CEE 598 SH: Stochastic Hydrology

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COURSE INFORMATION

CEE 598 SH: Stochastic Hydrology
Department of Civil and Environmental Engineering
Fall semester 2017, 4 credits

Class meeting: 8:00-9:50 AM, 2312 Newmark

Textbook (required):
Qian, Song S. (2017). Environmental and Ecological Statistics with R. 2nd edition. CRC Press, ISBN: 978-1-4987-2872-0.

Reference (recommended):
James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. (2013). An Introduction to Statistical Learning, with Applications in R. Springer, ISBN: 978-1-4614-7137-0.
McCuen, Richard H. (2003). Modeling Hydrologic Change: Statistical Methods. CRC Press, ISBN: 1-56670-600-9.

Course website: https://compass2g.illinois.edu

This course will cover stochastic and statistical methods of characterizing, analyzing, and modeling water resources. Students will be introduced to statistical and related software packages (e.g., R, ArcGIS) and innovative stochastic approaches unique to water resources via recently published peer-reviewed literature.

Course activities include lecture, homework, presentation and discussion of journal papers, a midterm exam, and an individual project with oral presentation.

Prerequisites: CEE 450 and an introductory course in statistics (e.g., CEE 202).

COURSE POLICIES

Academic integrity: Each student is expected to complete his/her own work. Cheating, plagiarism, and/or copyright infringement of any kind will not be tolerated and will be reported to the appropriate administration. In the event of academic dishonesty, suspension or dismissal from the University may occur. For more information, see the University's statement on Academic Integrity and Procedure at http://admin.illinois.edu/policy/code/article1_part4_1-402.html.

Disability accommodations: To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, visit 1207 S. Oak St., Champaign, call 217-333-4603 (V/TTY), or email disability@illinois.edu.

Attendance and participation: Class attendance and participation in discussion are required and constitute a portion of the overall grade.

Late assignments and make-up exams: Late assignments will be accepted up to 24 hours after the due date for a 10% grading penalty. For example, if an assignment is due at 8:00 AM and is submitted at 11:00 AM (3 hours late), the original (hypothetical) grade of 83% will be recorded as 73%. Assignments submitted more than 24 hours late will be given a zero. Make-up exams are not allowed, except under extreme circumstances approved by the instructor in advance.

IMPORTANT DATES*

*Confirm online.

Sept 11	Add course deadline
Oct 5	Project proposal due, 8:00 AM via email as PDF
Oct 19	Midterm exam (take-home; due Oct 24)
Oct 20	Drop course deadline via Student Self-Service
Nov 2	Project status update due, 8:00 AM via email as PDF
Nov 17	Drop course deadline without grade of W; credit/no credit deadline
Nov 18-26	Fall break
Dec 15	Final paper due, 5:00 PM via email as PDF

ASSIGNMENTS

Individual project

The main assignment of this course is an individual project, including an 8,500-word written paper and 15-minute oral presentation. Use the *Environmental Science & Technology* Author Guide to determine the word-equivalents for tables and figures: http://pubs.acs.org/paragonplus/submission/esthag/esthag_authguide.pdf. The project

should be an original analysis applying one or more statistical methods to a water-related topic.

A 1-page project proposal is due at 8:00 AM on October 5, and should be *submitted to the instructor via email as a PDF document*. The proposal should include a brief synopsis and scope of the proposed project, an outline of the methodological approach, and pertinent data sets to complete the analysis.

A 3-page project status update is due at 8:00 AM on November 2, and should be *submitted to the instructor via email as a PDF document*. The status update should include a summary of progress, pertinent tables/figures, and remaining tasks for project completion.

The final paper, meeting the length requirements above, is due at 5:00 PM on December 15, and should be *submitted to the instructor via email as a PDF document*. Supporting information is allowed and will not count against the word limit. Oral presentations (of no more than 15 minutes) will be scheduled during the last full week of class (December 5 and 7).

Journal paper presentation/mini-lecture

Beginning September 12, each student will give a 15-minute mini-lecture to the class on a journal paper (either one of the week's assigned journal papers or another relevant paper). Instructor approval is required to avoid duplicate presentations. The purpose of these presentations is 1) read and understand dense scientific material, 2) gain teaching experience in a classroom setting, and 3) recognize the on-going academic research related to course topics. The assigned journal papers for the week are required reading for everyone.

For the presentation, no more than 2 PowerPoint slides of pertinent figures or tables are allowed. A vast majority of the presentation should take place at the chalkboard, walking the class through the mathematical details of the journal paper methods.

Homework

Homework assignments will take place throughout the semester to reinforce the technical and mathematical concepts from class. Students may work in groups or individually; however, *each student must turn in his/her own individual work*. Copying or other academic integrity violations will not be tolerated and will result in a zero. Homework is due at the beginning of class – assignments turned in after the start of class are considered late and subject to a 10% penalty described previously.

Midterm exam

The midterm exam will be a take-home exam, issued on Thursday, October 19, at 8:00 AM, and due on Tuesday, October 24, at 8:00 AM. Topics covered by the exam will be described in class.

GRADING

Attendance and participation*	5%
Journal paper presentation	15%
Homework	15%
Midterm exam	25%
Project paper	25%
Project oral presentation	15%
	100%

*More than 2 absences will reduce the attendance grade.

Letter grades will be assigned using a plus/minus system, as below:

A	93.0-100.0%
A-	90.0-92.9%
B+	87.0-89.9%
B	83.0-86.9%
B-	80.0-82.9%
C+	77.0-79.9%
C	73.0-76.9%
C-	70.0-72.9%
D+	67.0-69.9%
D	63.0-66.9%
D-	60.0-62.9%
F	59.9% and below

LEARNING RESOURCES

Journal papers

Resources for the journal paper presentation (and others for reference) will be available on the class Compass 2g site, and will include the following:

- Ameli, Nadia, and Nicola Brandt. (2015). “Determinants of households’ investment in energy efficiency and renewables: evidence from the OECD survey on household environmental behaviour and attitudes.” *Environmental Research Letters*. 10(4), 044015.
- Borgomeo, Edoardo, Jim W. Hall, Fai Fung, Glenn Watts, Keith Colquhoun, and Chris Lambert. (2014). “Risk-based water resources planning: Incorporating probabilistic nonstationary climate uncertainties.” *Water Resources Research*. 50(8), 6850-6873.
- Borgomeo, Edoardo, Christopher L. Farmer, and Jim W. Hall. (2015). “Numerical rivers: A synthetic streamflow generator for water resources vulnerability assessments.” *Water Resources Research*. 51(7), 5382-5405.
- Caldwell, Jason, Balaji Rajagopalan, and Eric Danner. (2015). “Statistical Modeling of Daily Water Temperature Attributes on the Sacramento River.” *Journal of Hydrologic Engineering*. 20(5), 04014065.

- Maggioni, Elena. (2015). "Water demand management in times of drought: What matters for water conservation." *Water Resources Research*. 51(1), 125-139.
- Mazdiyasni, Omid, and Amir AghaKouchak. (2015). "Substantial increase in concurrent droughts and heatwaves in the United States." *Proceedings of the National Academy of Sciences of the United States of America*. 112(37), 11484-11489.
- Petersen, John E., Cynthia M. Frantz, Md. Rumi Shammin, Tess M. Yanisch, Evan Tincknell, and Noel Myers. (2015). "Electricity and Water Conservation on College and University Campuses in Response to National Competitions among Dormitories: Quantifying Relationships between Behavior, Conservation Strategies and Psychological Metrics." *PLoS ONE*. 10(12), e0144070.
- Read, Laura K., and Richard M. Vogel. (2015). "Reliability, return period, and risk under nonstationarity." *Water Resources Research*. 51(8), 6381-6398.
- Svensson, Cecilia, Jamie Hannaford, and Ilaria Prosdocimi. (2017). "Statistical distributions for monthly aggregations of precipitation and streamflow in drought indicator applications." *Water Resources Research*. 53(2), 999-1018.
- Tonidandel, Scott, and James M. LeBreton. (2011). "Relative Importance Analysis: A Useful Supplement to Regression Analysis." *Journal of Business and Psychology*. 26(1), 1-9.
- Vertommen, Ina, Roberto Magini, and Maria de Conceição Cunha. (2015). "Scaling Water Consumption Statistics." *Journal of Water Resources Planning and Management*. 141(5), 04014072.
- Weingarten, M., S. Ge, J. W. Godt, B. A. Bekins, and J. L. Rubinstein. (2015). "High-rate injection is associated with the increase in U.S. mid-continent seismicity." *Science*. 348(6241), 1336-1340.

Recommended for further reading (not required for course)

- Barnett, Vic. (2004). Environmental Statistics: Methods and Applications. John Wiley & Sons, Ltd, ISBN: 0-471-48971-9.
- Helsel, D.R. and R.M. Hirsch. (2002). Statistical Methods in Water Resources. Techniques of Water-Resources Investigations of the United States Geological Survey, http://pubs.usgs.gov/twri/twri4a3/pdf/twri4a3-new.pdf.

PROPOSED SCHEDULE*

*Changes and updates are likely.

Date(s)	Topic	Journal Reading(s)	Textbook Reference
Aug 29, 31	Introduction & Data Visualization • Statistical tools for summarizing • Accurate and precise communication • Introduction to hydrologic statistics		Qian: 1.1-2.4
Sept 5, 7	Statistical Basics • Introduction to R • Probability distributions • Statistical assumptions		Qian: 3.1-3.5
Sept 12, 14	Statistical Inference: Hypothesis Testing • Testing, confidence intervals • Significance	Vertommen et al. (2015)	Qian: 4.1-4.6
Sept 19, 21	Statistical Inference: Analysis of Variance • One-way ANOVA • Comparisons and uncertainty	Borgomeo et al. (2014)	Qian: 4.7-4.8
Sept 26, 28	Frequency Analysis • Population, sample, return period • Population models • Flood records and urbanization	Read & Vogel (2015)	McCuen: 5.1-5.4
Oct 3, 5	Linear Models • Simple and multiple linear regression models • Goodness of fit statistics • Heteroskedasticity, autocorrelation, analysis of residuals	Maggioni (2015); Ameli & Brandt (2015)	Qian: 5.1-5.6
Oct 5	**Project proposal due 8:00 AM**		
Oct 10, 12	Relative Importance Analysis • Weighting factors • Level of importance	Tonidandel & LeBreton (2011)	
Oct 17, 19	Nonlinear Models • Model fit in R • Nonlinear regression • Smoothing	Caldwell et al. (2015)	Qian: 6.1-6.3
Oct 19	**Midterm exam (take-home); due Oct 24, 8:00 AM**		
Oct 24, 26	Generalized Linear Models • Logistic regression • Poisson regression • Multinomial regression	Petersen et al. (2015)	Qian: 8.1-8.7
Oct 31	CUAHSI remote lecture		
Nov 2	Outliers and Extreme Values • Order-based inference • Methods and tests • Correcting for outliers	Mazdiyasni & AghaKouchak (2015)	McCuen: 4.1-4.6, 9.1-9.5
Nov 2	**Project status update due 8:00 AM**		
Nov 7, 9	Time Series Modeling • Trends, variations • Autocorrelation, cross-correlation analysis	Svensson et al. (2017)	McCuen: 2.1-2.7

Date(s)	Topic	Journal Reading(s)	Textbook Reference
Nov 14, 16	Time Series Modeling • Autoregressive-moving average model • Model formulation, calibration, verification, reliability	Borgomeo et al. (2015)	McCuen: 10.1-10.6
Nov 21, 23	NO CLASS – FALL BREAK		
Nov 28, 30	Spatial Statistics • Geographic information systems • Kriging	Weingarten et al. (2015)	
Dec 5, 7	Project oral presentations		
Dec 15	**Project paper due 5:00 PM**		