Center for Advancing Research in
Transportation Emissions, Energy, and Health
A USDOT University Transportation Center

CARTEEH Curriculum for Transportation Emissions and Health

Citation: Khreis, Haneen, in collaboration with Center for Advancing Research in Transportation Emissions, Energy, and Health consortium member institutions (2019). *CARTEEH Curriculum for Transportation Emissions and Health.* College Station, Texas: Center for Advancing Research in Transportation Emissions, Energy, and Health, July 2019.

Course Description and Target Audience

The Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH) (https://www.carteeh.org/) has developed a unique, cross-disciplinary course titled "Traffic-Related Air Pollution: Emissions, Human Exposures, and Health."

Course Title

Traffic-Related Air Pollution: Emissions, Human Exposures, and Health

The course is intended to form the basis for a three-credit-hour graduate-level course offered by consortium member institutions and targeted at students and practitioners in the areas of urban planning, transportation planning, transportation policy, transportation engineering, geography, environmental sciences, environmental epidemiology, environmental policy, and public health. However, the course's individual lectures are designed to stand alone, and as such, they can be mixed and matched to be transferable to other locations and other purposes, including:

- complementing existing academic or professional courses, including at the undergraduate level; and
- devising a smaller course with select lectures for target audiences with specific needs and/or existing knowledge.

In its entirety, the course is designed to equip participants with cutting-edge knowledge and the skill sets required to understand, assess, and quantify road traffic, vehicle emissions, traffic-related air pollution (TRAP), human exposures, biological mechanisms, associated health effects, and population-based impacts and their societal costs. Further, the course will specifically explore the role of current knowledge in environmental regulation and real-world policy making and practice.

The course will conclude with an introduction to the basics of policy option generation and selection, methods and tools to assess policy feasibility and effectiveness to mitigate the adverse environmental and health effects of TRAP, and an overview of available and emerging policy and technology options. Barriers and facilitators to good practice, co-benefits to other sectors, and overlap with the sustainability agenda will be presented, alongside real-world examples and case studies.

Tracks

The course can be offered in three high-level separate tracks, reflecting CARTEEH's vision and tailored to the participants' existing knowledge and potential application. Each lecture within the course will be marked as HT, TT, PPT, or multiple:

- **health track (HT)**—mainly targeted at urban planners, transportation planners, and engineers with limited knowledge of public health-related concepts;
- **transportation track (TT)**—mainly targeted at environmental epidemiologists and public health professionals with limited knowledge of transportation-related concepts; and
- **planning and policy track (PPT)**—mainly targeted at planners, civil servants, and policy and decision makers with particular interest in the science-policy link.

Reviewers and Collaborators

The following collaborators have reviewed this curriculum's outline and content:

- Andrew Glazener at The University of Texas at Austin;
- Carolyn Daher at the Barcelona Institute for Global Health;
- David Rojas Rueda at the Barcelona Institute for Global Health and Colorado State University;
- Inyang Uwak at the Texas A&M School of Public Health;
- Joe Zietsman at the Texas A&M Transportation Institute (TTI);
- Kanok Boriboonsomsin at the Center for Environmental Research and Technology at the University of California, Riverside (UCR);
- Kirsten Koehler at the Johns Hopkins School of Public Health;
- Kristen Sanchez at TTI;
- Mark Nieuwenhuijsen at the Barcelona Institute for Global Health;
- Mary Fox at the Johns Hopkins School of Public Health;
- Mike Rodgers at the Georgia Institute of Technology;
- Mohammad Hashem Askariyeh at TTI;
- Natalie Johnson at the Texas A&M School of Public Health;
- Natalie Mueller at the Barcelona Institute for Global Health;
- Nicole Davis at the Center for Environmental Research and Technology at UCR;
- Tara Ramani at TTI;
- Yanzhi (Ann) Xu at TTI; and
- Wen-Whai Li at The University of Texas at El Paso (UTEP).

The HT provides an overview and the basics of the health side of the spectrum (including lectures such as an introduction to epidemiology, overview of epidemiological studies, designs/types, etc.).

The TT provides an overview and the basics of the transportation side of the spectrum (including lectures such as an introduction to transportation planning, overview of traffic measurement and modeling, etc.).

The HT and TT both cover policy background, policy options generation, and (scenario) analysis, and most individual lectures do not fit in one track alone but rather in both.

The PPT mainly targets practitioners and policy decision makers, and provides a more holistic overview of the health and transportation sides of the spectrum, alongside a focus on the science-policy link and real-world case studies.

Key Topics

Cross-disciplinary in nature, the course will cover key topics from transportation, urban planning, the environment, exposure assessment, public health, and public policy, notably including:

- introduction to air pollution and traffic-related air pollution;
- introduction to vehicle emissions and air quality standards and regulations;
- traffic monitoring and modeling;
- vehicle emissions monitoring and modeling;
- air pollution monitoring and modeling;
- air pollution and traffic-related air pollution exposure assessment;
- epidemiology;
- health impacts and burden of disease assessment;
- health effects and impacts of traffic-related air pollution;
- toxicological and mechanistic evidence;
- policy option generation, selection, and implementation;
- emerging technologies and disrupters;
- policy (scenario) analysis, effectiveness, and feasibility; and
- barriers and facilitators to good practice and real-world examples.

Course Outcomes

Participants of this course will become equipped with a unique cross-disciplinary background that is not currently offered by any other course/curriculum on the market. Participants are also expected to gain expertise to support policy makers, confidently use analytical tools and methods from the different disciplines, and interpret and clearly communicate results and their relevance in policy and practice circles.

Preferred Prerequisites

The course is designed at the graduate level for those knowledgeable of the basics of transportation or environmental health. It is therefore preferred that participants have an undergraduate degree in:

- civil or transportation engineering;
- urban, regional, or transportation planning;
- geography;
- medicine;
- (bio)environmental sciences;

- public or community health; or
- equivalent education or experience.

However, because the course covers the basics of transportation and environmental health, these prerequisites are preferred but not essential.

Delivery Methods

Each of the proposed 60 lectures will be a 15-minute prerecorded audio lecture, which participants can either listen to prior to or during the relevant class, depending on the instructors' preference and experience. Exams, papers, quizzes, and homework assignments can be assigned based on the instructors' preference but are not further discussed in this outline.

Each prerecorded audio lecture will be complemented by a set of slides in a predefined CARTEEH template and either a book chapter or a set of notes including a reading list, which the participant can refer to for more complete and in-depth information. The curriculum development is being undertaken in parallel with editing an Elsevier book on the same topic of traffic-related air pollution: emissions, human exposures, and health.

During the actual class, the participants focus on discussion (including discussion of the reading list, the chapter where applicable, and the prerecorded audio), problem solving, and laboratory or hands-on software activities, complemented by talking to instructors and peers.

Course Outline

1. Basics of Air Pollution, Air Quality, and Vehicle Emission Standards and Environmental Regulation

1. Air quality and air pollution
2. Traffic-related air pollution
3. Other transportation-related emissions and air pollution
4. Air quality standards and health
5. Air quality monitoring and use in compliance determination
6. Vehicle emission standards and underlying evidence base
7. History of key laws and regulations and quantifiable impacts
8. Environmental justice

2. Monitoring and Modeling of Traffic, Traffic-Related Emissions, and Traffic-Related Air Pollution

A. Introduction to Traffic Monitoring and Modeling

1. Transportation and land-use planning
2. Traffic measurement methods and data sources
3. Traffic modeling methods and data sources

B. Introduction to Traffic Emissions Monitoring and Modeling

1. Emission measurement/characterization methods and data sources
2. Emission modeling methods and data sources

C. Introduction to Air Pollution Monitoring and Modeling

1. Air pollution measurement methods and data sources
2. Air pollution dispersion modeling methods and data sources
3. Photochemical modeling methods and data sources

3. Exposure Assessment of Traffic-Related Air Pollution

A. Introduction to Air Pollution Exposure Assessment

1. Air pollution exposure
2. Air pollution exposure assessment methods
3. Traffic-related air pollution exposure assessment methods

B. Air Pollution Exposure Assessment Methods

1. Air pollution dispersion modeling
2. Land-use regression modeling
3. Exposure surrogates
4. Personal monitoring in exposure assessment and the contribution of traffic
5. Source apportionment and micro-environmental exposures

4. The Effects and Impacts of Traffic-Related Air Pollution Exposure on Human Health

A. Epidemiological Studies, Designs, and Need for Exposure Indices

1. Introduction to air pollution epidemiology
2. Observational descriptive epidemiological studies
3. Observational analytical epidemiological studies
4. Experimental studies
5. Prevalence, incidence, and measures of associations
6. Systematic reviews and meta-analyses

B. Evidence of the Effects of Traffic-Related Air Pollution Exposure on Human Health

1. Effects of traffic-related air pollution on human health—well-established evidence
2. Effects of traffic-related air pollution on human health—emerging evidence
3. Effects of traffic-related air pollution on human health—toxicological and mechanistic evidence
4. Transferability of toxicological evidence and human relevance
5. Biomarkers including OMICS (genomics, proteomics, or metabolomics) of health effects associated with traffic-related air pollution
6. Sensitive subpopulations (children, the elderly, the ill, and lower socioeconomic classes) and differential health effects in sensitive subpopulations

5. Health Impacts and Burden of Disease Assessment of Traffic-Related Air Pollution

1. Qualitative health impact assessment
2. Quantitative health impact and burden of disease assessment
3. Undertaking health impact and burden of disease assessment of traffic-related air pollution—Part 1
4. Undertaking health impact and burden of disease assessment of traffic-related air pollution—Part 2
5. The impacts of traffic-related air pollution on health in policy and decision making
6. Differential burden of disease of traffic-related air pollution in sensitive sub-populations

6. Policies and Technologies to Mitigate Traffic-Related Air Pollution and Adverse Health Effects and Impacts

A. Policies, Strategies, and Effectiveness

1. Transportation decision making—overview and process
2. Transportation decision making—tools and methods
3. Option generation and policy selection
4. Option generation tools
5. Cost-effectiveness calculations and feasibility of policies
6. Policies to mitigate traffic-related emissions
7. Policies to mitigate traffic-related air pollution
8. Policies to mitigate traffic-related air pollution exposures
9. Overlap with sustainable transportation and built environment policies
10. Barriers and facilitators
11. Co-benefits

B. Emerging Technologies, Disruptors, and Market Solutions

1. Alternative and emerging technologies—connected and automated vehicles
2. Alternative and emerging technologies—shared mobility
3. Alternative and emerging technologies—zero and near-zero emission vehicles
4. Alternative and emerging fuels
5. Implications to environmental justice
6. Market solutions
7. Concluding inspirational talk—How do we make health a priority? Are we doing the right research?