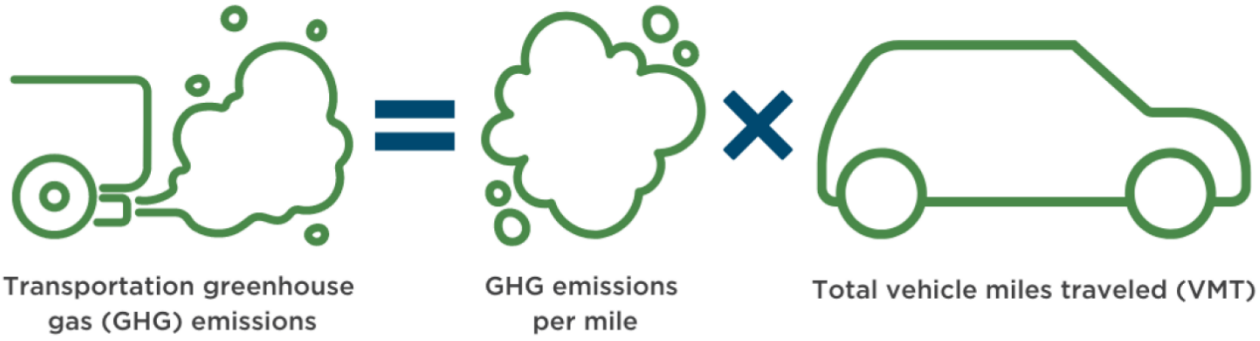
URBAN 533 A Sp 25: Sustainable Transportation And The Environment



Department of Urban Design and Planning

College of Built Environments University of Washington

SUSTAINABLE TRANSPORTATION AND THE ENVIRONMENT

Course number:	URBDP 533A (SLN21233)
Quarter:	Spring 2025
Number of Credits:	3
Class:	F 10:30 am - 1:20 pm
Classroom:	HRC 155
Canvas:	https://canvas.uw.edu/courses/1818420

OFFICE HOURS & COMMUNICATION

Instructor:	Chang-Hee Christine Bae, Ph.D., Associate Professor
Hours:	W, Noon-12:50 pm, 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 indirect impact on habitat and water quality 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 the impact on urban air quality, and tries to address, but is 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. Because the transport sector is responsible for nearly a quarter of global greenhouse gas (GHG) emissions and 29% of US GHG emissions, the automobile impact on global climate change has recently received much more attention. The Paris Accords in 2015 mobilized 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 (40 mil metric tons) in 2019, followed by residential, commercial, and industrial sectors(25%) and electricity (21%) sectors (WA DOE, https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/tracking-greenhouse-gases/ghg-inventories#inventory). The high share of transport sector's contribution to GHG emission gets even worse in King County (43% as of 2019) 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 2.97 million registered vehicles in Washington State (US: 283 million in 2022), the task of reducing 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 compared to (cities in) other states?

On the other hand, characteristic of *micro-scale* traffic-related air pollution (TRAP) is evaporative emissions, and it 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 rapidly into the air, immense vehicle volumes on the road and the cumulative impacts on the health of humans and nature are compounded. Near road air pollution becomes more important in the contemporary urban planning practices in the era of *sustainable transportation*: 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. PM2.5, PM0.1, etc) that contribute to various human health issues. They have especially more harmful effects to vulnerable populations such as children, the elderly, and those with pre-existing

respiratory illnesses. As more of the population (24%) lived near high-traffic roadways in 2020, with more non-white and low-middle-income populations in the area, air pollution exposure to the near-road population became a serious environmental justice and public health issue.

In this course, Sustainable Transportation and the Environment (UrbDP 533), we will try to learn and analyze the above issues. We will discuss the major challenges facing us and search for effective policies. Much of the course will focus on mobile sources of the urban air quality problems and existing policies. Other transport-related environmental issues could also be considered as needed.

Key issues include: Transportation-Related Air Pollution (TRAP), Near Road Air Pollution, Washington State Climate Change strategies, Climate Commitment Act, 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; alternative fuel vehicles and infrastructure

This quarter, we cannot collaborate with the scientists from the Puget Sound Clean Air Agency to measure real-time, real-exposure to air pollution, but I will have two portable PM2.5 monitor, AirBeam (with help of AirCasting plantform) that allow to check hyperlocal PM2.5 exposure levels where you travel.

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 (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 **(Please note that the final project is very important (60%). Let's pledge ourselves to do our part: everyday/class is a very important day/class to learn environmental problems and strive to find solutions (Class participation is 15%).**

[Note] Grading report due date: June 11 (Tuesday 5:00 pm)

The following table shows the class assignments and due dates.

Weights	Assignments	Due Dates

25%	Midterm Essay	24-Apr
60%	Final Projects	
	Proposal: One page final project workplan (5%)	25-Apr
	Project meeting with Prof. Bae (5%)	TBA
	Presentation (20-min including Q/As) (20%)	TBA
	Peer review (5%)	TBA
	Written report (25%)	9-Jun
15%	Class Participation	
	Attendance	
	Various class activities	

[Note: There is no text book, but the following books address the extent to which environmental problems brought by modern automobile dominant transportation system and transitional era from ICE to alternative fuel vehicles]

Transportation Research Board, 1997, *Toward a Sustainable Future: Addressing Long-term Effects of Motor Vehicle Transportation on Climate and Ecology*. Special Report 251. [PDF]
Sperling, Daniel et. al., 2007, Two Billion Cars: Driving Toward Sustainability. Oxford: Oxford University Press. E-book downloadable from the UW Bookstore [Chapter 1. Two billion cars] [Chapter 4. Low Carbon Fuel] [Chapter 9. Driving toward Sustainability]

Course readings could be found in the course website, $CANVAS_COURSE_REFERENCE$/modules

CLASS TOPICS AND RELATED READINGS

Apr 4(F): Course Introduction

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

Stages of Transportation and Urban Form

Transportation and urban form in the US

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

- Introduction
- Transportation and urban form in the US
    - 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. [PDF]
- Travel Trends in US cities
    - TRB, 1997, "Trends and outlook in motor vehicle transportation," Chapter 2, pp. 37-72 in Toward a Sustainable Future [PDF]

Apr 11 (F): Automobile Dependency and Sustainable Transportation

- Automobile dependence outside the US

    - 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. [PDF]
    - Newman and Kenworthy, 1999, Chapter 2 in *Sustainability and Cities*. Washington, D.C.: Island Press [PDF]
- Sustainable transportation
    - 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. [PDF]
    - TRB, 1997, “Sustainability and transportation,” Chapter 1, pp. 15-36 in *Toward a Sustainable* Future [PDF]
    - Sperling, et. al., 2007, “Surviving Two Billion Cars,” Chapter 1, pp. 1-12, “Beyond the Gas-Guzzler Monoculture,” Chapter 2, pp.13-45 in Two Billion Cars. [PDF] [PDF]

Environmental Regulations for Air Pollution

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

Clean Air Act and Background

Part 2: Mobile Source Air Pollution: what we know

Apr 18 (F)

- Clean Air Act, Criteria Pollutants
    - Bae, Chang-Hee Christine, 2004, “Transportation and the environment,” Chapter 13, pp. 356-381 in *The Geography of Urban Transportation*. [PDF]
    - 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 Books [PDF]
    - [*New addition] Fowler, David, et. al., 2020, "A chronology of global air quality," *Philosophical Transactions A.* 378: 20190314. http://dx.doi.org/10.1098/rsta.2019.0314Links to an external site.
    - [*New addition] Lane, Haley, et. al., 2022, "Historical redlining is associated with present-day air pollution disparities in US Cities," *Environmental Science & Technology Letters*. 9 (4): 345-350. [PDF]

Traffic-Related Air Pollution I

Keywords: TRAP/FAPs, Measuring exposure, air toxics

- Air quality trends in the U.S.
    - EPA, 2024, Our Nation's Air: Trends Through 2023. [Link.]
    - EPA, 2020, *Air Quality - National Summary*. [Link.]
- Air toxics
    - Puget Sound Clean Air Agency, 2003, “Final report: Puget Sound air toxic evaluation,” http://www.pscleanair.org/airq/basics/psate_final.pdf.
    - Links to an external site.Puget Sound Clean Air Agency, 2009, “National air toxics assessment,” http://www.pscleanair.org/airq/basics/PSCAA_4_16_09_NATA_info_sheet.pdf

- The Seattle Times, "Puget Sound area ranks high in cancer risk from toxic air pollution, report say," by Sandi Doughton, June 25, 2009 [Link.] http://seattletimes.nwsource.com/html/health/2009381228_pollution25m0.htmlLinks to an external site.
- "Air has elevated cancer risk in 600 neighborhoods," 06/24/2009, WTHR.com [Link]

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
  - 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/abstr act/6984/report. [PDF]
  - Barboza, Tony and Jon Schleuss, March 5, 2017. A Times Investigation; Life in freeway danger zones; Southern California continues a surge of residential building in high-traffic pollution zones, even though living there makes people sick. *Los Angeles Times*. p. A1. [PDF]
- Freeway (or heavy traffic roadside) air pollution
  - 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 [PDF]
  - 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 [PDF]
  - 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. [PDF]
  - 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.
  - 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 AP
  - 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]

Apr 25 (F) Traffic-Related Air Pollution II

Key words: Bicyclists and pedestrian exposure

- Bicyclists and Air Pollution

- 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 . [PDF]
- 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. [PDF]

- 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 Perspec*tives, 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
  - 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
- Living Near Road
  - US EPA. (n.d.). "Research on Near Roadway and Other Near Source Air Pollution," Near Roadway and Other Near Source Air Pollution, https://www.epa.gov/air-research/research-near-roadway-and-other-near-source-air-pollution.
  - Nichols, M. (2023, Sept 20). Highway traffic pollution puts communities of color at greater health risk, data analysis shows. *ABC News*. https://abcnews.go.com/US/highway-traffic-pollution-puts-communities-color-greater-health/story?id=103340992#:~:text=An%20ongoing%20environmental%20health%20problem%20that%20has%20racial%20undertones%2C%20according,from%20a%20highway%20are%20nonwhite.
  - American Lung Association (n.d.) Who is most affected by outdoor air pollution? https//www.lung.org/clean-air/outdoors/who-is-at-risk.

Traffic and Noise Pollution

- **Guest Speaker: Rachel Miller, Senior Associate, Makers Architecture and Urban Design** (subject to confirmation)

Key words: noise and health, noise exposure and transportation mode, mitigation measures

- Noise
  - Harris, David, 1997, "Noise control principles," Chapter 1, pp. 1-36 in Noise Control Manual for Residential Buildings.
  - US Department of Transportation, Federal Highway Administration, Highway Traffic Noise http://www.fhwa.dot.gov/environment/htnoise.htm.
  - 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

May 2: Climate Change: Greenhouse Gas emissions

Key words: GHG emissions, Carbon neutral cities

- Greenhouse gas emissions and transportation
    - Washington State:
        - Washington State Department of Ecology, 2022, *Washington's Greenhouse Gas Emissions Inventory, 1990-2019*. Publication no. 22-02-054
        - https://apps.ecology.wa.gov/publications/documents/2202054.pdf.
        - https://ecology.wa.gov/Air-Climate/Reducing-Emissions/Tracking-greenhouse-gases/GHG-inventories
        - Washington State Department of Transportation, Climate Change and Transportation https://wsdot.wa.gov/construction-planning/protecting-environment/climate-change-transportation
    - US EPA:
        - US EPA, 2024, US Greenhouse Gas Emissions and Sink, 1990-2022
        - https://www.epa.gov/system/files/documents/2024-02/us-ghg-inventory-2024-main-text.pdf
        - ExecutiveSummary https://www.epa.gov/system/files/documents/2024-02/us-ghg-inventory-2024-chapter-executive-summary.pdf
        - US EPA "Fast Facts: US Transportation Sector Greenhouse Gas Emissions, 1990-2021" https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.
        - Global: https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data.
    - World:
        - World Bank: https://data.worldbank.org/indicator/EN.CO2.TRAN.ZS.
        - IPCC, Chapter 6: Cities, Settlement, and Key Infrastructure, in Climate Change 2022: Impacts, Adaptation, and Vulnerability https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf

Climate Change: Energy consumption and GHG emissions

Key words: transportation and energy, GHG emissions

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

May 9 (F) Climate Change: Electric Vehicles

Key words: Electric Vehicle

- General reading:
- 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

Transition to Electric Vehicles II

Guest Speaker: Dr. Boyang Sa, Senior Data Scientist, The Center for Sustainable Energy

"Electric Vehicle Charging Program in Washington and California"

https://energycenter.org/thought-leadership/news/washington-state-taps-center-sustainable-energy-launch-ev-charging-program
https://energycenter.org/default-search?search_api_fulltext=Charging+stations+in+California.

May 9(F) Transition to Electric Vehicles III: Electric Bus

Guest Speaker: King County Metro "Bus Electrification"

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.

- Castleman, Terry (2023, Mar 7), "L.A. residents who drive less are exposed to more air pollution, study finds," *Los Angeles Times*.
    - Boeing, Geoff, Yougeng Lu, Clemens Pilgram, 2023, "Local inequities in the relative production of and exposure to vehicular air pollution in Los Angeles," *Urban Studies*, 60 (12) https://doi.org/10.1177/00420980221145403

May XX: Seminar preparation. Meeting with Prof. Bae

May 16 (F) Transportation and Cumulative Ecological Effects

Keywords: Ecological impacts, vegetation and PM2.5 reduction

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

    - Foreman, Richard, et. al., 2003, *Road Ecology: Science and Solutions*. Washington, D.C.: Island Press
- Vegetation and PM2.5
    - 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
    - Pitt, Robert, 1995, "Biological effects of urban runoff discharges," Chpater 9, pp.127-162 in Herricks, Edwin, ed, *Stormwater Runoff and Receiving Systems*. New York: Lewis Publishers.
    - Horner, Richard, 1995, "Toward ecologically based urban runoff management," Chapter 23, pp. 365-377, ibid.
- Oil spills

Part 4: Searching for Solutions

May 23: Individual project meeting with Prof. Bae

May 30-June 6: Student projects

Potential topics:

- **Future alternative transportation (Electric/hybrid vehicles: passenger cars, buses): How well are cities prepared?**
- **Intercity comparative research on Transport sector GHG emission reduction policies**
- **What are the exposure levels during my commute?**
- **Comparison of TRAP among different neighborhoods**
- **Environmental justice and urban air pollution**
- **Fuel efficient vehicles: comparison, incentives?**
- **Comparative studies of air pollution in mega cities [aqicn.org data]**
- **Issues related to a lid on highway and air/noise pollution**