Marcotullio Syllabus

Course Title:	Critical urban infrastructure for sustainable development, SUMA 5050
Schedule:	Wednesday, 6:10 – 8:00 pm
Credits:	3
Instructors:	Peter J. Marcotullio, pjm12@columbia.edu
Office Hours:	Wednesdays, 6:10 – 8:00 pm
Response policy	email is preferred communications, will respond within 24 hours on 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.
- Worldwatch Institute, (2016) *Can a City be Sustainable?* Washington, DC: Worldwatch Institute
- Ian Douglas (2013) *Cities: An Environmental History* I.A.B. Tauris

Required articles, reports and chapters include:

- Ali, S. Harris and Roger Keil (2006) "Global Cities and the Spread of Infectious Disease: The Case of Severe Acute Respiratory Syndrome (SARS) in Toronto, Canada", *Urban Studies* 43(3): 491-509.
- Arup & C40 *Deadline 2020, How Cities Will Get the Job Done* https://www.c40.org/other/deadline_2020
- Boyle, C *et al* (2010) "Delivering sustainable infrastructure that supports the urban built environment," *Environmental Science and Technology*, 44: 4836-4840.
- Grubler, Arnulf, *et al* (2013) "Urban Energy Systems", in IIASA (Ed), *Global Energy Assessment*, New York: Cambridge University Press, pp. 1307-1400.
- IPCC, (2018) *Summary for urban policy makers, What the IPCC special report on global warming of 1.5℃ means for cities*, IPCC, pp 1-30.
- McGranahan, G. (2007) " Urban environments, wealth and health: shifting burdens and possible responses in low and middle-income nations," Human Settlements Discussion Paper, IIED.
- McKinsey (2017) *Focused Acceleration, A Strategic Approach to Climate Action in Cities to 2030*, McKinsey Center for Business and Environment and C40 Cities.
- 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
- Rutherford, Jonathan and Olivier Coutard, 2014, "Urban energy transitions: Places, processes and politics of socio-technical change," *Urban* Studies, 51(7):1353-1377.
- Seto, Karen C. and Navin Ramankutty (2016) "Hidden linkages between urbanization and food systems," *Science*, 352(6288): 943-945
- Webber, Melvin, (1963) "Order in diversity: community without propinquity", in Wingo, Lowdon, Jr., (ed.) *Cities and space*. Baltimore, Johns Hopkins Press p. 23-56
- 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

Course methods

During the semester we will focus on several texts and a number of articles. For each class, reading requirements are identified in the syllabus with links in Canvas whenever possible. During the first section, the course is run as lectures and discussion lead by the instructor. In section 2, we move to a seminar format where students are required to present a summarized version of the readings and lead discussion, with the help of the instructor. The number of students leading a particular class will depend upon student interest and the size of the class. 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:

1) 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.
2) The completion of four further assignments.
    a. Students are required to run a seminar working 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 to review the readings, but rather present a synthesis of information and contribute thoughts and further ideas to a discussion as well as lead a question and answer period. 15%. L1, L2, L3, L4.
    b. Students will prepare a paper based upon, or related to any topic directly covered during the seminar (critical infrastructure systems). The paper is due at the end of the semester. The final paper should be approximately 5,000-8,000 words including bibliography, tables and charts. The length of the paper should not be longer than a journal article. 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). 50%. L3.
    c. During the semester, short lectures, given by the instructor, on aspects of research writing will be the basis of low-risk assignments (submitted/not-submitted). Assignments from students 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.
    d. Students will be broken into three groups for presentations during the last class. Each group will present upon one of three different proposals from the 116th US Congress directly related to infrastructure investment in the US . The proposals include H. Res 109 (also known as the "Green New Deal"), S. 1038 (also known as the "Build USA Infrastructure Act") and the Majority Staff Report, "Solving the Climate Crisis" (subtitled, "The Congressional action plan for a clean energy economy and a healthy, resilient and just America"), Basic information about these proposed bills and reports are provided to students through Canvas, but students are further encouraged to find other material. Presentations should summarize each of these proposals, focusing on infrastructure and evaluate each proposal based upon the issues discussed during the semester. 20%. 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 seminar	15
Low-risk assignments	5
Final paper	50
Group presentation	20

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).

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.

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 climate 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)
9/9	**Section 1: Introduction to climate sustainable urban infrastructure** *Urbanization, climate change, sustainability and transitions* Global urbanization and the physical development of cities. History, present state and projected trends	-Cohen and Dong, Chapter 1, Defining the sustainable city -IPCC, *Summary for urban policy makers, What the IPCC special report on global warming of 1.5C means for cities*, pp 1-30. - McKinsey (2017) Chapter 1 "The growing role of cities in climate action"
9/16	**Section 1: Introduction to climate sustainable urban infrastructure** *Overview of infrastructure sustainability challenges* Review of urban sustainability challenges with special reference to climate change challenges	-Cohen and Dong, Chapter 2, "Sustainable urban systems" -Douglas, Chapter 1, "Trading village to global megalopolis: The origins and expansion of cities," pp 7-22 -Arup, C40, (2016) *Deadline 2020, How Cities Will Get the Job Done*

9/23	**Section 1: Introduction to climate sustainable urban infrastructure** *Transition theory: How do we get from here to there?* Review of transition theory with regard to historical transitions in cities	-Boyle, C et al (2010) "Delivering sustainable infrastructure that supports the urban built environment," *Environmental Science and Technology*, 44: 4836-4840 -Douglas, Chapter 2, "Communities responding to disasters and threats: vulnerability and resilient cities," pp. 23-45. -Cohen and Dong, Chapter 6, "Sustainable urban development"
9/30	**Section 2: Physical elements of the climate sustainable city** *Critical Urban Energy Infrastructure*	-Worldwatch, Chapter 6, "Cities and greenhouse gas emissions: The scope of the challenge," pp. -Worldwatch, Chapter 10 "Is 100 percent renewable energy in cities possible?" pp. -Cohen and Dong, Chapter 9, "Building the smart grid" -Grubler, et al (2013) Urban Energy Systems, pp. - McKinsey (2017) Chapter 2, "Decarbonizing the electric grid" **Low risk assignment 1: Topic sentences**
10/7	**Section 2: Physical elements of the climate sustainable city** *Critical Urban Transportation Infrastructure*	-Cohen and Dong, Chapter 8, "Mass and personal transit" - McKinsey (2017) Chapter 2, "Enabling next-generation mobility" -Worldwatch, Chapter 12, "Supporting sustainable transportation" -Worldwatch, Chapter 13, "Urban transport and climate change"
10/14	**Section 2: Physical elements of the climate sustainable city** *Critical Urban Water Supply Infrastructure*	-Douglas, Chapter 5, "Water from the hill, the ground, the sea and the roof: towards integrated water resource management in cities", pp.
10/21	**Section 2: Physical elements of the climate sustainable city** *Critical Building Infrastructure*	-Worldwatch, Chapters 8 "Reducing the environmental footprint of buildings, and "Energy efficiency in buildings: A crisis of opportunity" -Worldwatch, Chapters 9 "Energy efficiency in buildings: A crisis of opportunity"

		-McKinsey (2017) Chapter 2, "Optimzing energy efficiency in buildilgs" **Low risk assignment 2 Data**
10/28	**Section 2: Physical elements of the climate sustainable city** *Critical Waste water and Solid waste Infrastructure*	-Douglas, Chapter 6, "Sanitation, sewage and mountains of trash: wastewater and garbage in cities" -Cohen and Dong, Chapter 7 "Waste management in New York City, Hong Kong and Beijing" -Worldwatch, Chapter 13 "Source reduction and recycling of waste" -Worldwatch, Chapter 14, "Solid waste and climate change" McKinsey(2017), Chapter 2, "Improving waste management"
11/4	**Section 2: Physical elements of the climate sustainable city** *Critical Urban Food Infrastructure*	-Douglas, Chapter 3, Foods, goods, materials and ornament: The metabolism of cities, pp 46 – 66 -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 -Seto, Karen C. and Navin Ramankutty (2016) "Hidden linkages between urbanization and food systems," *Science*, 352(6288): 943-945 **Low risk assignment 3 Annotated Bibliography**
11/11	**Section 2: Physical elements of the climate sustainable city** *Critical Urban Health Infrastructure*	-Douglas, Chapter 4, "Smoke, fumes, dust and smog: Changing the atmosphere of cities", pp. 67-105. - S. Harris Ali and Roger Keil (2006) "Global Cities and the Spread of Infectious Disease: The Case of Severe Acute Respiratory Syndrome (SARS) in Toronto, Canada", *Urban Studies* 43(3): 491-509. - 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
11/18	**Section 2: Physical elements of the climate sustainable city**	-Douglas, Chapter 9, "Urban greenspaces: The tamed and wild nature in cities," pp. 252-285

	Critical Urban Open Space Infrastructure	-Cohen and Dong, Chapter 10, "Parks and public space" -Worldwatch, Chapter 17, "The vital role of biodiversity in urban sustainability" **Low risk assignment 4 - Outline**
12/2	**Section 3: Transitioning towards urban climate sustainability**	-Douglas, Chapter 10, "Urban sustainability: cities for future generations", pp 286-304. -Worldwatch, Chapter 16, "Re-municipalization, the low-carbon transition and energy democracy" -Cohen and Dong, Chapter 12, "Toward a sustainable city"
12/9	**Section 3: Transitioning towards urban climate sustainability** *Student group presentations on US infrastructure-related proposals.*	
12/26		**Student Papers due**