ENVR 685, PLAN 685 – Spring 2022 Fridays, 9:05 am-11:45 am

*Instructor:* Dale Whittington (Dale\_Whittington@unc.edu) Office hours by appointment

*TA:* Saumitra Sinha (saumitra@live.unc.edu) Rosenau (PH) - Rm 0230

**Water & Sanitation Planning and Policy in Developing Countries: Course Syllabus**

**LEARNING OBJECTIVES**

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| **No.** | **Course Learning Objective** | **Related Departmental Competency** |
| 1 | To develop the knowledge basis and understanding of status quo (baseline) conditions in the water and sanitation sector in less developed countries; and how “problems” are defined | - “Identify environmental engineering problems …”  - “Develop a depth of knowledge in one area within environmental sciences & engineering |
| 2 | To understand current trends in water and sanitation conditions and where current programs, economic growth, population growth, and demographic changes are headed (dynamic baseline) | - “Identify environmental engineering problems …”  - “Develop a depth of knowledge in one area within environmental sciences & engineering |
| 3 | To understand and think critically about the different types of policy interventions (instruments) that can be used to improve water and sanitation conditions in developing countries | - “Develop and design appropriate controls and facilities to solve environmental engineering problems.”  - “Specify approaches for assessing, preventing, and controlling environmental hazards that pose risks to human health and safety.” |
| 4 | To understand the policy objectives (criteria) that governments and donors use to assess the outcomes of policy interventions in the water and sanitation sector | “Identify environmental engineering needs and objectives …”  “Demonstrate awareness of and sensitivity to the varied perspectives, norms, and values of others based on individual and ethnic/cultural differences” |
| 5 | To understand the causal links between policy interventions and outcomes; to critically assess the available evidence about how effective different policy instruments are in improving conditions in the water and sanitation sector | - “Explain the relationships between scientific knowledge, exposure, risk assessment, environmental management, and environmental policy.”  - “Apply evidence-based concepts in public health decision-making” |
| 6 | To think critically about implementation issues and the lessons learned about implementation, monitoring and evaluation | - “Show familiarity with public health practice” |
| 7 | To develop critical writing and communication skills in order to better explain policy recommendations in the water and sanitation sector to decision-makers | - “Demonstrate written and oral communication skills related to environmental engineering”  - “Analyze, interpret, and explain the results of original research |
| 8 | To learn how to read and synthesize professional and scientific literature on a policy issue in the water and sanitation sector | - “Review and synthesize a body of research |

**ASSIGNMENTS**

There will be three required assignments in this course. Students can then choose between writing a term paper or taking a final exam. If a student cannot attend the final exam at the regularly scheduled time, they should opt to write a term paper.

**GRADING POLICY**:

Grades for the course will be based on the following weights:

Assignment No. 1 (due Feb. 11) - 20%

Assignment No. 2 (due April 1) - 20%

Assignment No. 3 (due April 22) - 20%

Final Exam or Term Paper (May 5th) – 30%

Class participation and presentations – 10%

TOTAL = 100%

Participation in discussion of recorded lectures, class debates, and student-led discussions of papers, and in-class discussion teaching cases (required):

* *Discussion of Recorded Lectures*: Students should watch the assigned recorded lectures before class and come to class prepared to discuss these materials. Each student is requested to send the teaching assistant at least one question about the recorded lectures 24 hours before the start of the class. The TA will then organize and send these questions to Prof. Whittington for discussion in class. I also encourage you to ask questions in class.
* *Debates*: Students will participate in 1 of the 2 debates, on either the pro or con side, based on random assignment. Debate topics and dates are listed in the schedule below.
* *Student-led Discussions*: Students (alone or in pairs) will present a summary and lead a critical discussion of an assigned reading. The length of the presentation will vary but will typically be between 20-30 minutes. Students who are not presenting are expected to participate in the discussion.
* *Teaching Cases*: There are three teaching cases during the semester. Students are expected to read the teaching case before class and come prepared for discussion (and/or presentation, if described in the teaching case assignment).

Final Exam (30%):

* *Date*: Tuesday, May 5th, 8:00 – 11 am
* *Description*: The final written exam will consist of multiple short answer questions and one essay question based on the lecture material and required readings. You will be given a selection of questions from which to choose. The exam is closed-book.

Overall Grade:

Pass/Fail grades (graduate students):

* A grade of H indicates superior performance, over and above the mastery of basic concepts.
* A grade of P indicates satisfactory performance.
* A grade of L indicates a low pass and that the student has a poor understanding of numerous concepts covered in the course.
* A grade of F indicates a failure to understand the basic concepts covered in the course.

Other grades (undergraduate students and non-UNC graduate students):

* Grades will be converted to an A/B/C etc. scale for undergraduates and graduate students from non-UNC institutions that do not use a pass/fail grading system.

**All students are bound by the UNC honor code:** “It shall be the responsibility of every student at the University of North Carolina at Chapel Hill to obey and to support the enforcement of the honor code, which prohibits lying, cheating, or stealing when these actions involve academic processes or University, student or academic personnel acting in an official capacity.”

**COURSE AT A GLANCE:**

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| **Session** | **Date** | **Topic** | **Student presentations** | **Assignments** | **Other activities** |
| **Part 1- Understanding Status Quo Conditions** | | | | | |
| 1 | 14-Jan | Introduction, Conceptual framework, Ancient instincts |  |  |  |
| 2 | 21-Jan | Infrastructure Coverage, Dynamic Baseline, Water & Climate Change | Hoque and Hope (2019) and Goddard et al. (2021) | Distribute Assign 1 | Video questions |
| 3 | 28-Jan | Water Vending, Corruption | Raina et al (2019) |  | Teaching case 1, Video questions |
| 4 | 4-Feb | Understanding the Supply-side - Costs & Technologies |  |  | Video questions |
| 5 | 11-Feb | Understanding Demand for Improved Water and Sanitation Services | Cook et al. (2018), Devoto et al. (2012) | Assign 1 Due. Student presentations of assignment | Video questions |
| 6 | 18-Feb | Water development paths; Sustainability of Rural Water Supply Projects | Geels (2006), Foster et al. (2017), Foster et al. (2018) |  | Video questions |
| **Part 2 – Policy Interventions** | | | | | |
| 7 | 25-Feb | Planning protocols | Therkildsen (1988) |  | Debate 1, Video questions |
| 8 | 4-Mar | Information Treatments |  | Distribute Assign 2 | Debate 2, Video questions |
| 9 | 11-Mar | Water Pricing and Tariff Design | Fuente et al. (2016), World Bank (2021) |  | Video questions |
|  | 18-Mar | No class. Spring Break |  |  |  |
| 10 | 25-Mar | Designing Subsidy Schemes to Reach the Poor | Gómez-Lobo, A. & D. Contreras. (2003) and Contreras et al. (2018) |  | Video questions |
| 11 | 1-Apr | Changing Institutions: Privatization | Galiani (2005) | Assign 2 Due. Student presentations of assignment Distribute Assign 3 | Teaching case 2, Video questions |
| 12 | 8-Apr | UK Privatization; the Regulation of Water Utilities | Littlechild (1988), Gassner and Pushak (2014) |  | Video questions |
|  | 15-Apr | No class. Good Friday |  |  |  |
| 13 | 22-Apr | Case Study: Phnom Penh Water Supply Authority; Wrapping up |  | Assign 3 Due. Student presentations of assignment | Teaching case 3 |
| **FINALS** | | | | | |
|  | 5-May | FINAL EXAM (8:00 - 11:00 am), or Final papers due |  |  |  |

**SCHEDULE AND READINGS**

**Part 1- Understanding Status Quo Conditions**

**Session 1 (January 14) – Introduction, Conceptual framework, Ancient instincts**

In-class activities

* Introduction, Course Organization
* Student WASH experiences
* Conceptual Framework Discussion of course requirements
* Facts about water
* DW Lecture: Ancient Instincts

Readings

Whittington, D. (2016). Ancient Instincts: Implications for Water Policy in the 21st Century". *Water Economics and Policy*, 2(2). DOI: 10.1142/S2382624X16710028.

Priscoli, J. D. (2000) Water and civilization: Using history to reframe water policy debates and to build a new ecological realism. *Water Policy, 1* (6), 623-636.

**Session 2 (Jan. 21) -** **Infrastructure Coverage, Dynamic Baseline, Water & Climate Change**

In-class activities

* Class discussion - questions about videos
* DW Lecture: Forecasts of Coverage
* WASH SGDs: discussion of new targets & affordability
* Student-led discussion of Hoque and Hope (2019) and Goddard et al. (2021)
* Distribution of Assignment No. 1 (Performance Indicators - due Feb. 11) and Teaching Case No. 1: “USAID Mission to Haiti” (for class discussion January 28)

MOOC Videos

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| --- | --- |
| 1. Facts About Water | <https://youtu.be/7JpwuBSv4vY> |
| 1.1 Global Water and Sanitation Coverage | <https://youtu.be/Ml3uSQz3YTE> |
| 1.2 Infrastructure Coverage (Electricity, Sewerage, Water, Telephone) | <https://youtu.be/vvB34Fzco58> |
| 1.3 Forecasts of Coverage | <https://youtu.be/qhY20OIPp7M> |
| 1.4 Conversation with Clarissa Brocklehurst | <https://youtu.be/uLlYVhZb0OU> |
| 5.5 Effects of Climate Change on Water Utilities | <https://youtu.be/ntTwhkFU8Tg> |
| 5.6 Conversation with Clive Agnew | <https://youtu.be/ibmTcHPhfcs> |

Additional Videos

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| --- | --- |
| Hans Rosling: 2006 TED Conference in Monterey | <https://www.youtube.com/watch?v=hVimVzgtD6w> |
| Hans Rosling: A Slum Insight | <https://www.youtube.com/watch?v=21v4HBNqjfw> |

Readings

Goddard, J.J., I. Ray, C. Balazs. (2021). “How should water affordability be measured in the United States? A critical review.” *WIREs Water*. Dec. 16.

*The Measurement & Monitoring of Water Supply and Sanitation, and Hygiene Affordability – A Missing Element of Monitoring of Sustainable Development Goal (SDG) Targets 6.1 and 6.2*. (2021). WHO/UNICEF.

Jeuland, M., S. Ozdemir, D. Fuente, M. Allaire, D. Whittington. (2013). “The long-term dynamics of morality benefits from improved water and sanitation in less developed countries.” *PLOS One*. October, Volume 8, Issue 10, e74804.

Hoque, S. F. and Hope, R. (2019) “Examining the economics of affordability through water diaries in coastal Bangladesh.” *Water Economics and Policy*. 1950011-1 - 1950011-29 <https://doi.org/10.1142/S2382624X19500115>

UNICEF/WHO (2020), “State of the World’s Sanitation: An Urgent Call to Transform Sanitation for better Health, Environments, Economies and Societies”

Background Readings

Fuente, David, Maura Allaire, Marc Jeuland, and Dale Whittington. (2020). “Forecasts of Mortality and Economic Losses from Poor Water and Sanitation in Sub-Saharan Africa.” *PLOS One*.

Njoh, Ambe J., Fenda A. Akiwumi (2011) “The Impact of Colonization on Access to Improved Water and Sanitation Facilities in African Cities.” *Cities,* Issue 28, 452-460.

Milly, P; Betancourt, J; Falkenmark, M; Hirsch, R; Kundzewicz, Z.; Lettenmaier, D; Stouffer, R. (2008) Stationarity Is Dead: Whither Water Management? *Science* 319 (5863): 573-574.

Komives, K., Whittington, D., and Wu, X. (2003). Infrastructure coverage and the poor: A global perspective. In P. Brook and T. Irwin (Eds.), *Infrastructure for poor people: Public policy for private provision* (pp. 77–124). Washington, D.C.: The World Bank Public–Private Infrastructure Advisory Facility.

Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.Chapters 1-4 only (Pp. 5-76).

UNICEF/WHO (2015), “25 Years Progress on Sanitation and Drinking Water. 2015 Update and MDG Assessment.”

UNICEF/WHO (2021), “State of the World’s Hand Hygiene. A Global Call to Action to Make Hand Hygiene a Priority in Policy and Practice”

**Session 3 (Jan. 28) – Water Vending, Corruption**

In-class activities

* Class discussion - questions about videos
* Student Presentation of Raina et al (2019)
* Teaching Case No. 1: “USAID Mission to Haiti.”

MOOC Videos

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| 2.1 Outrage Versus Strategy? | <https://youtu.be/8D0aQrpUPZw> |
| 2.2 Types of Vendors and Vendor Prices | <https://youtu.be/XQIKPzADiYQ> |
| 2.3 Money and Water Flows, Onitsha, Nigeria | <https://youtu.be/QK_g4vu_738> |
| 2.4 An Introduction to Corruption | <https://youtu.be/IPhl-cKm4ko> |
| 2.5 Corruption in South Asia | <https://youtu.be/ViDWUf88Ep4> |

* Additional Video: Water and Sanitation for the Poor: Independent Providers (18 min.)

https://drive.google.com/file/d/0B19EeNkEYzVURF9QZXFzMUxJN3c/view

Readings

Davis, Jennifer A. (2004). “Corruption in Public Services Delivery: Experience from South Asia’s Water and Sanitation Sector.” *World Development*. Vol. 32, No. 1. pp. 53-71.

Zuin, V., Ortolano, L., Davis J. (2014). “The entrepreneurship myth of small-scale service provision: water resale in Maputo, Mozambique.” *Journal of Water, Sanitation and Hygiene for Development*. Vol. 4, No 2, pp. 281–292.

Raina, A., J. Zhao, L. Kunwar, N. Chindarkar, Y, J. Chen, X. Wu, and D. Whittington. (2019). “The structure of water vending markets in Kathmandu, Nepal.” *Water Policy*. 21: 50–75.

Background Readings

Whittington, Dale, Donald T. Lauria and Xinming Mu. (1991). "A Study of Water Vending and Willingness to Pay for Water in Onitsha, Nigeria." *World Development*. Vol. 19, No. 2/3, pp. 179-198.

Jenkins, M. (2017). “The impact of corruption to safe water and sanitation for people living in poverty.” *U4 Anti-Corruption Resource Centre, Transparency International*, CMI, Technical Report No. 2017:6

Lovei, Laszlo, and D. Whittington. (1993). "Rent-Seeking in the Water Supply Sector: A Case Study of Jakarta, Indonesia." *Water Resources Research*. Vol. 29, No. 7, July. pp. 1965-1974.

Crane, Randall. (1994). “Water Markets, Market Reform and the Urban Poor: Results from Jakarta, Indonesia.” *World Development*. Vol. 22, No. 1, pp. 71-83.

Kariuki, M. and Schwartz, J. (2005). “Small-Scale Private Service Providers of Water Supply and Electricity: A Review of Incidence, Structure, Pricing and Operating Characteristics.” *World Bank Policy Research Working Paper 3727*. The World Bank: Washington, DC.

Teaching Case #1 - Materials

Fass, Simon. (1988). Chapter 4: “Water,” in *Political Economy in Haiti: The Drama of Survival*. Transaction Publishers: New Brunswick, New Jersey.

Additional Video for Teaching Case

|  |  |
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| PBS Frontline – “Battle for Haiti” - for students to watch before the class in preparation of case discussion | <http://video.pbs.org/video/1737171448> |

**Session 4 (Feb. 4) - Understanding the Supply-side - Costs & Technologies**

In-class activities

* Class discussion - questions about videos
* Lecture: The costs of water and sanitation services embedded in housing (Saumitra Sinha)
* Guest lecture: Condominial sewers by Grace Beeler

MOOC Videos

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| 3.0 The Cost of Serving Households with Piped Networks | <https://youtu.be/SPWWcApx27Y> |
| 3.1 Solution to Cost Calculation | <https://youtu.be/ThYhGYwQFQM> |
| 3.2 Cost Components and More on Costs | <https://youtu.be/ZXWITS36xYM> |
| 3.3 Costs of Non-Piped Technologies | <https://youtu.be/apQWMRM7Qr4> |
| 3.4 Condominial sewers and desalination | <https://youtu.be/3E0w1lEtdi0> |
| 3.5 Conversation with Don Lauria - Part One | <https://youtu.be/-3Aojeihcj8> |
| 3.6 Conversation with Don Lauria – Part Two | <https://youtu.be/mYTJZWTIcEo> |

Other Videos to watch before class

* The World Bank and the United Nations Centre for Human Settlements: Water Supply and Sanitation in Development, Film 2: Problems and Solutions

<https://drive.google.com/file/d/1f6o1Kyx6ugwJUhW03BEVysgd2HnXnT65/view?usp=sharing>

Readings

Sainati, Tristano, Fiona Zakaria, Giorgio Locatelli, P. Andrew Sleigh, and Barbara Evans (2020). “Understanding the costs of urban sanitation: towards a standard costing model.” *Journal of Water, Sanitation and Hygiene for Development*. Issue 10, Volume 4 doi: 10.2166/washdev.2020.093

Whittington, Dale, W. Michael Hanemann, Claudia Sadoff, and Marc Jeuland. "The Challenge of Improving Water and Sanitation Services in Less Developed Countries." *Foundations and Trends in Microeconomics*. Vol. 4, Issues 6-7, 2009. pp. 469-609.

Melo, Jose Carlos (2005) “The Experience of Condominial Water and Sewerage Systems in Brazil: Case Studies from Brasilia, Salvador and Parauapebas.” The World Bank. Washington D.C.

Background Readings

Watson, Gabrielle. (1995). *Good Sewers Cheap: Agency-Customer Interaction in Low-Cost Urban Sanitation in Brazil*. Water and Sanitation Currents. UNDP Water and Sanitation Program. 56 pages plus annexes.

Hutton, Guy, Mili Varughese (2016). “The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene.” Water and Sanitation Program, the World Bank. Washington D.C.

Dodane, Pierre-Henri, Mbaye Mbeguere, Osumane Sow, and Linda Strande (2012) “Capital and Operating Costs of Full-Scale Fecal Sludge Management and Wastewater Treatment Systems in Dakar, Senegal.” *Environmental Science and Technology*. Issue 46, 3705-3711 dx.doi.org/10.1021/es2045234.

Franceys, R., A. Naafs, C. Pezon, and C. Fonseca. (2011). “The cost of capital: costs of financing capital expenditure for water and sanitation.” September. WASH Cost Briefing Note 1c. Available from WASHCost website at: [www.washcost.info/pubs](http://www.washcost.info/pubs).

OECD. (2009). *Measuring Capital 2009*. OECD Manual. Second Edition.

Nance, Earthea. (2012). *Engineers and Communities: Transforming Sanitation in Contemporary Brazil*. Lanham. Lexington Books.

**Session 5 (Feb. 11) – Understanding Demand for Improved Water and Sanitation Services**

In-class activities

* Class discussion - questions about videos
* Student-led discussion of Cook et al. (2018), Devoto et al. (2012)
* Student presentations - Assignment No. 1

**Assignment No. 1 due**

MOOC Videos

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| 4.1: Introduction to Modeling Household Water Demand | <https://youtu.be/cs43N0X0WQI> |
| 4.2: Households with Piped Connections - Price and Income Elasticities | <https://youtu.be/ZYDJoBF-71Q> |
| 4.3: Households with Water Sources Outside the Home | <https://youtu.be/AftnzwmBpSA> |
| 4.4: Household Demand for Drinking Water Quality Improvements | <https://youtu.be/ggnUdbHM7Zo> |
| 4.5: Effect of Social Norms on Household Water Use | <https://youtu.be/o9x5AdXpWeg> |
| 4.6: Conversation with Marc Jeuland | <https://youtu.be/pI4VteXiIrg> |
| 5.1: Facts About Water and Health | <https://youtu.be/-nLJe-_2Ny8> |
| 5.2: Estimating the Economic Value of Health Benefits | <https://youtu.be/MfyAzscg82Y> |
| 5.3: Exercise on Health vs. Non-Health Benefits for Households with Water Sources Outside the Home | <https://youtu.be/Sn76q60Ux5U> |
| 5.4: Climate Change on Water and Health | <https://youtu.be/jnig0DEY0is> |

*Water*

Readings

Katui-Kafui, Mungati et al. (2002). *Drawers of Water II: Kenya Country Study.*

Cook, J., J. Kabubo-Mariara, P. Kimuyu. “Happy collecting water? Measuring time use and affect among water carriers in rural Kenya using the Experience Sampling Method.” May 2018.

Devoto, Florencia, Esther Duflo, Pascaline Dupas, William Pariente, and Vincent Pons. (2012). “Happiness on Tap: Piped Water Adoption in Urban Morocco. *American Economic Journal: Economic Policy*, 4 (4): 68-99.

Background Readings

Nauges, C. and Whittington, D. (2009). Estimation of Water Demand in Developing Countries: An Overview. *The World Bank Research Observer*, *25*(2), 263-294. doi:10.1093/wbro/lkp016.

Ashraf, N., J. Berry, and J.M. Shapiro. (2010). “Can Higher Prices Stimulate Product Use? Evidence from a Field Experiment in Zambia.” *American Economic Review*. December, 2383–2413.

White, Gilbert, David Bradley, and Anne White. (1972). *Drawers of Water: Domestic Water Use in East Africa*. University of Chicago Press. Chapters 1-3, 6.

Collin, Daryl, Jonathan Morduch, Stuart Rutherford, and Orlanda Ruthven. (2009). *Portfolios of the Poor: How the World’s Poor Live on $2 a day.* 281 pages.

Koehler, J., Rayner, S., Katuva, J., Thomson, P. and Hope, R. (2018) [A cultural theory of drinking water risks, values and institutional change](http://dx.doi.org/10.1016/j.gloenvcha.2018.03.006). *Global Environmental Change*, 50: 268-277.

Pattanayak, Subhrendu K, Jui-Chen Yang, Katherine L Dickinson, Christine Poulos, Sumeet R

Patil, Ranjan K Mallick, Jonathan L Blitstein, & Purujit Praharaj. (2009). “Shame or subsidy

revisited: social mobilization for sanitation in Orissa, India.” *Bulletin of the World Health Organization*. 87: 580-587.

**Session 6 (Feb. 18) – Water development paths; Sustainability of Rural Water Supply Projects**

In-class activities

* Class discussion - questions about videos
* Student-led discussion of Geels (2006)
* Student-led discussion of Foster et al. (2017 & 2018)

MOOC Videos

6.0: Possible Solutions to the Water Development Paths Exercise <https://youtu.be/lgi8M23o1WQ>

6.1: A Historical Development Path - London and Manchester <https://youtu.be/xkXejfSZpUY>

6.2: Changing Knowledge - Practices and Perceptions <https://youtu.be/U6sJebYNfLw>

6.3: Path Dependency <https://youtu.be/09y2AzuVCts>

6.4: Changing Course <https://youtu.be/C2d2zLAdH3g>

6.5: Capital intensity - England and Wales <https://youtu.be/HmRxhHrfPoE>

6.6: Conversation with Marie Hart <https://youtu.be/tftL4zQPXXU>

6.7: Wrap-up and Reflections <https://youtu.be/4x8Cgg9c08Y>

Additional Video “Water of Ayole” <https://vimeo.com/6281949>

Readings – Water Development Paths

Geels, Frank. (2006). The hygienic transition from cesspools to sewer systems (1840-1930): The dynamics of regime transformation. *Research Policy*: 35, 1069-1082.

Background Readings

Hamlin, C. (1992). Edwin Chadwick and the engineers, 1842-1854: Systems and antisystems in the pipe-and-brick sewers war. *Technology and Culture*: *33*(4), 680-709.

Tarr, J.A. (1979). The separate vs. combined sewer problem: A case study in urban technology design choice. *Journal of Urban History*: *5*(3), 308-339.

Konrad, K., Truffer, B., Vob, J.P. (2008). Multi-regime dynamics in the analysis of sectoral transformation potentials: evidence from German utility sectors. *Journal of Cleaner Production*: 16, 1190-1202.

Tarr , J.A., McCurley III, J., McMichel, F.C., Yosie, T. (1984). Water and wastes: A retrospective Assessment of wastewater technology in the United States, 1800-1932. *Technology and Culture*: *25*(2), 226-263.

Tarr, Joel. (1988). “Sewerage and the Development of the Networked City in the United States, 1850-1930.” *Technology and the Rise of the Networked City in Europe and America*. Edited by Joel Tarr and Gabriel Dupuy. Temple University Press, Philadelphia. pp. 159-185.

Readings: Sustainability of Rural Water Supply Systems

Foster, T. and Hope, R. (2017) [Evaluating waterpoint sustainability and access implications of revenue collection approaches in rural Kenya](http://dx.doi.org/10.1002/2016WR019634). *Water Resources Research*, 53(2): 1473-1490.

Foster, T., Willetts, J., Lane, M., Thomson, P., Katuva, J. and Hope, R. (2018) [Risk factors associated with rural water supply failure: A 30-year retrospective study of handpumps on the south coast of Kenya](http://dx.doi.org/10.1016/j.scitotenv.2017.12.302). *Science of The Total Environment*, 626: 156-164.

Background Readings

Whittington, Dale, Jennifer Davis, Linda Prokopy, Kristin Komives, Rich Thorsten, Heather Lukacs, Wendy Wakeman, and Alexander Bakalian. (2009). “How Well is the Demand-Driven, Community Management Model for Rural Water Supply Systems Doing? Evidence from Bolivia, Peru, and Ghana.” *Water Policy*. Vol. 11, No. 6. July/August, 2009.

Fisher, Michael, Katherine F. Shields, Terence U. Chan, Elizabeth Christenson, Ryan D. Cronk,

Hannah Leker, Destina Samani, Patrick Apoya, Alexandra Lutz, and Jamie Bartram. (2015). “Understanding handpump sustainability: Determinants of rural water source functionality in the Greater Afram Plains region of Ghana.” *Water Resources Research*. 51, doi:10.1002/2014WR016770.

**Part 2 – Policy Interventions**

**Session 7 (Feb 25) – Planning protocols**

In-class activities

* Class discussion - questions about videos
* Student-led discussion of Therkildsen (1988)
* Class debate No. 1 – RCTs

MOOC Videos

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| --- | --- |
| 2.0: Does better planning result in better outcomes? An example from Bolivia | <https://youtu.be/B5iWE6S1piw> |
| 2.1: Four types of planning protocols commonly used around the world | <https://youtu.be/KugD7IQR5Io> |
| 2.2: Demand-driven planning: Designing for community preferences and affordability | <https://youtu.be/X1QVLox7E1s> |
| 2.3: Do demand-driven planning protocols work? Evidence from Bolivia, Ghana and Peru | <https://youtu.be/4JRnTNNQ-2s> |
| 2.4: When do participatory, demand-driven approaches work best? Evidence from a World Bank study | <https://youtu.be/oh29Tab3rgA> |
| 2.5: Conversation between Arif Hasan and Diana Mitlin on participation | <https://youtu.be/WBubv3VvUm0> |

Additional Videos –

* Orangi: City of Hope <https://drive.google.com/file/d/0B19EeNkEYzVUSTNlVEJJNTEzdnM/view>
* Kumasi Strategic Sanitation Planning https://drive.google.com/file/d/0B19EeNkEYzVUWGhTMDhVVUd2WW8/view

*Participation*

Readings

Therkildsen, Ole. (1988). *Watering White Elephants: Lessons from Donor-Funded Planning and Implementation of Rural Water Supplies in Tanzania*. Scandinavian Institute of African Studies. Uppsala. 224 pages.

Background Readings

Kleemeier E. (2000). “The Impact of Participation on Sustainability: An Analysis of the Malawi Rural Piped Scheme Program.” *World Development.* Vol. 28, No. 5, pp. 929-944.

Prokopy, L. S. (2005). "The relationship between participation and project outcomes: Evidence from rural water supply projects in India." *World Development*. 33(11): 1801-1819.

Mansuri, G. and V. Rao. (2013). *Localizing Development: Does Participation Work?* A World Bank Policy Research Report. Washington D.C. World Bank.

*Designing Demand-Driven Rural Water Programs*

Readings

World Bank Water Demand Research Team. (1993). “The Demand for Water in Rural Areas: Determinants and Policy Implications.” *The World Bank Research Observer*. pp. 47-70.

Garn, Harvey A. (undated). “Lessons from Large-Scale Rural Water and Sanitation Projects: Transition and Innovation.” Draft working paper. UNDP/World Bank Water and Sanitation Program. Washington D.C.15 pages.

*Designing Demand-Driven Urban Sanitation Programs*

Readings

Whittington, Dale, Jennifer Davis, Harry Miarsono, and Richard Pollard. (2000). “Designing a ‘Neighborhood Deal’ for Urban Sewers: A Case Study of Semarang, Indonesia.” *Journal of Planning Education and Research.* Vol. 19, pp. 297-308.

**Class Debate No. 1 – Proposition: Any risks associated with RCTs in low and middle-income countries have been overblown, and should not impede WASH-related research.**

Readings for debate:

Deaton, Angus (2020) “Randomization in the Tropics Revisited: A Theme and Eleven Variations” NBER working Paper No. 27600

Coville, Aidan, Sebastian Galiani, Paul Gertler, & Susumu Yoshida (2020) “Enforcing payment for water and sanitation serveices in Nairobi’s slums.” *NBER Working Paper Series*, Working Paper 27569. http://www.nber.org/papers/w27569

Twitter on Kenya’s RCT Paper: “Enforcing Payment for Water and Sanitation Services in Nairobi “ https://twitter.com/joshbudlender/status/1292170843389386761

“In India’s Water Stress Villages, Modi Seeks a Tap for Every Home” - New York Times, Dec. 21, 2021.

**Session 8 (March 4) – Information Treatments**

In-class activities

* Class discussion - questions about videos
* Class Debate No. 2 – The Human Right to Water

Distribution of Assignment No. 2 (Cape Town Drought)

MOOC Videos

|  |  |
| --- | --- |
| 4.0: Introduction to information treatments as a policy intervention | <https://youtu.be/HonMKqVeNDc> |
| 4.1: Information treatment Case 1: In-house water quality testing | <https://youtu.be/S1jy0LivYc4> |
| 4.2: Information treatment Case 2: Information provision via water bills and evidence from OWASA, Chapel Hill, USA | <https://youtu.be/O64sQCEm7xk> |
| 4.3: Information treatment Case 3: Community-Led Total Sanitation (CLTS) | <https://youtu.be/VTnGdQnyy1I> |
| 4.4: Information treatment Case 3: Evidence from CLTS in Mali, West Africa | <https://youtu.be/8IT12nZpMQc> |
| 4.5: Information treatment Case 4: Information provision via water bills in Jerico, Colombia | <https://youtu.be/6sjGtp_-eWE> |
| 4.6: Information treatment Case 4: UN Declaration on the Human Right to Water | <https://youtu.be/5XPlwcedki4> |
| 4.7: Conversation with Barbara Evans on CLTS | <https://youtu.be/ajMFUT2h35M> |
| 4.8: Conversation with Kamal Kar on CLTS (in 7 parts) | <https://youtu.be/IhGPOzflC8A> |

Other Videos to Watch

- UNICEF –

Dividing the Mango; https://www.youtube.com/watch?v=T3CTi0dE1uM

Meena’s Three Wishes; https://www.youtube.com/watch?v=iulgE0jEJNc

I’m Meena https://drive.google.com/file/d/0B19EeNkEYzVUNFhKQmdHVFlLQlk/view

Readings on CLTS, Sanitation

Whittington, Dale, Mark Radin, and Marc Jeuland. (2020). “Evidence-based Policy Analysis? The Strange Case of the Randomized Controlled Trials of Community-Led Total Sanitation.” *Oxford Review of Economic Policy.* Vol. 36, No. 1, pp. 191-221.

Radin, Mark, Marc Jeuland, Hua Wang, and Dale Whittington. (2020). “Benefit-Cost Analysis of Community-Led Total Sanitation: Incorporating Results from Recent Evaluations.”

*Journal of Benefit-Cost Analysis*. 1-30. Doi:10.1017/bca.2006.6

Zuin, Valentina, Caroline Delaire, Rachel Peletz, Alicea Cock-Esteb, Ranjiv Khush, Jeff Albert. (2019). “Policy Diffusion in the Rural Sanitation Sector: Lessons from Community-Led Total Sanitation (CLTS).” *World Development*. https://doi.org/10.1016/j.worlddev.2019.104643

Guiteras, R., J. Levinsohn, A. M. Mobarak. (2015). “Encouraging sanitation investment in the developing world: A cluster-randomized trial.” *Science*. May 22. Issue 6237. 903-906.

Gertler, P., M. Shah, M. L. Alzua, L. Cameron, S. Martinez, S. Patil. “How does Health Promotion Work? Evidence from the Dirty Business of Eliminating Open Defecation.” Working Paper 20997. <http://www.nber.org/papers/w20997>.

Jenkins, M. and S. Sugden (2006)."Rethinking Sanitation: Lessons and Innovation for Sustainability and Success in the New Millennium." UNDO Human Development Office Occasional Paper Series.  
<http://www.communityledtotalsanitation.org/sites/communityledtotalsanitation.org/files/cltshandbook.pdf>

Peal, A., B. Evans, C. van der Voorden (2010) "Hygiene and Sanitation Software. An overview of approaches" Water Supply and Sanitation Collaborative Council (WSSCC) pp. 2-17.  
<http://www.wsscc.org/sites/default/files/publications/wsscc_hygiene_and_sanitation_software_2010.pdf>

Kar, K. and R. Chambers. (2008). *Handbook on Community-Led Total Sanitation*. IDS Sussex and Plan International pp. 7-11.  
<http://www.communityledtotalsanitation.org/sites/communityledtotalsanitation.org/files/cltshandbook.pdf>

Chambers, Robert (2009). *Going to Scale with Community-Led Total Sanitation:  
Reflections on Experience, Issues and Ways Forward*. IDS Practice Paper.  
Institute of Development Studies, University of Sussex, UK.

<http://www.communityledtotalsanitation.org/resource/going-scale-community-led-total-sanitationreflections-experience-issues-and-ways-forward>- Accessed March 2010.

Dickinson, Katherine L., Sumeet R. Patil, Subhrendu K. Pattanayak, Christine Poulos, and Jui-Hen Yang (2015) “Nature’s Call: Impacts of Sanitation Choices in Orissa, India” *Economic Development and Cultural Change*, Vol 64 No. 1

Background readings

Goddard, Jessica J., Ray, Isha, Balazs, Carolina (2021), “Water Affordability and Human Right to Water Implications in California” *PLOS One,* 16(1)

**Class debate No. 2 – Proposition: “The United Nations Declaration establishing a human right to water and sanitation is a big step forward and will result in many more poor households receiving improved WASH services in the future.”**

Readings for Debate:

Resolution A/RES/64/292. United Nations General Assembly, July 2010. Available at: <http://www.un.org/es/comun/docs/?symbol=A/RES/64/292&lang=E>

Briscoe, J. (2011). Invited opinion interview: Two decades at the center of world water policy. Interview with John Briscoe by the Water Policy Editor-in-Chief. *Water Policy* *13*, 147-160. doi: 10.2166/wp.2010.000.

Meier, B.M., G. L. Kay, U.Q. Amjad, and J. Bartram. (2013). Implementing an evolving human right through water and sanitation policy.” *Water Policy 15*, 116-133.

Robin Burgess, Michael Greenstone, Nicholas Ryan, and Anant Sudarshan (2020). “The Consequences of treating electricity as a right”*.* *Journal of Economic Perspectives*. Volume 34, Issue 1, 145-169.

New York Times. “In India’s Water Stressed Villages, Modi Seeks A Tap for Every Home.” Dec 21, 2021.

**Session 9 (March 11) – Water Pricing and Tariff Design**

In-class activities

* Class discussion - questions about videos
* Student-led discussion of Fuente et al. (2016), World Bank (2021)

MOOC Videos

|  |  |
| --- | --- |
| 3.0: Introducing municipal water pricing and tariff design | <https://youtu.be/hAYDKYkw9QU> |
| 3.1: What are the objectives of tariff design? | <https://youtu.be/cmMo4CsE-nc> |
| 3.2: Possible types of tariff structures | <https://youtu.be/y1E3b4b-mBI> |
| 3.3: Current tariff structures in low and middle-income countries | <https://youtu.be/rbcNVasBz-k> |
| 3.4: Problems with increasing block tariffs (IBTs) | <https://youtu.be/8xaEWnDXhv0> |

Readings

Fuente, D., J. Gakii Gatua, M. Ikiara; J. Kabubo-Mariara; M. Mwaura, and D. Whittington. “Water and sanitation service delivery, pricing, and the poor: An empirical analysis of subsidy incidence in Nairobi, Kenya. *Water Resources Research*. 2016.

Andres et al. (2021) *Troubled Tariffs: Revisiting Water Pricing for Affordable and Sustainable Services*. World Bank: Global Water Practice.

Whittington, Dale. (2021). “The Development Path of Water and Sanitation Tariffs and Subsidies: Implications for China.” World Bank. Beijing. Knowledge Note. (draft).

Background Readings

J-PAL. (2011). The Price is Wrong. *J-PAL Bulletin* (April 2011). Available at: [https://www.povertyactionlab.org/sites/default/files/publications/The Price is Wrong.pdf](https://www.povertyactionlab.org/sites/default/files/publications/The%20Price%20is%20Wrong.pdf).

Whittington, Dale, John Boland, and Vivien Foster. (2002). “Water Tariffs and Subsidies in South Asia: Understanding the Basics.” World Bank. December. 16 pages.

Nauges, C. and D. Whittington. (2017). “Evaluating the Performance of Alternative Municipal Water Tariff Designs: Quantifying the Trade-offs between Equity, Economic Efficiency, and Cost Recovery.” *World Development*. Vol. 9, pp. 125-143.

Whittington, D., C. Nauges, D. Fuente, X. Wu. (2015). “A diagnostic tool for estimating the incidence of subsidies delivered by water utilities in low- and medium-income countries, with illustrative simulations. *Utilities Policy*. <http://dx.doi.org/10.1016/j.jup.2014.12.007>. Vol. 34, pp 70-81.

Boland, John, and Dale Whittington. (2000). “The Political Economy of Increasing Block Water Tariffs in Developing Countries.” *The Political Economy of Water Pricing Reforms*. Ariel Dinar, Editor. Oxford University Press. 2000. Pp. 215-236.

Whittington, Dale. (2003). “Municipal Water Pricing and Tariff Design: A Reform Agenda for South Asia.” *Water Policy*. 5, pp. 61-76.

Perez-Urdiales, Maria and Kenneth A. Baerenklau. (2019). “Learning to live within your (water) budget: Evidence from allocation-based rates. *Resource and Energy Economics*. 57: 205-221.

Baerenklau, Kenneth A. and MariaPerez-Urdiales. (2019). “Can Allocation-Based Water Rates Promote Conservation and Increase Welfare? A California Case Study.” Water Economics and Policy. 5:2, 26 pages.

**Friday, March 18 – SPRING BREAK**

**Session 10 (March 25) – Designing Subsidy Schemes to Reach the Poor**

In-class activities

* Class discussion - questions about videos
* Student-Led Discussions of Gómez-Lobo, A. & D. Contreras. (2003) and Contreras et al. (2018)

MOOC Videos

|  |  |
| --- | --- |
| 3.5: Designing and targeting subsidies in the water and sanitation sector in LDCs | <https://youtu.be/GRc35p1iB68> |
| 3.6: Distribution of subsidies in Chile and Colombia | <https://youtu.be/j6npI_KNrik> |
| 3.7: Evidence on subsidy schemes in Chile and Colombia | <https://youtu.be/f6yax4IvJ6s> |
| 3.8: Designing improved water subsidy schemes | <https://youtu.be/GJFAX685AeE> |

Readings

Cook, Joe, David Fuente, and Dale Whittington. (2020). “Choosing among pro-poor policy options in water supply and sanitation.” *Water Economics and Policy*. 6:3. 21 pages.

Gómez-Lobo, A. and D. Contreras. (2003). “Water Subsidy Policies: A Comparison of the Chilean and Colombian Schemes.” *The World Bank Economic Review*, 17 (3), pp. 391-407.

Dante Contreras, Andrés Gómez-Lobo, and Isidora Palma. (2018). “Revisiting the distributional impacts of water subsidy policy in Chile: a historical analysis from 1998–2015.” *Water Policy*. 20: 1208–1226.

Background Readings

Mitlin, Diana, Victoria A. Beard, David Satterthwaite, and Julian Du. (2019). Towards a More Equal City: Unaffordable and Undrinkable – Rethinking Urban Water Access in the Global South. World Resources Institute. Working Paper. Washington D.C. 60 pages.

Andres, Luis A., Michael Thibert, Camilio Lombana Cordoba, Alexander V. Danilenko, George Joseph, Andres, Luis A.,, and Christian Borja-Vega. (2019). *Doing More with Less – Smarter Subsidies for Water Supply and Sanitation*. August. World Bank. Washington D.C. 135 pages.

Komives, Kristin, Jon Halpern, Vivien Foster, Quetin Wodon, and Roohi Abdullah. (2007). Utility Subsidies as Social Transfers: An Empirical Evaluation of Targeting Performance. *Development Policy Review*. 25 (6) pp. 659-679.

Leigland, J., S. Trémolet, J. Ikeda. (2016). “Achieving Universal Access to Water and Sanitation by 2030: The Role of Blended Finance.” World Bank. August. 20 pages.

**Session 11 (April 1) – Changing Institutions: Privatization**

In-class activities

* Class discussion - questions about videos
* Discussion of Assignment #2
* Student-led discussion of Galiani (2005)
* Teaching Case #2 – Manila Privatization

**Assignment #2 Due**

Distribution of Assignment No. 3 (Re-nationalization of the England and Wales Water Industry? (due April 22)

MOOC Videos: Privatization

|  |  |
| --- | --- |
| 5.0: Introduction to public private partnerships (PPP) | <https://youtu.be/rCenSSemF5U> |
| 5.1: The seven main types of PPP deal structures | <https://youtu.be/_nKx1ZyNh1A> |
| 5.2: Some challenges of PPPs from the private operator’s perspective | <https://youtu.be/ffxHSJGTZIo> |
| 5.3: Do PPPs improve performance? Evidence from a World Bank study | <https://youtu.be/8D9tPbnvklo> |
| 5.4: Comparative experiences with PPPs in the water and sanitation sector: China versus India | <https://youtu.be/KfRxfTYMrC4> |
| 5.5: Conversation with Wu Xun on privatization in China and India | <https://youtu.be/77VzJnPybWg> |
| 5.6: Conversation with Leong Ching on the devil’s shift in water privatization in Jakarta, Indonesia | <https://youtu.be/Ifg5aWreCQY> |

Other Videos to watch before class

* The World Bank – Public Water, Private Partners (27 min) https://drive.google.com/file/d/0B19EeNkEYzVUMl9yNFZQV1k4MVU/view
* Manila Privatization Video

https://drive.google.com/file/d/0B19EeNkEYzVURWNBU1JwRnNpWXM/view

Readings

Dumol, Mark. (2000). *The Manila Water Concession: A Key Government Official’s Diary of the World’s Largest Privatization*. 137 pages. The World Bank, Washington D.C.

Galiani, Sebastian, Paul Gertler, and Ernesto Schangrodsky. (2005). “Water for Life: The Impact of the Privatization of Water Services on Child Mortality.” *Journal of Political Economy*. Vol. 113, No. 1. pp. 83-119.

Background readings

Davis, Jennifer. (2005). Private-sector Participation in the Water and Sanitation Sector. *Annual Review of Environment and Resources.* 30: 1-39.

Barraque, B. (2012). “Return of drinking water supply in Paris to Public Control.” *Water Policy*. 14, pp. 903-914.

Readings for Teaching Case #2 – Manila Privatization

Teaching Case:

* Manila Water Company (A). Harvard Business School Case No. 9-401-014. August 31, 2000.
* Manila Water Company (B). Harvard Business School Case No. 9-401-015. July 14, 2000.

**Note: these teaching cases are available from Harvard Business Publishing. This is the link to purchase them:**

<https://hbsp.harvard.edu/import/896026>

Background Reading for Manila Teaching Case

Wu, Xun and and Nepomuceno Malaluan. (2008). “A Tale of Two Concessionaires: A Natural Experiment of Water Privatization in Metro Manila.” *Urban Studies*. January. 45 (1). Pp. 207-227.

Wu, Xun, Olivia Jensen, and Schuyler House (undated) “Revival of a ‘Failed’ Water Concession: A Comparative Study of the ‘Old’ and ‘New’ Maynilad”

**Session 12 (April 8) – UK Privatization; the Regulation of Water Utilities**

In-class activities

* Class discussion - questions about videos
* Student-led discussion of Littlechild (1988), Gassner and Pushak (2014)

MOOC Videos: UK Privatization

|  |  |
| --- | --- |
| 6.0: The significance of institutional change in the UK water sector: Privatization and regulation | <https://youtu.be/n7yeXsMan-I> |
| 6.1: The historical setting and promises of the UK privatization programme | <https://youtu.be/JzMhBZSusGA> |
| 6.2: Why full divestiture for the England and Wales water industry? Four prerequisites | <https://youtu.be/Z1kY_MyoQ74> |
| 6.3: Determining a sale price for the England and Wales water industry | <https://youtu.be/vz9O3H7uHUw> |
| 6.4: Some outcomes of UK water privatization, part 1: Good news | <https://youtu.be/qhs4SFJ8mwQ> |
| 6.5: Some outcomes of UK water privatization, part 2: Bad news | <https://youtu.be/7GeH4bxCuyY> |
| 6.6: Some outcomes of UK water privatization, part 3: Unclear future? | <https://youtu.be/QUdDvXD5Ceo> |

MOOC Videos

|  |  |
| --- | --- |
| 7.0: Regulation of the water utilities in LDCs | <https://youtu.be/TuxxllXblsw> |
| 7.1: UK water regulation 1: The original vision | <https://youtu.be/jUfOW1kBgHA> |
| 7.2: UK water regulation 2: Evolution in practice, 1989 to 2016 | <https://youtu.be/UHQgi8ITrKY> |
| 7.3: UK water regulation 3: Innovation and future challenges | <https://youtu.be/YneLLEXb-KM> |
| 7.4: Conservation with Stephen Littlechild on inventing the UK regulatory model | <https://youtu.be/cKv68aRxIM4> |
| 7.5: Conservation with Regina Finn on reforming UK water regulation | <https://youtu.be/ZBn4ayZit4A> |
| 7.6: The case of Phnom Penh, Cambodia | <https://youtu.be/GbqpdRVMrlg> |
| 7.7: Part 2 MOOC Overall Wrap-up | <https://youtu.be/prykPLC4V-g> |

Readings

Gassner, Katharina and Nataliya Pushak. 2014. “30 years of British utility regulation: Developing country experience and outlook.” *Utilities Policy*, 31, 44–51.

Littlechild, Stephen C. “Economic Regulation of Privatized Water Authorities and Some Further Reflections.” *Oxford Review of Economic Policy*. Vol. 4, No. 2, 1988. pp. 40-68.

Background Readings

Helm, D. (2005). Water, the environment, and regulation: Changing functions, changing frameworks. Available at: <http://www.dieterhelm.co.uk/sites/default/files/WaterEnvironmentRegulation.pdf>

Helm, D. and Yarrow, G. (1988). The Assessment: The Regulation of Utilities. *Oxford Review of Economic Policy*. *4*(2).

Bartle, I. (editor). (2003). *The UK Model of Utility Regulation. A 20th Anniversary Collection to Mark the ‘Littlechild Report’. Proceedings of a joint LBS Regulation Initiative, CRI and City University Business School Conference*. *Chaired by Professor John Cubbin and Professor Ralph Turvey* *held on 9th April 2003 at The Cass Business School, City University, London*. Desktop published by Jan Marchant, CRI PROCEEDINGS 31 © The University of Bath.

**Friday, April 15 – HOLIDAY (no class)**

**Session 13 (April 22) – Case Study: Phnom Penh Water Supply Authority; Wrapping up**

In-class activities

* Student Presentations of Assignment #3
* Teaching Case #3 - “Ek Son Chan and the Transformation of the Phnom Penh Water Supply Authority.”

**Assignment No. 3 – due**

MOOC Videos

|  |  |
| --- | --- |
| 7.6: The case of Phnom Penh, Cambodia | <https://youtu.be/GbqpdRVMrlg> |
| 7.7: Part 2 MOOC Overall Wrap-up | <https://youtu.be/prykPLC4V-g> |

Other Videos to watch before class

* The Connection (Phnom Penh)
* https://drive.google.com/open?id=0B19EeNkEYzVUdHdOdUp3SFJTOVU&authuser=0

Reading for Teaching Case #3 - “Ek Son Chan and the Transformation of the Phnom Penh Water Supply Authority.”

Ching, Leong (2009), “Ek Son Chan and the Transformation of the Phnom Penh Water Supply Authority.” *Institute of Water Policy, Lee Kuan Yew School of Public Policy, NUS*

Biswas, A.K., and C. Tortajada. (2010). “Water Supply of Phnom Penh: An Example of Good Governance.” *International Journal of Water Resources Development*. 26:2, 157-172.

**Exam: May 5th, Thursday. 8:00 – 11:00 am**

**Note on WASH Interventions and Health:**

**Understanding the link between water and sanitation interventions and health improvements is essential for the economic evaluation of water and sanitation projects. However, this subject is not discussed in detail in this course because it is covered elsewhere in the ENVR curriculum. Students are encouraged to do the following background readings if they are not familiar with the causal relationships between improved water and sanitation infrastructure and health outcomes:**

***Linking improved water and sanitation conditions to health outcomes – Selected Readings***

Kremer, M., Leino, J., Miguel, E., and Zwane, A. P. (2011). Spring cleaning: A randomized evaluation of source water quality improvement*.* *Quarterly Journal of Economics*: 126, 145-205.

Fewtrell, L., Kaufmann, R., Kay, D., Enanoria, W., Haller, L., et al. (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: A systematic review and meta-analysis. *Lancet Infectious Diseases 2005, 5* (1), 42-52.

Zwane, Alix, and Michael Kremer. (2007). “What Works in Fighting Diarrheal Diseases in Developing Countries: A Critical Review.” *The World Bank Research Observer*. Vol. 22, No. 1, pp. 1-24.

Hunter, P.R., Zmirou-Navier, D., Hartemann, P. (2009). Estimating the impact on health of poor reliability of drinking water interventions in developing countries. *Science of the Total Environment*, *407*, 2621–2624.

Cutler, D., and G. Miller. (2005), “The Role of Public Health Improvements in Health Advances: The 20th Century United States.” *Demography,* 42 (1): 1–22.

VanDerslice, J. and Briscoe, J. (1993). All Coliforms are Not Created Equal: A Comparison of the Effects of Water Source and in-House Contamination on Infantile Diarrheal Disease. *Water Resources Research*. *29* (7), 1983-1995.

Curtis, Val, and Sandy Cairncross. (2003). “Effect of washing hands with soap on diarrhea risk in the community: a systematic review. *The Lancet Infectious Diseases*. Vol. 3, May. Pp. 275-281.

Jalan, J., and Ravallion, M. (2003). Does piped water reduce diarrhea for children in rural India? *Journal of Econometrics*, *112* (1), 153-173.

Arnold, B. F., and Colford, J. M. J. (2007). Treating water with chlorine at point-of-use to improve water quality and reduce child diarrhea in developing countries: A systematic review and meta-analysis. *American Journal of Tropical Medical Hygiene, 76* (2), 354-364.