SWS 4245/5246 WATER RESOURCE SUSTAINABILITY

3 credits/Spring Semester

COURSE MOTIVATION AND DESCRIPTION

This course is about the global water crisis: the challenge of providing sufficient and equitable water supply for all people while also supporting ecosystem functions. Four key themes are maintained: hydrology, ecological protection, social justice, and economic opportunity.

Global demand for freshwater resources grows continuously, while at the same time there is increasing emphasis on preventing pollution and leaving enough water for natural ecosystem functions. These combined pressures define the need for sustainable water resource management. This course describes the effects of human impacts on hydrologic ecosystems (aquifers, rivers, coastal zones, lakes, and wetlands) with quantitative measures of impacts and mitigation/attenuation efforts. Case studies from around the world are used to illustrate both the detrimental effects of unsustainable resource utilization and the benefits of implementing sustainable resource management strategies.

This course is intended for graduate and advanced undergraduate students interested in the interactions between human civilization and hydrologic systems and should be of interest to environmental and agricultural scientists and engineers, and natural resource managers.

Instructor

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BRIEF OUTLINE

Topic	Weeks
1. Water resource sustainability	**1**
2. How do water resources underpin human society?	**2-3**
3. Where are the world's water resources?	**4**
4. Equitable water allocation (meeting present and future minimum water needs)	**5**
5. Groundwater sustainability	**6-7**
6. Water quality (groundwater and surface water)	**7-8**
7. Rivers and humans	**9**
8. Urban water services	**10**
9. Water transfers	**11**
10. Water control infrastructure (including dams)	**12-13**
11. Water institutions (including large-scale management)	**14-15**

ASSIGNMENTS

Your success as a professional will be based, in large part, on your ability to effectively communicate your ideas in both written and verbal forms. We all need practice to develop and improve these technical communication skills.

1. All students: Weekly readings from scholarly research articles, news analyses, and commentaries are assigned for each module, with a required corresponding written response of approximately **500**

words. These will be submitted in Canvas or typed hardcopies in class, due following the discussion period (usually Fridays). These should be a critical evaluation and brief synthesis of the week's readings, including discussion of assigned questions related to the readings. You are likely to be *called upon in class* to share your comments.

2. All students: Reports on site visits to hydrologic/hydraulic features related to concepts and topics discussed in class. Site visits must be during the semester. Credit can only be received through coordination with the instructor. Due by the end of Week 13.
3. Graduate students: Take leadership roles during weekly discussions of reading assignments. Complete an individual research assignment on a water resource topic chosen with consent of the instructor.

GRADING SYSTEM

To reflect the different skills required for professional success, the final grade in this course is based on analytical reading/writing assignments, thoughtful and consistent participation, formal essay exams, and interesting individual and group projects.

	Points for grade	
Course components	**SWS4245**	**SWS5246**
Weekly one-page assignments (5 points each)	50	50
Exam 1	100	100
Exam 2	100	100
Individual field trip	30	15
Class engagement/leadership, part 1	10	10
Class engagement/leadership, part 2	10	10
Individual research assignment		15
Total points	**300**	**300**

Exams

- are primarily essay questions linking concepts with specific information from case studies,
- exam grades are historically highly correlated to class attendance,
- exam dates and times are fixed FIRMLY.

Class participation

- entails regular, on-time attendance and engagement, and active interaction in periodic small-group discussions in rotating roles (discussion leader, reporter)
- participation points will be assigned separately for each half of the semester.

Late assignments will be penalized in proportion to the time since the due date, with zero credit after two weeks.

Grade Scale

A ≥ 92 > A- ≥ 89 > B+ ≥ 86 > B ≥ 83 > B- ≥ 80 > C+ ≥ 77 > C ≥ 74 > C- ≥ 71 > D+ ≥ 68 > D ≥ 65 > D- ≥ 62 > E

The mind does not require filling like a bottle, but rather, like wood, it only requires kindling to create in it an impulse to think independently.

- Plutarch, c. 100 AD, *Moralia*, *On Listening to Lectures* 48C (Loeb Classic Library 1.259)

The greatest obstacle to discovery is not ignorance - it is the illusion of knowledge.

- Daniel J. Boorstin, 1983, *The Discoverers*

COURSE SCHEDULE (writing assignments are due on the last date for each module)

Topic 1 Getting serious about sustainability 9,11,12,16 January

1. How do water resources intersect with people's lives? Which people?
2. What are the implications of rivalrous vs excludable resources?
   2.1. Which resources are subject to overconsumption or degradation?
   2.2. What are the potential remedies for resource depletion or degradation?
3. What is it we wish to sustain?
   3.1. What are the relationships between the components of sustainability?
4. What explains resource consumption rate trends?
   4.1. What is a demographic transition?
   4.2. Who is doing the consuming, and how will that change?
5. What are the limits to peak use of renewable vs nonrenewable resources?
   5.1. How does local depletion relate to globalization?

1. Ostrom E et al., 1999. Revisiting the commons: Local lessons, global challenges. *Science*, 284(5412), 278-282.

2. *The Economist*, 2021. Family matters: Why the demographic transition is speeding up, 11 December.

3. Gleick PH and Palaniappan M, 2010. Peak water limits to freshwater withdrawal and use, *Proceedings of the National Academy of Sciences*, 107(25): 11155–11162.

2 Hydraulic societies: Then and now 18,19,23,25,26 January

6. How does climate relate to societal development?
   6.1. Where will future climate change be important?
7. What is a hydraulic society?
8. How are water resources connected to societal development and decay in…
   8.1. Egypt, Rome, West Asia, Mesoamerica?
9. How are ancient societies relevant today?
   9.1. How have human interventions in the hydrologic cycle evolved with time?

4. Hall P, 1998. *Cities in Civilization,* Chapter 22: The Imperial Capital: Rome 50BC – AD 100, Pantheon, NY. (pp. 621-656)

5. Castro, José Esteban, 2006. The sociogenesis of water stress, Ch. 2 in *Water, Power and Citizenship: Social Struggle in the Basin of Mexico*, Palgrave Macmillan.

3 Water availability: Uneven distribution in space and time 30 January, 1,2 February

10. Where is the world's fresh water?
    10.1. How is water distributed among the major water storages?
    10.2. What are the determinants of the spatial distribution of the major water flows?
    10.3. How do we measure storages and flows?
    10.4. What are the important temporal components of these fluxes?
11. How does the global spatial distribution of people relate to water availability?
12. What are the elements of the hydraulic cycle vs the hydrologic cycle?
    12.1. What is the spatial distribution of human water use?
    12.2. Which human activities use the most water?
    12.3. How does economic power relate to water stress?

6. United Nations, 2023. *The United Nations World Water Development Report 2023: Partnerships and*

Cooperation for Water. UNESCO, Paris. **Prologue Part 1: pp. 12-19**

7. Oki T and Quiocho RE, 2020. Economically challenged and water scarce: Identification of global populations most vulnerable to water crises. *International Journal of Water Resources Development*, 36(2-3): 416-428.

4 Water for people: Progress and remaining gaps 6,8,9 February

14. How much water do humans need?
    14.1. Does everyone have access to enough water?
    14.2. Why is there water scarcity?
15. What progress was made from the Millennium Development Goals?
16. How do the Sustainable Development Goals compare to the MDGs?
17. How does sanitation access differ from water access?
    17.1. What are consequences of sanitation gaps?
18. When/where was the public health revolution?
    18.1. How do developing countries of today compare to industrialized countries?
    18.2. Where is there progress and what barriers remain?

8. United Nations, 2023. *The United Nations World Water Development Report 2023: Partnerships and Cooperation for Water*. UNESCO, Paris. **Prologue Part 2: pp. 21-28**

9. de la Cruz, B, 2023. Waiting for water: It's everywhere in this Colombian city — except in the pipes, *National Public Radio*, 3 December, https://www.npr.org/sections/goatsandsoda/2023/12/03/1216561130/colombia-water-scarcity

10. Gifford R, 2011. Phnom Penh's feat: Getting clean tap water flowing, *National Public Radio*, 2 June, http://www.npr.org/2011/06/02/136394058/phnom-penhs-feat-getting-clean-tap-water-flowing

11. Paviour B, 2016. In Phnom Penh, a looming sewage crisis, *The Cambodia Daily*, April 16, https://english.cambodiadaily.com/editors-choice/111364-111364/

5 Groundwater: The shouting present vs the whispering future 13,15,16,20 February

19. Who uses groundwater?
20. What are the important physical characteristics of aquifers related to storage and flow?
21. What are the major groundwater resources in Florida?
22. How is groundwater accessed?
23. What are the effects of pumping groundwater?
    23.1. What are the pumping implications for confined vs unconfined aquifers?
    23.2. Where is regional groundwater depletion important?
    23.3. Where are the links between groundwater and surface waters important?

12. Rojanasakul M, Flavelle C, Migliozzi B, and E Murray, 2023. America is using up its groundwater like there's no tomorrow, *New York Times*, 28 August. https://www.nytimes.com/interactive/2023/08/28/climate/groundwater-drying-climate-change.html (NYT is free for UF students: https://businesslibrary.uflib.ufl.edu/wsj-nyt-economist)

13. Searcey D, 2024. Indiana's plan to pipe in groundwater for microchip-making draws fire, *New York Times*, 2 January. https://www.nytimes.com/2024/01/02/climate/indiana-leap-groundwater-pipe-microchips.html

14. de Graaf et al., 2019. Environmental flow limits to global groundwater pumping. *Nature*, 574(7776), pp.90-94.

6 Water quality: Impacts and societal response — 22,23,27,29 February

24. Why does water get contaminated?
    24.1. What are the impacts?
    24.2. Who is responsible?
    24.3. How should we respond?
    24.4. What conceptual frameworks can help us understand these questions?
25. How do we expect trajectories of water quality impairment and societal response to evolve through time?
26. What are the sources of water quality impairment?
    26.1. Where are these different sources important?

15. Loewenberg S, 2017. The poisoning of Bangladesh: How arsenic is ravaging a nation, *Undark*, 16 August, https://undark.org/2017/08/16/bangladesh-arsenic-poisoning-drinking-water/

16. Maag C, 2009. From the ashes of '69, a river reborn, *New York Times*, 21 June.

17. *The Memory Palace* [podcast], 2016. Oil, Water. Episode 92: 14 July. https://thememorypalace.us/oil-water/

MIDTERM EXAM 1 MARCH

7 Rivers as transport corridors — 5,7,8,19,21 March

27. How do watersheds connect people and ecosystems?
28. How has the importance of rivers as transport corridors changed over time?
29. What is the global relationship between rivers and human settlements?
    29.1. How have changing transport modes affected the relationship between human settlements and rivers?
30. What patterns do we expect in river corridors between population density, land cover, and hydraulic infrastructure?

18. *The Economist*, 2020. Follow the bottle: How to get beer around Congo, a country with hardly any roads, 18 January

19. Godfrey MC, and Catton T, 2011. Ch. 5 Flexing the Environmental Muscle: The Cross-Florida Barge Canal, the Everglades Jetport, and Big Cypress Swamp, In *River of Interests: Water Management in South Florida and the Everglades, 1948-2010,* US Army Corps of Engineers, **[pp. 69-74]**

20. Fang Y and Jawitz JW, 2019. The evolution of the human population distance to water in the USA from 1790 to 2010, *Nature Communications*, 10(1), 430.

SPRING BREAK — 11-15 March

8 Urban water services — 22,26,28,29 March

30. What are the foundational roles of urban water services?
31. What are the key elements of urban water infrastructure?
32. How have urban water services evolved over time?
33. What are current and future challenges related to regeneration and renewal?

21. *99% Invisible* [podcast], 2013. Reversal of fortune, Episode 86: August. https://99percentinvisible.org/episode/episode-86-reversal-of-fortune/

22. Kimmelman M, 2022. Remaking the river that remade L.A., *New York Times*, November 10, https://www.nytimes.com/interactive/2022/11/10/magazine/la-river-redesign.html

23. Betancourt M, 2021. The Capital's waterways could be swimmable by 2030, *Eos*, 102, https://doi.org/10.1029/2021EO210599
24. *The Economist*, 2021. Good job, Newark. 17 April

9 Water transfer: Local consumption, distant impacts — 2,4,5 April

34. What infrastructure is used for water physical transfer?
35. What are the beneficial uses at the destination of transferred water?
    35.1. What are the detrimental impacts at the origin of water transfer?
36. How does drainage reverse the impact/benefit locations?
37. Where have historic water transfers been most significant?
38. Where are important current water transfers?
39. What is the future of large-scale water transfer?

25. *China Daily*, 2017. South-to-north water diversion benefits 50 million Chinese, 14 September, http://www.chinadaily.com.cn/china/2017-09/14/content_32000250.htm
26. *The Economist*, 2018. China has built the world's largest water-diversion project, April 18
27. Shih G, 2023. Taliban bringing water to Afghanistan's parched plains via massive canal, *The Washington Post*, 20 August, https://www.washingtonpost.com/world/2023/08/20/afghanistan-taliban-canal-amu-darya/
28. Flavelle C, 2022. As the Great Salt Lake dries up, Utah faces an 'environmental nuclear bomb', *New York Times*, 7 June, https://www.nytimes.com/2022/06/07/climate/salt-lake-city-climate-disaster.html
29. Kruzman D, 2021. U.S. Southwest, already parched, sees 'virtual water' drain abroad, *Undark*, 31 May, https://undark.org/2021/05/31/foreign-farms-virtual-water/

10 Infrastructure: Dams and flood protection structures — 9,11,12 April

40. What is the nature of flood risk?
    40.1. Where are risks highest?
    40.2. Who is most at risk?
41. Why are dams built?
    41.1. What benefits are provided?
    41.2. Are there alternatives for providing these benefits?
    41.3. Where are dams important?
42. What are the societal costs of large-scale river regulation?
43. What is the future of large-scale infrastructure?

30. Tate E, Rahman MA, Emrich CT, Sampson CC, 2021. Flood exposure and social vulnerability in the United States. *Natural Hazards*. 106(1):435-57.
31. Bearak M and Raghavan S, 2020. Africa's largest dam powers dreams of prosperity in Ethiopia — and fears of hunger in Egypt, *Washington Post*, 15 October, https://www.washingtonpost.com/world/interactive/2020/grand-ethiopian-renaissance-dam-egypt-nile/
32. O'Connor et al., 2015. 1000 dams down and counting, *Science*, 348:496-497.
33. Yee V, 2023. Years of graft doomed 2 dams in Libya, leaving thousands in muddy graves, *New York Times*, 27 September, https://www.nytimes.com/2023/09/27/world/middleeast/libya-flooding-derna-corruption.html

INDIVIDUAL PROJECTS DUE THURSDAY 18 APRIL

11 Institutions: Spatiotemporal scales of water management 16,18,19 April

44. What rules are used to allocate water among competing demands?
    44.1. What are the origins of regionally varying rule systems?
45. What are the foundational elements of Florida's water management system?
46. How do asymmetries in political/economic/military power affect water allocation?
47. What are the likelihoods of conflict vs cooperation in transboundary water management?
48. What strategies should water managers pursue to support water resource sustainability?

34. Flavelle C and Rojanasakul M, 2023. As groundwater dwindles, powerful players block change, New York Times, 24 November, https://www.nytimes.com/interactive/2023/11/24/climate/groundwater-levels.html

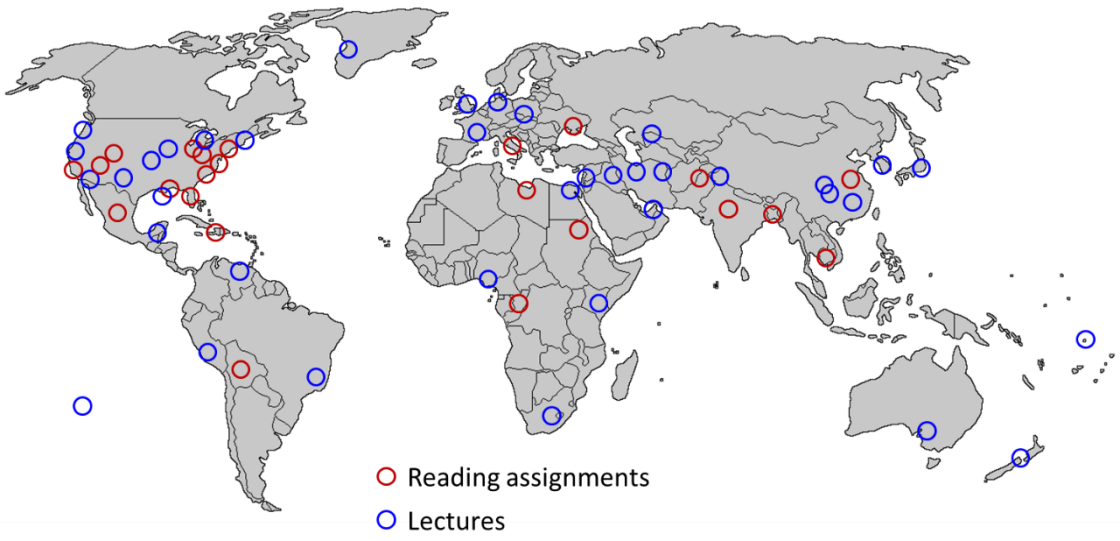
35. Munson AB, Delfino JJ, and Leeper DA, 2005. Determining minimum flows and levels: The Florida experience, *Journal of the American Water Resources Association*, 41(1): 1-10.

36. Félix V, 2023. A controversial irrigation canal is a new symbol of hope for Haiti, *New Lines Magazine*, 27 November, https://newlinesmag.com/spotlight/a-controversial-irrigation-canal-is-a-new-symbol-of-hope-for-haiti/

37. Dolgin E, 2023. Water and warfare: The battle to control a precious resource, *Nature Outlook: Water*, 14 December, https://doi.org/10.1038/d41586-023-03883-w

FINAL EXAM: 2 MAY 5:30 PM (this date is set firmly by UF)

37 readings. Global coverage. Median publication year = 2020.



UF Policies (Updated August 2021)
http://aa.ufl.edu/media/syllabusufledu/syllabi_policy_8_5_2021.pdf

Grades and Grade Points: For information on current UF policies for assigning grade points, see https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/.

Attendance and Make-Up Work: Requirements for class attendance and make-up exams, assignments and other work are consistent with university policies that can be found at: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/.

Online Course Evaluation Process: Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

Services for Students with Disabilities: Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center, https://disability.ufl.edu/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Academic Honesty: UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Conduct Code specifies a number of behaviors that are in violation of this code and the possible sanctions.

Campus Helping Resources: Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling& Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

- University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575, www.counseling.ufl.edu, Counseling Services, Groups and Workshops, Outreach and Consultation, Self-Help Library, Wellness Coaching
- U Matter We Care, www.umatter.ufl.edu/
- Career Connections Center, First Floor JWRU, 392-1601, https://career.ufl.edu/.
- Student Success Initiative, http://studentsuccess.ufl.edu.

In-class Recording: Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor