CEE 433: Water Technology & Policy

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COURSE INFORMATION

CEE 433: Water Technology & Policy
Civil and Environmental Engineering
Spring semester 2024, 3-4 credits

Class meeting: Tuesdays and Thursdays, 8:00-9:20 AM; 3310 Newmark
(All times in this syllabus are in U.S. Central time)

Course websites: http://canvas.illinois.edu; https://mediaspace.illinois.edu
Lecture recordings: https://mediaspace.illinois.edu

This course will cover technical and social concepts of water and wastewater treatment, water resources, water policy and economics, and water in culture. Emphasis will be on the intersection between water technology (from an engineering perspective) and water policy (from economic and societal perspectives). Communication is an important element of this course: engineers will learn to "speak" policy via writing assignments, multimedia presentation, and briefings (4-credit students only).

Course objectives. Throughout this course, students will 1) research water technology- and policy-related topics, 2) analyze interrelated systems, 3) synthesize ideas into technical analyses, and 4) present the results in a technology- and policy-related manner.

Prerequisites. Upper-level undergraduate or graduate standing; CEE 330, CEE 340, or CEE 350, or consent of instructor.

OFFICE HOURS

Office hours: Mondays and Tuesdays 1:30-3:00 PM, 3030 CEEB

COURSE POLICIES

Academic integrity. Each student is expected to complete their own work. Academic dishonesty, including cheating, plagiarism, and/or copyright infringement of any kind, will not be tolerated and will be reported to the appropriate administration. Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Ask the instructor if you are in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Illness, including COVID. Following University policy, all students are required to engage in appropriate behavior to protect the health and safety of the community. *Students who feel ill*

must not come to class. In addition, students who test positive for COVID-19 must not attend class and should follow current University and CDC guidance. The University can provide absence information to the instructor, in a manner that complies with privacy laws; consult the Office of the Dean of Students for more information. Students who miss class due to illness should view the recorded lecture online, contribute to the Canvas discussion board, and contact the instructor via email about options for making up missed work.

Emergency response recommendations. Emergency response recommendations can be found at the following website: https://police.illinois.edu/em/. Review this website and the campus building floor plans website to familiarize yourself with the building in the event of an emergency: https://police.illinois.edu/em/building-emergency-action-plans/.

Disability-related accommodations. To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, visit 1207 S. Oak St., Champaign, call 217-333-4603, e-mail disability@illinois.edu, or go to https://dres.illinois.edu. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnose a previously undiagnosed disability. Access these resources by visiting the DRES website and selecting “Support Services”.

Family Educational Rights and Privacy Act (FERPA). Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

Anti-racism and inclusivity. The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course instructor if you feel comfortable. You can also report these behaviors to the Campus Belonging Resources team at https://diversity.illinois.edu/diversity-campus-culture/belonging-resources/. Based on your report, Campus Belonging Resources members will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.

Religious observances. Illinois law requires the University to reasonably accommodate its students’ religious beliefs, observances, and practices regarding admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of

your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/ to request appropriate accommodations. This request should be made in the first two weeks of classes.

Sexual misconduct reporting obligation. The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/#confidential. Other information about resources and reporting is available here: wecare.illinois.edu.

CLASS PARTICIPATION

Participation in class discussion is required and constitutes a portion of the overall grade. See "Class discussion" under "Assignments".

LATE WORK POLICY

Late assignments. Late assignments will be accepted up to 24 hours after the due date for a 10% grading penalty. For example, if an assignment is due at 8:00 AM and is submitted at 5:00 PM (9 hours late), the original (hypothetical) grade of 83% will be recorded as 73%. Assignments submitted more than 24 hours late will be given a zero.

Late exams/quizzes. Late or make-up exams and quizzes are not allowed, except under extreme circumstances approved by the instructor in advance. Conflict exams must be taken in advance of the regularly scheduled exam, and only when approved by the instructor in advance. The late assignment policy does not apply to the take-home final, which will not be accepted late.

IMPORTANT DATES*

*University dates vary for undergraduate and graduate students. Confirm online for exact dates.

Jan 29	Add course deadline
Feb 20	Individual project proposal due, 8:00 AM
Mar 5	Midterm exam, 8:00 AM
Mar 8	(Undergraduate) drop course deadline; credit/no-credit deadline
Mar 9-17	Spring break
Mar 28	Project outline due, 8:00 AM
Apr 11	Case study due, 8:00 AM
Apr 12	(Graduate) drop course deadline; credit/no-credit deadline
Apr 30	Project paper and video due, 5:00 PM
May 7	Take-home final exam due, 9:00 AM

ASSIGNMENTS

Individual project. The main assignment of this course is an individual project, including an analytical paper and video (multimedia presentation). Length requirements vary for 3-credit and 4-credit students:

3-credit students	Paper: ≤ 8 single-spaced pages	Video: 3 ± 0.5 minutes
4-credit students	Paper: ≤ 12 single-spaced pages	Video: 5 ± 0.5 minutes

The project should be an original analysis (beyond a literature review) of a water-related topic, including elements of both technology and policy. Papers that focus completely on technologies with no consideration for policy or analyze policy without including engineering elements will not score highly. Both engineering and policy concepts must be present in the analysis. Technology considerations must include 2 or more traditional civil engineering areas.

A 1-page project proposal is due at 8:00 AM on February 20. The proposal should include a brief synopsis and scope of the proposed project, an outline of the methodological approach, and pertinent data sets and references to complete the analysis.

A detailed 3-page outline including references is due at 8:00 AM on March 28.

The final paper, meeting the length limits above, is due at 5:00 PM on April 30.

Communicating in a modern policy environment requires more than just effective written communication. Use of multimedia technology is increasingly important in a policy context, and can be an efficient method of describing rigorous work to broad audiences. Each student will create a video (multimedia presentation), meeting the time requirements above, describing the analysis covered in their paper. The video should use both audio and visual elements to convey information. Be conscious of copyright requirements and do not use copyrighted material without proper permissions.

The video is due at 5:00 PM on April 30, and should be uploaded to the class MediaSpace channel.

Additional details regarding the project paper and video, including resources to help complete the project, will be discussed later in the semester.

Homework/quizzes and case study. Homework assignments and in-class quizzes will take place throughout the semester. Homework assignments will reinforce the technical concepts from class. In-class quizzes will cover reading assignments for weeks with more policy material. Online students should complete quizzes on Canvas on the same day as in-class students. One case study, to be completed in pairs/groups, will take place during the semester and is due at 8:00 AM on April 11.

Midterm exam. The midterm exam will take place on March 5 in class. Topics covered by the exam will be described during the in-class review.

Take-home final exam. The take-home final exam will be issued during the last day of class and is due at 9:00 AM on May 7.

Class discussion. Different perspectives inform how we think about water issues, and discussion can be a productive means of sharing information. Participation in class discussion

constitutes a portion of the overall course grade. In lieu of in-class participation, online and in-class students may contribute to the asynchronous Canvas discussion board for each week's topic for participation points. Discussion contributions should be substantial, productive, and respectful. Contributions to the weekly Canvas discussion board are due by noon on Monday of the following week.

Additional requirements for 4-credit students. Students enrolled in the 4-credit section will have additional assignments to justify the additional credit. Throughout the semester, 4-credit students will write three 2-page policy memos on a topic of choice pertaining to water technology and policy. All three memos are due by 8:00 AM on April 30; however, the memos may be submitted at any time throughout the semester. It is highly suggested that 4-credit students complete and submit memos early in the semester to avoid time management issues between the memos and the individual project.

In addition to the three policy memos, each 4-credit student will give a 3-minute oral policy briefing to the class. The briefing may cover a topic addressed in the memos or a different topic, as long as the subject matter is related to water technology and policy. Briefings will take place synchronously at the beginning of class, and the instructor will determine the schedule. Asynchronous oral briefings are allowed with approval in advance.

GRADING

3-credit students	
Project paper	20%
Project video	10%
Final exam	20%
Midterm exam	20%
Homework/quizzes	10%
Case study	10%
Participation*	10%
	100%

4-credit students	
Project paper	20%
Project video	10%
Final exam	20%
Midterm exam	20%
Homework/quizzes	10%
Case study	5%
Policy memos	5%
Briefing	5%
Participation*	5%
	100%

*Grading for participation will be assessed based on discussion in class or asynchronous Canvas discussion board posts. More than 2 absences without substantial contributions to the week's discussion board on Canvas by noon on Monday of the following week will reduce the participation grade.

Letter grades will be assigned using a plus/minus system, as below:

A	93.0-100.0%
A-	90.0-92.9%
B+	87.0-89.9%
B	83.0-86.9%
B-	80.0-82.9%
C+	77.0-79.9%
C	73.0-76.9%
C-	70.0-72.9%
D+	67.0-69.9%
D	63.0-66.9%
D-	60.0-62.9%
F	59.9% and below

LEARNING RESOURCES

Required materials. Reading materials required for the course will be available on the class Canvas site. Resources include the following:

- Acuña, V., T. Datry, J. Marshall, D. Barceló, C. N. Dahm, A. Ginebreda, G. McGregor, S. Sabater, K. Tockner, and M. A. Palmer. (2014) "Why Should We Care About Temporary Waterways?" *Science*. 343(6175), 1080-1081.
- Clack, Christopher T. M., Staffan A. Qvist, Jay Apt, Morgan Brazilian, Adam R. Brandt, Ken Caldeira, Steven J. Davis, Victor Diakov, Mark A. Handschy, Paul D. H. Hines, Paulina Jaramillo, Daniel M. Kammen, Jane C. S. Long, M. Granger Morgan, Adam Reed, Varun Sivaram, James Sweeney, George R. Tynan, David G. Victor, John P. Weyant, and Jay F. Whitacre. (2017) "Evaluation of a proposal for reliable low-cost grid power with 100% wind, water, and solar." *Proceedings of the National Academy of Sciences*. 114(26), 6722-6727.
- Clean Water Act (CWA), Federal Water Pollution Control Act. U.S. Congress. http://www.epw.senate.gov/water.pdf. (skim)
- Clean Water Rule: Definition of "Waters of the United States" (WOTUS). (2015) U.S. Federal Register, Vol. 80, No. 124. (skim)
- Edwards, Marc A. and Amy Pruden. (2016) "The Flint Water Crisis: Overturning the Research Paradigm to Advance Science and Defend Public Welfare." *Environmental Science & Technology*. 50(17), 8935-8936.
- Fagan, Brian. (2011) Elixir: A History of Water and Humankind. Bloomsbury Press, New York. ISBN: 978-1-60819-003-4. (ch. 13-14)
- Gerbens-Leenes, Winnie, Arjen Y. Hoekstra, and Theo H. van der Meer. (2009) "The water footprint of bioenergy." *Proceedings of the National Academy of Sciences*. 106(25), 10219-10223.
- Grubert, Emily, and Kelly T. Sanders. (2018). "Water Use in the United States Energy System: A National Assessment and Unit Process Inventory of Water Consumption and Withdrawals." *Environmental Science & Technology*. 52(11), 6695-6703.
- Howe, Ben Ryder. (2021) "Wall Street Eyes Billions in the Colorado's Water." *New York Times*, January 3, 2021. https://www.nytimes.com/2021/01/03/business/colorado-river-water-rights.html.
- Jacobson, Mark Z., Mark A. Delucchi, Mary A. Cameron, and Bethany A. Frew. (2015) "Low-cost solution to the grid reliability problem with 100% penetration of intermittent wind, water, and solar for all purposes." *Proceedings of the National Academy of Sciences*. 112(49), 15060-15065.
- Jacobson, Mark Z., Mark A. Delucchi, Mary A. Cameron, and Bethany A. Frew. (2017) "The United States can keep the grid stable at low cost with 100% clean, renewable energy in all sectors despite inaccurate claims." *Proceedings of the National Academy of Sciences*. 114(26), E5021-E5023.
- Jones, P. Andrew. (2015) "Colorado Water Markets." *Proceedings of the American Bar Association Water Law Conference*. June 4-5, 2015, Denver, CO.
- Navigable Waters Protection Rule: Definition of "Waters of the United States." (2018) Department of the Army, Corps of Engineers, Department of Defense; and Environmental Protection Agency (EPA).
- Papacostas, C.S. (2014) "Traditional water rights, ecology and the public trust doctrine in Hawaii." *Water Policy*. 16(1), 184-196.
- Pennell, Kelly G., Marcella Thompson, James W. Rice, Laura Senier, Phil Brown, and Eric Suuberg. (2013) "Bridging Research and Environmental Regulatory Processes: The Role of Knowledge Brokers." *Environmental Science & Technology*. 47(21), 11985-11992.

- Perramond, Eric. (2020). "Water rights, river compacts, and legal-policy stationarity in the American West." *Environmental Research Letters*. 15(2), 025002.
- Podolak, Charles J.P., and Martin Doyle. (2015) "Conditional Water Rights in the Western United States: Introducing Uncertainty to Prior Appropriation." *Journal of the American Water Resources Association*. 51(1), 14-32.
- Purtill, Corinne and Susanne Rust. (2024). "Researchers discover thousands of nanoplastic bits in bottles of drinking water." *LA Times*, January 8, 2024. https://www.latimes.com/environment/story/2024-01-08/thousands-of-nanoplastics-found-in-bottled-drinking-water.
- Rhodes, Joshua D. (2017) "Energy wonks have a meltdown over the US going 100 percent renewable. Why?" *The Conversation*. June 22, 2017.
- Rosinger, Asher Y. and Sera L. Young. (2020). "In-Home Tap Water Consumption Trends Changed Among U.S. Children, but Not Adults, Between 2007 and 2016." *Water Resources Research*. 56(7), e2020WR027657.
- Schutz, Jonathan R. (2012) "Why the Western United States' prior appropriation water rights system should weather climate variability." *Water International*. 37(6), 700-707.
- Springer, Nathaniel P. and Faye Duchin. (2014) "Feeding Nine Billion People Sustainably: Conserving Land and Water through Shifting Diets and Changes in Technologies." *Environmental Science & Technology*. 48(8), 4444-4451.
- Stokstad, Erik. (2014) "Will fracking put too much fizz in your water?" *Science*. 344(6191), 1468-1471.
- Teodoro, Manuel P. and Robin Rose Saywitz. (2020). "Water and sewer affordability in the United States: a 2019 update." *AWWA Water Science*. 2(2), e1176.
- Wang, Tianqi, Jooho Kim, and Andrew J. Whelton. (2019) "Management of plastic bottle and filter waste during the large-scale Flint Michigan lead contaminated drinking water incident." *Resources, Conservation & Recycling*. 140, 115-124.
- West, Paul C., James S. Gerber, Peder M. Engstrom, Nathaniel D. Mueller, Kate A. Brauman, Kimberly M. Carlson, Emily S. Cassidy, Matt Johnston, Graham K. MacDonald, Deepak K. Ray, and Stefan Siebert. (2014) "Leverage points for improving global food security and the environment." *Science*. 345(6194), 325-328.

Recommended for further reading (not required for course):

- Christian-Smith, Juliet and Peter H. Gleick. (2012) A Twenty-First Century U.S. Water Policy. Oxford University Press, Oxford. ISBN: 978-0-19-985944-3.
- Doyle, Martin. (2018) The Source: How Rivers Made America and America Remade its Rivers. W. W. Norton & Company, New York. ISBN: 978-0-393-35661-8.
- George, Rose. (2008) The Big Necessity: The Unmentionable World of Human Waste and Why It Matters. Henry Holt and Company, New York. ISBN: 978-0-8050-9083-3.
- Gleick, Peter H. (2010) Bottled and Sold: The Story Behind Our Obsession with Bottled Water. Island Press, Washington. ISBN: 978-1-59726-528-7.
- Glennon, Robert. (2009) Unquenchable: America's Water Crisis and What to Do About It. Island Press, Washington. ISBN: 978-1-59726-436-5.
- Hanemann, W. Michael. (2005) *The Economic Conception of Water*. Working Paper No. 1005. California Experiment Station, Giannini Foundation of Agricultural Economics.
- Reisner, Marc. (1993) Cadillac Desert: The American West and its Disappearing Water. Penguin Books, New York. ISBN: 978-0-14-017824-1.
- Sedlak, David. (2014) Water 4.0: The Past, Present, and Future of the World's Most Vital Resource. Yale University Press, New Haven, CT. ISBN: 978-0-300-21267-9.
- Webber, Michael E. (2016) Thirst for Power: Energy, Water, and Human Survival. Yale University Press, New Haven, CT. ISBN: 978-0-300-21246-4.

SCHEDULE

Assigned reading is to be completed before the start of class.

Week	Date(s)	Topic	Reading	Assignment Due
1	Jan 16	Importance of water		
	Jan 18	Water and civilization	Fagan; Pennell et al.	
2	Jan 23	Hydrology: surface water		
	Jan 25	Hydrology: groundwater		
3	Jan 30	Water management case studies		
	Feb 1	Water law: Clean Water Act	(skim) CWA; Papacostas	HW1
4	Feb 6	Water law: water rights systems	Perramond; Schutz	
	Feb 8	Water law: water rights systems (continued)	Podolak & Doyle	Q1
5	Feb 13	Water law: WOTUS	Acuña et al.; (skim) WOTUS rules (2015 and 2018)	
	Feb 15	Water law: WOTUS (continued)		
6	Feb 20	Water financing: cost-benefit analysis		Project proposal
	Feb 22	Water financing: markets	Howe; Jones	HW2
7	Feb 27	Water financing: economics (price, cost, value)	Teodoro & Saywitz	Q2
	Feb 29	Water financing: privatization		HW3
8	**Mar 5**	**Midterm exam**		
	Mar 7	Video-making tutorial		
9	NO CLASS – Spring Break (Mar 12, 14)			
10	Mar 19	Treatment: drinking water; desalination		
	Mar 21	Treatment: water quality in distribution systems	Edwards & Pruden; Wang et al.	
11	Mar 26	Treatment: wastewater treatment		
	Mar 28	WWTP field trip (tentative)		Project outline
12	Apr 2	Energy: hydraulic fracturing	Stokstad	
	Apr 4	Energy: power generation	Grubert & Sanders; Gerbens-Leenes et al.	
13	Apr 9	Energy: renewables and the grid	(read in order): Jacobson et al. (2015); Clack et al.; Jacobson et al. (2017); Rhodes	Q3
	Apr 11	Energy: biofuels		Case study
14	Apr 16	Power plant field trip		
	Apr 18	Water and food	Springer & Duchin; West et al.	Q4
15	Apr 23	Bottled water	Rosinger & Young; Purtill & Rust	
	Apr 25	Bottled water (continued)		
16	Apr 30	Water at the movies		
	Apr 30	**Project paper and video due 5:00 PM U.S. Central time**		
	May 7	**Final exam due 9:00 AM U.S. Central time**		