

Department of Urban Design and Planning
College of Built Environments University of Washington

COURSE

Title: **SUSTAINABLE TRANSPORTATION AND THE ENVIRONMENT**
Quarter: Winter 2023
Number of Credits: 3
Class: T, TH 8:30 – 9:50 am
Classroom: Gould 440, or Zoom
Canvas: <https://canvas.uw.edu/courses/1614626>

INSTRUCTOR, OFFICE HOURS & COMMUNICATION

Instructor: Chang-Hee Christine Bae, Ph.D., Associate Professor
Hours: TH 10:00-11:00, or by appointment
Email address: cbae@uw.edu

COURSE OVERVIEW & PURPOSE

Major cities around the world experience different types of transportation problems. Despite planning efforts to advocate public transportation, automobile transport is a widespread, and dominant transportation mode in most developed, and rapidly developing countries (There are almost 1.5 billion cars in the world). However, the convenience of automobile comes with high environmental costs. The negative environmental externalities of transportation are among the most important issues in the world. The modern transportation system has three layers of impact on the nature. The most well-known direct environmental problem is related to air pollution, which is linked to direct emissions from the use of vehicles. Other dimension of the transportation problem is the impact of habitat from the construction/existence of transportation systems, especially road networks. However, it is one of the most difficult, persistent planning and environmental problems without clear solutions. This course focuses on many key issues, especially impact on air quality, and try to address, but not limited to, the following questions: What are the main sources of the externalities? What policies have been implemented to address them? Were the measures successful? What options are available? What should be done in the future?

There are three major scale issues in transportation-related environmental problems:

macro (global), *regional*, and *micro* scale. As transport sector is responsible nearly a quarter of global greenhouse gases (GHG) emissions, the automobile impact on global climate change has recently received much more attention. The Paris Accords in 2015 mobilize many countries to set nationally determined contributions (NDC) to reduce GHG emissions and submit to UNFCCC (United Nations Framework Convention on Climate Change). There have been aggressive efforts in some of the European countries to reduce CO₂ emissions and to achieve de-carbonization. In this regard, what attempts have been made in the US?

In Washington State, transportation is the largest single sector that is responsible for 39% of GHG emissions in 2019. The share is higher than GHG emissions from residential, commercial and industrial sectors(25%) and electricity (21%) sectors (WA DOE, <https://ecology.wa.gov/Air-Climate/Reducing-Emissions/Tracking-greenhouse-gases/GHG-inventories>). The high share of transport sector's contribution to GHG emission gets even worse in the City of Seattle (61% as of 2020, https://www.seattle.gov/documents/Departments/OSE/ClimateDocs/GHG%20Inventory/2020_GHG_Inventory_Oct_2022.pdf).

With more than 2.94 (US: 269 million in 2016) million registered vehicles in Washington State, the task to reduce GHG emissions seems daunting. What are the Washington State (and other states) strategies for GHG emission reductions? How have cities responded to State strategies? How are we doing compare to (cities in) other states?

On the other hand, characteristic of *micro-scale* traffic-related air pollution (TRAP) is evaporative emissions, and has human-health consequences. It poses triple burdens to road users: higher level exposure to air, noise pollution, and safety. Although air and noise emissions from vehicles diffuse on the air rapidly, immense vehicle volumes on the road, the cumulative impacts on the health of human and nature are compounded. It becomes more important in the contemporary urban planning practices in the era of *sustainable transportation* with emphasis of land use and built environments; promoting walking and biking with higher density mixed-use, compact cities to reduce the GHG emissions could mean higher levels of pollution exposure to non-motorized transportation users as well as people live and work close to high traffic areas. The new scientific findings of TRAP identify the smallest particle sizes (e.g. PM_{2.5}, PM_{0.1}, etc) that contribute to various human health issues. Especially, they have more harmful effects to vulnerable populations such as children, elderly, and pre-existing respiratory illnesses.

In this course, Sustainable Transportation and the Environment (UrbDP 598A/498B), we will try to learn and to analyze the above issues. We will discuss the major challenges facing us and search for effective policies to enhance the quality of life in urban areas. Much of the course will focus on mobile sources of the urban air quality problems and existing policies. Other transport-related environmental problems such as water quality from urban runoff, transportation and wildlife protection, etc. could also be considered as needed.

Key issues include: Washington State Climate Change strategies, Transportation-Related Air Pollution (TRAP), citizen scientist, land use-transportation-air quality, green transportation, the effectiveness of emissions technology vs. non-technological strategies; the potential for changing travel behavior to promote environmental quality, e.g. parking, transit, paratransit options; the congestion-air quality nexus; energy consumption implications; and the meaning of sustainable transportation.

In this quarter, we cannot collaborate with the scientists from the Puget Sound Clean Air Agency to measure real-time, real-exposure to air pollution (subject to confirmation) because of the coordination difficulties under the volatilities of COVID-19. This year, the course is designed as a combination of lecture and seminar format. All students are encouraged to conduct their own, either individual or a small group, research re. various sustainable transportation and environmental issues and conduct seminar presentations and final paper (For potential topics, please scroll down to the Student Seminar section below).

OBJECTIVES

1. To recognize the importance of transportation-related environmental problems and travel behaviors in global, national, regional and local contexts
2. To understand transportation-related air pollution under the Clean Air Act, and the new scientific findings of traffic related air pollution and human health implications
3. To understand and identify transportation-environmental policies (in the U.S.)
4. To research various vehicle electrification incentives
5. To evaluate the effectiveness of the existing policies with respect to mobility and environmental quality
6. To search for and/or propose potential policies to solve identified problems

COURSE ASSIGNMENTS

Grading report due date: [March 21 \(Tuesday 5:00 pm\)](#)

The following table shows the class assignments and due dates.

Weights	Assignments	Due Dates
15%	A. Essay 1	1/14
15%	B. Essay 2	1/28
	C. Final Projects	
3%	a. Proposal	Submit one-page seminar preparation sheet 1/24 - 2/2

2%		Project meeting with Prof. Bae	2/7 - 2/9
20%	b.	Seminar Presentation (20-min)	TBA
5%		Peer review (5-min)	TBA
25%	c.	Written report	3/15
15%	D.	Class Participation	

Grading Scale

Grades will be assigned according to the following UW Standard Grading System:

A	4.0-3.9
A-	3.8-3.5
B+	3.4-3.2
B	3.1-2.9
B-	2.8-2.5
C+	2.4-2.2
C	2.1-1.9
C-	1.8-1.5
D+	1.4-1.2
D	1.1-0.9
D-	0.8-0.7
E	0

Late Assignments/Final paper

All students are expected to turn in their assignments on canvas by the due date. Late assignments will be accepted up to 3 days after the deadline with a 10% penalty. Beyond that timeframe no assignments will be accepted. If a verifiable emergency occurs and the student is not able to submit his/her final paper at the specified date, he/she is required to notify the instructor immediately and will be given an extension to submit it electronically **until March 16th**, otherwise the final paper will not be included in their final grade.

Disability Accommodation

The program is committed to ensuring learning opportunities for students with disabilities. If you would like to request academic accommodations due to a disability, please contact the office of Disability Resources for Students (<http://depts.washington.edu/uwdrs/>). *Please note that it can take multiple weeks to get approvals through DRS, so you need to submit any requests as quickly as possible to have the best outcome.* If you have a letter from the office of Disability Resources for Students indicating you

have a disability that requires academic accommodations, please present it to the instructor so we can discuss specific accommodations for this class.

Academic Integrity

The University takes academic integrity very seriously. Behaving with integrity is part of our responsibility to our shared learning community. If you're uncertain about if something is academic misconduct, ask me. I am willing to discuss questions you might have.

Acts of academic misconduct may include but are not limited to:

- Cheating (working collaboratively on quizzes/exams and discussion submissions, sharing answers and previewing quizzes/exams)
- Plagiarism (representing the work of others as your own without giving appropriate credit to the original author(s))
- Unauthorized collaboration (working with each other on assignments)

Concerns about the above or other behaviors prohibited by the Student Conduct Code will be referred for investigation and adjudication to the program director, Department chair and if needed Associate Dean of Student Services. Students found to have engaged in academic misconduct may receive a zero on the assignment

Students are expected to adhere to the UW's code of conduct. The student conduct code requires students to practice "high standards of academic and professional honesty and integrity." Students who are suspected of cheating or plagiarism will be confronted directly by the instructor, who will inform the appropriate parties within the Department, College, and University to determine if the student's actions warrant zero points and/or disciplinary action, which may include probation or dismissal. The University's Student Conduct Code is Washington Administrative Code 478-120: (<http://app.leg.wa.gov/WAC/default.aspx?cite=478-120>). Also Student conduct code: <https://www.washington.edu/cssc/for-students/student-code-of-conduct/> Additionally, please keep in mind that the university provided site (SimCheck) will screen your assignments and the final paper, helping in the identification of plagiarism from internet resources.

Student Safety

Students are advised to refer to UW policies and procedures to ensure their safety and security on campus. For more information, go to: <http://www.washington.edu/safecampus/> To report threats, seek advice, or get counseling, dial 206-685-SAFE (7233).

Religious Accommodations

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at:

- [Religious Accommodations Policy, and Resources](#)
- [Religious Accommodations Request Form](#)

Student Athletes

Student athletes who have conflicts attending any lecture or submitting any assignment should submit a list of such conflicts to the instructor along with a letter from the athletics department, by February 2nd, 2022.

CLASS TOPICS AND RELATED READINGS

[Note: There is no text book, but the following book addresses the extent to which environmental problems brought by modern transportation system in one book. Students are expected to review the readings before class, and the PowerPoints files after the class.]

Transportation Research Board, 1997, *Toward a Sustainable Future: Addressing Long-term Effects of Motor Vehicle Transportation on Climate and Ecology*. Special Report 251.

<http://onlinepubs.trb.org/onlinepubs/sr/sr251.pdf> [PDF]

The following course readings could be found in the course website, <https://canvas.uw.edu/courses/1614626>

Jan 3 (T): Course Introduction

Part I. Transportation, Travel Behavior, Urban Form and Environmental Consequences

Key words: four stages of transportation and urban form; travel trends; sustainable transportation

- ◆ Introduction

- ◆ Transportation and urban form in the US

- o Muller, Peter, "Transportation and urban form: stages in the spatial evolution of the American metropolis" Chapter 3, pp. 59-85 in *The Geography of Urban Transportation*.

- ◆ Travel Trends in US cities

- o TRB, 1997, "Trends and outlook in motor vehicle transportation," Chapter 2, pp. 37-72 in *Toward a Sustainable Future* <http://onlinepubs.trb.org/onlinepubs/sr/sr251.pdf>

Jan 5 (TH): Automobile Dependency and Sustainable Transportation

- ◆ Automobile dependence outside the US

- o Newman and Kenworthy, 1989, "Gasoline consumption and cities: A comparison of the US cities with a global survey," *Journal of the American Planning Association*, 55(1), pp. 24-37.

- o Newman and Kenworthy, 1999, Chapter 2 in *Sustainability and Cities*. Washington, D.C.: Island Press

- ◆ Sustainable transportation

- o Newman, Peter and Jeffrey Kenworthy, 1999, "The concept of sustainability and its relationship to cities," Chapter 1, pp. 1-26, in *Sustainability and Cities*. *ibid*.

- o TRB, 1997, "Sustainability and transportation," Chapter 1, pp. 15-36 in *Toward a Sustainable Future* <http://onlinepubs.trb.org/onlinepubs/sr/sr251.pdf>

Environmental Regulations for Air Pollution

Key words: Clean Air Act, Criteria Pollutants, Transportation-Related Air Pollution (TRAP)

Jan 10 (T) and 12 (TH)

Part 2. Mobile Source Air Pollution: what we know

- ◆ Clean Air Act, Criteria Pollutants

- o Bae, Chang-Hee Christine, 2004, "Transportation and the environment," Chapter 13, pp. 356-381 in *The Geography of Urban Transportation*.

o Spirn, Anne Whiston, 1984, "Dirt and discomfort," Chapter 2, pp. 41-61; "Improving air quality, enhancing comfort, and conserving energy," Chapter 3, pp. 62-87 in *The Granite Garden*. New York: Basic Book

Jan 12(TH) Traffic-Related Air Pollution I

Key words: TRAP/FAPs, Measuring exposure, air toxics

◆ Air quality trends in the U.S.

◆ Air toxics

o Puget Sound Clean Air Agency, 2003, "Final report: Puget Sound air toxic evaluation," http://www.pscleanair.org/airq/basics/psate_final.pdf

o Puget Sound Clean Air Agency, 2009, "National air toxics assessment," http://www.pscleanair.org/airq/basics/PSCAA_4_16_09_NATA_info_sheet.pdf

o The Seattle Times, "Puget Sound area ranks high in cancer risk from toxic air pollution, report say," by Sandi Doughton, June 25, 2009 http://seattletimes.nwsourc.com/html/health/2009381228_pollution25m0.html

o The Seattle Times, "Air has elevated cancer risk in 600 neighborhoods," http://seattletimes.nwsourc.com/html/politics/2009375802_apusairtoxics.html

Jan 17 (TH)Key words: TRAP and health, Pollution exposure and transportation mode

o Hankey, S. G. Lindsey, JD Marshall, 2017, "Population-level exposure to particulate air pollution during active travel: Planning for low-exposure, health-promoting cities," *Environmental Health Perspectives*, 125 <https://ehp.niehs.nih.gov/ehp442/>

◆ Ultrafine particles

o Hinds, William, et. al., 2006, "Final Report: Relationship Between Ultrafine Particle Size Distribution and Distance From Highways," Report to EPA, # R827352C006 http://cfpub.epa.gov/ncer_abstracts/INDEX.cfm/fuseaction/display.abstractDetail/abstract/6984/report/F

o UCLA School of Public Health Press Releases, "People living or working near major freeways are exposed to 30 times the concentration of dangerous particles from motor vehicle emissions," October 15, 2002, <http://airmap.unh.edu/assessment/pdf/021021-UltrafineParticleStudies.pdf>

o Hinds, William, et. al., "Final Report: Relationship Between Ultrafine Particle Size Distribution and Distance From Highways," Report to EPA, # R827352C006 http://cfpub.epa.gov/ncer_abstracts/INDEX.cfm/fuseaction/display.abstractDetail/abstract/6984/report/F

◆ Freeway (or heavy traffic roadside) air pollution

o Bae, C.-H. C., Gail Sandlin, Alon Bassok, and Sungyop Kim, 2007, "The exposure of disadvantaged populations in freeway air-pollution sheds: a case study of the Seattle and Portland regions," *Environment and Planning B*, 34, pp. 154-170

o Bassok, Alon, Phil Hurvitz, C.-H.C. Bae, and Timothy Larson, 2010, "Measuring neighborhood air pollution: the case of Seattle's international district," *Journal of Environmental Planning and Management*, 53(1), pp. 23-39

o Jansen KL, Larson TV, Koenig JQ, Mar TF, Fields C, Stewart J, Lippmann M. 2005. Associations between health effects and particulate matter and black carbon in subjects with respiratory disease. *Environmental Health Perspectives*, 113 (12): 1741.

- o Power M, Weisskopf M, Alexeeff S, Coull B, Spiro AIII, Schwartz J, 2010, Traffic related air pollution and cognitive function in a cohort of older men. *Environmental Health Perspectives* 119(5):682-7.
- o Suglia SF, Gryparis A, Wright RO, Schwartz J, Wright RJ, 2008. Association of black carbon with cognition among children in a prospective birth cohort study. *American Journal of Epidemiology*, 167: 280–286

◆ Active travel and exposure to Air pollution

- o Hankey, S. G. Lindsey, JD Marshall, 2017, “Population-level exposure to particulate air pollution during active travel: Planning for low-exposure, health-promoting cities,” *Environmental Health Perspectives*, 125 <https://ehp.niehs.nih.gov/ehp442/> [PDF]

Jan 19 (TH) Traffic-Related Air Pollution II

◆ Bicyclists and Air Pollution

- o Hong, EA and CHC Bae, 2012, “Bicyclists’ Exposure to Air Pollution in Seattle: A Hybrid Analysis Using Personal Monitoring and Land Use Regression,” *Transportation Research Record*, 2270, pp. 59-66 .
- o Thaia, A., Mckendrya, I., Brauer, M., 2008, “Particulate matter exposure along designated bicycle routes in Vancouver, British Columbia,” *Science of the Total Environment*, 405(1-3), pp. 26–35.

◆ Pedestrians and Air Pollution

- o Bae, CHC, and D. Sinha*, “Measuring pedestrian exposure to PM2.5: Case of the Seattle, Washington, International District,” *Transportation Research Records*, 2570, pp. 139-147.
- o Marshall, Julian D., Michael Brauer, and Lawrence D. Frank, 2009, “Healthy Neighborhoods: Walkability and Air Pollution” *Environmental Health Perspectives*, Vol. 117, No. 11 (Nov., 2009), pp. 1752-1759.
- o Kaur S, Neiuwenhuijsen MJ, and Colvile RN, 2005, “Pedestrian Exposure to Air Pollution along a Major Road in Central London, UK,” *Atmospheric Environment*, 39: 7307-7320.

◆ Exposure to UFPs by Transportation Modes

- o Knibbs, L.D., Cole-Hunter, T., Morawska, L., 2011, ““A review of commuter exposure to ultrafine particles and its health effects,” *Atmospheric Environment*, 45, pp. 2611-2622

Jan 24 (T) Traffic and Noise Pollution Key words: noise and health, noise exposure and transportation mode, mitigation measures

◆ Noise

- o Harris, David, 1997, “Noise control principles,” Chapter 1, pp. 1-36 in Noise Control Manual for Residential Buildings.
- o US Department of Transportation, Federal Highway Administration, Highway Traffic Noise <http://www.fhwa.dot.gov/environment/htnoise.htm>
- o Gershon, R.R., Neitzel, R., Barrera M.A., Akram, M., 2006, “Pilot survey of subway and bus stop noise levels,” *Journal of Urban Health*, 83(5), pp. 802-12.

Part 3. Transportation and Cumulative Effects

Jan 26 (TH) Climate Change: Greenhouse Gas emissions

◆ Greenhouse gas emissions and transportation

Washington State:

o Washington State Department of Ecology, 2013, *Report to the legislature on Washington Greenhouse Gas Emissions Inventory, 2010-2013*. Publication no. 16-02-025 <https://fortress.wa.gov/ecy/publications/documents/1602025.pdf>

o Washington State Department of Transportation, Sustainable Transportation, Climate Change Adapting and Preparing <http://www.wsdot.wa.gov/SustainableTransportation/default.htm>
<http://www.wsdot.wa.gov/environment/climatechange/>
<http://www.wsdot.wa.gov/NR/rdonlyres/2F436F57-CFA9-420B-AE31-807197DD5356/0/AdaptationFolioNov8.pdf>

US EPA:

o US EPA, 2018, Draft Inventory of US Greenhouse Inventory and Sinks, 1990-2016, https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf

Executive Summary https://www.epa.gov/sites/production/files/2018-01/documents/2018_executive_summary.pdf

o US EPA “Sources of Greenhouse Gas Emissions: Transport Sector Emissions,” <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

Global: <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

World:

o World Bank: <https://data.worldbank.org/indicator/EN.CO2.TRAN.ZS>

o IPCC, Chapter 8: Executive Summary; Transport

https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter8.pdf

Carbon Neutral Cities Alliance, UNFCCC: TBA

Jan 31(T) Climate Change: Energy consumption and GHG emissions

Key words: transportation and energy, GHG emissions

◆ Transportation and Energy

o Greene, David, 2017, “Transportation and energy,” Chapter 12 in *The Geography of Urban Transportation* (4th edition).

o TRB, 1997, “Carbon dioxide buildup and motor vehicle transportation,” Chapter 3, pp. 73-163 in *Toward a Sustainable Future* <http://onlinepubs.trb.org/onlinepubs/sr/sr251.pdf>

◆ Alternative Fuel and Hybrid Vehicles

o TBA

Feb 2(TH) and 7 (T): Climate Change: Electric Vehicles

Key words: [Electric Vehicle](#)

o Greene, David, 2017, "Transportation and energy," Chapter 12 in *The Geography of Urban Transportation* (4th edition).

End of ICE, Transition to Alternative Fuel Vehicles

- ◆ Electric Vehicles: Market forces, Infrastructure provision
- ◆ Electric Vehicles: Planning policies and equity concerns
- ◆ Electric Vehicles: Environmental benefits and pitfalls

Feb 9 (TH) Social and Environmental Justice and Transportation

o Blumenberg, Evelyn, 2017, "Social equity and urban transportation," Chapter 13, in *The Geography of Urban Transportation* (4th ed). New York: The Guilford Press

o Forkenbrock, David and Lisa Schweitzer, 1999, "Environmental Justice in Transportation Planning," *Journal of the American Planning Association*, 65(1), pp. 96-112.

Feb 14 and 16: Seminar preparation self-study week according to Bae's feedback on the final project work plan. No Class (Prof. Bae is attending a conference)

Feb 21 (TH) Transportation and Cumulative Ecological Effects

◆ Impact on ecology

o TRB, 1997, "Cumulative ecological effects," Chapter 4, pp. 164-206 in *Toward a Sustainable Future* <http://onlinepubs.trb.org/onlinepubs/sr/sr251.pdf>

o Foreman, Richard, et. al., 2003, *Road Ecology: Science and Solutions*. Washington, D.C.: Island Press

◆ Vegetation and PM2.5

o Tong, Zheming et. al., 2015, "Quantifying the effect of vegetation on near road air quality using brief campaigns," *Environmental Pollution*, 201, pp. 141-149

◆ Urban runoff and water pollution

o Pitt, Robert, 1995, "Biological effects of urban runoff discharges," Chapter 9, pp.127-162 in Herricks, Edwin, ed, *Stormwater Runoff and Receiving Systems*. New York: Lewis Publishers.

o Horner, Richard, 1995, "Toward ecologically based urban runoff management," Chapter 23, pp. 365-377, *ibid.*

Part 4. Searching for Solutions: Student projects

Feb 23-March 9 **Mini Seminar by Students**

Potential topics:

- Future alternative transportation (Electric/hybrid vehicles: passenger cars, buses): How cities/countries are getting prepared for EV transitions?
- What are the exposure levels during my commute?
- Comparison of TRAP among different neighborhoods [use Fixed Monitoring Site data]
- Environmental justice and urban air pollution
- Fuel efficient vehicles: comparison, incentives?
- Comparative studies of air pollution in mega cities [aqicn.org data]