Syllabus

Course Title: CIVE T580: Stormwater Planning in the Era of Climate Change

Credits: 3

Pre-requisites: Approval of Instructor

Instructor: Franco Montalto, P.E., PhD

Meeting location: Online synchronous class, Wednesdays 4:00-6:50 PM

High Level Description of Course:

Drexel University will be offering an online class, *Stormwater Planning in the era of Climate Change*, during the Summer of 2020 to introduce students to new approaches to incorporate climate change considerations into urban stormwater planning and modeling. Students enrolled in the class, which will be open to both Drexel and continuing education students, will work directly with a set of pre-selected cities and water utilities who wish to incorporate climate change into their real-world operations. Students will learn how to quantify the extent to which climate change will modify the amount, timing, and distribution of precipitation in our region. Separate learning modules will cover the basics of Global Circulation Models (GCMs), where and how to access their output, as well as their shortcomings and strengths. The course will also teach students how to select different greenhouse gas emissions scenarios, or Representative Concentration Pathways (RCPs), for climate change planning. We will also review where to find different kinds of precipitation data, and how to analyze it. Finally, students will learn and immediately apply several approaches for forecasting changes in annual, seasonal, daily, hourly, and subhourly precipitation in the future.

Learning Objectives:

1) Gain insights into the decision-making needs of a real stormwater utility as it contemplates how to factor climate change into operations
2) Learn where and how to obtain historical and future climate data for a given location
3) Explore the variability intrinsic to downscaled climate projections produced from different models, under different emissions scenarios, for the same site
4) Expose students to the evolving "state of the art" regarding generation precipitation products (time series, events, IDF curves, etc) that reflect projected climate change and are useful to stormwater planners
5) Develop design storms from historic precipitation analyses and modify these using delta change factors to simulate future precipitation change
6) Explore the significance of design storm modifications using a simple site-scale hydrologic model. Does the variability matter?

Background:

Extreme precipitation events are occurring more frequently in many parts of the United States, according to the Fourth National Climate Assessment, and the frequency of these events are expected to grow further as the climate warms. Recent extreme events have illustrated the devastating impacts that heavy precipitation can bring to urban areas, including damaging and disruptive flooding, reduced drinking water and receiving water quality, and wastewater overflows. These extreme rainfall events also have exposed critical gaps in planning when it comes to effective urban stormwater and wastewater management in a changing climate. Increasingly, stormwater utilities, municipalities, departments of transportation, and other infrastructure sectors, and their consultants, are initiating efforts to update their planning and policy to consider future changed precipitation.

In March, 2020, the Consortium for Climate Risks in the Urban Northeast (CCRUN), working with the Mid-Atlantic Regional Integrated Sciences and Assessment Team (MARISA) organized a workshop to exchange ideas, discuss best practices, and the state of the art in this field. Funded by the Climate Program Office of the National Oceanic and Atmospheric Administration (CPO-NOAA), the event included a series of pre-recorded webinars describing some of the more quantitative strategies that are being used to produce two, specific products: a) sub-hourly precipitation time series for the future that can be used to simulate the effects of climate change on stormwater collection systems, and b) updated Intensity-Duration-Frequency (IDF) curves that can be used for stormwater facility planning. During the workshop, the production of these two products was discussed with respect to a few specific case study cities, but many other workshop attendees left with the desire to conduct the same sets of analyses for their own data.

Representative Readings (subject to change):

- Anandhi et al (2011) Examination of change factor methodologies for climate change impact assessment
- ARC3.2 Chapter 2
- Cook, LM et al (2020) The effect of modeling choices on updating intensity-duration-frequency curves and stormwater infrastructure designs for climate change
- DeGaetano , AT et al (2017) Future Projections of Extreme Precipitation Intensity-Duration-Frequency Curves for Climate Adaptation Planning in New York City
- Maimone et al (2019) Transforming global climate model precipitation output for use in urban stormwater applications
- Milly, PCD et al (2008) Stationarity is Dead: Whither Water Management?
- NCA4 Chapter 4
- NYC Climate Resiliency Design Guidelines

Grading/PDH credits (maximum of 20 PDHs available):

- Homeworks (FOUR assignments @ 10% each) – 40% of grade/max PDH
- Class participation – 20% of grade/max PDH
- Final presentation – 20% of grade/max PDD
- Final report – 20% of grade/max PDH

Guidelines for Community Based Learning:

1. Respect other people's beliefs/values/opinions
2. Recognize different backgrounds/different journeys
3. Inclusive environment where all can share and be heard
4. Assume good intentions
5. Jump forward/step back (push yourself to talk more or less than is comfortable)
6. Ask questions and don't be afraid not to know something
7. Recognize we're all here to learn (we all have different forms of knowledge and are learning at different paces)
8. Speak up if you have a question or need more information about something, ask clarifying questions
9. Actively listen, be present
10. JUST Listen

Week by Week Breakdown of Classes and Participant Responsibilities

[see following pages]

	Week starting	At home Readings/Multimedia	In-class lecture, discussion topic	In-class activity	Assignments
1	6/24	N.A.	Introductions, Overview of class goals and expectations; Overview of community-based learning strategy	What flooding looks like	1) Interview your city rep; what are the key stormwater planning issues that need to be addressed? How is stormwater managed currently? Which design storms are used in different planning processes? When were these decisions made? Have these storms been updated? What are the implications of these design storms on local infrastructure.
2	7/1	Online lecture #1: Introduction to cloud formation and convection in the atmosphere, and Online lecture #2: Introduction to convective storms and precipitation formation and Read Milly et al (2008)	Precipitation physics 101; Causes of precipitation; use of precipitation data in stormwater planning; H&H modeling 101; Design storms; IDF curves	Watch Kate Marvel Ted Talk, and Activity: Make a Thunderstorm;	
3	7/8	Read ARC3.2 chapter 2 and, NCA4 Chapter 4	Climate Change 101; What are GCMs and RCPs? Approaches to downscaling (Speaker: Dan Bader, Columbia University).	Tour of Climate Explorer; ASSIGNMENT #1 PRESENTATION	2) Use the Climate Explorer to produce a NPCC-style table of climate changes for your municipality). Write up a one-page report summarizing how climate will change, addressing uncertainty due to different models and RCPs appropriately.
4	7/15	Online lecture #3: Transforming Daily GCM data for use in H&H models and Online lecture #4: A Practical Weather Generator and Maimone et al (2019)	Why we can't use the GCM precipitation output directly; how can we can use it indirectly to develop delta change factors?	Tour of the MACA tool; ASSIGNMENT #2 PRESENTATION	3) Use the MACA tool to develop delta factors for different GCMs, different months, and different RCPs for your city. Develop a distribution of delta factors to discuss with your city.

5	7/22	Online lecture #5: A hybrid approach to downscaling and bias correcting IDF curves for NYC And Anandhi et al (2011) And DeGaetano and Castellano (2017)	Downscaling extreme precipitation using historical analogs (Speaker: Art DeGaetano)	Tour of NYC Interactive Tool for Extreme Precip Analysis	
6	7/29	Online lecture #6: Using Pressure Change to Stochastically Disaggregate Hourly Precipitation Series, And NYC Climate Resiliency Design Guidelines	Climate change impacts on combined sewer overflow volumes (Speaker: Ziwen Yu); creating NRCS precipitation distributions, and modification with delta change factor	Tour of Atlas 14, ASSIGNMENT #3 PRESENTATION	4) Identify the depths of the 1 yr, 5 yr, 10 yr, 25 yr, 50 yr, and 100 yr storms for your municipality from Atlas 14. Develop its NRCS Type II distribution. Increase the precipitation amounts using the delta change factors of greatest interest to your city.
7	8/5	Cook et al (2020)	Introduction US Climate Resilience Toolkit	Introduction to EPA SWMM	
8	8/12	TBD	Introduction to SWMM-CAT	ASSIGNMENT #4 PRESENTATION	5) Select a case study location in your city and compare runoff quantities with and without climate change, in event-based simulations. How much does climate change affect runoff?
9	8/19	TBD	In class work day		
10	8/26		FINAL REPORTS DUE		
Final	9/2		FINAL PRESENTATION - Student presentations to class advisors and city representatives		

Drexel Registered Students (take class for grade)	Continuing Education Students (maximum of 20 PDHs)	Governmental Partners (will sign MOU with DU)
• Attend online class weekly • Complete 4 project assignments (Assignments #1 through #4) – **each assignment is 10% of grade** • Do weekly readings and watch online lectures • Participate actively in synchronous online discussions (zoom calls) – **participation is 20% of grade** • Complete Final Presentation – **20% of grade** • Complete Final Report – **20% of grade**	• Attend online class weekly • Complete 4 project assignments (Assignments #1 through #4) – **each assignment is worth 2 PDHs** • Do weekly readings and watch online lectures • Participate actively in synchronous online discussions (zoom calls) – **participation is worth 4 PDHs** • Complete Final Presentation – **worth 4 PDHs** • Complete Final Report – **worth 4 PDHs**	• Sign an MOU with Drexel University • Make at least one knowledgeable staffer available for a maximum of five (5), 1-hour calls with students throughout the term (Students are responsible for scheduling) • Assign at least one knowledgeable staffer to serve as a virtual critic for one (1) hour in at least two (2) of the following classes: 7/8, 7/15, 7/29, 8/12 • Produce a map identifying the boundaries of one site where you would like to simulate the percent increase in stormwater that could result from climate change. • Listen to and interact with the students during the final presentations on 8/26