

SUMA K4147: Water Resources and Climate

Summer 2017

Syllabus

Scheduled class times:

Tuesday and Thursday, 6:10-8:00 pm

Note: lectures during first week will be held on 6 July (Thursday) and 7 July (Friday).

Office hours:

By appointment; place TBD

Instructors information:

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Emails will be responded within 12 hours during the workweek. Emails sent on Saturday may not likely receive a response until Monday.

Course Overview:

The fragility of water resources under a changing climate has received increasing awareness amongst policy makers, planning and environmental agencies, stakeholders and beyond; driven by exciting developments in climate science and bolstered by a surge in media coverage.

An important driver of water resource availability is the interaction between the hydrologic cycle and the climate system. With climate models projecting a future of an increasingly variable and extreme climate system, the resulting impacts on the water cycle are of key relevance to the sustainable management of water resources.

This course will cover the science needed to understand the main features of the global water/hydrologic cycle, the link between science of water and climate, and how climate variability and change is affecting the water cycle, and by association the natural and human systems. Using this knowledge, students will use case studies and review scientific literature to critically evaluate real-world water security issues and develop sustainable solutions to address them.

The interaction between water and climate plays an integral role on the coupling between natural and human systems, and the experiences gained in this course are a valuable complement to other courses in the Sustainability Management Program.

Learning Objectives:

1. Understand the water/hydrological cycle and its connection to climate.
2. Understand how variability and changes in climate affect/will affect water supply/availability on land.
3. Understand how water impacts ecosystems.
4. Learn how to critically evaluate a scientific article and write a review.
5. Diagnose the cause of a climate-related water problem and develop solutions to address it.

-- *This syllabus is a guide for our course and is subject to further changes.* --

Text/Readings:

There is no assigned textbook for this class. Readings will be taken from reports and scientific articles, and may be supplemented with news articles, depending on current events as the class progresses.

Resources and Communication Channels:

Courseworks/Canvas will be used to distribute reading materials, lecture slides, and to turn in assignments unless specified otherwise. Students are expected to check email on a daily basis during weekdays to stay current with course-related communications.

Course Requirements and Grading:

The course will consist of readings, homework assignments, one exam, and a final project, consisting of a paper and a presentation in class. The final grade will be calculated as follows:

- 5% - Attendance
- 35% - Written critiques
- 10% - Participation
- 20% - Exam
- 30% - Final Project (15% written paper + 15% presentation)

Most classes will be divided in two sections. During the first part the instructor will deliver a theoretical basis, while on the second part a reading discussion will be held.

Final grade letter equivalent

A+	100% to 98%	C+	< 80% to 77%
A	< 98% to 93%	C	< 77% to 74%
A-	< 93% to 90%	C-	< 74% to 70%
B+	< 90% to 87%	D	< 70% to 66%
B	< 87% to 84%	F	< 66% to 0%
B-	< 84% to 80%		

Attendance

(5% of final grade)

Students are expected to attend class. The attendance grade will be proportional to the number of classes attended. Missing classes without justification may imply losing the complete attendance grade.

Written critiques

(35% of final grade)

Written assignments will be requested for 7 scientific papers discussed in class. For all students, these written critiques are due via Courseworks/Canvas at noon of the day of class.

The grades of the 7 written critiques will make up 35% of the student's total grade.

Each critique must include:

- A short essay giving an overview of the reading (not less than 200 and no more than 300 words)
- Two strengths and two weaknesses of the investigation/reading
- Two critical questions that can be used as a part of the class discussion

The critique should discuss the readings in terms of the topics covered, the strengths and weaknesses of the articles, and critical aspects of the research presented. We have included the following list to act as a guideline for preparing your critique. Not all points need to be included in every critique.

- Provide a general overview
- Explain the main ideas
- Explain important numbers/facts
- Incorporate original thought
- Tie the paper into the overarching theme of the course

Late Submission

Written critiques are due before ***NOON on the day of class***. Please let us know of any extenuating circumstances that may prevent you from meeting this deadline as soon as possible. Critiques received after noon will be subject to deductions:

- 12:01 to 6:00 PM (day of class) – 5 point deduction
- 6:01 PM to Midnight on day of class – 10 point deduction
- Day after class – 15 point deduction

Later than day after class– maximum grade possible will be 80. Feedback from the instructor will not be guaranteed.

Participation

(10% of final grade)

Participation on the topics of discussion of the course will account for 7% of the final grade, while the 3% will be based on the student's participation in the online discussions and forums in CANVAS. This final grade will be an average from the individual evaluation of the instructors.

This participation grading will be elaborated based on the participation of the students on the discussions of the readings during class, and on these and other topics proposed through Courseworks/Canvas. The students are expected to show critical thinking, respectful interactions with classmates and a positive attitude towards learning and freely discussing the topics proposed. Students are encouraged to share the critical questions from their assignments with their peers.

Exam

(20% of final grade)

There will be one in-class two-hour written exam that will evaluate concepts, ideas, themes and issues that were covered in class until the evaluation date. It will be composed of short-answer essay questions. The specific point value of each question will be detailed at the time of the exam.

Final project

(30% of final grade)

The final project for this course will be a paper on an issue of the student's choice related to **water resources and climate**. The total grade for the final project (30%) will be based on the written paper (15%) and the presentation (15%).

A mandatory **project proposal** will be due on **July 24th** for topic approval. The proposal will not be graded; it is meant to ensure an appropriate topic and it is a pre-requisite for the acceptance of the final project. For the **proposal** we request the submission of a document of less than one page describing the project and how you plan to approach your paper. Failing to turn the proposal on a timely manner will forfeit the submission of the final project or points removal from the final written project.

The student will be responsible for reading primary source material on the topic, evaluating the scientific certainty/uncertainty behind the issue, and recommending a solution/management/adaptation strategy as appropriate depending on the topic discussed. The student will also be responsible for making the appropriate links and associations with the relevant theoretical material covered during the course.

The **written paper** will be due on **August 9th**. This paper will be evaluated based on: 1) demonstrating a critical understanding of the scientific literature that addresses the selected topic; and 2) proposing a creative, but feasible solution/management/adaptation strategy to the issue. The written paper grades will be an average from the individual evaluation of the instructors.

The **presentations** will take place on **August 10th**. The presentation will be evaluated for the ability to clearly present the problem and solution to your peers, to address any questions and

to defend the proposed strategy on a timely manner (TBD before the presentation). Presentation grades will be an average from the individual evaluations of the instructors and classmates.

More complete **final project guidelines** will be circulated through Courseworks/Canvas in advance of the deadlines.

Policies and expectations: Attendance, late papers, missed tests, class behavior and civility

Students are expected to arrive on time, attend all classes, and to stay until the end of class unless they have notified the instructor otherwise. Students are responsible for completing assigned readings and homework. Late assignments will be marked down unless an extension was granted. We ask that mobile devices be turned off during class.

COURSE SCHEDULE

	LECTURE/EVENTS	MAIN READING	ADDITIONAL MATERIAL
Jul 6 th	LECTURE 1 Water resources and climate: an overview		¹ Khoo (2009) ² Sivapalan et al. (2012) ³ Schwarz et al. (2011)
Jul 7 th	LECTURE 2 Introduction to the water cycle	⁴ Milly et al. 2008 (in class)	⁵ Gleick & Palaniappan (2010) ⁶ Dingman (2015)- Chapter 2, 8 & Appendix B
Jul 11 th	LECTURE 3 Connections between climate and water	- <i>Written critique 1 due</i> ⁷ Oki & Kanae (2006)	⁸ Bates et al. (2008)- Chapter 1 ⁹ Glick et al. (2000) ¹⁰ De Loë & Kreutzwiser (2000)
Jul 13 th	LECTURE 4 Climate variability and change	- <i>Written critique 2 due</i> ¹¹ Fyfe et al. (2016)	¹² Trenberth (2015) ¹³ Folland & Karl (2002)
Jul 18 th	LECTURE 5 The impact of climate change on the water cycle	- <i>Written critique 3 due</i> ¹⁴ Trenberth (2011)	¹⁵ Held and Soden (2006) ¹⁶ Hegerl et al. (2015) ⁸ Bates et al. (2008)- Chapter 2&3
Jul 20 th	LECTURE 6 The role of ecosystems to changes in the hydrological cycle	- <i>Written critique 4 due</i> ¹⁷ Allen & Breshears (1998)	¹⁸ Williams et al. (2010) ¹⁹ Aragão (2012) ²⁰ Bonan (2008)

	LECTURE/EVENTS	ASSIGNMENTS	ADDITIONAL MATERIAL
Jul 24 th		FINAL PROJECT PROPOSAL DUE	
Jul 25 th	LECTURE 7 Paleo-perspectives on hydroclimate variability	- <i>Written critique 5 due</i> ²¹ Cook et al. (2010)	²² Cobb et al. (2003)
Jul 27 th	LECTURE 8 The coupling of hydroclimate variability with human systems	- <i>Written critique 6 due</i> ²³ Buckley et al. (2010)	²⁴ Pederson et al. (2014) ²⁵ deMenocal (2011) ²⁶ Cook et al. (2010) ²⁷ Gemenne et al. (2011)
Aug 1 st	LECTURE 9 Climate change projections	- <i>Written critique 7 due</i> ²⁸ Sedláček & Knutti (2014)	⁸ Bates et al. (2008)- Chapter 4&5 ²⁹ Hawkins (2011) ³⁰ Taylor et al. (2012) ³¹ Cook et al. (2015)
Aug 3 rd	CLASS 10 EXAM	STUDY!	
Aug 8 th	CLASS 11 WORKSHOP: Tools for Analyses I. IRI Timescales decomposition tool II. Climate Explorer	³² Greene et al. (2011)	
Aug 9 th		FINAL PROJECT DUE	
Aug 10 th	CLASS 12 FINAL PROJECT PRESENTATIONS		

Reading Material References

1. Khoo, Teng Chye. "Singapore water: yesterday, today and tomorrow." *Water Management in 2020 and Beyond*. Springer Berlin Heidelberg, (2009). 237-250.
2. Sivapalan, M, et al. Socio-hydrology: A new science of people and water *Hydrological Processes* (2012)
3. Schwarz, Andrew, et al. "Climate change handbook for regional water planning." (2011).
4. Milly, P.C.D, et al. Stationarity is Dead: Whither Water Management? *Science* 319 (2008)
5. Gleick, Peter H., and Meena Palaniappan. "Peak water limits to freshwater withdrawal and use." *Proceedings of the National Academy of Sciences* 107.25 (2010): 11155-11162.
6. Dingman, S. Lawrence. *Physical hydrology*. Waveland press, 2015.

7. Oki, Taikan, and Shinjiro Kanae. "Global hydrological cycles and world water resources." *science* 313.5790 (2006): 1068-1072.
8. 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.
9. Gleick, P.K, et al. Water: The Potential consequences of climate variability and change for the water resources of the United States. (2000)
10. De Loë R.C and Kreutzwiser R.D. Climate variability, climate change and water resource management in the Great Lakes. *Climatic Change* 45 : 163-179 (2000).
11. Fyfe, John C., et al. "Making sense of the early-2000s warming slowdown." *Nature Climate Change* 6.3 (2016): 224-228.
12. Trenberth, Kevin E. "Has there been a hiatus?." *Science* 349.6249 (2015): 691-692.
13. Folland, CK. & Karl TR. "Observed Climate Variability and Change." *IPCC-TAR 2*. (2002)
14. Trenberth, Kevin E. "Changes in precipitation with climate change." *Climate Research* 47.1-2 (2011): 123-138.
15. Held, Isaac M., and Brian J. Soden. "Robust responses of the hydrological cycle to global warming." *Journal of Climate* 19.21 (2006): 5686-5699.
16. Hegerl, Gabriele C., et al. "Challenges in quantifying changes in the global water cycle." *Bulletin of the American Meteorological Society* 96.7 (2015): 1097-1115.
17. Allen, Craig D., and David D. Breshears. "Drought-induced shift of a forest–woodland ecotone: rapid landscape response to climate variation." *Proceedings of the National Academy of Sciences* 95.25 (1998): 14839-14842.
18. Williams, A. Park, et al. "Forest responses to increasing aridity and warmth in the southwestern United States." *Proceedings of the National Academy of Sciences* 107.50 (2010): 21289-21294.
19. Aragão, Luiz EOC. "Environmental science: The rainforest's water pump." *Nature* 489.7415 (2012): 217-218.
20. Bonan, Gordon B. "Forests and climate change: forcings, feedbacks, and the climate benefits of forests." *science* 320.5882 (2008): 1444-1449.
21. Cook, Edward R., et al. "Megadroughts in North America: Placing IPCC projections of hydroclimatic change in a long-term palaeoclimate context." *Journal of Quaternary Science* 25.1 (2010): 48-61.
22. Cobb, Kim M., et al. "El Nino/Southern Oscillation and tropical Pacific climate during the last millennium." *Nature* 424.6946 (2003): 271-276.
23. Buckley, Brendan M., et al. "Climate as a contributing factor in the demise of Angkor, Cambodia." *Proceedings of the National Academy of Sciences* 107.15 (2010): 6748-6752.
24. Pederson, Neil, et al. "Pluvials, droughts, the Mongol Empire, and modern Mongolia." *Proceedings of the National Academy of Sciences* 111.12 (2014): 4375-4379.
25. deMenocal, Peter B. "Climate and human evolution." *Science* 331 (2011): 540.
26. Cook, Edward R., et al. "Asian monsoon failure and megadrought during the last millennium." *Science* 328.5977 (2010): 486-489.
27. Gemenne, François. "Why the numbers don't add up: A review of estimates and predictions of people displaced by environmental changes." *Global Environmental Change* 21 (2011): S41-S49.
28. Sedláček, Jan, and Reto Knutti. "Half of the world's population experience robust changes in the water cycle for a 2° C warmer world." *Environmental Research Letters* 9.4 (2014): 4008.

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30. Taylor, Karl E., Ronald J. Stouffer, and Gerald A. Meehl. "An overview of CMIP5 and the experiment design." *Bulletin of the American Meteorological Society* 93.4 (2012): 485-498.
31. Cook, Benjamin I., Toby R. Ault, and Jason E. Smerdon. "Unprecedented 21st century drought risk in the American Southwest and Central Plains." *Science Advances* 1.1 (2015): e1400082.
32. Greene, Arthur M., Lisa Goddard, and Rémi Cousin. "Web tool deconstructs variability in twentieth-century climate." *Eos, Transactions American Geophysical Union* 92.45 (2011): 397-398.

Appendix A

Policies and Expectations:

Academic Integrity

The School of Continuing Education does not tolerate cheating and/or plagiarism in any form. Those students who violate the Code of Academic and Professional Conduct will be subject to the Dean's Disciplinary Procedures. The Code of Academic and Professional Conduct can be viewed online:

<http://ce.columbia.edu/node/217>

Please familiarize yourself with the proper methods of citation and attribution. The University provides some useful resources online; we strongly encourage you to familiarize yourself with these various styles before conducting your research:

<http://library.columbia.edu/locations/undergraduate/citationguide.html>

Violations of the Code of Academic and Professional Conduct will be reported to the Associate Dean for Student Affairs.

You can find reference and citation management tools at:

<http://library.columbia.edu/research/citation-management.html>

http://www.chicagomanualofstyle.org/tools_citationguide.html

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<http://health.columbia.edu/services/ods/support>