

## **Adaptation and Resilience in Water Resources Systems - GEOG6960**

Meets: Tuesdays 1:00 - 3:30PM

ENR2 Building, Room S495

### **Instructor**

Christopher Scott [cascott@email.arizona.edu](mailto:cascott@email.arizona.edu)

Udall Center for Studies in Public Policy (803 E. 1<sup>st</sup> St. [corner of 1<sup>st</sup> & Euclid], phone 626-4393), or  
School of Geography & Development, ENR2 Building, Room S421

Office hours: by appointment

### **Seminar summary**

*[from course catalog]* Climate change, urban growth, energy demand, and global food trade alter water in coupled human-natural systems. This seminar addresses adaptation and resilience using material on river basins, aquifers, infrastructure, policy, and institutions from Southwest U.S., transboundary U.S.-Mexico, and international cases.

As we enter an era of drastically heightened pressure on water resources combined with greater exposure to extremes (drought and floods), human societies and ecosystems adapt in unforeseen ways. Decision-making by water users, agencies, and global water initiatives must rethink conventional approaches that have assumed bounded variability in hydrologic, water demand, and institutional terms. The new conception of water resource systems – unbounded to allow for multiple future outcomes – seeks to better integrate scientific, engineering, social, and institutional perspectives. It requires new understanding of multiple factors that influence how water is used and managed and how innovation and adaptation arise and can be strengthened. Thresholds, system reorganization, multiple equilibria, and the societal and ecosystem implications of alternative water resource systems will be addressed.

### **What can students expect to gain from this seminar?**

This is an opportunity to refine your interests related to adaptation and resilience of water resources systems in the context of global change, inter-sectoral water allocation, and progressive policy. I emphasize a geographical perspective on international and transboundary dimensions of adaptive water management, and promote inter-disciplinary scholarship. I strongly encourage you to use seminar discussions and the research paper as the means to fine-tune your own research design and make headway on your comprehensive exams, thesis, dissertation, or research proposal, if applicable. Please feel free to contact me if you would like to discuss these options.

### **Seminar objectives**

1. Place societal water use and dependence in the broader context of global change
2. Sample the literature on the theory and application of adaptation and resilience with particular emphasis on water resources
3. Identify and discuss resource and human security in complex human-natural systems
4. Relate seminar content to your experience and provide insights that should be useful in your future
5. Write and present, as part of the seminar, a scholarly research paper
6. Build inter-disciplinary bridges among students and faculty across campus and beyond

## Requirements

Students must actively participate in seminar discussions, including the submission of notes on reading material for at least three weekly topics volunteered or assigned to each student; notes must be posted to D2L by 1:30PM on the Monday prior to each seminar. Each student is required to write an original research paper (min. 20 pages, double-spaced). The paper will be conceptualized, researched, orally presented in seminar (with feedback from the instructor and fellow students), and finalized as part of the course.

There is no pre-requisite for this course.

## Grading policy

Grades are based on regular participation in seminar discussions, in-class presentation of your research paper, and final assessment of the research paper. Using the rubrics below, regular grades (A, B, C, D, or E) will be awarded upon completion of the seminar.

### Seminar participation (total 40%) based on:

30% - Lead discussions of readings

### Expectation for A-grade

*Clearly relate theory/ main argument to broader context (minimum three per student over semester); 24-hours in advance, post to D2L your written comments/ questions for the topic (D2L, Discussions, Week/date, if required "Start a new thread" and upload a Word file for grading by instructor; be sure to include your name and the Week/date in the filename).*

10% - Join discussions led by others

*Insightful oral and written response comments on reading material for which you are not the discussion leader (one page per session; minimum two over semester, posted to D2L-Discussion as Word file within one week, by Monday 1:00PM following the seminar; each week late will drop your score by one letter grade).*

### Research paper (total 60%) based on:

10% - Abstract & prelim. lit review (due 2/14)

*Descriptive title, articulate research question, min. ten annotated references (not including seminar readings).*

Presentation (during 4/18 and 4/25 seminars)

5% - Assessment by fellow students

*Effective communication, topic with scientific merit and societal relevance.*

15% - Assessment by instructor

*Paper: summarize research questions and findings.*

Final paper

30% - Final paper (due 5/2, 5PM)

*Review literature, identify theoretical/ conceptual gaps in which to situate your research. Be analytically rigorous, relate discussion to theory and concept, explore ways forward/ next steps. Email your final paper as Word attachment to instructor by no later than 5PM on 5/2 (note, late submission will drop your grade).*

### Course materials

Walker, Brian and David Salt. 2012. Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function. Washington D.C.: Island Press.

Gunderson, Lance H., Craig R. Allen and C.S. Holling (eds.). 2010. Foundations of Ecological Resilience. Washington, D.C.: Island Press.

Leichenko, Robin M. and Karen L. O'Brien. 2008. Environmental Change and Globalization: Double Exposures. New York: Oxford University Press.

(Optional):

Hollnagel, Erik, David D. Woods, and Nancy Leveson (eds.). 2006. Resilience Engineering: Concepts and Precepts. Ashgate Publishing.

Journal articles and book chapters (to be jointly identified by students) will be posted to D2L or circulated by email.

### Seminar policies

All students should be familiar with the following University of Arizona policies:

- Student Code of Conduct: <http://deanofstudents.arizona.edu/policiesandcodes/studentcodeofconduct>
- Code of Academic Integrity: <http://deanofstudents.arizona.edu/codeofacademicintegrity>

### Students with disabilities

Please register with the Disability Resource Center and see me in order to accommodate any special needs you may have.

**SCHEDULE of TOPICS** (subject to revision as agreed/ announced)

Date	Topic	Reading / Notes
1/17	<p>Introductions by seminar participants</p> <p>Seminar overview and key concepts</p>	<p><i>(PDFs posted on D2L site – please read fully in advance of 1/31 seminar):</i></p> <p>Walker, B., D. Salt. 2006. Preface, Foreword, and “Living in a Complex World: An Introduction to Resilience Thinking” (pp. ix-14). <u>Resilience Thinking</u>. Island Press.</p> <p>Leichenko, R., K. O'Brien. 2008. Introduction (pp. 3-12). <u>Environmental Change and Globalization</u>. Oxford University Press.</p> <p>Schwartz, P. 1996. “Pathfinder’s Tale” (pp. 3-15). <u>Art of the Long View</u>. Doubleday.</p> <p>Barrett, C.B., M.A. Constatas. 2014. Toward a theory of resilience for international development applications. <i>Proceedings of the National Academy of Sciences</i> 111(40): 14625-14630.</p>
1/24	<p>Adaptation and resilience to what, by whom?</p> <p><i>(Panel of UA post-docs: Jacob Petersen-Perlman, Adriana Zúñiga, America Lutz, Chris Knudson)</i></p>	<p>Petersen-Perlman, J.D. 2016. Projecting river basin resilience in the Zambezi River Basin through global analyses and basin realities. <i>Water Resources Management</i> 30(6): 1987-2003.</p> <p>Zúñiga-Teran, A., B. Orr, R. Gimblett, V. Chalfoun, D. Guertin, S. Marsh. 2017 Neighborhood design, physical activity, and wellbeing: Applying the Walkability Model. <i>International Journal of Environmental Research and Public Health</i> 14(76): doi: 10.3390/ijerph14010076.</p> <p>Eakin, H., C.M. Tucker, E. Castellanos, R. Diaz-Porras, J.F. Barrera, H. Morales. 2014. Adaptation in a multi-stressor environment: perceptions and responses to climatic and economic risks by coffee growers in Mesoamerica. <i>Environment, Development and Sustainability</i> 16 (1): 123-139.</p> <p>Leichenko, R.M., K.L. O'Brien, W.D. Solecki. 2010. Climate change and the global financial crisis: a case of double exposure. <i>Annals of the Association of American Geographers</i> 100(4): 963-972.</p>
1/31	<p>Global change: climate, energy, population, economic growth, and water resources</p> <p>Double exposures</p>	<p>Milly, P.C.D., J. Betancourt, M. Falkenmark, R.M. Hirsch, Z.W. Kundzewicz, D.P. Lettenmaier, R.J. Stouffer. 2008. Stationarity is dead: Whither water management? <i>Science</i> 319: 573-574. doi 10.1126/science.1151915.</p> <p>Rockström, J., W. Steffen, K. Noone, Å. Persson, F.S. Chapin, E.F. Lambin, T.M. Lenton, M. Scheffer, C. Folke, H.J. Schellnhuber, B. Nykvist, C.A. de Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P.K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R.W. Corell, V.J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, J.A. Foley. 2009. A safe operating space for humanity. <i>Nature</i> 461: 472-475.</p> <p>Leichenko, R., K. O'Brien. 2008. <i>(read the rest of the book)</i> <u>Environmental Change and Globalization</u>. Oxford University Press.</p>

2/7	Social-ecological systems, panarchy, adaptive cycles	<p>Gunderson, Lance and C.S. Holling (eds.). 2002. <u>Panarchy: Understanding Transformations in Human and Natural Systems</u>. Washington D.C.: Island Press. <i>READ:</i>  Ch. 1: In quest of a theory of adaptive change  Ch. 2: Resilience and adaptive cycles  Ch. 9: A future of surprises</p> <p>Berkes, Fikret, Johan Colding and Carl Folke (eds.). 2003. <u>Navigating Social-Ecological Systems: Building Resilience for Complexity and Change</u>. Cambridge UK: Cambridge University Press. <i>READ:</i>  Ch. 1: Introduction  Ch. 4: Redundancy and diversity: do they influence optimal management?  Ch. 14: Synthesis: building resilience and adaptive capacity in social-ecological systems</p>
2/14	Institutions and governance for adaptive systems	<p><i>Abstract and preliminary literature review for research term paper due (e-mail as .doc).</i></p> <p>Young, O.R. 2010. Institutional dynamics: Resilience, vulnerability and adaptation in environmental and resource regimes. <i>Global Environmental Change</i> 20: 378–385.</p> <p>Westley, F.R., O. Tjornbo, L. Schultz, P. Olsson, C. Folke, B. Crona, Ö. Bodin. 2013. A theory of transformative agency in linked social-ecological systems. <i>Ecology &amp; Society</i> 18(3): 27, doi: 10.5751/ES-05072-180327.</p> <p>Garmestani, A.S., C.R. Allen, and M.H. Benson. 2013. Can law foster social-ecological resilience? <i>Ecology &amp; Society</i> 18(2): 37, doi: 10.5751/ES-05927-180237.</p> <p>Hurlbert, M., P. Mussetta. 2016. Creating resilient water governance for irrigated producers in Mendoza, Argentina. <i>Environmental Science &amp; Policy</i> 58: 83-94.</p>
2/21	Adaptive systems, adaptive management	<p>Walker, Brian and David Salt. 2012. <u>Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function</u>. Washington D.C.: Island Press. <i>READ:</i>  Foreword, Preface, Ch. 1: Preparing for Practice (pp. ix-25)  Ch. 2: Describing the System (pp. 35-53)</p> <p>Scott, C.A., F.J. Meza, R.G. Varady, H. Tiessen, J. McEvoy, G.M. Garfin, M. Wilder, L.M. Farfán, N. Pineda Pablos, E. Montaña. 2013. Water security and adaptive management in the arid Americas. <i>Annals of the Association of American Geographers</i> 103(2): 280-289, doi: 10.1080/00045608.2013.754660.</p> <p>Pahl-Wostl, C., P. Kabat, J. Moltgen (eds.). 2008. Preface and “Requirements for Adaptive Water Management” (pp. IX-22). <u>Adaptive and Integrated Water Management</u>. Springer.</p>
2/28	Resilience practice	<p>Walker, Brian and David Salt. 2012. <u>Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function</u>. Washington D.C.: Island Press. <i>READ rest of the book starting from Case Study 2: From Taos to Bali to Sri Lanka (pp. 55-65) to the end.</i></p>

		Biggs, R., M. Schlüter, D. Biggs, E.L. Bohensky, S. BurnSilver, G. Cundill, V. Dakos, T.M. Daw, L.S. Evans, K. Kotschy, A.M. Leitch, C. Meek, A. Quinlan, C. Raudsepp-Hearne, M.D. Robards, M.L. Schoon, L. Schultz, P. C. West. 2012. Toward principles for enhancing the resilience of ecosystem services. <i>Annual Review of Environment and Resources</i> 37: 421-448.
3/7	Building resilience	Gautam, M.R., K. Chief, W.J. Smith Jr. 2013. Climate change in arid lands and Native American socioeconomic vulnerability: The case of the Pyramid Lake. <i>Climatic Change</i> . doi: 10.1007/s10584-013-0737-0.  Wilder, M., C.A. Scott, N. Pineda Pablos, R.G. Varady, G.M. Garfin, J. McEvoy. 2010. Adapting across boundaries: climate change, social learning, and resilience in the U.S.-Mexico border region. <i>Annals of the Association of American Geographers</i> 100(4): 917-928, doi: 10.1080/00045608.2010.500235.  Angeler, D.G., C.R. Allen, A.S. Garmestani, L.H. Gunderson, I. Linkov. 2016. Panarchy use in environmental science for risk and resilience planning. <i>Environment Systems and Decisions</i> 36(3): 225-228.
3/14	No seminar	Spring Break
3/21	Engineering resilience;  Infrastructure resilience	Hashimoto, T., J.R. Stedinger, D.P. Loucks. 1982. Reliability, resiliency, and vulnerability criteria for water resource system performance evaluation. <i>Water Resources Research</i> 18(1): 14-20.  Fiering, M.B. 1982. Alternative indices of resilience. <i>Water Resources Research</i> 18(1): 33-39.  Holling, C.S. 1996. "Engineering Resilience versus Ecological Resilience" (pp. 51-66) in Gunderson et al (eds). 2010. <u>Foundations of Ecological Resilience</u> .  Hollnagel, E., D.D. Woods, N. Leveson (eds.). 2006. Preface, Prologue, and "Typology" (pp. xi-6, 55-65). <u>Resilience Engineering</u> . Ashgate.  Scott, C.A., A. Lutz Ley. 2016. Enhancing water governance for climate resilience: Arizona, USA - Sonora, Mexico comparative assessment of the role of reservoirs in adaptive management for water security. Ch. 2 in C. Tortajada (ed.) <u>Increasing Resilience to Climate Variability and Change: The Role of Infrastructure and Governance in the Context of Adaptation</u> , Springer, Berlin, pp. 15-40.
3/28	Science-policy co-production	Jacobs, K., L. Lebel, J. Buizer, L. Addams, P. Matson, E. McCullough, P. Garden, G. Saliba, T. Finan. 2010. Linking knowledge with action in the pursuit of sustainable water-resources management. <i>Proceedings of the National Academy of Sciences</i> , doi: 10.1073/pnas.0813125107.  Lemos, M. C. and B. J. Morehouse. 2005. The co-production of science and policy in integrated climate assessments. <i>Global Environmental Change</i> 15: 57-68.  Brenner, R.M. 2011. Knowledge to practice in the vulnerability, adaptation and resilience literature: A propositional inventory. pp. 23-50 in R.E. Kasperson & M.

		Berberian (eds.). <u>Integrating science and policy: Vulnerability and resilience in global environmental change</u> . Routledge.
4/4	No seminar	American Association of Geographers Annual Meeting, Boston, MA
4/11	Beyond panaceas; is resilience the new sustainability?	Ostrom, E. 2007. A diagnostic approach for going beyond panaceas. <i>Proceedings of the National Academy of Sciences</i> 104(39): 15181–15187. Benson, M.H., R.K. Craig. 2014. The end of sustainability. <i>Society &amp; Natural Resources</i> 27(7): 777-782, doi: 10.1080/08941920.2014.901467. Redman, C.L. 2014. Should sustainability and resilience be combined or remain distinct pursuits? <i>Ecology &amp; Society</i> 19(2): 37. doi: /10.5751/ES-06390-190237.
4/18	Research presentations	<i>Presentations, discussion, and feedback of draft papers and proposals</i>
4/25	Research presentations	<i>Presentations, discussion, and feedback of draft papers and proposals (cont.)</i>
5/2	Adaptation and resilience seminar synthesis	<i>Final paper due by 5:00PM (email as .doc attachment for ease of editing)</i> Walker and Salt. 2012. <u>Resilience Practice</u> . pp. 185-204 Gunderson, Allen and Holling (eds.). 2010. <u>Foundations of Ecological Resilience</u> . pp. 423-444. Leichenko and O'Brien. 2008. <u>Environmental Change and Globalization</u> . pp. 104-113. Chaffin, B.C., H. Gosnell, B.A. Cosens. 2014. A decade of adaptive governance scholarship: synthesis and future directions. <i>Ecology &amp; Society</i> 19(3): 56. doi: 10.5751/ES-06824-190356.

### Final note

All information contained in this syllabus, except the grading policy, may be subject to change with reasonable advance notice, and considering seminar participants' input.