SUMA K4147: Water Resources and Climate
Fall 2016

Syllabus

Scheduled class times:

Wednesdays, 6:10-8:00 pm

Office hours:

By appointment; place TBD

Instructors information:

Dr. Laia Andreu-Hayles [1] <lah@ldeo.columbia.edu>

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Affiliation/Office location:

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Emails will be responded within 12 hours during the workweek. Emails sent on Saturday will 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 hydrologic cycle, the link between hydrology and climate, and how climate 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 and 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 hydrological cycle and its connection to climate.

2. Understand how changes in climate affected/will affect how much water is available on land.

3. Understand how water impacts ecosystems.
4. Learn how to critically evaluate a scientific article.
5. Diagnose the cause of a climate-related water problem and develop solutions to address it.

-- This syllabus is a guide for our semester 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 hold.

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 9 scientific papers discussed in class. For all students, these written critiques are due via Courseworks/Canvas at noon the day of class.

The grades of the 9 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 75. 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 10% of the final grade. This 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 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 **October 17th** 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.

The student will be responsible for reading primary source material on the topic, evaluating the scientific certainty/uncertainty behind the issue, and recommending an adaptation strategy. 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 **December 5th**. 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 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 **December 7th**. 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 adaptation 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	ASSIGNMENTS	ADDITIONAL MATERIAL
Sep 7th	**CLASS 1** **Introduction to the hydrological cycle**		[1] Dingman (2015)- Chapter 2, 8 & Appendix B
Sep 14th	**CLASS 2** **Introduction to climate and water**	**- Written critique 1 due** [2] Oki and Kanae (2006)	[3] Bates et al. (2008)- Chapter 1
Sep 21st	**CLASS 3** **The impact of climate change on the hydrological cycl**e	**- Written critique 2 due** [4] Trenberth (2011)	[5] Held and Soden(2006) [3] Bates et al. (2008)- Chapter 2&3 [6] Hegerl et al.(2015)
Sep 28th	**CLASS 4** **Climate variability and change**	**- Written critique 3 due** [7]Fyfe et al. (2016)	[8] Greene et al. (2011) [9] Trenberth (2015)
Oct 5th	**CLASS 5** **The role of ecosystems to changes in the hydrological cycle**	**- Written critique 4 due** [10] Bonan (2008)	[11] Williams et al. (2012) [12] Allen and Breshears (1998) [13] Aragão (2012)
Oct 12th	**CLASS 6** **Paleo-perspectives on hydroclimate variability**	**- Written critique 5 due** [14] Cook et al. (2010)	[15] Cobb et al. (2003)
Oct 17th		**FINAL PROJECT PROPOSAL DUE**	
Oct 19th	**CLASS 7** **The coupling of hydroclimate variability with human systems**	**- Written critique 6 due** [16] Buckley et al. (2010)	[17] Pederson et al. (2014) [18] DeMenocal (2011) [19] Cook et al. (2010) [20] Gemenne et al. (2011)
Oct 26th	**CLASS 8** **WORKSHOP:** **Tools for Analyses** **I. IRI Timescales decomposition tool** **II. Climate Explorer**		[8] Greene et al. (2011)
Nov 2nd	**CLASS 9** **Climate change projections**	**- Written critique 7 due** [21] Sedlácek and Knutti (2014)	[3] Bates et al. (2008)- Chapter 4&5 [22] Hawkins (2011)

	LECTURE/EVENTS	ASSIGNMENTS	ADDITIONAL MATERIAL
Nov 9th	**CLASS 10** **Regional climate projections and their applications**	**- Written critique 8 due** [23] Rummukainen (2010)	[24] Giorgi (2008) [25] Winkler et al. (2011)
Nov 16th	**CLASS 11** **EXAM**	**STUDY!**	
Nov 30th	**CLASS 12** **Water management approaches to climate change adaptation and mitigation**	**- Written critique 9 due** [26] Heikkila et al. (2012)	[27] Khoo (2009) [28] Thomson et al. (2011) [29] Sweeney et al. (2014) [30] Schwarz et al. (2011)
Dec 5th		**FINAL PROJECT DUE**	
Dec 7th	**CLASS 13** **FINAL PROJECT PRESENTATIONS**		

Reading Material References

1. Dingman, S. Lawrence. *Physical hydrology*. Waveland press, 2015.

2. Oki, Taikan, and Shinjiro Kanae. "Global hydrological cycles and world water resources." *science* 313.5790 (2006): 1068-1072.

3. 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.

4**.** Trenberth, Kevin E. "Changes in precipitation with climate change." *Climate Research* 47.1-2 (2011): 123-138.

5. Held, Isaac M., and Brian J. Soden. "Robust responses of the hydrological cycle to global warming." *Journal of Climate* 19.21 (2006): 5686-5699.

6. 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.

7. Fyfe, John C., et al. "Making sense of the early-2000s warming slowdown." *Nature Climate Change* 6.3 (2016): 224-228.

8. 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.

9. Trenberth, Kevin E. "Has there been a hiatus?." *Science* 349.6249 (2015): 691-692.

10. Bonan, Gordon B. "Forests and climate change: forcings, feedbacks, and the climate benefits of forests." *science* 320.5882 (2008): 1444-1449.

11. 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.

12. 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.

13. Aragão, Luiz EOC. "Environmental science: The rainforest's water pump." *Nature* 489.7415 (2012): 217-218.

14. 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.

15. Cobb, Kim M., et al. "El Nino/Southern Oscillation and tropical Pacific climate during the last millennium." *Nature* 424.6946 (2003): 271-276.

16. 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.

17. Pederson, Neil, et al. "Pluvials, droughts, the Mongol Empire, and modern Mongolia." *Proceedings of the National Academy of Sciences* 111.12 (2014): 4375-4379.

18. deMenocal, Peter B. "Climate and human evolution." *Science* 331 (2011): 540.

19. Cook, Edward R., et al. "Asian monsoon failure and megadrought during the last millennium." *Science* 328.5977 (2010): 486-489.

20. 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.

21. Sedlácek, 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.

22. Hawkins, Ed. "Our evolving climate: communicating the effects of climate variability." *Weather* 66.7 (2011): 175-179.

23. Rummukainen, Markku. "State-of-the-art with Regional Climate Models." *Wiley Interdisciplinary Reviews: Climate Change* 1.1 (2010): 82-96.

24. Giorgi, Filippo. "Regionalization of climate change information for impact assessment and adaptation." *Bulletin of the World Meteorological Organization* 57.2 (2008): 86-92.

25. Winkler, Julie A., et al. "Climate Scenario Development and Applications for Local/Regional Climate Change Impact Assessments: An Overview for the Non-Climate Scientist." *Geography Compass* 5.6 (2011): 301-328.

26. Heikkila, Tanya, et al. "Designing Sustainable and Scalable Rural Water Supply Systems: Evidence and Lessons from Northeast Brazil." (2012).

27. Khoo, Teng Chye. "Singapore water: yesterday, today and tomorrow." *Water Management in 2020 and Beyond*. Springer Berlin Heidelberg, 2009. 237-250.

28. Thomson, Madeleine C., et al. "Africa needs climate data to fight disease." *Nature* 471.7339 (2011): 440-442.

29. Sweeney, Alexandra, et al. "Utilizing remote sensing to explore environmental factors of visceral leishmaniasis in South Sudan." *EO Heal* (2014).

30. Schwarz, Andrew, et al. "Climate change handbook for regional water planning." (2011).

APPENDIX A

Student Information Page

Please complete this information page and post to the Courseworks site before the first class meeting. We will use this information to plan the semester, to get to know you, and to contact you by email or phone if the need arises. We will not share this information with anyone without your consent.

Name_____ Student ID# _____

Preferred contact phone: _____

My UNI email address: _____

Identify the degree program or certificate program you are in:

Explain why you are you taking this course and how it fits into your degree or certificate program.

What are your expectations for the course?

Briefly describe related experiences or courses that are relevant to this course:

If you require special accommodations, please indicate that below and be sure to discuss them with me soon.

Appendix B

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 School provides some useful resources online; we strongly encourage you to familiarize yourself with these various styles before conducting your research:
http://library.columbia.edu/help/howto/endnote.html

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

Accessibility Statement

Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website:
http://health.columbia.edu/services/ods/support