# SUMA K4147: Water Resources and Climate Spring 2024

# **COURSE SYLLABUS**

#### Scheduled class times:

Thursdays, 6:10-8:00 pm, in-person

#### Office hours:

Thursdays, 5:30-6:10pm, in-person (and upon individual request)

#### Instructors' contact information:

Dr. Nicole Davi<sup>1,2</sup> < <u>ndavi@ldeo.columbia.edu</u> >, Professor. Dr. Indrani Pal <sup>3,4</sup> < <u>ip2235@columbia.edu</u> >, Professor. Alan Cohn<sup>5</sup> < <u>ac5079@columbia.edu</u> >, Associate Instructor.

# Affiliation/Office location:

<sup>1</sup>Lamont Doherty Earth Observatory (LDEO), The Earth Institute, Columbia University.

<sup>2</sup> William Paterson University, Department of Environmental Science.

<sup>3</sup> School of Professional Studies, Columbia University.

<sup>4</sup> Division of Clean Energy, New Jersey Board of Public Utilities, Trenton, New Jersey.

<sup>5</sup> New York City Department of Environmental Protection, Bureau of Sustainability.

Emails will be responded to as soon as possible, within a day or two during the workweek. Emails sent on Saturday may not likely receive a response until Monday.

#### **Course Overview:**

"Water Stress" has made it to the TIME's <u>top 10 global risks of 2023</u>. The fragility of water resources under human development and a changing climate is receiving increasing awareness everywhere. There are many exciting developments involving public and private institutions as they are constantly reminded of and felt by the surge in climate risks via water lenses across the world.

Water resources security depends on the interaction among the hydrologic cycle, climate system, land-surface, and society. With a world where 9 billion or more people will live in 2050, over 70% of which in urban areas, and a future where an increasingly variable and extreme climate system prevails, to understand the linkage between climate, water and society is key for sustainable management of water resources and evaluating the future risk of all systems connected with water & climate.

Relying on peer-reviewed evidence, project-based learning, and a hands-on-training workshop this course covers: (1) Teaching the science needed to understand the interactions between water resources and climate system; (2) Analysis of water-climate data on online web tools to

teach students making data-driven decisions; (3) Guiding how to read scientific papers and writing critical opinions on state-of-the-art science; (4) Synergies with class peers and instructors through exciting discussions about ongoing socio-economic issues around the world related to water & climate. Finally, using such versatile knowledge and new skills acquired during the course, students will identify a real world issue in relation to water, climate and society as a case study of their own choice and will propose potential solutions that she/he most cares about with reasons.

The interactions between water and climate plays an integral role in the coupling between natural and human ecosystems, and thus the versatile experience gained in this course via scientific and project-based-training will be a valuable asset to other courses and the Sustainability Management & Sciences Programs at large.

# **Specific Learning Objectives:**

- **1.** Understand science relevant to global & local water resources and its connection to climate.
- **2.** Understand how variability and changes in the climate affect/will affect water supply and availability on the land.
- **3.** Understand how water impacts society & ecosystems at large and vice versa.
- **4.** Learn how to critically evaluate a scientific article and write a critical review / opinion.
- 5. Learn how to use web tools to analyze water-climate data independently.
- **6.** Diagnose a water resources problem, its connections to the climate system & society, and propose solutions for them.

-- 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 peer-reviewed scientific reports and journal articles of high standard, and will be supplemented with on-going issues and articles that are supported by peer-reviewed science and/or based on scientific evidence.

During the course, the students are expected to be critical about non-peer reviewed reports and articles. For example, information can be highly variable when articles are published by the Wall Street Journal vs New York Times. Discussions of what can be considered "reliable sources" will be held during the course in order to help students in the search for information for their final project. For instance, outlets such as "ScienceDaily" and "AGU-Eos" that are based on fact-based science or news based on peer-reviewed articles can be a good source of information that helps students find 'real' sources of scientific information.

# **Resources and Communication Channels:**

Courseworks will be used to distribute reading materials, lecture slides, and to turn in assignments unless specified otherwise. Students are expected to check emails on a daily basis during weekdays to stay up-to-date 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 the 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)

#### Final grade letter equivalent

A+	100%	to 98%	C+	< 80%	to 77%
Α	< 98%	to 93%	С	< 77%	to 73%
<b>A</b> -	< 93%	to 90%	<b>C</b> -	< 73%	to 70%
B+	< 90%	to 87%	D	< 70%	to 60%
В	< 87%	to 83%	F	< 60%	to 0%
B-	< 83%	to 80%			

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

#### <u>Attendance</u>

(5% of final grade)

(35% of final grade)

Students are expected to arrive on time, attend all classes, and stay until the end of class unless they have notified the instructors otherwise. 5% is allocated for attendance grading.

#### Written critiques

Written assignments will be requested for 7 scientific papers. For all students, these written critiques are due via Courseworks by **3PM** on the day of class.

The grades of the 7 written critiques will make up 35% of the student's total grade. The students are urged to pay attention to them.

Each critique must include:

- A short essay giving an overview of the reading (not less than 200 and no more than 300 words). This shouldn't just be a copy and paste the abstract.
- Two strengths and two weaknesses of the investigation/reading not based on personal thoughts. These should be based on scientific facts and evidence.
- One critical question that can be used as a part of the class discussion.

The critique should discuss, in the student's own language, 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 a critique.

- Provide a general overview
- Explain main ideas
- Explain important numbers/facts
- Incorporate original thoughts based on scientific evidence/methodologies.
- Tie the paper into the overarching theme of the course

#### Late Submission

Written critiques are due by **3PM on the day of class.** Please inform the acting professor/associate of any extenuating circumstances that may prevent you from meeting this deadline. It is crucial that all the students read and write a thoughtful review before class. For this reason, critiques received after 3PM will be subject to deductions (on a scale 0-100):

- 3:01 PM to 6:00 PM (day of class) 5 points deduction
- 6:01 PM to Midnight on day of class 10 points deduction
- Day after class 15 points deduction
- Later than the day after class maximum grade possible will be **80**. Feedback from the instructor is not guaranteed.

#### **Participation**

#### (10% of final grade)

Participation on the topics of discussion of the course will account for 10% of the final grade, while the 7% will be based on the student's in-class active participation and 3% on Courseworks forum participation (discussion forum). This grade will be an average from the individual evaluation of the instructors.

The students are expected to show critical thinking, respectful interactions with classmates and a positive attitude towards learning and a free-flowing discussion on topics proposed. Students are also encouraged to share their critical questions from the assignments with their peers. These recommendations apply for both class and forum discussions.

#### **Discussion Forum**

Throughout the semester, students are encouraged to post news or information of interest on the CANVAS discussion forum. Thoughtful thinking connecting the topics learned in class to real world problems are very much welcome.

#### Exam

#### (20% of final grade)

There will be one two-hour quiz 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 research paper written on an issue of the student's choice related to the class theme "Water Resources and Climate". A real-world problem in

relation to water and climate should be presented. 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 **Feb 23**<sup>rd</sup> for topic approval. The proposal will not be graded; it is meant to ensure an appropriate topic and it is a prerequisite 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 in a <u>timely manner</u> 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 peer-reviewed materials on the topic, evaluating the scientific uncertainty behind the issue, and recommending adaptation options, management approaches and/or strategies as appropriate depending on the topic discussed. We reiterate – any issue proposed, studied or solutions discussed should be backed by scientific consensus, and evidence, no personal thoughts or discovery is needed. The student will also be responsible for making the appropriate associations with the relevant theoretical material covered during the course. Students are expected to choose an interesting topic with social good as focus.

The **written paper** will be due on **Monday April 22<sup>nd</sup>.** This paper will be evaluated based on: 1) demonstrating a critical understanding of the peer-reviewed ONLY scientific literature and consensus knowledge that addresses the self-selected topic; and 2) proposing a creative, but feasible solution/management/adaptation strategy to the issue. A wide range of strategies can be proposed, but an approach demonstrated in the paper should have proven to be realistic or adapted elsewhere. The written paper grades will be an average from the individual evaluation of the <u>instructors</u>.

The **presentations** will take place on **Thursday April 25**<sup>th</sup>. The presentation will be evaluated by the ability to clearly present the problem and potential solutions to the peers, to address any questions and to defend the proposed adaptation strategy in a timely manner.

Presentation grades will be an average from the individual evaluations of the <u>instructors</u>. More complete **final project guidelines** will be circulated through Courseworks in advance.

**Policies and expectations: Attendance, late papers, missed tests, class behavior and civility:** Students are responsible for completing assigned readings and homework. Late assignments will be marked down unless an extension was granted.

# COURSE SCHEDULE

	LECTURE/EVENTS	MAIN READING	ADDITIONAL READING		
Jan 18 <sup>th</sup>	CLASS 1 Water resources and climate : an overview		Milly et al. 2008 Sivapalan et al. (2012) Gleick & Palaniappan (2010) Dingman (2015) Chapter 2, 8 & Appendix B		
Jan 25 <sup>th</sup>	CLASS 2 Connections between climate and water	Written critique 1 due: Oki & Kanae (2006) *Students get full grade in this first exercise, and written feedback for the following critiques	Bates et al. (2008)- Chapter 1 De Loë & Kreutzwiser (2000) Zhang & Wei (2021)		
Feb 1 <sup>2t</sup>	CLASS 3 The impact of climate change on the water cycle	<b>Written critique 2 due:</b> Trenberth (2011)	Held and Soden (2006) Hegerl et al. (2015) Bates et al. (2008)- Chapter 2&3		
Feb 8 <sup>th</sup>	CLASS 4 The role of ecosystems to changes in the hydrological cycle	<i>Written critique 3 due:</i> Allen & Breshears (1998)	Williams et al. (2010) Aragão (2012) Bonan (2008)		
Feb 15 <sup>th</sup>	CLASS 5 Paleo-perspectives on hydroclimate variability	<i>Written critique 4 due:</i> Cook et al. (2010)	Cobb et al. (2003)		
Feb 22 <sup>nd</sup>	CLASS 6 Climate modes: variability and change	<i>Written critique 5 due:</i> Fyfe et al. (2016)	Trenberth (2015) Folland & Karl (2002)		
Feb 23 <sup>rd</sup>	FINAL PROJECT PROPOSAL DUE				
Feb 29 <sup>th</sup>	CLASS 7 Workshop Tools for Analyses I. IRI Timescales decomposition tool	<i>Reading for workshop</i> Greene et al. (2011)			

	II. Climate Explorer								
Mar 7 <sup>th</sup>	CLASS 8 The coupling of hydroclimate variability with human systems Guest Lecture: Walter Meyer, Local Office	<i>Written critique 6 due:</i> Buckley et al. (2010)	Pederson et al. (2014) deMenocal (2011) Cook et al. (2010) Gemenne et al. (2011)						
	Design (to be confirmed)								
	SPRING BREAK Monday, Mar 11-Friday, Mar 15, 2024								
Mar 21 <sup>st</sup>	CLASS 9 Climate Change Projections (Global Climate Models)	<b>Written <i>critique 7 due:</i></b> Sedlácek & Knutti (2014)	Bates et al. (2008)- Chapter 4&5 Hawkins (2011) Taylor et al. (2012) Cook et al. (2015)						
Mar 28 <sup>th</sup>	CLASS 10 Climate information and applications	<b>Reading:</b> Goddard et al. (2014)	Dinku et al. (2014) del Corral et al. (2012)						
Apr 4 <sup>th</sup>	CLASS 11 EXAM	STUDY!							
Apr 11 <sup>th</sup>	CLASS 12 Good Practices of Scientific Research & Reporting : Discussions on the Projects								
Apr 18 <sup>th</sup>	CLASS 13 Water Management Approaches		Moss et al. (2017) Khoo (2009) Thomson et al. (2011) Sweeney et al. (2014) Schwarz et al. (2011)						
Apr 22 <sup>nd</sup>		FINAL PROJECT DUE							
Apr 25 <sup>th</sup>	CLASS 14 FINAL PROJECT PRESENTATIONS								

# **READING MATERIAL REFERENCES**

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.

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

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.

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

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.

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

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.

Cook, Edward R., et al. (a) "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.

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

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

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

Dinku, T., Block, P., Sharoff, J. et al. Earth Perspectives (2014) 1: 15. <u>https://doi.org/10.1186/2194-6434-1-15</u>

Folland, C.K. Karl, T. Salinger, M. Observed climate variability and change. *Weather*, 57 (2002), pp. 269-278

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

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.

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.

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.

Goddard, L, Baethgen W, Bhojwani H, and Robertson A, (2014) The International Research Institute for Climate & Society: why, what and how. Earth Perspectives 2014, 1:10.

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

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.

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

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

Milly, P.C.D, et al. Stationarity is Dead: Whither Water Management? Science 319 (2008).

Moss, R. H., et al. Hell and High Water: Practice-Relevant Adaptation Science. Science 342 (6159), 696-698.(2017)

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

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

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

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.

Sivapalan, M., Savenije, H.H.G., and Blöschl, G., Socio-hydrology: a new science of people and water. *Hydrological Processes*, 26, (2012): 1270–1276.

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

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

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Wilby, R.L., and Dessai S. "Robust adaptation to climate change." Weather 65.7 (2010): 180-185.

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.

Zhang, M., and Wei, X. " Deforestation, forestation, and water supply". Science. 371(6533): pp990.

# **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 School provides some useful resources online; we strongly encourage you to familiarize yourself with these various styles before conducting your research: <u>http://library.columbia.edu/locations/undergraduate/citationguide.html</u>

# 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

# 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

#### **Diversity Statement**

It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture.

# Accessibility

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: https://health.columbia.edu/services/ods/support.

# School Policies and Expectations:

Accessibility Statement – I want you to succeed in this course. Contact disability@columbia.edu<mailto:disability@columbia.edu> for learning accommodations.

# Names/Pronouns

You deserve to be addressed in a manner that reflects your identity. You are welcome to tell me your pronoun(s)and/or name (if different from University records) at any time, either in person or via email.

# Discrimination

We embrace the diversity of gender, gender identity & expression, sex, sexual orientation, race, ethnicity, national origin, age, religion, disability status, family status, socioeconomic background, and other visible and non-visible identities. Columbia University does not tolerate unlawful discrimination, discriminatory harassment, sexual assault, domestic violence, dating violence, stalking, or sexual exploitation and all such conduct is forbidden by Columbia University Policy.

# Duty to Report

You deserve a University community free from discrimination, harassment, and gender-based misconduct including sexual harassment, sexual assault, domestic and dating violence, stalking, and sexual exploitation. It is therefore University policy to require Columbia faculty and staff to report to EOAA any instance or allegation of prohibited conduct involving any undergraduate or any graduate student that is disclosed to, observed by, or otherwise known to that employee. This requirement to report is in place to help ensure that students are provided appropriate resources and to allow the University to mitigate harm to our community.

# **Confidential Resources**

There are confidential resources on campus who do not have a Duty to Report, including:

- \* Sexual Violence Response & Rape Crisis/Anti-Violence Support Center (SVR)
- \* Ombuds Office
- \* Medical Services
- \* University Counseling and Psychological Services
- \* University Pastoral Counseling
- \* Columbia Office of Disability Services

University employees working in a confidential capacity will not report information shared with them.

#### Inclusion

In the M.S. in Sustainability Management program, faculty and staff are committed to the creation and maintenance of "inclusive learning" spaces – classrooms and other places of learning where you will be treated with respect and dignity, and where all individuals are provided equitable opportunity to participate, contribute, and succeed.

All students are welcome regardless of race/ethnicity, gender identities, gender expressions, sexual orientation, socio-economic status, age, disabilities, religion, regional background, Veteran status, citizenship status, nationality and other diverse identities that we each bring to class.