

EVPP 434/ 534: Food-Energy-Water Nexus

Spring 2021

Tuesdays/Thursdays 3:00 pm-4:15 pm

Instructor

Dr. Jennifer Sklarew

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Hours: Thursdays, 1:30 pm to 2:30 pm by appointment

Course description: Food, energy and water systems face individual challenges to their sustainability and resilience. The linkages between these systems can generate additional challenges. Integrative solutions that leverage these systems' interdependencies are emerging. In EVPP 434/534: Food Energy Water Nexus, we'll discuss resilience and sustainability challenges that involve the food, energy water nexus, as well as innovative solutions to these challenges. Our discussions will bridge multiple disciplines, as we examine the technological, economic, and institutional dimensions of the nexus in various places around the globe at local and national scales.

Course Learning Objectives:

- 1) understand linkages between food, energy and water systems;
- 2) understand interlinked challenges facing these systems;
- 3) understand some existing solutions to these challenges;
- 4) apply existing and new solutions to these challenges;
- 5) recognize how the parameters for 1-4 vary for different places.

Weekly Learning Objectives:

Weekly learning objectives will help us to move toward our course learning objectives.

Readings:

Required text:

Dodds, Felix, and Jamie Bartram, Eds. 2016. *The Water, Food, Energy and Climate Nexus: Challenges and an agenda for action*. Routledge.

Weekly readings and videos: All students must read all of the required readings and watch the required videos. Graduate students must also read the optional readings marked with **.

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Assignments:

1) **Article for discussion:** At least once during the semester, each student will find an article (newspaper, journal, magazine, website posting, etc.) on the food-energy-water nexus for discussion in class. Please send the article to me as a PDF via email by midnight the Saturday before class so I can distribute it for everyone to read before class. Please also send me 2-3 questions for the class to discuss. Be prepared to lead a 15-minute discussion of the article and your discussion questions in class, including a brief summary of the article and how it relates to that week's topic. Graduate students also must create a short slide presentation summarizing their article and how it relates to the food-energy-water nexus, and must send their slide presentations to me by midnight the day before class. Late penalties for all submissions apply (see deadlines below).

2) Semester project and interim assignments:

The semester project will enable you to explore the food-energy-water nexus challenges in a place or organization of your choosing. You also will examine solutions that leverage these systems' interdependencies. You will have the opportunity to apply your own specific research interests.

Semester project:

The overall assignment is to examine a food-energy-water nexus problem and assess solutions in a place or organization you choose. Graduate students also must include identification of lessons on challenges and solutions that can apply to other organizations or places, including technical, economic, institutional, and/or other aspects. If you choose a place/organization that already has resolved a problem, you can conduct a case study of this place, including challenges they overcame and lessons for other places.

Interim assignments:

1. 3rd week: Project topic selection: Choose an organization, city, county, state or country that is facing or has faced a food-energy-water nexus challenge.
2. 7th week: Nexus challenge and actors involved: (3-5 pages for undergrads, 6-8 pages for grad students)
 - a. Describe the food-energy-water nexus challenge on which you will focus in the organization or place you selected. Describe the ecological, economic, and institutional aspects of the challenge.
 - b. Describe the actors involved in creating the challenge, including government, private sector, NGOs, citizens, and other entities. Describe these actors' roles in creating the challenge.
 - c. Describe the actors affected by the challenge, including government, private sector, NGOs, citizens, and other entities. Describe how they are affected.
 - d. Graduate students also need to include: an analysis of how the challenge they have selected can apply to other organizations or places, including technical, economic, institutional, and/or other aspects.
 - e. References/citations

3. 13th week: Nexus solutions, actors involved, and challenges to the solutions: (6-8 pages for undergrads, 10-12 pages for grad students)
- Describe any solutions already attempted, and propose your own solution(s). These can include technical, economic, institutional, and other aspects.
 - Describe the actors involved in these solutions, including government, private sector, NGOs, citizens, and other entities.
 - Describe the actors affected – positively or negatively – by these solutions.
 - Assess challenges to these solutions, including technological, economic, and institutional aspects.
 - Graduate students also need to include: a description of lessons from a-d above that can apply to other organizations or places, including technical, economic, institutional, and/or other aspects.
 - References/citations

4. 15th week: Turn in final papers incorporating revision of the interim assignments, .

3) **Presentation:** At the end of the semester, each student must give a short presentation that explains his/her semester project results. Graduate students' presentations will include applied lessons for other places. More details will be provided later in the semester. (undergraduates: 15 minutes; graduate students: 20 minutes)

4) **Class discussion of FEW nexus challenges and solutions:** One class session will be dedicated to class discussion of challenges and solutions from your semester project research. Graduate students will each provide 2 questions for this class discussion session.

5) **Extra credit presentation:** Sometime during the semester, you may give a short guest lecture on a topic related to the food-energy-water nexus, but not already covered in class or in semester projects (up to five extra credit points).

Deadlines: In fairness to all students, I will lower your grade by ten points for each day that any assignment is late without a previously approved extension, starting from the time of the deadline. E.g., if you hand in your assignment within 24 hours after the deadline, 10 points off; within 2 days, 20 points off, etc. Extensions will be granted only for written requests that involve an emergency or other reason deemed valid by the instructor.

Class participation/Group discussion: Aside from the textbook readings, I will post on Blackboard all of the required readings and videos, including the article of the week chosen by you, along with questions for you to consider while reading/watching. We'll discuss these questions in class. Optional readings marked with ** are required for graduate students, who will summarize them in class. Your participation grade is based on your attendance in class and your active participation, which enables me to assess your understanding of the readings and concepts. One class session during the semester will be dedicated to discussion of FEW nexus challenges and solutions discovered through students' semester project research. Graduate students will each provide 2 questions for this class discussion session.

Attendance:

- Missing class: If you need to miss class due to illness, travel, family obligations, etc., please notify me ahead of time via email. **To receive credit for the missed class, please choose two of the reading questions and email your responses to me within two days after the missed class or by a deadline approved by me.** If you have an unexcused absence and do not send answers to the questions, you will receive a zero for that day. If you have an excused absence but do not answer the questions, the class will not count toward your grade.
- Late arrival: If you are more than 15 minutes late to class without a valid explanation, your participation grade for that day will be reduced by 10 points.
- Non-attendance with login: If you join the class session but do not participate orally or via the comment box, I will contact you to ask whether you were attending class for the entire session.

Basis of Grading: EVPP 434

Class participation	10%
Article Discussion Leadership	5%
Interim paper 1: 3-5 pages	15%
Interim paper 2: 6-8 pages	20%
Semester Paper: 10-15 pages	25%
Final Presentation: 15 minutes	25%

Basis of Grading: EVPP 534

Class participation and Class Discussion Leadership	10%
Article Discussion Leadership and Slide Presentation	5%
Interim paper 1: 6-8 pages	15%
Interim paper 2: 10-12 pages	20%
Semester Paper: 18-25 pages	25%
Final Presentation: 20 minutes	25%

Grade table (General grading criteria for writing assignments, class participation and presentation will be provided separately, and specific criteria for each assignment will be provided during the semester.)

Grade	Percent
A	93-100%
A-	90-92.9%
B+	87-89.9%
B	83-86.9%
B-	80-82.9%
C+	77-79.9%
C	70-76.9%
F	<70%

Plagiarism Statement:

What is it? Plagiarism means using the exact words, opinions, or factual information from another person or source without giving that person or source credit.

Plagiarism and the Internet: Copyright rules also apply to users of the Internet who cite from Internet sources. Information and graphics accessed electronically must also be cited, giving credit to the sources. This material includes but is not limited to e-mail (don't cite or forward someone else's e-mail without permission), newsgroup material, and information from Web sites, including graphics. Even if you give credit, you must get permission from the original source to include any graphic that you did not create on your web page. Shareware graphics are not free. Freeware clipart is available for you to freely use. If the material does not say "free," assume it is not. Putting someone else's Internet material on your web page is stealing intellectual property. Making links to a site is currently acceptable, but getting permission is strongly advised, since many Web sites have their own requirements for linking to their material. (Source: <http://mason.gmu.edu/~montecin/plagiarism.htm>)

How to avoid it? Authors must credit original sources through accepted documentation styles, such as parenthetical citation, footnotes, or endnotes; a listing of books and articles is not sufficient. Direct quotations always require citations. So do paraphrases and summaries of opinions or factual information formerly unknown to the writers or which the writers did not discover themselves. Exceptions include factual information that can be obtained from a variety of sources; the writers' own insights or findings from their own field research; and what has been termed common knowledge. Common knowledge is sometimes difficult to determine, so feel free to ask. Work that requires citations is not limited to text. Templates, data (facts/figures) for charts, and even cartoons used in presentations require citations! If you are uncertain about whether information should be cited, please cite to be safe, or ask me before turning in your work.

Why avoid it? Plagiarism is a violation of Mason's Honor Code:

<http://www.gmu.edu/facstaff/handbook/aD.html> Plagiarism also reflects poorly on the intellectual capability of the person plagiarizing, and it is unfair to the original source of the plagiarized material. It also will earn you a failing grade in this class. I know professors who have failed students for plagiarism. Please don't turn me into one of them.

Writing Assistance

Mason's Writing Center can provide tutoring and guidance on structure and grammar for course assignments, theses, and other projects. They provide in-person and on-line services. They are located in Robinson Hall, room 114A. Please see <http://writingcenter.gmu.edu/> or contact them at wcenter@gmu.edu or 703-993-1200.

General Support

Student Support and Advocacy Center (SSAC) and Resources for Crises: OSSCM - <https://ssac.gmu.edu> -- provides comprehensive (and confidential) services for your safety and well-being.

Counseling and Psychological Services (CAPS): provides a wide range of services to students by a staff of professional counseling and clinical psychologists, social workers, and counselors. CAPS individual and group counseling, workshops and outreach programs are designed to enhance students' personal experience and academic performance. <http://caps.gmu.edu/>

WAVES: helps students develop and maintain healthy lifestyles through one on one support, interactive programs and resources. Topics include healthy relationships, stress management, nutrition, sexual assault, drug and alcohol use and sexual health. <http://waves.gmu.edu/>

Gender-based/Sexual Discrimination: The 1-page [George Mason University Title IX Resources](#) sheet may benefit those of you seeking resources to prevent, address &/or recover from gender-based discrimination – including sexual harassment, sexual assault, stalking, domestic violence, and sexual exploitation. It includes 16 on- and off-campus sources of assistance, including confidential ones.

Session Topics and Readings:

Week 1 (January 26/28): Syllabus Overview and Introduction: Defining the FEW Nexus

Session overview: We'll discuss the concept of the food-energy-water nexus and its relevance to policymaking and private sector challenges in different locations and at different scales.

Required Readings and Videos:

1. Andy Wales (SABMiller) video: The Water-Food-Energy Nexus - Why Everything you Consume is Connected <https://www.youtube.com/watch?v=T-eATjiXTOQ>

INTERCONNECTIONS

Week 2 (February 2/4): System interconnections: overview

Session overview: We'll discuss broad connections between food, energy and water systems and connections to sustainable development at global, national and local levels.

Reading Questions:

- 1) What are some of the approaches to food-energy-water nexus thinking, and what are some key areas that connect these three systems?
- 2) How is the food-energy-water nexus linked to resilience and sustainable development?
- 3) What types of priorities drive private sector interest in the food-energy-water nexus?
- 4) How does the FEW nexus respond to shocks?

Required Readings and Videos:

1. Al-Saidi, Mohammed, and Lars Ribbe. (2017.) Development and Use of Nexus Assessments. In *Nexus Outlook Report: Assessing International Challenges*: 13-18.
2. SABMiller and WWF. (2014.) The Water-Food-Energy Nexus: Insights into resilient development.
3. Jones, Kristal, Nicholas R. Magliocca and Kelly Hondula. (2017.) *White Paper: An Overview of Conceptual Frameworks, Analytical Approaches and Research Questions in the Food-Energy-Water Nexus*. SESYNC White Paper, National Socio-Environmental Synthesis Center (SESYNC), University of Maryland, March 2017.
4. Redmon, Jennifer HoPONICK, Justin Baker and A.J. Kondash. 2020. How the COVID-19 Pandemic Affects Food, Energy, and Water Systems in the U.S. RTI International Insights. May 13.
<https://www.rti.org/insights/covid-19-impact-on-us-systems>

Douglas County, KS Energy video: <https://www.youtube.com/watch?v=MBwahkFcUsI>

Costa Rica Ag & Drought video: <https://www.youtube.com/watch?v=3jUsTzYlcMc>

Alaskan Oil Exploration video: <https://www.youtube.com/watch?v=5fMCUDrO738>

Optional Reading:

** Bazilian, M., et al. (2011.) Considering the energy, water and food nexus: Towards an integrated modelling approach. *Energy Policy* 39: 7896–7906.

Week 3 (February 9/11): Ecological aspects

ASSIGNMENT 1 DUE

Session overview: We'll discuss the ecological aspects of the nexus at global, national and local levels.

Reading Questions:

- 1) What are some of the ecological aspects of the food-energy-water nexus at different scales?
- 2) How do ecological aspects of nexus thinking differ in developing vs. developed nations, wealthy vs. impoverished communities, and rural vs. urban areas?
- 3) Which actors are interested in the ecological aspects of the food-energy-water nexus, and what are their priorities?

Required Readings and Videos:

Allan, Tony, and Nathaniel Matthews. The Water, Energy And Food Nexus and ecosystems: The political economy of food and non-food supply chains. In Dodds and Bartram, Eds. Part 1, chapter 5.

Scanlon, Bridget, et al. 2017. The food-energy-water nexus: Transforming science for society. *Water Resources Research*, 3550-3556.

Liu, Q. (2016.) Interlinking climate change with water- energy-food nexus and related ecosystem processes in California case studies. *Ecological Processes* 5:14.

India's FEW Nexus video: <https://www.newsecuritybeat.org/2015/03/indias-food-water-energy-conundrum-part-1-2/>

Malawi's FEW Nexus video: <https://www.youtube.com/watch?v=CGVMWHXBoTY>

Week 4 (February 16/18): Economic aspects

Session overview: We'll discuss the economic aspects of the nexus at global, national and local levels.

Reading Questions:

- 1) What are some of the economic aspects of the food-energy-water nexus at different scales?
- 2) How do economic aspects of nexus thinking differ in developing vs. developed nations, wealthy vs. impoverished communities, and rural vs. urban areas?
- 3) Which actors are interested in the economic aspects of the food-energy-water nexus, and what are their priorities?

Required readings and Videos:

von Braun, Joachim, and Alisher Mirzabaev. Nexus scientific research: Theory and approach serving sustainable development. In Dodds and Bartram, Eds. Part 1, chapter 3.

Asian Development Bank. (2013.) Executive Summary. In *Thinking about Water Differently: Managing the Water–Food–Energy Nexus*: vi-ix.

Becker, Rike, and Laura Margarete Simon. (2017.) The Water-Energy-Food Nexus: Challenges for Chilean agriculture. In *Nexus Outlook Report: Assessing International Challenges*: 22-29.

Conservation International Business and Sustainability Council. (2013.) Resources: The Energy-Water-Food Nexus.

Nepal's FEW Nexus video: <https://www.youtube.com/watch?v=Sxr0RqYL1F0>

Week 5 (February 23/25): Institutional aspects

Session overview: We'll discuss the institutional aspects of the nexus at global, national and local levels.

Reading Questions:

- 1) How do interactions between different actors and levels of government influence the food-energy-water nexus? Do they make it more challenging, more beneficial, or both?
- 2) How do institutional aspects of nexus thinking differ in developing vs. developed nations, wealthy vs. impoverished communities and rural vs. urban areas?

Required Readings and Videos:

Norman, David, and Stuart Orr. Building partnerships for resilience. In Dodds and Bartram, Eds. Part 6, chapter 16.

Dodds, Felix, and Cole Simons. Principles for the integration of the Nexus within business. In Dodds and Bartram, Eds. Part 6, chapter 18.

Nebraska Collaborative for Food, Energy, and Water Education. Food-Energy-Water-Nexus.

<https://www.unl.edu/nc-few/food-energy-water-nexus>

Sklarew D. and J. Sklarew. (2018.) Integrated water-energy policy for sustainable development. *Foresight and STI Governance* 12(4): 10-19.

Tackling Trade-offs in the FEW Nexus video: watch only 1) Melissa Leach intro: 7:37, 2) Peter Newborne/Brazil: 21:25, 3) Amanda Lenhardt: 5:25, and 4) Joel Oedraogo: 16:52

<https://www.odi.org/events/4000-tackling-trade-offs-food-water-energy-nexus-lessons-sdgs>

CHALLENGES

Week 6 (March 2/4): System challenges: overview

Session overview: We'll broadly discuss food, energy and water system interconnection challenges in the context of sustainability and resilience of all three systems at global, national and local levels.

Reading Questions:

- 1) How do food-energy-water nexus challenges influence resilience and sustainable development?
- 2) How do nexus challenges differ in developing vs. developed nations, wealthy vs. impoverished communities, and rural vs. urban communities?
- 3) Which actors are creating or contributing to these challenges?
- 4) Which actors are affected by these challenges, and how?

Required readings:

Grobicki, Ania. Water–food–energy–climate: Strengthening the weak links in the Nexus. In Dodds and Bartram, Eds. Part 3, chapter 9.

Lee, Sylvia. Natural resource security in an uncertain world. In Dodds and Bartram, Eds. Part 3, chapter 10.

Rodriguez, Diego, Anna Delgado Martin and Antonia Sohns. Adding to complexity: Climate change in the Energy–Water Nexus. In Dodds and Bartram, Eds. Part 4, chapter 13.

The National Academies of Sciences, Engineering and Medicine. Environmental Engineering for the 21st Century: Addressing Grand Challenges (2019.) Chapter 3: Grand Challenge 1: Sustainably Supply Food, Water, and Energy
The National Academies Press. 8-top of 24.
<https://www.nap.edu/read/25121/chapter/3>

Smedly, Tim. (2013.) Can 'nexus thinking' alleviate global water, food and energy pressures? *The Guardian*.

Optional Readings

** Liu, J., H. Yang, C. Cudennec, A.K. Gain, H. Hoff, R. Lawford, J. Qi, L. de Strasser, P.T. Yillia & C. Zheng (2017) Challenges in operationalizing the water-energy-food nexus, *Hydrological Sciences Journal*, 62:11, 1714-1720

Week 7 (March 9/11): Ecological aspects

ASSIGNMENT 2 DUE on Thursday by midnight

Session overview: We'll discuss ecological aspects of food, energy and water system interconnection challenges at global, national and local levels.

Reading Questions:

- 1) What are some of the ecological aspects of food-energy-water nexus challenges at different scales?
- 2) How do these ecological challenges differ in developing vs. developed nations, wealthy vs. impoverished communities, and rural vs. urban areas?
- 3) Which actors are creating or contributing to the ecological aspects of these challenges, and why?
- 4) Which actors are affected by these challenges, and how?

Required Readings and Videos:

D'Odorico, Paolo, Kyle Frankel Davis, Lorenzo Rosa, Joel A. Carr, Davide Chiarelli, Jampel Dell'Angelo, Jessica Gephart, Graham K. MacDonald, David A. Seekell, Samir Suweis and Maria Cristina Rulli, (2018.) The Global Food-Energy-Water Nexus, *Reviews of Geophysics*, 56, 3, (456-531). Pages 456-497 (stop at "10. Resilience of the Food-Energy-Water Nexus").

Watch University of Michigan REFRESH Project (11 minutes, 37 seconds)
<https://www.youtube.com/watch?v=SKfinlijae8>

Optional Readings:

**Wakeford, Jeremy & Mentz-Lagrange, Sasha & Kelly, Candice. (2016). Managing the Energy-food-water Nexus in Developing Countries: Case Studies of Transition Governance.

Week 8 (March 16/18): Economic aspects

Session overview: We'll discuss economic challenges associated with the nexus, including challenges specific to developing vs. developed nations and wealthy vs. impoverished communities.

Reading Questions:

- 1) What are some of the economic challenges of the food-energy-water nexus at different scales?
- 2) How do these economic challenges differ in developing vs. developed nations, wealthy vs. impoverished communities, and rural vs. urban areas?
- 3) Which actors are creating or contributing to these challenges, and why?
- 4) Which actors are affected directly or indirectly by these challenges, and how?

Required Readings and Videos:

Asian Development Bank. (2013.) The Water-Food-Energy Nexus. In *Thinking about Water Differently: Managing the Water-Food-Energy Nexus*: 6-18.

Spiegelberg, M., S. Hoshino, and S. Hashimoto. (2015.) Serving the underserved: the water-energy-food nexus in socio-ecological production landscapes. *WIT Transactions on Ecology and The Environment*, Vol 193. 183-191.

Treemore-Spears, Lara, J. Morgan Grove, Craig K. Harris, Lawrence D. Lemke, Carol J. Miller, Kami Pothukuchi, Yifan Zhang, Yongli L. Zhang. (2016.) A workshop on transitioning cities at the food-energy-water nexus. *Journal of Environmental Studies and Sciences*.

Givens, Jennifer E., Julie Padowski, Christian D. Guzman, Keyvan Malek, Rebecca Witinok-Huber, Barbara Cosens, Michael Briscoe, Jan Boll, and Jennifer Adam. (2018.) Incorporating Social System Dynamics in the Columbia River Basin: Food-Energy-Water Resilience and Sustainability Modeling in the Yakima River Basin. *Frontiers in Environmental Science*, 19 September 2018.

Optional Readings:

** Sperling, Joshua, and Philip Berke. (2017.) Urban Nexus Science for Future Cities: Focus on the Energy-Water-Food-X Nexus. FEW Nexus Workshop on

Integrated Science, Engineering, and Policy: A Multi Stakeholder Dialogue, January 26 -27, 2017, College Station, Texas.

Gurría, Angel. (2014.) Water-Energy-Food: Taking on the Nexus. Opening Remarks delivered at the Global Forum on the Environment: New Perspectives on the Water-Energy-Food Nexus. November 27, 2014. Paris, France.

Week 9 (March 23/25): Institutional aspects

Session overview: We'll discuss institutional challenges associated with the nexus at local, national and global scales, including challenges specific to developing vs. developed nations and wealthy vs. impoverished communities.

Reading Questions:

- 1) What are some of the institutional aspects of food-energy-water nexus challenges at different scales?
- 2) How do these institutional challenges differ in developing vs. developed nations, wealthy vs. impoverished communities, and rural vs. urban areas?
- 3) Which actors are creating or contributing to these challenges, and why?
- 4) Which actors are affected by these challenges, and how?

Required Readings and Video:

Pardoe, Joanna, Declan Conway, Emilinah Namaganda, Katharine Vincent, Andrew J. Dougill, and Japhet J. Kashaigili. (2017.) Climate change and the water–energy–food nexus: insights from policy and practice in Tanzania. *Climate Policy*, Volume 18, 2018, Issue 7: 863-877.

Taniguchi Makoto, Aiko Endo, Jason Gurdak, and Peter Swarzenskic. (2017.) Water-Energy-Food Nexus in the Asia-Pacific Region. *Journal of Hydrology: Regional Studies*, Volume 11:1-8.

White, Dave, et al. (2017.) Stakeholder Analysis for the Food-Energy-Water Nexus in Phoenix, Arizona: Implications for Nexus Governance. *Sustainability* 2017: 9.

Arizona FEW Case study video:

<https://www.google.com/url?sa=t&source=web&rct=j&url=https://m.youtube.com/watch%3Fv%3D1Vk8RoalRtg&ved=2ahUKEwiioehvJPmAhdVdqp4KHUYDfM4ChCjtAEwBHoECAAQCg&usg=AOvVaw0r2StC2UwwePF2fYFj8Jss>

Optional Readings:

** Weitz, Nina, Claudia Strambo, Eric Kemp-Benedict, and Måns Nilsson. (2017.) *Governance in the water-energy-food nexus: Gaps and future research needs*. Stockholm Environment Institute.

SOLUTIONS

Week 10 (March 30/April 1): Solutions: overview

Session overview: We'll discuss broad solutions to food, energy and water system interconnection challenges in the context of sustainability and resilience of all three systems at global, national and local levels.

Reading Questions:

- 1) How do nexus solutions parameters differ in developing vs. developed nations wealthy vs. impoverished communities, and rural vs. urban areas?
- 2) How do food-energy-water nexus solutions influence resilience and sustainable development?
- 3) What types of actors are creating or contributing to these solutions?
- 4) How are different actors affected?

Required readings:

Wouters, Frank, and Divyam Nagpal. Renewable energy: Nexus-friendly pathways for growth. In Dodds and Bartram, Eds. Part 4, chapter 12. 163-175.

Drechsel, Pay, and Munir A. Hanjra. Green opportunities for urban sanitation: challenges through energy, water and nutrient recovery. In Dodds and Bartram, Eds. Part 5, chapter 15. 204-218.

D'Odorico, Paolo, Kyle Frankel Davis, Lorenzo Rosa, Joel A. Carr, Davide Chiarelli, Jampel Dell'Angelo, Jessica Gephart, Graham K. MacDonald, David A. Seekell, Samir Suweis and Maria Cristina Rulli, The Global Food-Energy-Water Nexus, *Reviews of Geophysics*, 56, 3, (456-531), (2018). Pages 497-514.

Optional Readings:

** K.J. Helmstedt, J.R. Stokes-Draut, A.E. Larsen and M.D. Potts. 2018. Innovating at the food, water, and energy interface, *Journal of Environmental Management*, 10.1016/j.jenvman.2017.12.026, 209, (17-22).

Week 11 (April 6/8): Technological aspects

Session overview: We'll discuss technological aspects of solutions to food, energy and water system interconnection challenges at global, national and local levels.

Reading Questions:

- 2) How do these solutions differ in developing vs. developed nations, wealthy vs. impoverished communities, and rural vs. urban areas?
- 3) Which actors are creating or contributing to these solutions?
- 4) How are different actors affected?

Required Readings and Videos:

Food and Agriculture Organization of the United Nations. Water-energy-food nexus. <http://www.fao.org/land-water/water/watergovernance/waterfoodenergynexus/en/>

Sarni, Will. (2015.) Deflecting the scarcity trajectory: Innovation at the water, energy, and food nexus. *Deloitte Review Issue 17*.

Wolfe, M.L., Ting, K.C., Scott, N. et al. (2016.) Engineering solutions for food-energy-water systems: it is more than engineering. *J Environ Stud Sci* (2016) 6: 172.

Floatovoltaics Video: <https://www.youtube.com/watch?v=xvCR2b0HeBE>

Apocalypse game: <https://news.unl.edu/newsrooms/today/article/apocalypse-project-highlights-food-energy-water-nexus/>

(6 minutes)

Optional Readings:

Cansino-Loeza, Brenda, and Jose Maria Ponce-Ortega. (2019.) Involving the Water-Energy-Food Nexus in Integrating Low-Income and Isolated Communities. *ACS Sustainable Chemical Engineering*, 2019, 7 (1), pp 1399-1418.

Rao, Prakash & KostECKI, Robert & Dale, Larry & Gadgil, Ashok. (2017). Technology and Engineering of the Water-Energy Nexus. *Annual Review of Environment and Resources*. 42. 407-437. 10.1146/annurev-environ-102016-060959.

Week 12 (April 13/15): Economic aspects

Session overview: We'll discuss economic aspects of solutions to food, energy and water system interconnection challenges at global, national and local levels.

Reading Questions:

- 1) What are some of the economic solutions to food-energy-water nexus challenges at different scales?

- 2) How do these solutions differ in developing vs. developed nations and wealthy vs. impoverished communities?
- 3) Which actors are creating or contributing to these solutions?
- 4) Are there any challenges to these solutions?

Required readings:

Brekke, Kathrine, and Jeb Brugmann. Operationalizing the Urban Nexus: Increasing the productivity of cities and urbanized nations. In Dodds and Bartram, Eds. Part 2, chapter 7.

Bieber, Niclas, Jen Ho Ker, Xiaonan Wang, Charalampos Triantafyllidis, Koen H. van Dam, Rembrandt Koppelaar, and Nilay Shah. (2018.) Sustainable planning of the energy-water-food nexus using decision making tools. *Energy Policy* 113: 586-407.

Coca-Cola. *Water Stewardship & Replenish Report: Looking Ahead: The Water-Energy-Food Nexus*.

Optional Readings:

**Asian Development Bank. (2013.) New Water Accounting. In *Thinking about Water Differently: Managing the Water–Food–Energy Nexus*: 19-24.

Week 13 (April 20/22): Institutional Aspects Readings Discussion and Class Discussion of Nexus Challenges

ASSIGNMENT 3 DUE on Thursday by midnight

Session overviews:

- 1) We'll discuss institutional aspects of solutions to food, energy and water system interconnection challenges at global, national and local levels.
- 2) Class discussion/brainstorming on nexus problems and solutions discovered through your research for assignments 2 and 3. Graduate students will each provide 2 questions for class discussion.

Reading Questions:

- 1) What are some of the institutional solutions to food-energy-water nexus challenges at different scales?
- 2) How do these solutions differ in developing vs. developed nations, wealthy vs. impoverished communities, and rural vs. urban areas?
- 3) Which actors are creating or contributing to these solutions?

Required readings:

You, Nicholas. The contribution of innovation in urban resilience and sustainability to realizing the urban Nexus. In Dodds and Bartram, Eds. Part 2, chapter 6.

Marker, Carolin, Sandra Venghaus, and Jurgen-Friedrich Hake. (2018.) Integrated governance for the food–energy–water nexus – The scope of action for institutional change. *Renewable and Sustainable Energy Reviews*, Volume 97, December 2018, 290-300.

United Nations. Food, Energy-Water (FEW) NEXUS Partnerships.
<https://sustainabledevelopment.un.org/partnership/?p=27246>

Optional readings:

**Janssen, Davine N. G., Eunice Pereira Ramos, Vincent Linderhof, Nico Polman, Chrysi Laspidou, Dennis Fokkinga and Duarte de Mesquita e Sousa. (2020.) The Climate, Land, Energy, Water and Food Nexus Challenge in a Land Scarce Country: Innovations in the Netherlands. *Sustainability*.

Week 14 (April 27/29): Concluding Thoughts on the Nexus and Student Presentations

Session overview: We'll discuss the effectiveness of the nexus in framing food-energy-water challenges and solutions in different types of communities at global, national and local levels.

Student presentations

Week 15 (May 6, 1:30 pm-4:15 pm): Student Presentations

FINAL PAPERS DUE on Tuesday, May 4, by noon. Final papers should 1) incorporate revision of both interim assignments to address all of the instructor's comments/feedback and any new material you wish to include; 2) indicate all changes and revisions of interim assignment text using track changes, highlighting, bold, underlining, etc.

PRESENTATION SLIDES DUE on Wednesday, May 5, by midnight