

## **EAS 567 Social Vulnerability and Adaptation to Environmental Change (3 credits)**

### **Fall 2019 Syllabus**

**Time and Location:** Fridays, 9:00-11:50 AM in Dana 3556

**Instructor:** Paige Fischer, Assistant Professor, SEAS, 3008 Dana, [apfisch@umich.edu](mailto:apfisch@umich.edu)

**Office hours:** By request, Friday afternoons generally work well

**Course overview:** Increasingly frequent and severe wildfire, flooding and storm events are raising concerns about how society can adapt to environmental change. Key to identifying opportunities for adaptation is the concept of social vulnerability. Social vulnerability refers to the geographic and socio-economic influences on the chance of harm to humans and the capacity of people to prepare and respond. This three-credit course will introduce students to the concepts of social vulnerability and adaptation as well as frameworks for assessing vulnerability and planning adaptation in human communities. The course will not address these concepts from an environmental policy or politics perspective. Rather, the course will explore theories and methods for investigating social vulnerability and adaptation from a behavioral perspective.

Students will learn methods and skills for evaluating exposure, sensitivity and adaptive capacity at different levels of social organization (individuals, communities, institutions), and designing vulnerability assessments and adaptation plans. The focus will be on climate change and related natural hazards relevant to coastal and inland areas, including wildfire, drought, flooding, sea level rise and storm events. Small group discussions, projects and conversations with practitioners will engage students in co-learning.

**Expectations:** This is a graduate-level course geared toward students in the natural and social sciences who are interested in natural resource and hazards management, environmental conservation and human-environment interactions. The course will entail considerable reading, writing and participation in class discussions. Class meetings will involve discussions of the topic areas led by the instructor, student-led discussions of the readings, lectures by guest speakers, and one or more field trips. Students will submit weekly writing assignments, and lead and participate actively in class discussions. For the final project students will design a social vulnerability assessment or adaptation plan.

**Learning outcomes:** Upon completion of this course, students will be able to:

- Define and describe social vulnerability and adaptation and their different dimensions
- Compare and contrast perspectives on vulnerability and adaptation
- Articulate needs, challenges, and opportunities for reducing vulnerability and increasing adaptation
- Identify relevant data and how to collect and analyze them
- Design vulnerability assessments and adaptation plans
- Present arguments and recommendations regarding vulnerability and adaptation in a coherent, articulate and professional manner

**Assessment:** Progress toward learning outcomes will be assessed through evaluation of:

- Weekly critiques of the reading 50%
- Facilitation of class discussions of the reading 10%
- Participation in class discussions 15%
- Final presentation 10%
- Final paper 15%

***Weekly reflections on assigned reading:*** At the designated time before the class meeting each week students will submit a clearly and tightly written 300-word essay reflecting on the assigned reading. Students should identify key problems or issues addressed by the readings, critique assumptions about social vulnerability made by the authors and identify potential contributions made to understanding of social vulnerability. Students do not have to discuss each paper in equal depth, but must demonstrate that they read each paper carefully. Students are encouraged to review each other's reflections in preparation for a class discussion. One point will be deducted for each day of each late submission.

***Facilitation of class discussions of assigned reading:*** Students will work in groups to lead class discussions of the readings for at least one class meeting. Students must come prepared to summarize the readings, pose questions to engage class members in discussion, and make critical arguments about the readings.

***Class participation:*** Students must demonstrate that they have thoroughly read and reflected on the assigned readings by actively participating and engaging fellow students in class discussion of the readings and with any guest speakers. Students must attend all classes unless arrangements are made ahead of time. One point will be deducted for each unexcused absence.

***Final project:***

***Final paper:*** Students will assess the vulnerability of a specific community or social group in a specific geographic area in relation to a specific set of environmental changes in a maximum 10-page double-spaced concise, extremely well-written paper (not including tables, figures or references). The final papers must contain: (1) a review of scholarly literature about social vulnerability, situating yourself in different approaches to vulnerability; (2) background information about the community, its history and socio-economic and demographic context; (3) a detailed description of the community's exposure, sensitivity, and capacity to adapt to environmental change; (4) critical discussion of any vulnerability assessments and adaptation plans that have already been developed for the community; (5) recommendations for future vulnerability assessment and adaptation actions and strategies for the community; (6) a discussion of knowledge gaps and opportunities for future research and practice in the area of vulnerability and adaptation. See instructions and grading rubric for more details.

***Final presentation:*** Students will form groups and present syntheses of their final papers

**Grading scheme:** Minimum for A+=97, A=93, A-=90, B+=87, B=83, B-=80, C+=77, C=73, C-=70, D+=67, D=63, D-=60, F=40

EAS 567 Social Vulnerability and Adaptation to Environmental Change Course Schedule Paige Fischer <apfisch@umich.edu>

Week	Objectives	Assignments (Submitted items due by 3PM the day before class)	In-class activities	Lectures
1 (9/6)	1) Understand course goals and expectations 2) Become familiar with key concepts		<b>Course overview</b> <b>Introductions</b>	1) Introduction to social vulnerability
2 (9/13)	3) Become familiar with concept of social vulnerability and the evolution of the concept	<b>Written reflections on vulnerability readings:</b> 1) Eakin, H., and A. L. Luers. 2006. Assessing the vulnerability of social-environmental systems. <i>Annual Review of Environment and Resources</i> 31(1):365-394. 2) Haalboom, B., and D. C. Natcher. 2012. The power and peril of "vulnerability": Approaching community labels with caution in climate change research. <i>Arctic</i> 65(3):319-327. <b>Come prepared to describe the social vulnerability of a community with which you are familiar</b>	<b>Discussion of Reading:</b> Vulnerability <b>Activity:</b> Discuss exposure, sensitivity and adaptive capacity of communities with which students are familiar	2) Exposure
3 (9/20)	4) Understand exposure as a dimension of social vulnerability 5) Become aware of methods for assessing exposure	<b>Written reflections on exposure readings:</b> 1) Frazier, T. G., N. Wood, B. Yarnal, and D. H. Bauer. 2010. Influence of potential sea level rise on societal vulnerability to hurricane storm-surge hazards, Sarasota County, Florida. <i>Applied Geography</i> 30(4):490-505. 2) Collins, T. W. 2009. Influences on Wildfire Hazard Exposure in Arizona's High Country. <i>Society &amp; Natural Resources</i> 22(3): 211-229.	<b>Discussion of Reading:</b> Exposure <b>Special guest:</b> Tim Frazier, Hazards Analytics and Resilience Planning [ <b>Rescheduled</b> ]	3) Sensitivity
4 (9/27)	6) Understand sensitivity as a dimension of social vulnerability 7) Become familiar with methods for assessing sensitivity	<b>Written reflections on sensitivity readings:</b> 1) Emrich, C. T., and S. L. Cutter. 2011. Social vulnerability to climate-sensitive hazards in the Southern United States. <i>Weather, Climate, and Society</i> 3(3):193-208. 2) Ford, J. D., B. Smit, and J. Wandel. 2006. Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada. <i>Global Environmental Change</i> 16(2):145-160.	<b>Discussion of Reading:</b> Sensitivity <b>Special guest:</b> Patty Gude, Headwaters Economics	4) Adaptive capacity
5 (10/4)	8) Understand adaptive capacity as a dimension of social vulnerability 9) Become familiar with methods for assessing adaptive capacity	<b>Read ASAP framework and guide from Beth Gibbons</b> <b>Written reflections on adaptive capacity readings:</b> 1) Nelson, R., P. Kokic, S. Crimp, P. Martin, H. Meinke, S. M. Howden, P. de Voil, and U. Nidumolu. 2010. The vulnerability of Australian rural communities to climate variability and change: Part II—integrating impacts with adaptive capacity. <i>Environmental Science &amp; Policy</i> 13(1):18-27 and appendix	<b>Discussion of Reading:</b> Adaptive capacity <b>Special guest:</b> Beth Gibbons, American Society of Adaptation Professionals	5) Adaptation

		2) Gupta, J., C. Termeer, J. Klostermann, S. Meijerink, M. van den Brink, P. Jong, S. Nootboom, and E. Bergsma. 2010. The adaptive capacity wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. <i>Environmental Science and Policy</i> 13(6):459-471.		
6 (10/11)	10) Understand the concept of adaptation and how it differs from coping and maladaptation 11) Become familiar with frameworks for assessing adaptation	<b>Final project proposal</b> <b>Written reflections on adaptation readings:</b> 1) Smit, B., Burton, I., Klein, R. J. T. & Wandel, J. 2000. An Anatomy of Adaptation to Climate Change and Variability. <i>Climatic Change</i> 45: 223-251. 2) Adger, W. N., S. Dessai, M. Goulden, M. Hulme, I. Lorenzoni, D. Nelson, L. Naess, J. Wolf, and A. Wreford. 2009. Are there social limits to adaptation to climate change? <i>Climatic Change</i> 93(3-4):335-354.	<b>Discussion of Reading:</b> Adaptation <b>Final project proposal presentations</b> (2 min each) <b>Special guest:</b> Carl Lindquist, Superior Watershed Council	
7 (10/18)	12) Learn how a community of tart cherry producers is vulnerable to climate change and how they are responding	<b>Written reflections on MSC narrative and edge notes:</b> <a href="https://www.learnkala.com/magic_link?key=Ohz1Ngnr4aD-XsHH9YWBIA">https://www.learnkala.com/magic_link?key=Ohz1Ngnr4aD-XsHH9YWBIA</a>	<b>MSC Activity 1</b>	
8 (10/25)	13) Learn how small cities like Ann Arbor are adapting to climate change		<b>Field trip:</b> Climate change vulnerability and adaptation in Ann Arbor	
9 (11/1)	14)	<b>Written reflections on what you learned about vulnerability and adaptation through the field trip</b> <b>Complete final project spreadsheet:</b> <a href="https://docs.google.com/spreadsheets/d/1f5twffMJMGhlcM4LExzV_YLDOxx4iGrQOv84ueA6Qb4/edit?usp=sharing">https://docs.google.com/spreadsheets/d/1f5twffMJMGhlcM4LExzV_YLDOxx4iGrQOv84ueA6Qb4/edit?usp=sharing</a>	<b>Debrief on field trip</b> <b>Check in on final projects</b>	6) Adaptation at the level of individuals
10 (11/8)	15) Understand risk and response appraisal 16) Become familiar with methods for investigating cognitive and social influences on risk perception and response	<b>Written reflections on individual adaptation readings:</b> 1) Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. <i>Global Environmental Change</i> , 15(3), 199-213. 2) Wolf, J., Adger, W. N., Lorenzoni, I., Abrahamson, V., & Raine, R. (2010). Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities. <i>Global Environmental Change</i> , 20(1), 44-52.	<b>Discussion of Reading:</b> Individual adaptation <b>Discussion of progress on final projects</b>	7) Adaptation at the level of communities
11 (11/15)	17) Understand the role of institutions in access to	<b>Written reflections on community adaptation readings:</b>	<b>Discussion of Reading:</b> Community adaptation	8) Principles of vulnerability

	<p>information and resources for adaptation</p> <p>18) Become familiar with methods for investigating adaptive capacity of institutions</p>	<p>1) Vásquez-León, M., C. T. West, and T. J. Finan. 2003. A comparative assessment of climate vulnerability: Agriculture and ranching on both sides of the US–Mexico border. <i>Global Environmental Change</i> 13(3):159-173.</p> <p>2) Trainor, S. F., M. Calef, D. Natcher, F. S. Chapin, A. D. McGuire, O. Huntington, P. Duffy, T. S. Rupp, L. O. DeWilde, M. Kwart, N. Fresco, and A. L. Lovecraft. 2009. Vulnerability and adaptation to climate-related fire impacts in rural and urban interior Alaska. <i>Polar Research</i> 28(1):100-118.</p>	<p><b>Special guest:</b> Sara Hughes, SEAS</p>	<p>assessment and adaptation planning</p>
12 11/22	<p>19) Understand principles of vulnerability assessment and adaptation planning</p> <p>20) Distinguish between climate change and natural hazard approaches</p>	<p><b>Written reflections on vulnerability assessment and adaptation planning readings:</b></p> <p>1) Romieu, E., T. Welle, S. Schneiderbauer, M. Pelling, and C. Vinchon. 2010. Vulnerability assessment within climate change and natural hazard contexts: Revealing gaps and synergies through coastal applications. <i>Sustainability Science</i> 5(2):159-170.</p> <p>2) van Aalst, M. K., T. Cannon, and I. Burton. 2008. Community level adaptation to climate change: The potential role of participatory community risk assessment. <i>Global Environmental Change</i> 18(1):165-179.</p> <p>3) Cross, J. A. 2001. Megacities and small towns: Different perspectives on hazard vulnerability. <i>Global Environmental Change</i> 3(2):63-80.</p>	<p><b>Discussion of Reading:</b> Vulnerability assessment and adaptation planning <b>MSC Activity 2</b> <b>Course evaluations</b></p>	<p>9) Recap</p>
13 (11/29)	Thanksgiving/no class	<b>Final paper due (11/27 3PM)</b>		
14 (12/6)			<b>Group presentations</b> <b>Course evaluations</b>	
15 (12/13)	Finals week/no class			

*This lists below are required and optional readings that convey important social vulnerability concepts and methods, and that provide empirical examples of investigations of vulnerability and adaptation using different approaches and methods. These are not all meant to be seminal papers in the field; rather a survey of conceptual frameworks and methodological approaches. Also, note the emphasis on North America, and developed countries to provide examples of vulnerability in geographic areas with many resources.*

#### General social vulnerability:

- Eakin, H., and A. L. Luers. 2006. Assessing the vulnerability of social-environmental systems. *Annual Review of Environment and Resources* 31(1):365-394.
- Adger, W. N., S. Dessai, M. Goulden, M. Hulme, I. Lorenzoni, D. Nelson, L. Naess, J. Wolf, and A. Wreford. 2009. Are there social limits to adaptation to climate change? *Climatic Change* 93(3-4):335-354.
- Füssel H-M. 2007. Vulnerability: A generally applicable conceptual framework for climate change research *Global Environmental Change* 17: 155-167.
- Ionescu C, Klein R, Hinkel J, *et al.* 2009. Towards a formal framework of vulnerability to climate change *Environmental Modeling and Assessment* 14: 1-16.
- Smit, B., and J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* 16(3):282-292.
- Turner, B. L., R. E. Kasperson, P. A. Matson, J. J. McCarthy, R. W. Corell, L. Christensen, N. Eckley, J. X. Kasperson, A. Luers, M. L. Martello, C. Polsky, A. Pulsipher, and A. Schiller. 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences* 100(14):8074-8079.
- Davidson, D. J., et al. (2003). "Understanding climate change risk and vulnerability in northern forest-based communities." *Canadian Journal of Forest Research* 33(11): 2252-2261.

#### Exposure:

- Collins, T. W. 2009. Influences on Wildfire Hazard Exposure in Arizona's High Country. *Society & Natural Resources* 22(3): 211-229.
- T. S. Rupp. 2004. Assessing fire risk in the wildland-urban interface. *Journal of Forestry* 102(7):41-48.
- Emrich, C. T., and S. L. Cutter. 2011. Social vulnerability to climate-sensitive hazards in the Southern United States. *Weather, Climate, and Society* 3(3):193-208.
- Fischer, A. P. and T. G. Frazier. 2018. "Social Vulnerability to Climate Change in Temperate Forest Areas: New Measures of Exposure, Sensitivity, and Adaptive Capacity." *Annals of the American Association of Geographers* 108(3): 658-678.
- Frazier, T. G., N. Wood, B. Yarnal, and D. H. Bauer. 2010. Influence of potential sea level rise on societal vulnerability to hurricane storm-surge hazards, Sarasota County, Florida. *Applied Geography* 30(4):490-505.
- Wood, N., C. Burton, and S. Cutter. 2010. Community variations in social vulnerability to Cascadia-related tsunamis in the U.S. Pacific Northwest. *Natural Hazards* 52(2):369-389.
- Radeloff, and Wood, N., C. Burton and S. Cutter (2010). "Community variations in social vulnerability to Cascadia-related tsunamis in the U.S. Pacific Northwest." *Natural Hazards* 52(2): 369-389.

#### Sensitivity:

- Emrich, C. T., and S. L. Cutter. 2011. Social vulnerability to climate-sensitive hazards in the Southern United States. *Weather, Climate, and Society* 3(3):193-208.
- Gaither, C. J., N. C. Poudyal, S. Goodrick, J. M. Bowker, S. Malone, and J. Gan. 2011. Wildland fire risk and social vulnerability in the southeastern United States: An exploratory spatial data analysis approach. *Forest Policy and Economics* 13(1):24-36.

- Fischer, A. P. and T. G. Frazier. 2018. "Social Vulnerability to Climate Change in Temperate Forest Areas: New Measures of Exposure, Sensitivity, and Adaptive Capacity." *Annals of the American Association of Geographers* 108(3): 658-678.
- Ford, J. D., B. Smit, and J. Wandel. 2006. Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada. *Global Environmental Change* 16(2):145-160.
- Cutter, S. L., B. J. Boruff, and W. L. Shirley. 2003. Social vulnerability to environmental hazards. *Social Science Quarterly* 84(2):242-261.
- Clark, G., S. Moser, S. Ratick, K. Dow, W. Meyer, S. Emani, W. Jin, J. Kasperson, R. Kasperson, and H. Schwarz. 1998. Assessing the vulnerability of coastal communities to extreme storms: The case of Revere, MA, USA. *Mitigation and Adaptation Strategies for Global Change* 3(1):59-82.
- Vásquez-León, M., C. T. West, and T. J. Finan. 2003. A comparative assessment of climate vulnerability: Agriculture and ranching on both sides of the US–Mexico border. *Global Environmental Change* 13(3):159-173.
- Wood, N., C. Burton and S. Cutter (2010). "Community variations in social vulnerability to Cascadia-related tsunamis in the U.S. Pacific Northwest." *Natural Hazards* 52(2): 369-389.

#### Adaptive capacity:

- Pelling, M., and C. High. 2005. Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental* 15(4):308-319.
- Lopez-Marrero, T. 2010. An integrative approach to study and promote natural hazards adaptive capacity: A case study of two flood-prone communities in Puerto Rico. *Geographical Journal* 176(2):150-163.
- Vásquez-León, M., C. T. West, and T. J. Finan. 2003. A comparative assessment of climate vulnerability: Agriculture and ranching on both sides of the US–Mexico border. *Global Environmental Change* 13(3):159-173.
- Adger, W. N. 2003. Social capital, collective action, and adaptation to climate change. *Economic Geography* 79(4):387-404.
- Fischer, A. P. and T. G. Frazier. 2018. "Social Vulnerability to Climate Change in Temperate Forest Areas: New Measures of Exposure, Sensitivity, and Adaptive Capacity." *Annals of the American Association of Geographers* 108(3): 658-678.
- Frazier, T. G., C. M. Thompson, and R. J. Dezzani. 2014. A framework for the development of the SERV model: A spatially explicit resilience-vulnerability model. *Applied Geography* 51(0):158-172.
- Ford, J. D., T. Pearce, F. Duerden, C. Furgal, and B. Smit. 2010. Climate change policy responses for Canada's Inuit population: The importance of and opportunities for adaptation. *Global Environmental Change* 20(1):177-191.
- Ford, J. D., B. Smit, and J. Wandel. 2006. Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada. *Global Environmental Change* 16(2):145-160.
- Norris, F., S. Stevens, B. Pfefferbaum, K. Wyche, and R. Pfefferbaum. 2008. Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology* 41(1):127-150.
- Nelson, D. R., W. N. Adger, and K. Brown. 2007. Adaptation to environmental change: Contributions of a resilience framework. *Annual Review of Environment and Resources* 32(1):395-419.
- Nelson, R., P. Kokic, S. Crimp, P. Martin, H. Meinke, S. M. Howden, P. de Voil, and U. Nidumolu. 2010. The vulnerability of Australian rural communities to climate variability and change: Part II—integrating impacts with adaptive capacity. *Environmental Science & Policy* 13(1):18-27.

#### Adaptation:

- Smit, B., and J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* 16(3):282-292.
- Adger, W. N., S. Dessai, M. Goulden, M. Hulme, I. Lorenzoni, D. Nelson, L. Naess, J. Wolf, and A. Wreford. 2009. Are there social limits to adaptation to climate change? *Climatic Change* 93(3-4):335-354.

- Barnett, J., & O'Neill, S. (2010). Maladaptation. *Global Environmental Change*, 20(2), 211-213.
- Juhola, S., Glaas, E., Linnér, B.-O., & Neset, T.-S. (2016). Redefining maladaptation. *Environmental Science & Policy*, 55(Part 1), 135-140.
- Head, L., et al. (2011). "A fine-grained study of the experience of drought, risk and climate change among Australian wheat farming households." *Annals of the Association of American Geographers* 101(5): 1089-1108.
- Ford, J. D., T. Pearce, F. Duerden, C. Furgal, and B. Smit. 2010. Climate change policy responses for Canada's Inuit population: The importance of and opportunities for adaptation. *Global Environmental Change* 20(1):177-191.
- Ford, J. D., B. Smit, and J. Wandel. 2006. Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada. *Global Environmental Change* 16(2):145-160.
- Trainor, S. F., M. Calef, D. Natcher, F. S. Chapin, A. D. McGuire, O. Huntington, P. Duffy, T. S. Rupp, L. O. DeWilde, M. Kwart, N. Fresco, and A. L. Lovecraft. 2009. Vulnerability and adaptation to climate-related fire impacts in rural and urban interior Alaska. *Polar Research* 28(1):100-118.

#### Rural, natural resource-based communities:

- Flint, C. G., and A. E. Luloff. 2005. Natural resource-based communities, risk, and disaster: An intersection of theories. *Society & Natural Resources* 18(5):399-412.
- Cross, J. A. 2001. Megacities and small towns: Different perspectives on hazard vulnerability. *Global Environmental Change* 3(2):63-80.
- Lal, P., J. R. Alavalapati, and E. Mercer. 2011. Socio-economic impacts of climate change on rural United States. *Mitigation and Adaptation Strategies for Global Change* 16(7):819-844.
- Trainor, S. F., M. Calef, D. Natcher, F. S. Chapin, A. D. McGuire, O. Huntington, P. Duffy, T. S. Rupp, L. O. DeWilde, M. Kwart, N. Fresco, and A. L. Lovecraft. 2009. Vulnerability and adaptation to climate-related fire impacts in rural and urban interior Alaska. *Polar Research* 28(1):100-118.

#### Risk perception:

- Dessai, S., W. Adger, M. Hulme, J. Turnpenny, J. Köhler, and R. Warren. 2004. Defining and experiencing dangerous climate change. *Climatic Change* 64(1):11-25.
- Grothmann, T., and A. Patt. 2005. Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change* 15(3):199-213.
- McCaffrey, S. 2004. Thinking of wildfire as a natural hazard. *Society and Natural Resources* 6(17):509-516.
- Lindell, M. K., and R. W. Perry. 2012. The protective action decision model: Theoretical modifications and additional evidence. *Risk Analysis* 32(4):616-632.

#### Social construction of risk:

- Tierney, K. J. 1999. Toward a critical sociology of risk. *Sociological Forum* 14(2):215-242.
- Niemeyer, S., J. Petts, and K. Hobson. 2005. Rapid climate change and society: Assessing responses and thresholds. *Risk Analysis* 25(6):1443-1456.
- Dake, K. 1992. Myths of nature: Culture and the social construction of risk. *Journal of Social Issues* 48(4):21-37.
- Clarke, L., and J. F. Short, Jr. 1993. Social organization and risk: Some current controversies. *Annual Review of Sociology* 19:375-399.
- Kasperson, R. E., and J. X. Kasperson. 1996. The social amplification and attenuation of risk. *Annals of the American Academy of Political and Social Science, Challenges in Risk Assessment and Risk Management* 545:95-105.



## Social networks

- Wolf, J., W. N. Adger, I. Lorenzoni, V. Abrahamson, and R. Raine. 2010. Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities. *Global Environmental Change* 20(1):44-52.
- Ramirez-Sanchez, S., and E. Pinkerton. 2009. The impact of resource scarcity on bonding and bridging social capital: The case of fishers' information-sharing networks in Loreto, BSC, Mexico. *Ecology and Society* 14(1):22.
- Cassidy, L., and G. D. Barnes. 2012. Understanding household connectivity and resilience in marginal rural communities through social network analysis in the village of Habu, Botswana. *Ecology and Society* 17(4):11.
- Sandström, A., and C. Rova. 2010. The network structure of adaptive governance: A single case study of a fish management area. *International Journal of the Commons* 4(1):528-551.

## Institutions

- Gupta, J., C. Termeer, J. Klostermann, S. Meijerink, M. van den Brink, P. Jong, S. Nooteboom, and E. Bergsma. 2010. The adaptive capacity wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science and Policy* 13(6):459-471.
- Engle, N. L., and M. C. Lemos. 2010. Unpacking governance: Building adaptive capacity to climate change of river basins in Brazil. *Global Environmental Change* 20(1):4-13.
- Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources* 30(1):441-473.
- Armitage, D. 2005. Adaptive capacity and community-based natural resource management. *Environmental Management* 35(6):703-715.
- Olsson, P., C. Folke, and F. Berkes. 2004. Adaptive comanagement for building resilience in social-ecological systems. *Environmental Management* 34(1):75-90.

## Ethical considerations

- Haalboom, B., and D. C. Natcher. 2012. The power and peril of "vulnerability": Approaching community labels with caution in climate change research. *Arctic* 65(3):319-327.
- Arora-Jonsson, S. 2011. Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change* 21(2):744-751.

## Planning and assessment approaches

- van Aalst, M. K., T. Cannon, and I. Burton. 2008. Community level adaptation to climate change: The potential role of participatory community risk assessment. *Global Environmental Change* 18(1):165-179.

## All:

- Adger, W. N. 2003. Social capital, collective action, and adaptation to climate change. *Economic Geography* 79(4):387-404.
- Armitage, D. 2005. Adaptive capacity and community-based natural resource management. *Environmental Management* 35(6):703-715.
- Berkes, F., and H. Ross. 2012. Community resilience: Toward an integrated approach. *Society & Natural Resources* 26(1):5-20.

- Cassidy, L., and G. D. Barnes. 2012. Understanding household connectivity and resilience in marginal rural communities through social network analysis in the village of Habu, Botswana. *Ecology and Society* 17(4):11.
- Clark, G., S. Moser, S. Ratick, K. Dow, W. Meyer, S. Emani, W. Jin, J. Kasperson, R. Kasperson, and H. Schwarz. 1998. Assessing the vulnerability of coastal communities to extreme storms: The case of Revere, MA, USA. *Mitigation and Adaptation Strategies for Global Change* 3(1):59-82.
- Clarke, L., and J. F. Short, Jr. 1993. Social organization and risk: Some current controversies. *Annual Review of Sociology* 19:375-399.
- Cross, J. A. 2001. Megacities and small towns: Different perspectives on hazard vulnerability. *Global Environmental Change Part B: Environmental Hazards* 3(2):63-80.
- Cutter, S. L., B. J. Boruff, and W. L. Shirley. 2003. Social vulnerability to environmental hazards. *Social Science Quarterly* 84(2):242-261.
- Dake, K. 1992. Myths of nature: Culture and the social construction of risk. *Journal of Social Issues* 48(4):21-37.
- Dessai, S., W. Adger, M. Hulme, J. Turnpenny, J. Köhler, and R. Warren. 2004. Defining and experiencing dangerous climate change. *Climatic Change* 64(1):11-25.
- Eakin, H., and A. L. Luers. 2006. Assessing the vulnerability of social-environmental systems. *Annual Review of Environment and Resources* 31(1):365-394.
- Emrich, C. T., and S. L. Cutter. 2011. Social vulnerability to climate-sensitive hazards in the Southern United States. *Weather, Climate, and Society* 3(3):193-208.
- Engle, N. L., and M. C. Lemos. 2010. Unpacking governance: Building adaptive capacity to climate change of river basins in Brazil. *Global Environmental Change* 20(1):4-13.
- Flint, C. G., and A. E. Luloff. 2005. Natural resource-based communities, risk, and disaster: An intersection of theories. *Society & Natural Resources: An International Journal* 18(5):399 - 412.
- Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources* 30(1):441-473.
- Ford, J. D., T. Pearce, F. Duerden, C. Furgal, and B. Smit. 2010. Climate change policy responses for Canada's Inuit population: The importance of and opportunities for adaptation. *Global Environmental Change* 20(1):177-191.
- Ford, J. D., B. Smit, and J. Wandel. 2006. Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada. *Global Environmental Change* 16(2):145-160.
- Frazier, T. G., C. M. Thompson, and R. J. Dezzani. 2014. A framework for the development of the SERV model: A spatially explicit resilience-vulnerability model. *Applied Geography* 51(0):158-172.
- Frazier, T. G., N. Wood, B. Yarnal, and D. H. Bauer. 2010. Influence of potential sea level rise on societal vulnerability to hurricane storm-surge hazards, Sarasota County, Florida. *Applied Geography* 30(4):490-505.
- Füssel H-M. 2007. Vulnerability: A generally applicable conceptual framework for climate change research *Global Environmental Change* 17: 155-167.
- Füssel, H. M. 2007. Adaptation planning for climate change: Concepts, assessment approaches, and key lessons. *Sustainability Science* 2(2):265-275.
- Gaither, C. J., N. C. Poudyal, S. Goodrick, J. M. Bowker, S. Malone, and J. Gan. 2011. Wildland fire risk and social vulnerability in the southeastern United States: An exploratory spatial data analysis approach. *Forest Policy and Economics* 13(1):24-36.
- Grothmann, T., and A. Patt. 2005. Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change* 15(3):199-213.
- Gupta, J., C. Termeer, J. Klostermann, S. Meijerink, M. van den Brink, P. Jong, S. Nooteboom, and E. Bergsma. 2010. The adaptive capacity wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science and Policy* 13(6):459-471.
- Haalboom, B., and D. C. Natcher. 2012. The power and peril of "vulnerability": Approaching community labels with caution in climate change research. *Arctic* 65(3):319-327.

- Haight, R. G., D. T. Cleland, R. B. Hammer, V. C. Radeloff, and T. S. Rupp. 2004. Assessing fire risk in the wildland-urban interface. *Journal of Forestry* 102(7):41-48.
- Ionescu C, Klein R, Hinkel J, *et al.* 2009. Towards a formal framework of vulnerability to climate change. *Environmental Modeling and Assessment* 14: 1-16.
- Kasperson, R. E., and J. X. Kasperson. 1996. The social amplification and attenuation of risk. *Annals of the American Academy of Political and Social Science, Challenges in Risk Assessment and Risk Management* 545:95-105.
- Kelly, P. M., and W. N. Adger. 2000. Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change* 47(4):325-352.
- Lal, P., J. R. Alavalapati, and E. Mercer. 2011. Socio-economic impacts of climate change on rural United States. *Mitigation and Adaptation Strategies for Global Change* 16(7):819-844.
- Lindell, M. K., and R. W. Perry. 2012. The protective action decision model: Theoretical modifications and additional evidence. *Risk Analysis* 32(4):616-632.
- Lopez-Marrero, T. 2010. An integrative approach to study and promote natural hazards adaptive capacity: A case study of two flood-prone communities in Puerto Rico. *Geographical Journal* 176(2):150-163.
- McCaffrey, S. 2004. Thinking of wildfire as a natural hazard. *Society and Natural Resources* 6(17):509-516.
- Melillo, J. M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds. (2014). Climate change impacts in the United States: The third national climate assessment, U.S. Global Change Research Program: 841.
- Moser, S. C., and J. A. Ekstrom. 2011. Taking ownership of climate change: Participatory adaptation planning in two local case studies from California. *Journal of Environmental Studies and Sciences* 1(1):63-74.
- Nelson, R., P. Kokic, S. Crimp, P. Martin, H. Meinke, S. M. Howden, P. de Voil, and U. Nidumolu. 2010. The vulnerability of Australian rural communities to climate variability and change: Part ii—integrating impacts with adaptive capacity. *Environmental Science & Policy* 13(1):18-27.
- Nelson, D. R., W. N. Adger, and K. Brown. 2007. Adaptation to environmental change: Contributions of a resilience framework. *Annual Review of Environment and Resources* 32(1):395-419.
- Niemeyer, S., J. Petts, and K. Hobson. 2005. Rapid climate change and society: Assessing responses and thresholds. *Risk Analysis* 25(6):1443-1456.
- Norris, F., S. Stevens, B. Pfefferbaum, K. Wyche, and R. Pfefferbaum. 2008. Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology* 41(1):127-150.
- O'Brien, K., R. Leichenko, U. Kelkar, H. Venema, G. Aandahl, H. Tompkins, A. Javed, S. Bhadwal, S. Barg, L. Nygaard and J. West (2004). Mapping vulnerability to multiple stressors: Climate change and globalization in India. *Global Environmental Change* 14(4): 303-313.
- Olsson, P., C. Folke, and F. Berkes. 2004. Adaptive comanagement for building resilience in social-ecological systems. *Environmental Management* 34(1):75-90.
- Parkins, J. R., and N. A. MacKendrick. 2007. Assessing community vulnerability: A study of the mountain pine beetle outbreak in British Columbia, Canada. *Global Environmental Change* 17:460-471.
- Paveglio, T. B., M. S. Carrol, and P. Jakes. 2012. Exploring the social characteristics of adaptive capacity for wildfire: Insights from Flathead County, Montana. *Human Ecology Review* 19(2):110-124.
- Pelling, M., and C. High. 2005. Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental* 15(4):308-319.
- Peterson, G. D., G. S. Cumming, and S. R. Carpenter. 2003. Scenario planning: A tool for conservation in an uncertain world. *Conservation Biology* 17(2):358-366.
- Quay, R. 2010. Anticipatory governance. *Journal of the American Planning Association* 76(4):496-511.
- Ramirez-Sanchez, S., and E. Pinkerton. 2009. The impact of resource scarcity on bonding and bridging social capital: The case of fishers' information-sharing networks in Loreto, BSC, Mexico. *Ecology and Society* 14(1):22.
- Reo, N. J., K. P. Whyte, D. McGregor, M. A. P. Smith, and J. Jenkinse. In Review. Seven principles for indigenous partnerships in landscape-scale conservation.

- Romieu, E., T. Welle, S. Schneiderbauer, M. Pelling, and C. Vinchon. 2010. Vulnerability assessment within climate change and natural hazard contexts: Revealing gaps and synergies through coastal applications. *Sustainability Science* 5(2):159-170.
- Sandström, A., and C. Rova. 2010. The network structure of adaptive governance: A single case study of a fish management area. *International Journal of the Commons* 4(1):528-551.
- Smit, B., and J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* 16(3):282-292.
- Tierney, K. J. 1999. Toward a critical sociology of risk. *Sociological Forum* 14(2):215-242.
- Trainor, S. F., M. Calef, D. Natcher, F. S. Chapin, A. D. McGuire, O. Huntington, P. Duffy, T. S. Rupp, L. O. DeWilde, M. Kwart, N. Fresco, and A. L. Lovecraft. 2009. Vulnerability and adaptation to climate-related fire impacts in rural and urban interior Alaska. *Polar Research* 28(1):100-118.
- Turner, B. L., R. E. Kasperson, P. A. Matson, J. J. McCarthy, R. W. Corell, L. Christensen, N. Eckley, J. X. Kasperson, A. Luers, M. L. Martello, C. Polsky, A. Pulsipher, and A. Schiller. 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences* 100(14):8074-8079.
- van Aalst, M. K., T. Cannon, and I. Burton. 2008. Community level adaptation to climate change: The potential role of participatory community risk assessment. *Global Environmental Change* 18(1):165-179.
- Vásquez-León, M., C. T. West, and T. J. Finan. 2003. A comparative assessment of climate vulnerability: Agriculture and ranching on both sides of the US–Mexico border. *Global Environmental Change* 13(3):159-173.
- Winkler, J. A., R.W. Arritt, S.C. Pryor. 2012. Climate projections for the Midwest: Availability, interpretation and synthesis. In U.S. National Climate Assessment Midwest Technical Input Report, edited by J. Andresen J. Winkler, J. Hatfield, D. Bidwell, and D. Brown. Ann Arbor, MI: Great Lakes Integrated Sciences and Assessment (GLISA) Center.
- Wolf, J., W. N. Adger, I. Lorenzoni, V. Abrahamson, and R. Raine. 2010. Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities. *Global Environmental Change* 20(1):44-52.
- Wood, N., C. Burton, and S. Cutter. 2010. Community variations in social vulnerability to Cascadia-related tsunamis in the U.S. Pacific Northwest. *Natural Hazards* 52(2):369-389.