Master of Science in Sustainability Management

SUMA PS5050: Critical Urban Infrastructure for Sustainable Development
Thursday: 6:10PM – 8:00PM EST
3 Credits

Instructor:	**Dan Mathis, JD	d.mathis@columbia.edu**
Office Hours:	By appointment
Response Policy:	Email communication is preferred and students can expect responses within 24 hours on weekdays. Weekend communication will be limited with delayed response.

Facilitator/Teaching Assistant:	Kristen Tadrous	kvt2106@columbia.edu
Office Hours:	By appointment

Course Overview

Infrastructure is the foundation of the sustainable city. Infrastructure includes the basic physical and organizational structures and facilities (e.g., buildings, roads, water, and energy supplies) that keep societies operating. Infrastructure investments have long-term implications and are critically important in the efforts of cities around the world to tackle the climate crisis, strengthen urban resilience, and promote sustainability.

The historic Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act) of 2021, that provided for a trillion-dollar investment in America's infrastructure, will serve as a framework for our work to address the climate crisis, advance environmental justice, and invest in communities that have historically been overburdened and under-resourced. The law's goals to help bolster the transportation sector, expand access to clean drinking water, and ensure access to high-speed internet (among many other efforts), will help us to assess the function and impact of infrastructure policies, plans, and projects across varied communities.

This course will survey policies, projects, and proposals to understand how cities use infrastructure to enhance urban resilience, mitigate environmental impacts, and promote social and economic equity. Students will gain a theoretical understanding of urban sustainability transitions by analyzing infrastructure systems, both domestic and abroad; learn to evaluate urban infrastructure and assess development goals; and identify challenges to developing and maintaining sustainable urban infrastructure. The class will examine these efforts across multiple sectors with an emphasis on interpreting and analyzing policies that impact the sustainable built environment and contribute to equity and social justice goals.

We will set out to better understand how infrastructure policy and investments impact communities. Equity in the built environment will be a primary focus and we will center participatory activities (e.g., student-led discussions, paired analyses, team exercises) designed to encourage students to consider issues from multiple perspectives—including identifying disparities and assessing opportunities for advancing equitable outcomes.

Learning Objectives

Upon successful completion of this course, students should be able to:

L-1: Develop and organize a general theoretical framework by which to assess the impact of urban infrastructure; compare the substance of infrastructure policies and policy proposals

L-2: Classify urban sustainable infrastructure challenges for different sectors; evaluate current and emerging infrastructure policy developments

L-3: Identify and examine disparities that exist or persist as a result of inequitable infrastructure policies, investments, and developments, particularly along race and socioeconomic lines; articulate how equity interacts with and/or contributes to infrastructure policy goals

L-4: Indicate an understanding of the diversity of policymaking bodies creating sustainability-related infrastructure policies; articulate examples of equity-oriented policy related to urban sustainability transitions; read, interpret, and analyze policy texts (including laws, legislation, regulations, guidance, and proposals) from varying bodies including, but not limited to, federal, state, and local governments

Readings

Required books, articles, reports, and other readings:

Andersson, K., Dickin, S., & Rosemarin, A. (2016). Towards "Sustainable" Sanitation: Challenges and Opportunities in Urban Areas. *Sustainability, 12*, 1289. https://doi.org/10.3390/su8121289 (14 pages)

Assessing Broadband Equity in the New York Region. RPA. (2022). Retrieved from https://rpa.org/work/reports/broadband-equity-ny-tri-state https://rpa.org/work/reports/broadband-equity-ny-tri-state (11 pages)

Balazs, C. L., & Ray, I. (2014). The Drinking Water Disparities Framework: On the Origins and Persistence of Inequities in Exposure. *American Journal of Public Health, 4*, 603–611. https://doi.org/10.2105/ajph.2013.301664 (9 pages)

Barajas, J. M. (2021). The roots of racialized travel behavior. In *Advances in Transport Policy and Planning* (pp. 1–31). Elsevier. http://dx.doi.org/10.1016/bs.atpp.2021.06.007 (31 pages)

Bouzarovski, S., & Simcock, N. (2017). Spatializing energy justice. *Energy Policy, 640–648.* https://doi.org/10.1016/j.enpol.2017.03.064 (9 pages)

Bullard, R. D. (1983). Solid Waste Sites and the Black Houston Community. Sociological Inquiry, 2–3, 273–288. https://doi.org/10.1111/j.1475-682x.1983.tb00037.x (14 pages)

Carmichael, C., Danks, C., & Vatovec, C. (2019). Green Infrastructure Solutions to Health Impacts of Climate Change: Perspectives of Affected Residents in Detroit, Michigan, USA. *Sustainability, 20*, 5688. https://doi.org/10.3390/su11205688 (15 pages)

Cincinnati, OH - New Market Solar Farm. American Cities Climate Challenge. (2022, May 17). Retrieved from https://cityrenewables.org/story/cincinnati-oh

DeGood, K. (2021, June 28). *Building Infrastructure That Supports Opportunity, Equity, and Sustainability*. Center for American Progress. https://www.americanprogress.org/article/building-infrastructure-supports-opportunity-equity-sustainability/ (33 pages)

Durrant, D. (2017). Infrastructure, Equity and Urban Planning: A Just Process for the Allocation of Benefits and Burdens. In: Bishop, J. (eds) Building Sustainable Cities of the Future. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-319-54458-8_8 (21 pages)

Fredericks, R. (2014). Vital Infrastructures of Trash in Dakar. *Comparative Studies of South Asia, Africa and the Middle East 34(3)*, 532-548. https://www.muse.jhu.edu/article/566150. (15 pages)

Heck, S. (2021). Greening the color line: historicizing water infrastructure redevelopment and environmental justice in the St. Louis metropolitan region. *Journal of Environmental Policy & Planning, 5*, 565–580. https://doi.org/10.1080/1523908x.2021.1888702 (16 pages)

Hoover, F.-A., Meerow, S., Grabowski, Z. J., & McPhearson, T. (2021). Environmental justice implications of siting criteria in urban green infrastructure planning. *Journal of Environmental Policy & Planning, 5*, 665–682. https://doi.org/10.1080/1523908x.2021.1945916 (18 pages)

Ikeme, J. (2003) Equity, environmental justice and sustainability: incomplete approaches in climate change politics. *Global Environmental Change, Volume 13, Issue 3*, 195-206. https://doi.org/10.1016/S0959-3780(03)00047-5 (12 pages)

Jenkins, K., McCauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: A conceptual review. *Energy Research & Social Science, 174–182*. https://doi.org/10.1016/j.erss.2015.10.004 (9 pages)

Klinenberg, E. (2018, September 20). *America's Social Infrastructure Is Falling Apart*. The Atlantic. https://www.theatlantic.com/ideas/archive/2018/09/worry-less-about-crumbling-roads-more-about-crumbling-libraries/570721/ (6 pages)

Latham, A., & Layton, J. (2019). Social infrastructure and the public life of cities: Studying urban sociality and public spaces. *Geography Compass*, 7, e12444. https://doi.org/10.1111/gec3.12444 (15 pages)

M-21-28, Interim Implementation Guidance for the Justice40 Initiative. Executive Office of the President, Office of Management and Budget. (July 20, 2021). (13 pages)

Peischel, W. (2022, May 23). Environmental concerns grow over incinerators in U.S. Bloomberg.com. Retrieved from https://www.bloomberg.com/news/articles/2022-05-23/environmental-concerns-grow-over-incinerators-in-u-s (8 pages)

Penn, I. (2022, December 15). California reduces subsidies for homes with rooftop solar. The New York Times. Retrieved from https://www.nytimes.com/2022/12/15/business/energy-environment/california-rooftop-solar-subsidy.html?campaign_id=54&emc=edit_clim_20221220&instance_id=80685&nl=climate-forward%C2%AEi_id=98348406&segment_id=120377&te=1&user_id=96e9d519f8eef749157516cb58c77359

Phinney, S. (2022). The policing of Black debt: how the municipal bond market regulates the right to water. *Urban Geography, 1–24.* https://doi.org/10.1080/02723638.2022.2107257 (24 pages)

Pitter, J. (2021, August 11). *Equitable Infrastructure: A resource framing infrastructure types using an equitable placemaking lens.* Policy Commons; Community Foundations of Canada. https://policycommons.net/artifacts/2165791/equitable-infrastructure-a/2921477/ (24 pages)

Robbins, J. (2019). In era of drought, Phoenix prepares for a future without Colorado River Water. Yale E360. Retrieved from https://e360.yale.edu/features/how-phoenix-is-preparing-for-a-future-without-colorado-river-water

Saint , R., & Pomponi , F. (2022, September 13). Cities and climate change: Why low-rise buildings are the future – not skyscrapers. The Conversation. Retrieved from https://theconversation.com/cities-and-climate-change-why-low-rise-buildings-are-the-future-not-skyscrapers-17063

Schuurmans, A., Dyrbøl, S., & Guay, F. (2018). Buildings in Urban Regeneration. In A. Almusaed, & A. Almssad (Eds.), *Sustainable Cities - Authenticity, Ambition and Dream.* IntechOpen. https://doi.org/10.5772/intechopen.81803 (21 pages)

Shain, S. (2023, January 1). How Central Ohio got people to eat their leftovers. The New York Times. Retrieved from https://www.nytimes.com/2023/01/01/headway/composting-food-leftovers.html (15 pages)

Smith, M. (2021, April 13). Here's how a Texas border city is closing its digital divide. El Paso Matters. Retrieved from https://elpasomatters.org/2021/04/13/how-mcallen-closed-its-digital-divide-with-citywide-internet/ (8 pages)

Swindells, K. (2022, November 1). The Stark disparity across internet access in the US. City Monitor. Retrieved from https://citymonitor.ai/community/equity/us-city-least-internet-access (9 pages)

The White House. (2021). The Bipartisan Infrastructure Deal [Fact Sheet]. https://www.whitehouse.gov/briefing-room/statements-releases/2021/11/06/fact-sheet-the-bipartisan-infrastructure-deal/ (4 pages)

Tomer, A., George, C., Kane, J., & Bourne, A. (2021, November 9). *America has an infrastructure bill. What happens next?* Brookings. https://www.brookings.edu/blog/the-avenue/2021/11/09/america-has-an-infrastructure-bill-what-happens-next/ (8 pages)

Vock, D. C. (2021, June 4). Rebuilding America's infrastructure. *CQ researcher, 31*, 1-29. http://library.cqpress.com/ (29 pages)

Walker, O., & Ross, M. (2022, December 13). LA becomes largest CA city to electrify new buildings. NRDC. Retrieved from https://www.nrdc.org/experts/olivia-walker/becomes-largest-ca-city-electrify-new-buildings

Woetzel, J., Pinner, D., Samandari, H., Engel, H., Krishnan, M., Boland, B., Cooper, P., & Ruby. (2020, August 19). *Will climate change cause infrastructure to bend or break?* McKinsey & Company.

https://www.mckinsey.com/capabilities/sustainability/our-insights/will-infrastructure-bend-or-break-under-climate-stress (26 pages)

Worldwatch Institute. (2016) *Can a City be Sustainable?* Washington, DC: Island Press.

Zhang, M., & Batjargal, T. (2022). Review on new spending of United States Bipartisan Infrastructure Bill. *Journal of Infrastructure, Policy and Development, 2,* 1507. https://doi.org/10.24294/jipd.v6i2.1507 (18 pages)

Zuluaga, S., Karney, B. W., & Saxe, S. (2021). The concept of value in sustainable infrastructure systems: a literature review. *Environmental Research: Infrastructure and Sustainability, 2*, 022001. https://doi.org/10.1088/2634-4505/ac0f32 (19 pages)

Optional resources:

Towne, R., & Polanski, R. (1974, June 20). *Chinatown* [Drama, Mystery, Thriller].

Assignments and Assessments

Student-led seminar – 25% (Group/Team – L1, L2, L3, L4)

Students are required to facilitate a portion of a class session covering a specific infrastructure sector. The facilitation may be led alone or in pairs/groups depending on the size of the class and student interest in the topic. The expectation is not to review the readings, but instead present a synthesis of information, contribute further thoughts, and stimulate the discussion of ideas. Students are expected to work with the course's Teaching Assistant to help prepare for their assigned session.

Final Paper – 40% (Individual – L1, L2, L3, L4)

Students will prepare a paper based on, or related to, an infrastructure sector/system covered during the semester. The final paper should be approximately 5,000-6,000 words including tables and charts. The paper can include a case study of an individual city and critical infrastructure sectors or be an overview of a particularly important issue for cities at the regional, national, or global scales (e.g., equity considerations in a particular infrastructure sector). Using policy frameworks that will be introduced during the course, each student should assess challenges in their chosen sector, current strategies (or lack thereof) to advance equitable infrastructure, and discuss potential solutions using different levers.

Students may be asked to share periodic updates on the final paper throughout the semester to solicit feedback and help to better prepare for the final submission. These updates may include their chosen infrastructure sectors, research questions, literature reviews, and data sources. More on the final paper and these intermediate updates will be provided in class.

Final Project/Presentation – 20% (Group/Team Grade – L1, L2, L3, L4)

Students will be assigned to groups to present upon selected infrastructure policy proposals and/or developments. Foundational information about these policies will be provided to students through Canvas, but students are expected to further develop their analysis through the use of additional resources and materials.

Each group will prepare a short presentation summarizing their analysis and present a final presentation to the class that will provide an overview of the infrastructure-related issue(s) the proposal seeks to address, proposed solutions, relevant decision-makers, concerns of impacted communities, and the overall impact on equitable outcomes.

Presentations will be evaluated on the team's ability to identify and discuss the policy levers used; their analysis of the inclusion of equity-oriented measures; and the quality/rigor of the presentation in terms of context and substance. Presentations should reflect thoughtful incorporation and analysis of the concepts introduced in the course. More details will be made available on Canvas as the course progresses.

Participation and Attendance – 15% (Individual Grade – L1, L2, L3, L4)

Students should come to each class prepared to discuss the readings and relevant materials when called upon. Relevant, respectful dialogue, and thoughtful comments are vital for shared learning efforts. *The Socratic Method will be used* to help students develop critical thinking skills and confidently engage with the content of the course.

Grading
The final grade will be calculated as described below:

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

Assignment/Assessment	% Weight	Individual or Group/Team Grade

Participation		15%	Individual
Leading Seminar		25%	Group/Team
Final Project/Presentation		20%	Group/Team
Final Paper		40%	Individual

Course Schedule/Course Calendar

	Date	Topics and Activities	Readings (due on this day)	Assignments (due on this date)
Week 1	1/19/23	**Section 1: Foundations of equitable infrastructure** *Course introductions* *Overview of critical urban infrastructure*	Klinenberg, E. Worry Less About Crumbling Roads, More About Crumbling Libraries. Latham, A & Layton, J. Social infrastructure and the public life of cities: Studying urban sociality and public spaces.	
Week 2	1/26/23	**Section 2: Infrastructure policy development** *Federal infrastructure policy efforts*	Vock, D. C. Rebuilding America's infrastructure. The White House. The Bipartisan Infrastructure Deal [Fact Sheet]. Brookings. America has an infrastructure bill. What happens next? OPTIONAL: Zhang, M., & Batjargal, T. Review on new spending of the United States Bipartisan Infrastructure Bill.	
Week 3	2/2/23	**Section 3: Theoretical framing of equity and justice** *'Equitable' infrastructure?*	Pitter, J. Equitable Infrastructure. Zuluaga et al. The concept of value in sustainable infrastructure systems.	Seminar sign-ups due

			Ikeme, J. Equity, environmental justice, and sustainability.	
Week 4	2/9/23	**Section 3: Theoretical framing of equity and justice** *Equitable infrastructure cont'd.*	Durrant, D. Infrastructure, Equity and Urban Planning. M-21-28, Interim Implementation Guidance for the Justice40 Initiative.	
Week 5	2/16/23	**Section 4: Models of urban governance** *Green infrastructure planning frameworks*	Heck, S. Greening the color line. Carmichael et al. Green Infrastructure Solutions to Health Impacts of Climate Change. Hoover, F.-A. et al. Environmental justice implications of siting criteria in urban green infrastructure planning.	
Week 6	2/23/23	**Section 5: Infrastructure sectors and systems** *Waste Management Sanitation*	Andersson et al. Towards "Sustainable" Sanitation: Challenges and Opportunities in Urban Areas. Bullard, R. D. Solid Waste Sites and the Black Houston Community. Peischel, W. Environmental concerns grow over incinerators in the U.S. Shain, S. How Central Ohio got people to eat their leftovers. Fredericks, R. Vital Infrastructures of Trash in Dakar.	Student-led seminars begin
Week 7	3/2/23	**Section 5: Infrastructure sectors and systems**	Barajas, J. M.The roots of racialized travel behavior.	Final paper sector choices due

		Transportation	DeGood, K. Building Infrastructure That Supports Opportunity, Equity, and Sustainability.	
Week 8	**3/9/23**	**Section 5: Infrastructure sectors and systems** *Communications*	Regional Plan Assocation. Assessing Broadband Equity in the New York Region. Swindells, K. The Stark disparity across internet access in the US. Smith, M. (2021, April 13). Here's how a Texas border city is closing its digital divide.	
Break	**3/16/23**	**Spring Recess** *NO CLASS*		
Week 9	**3/23/23**	**Section 5: Infrastructure sectors and systems** *Water*	Phinney, S. The policing of Black debt: how the municipal bond market regulates the right to water. Balazs, C. L., & Ray, I. The Drinking Water Disparities Framework: On the Origins and Persistence of Inequities in Exposure. Robbins, J. In era of drought, Phoenix prepares for a future without Colorado River Water. Optional: VIDEO: *Chinatown*	Groups for final project assigned
Week 10	**3/30/23**	**Section 5: Infrastructure sectors and systems** *Energy*	Worldwatch. Can a City be sustainable? Chapters 6, 10. Jenkins, K. et al. Energy justice: A conceptual review.	

			Bouzarovski, S., & Simcock, N. Spatializing energy justice.	
Week 11	**4/6/23**	**Section 5: Infrastructure sectors and systems** *Buildings*	Schuurmans, A., Dyrbøl, S., & Guay, F. Buildings in Urban Regeneration. Walker, O., & Ross, M. LA becomes largest CA city to electrify new buildings. Saint , R., & Pomponi , F. Cities and climate change: Why low-rise buildings are the future – not skyscrapers. Penn, I. California reduces subsidies for homes with rooftop solar. Cincinnati, OH - New Market Solar Farm. American Cities Climate Challenge.	
Week 12	**4/13/23**	**Section 6: Advancing equitable infrastructure** *Potential guest speaker/practitioner(s)*		
Week 13	**4/20/23**	**Section 6: Advancing equitable infrastructure** *Group presentations*		
Week 14	**4/27/23**	**Section 6: Advancing equitable infrastructure** *Group presentations*		Final papers due 4/28
	5/1/23	**Last Day of Classes**		

Course Policies

Participation and Attendance
You are expected to complete all assigned readings, attend all class sessions, and engage with others in classroom discussion. I will use the Socratic Method, which will require you to think deeply about the materials and

confidently engage with questions of policy and law. Your participation may require that you answer questions, articulate your point of view, and respectfully engage with the perspectives of others.

If, for any reason, circumstances prevent you from being fully prepared on any given day, please provide a notification before the class begins. If you need to miss a class for any reason, please discuss the absence with me in advance. More than one absence will affect your grade.

Late work
Work that is not submitted on the due date noted in Canvas without advance notice and permission from the instructor will be graded down 1/3 of a grade for every day it is late (e.g., from a B+ to a B).

Citation & Submission
All written assignments must use the APA citation format, cite sources, and be submitted to the course website (not via email).

School and University Policies and Resources

Copyright Policy
Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

> The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity
Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at https://sps.columbia.edu/students/student-support/academic-integrity-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Diversity Statement
It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are

respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture.

Accessibility
Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: https://health.columbia.edu/content/disability-services.

Class Recordings
All or portions of the class may be recorded at the discretion of the Instructor to support your learning. At any point, the Instructor has the right to discontinue the recording if it is deemed to be obstructive to the learning process.

If the recording is posted, it is confidential and it is prohibited to share the recording outside of the class.

SPS Academic Resources
The Division of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: https://sps.columbia.edu/students/student-support/student-support-resources.

Columbia University Information Technology
Columbia University Information Technology (CUIT) provides Columbia University students, faculty and staff with central computing and communications services. Students, faculty and staff may access University-provided and discounted software downloads.

Columbia University Library
Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online.

The Writing Center
The Writing Center provides writing support to undergraduate and graduate students through one-on-one consultations and workshops. They provide support at every stage of your writing, from brainstorming to final drafts. If you would like writing support, please visit the following site to learn about services offered and steps for scheduling an appointment. This resource is open to Columbia graduate students at no additional charge. Visit http://www.college.columbia.edu/core/uwp/writing-center.

Career Design Lab
The Career Design Lab supports current students and alumni with individualized career coaching including career assessment, resume & cover letter writing, agile internship job search strategy, personal branding, interview skills, career transitions, salary negotiations, and much more. Wherever you are in your career journey, the Career Design Lab team is here to support you. Link to https://careerdesignlab.sps.columbia.edu/

Netiquette
 [Only applies to courses using online platforms]

Online sessions in this course will be offered through Zoom, accessible through Canvas. A reliable Internet connection and functioning webcam and microphone are required. It is your responsibility to resolve any known technical issues prior to class. Your webcam should remain turned on for the duration of each class, and you should expect to be present the entire time. Avoid distractions and maintain professional etiquette.

Please note: Instructors may use Canvas or Zoom analytics in evaluating your online participation.

More guidance can be found at: https://jolt.merlot.org/vol6no1/mintu-wimsatt_0310.htm

Netiquette is a way of defining professionalism for collaborations and communication that take place in online environments. Here are some Student Guidelines for this class:

- Avoid using offensive language or language that is not appropriate for a professional setting.
- Do not criticize or mock someone's abilities or skills.
- Communicate in a way that is clear, accurate and easy for others to understand.
- Balance collegiality with academic honesty.
- Keep an open-mind and be willing to express your opinion.
- Reflect on your statements and how they might impact others.
- Do not hesitate to ask for feedback.
- When in doubt, always check with your instructor for clarification.

Course Title:	Critical urban infrastructure for sustainable development
Number:	SUMAPS 5050 001
Schedule:	Thursday 6:10 – 8:00 pm
Credits:	3
Location:	TBD
Instructors:	Peter J. Marcotullio, pjm12@columbia.edu
Office Hours:	By Appointment
Response policy on	email is preferred communications, will respond within 24 hours

weekdays

Course Overview

The human population is expected to continue rising over the coming century. The UN, for example, projects that it will exceed 11.2 billion (range: 7.3-16.6 billion) by 2100. Importantly, all population growth after 2030 will be entirely in the world's cities, largely in developing countries. Developing world urban populations are projected to increase from 2.6 billion in 2010 to 7.8 billion in 2100. In response to this wave of population growth and urbanization, governments and the private sector will invest an estimated US$90 trillion in infrastructure by 2030 (or about $6 trillion a year.   Approximately three-quarters of this infrastructure will be in urban areas and much of this investment will in developing countries.

Infrastructure includes the basic physical and organizational structures and facilities (e.g. buildings, roads, water and power supplies) that keep societies operating. Choices in infrastructure can have lasting impact, as projects are large, expensive and long-lived, helping to lock-in development pathways.   Deployed urban infrastructure made over the next 10 to 15 years can have mid- to long-term implications for global sustainability.

What are urban infrastructures that promote sustainability? Such infrastructure must reduce environmental pollution at all scales, provide necessary urban services efficiently and enhance urban resilience to multiple potential crises (i.e., natural and industrial, climate-related and pandemic hazards). Sustainable infrastructure also must promote social and economic equity and environmental justice. And sustainable infrastructure

must be economically feasible. This class will use these concepts to evaluate urban infrastructure and identify challenges and to making urban infrastructure sustainable. Importantly, the course will use theories of urban transitions to help identify the drivers of potential change in infrastructure development and envisioning the emergence of sustainable infrastructure. This class will examine these notions across the energy, transportation, water supply and waste water treatment, buildings, health and open space urban sectors.

The proposed course fulfills Curriculum Area 3, Physical Dimensions of Sustainability, in the Sustainability Management program. The physical dimensions requirement teaches students about the connections between environmental inputs (i.e., natural resources) and outputs (i.e., energy), and their effects on the natural environment. The emphasis in this requirement will be on understanding the environmental impacts from organizational activities. The planning, design or architecture courses give students a foundation in planning, design and spatial issues. This is particularly important, as many sustainability initiatives concern land use, buildings and other physical entities.

The sustainability of the built environment on an urban scale is a major area of environmental impact, and a field in which many of our students find work. While our curriculum includes a course on sustainable cities (SUMA PS4130 Sustainable Cities) and on infrastructure (SUMA PS5690 Environmental Infrastructure for Sustainable Cities), we were looking for a course that provides an overview of the sustainable built environment and answers the following questions: What are its elements (e.g., buildings, parks, water systems, energy, transportation, etc.)? How does a city transition from the current built environment to the sustainable one? How do the pieces fit together and how does one plan or make policy choices among these elements? What issues do private and public decision makers face? The proposed course complements our existing curriculum, addresses these questions, and provides students with the tools to address climate change through the sustainable built environment, preparing them for careers in sustainable planning and the management of cities with a focus on infrastructural technologies.

Learning objectives

At the conclusion of this class, participants will be able to:

- L1: Develop and organize a general framework by which to integrate urban infrastructure sustainability
- L2: Explain urban transition theories and apply conceptual elements and dynamics to critical infrastructure development
- L3: Classify urban sustainable infrastructure challenges for different sectors

- L4: Describe current drivers of urban infrastructure transitions within a sector and evaluate the potential to address climate change challenges

Required books readings include:

- Steven Cohen and Guo Dong, (2020) *The Sustainable City*, Second Edition, New York: Columbia University Press.

Required articles, reports and chapters posted on Canvas

Course methods

During the semester we will focus on several texts and a number of articles. For each class, reading provide background and are linked to in Canvas whenever possible. The course is run as lectures and lead by the instructor. In section 2, however, we include student presentations. All students are required to present on some aspect related to the readings and lead a subsequent discussion, with the help of the instructor. The presentations should not last longer than 15 minutes with a 10 minutes discussion period. The number of students leading a single class will depend upon student interest and the size of the class. The presentation will happen at the end of the instructor's lecture. While the specific seminar is run by selective students all classmates are expected to contribute and/or present thoughts, information and experiences. Presentations and participation are a major contribution to the success of the class.

Course Requirements (Assignments)

Evaluations are based upon:

- Class attendance and participation. Participation in class discussion is vital for learning. As mentioned, a significant portion of class time is devoted to discussion of readings and class lectures. 10%. L1, L2, L3, L4.
- The completion of four further assignments.
    4. Students are required to present on a specific critical infrastructure issue for part of a seminar (15 minute presentation and 10 minute discussion). They may work alone or in groups depending upon the size of the class and student interest in the topic. All student will receive a template by which to present material. Expectations are

not bring their experiences to the class. Presentations should last about 15-20 minutes 15%. L2, L4.

5. Students will prepare two short policy briefs based upon, or related to any topic directly covered during the seminar (critical infrastructure systems). The policy briefs will be due during after the first and second months of class (early October and early November) 20% L1, L4.

6. The students are required to submit a final paper which is due at the end of the semester. The final paper should be approximately 2,000 - 3,000 words including bibliography, tables and charts. The paper could include a case study of an individual city and critical infrastructure sectors or overview of a particularly important issue for cities at the national, regional or global scales (i.e., infrastructure transitions to urban sustainability) 40%. L1, L2, L3, L4.

7. During the semester, short lectures, given by the instructor, on aspects of writing the final paper with short assignments. These assignments will be peer-reviewed by other students for critical feedback. All students are required to submit material and peer review at least one other student's work. The assignments are directly related to the student research project final papers. Examples of assignments include topic sentences, research question, literature review, annotated bibliography, data sources, methods, paper outline, etc., 5%. L1.

8. Students will present their final papers to the entire class at the end of the semester. 10%, L1, L2, L3, L4.

Evaluation/Grading

The final grade will be calculated as described below:

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %

B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

ASSIGNMENT	% Weight
Class participation	10
Leading special seminar	15
2 Policy Briefs	20
Short paper assignments	5
Final paper	40
Final presentation	10

Course Policies

We expect you to come to class on time and thoroughly prepared. We will keep track of attendance and look forward to an interesting, lively and confidential discussion. If you miss an experience in class, you miss an important learning moment and the class misses your contribution. Engagement with your peers will be an important part of the course. Through posts on the course website and participation in the live sessions, you need to actively contribute to course discussions. In addition, you will have the opportunity both to present before your peers and to respond to their presentations in small group work. You are also expected to complete all assigned readings, attend all class sessions, and engage with others. If you need to miss a class for any reason, please discuss the absence with me in advance.

Participation and Attendance

You are expected to complete all assigned readings, attend all class sessions, and engage with others in online discussions. Your participation will require that you answer questions, defend your point of view, and challenge the point of view of others. If you need to miss a class for any reason, please discuss the absence with me in advance.

Late work

Work that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor will be graded down 1/3 of a grade for every day it is late (e.g., from a B+ to a B).

Citation & Submission

All written assignments must, cite sources, and have full bibliographic references. Papers cannot be solely based newspaper or web-site references. Each paper must have at least 15 references, three quarters of which must come from scholarly journal, books and or government reports. All assignments will be submitted to the course website (not via email)

Course module/section description

Section 1: Introduction

This section provides an overview of the fundamentals that underpin the reading and discussions of the course. It includes an examination of the trends in urbanization, infrastructure investment, potential climate change impacts on cities and transition theories. The goals of the section are to present and interrogate current and potential future challenges facing different cities around the work and the importance of critical infrastructure in addressing these challenges.   During the section of the course, the instructor will provide lectures and lead discussions.

Section 2: Infrastructure sectors

This is the largest section in the course. Classes examine the elements of a variety of different infrastructure systems and the histories / transitions they have already undergone. Emphasis is on both the elements and dynamics of critical infrastructure within the sector and the interlinkages between the infrastructure examined and other sectors. The readings in each section provide a general background and history to the specific infrastructure sector, an overview of the current state and trends of the sector at the global scale and promising infrastructure technologies, structures and institutions that can address sustainability challenges

Students will lead each of the seminars. Prior to this section, students will select specific sector topics of interest. The instructor will provide a template for students to follow to synthesize information from the given readings. Presentations can include PowerPoint slides, but do not necessarily need to follow this format.

Section 3: Transitioning to the sustainable city

In this final class, the instructor will review the lessons from previous lectures and critically compare the factors that have driven transitions in the past with an eye on whether we any potential infrastructure transitions are emerging today. The questions that will draw together the variety of readings and discussions during the semester are: How have transitions occurred in the past? What have been the driving factors in transitions? Were there unique characteristic of urban transitions? What have been the differences between different infrastructure sector transitions? How did policy influence these trends? What were the costs of the transitions?

Course Schedule/Course Calendar

Date	Topics	Readings and assignments (due on this day)
	Section 1: Introduction to critical urban infrastructure	Cohen and Dong, Chapter 1, Defining the sustainable city
9/7	*Urbanization, climate change, sustainability and transitions*	IPCC, *Summary for urban policy makers, What the IPCC special report on global warming of 1.5C means for cities*, pp 1-30.
	Global urbanization and the physical development of cities. History, present state and projected trends	McKinsey (2017) "The growing role of cities in climate action"
		Cohen and Dong, Chapter 2, "Sustainable urban systems"
9/14	**Section 1: Introduction to climate sustainable urban infrastructure** *Overview of infrastructure sustainability challenges*	Joel A. Tarr, (1984) "The Evolution of the Urban Infrastructure in the Nineteenth and Twentieth Centuries," pp 4-66, Royce Hanson, (Ed) *Perspectives on Urban Infrastructure*, Washington, DC: National Research Council.
	Review of urban sustainability challenges with special reference to climate change challenges	Arup, C40, (2016) *Deadline 2020, How Cities Will Get the Job Done*
9/21	**Section 1: Introduction to climate sustainable urban infrastructure**	McGranahan, Gordon (2007) "Urban environment, wealth and health: shifting burdens and possible responses in low and middle-income

	Transition theory: How do we get from here to there?	nations", IIED Human Settlements Discussion Paper Series.
	Review of transition theory with regard to historical transitions in cities	Cohen and Dong, Chapter 6, "Sustainable urban development"
		Breisford & Jones (2021) NAS Workshop
9/28	**Section 2: Elements of the climate sustainable city** *Critical Urban Energy Infrastructure*	Grubler, et al (2013) Urban Energy Systems, *Global Energy Assessment*. McKinsey (2017) "Decarbonizing the electric grid" **Low risk assignment 1: Topic sentences**
10/5	**Section 2: Elements of the climate sustainable city** *Critical Urban Transportation Infrastructure*	Cohen and Dong, Chapter 8, "Mass and personal transit" McKinsey (2017) "Enabling next-generation mobility"
10/12	**Section 2: Elements of the climate sustainable city** *Critical Urban Water Supply Infrastructure*	OECD (2014) Managing water for future cities, Policy Perspectives, Srinivasan et al (2012) "The nature and causes of the global water crisis: Syndromes from a meta-analysis of coupled human-water studies", *Water Resources Research*, 48.

		McKinsey (2017) "Optimizing energy efficiency in buildings"
10/19	**Section 2: Elements of the climate sustainable city** *Critical Building Infrastructure*	Yvan Dutil et al (2011) "Sustainable Buildings: An Ever Evolving Target" *Sustainability*, 3(2) Harvey, LLD (2013) "Recent advances in sustainable buildings: Review of the energy and costs performance of the state-of-the-art best practices from around the world" *Annual Reviews in Environment and Resources* 38 **Low risk assignment 2 Data**
10/26	**Section 2: Elements of the climate sustainable city** *Critical Waste water and Solid waste Infrastructure*	Cohen and Dong, Chapter 7 "Waste management in New York City, Hong Kong and Beijing" McKinsey(2017), "Improving waste management" Douglas, Chapter 3, Foods, goods, materials and ornament: The metabolism of cities, pp 46 – 66
11/2	**Section 2: Elements of the climate sustainable city** *Critical Urban Food Infrastructure*	Zimmerman et al (2018) "A Network Framework for Dynamic Models of Urban Food, Energy and Water Systems (FEWS)" *Environmental Progress and Sustainable Energy*, 37(1): 122-131 Clark et al (2021) "Essential, fragile, and invisible community food infrastructure: The role of urban governments in the United States," *Food Policy* 103.

		Low risk assignment 3 Annotated Bibliography
		Douglas, Ian (2013) "Communities Responding to Disasters and Threats", *Cities: an Environmental History*, pp. 23-45.
11/9	**Section 2: Elements of the climate sustainable city** *Critical Urban Health Infrastructure*	O'Sullivan, Tracey L. et al (2013) Unraveling the complexities of disaster management: A framework for critical social infrastructure to promote population health and resilience, *Social Science and Medicine*, 93: 238-246
		Rydin et al (2012) Shaping cities for health, *Lancet* 379(9831)
11/16	**Section 2: Elements of the climate sustainable city** *Critical Urban Open Space Infrastructure*	Galen Cranz and Michael Boland (2004) Defining the Sustainable Park: A Fifth Model for Urban Parks, *Landscape Journal*, 23(2) TPL (2021) Park Equity Plan for NYC, Trust for Public Land
		Low risk assignment 4 - Outline
11/30	**Section 2: Elements of the climate sustainable city** *Critical telecommunications Infrastructure*	Cohen and Dong, Chapter 9, "Building the smart grid" Simon Marvin (1998) Telecommunications and Sustainable Cities, *Urban Design International*, 3(4) McKinsey (2021) Smarter Cities are Resilient Cities
12/7		Student presentations

12/18	Final papers due

School Policies

Copyright Policy

Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity

Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at http://sps.columbia.edu/student-life-and-alumni-relations/academic-integrity-and-community- standards. You are required to read these standards within the first few

days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility

Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: http://health.columbia.edu/services/ods/support.

Accessibility Statement – I want you to succeed in this course.
Contact disability@columbia.edu for learning accommodations.

Names/Pronouns – You deserve to be addressed in a manner that reflects your identity. You are welcome to tell me your pronoun(s)and/or name (if different from University records) at any time, either in person or via email.

Discrimination – We embrace the diversity of gender, gender identity & expression, sex, sexual orientation, race, ethnicity, national origin, age, religion, disability status, family status, socioeconomic background, and other visible and non-visible identities. Columbia University does not tolerate unlawful discrimination, discriminatory harassment, sexual assault, domestic violence, dating violence, stalking, or sexual exploitation and all such conduct is forbidden by Columbia University Policy.

Duty to Report – You deserve a University community free from discrimination, harassment, and gender-based misconduct including sexual harassment, sexual assault, domestic and dating violence, stalking, and sexual exploitation. It is therefore University policy to require Columbia faculty and staff to report to EOAA any instance or allegation of prohibited conduct involving any undergraduate or any graduate student that is disclosed to, observed by, or otherwise known to that employee. This requirement to report is in place to help ensure that students are provided appropriate resources and to allow the University to mitigate harm to our community.

Confidential Resources - There are confidential resources on campus who do not have a Duty to Report, including:

- Sexual Violence Response & Rape Crisis/Anti-Violence Support Center (SVR)
- Ombuds Office
- Medical Services
- University Counseling and Psychological Services
- University Pastoral Counseling
- Columbia Office of Disability Services

University employees working in a confidential capacity will not report information shared with them.

Inclusion - In the M.S. in Sustainability Management program, faculty and staff are committed to the creation and maintenance of "inclusive learning" spaces – classrooms and other places of learning where you will be treated with respect and dignity, and where all individuals are provided equitable opportunity to participate, contribute, and succeed.

In our Sustainability Management K4100 classroom , all students are welcome regardless of race/ethnicity, gender identities, gender expressions, sexual orientation, socio-economic status, age, disabilities, religion, regional background, Veteran status, citizenship status, nationality and other diverse identities that we each bring to class.