Water Resource Economics
EAS 501, Section 086
Fall 2021

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Monday, Wednesday 1:00-2:20
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Introduction: The legal and policy institutions of water resources, along with their physical features, give rise to the field of water resource economics. The market is a core analytical concept of microeconomics. Yet rarely, if ever, do we observe markets at work in allocating water resources and water quality. Instead, the various settings of water allocation are often particular and idiosyncratic; this makes water resource economics challenging, and interesting, to study.

While we do not observe many markets, we continue to apply concepts of demand and supply, and the several forms of externalities, to water and water resources. In other words, we do not begin with a blank slate, nothing. Part of our practice will be to apply these concepts in a water context. Most of our subject matter will involve the United States – the physical, legal, and public-policy features of water resources in the United States.

Prerequisite: EAS 570, or a similar background in microeconomics.

Student Support: The University of Michigan recognizes disability as an integral part of diversity and is committed to creating an inclusive and equitable educational environment for students with disabilities. Students who are experiencing a disability-related barrier should contact Services for Students with Disabilities https://ssd.umich.edu/; 734-763-3000 or ssdoffice@umich.edu). For students who are connected with SSD, accommodation requests can be made in Accommodate. If you have any questions or concerns, please contact your SSD Coordinator or visit SSD's Current Student webpage. SSD considers aspects of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SSD, instructors, and the student may be warranted to ensure an accessible course experience.

Land Acknowledgment: We acknowledge that the land in this region of Michigan was originally called Michigami (Mishigami) and belongs to the People of Three Fires: Ojibwe, Odawa, and Potawatomi. We are honored to be guests on this land. We also recognize Michigan's 12 federally recognized Tribal Nations, historic Indigenous communities in Michigan, Indigenous individuals and communities who live here now, and those who were forcibly removed from their homelands in Michigami.

Water Acknowledgement: We recognize that many of the land reservations of the Tribal Nations are located in the arid western United States. While some Nations have established water rights to accompany the land, many Nations still need to establish legal title to water rights in addition to what is called "wet water" in the West – actual water coming to the Nations' lands and people. Rectifying this historic injustice is an essential task for the first half of this century.

Evaluation and Grading: The final grade will be based on: seven-to-nine homework assignments (35%), a take-home mid-term (30%), a take-home final exam (30%), and class participation (5%). The final exam is not cumulative.

Academic Integrity: Students are expected to take personal responsibility for understanding and observing the Rackham Academic and Professional Integrity Policy. Read the policy at: https://rackham.umich.edu/academic-policies/section8/.

Learning Goals: To apply the principles and methods of microeconomics and environmental economics to water resources; and to develop understanding of the physical, legal, and public-policy features of water resources in the United States.

Learning Mechanisms: (i) homework assignments, (ii) exams, (iii) lectures and in-class exercises, and (iv) readings. All materials will be distributed through the Canvas website.

Student Competencies: The **Learning Goals** translate into a set of **Knowledge Competencies** and **Skill Competencies** that you will achieve in the course.

Knowledge Competencies

(1) *Microeconomic principles of allocation institutions, including markets*

Allocation institutions of water quantity and water scarcity; markets for water resources; price and non-price approaches to urban water conservation; externalities in water resources

(2) *Principles and applications of environmental economics*

Non-market valuation of water quality; cap-and-trade programs for water pollutants; public-policy evaluation frameworks (benefit-cost and cost-effectiveness); discounting; climate change and rivers; water footprints

(3) *Legal and public-policy institutions of U.S. water resources*

Clean Water Act; legal frameworks for allocating scarce water resources; federal policies and programs for allocating water and river resources

Skill Competencies

(1) *Quantitative reasoning and skills*

Graphical analysis; algebra; regression statistical analysis (causal effects)

(2) *Excel for quantitative applications*

Algebra; regression statistical analysis; Net Present Value financial analysis

(3) *Policy reform*

Using economics to facilitate new water policies and programs

Course Outline

Part I. Water Quality
(Eight meetings; no class on Monday, Sept. 6)

Methods: (a) Causal effects in statistical regression analysis: difference-in-differences estimation. (b) Hedonic price method: estimating the effect of environmental quality on residential property values.

Water quality regulation in the United States: the Clean Water Act
- The government grants program for wastewater treatment plants
- The point-source permitting program: the basis for TMDLs in water bodies (TMDL = total maximum daily load)
- Cap-and-trade programs for water pollutants

Hedonic price applications to water quality
- Lake water quality in the United States
- Flint water crisis
- Great Lakes Restoration Initiative: the Area of Concern program

Travel cost applications to water quality
- Valuing lake water quality in Iowa
- Damage assessment for the BP oil spill in the Gulf of Mexico

Part II. Water Quantity: Allocating Water as a Scarce Resource
(Five-six meetings; no class on Monday, Oct. 18)

Quantity-based allocation institutions
- Interstate compacts and state water rights
- Agricultural water use with quantity-based allocations; the Bureau of Reclamation and its role in developing the American West

Water markets as a tool of water reallocation and price-based allocations
- Characterizing economic efficiency for a river and its water – the Colorado River
- How might we think about regulated markets for water?

Climate change: aridification of river systems

-- Take-home Mid-term Exam due Friday, October 22 --

Part III. Environmental Constraints on Water and River Use
(Four meetings)

Endangered Species Act: cost-effectiveness analysis of salmon recovery in the Snake-Columbia River system

Relicensing of hydropower dams by Federal Energy Regulatory Commission: benefit-cost analysis of Manistee River, Michigan

Dam removal: Ann Arbor's own Argo Dam, Huron River; contingent valuation method

Part IV. Selected Topics
(Eight-nine meetings; no class on Wednesday, Nov. 24)

Native American water rights; Animas-La Plata water project in Colorado

Principles, Requirements, and Guidelines for Federal Investments in Water Resources; official guidance for evaluating federal water projects and programs

Urban water demand and conservation; water shutoffs in Detroit

Groundwater as a common-pool resource; self organizing to solve externalities in Colorado

Water and national economic growth: applying the Environmental Kuznets Curve to water

Water footprinting and accounting in food production: a U.S. analysis

Virtual water: international trade in food products

-- Take-home Final Exam due Thursday, December 16 --

Course Schedule

Week	Dates	Topic	Reading
1	Aug. 30, Sept. 1	• Introduction to course **Part I: Water quality** • Methods: causal effects; hedonic price method • Clean Water Act	 1, 2 3
2	Sept. 8 (no class Sept. 6)	• Clean Water Act (continued)	3
3	Sept. 13, 15	• Cap-and-trade for water pollutants: principles • Maryland's cap-and-trade program; context of Total Maximum Daily Loads under the Clean Water Act	4 5,6,7
4	Sept. 20, 22	• Three hedonic price applications to water quality: (1) Lake water quality in the United States (2) Flint water crisis	 8 9
5	Sept. 27, 29	(3) Great Lakes Restoration Initiative grants made to remediate so-called Areas of Concern • Travel cost method applications to water quality	10 11,12
6	Oct. 4, 6	**Part II: Allocating water as a scarce resource** • The historical and legal setting for water allocation • Quantity-based allocation institutions: interstate river compacts and state water rights • Agricultural water use with quantity-based allocations	 13,14 15,16
7	Oct. 11, 13	• The economic conception of water • Water markets as a tool of water reallocation: laissez faire, or regulated markets in water and water rights?	17 18,19, 20
8	Oct. 20 (no class Oct. 18)	• Allocative efficiency and instream flow demands -- *Take-home Mid-term Exam due Friday, October 22* --	21
9	Oct. 25, 27	• Water, rivers, and climate change (Guest: Dean Jonathan Overpeck) **Part III: Environmental constraints on water & river use** • Environmental constraints on water use, Part 1: Endangered Species Act and the Snake-Columbia River	22, 23 24, 25, 26
10	Nov. 1, 3	• Environmental constraints on water use, Part 2: Hydropower relicensing by Federal Energy Regulatory Commission on the Manistee River, Michigan • Dam removal: Argo Dam on the Huron River, Ann Arbor	27 28, 29
11	Nov. 8, 10	**Part IV: Selected topics** • Native American water rights: the Animas-La Plata water project, Colorado • Evaluation of federal water projects and plans	 30, 31 32
12	Nov. 15, 17	• Urban water demand and conservation	33, 34
13	Nov. 22 (no class Nov. 24)	• Detroit water curtailments (Guest: Professor Sam Stolper)	
14	Nov. 29, Dec 1	• Groundwater depletion as a common pool resource	35

15	Dec. 6, 8	• Water use as a function of GDP: the Environmental Kuznets Curve applied to water • Water footprints; water accounting in food production • Virtual water: international trade in virtual water products	36 37 38
		Take-home Final Exam: due Thursday, December 16	

Readings

1. Difference-in-differences estimation for estimating causal effects in regression statistical analysis. https://www.publichealth.columbia.edu/research/population-health-methods/difference-difference-estimation

2. Hedonic price method: estimating the effect of environmental quality on residential property values. https://www.ecosystemvaluation.org/hedonic_pricing.htm

3. Keiser and Shapiro, "Consequences of the Clean Water Act and the Demand for Water Quality," *Quarterly Journal of Economics*, 134(1), February 2019, p. 349-396.

4. O'Neil and others, "Transferable Discharge Permits and Economic Efficiency: The Fox River," *Journal of Environmental Economics and Management*, 10, 1983, p. 346-355.

5. "Water Quality Trading," Chesapeake Bay Foundation, https://www.cbf.org/issues/water-quality-trading/index.html.

6. "Nutrient Trading for NPDES Permitees," Greg Busch, State of Maryland https://mde.maryland.gov/programs/Water/WQT/Documents/MDE%20Trading%20Webinar%2010.22.2018.pdf

7. Background references: homepage for Maryland's Water Quality Trading Program. https://mde.maryland.gov/programs/Water/WQT/Pages/index.aspx

Map with the program's "Edge of Tide factors," what we generically label as "impact factors." https://mdewin64.mde.state.md.us/WSA/Trading/index.html

8. Moore, Doubek, Xu, and Cardinale, "Hedonic Price Estimates of Lake Water Quality: Valued Attribute, Instrumental Variables, and Ecological-Economic Benefits," *Ecological Economics* 175, 2020.

9. Christensen, Keiser, and Lade, "Economic Effects of Environmental Crises: Evidence from Flint, Michigan," working paper, January 2021.

10. Cassidy, Meeks, and Moore, "Cleaning Up the Rust Belt: Housing Market Impacts of Removing Legacy Pollutants," working paper, January 2021.

11. Travel cost method: estimating demand for a recreation site while using "travel cost" as a surrogate for price of the good. https://www.ecosystemvaluation.org/travel_costs.htm

12. Egan, Herriges, Kling, and Downing, "Valuing Water Quality as a Function of Water Quality Measures," *American Journal of Agricultural Economics* 91(1), 2009, p. 106-123.

13. Reisner, *Cadillac Desert: The American West and Its Disappearing Water*, Introduction, 1986, p. 1-15.

14. Thompson et al., *Legal Control of Water Resources*, Chapter 1: Currents and Eddies: An Introduction to Water Resource Issues, 2018, p. 1-25.

15. Sengupta, "It's Some of America's Richest Farmland. But What is it Without Water?" *New York Times*, Aug. 3, 2021. https://www.nytimes.com/2021/06/28/climate/california-drought-farming.html

16. Hagerty, "Adaptation to Water Scarcity in Irrigated Agriculture," working paper, 2020.

17. Hanemann, "Chapter 4: The Economic Conception of Water," in *Water Crisis: Myth or Reality*, edited by Peter P. Rogers, M. Ramon Llamas, and Luis Martinez-Cortina. London; New York: Taylor & Francis, 2006, p. 61-91.

18. U.S. Department of the Interior, "Storymap: Drought in the Colorado River Basin." https://www.doi.gov/water/owdi.cr.drought/en/#Introduction

19. Booker and Young, "Modeling Intrastate and Interstate Markets for Colorado River Water Resources," *Journal of Environmental Economics and Management*, Vol. 26, 1994.

20. Howe, "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

21. The Nature Conservancy, "Tackling Water Shortage in the Colorado River Basin," 2018. https://www.nature.org/en-us/about-us/where-we-work/priority-landscapes/colorado-river/tackling-water-shortage/

22. Wick, "'Running out of options': California resorts to water cutoffs as drought worsens," *Los Angeles Times*, August 4, 2021. https://www.latimes.com/california/story/2021-08-04/california-drought-water-restrictions-how-bad-is-it

23. Overpeck and Udall, Climate change and the aridification of North America," *Proceedings of the National Academy of Sciences*, 2020.

24. Defenders of Wildlife and Save Our Wild Salmon, "Storymap: Imagining a New Future for the Lower Snake River," 2021. https://storymaps.arcgis.com/stories/9e59cb81113b415daf56e088b17e132e

25. Halsing and Moore, "Cost-Effective Management Alternatives for Snake River Chinook Salmon: A Biological-Economic Synthesis," *Conservation Biology*, 2008.

26. ECONorthwest, *Lower Snake River Dams: Economic Tradeoffs of Removal*, 7/29/2019. https://static1.squarespace.com/static/597fb96acd39c34098e8d423/t/5d41be440a153e0001fee548/1564589713452/LowerSnake_ExecSummary_FINAL_ECONWV4+copy.pdf

27. Kotchen, Moore, Lupi, and Rutherford. “Environmental Constraints on Hydropower: An Ex Post Benefit-Cost Analysis of Dam Relicensing in Michigan,” *Land Economics*, 2006.

28. American Rivers, “Supercharging river restoration: a landmark bill to boost dam removal nationwide,” July 9, 2021. And: Excerpts of a Senate bill, the “Twenty-First Century Dams Act.”

29. Materials from a SEAS Master’s Project: applying the Contingent Valuation Method to consider removal of Ann Arbor’s Argo Dam.

30. Marston, “Cease-fire called on the Animas-La Plata front,” *High Country News*, 1996.

31. Bureau of Reclamation, Department of the Interior, “Animas-La Plata Project: Economic and Financial Analyses Update,” June 1995.

32. Principles, Requirements, and Guidelines for Federal Investments in Water Resources, 2013 and 2014.

33. Olmstead and Stavins, “Comparing price and nonprice approaches to urban water conservation,” *Water Resources Research*, 2009.

34. Public Policy Institute of California, *Building Drought Resistance in California’s Cities and Suburbs*, 2017.

35. Smith and others, “Responding to a Groundwater Crisis: The Effects of Self-Imposed Economic Incentives,” *Journal of the Association of Environmental and Resource Economics*, 2017.

36. Katz, “Water use and economic growth: reconsidering the Environmental Kuznets relationship,” *Journal of Cleaner Production* 2015.

37. Heller and others, “Individual U.S. diets show wide variation in water scarcity footprints,” *Nature Food*, 2021.

38. Hoekstra and Hung, “Virtual water trade: A quantification of virtual water flows between nations in relation to international crop trade,” Chapter 2 in *Virtual Water Trade*, 2003.