and measuring vehicle electrification.

Table 1: CARTEEH Project Portfolio

Project	Lead Institution	Principal Investigator
<i>Transportation Emissions and Health Data Hub</i>	TTI	Dr. Andrew Birt
Reconciles differences in characteristics of transportation and health data; develops a platform to house datasets		
<i>Truck Emissions Exposure Study in Ports</i>	GaTech	Dr. Michael Rodgers
Assesses pollutant emissions at selected major ports; evaluates the potential reduction of exposure using multiple methodologies		
<i>Border Crossing Emissions Impact Study</i>	TTI	Dr. Tara Ramani
Characterizes the emissions impact of border crossings and identifies population groups most affected by the emissions		
<i>Healthy Living and Traffic-Related Air Pollution in an Underserved Community</i>	UTEP	Dr. Wen-Whai Li
Quantifies traffic-related air pollution and the associated respiratory health for vulnerable school children in El Paso, Texas		
<i>Development and Evaluation of Connected Vehicle Application for Alternative Fuel Trucks</i>	UCR	Dr. Peng Hao
Evaluates benefits of battery-electric trucks and plug-in hybrid electric trucks over conventional diesel trucks		
<i>Health Risk Characterization for Transportation Users</i>	JHU	Dr. Mary Fox
Develops a cumulative exposure and risk profile for transportation workers and/or system users considering chemical and other stressors		



<i>Assessing Regulatory Compliance and Community Air Pollution Impacts of Crude Oil by Rail (CBR) Transport in Baltimore City, Maryland</i>	JHU	Dr. Genee Smith
Delivers evidence-based characterization of emissions impacts of CBR within Baltimore City, Maryland		
<i>PM Exposure for Paratransit Transport</i>	GaTech	Dr. Alex Samoylov
Characterizes exposure to PM faced by sensitive populations using paratransit transport		
<i>Traffic-Related Air Pollution and Childhood Asthma in the United States: A Burden of Disease Assessment</i>	TTI	Dr. Haneen Khreis
Conducts a burden of disease estimate of childhood asthma attributable to traffic-related air pollution within the US		
<i>Characterizing In-Cab Air Quality in Heavy-Duty Diesel Construction Equipment</i>	TTI	Dr. Phil Lewis
Analyzes air quality and driver exposure inside the cabs of heavy-duty diesel construction equipment		
<i>Dockless Mobility: Addressing Safety, Emissions, and Gaps in Policy Making</i>	TTI	Dr. Suriya Vallamsundar
Examines emissions exposure on dockless mobility users in Dallas, Texas		
<i>Quantifying Bioavailable Metals and Potential Dust Emissions from Highway-Related and Desert Sediments at Lordsburg Playa, New Mexico</i>	UTEP	Dr. Thomas Gill
Scopes the presence of bioavailable metals and potential dust emissions from highway-related and desert sediments in New Mexico		
<i>Secondary Particulate Matter Exceed Primary Emissions from Current Gasoline Vehicles: Air Quality and Public Health Implications</i>	UCR	Dr. Georgios Karavalakis
Assesses emissions from gasoline direct injection and multipoint injection vehicles when operated under different driving cycles		
<i>Quantifying Traffic Congestion-Induced Change of Near-Road Air Pollutant Concentration</i>	UCR	Dr. Jill Luo
Develops a statistical model to quantify the contribution to the ambient air quality degradation due to traffic congestion		
<i>Transportation and Health - Conceptualization and Quantification</i>	TTI	Dr. Haneen Khreis
Addresses the transportation-health nexus beyond air quality and emissions; develops a comprehensive conceptual "pathways" model		
<i>Urban Policy Interventions and Their Effectiveness in Reducing Traffic Emissions and Traffic-Related Air Pollution</i>	TTI	Dr. Haneen Khreis



Identifies policy interventions to effectively reduce traffic emissions and traffic-related air pollution from on-road mobile sources		
<i>Technology Landscape and Future Direction for Transportation Emissions, Energy, and Health</i>	TTI	Dr. Yanzhi (Ann) Xu
Develops a technology roadmap for transportation emissions, energy, and health		
<i>Curriculum for Transportation Emissions and Health</i>	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.		
<i>Transportation Emissions and Health Literature Library</i>	TTI	Dr. Haneen Khreis
Downloadable spreadsheet resource tabulating and categorizing literature on transportation emissions, energy, and health.		
<i>Innovative Data Applications using CARTEEH's Data Hub</i>	TTI	Dr. Yanzhi (Ann) Xu
Use of CARTEEH's data hub infrastructure for data integration applications, including the development of a national emissions map		
<i>Development of an Emission-Based Selection Algorithm to Optimize Variable Message Signs Location (student project)</i>	TTI	Dr. Farinoush Sharifi
Develops an algorithm to identify locations of variable message signs to maximize emissions savings in situations of nonrecurring congestion		
<i>Real-World Data Measurement of Factors Affecting Air Quality for Nonroad Diesel Equipment Operators</i>	TTI	Dr. Phil Lewis
Characterizes the various factors affecting equipment operators' exposure to poor air quality, using real-world data and measurements.		
<i>Trace Metals in Airborne Particulate Matter and Genomic Characterization of Associated Microorganisms: Insights into Health Effects from an Industrialized, Near-Roadway Site in Houston</i>	TTI	Dr. Shankar Chellam
Investigates vehicular contributions of PM10, and its elemental components and microorganisms, to understand health effects and implications.		
<i>Making New Mobility a "Win" for Public Health</i>	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.		
<i>Improved Vehicle Emissions and Near-Road Dispersion Modeling Tool for Project Evaluation: Integrating MOVES-Matric, the FEC, and AERMOD</i>	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.		
<i>Modeling Air Quality Impacts of Pollution Mitigation Scenarios at a Multimodal Inland Port</i>	GaTech	Dr. Franklin Gbologah



Assessment of Nox and PM emissions and dispersion for various pollution control scenarios in an inland port.		
<i>Association of Traffic and Related Air Pollutants on Cardiorespiratory Risk Factors from Low-Income Populations in El Paso, TX.</i>	UTEP	Dr. Jsoyoung Jeon
Studies linkages between cardiorespiratory risk factors and levels of traffic-related air pollutants.		
<i>Onboard Sensing, Analysis, and Reporting (OSAR): Expanded Field Demonstrations and Development of Associated Visual Aids</i>	UCR	Dr. Kent Johnson
Develops the capability for spatial and temporal visualization of emissions from the OSAR on-board emissions measurement system.		
<i>Development of Full-Chain Transportation Emissions, Exposure and Health Modeling Platform</i>	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		
<i>Transportation as a Disease Vector - a Modeling Approach</i>	TTI	Dr. Joe Zietsman
Investigates the role of transportation vehicles and infrastructure in the spread of disease.		
<i>Runners air pollution exposure assessment using Low-cost Wearable (LCS) Sensors</i>	TTI	Benjamin Ettelman
The study attempts to bridge a gap in the literature by employing emerging low-cost sensor technology.		
<i>Feasibility Analysis and Infrastructure Requirements of Affordable, Shared, and Electric Mobility</i>	TTI	Dr. Yanzhi (Ann) Xu
Study assesses the feasibility of providing electric shared EV service to middle- and low-income households that live in multi-unit communities in Texas.		
<i>Economic Impacts of Electric Vehicle Infrastructure Expansion on Texas Metros</i>	TTI	Dr. Jacqueline Kuzio
This research project will produce a tool that utilizes both benefit-cost and economic impact modelling to show the benefits that could arise with an increased investment in electric vehicle infrastructure.		
<i>Effects of COVID-19 Lockdown on Air Quality and Mortality across Continental United States – A Data Driven Approach</i>	TTI	Dr. Rohit Jaikumar
Study aims to integrate observational air quality data from EPA and other state agencies monitoring networks with satellite data and epidemiological studies to quantif the health benefits of the lockdown measures imposed in response to the COVID-19 pandemic.		
<i>Developing a SMART Framework and Practitioner Toolkit to Enhance the Public Health Benefits of Transportation Infrastructure</i>	TTI	Benjamin Ettelman
Identify a range of qualitative and quantitative metrics for transportation-health pathways.		
<i>Drayage Truck Electrification Feasibility and Benefit Analysis</i>	TTI	Dr. Yanzhi (Ann) Xu
The goal of this study is to assess the feasibility of truck fleet and equipment electrification at POH.		
<i>Instant COVID-19 Diagnostic Devices on the Go to Improve Transportation Safety</i>	UTEP	Dr. Xiujun Li
This project aims to develop an “on-the-Go” COVID-19 quantitative diagnostic microdevice.		



<i>Understanding Modal Shift during the Pandemic and Quantifying its Public Health Impact</i>	JHU	Michelle Duren
The goal of the study is to provide useful insights for policymakers in transportation and health departments on travel behavior changes during the pandemic.		
<i>Locational Marginal Emission Evaluation for Electric Vehicle Charging Facility Planning</i>	UTEP	Dr. Yuanrui Sang
Develop a framework for hazardous gas LME evaluation and EV environmental impact mitigation.		
<i>Impacts of COVID-19 Induced Active Transportation Demand on the Built Environment and Public Health</i>	TTI	Dr. Bahar Dadashova
Develop data-driven tools and recommendations for implementing a bicycle- and pedestrian-friendly infrastructure to meet and maintain this new demand.		
<i>Develop a performance metric to quantify the inhalation of traffic-related air pollutants at both mesoscale and macroscale</i>	UCR	Dr. Ji Luo
Develop a performance metric to quantify the inhalation of traffic-related air pollutants at both mesoscale and macroscale.		
<i>Quantifying the Environmental and Health Impacts of Curbside Management for Emerging Multi-modal Mobility Services</i>	UCR	Dr. Guoyuan Wu
The research aims to investigate how curbside management strategies may help address traffic bottlenecks on roads and sidewalks due to intensive pick-up/drop-off activities.		
<i>Children's Exposure to Traffic Pollution in Texas School Districts: Analyzing Social Disparities and Adoption of Mitigation Strategies</i>	UTEP	Dr. Jayajit Chakraborty
This project seeks to analyze social disparities in exposure of school-aged children to vehicular air pollution and examine the adoption of mitigation strategies for reducing school exposure to vehicular pollution, across public school districts in Texas.		
<i>Quantification of traffic-related emissions and exposures at US-Mexico Border Crossings using real-time mobile sensors</i>	UTEP	Mayra Chavez
Exposure to traffic emissions related to border crossing occurs while people are waiting in line or on foot to cross the border.		
<i>Supporting Health-Transportation Education in Schools</i>	TAMU	Dr. Joanne Olson
This project supports CARTEEH's SMART Infrastructure initiative project by demonstrating how carefully designed educational STEM contents can promote a greater understanding and engagement of stakeholders in public schools (K-12 level).		

Dissemination of Research Results

CARTEEH researchers continue to disseminate their research results at conferences, invited talks, through publication of journal articles, and other stakeholder outreach. Key research findings and final reports are also disseminated through the CARTEEH website. CARTEEH continues to host webinars that feature completed work funded by the grant.

Plans for Next Reporting Period to Accomplish Research Goal

In the next reporting period, CARTEEH leadership will emphasize bringing ongoing projects to completion, and focus on the development of selected strategic research projects that would have impactful outcomes, aligned with our research, education, and technology transfer priorities.



CARTEEH Goal #2: Education and Workforce Development

CARTEEH's research involves several graduate and undergraduate students at each consortium member institution. CARTEEH focuses on mentoring the next generation of professionals through education and workforce development activities. The following subsections provide a summary of the education and workforce development activities conducted during this reporting period.

CARTEEH STEM Outreach Kit

During this reporting period, CARTEEH continued its collaboration with Texas A&M University's College of Education with a focus on Science, Technology, Engineering, Mathematics (STEM) outreach for school students. As part of a collaborative project, a STEM outreach kit was developed to support CARTEEH's public outreach programming to provide a hands-on experience for the public that is scalable and increases awareness of air pollution and health impacts, CARTEEH's research, and STEM careers. The outreach kit was piloted on October 19, 2021, at a STEM Family Night at the Greens Prairie Elementary School in College Station, Texas. Over 200 students and parents participated and interacted with the booth activities that included an air pollution demonstration, presentation by a CARTEEH researcher; a swine lung activity showing the impacts on health; and the creation of a mural with possible solutions to reduce air pollution. A post-event survey was implemented to measure changes in knowledge and attitudes. The survey as well as a report detailing the efforts involved in conducting STEM Family Night can be viewed [here](#). Figure 2 below provides a picture of the CARTEEH researcher and Texas A&M University's College of Education staff at Family Stem night.



Figure 2. CARTEEH Booth at STEM Family Night, Greens Prairie Elementary School



CARTEEH Curriculum

CARTEEH's cross-disciplinary course titled "*Traffic-Related Air Pollution, Human Exposures, and Health*" was previously completed and [posted on the CARTEEH website](#). Minor additions and updates continue to be made to the course. The curriculum is used by faculty and practitioners to supplement their educational courses and for self-guided learning.

CARTEEH Summer Internship Program

CARTEEH holds its annual summer internship program from May to July of each year, in conjunction with two other University Transportation Centers (UTCs) at the Texas A&M Transportation Institute. During this reporting period, preparations were made for the 2022 internship program, which will be held in a hybrid in-person and remote format (the 2020 and 2021 internships were held virtually due to COVID). CARTEEH selected five summer interns majoring in a diverse set of disciplines, including engineering, public health, GIS, and environmental studies. The interns will work with mentors at TTI on research projects and participate in weekly virtual events over the course of the internship, which will run from May 24 to July 31, 2022.

CARTEEH Webinar Series

CARTEEH continued its webinar series with two very successful webinars in this reporting period. The first webinar, held on December 9, 2021, titled "Educating the Future Workforce on Transportation Emissions, Energy and Health" featured Dr. Joe Zietsman, Dr. Joanne Olson, Dr. Mary Fox, and Dr. Michael O. Rogers who provided an overview of CARTEEH's initiatives related to educating the future transportation workforce and future educational initiatives and needs. The second webinar featured Dr. Kanok Boriboonsomsin and Dr. Aravind Kailas, who discussed their work examining the air pollution and health impacts of freight movement in environmental justice communities through truck electrification.

Materials and recordings from the webinars can be accessed and viewed at the [CARTEEH website](#).

CARTEEH Student of the Year

CARTEEH's student of the year award program solicited nominees from consortium members in accordance with DOT guidelines. The winner of the 2022 award is Kristen Sanchez of Texas A&M University. Kristen will receive a Master of Public Health in May 2022 and is currently featured on the CARTEEH website for this prestigious honor. Kristen was presented the student of the year award at a virtual ceremony held in January 2022.

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. CARTEEH is scheduled to continue participation in STEM related activities as part of the collaboration with the Texas A&M College of Education.

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 activities at all stages and in a cross-cutting manner. CARTEEH values stakeholder 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.

Clean Transportation Collaborative

During this reporting period, CARTEEH established the Clean Transportation Collaborative (CTC). The purpose of the CTC is to bring together interdisciplinary and intersectoral stakeholders to facilitate thought leadership and guide research in the transition to a low-emissions transportation system. The CTC will serve as a forum for interdisciplinary collaboration and discussion. CTC activities are envisioned to include workshops, seminars, development of white papers, and initiation of research, analysis, and testing activities at CARTEEH. A kick-off event for the CTC was held on April 13, 2022. The meeting featured keynote speakers including the Deputy Assistant Secretary for Sustainable Transportation at the US Department of Energy, Michael Berube and Interim Deputy Director for Joint Office of Energy and Transportation, Dr. Rachael Neale. Over eighty registrants registered and attended the kickoff CTC meeting. In addition, membership continues to grow as CTC activities continue to ramp up.

Technology Transfer Products

CARTEEH continues to maintain the [CARTEEH DataHub](#) with data from CARTEEH projects. In addition, CARTEEH continues to maintain the [CARTEEH Literature Library](#), which serves as a resource for students, researchers and practitioners interested in the area of transportation and health, especially in the area focusing on the impact of transportation emissions and air pollution on human health.

Dissemination of Technology Transfer Results

All Center activities are posted to the CARTEEH website, with several updates made to the site following this reporting period. CARTEEH has completed many projects during this cycle and has updated the center website to reflect completed projects. In the future, CARTEEH will highlight research by hosting webinars and disseminating project results through various venues.

Plans for Next Reporting Period to Accomplish Technology Transfer Goal

CARTEEH plans to continue the implementation of the Technology Transfer Plan, engaging with stakeholders, and developing tools and project outputs that can directly aid practitioners in their work.

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 and the Texas A&M School of Education are also involved. Johns Hopkins University, Georgia Tech University, the University of Texas-El Paso, and the University of California, Riverside, complete the partnership.

Partner Organizations and Other Significant Collaborators

CARTEEH's focus areas span multiple disciplines, bringing opportunities for a unique collaborative effort among various 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 Organizatoin	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
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
Sun Metro	El Paso, Texas	Project Stakeholder
El Paso County Transit	El Paso, Texas	Project Stakeholder
City of El Paso	El Paso, Texas	Project Stakeholder
Camino Real Regional Mobility	El Paso, Texas	Project Stakeholder
Center for Disease Control and Prevention	Atlanta, Georgia	Next Generation Sequencing
Children's Hospital Los Angeles	California	Collaboration
El Paso Electric Company	El Paso, Texas	Provided sample survey questions
Texas Commission on Environmental Quality	Houston, Texas	Sampling and logistics
LINK Houston	Houston, Texas	Collaboration
City of Riverside	California	In-kind support
Norfolk Southern Railway	Atlanta	Personnel, Collaboration
Ray C. Anderson Foundation	Atlanta	Data, Personnel

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	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
Dr. Shankar Chellam	TAMU	Collaborator	USA
Jennifer Dien Bard	Children's Hospital Los Angeles	Collaboration	USA
Kevin Hall	TTI	Data	USA
Jacob Aun	Socio-Environmental and Geospatial Analysis Lab, UTEP	Data collection access	USA
Ernesto Ortiz	El Paso Independent School District	Access	USA
Jacob Burns	Institute for Medical Information Processing, Biometry and Epidemiology	Collaboration	Germany
Anthony D. May	Institute for Transport Studies	Collaboration	The U.K.
Shams Tanvir	California State Polytechnique, San Luis Obispo	Collaboration	USA
Tom Durbin	University of California at Riverside	Data	USA



Cesunica Ivey	University of California at Riverside	Equipment	USA
Akura Ventakram	University of California at Riverside	Equipment	USA
Nanpeng Yu	University of California at Riverside	Data	USA
Ran Wei	University of California at Riverside	Data	USA
Amy Moore	Oak Ridge National Laboratory	Data, In-Kind Support	USA
Mary Katherine Watson	The Citadel	Collaboration	USA
Andrew Danneberg	University of Washington	In-Kind Support, Collaboration	USA
April Willis Rodgers	Samford University	Collaboration, In-Kind Support	USA
Daniel Rochberg	Emory University	In-Kind Support, Collaboration	USA
Dr. Teresa Penbrooke	GP RED and GreenPlay, LLC	Collaboration	USA

Outputs

CARTEEH continues to meet several of our outcome performance measures, including the number of attendees at seminar and outreach events, and the number of visitors to the CARTEEH website, Literature Library, and DataHub. For this six-month reporting period, CARTEEH had over 324 webinar attendees and far surpassed its website-visit goal (700) with over 3,000 unique visits. The Center is on track to exceed its yearly goals for these metrics.

Presentations

Name: Li, XiuJun

Event: PacifiChem 2021

Title: Low-cost bioassays using paper/polymer hybrid microdevices and thermometer-based photothermal nanotechnology

Name: Li, XiuJun

Event: PacifiChem 2021

Title: Microfluidic devices for dynamic single-cell analysis and beyond

Name: Dr. Joanne Olson, Natasha Wilkerson

Event: Educating the Future Workforce on Transportation Emissions, Energy and Health

Title: Educational Outreach: Supporting Health-Transportation Education in Schools

Name: Benjamin Janney, Natasha Wilkerson

Event: Expanding Your Horizons Workshop

Title: What's in the air you breathe?

Name: Mayra Chavez, Leonardo Vazquez

Event: Virtual Meeting: U.S. Customs Border Protection Agency

Title: UTEP study at BOTA

Name: Kenji Santacruz

Event: 53rd North American Power Symposium (November 2021)

Title: Tracking Renewable Energy Consumption in an Electricity Market



Name: Josias Zietsman, Ann Xu, Alice Grossman
Event: Eno Center for Transportation Webinar
Title: Electric Vehicle Charging Networks: Strategies, Data, and Models for States

Name: Ben Ettelman
Event: Thinking Transportation
Title: Upsides and Downsides: Transportation and public health share a complicated union.

Name: Ben Ettelman
Event: American Medical Society for Sports Medicine 2022 Annual Meeting
Title: Urban Planning Using Wearable Data to Promote Healthy Cities

Name: Alice Grossman
Event: Thinking Transportation
Title: Multiple Stakeholders, One Purpose: The vision of “clean transportation” involves much more than electric cars.

Name: Kenji Santacruz
Event: ASPIRE Student Presentations
Title: Tracking the Source of Marginal Electricity Generation and Emissions on a Spatial-Temporal Basis in an Electricity Market

Name: Alice Grossman
Event: TRB 101st Annual Meeting
Title: Case Studies in MOD Fare Integration with Public Transit Agencies

Name: Alice Grossman
Event: TRB 101st Annual Meeting
Title: Commute by Microtransit: Evaluating Google’s Microtransit Pilot Program

Conference Papers, Conference Papers, and Journal Articles

Fu, G.;* Hou, R.; Mou, X.; **Li, X.*** Integration of 3,3',5,5'-tetramethylbenzidine (TMB)-probed ELISA-like systems in a photothermal bar-chart microfluidic chip for multiplexed immunoassay, *Anal Chem* 2021, 93, 15105-15114. DOI: 10.1021/acs.analchem.1c03387. (IF 7.0)

Zhou, W.;* Dou, M.;* Sanjay, S. T.;* Xu, F.;* **Li, X.*** Recent innovations in cost-effective polymer and paper hybrid microfluidic devices, *Lab Chip* 2021, 21, 2658-2683. DOI: 10.1039/D1LC00414J. (Invited. IF 6.8).

Chakraborty J. 2022. Children’s Exposure to Vehicular Pollution: Environmental Injustice in Texas, USA. **Environmental Research** (ISI impact factor = 6.498). Volume 204, Part A, 112008. Available at: <https://doi.org/10.1016/j.envres.2021.112008>.

Chakraborty J, Schwanke L, and Salas K. 2021. Characteristics of Children and Vehicular Pollution in Texas School Districts Dashboard. Available at: <https://tinyurl.com/CCVPTXSD>.

Sourav Das, Brent V. Miller, Joseph Prospero, and Shankararaman Chellam (2022). Sr-Nd-Hf Isotopic Analysis of Reference Materials and Natural and Anthropogenic Particulate Matter Sources: Implications for Accurately Tracing North African Dust in Complex Urban Atmospheres. *Talanta*, **241**(15): 123236.



Media References

None

Website

The CARTEEH website continues to be regularly updated with the latest center activities as well as new publications and reports. The site also provides access to the Transportation Emissions and Health Data Hub, the Literature Library, and videos from CARTEEH seminars and webinars. From October 1, 2021, through March 31, 2022, the CARTEEH website had a total of 6,225 page views and a total of 3,200 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

CARTEEH has effectively met several of its 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 surpassing that goal.

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, including the establishment of a successful spin-off venture that builds on CARTEEH research. 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.

