CEE 4211 Syllabus

Water Resources Systems

Fall 2026

Instructor Information

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General Course Information

Description

This course (i) describes the purpose and challenges of water resources planning and management in the face of climatic, environmental, and socio-economic change; (ii) highlights an effective planning and management framework via participatory stakeholder processes; and (iii) emphasizes the key role of data, models, and quantitative analysis in creating the credible information necessary for robust decision making.

Course Learning Outcomes

This course is designed to provide students with (i) knowledge of the theory and practice of water resources planning and management; (ii) appreciation of and confidence for effective participation in cooperative team-work for comprehensive analysis of issues; and (iii) technical, organizational, and communication skills necessary to conceptualize plans, develop, and use data and modeling tools to analyze issues, evaluate alternative solutions, and communicate findings and recommendations to decision makers.

Required Course Materials

Primary Text: *Integrated Water Resources Systems Planning and Management* (2020-2026). Class notes by A. Georgakakos, Georgia Water Resources Institute, Georgia Tech. Notes to be provided at no cost.

Other References: (a) *Water Resources Systems Planning and Management, An Introduction to Methods, Models, and Applications* (2005). D.P. Loucks and E. van Beek. UNESCO Publishing. (Electronic version available free at http://ecommons.library.cornell.edu/handle/1813/2804)

(b) Water Resource Systems Planning and Analysis (1981). D.P. Loucks, J.R. Stedinger, and A. Haith, Prentice Hall.

References (a) and (b) are optional.

Grading Policy:

The course includes homework assignments and a comprehensive project. Grades will be determined based on active class participation (10%) and performance on homework assignments (40%) and project (50%). Additional details are provided next:

Assignments

- Homework assignment 1 requires that students research, describe, and critique the natural resources, socio-economic services, and water use stresses/conflicts of a river basin of their choice. This assignment requires teamwork in teams of three-four students.
- Homework assignments 2 and 3 require the development of modeling tools and their application on realistic water resources management problems.
- The comprehensive project assignment is motivated by real-world water resources problems and is to be completed by each student *individually*.

Description of Graded Components

- Homework assignment 1 requires teamwork by teams of three or four students. Students are asked to form their teams and announce their team membership and river basin selection to the course instructor in the first week of the semester. This assignment involves critical research (with a specific scope for each team member) to be summarized in a technical report and presented to the class. Each team member will be responsible for a particular component of the research, a particular section of the technical report, and a particular presentation segment. The team members will work together to co-author the team report describing the approach, research findings, and recommendations. Grading of this assignment will be based on report quality, completeness and coherence of contents, presentation clarity, and the degree to which the findings and recommendations reflect effective team collaboration and holistic thinking.
- Homework assignments 2 and 3 require that students work *individually*. Conceptual discussions among students are allowed but sharing of spreadsheets, computer codes, or other computational tools is not. Students are required to submit a self-explanatory technical report describing their approach, results, and findings, as well as a copy of the computational tools developed for the assignments.

- The comprehensive project will be a take-home assignment to be worked on by each student *individually*. Students are expected to (a) submit detailed technical reports describing their research activities, methods used, information sources, results, interpretation of findings, and recommendations and (b) develop 20-minute virtual presentations of their work. Grading will be based on the correctness of the approach, adequacy of the work performed, thoroughness and validity of the findings, and communication ability (written and oral) to present the work effort and findings in a clear, informative, and engaging fashion.

Course Policies

Attendance and/or Participation

The course lectures include frequent question-discussion-answer segments as a means of reinforcing and expanding student learning, but also as a means of monitoring the internalization efficiency of the instructional material. Regular class attendance is expected, except for planned or emergency absences as outlined in the GT catalog (https://catalog.gatech.edu/rules/4/) and handled as in the stated rules thereof. Active class participation is highly encouraged and graded by how often students engage in/add to class discussions in non-trivial and perceptive ways.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Students are expected to adhere to the Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail the course instructor as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The

Student-Faculty Expectations articulate some basic expectations that students can have of the course instructor and vice-versa. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, students are encouraged to remain committed to the ideals of Georgia Tech while in this class.

Pre- &/or Co-Requisites

This course is suitable for senior undergraduates as well as graduates at the Master's level. Background in hydrology (CEE 4210), probability and statistics (CEE 3770), and computing (CS 1371) is recommended but not strictly required. Students should discuss their working knowledge of these subjects with the instructor to ensure they have the necessary background and skills to succeed in the course. Homework assignments and projects involve computations, and experience with programming tools such as EXCELL, programming languages, and/or MATLAB is helpful.

Collaboration, Group Work, and Use of Generative AI

Students are expected to adhere to the following course policies regarding collaboration and the use of AI tools.

(i) Productive discussions between students on homework assignments are encouraged; however, students must develop and report their own, original work, clearly demonstrating their assignment understanding and solution effort. The rationale and computational process for all findings and solutions must be clearly stated. The submission of only numerical values and tables without clear explanation of how they are derived is unacceptable. Also unacceptable is the submission of just programming codes without reporting and discussing their results. Duplicating another student's work, splitting/sharing assignment tasks with other students, or outsourcing any part of an assignment represents a violation of the Georgia Tech Academic Honor Code.

(ii) Collaboration in the form of sharing spreadsheets and/or computational codes is not permitted on homework assignments and projects, nor is help from students who have already taken the course or any other individual.

(iii) Use of course materials from past semesters, such as homework solutions and associated computational tools (e.g., spreadsheets and programming codes) is not permitted.

(iv) All work submitted must be written exclusively by each student and reflect their own conceptual rationale and internalized understanding. The use of AI tools to *conceptualize* the approach taken on homework assignments and projects will be considered academic misconduct. AI tools *can* be used for compiling supporting information (from literature sources) on specific aspects of the course assignments as well as for polishing and improving report language (e.g., improving spelling, grammar, and writing style). The scope and extent of AI usage, if any, must be clearly stated in all assignment submissions.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams

Students must strive to submit homework assignments and projects within the allotted time, as unjustified late submissions have grading consequences. If there exist valid reasons for late submissions, students must inform the instructor and request authorization *prior* to the assignment due date. Authorization of late submissions will be evaluated on a case-by-case basis.

Student Use of Mobile Devices in the Classroom

In-class use of mobile devices (e.g., laptops, mobile phones, and tablets) is permitted only for note-taking or other course-related purposes, provided it does not distract other students or the lecturing process.

Campus Resources for Students

Student Well-Being

At Georgia Tech, we are concerned about our students' overall physical, social, and mental well-being. A comprehensive list of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being (student-resource-guide (gatech.edu))

Lecture Topics

- Lectures 1 & 2: Overview of Water Resources Systems, Need for Integrated Planning and Management
  Water resources systems elements, interactions, and services; regulatory environment; main challenges, and need for integrated planning and management. Highlights of real-life case studies from the U.S., Africa, Asia, Middle East, and Europe.
  - *Homework 1:* River basin under stress (team assignment)
  - *Student self-assessment:* Computational refresher (individual assignment)
- Lectures 3–4: Integrated Water Res. Planning/Management (IWRP/M) Framework
  Goals of planning and management processes; river basin natural resources and interactions (rivers, reservoirs, lakes, groundwater aquifers, wetlands, estuaries); primary and secondary stakeholders and interests; socio-economic sectors and services; available data and information; modelling needs and purpose.
- Lectures 5–8: Stakeholder Planning and Management Processes
  Developing a sustainable river basin planning and management plan through participatory stakeholder decision processes; inception phase, development phase, implementation

phase; stakeholder engagement; critical role of credible data and models; role of technical experts; building consensus for science-based decisions and policies.

- Lectures 9-10: Class Teamwork Assignment Presentations—River Basins under Stress.
  Team presentations of Homework 1; discussions; review and comments by classmates, invited guests, and instructors.
  - *Homework 2:* River basin model development (individual assignment)
- Lectures 11-15: River Basin Models and Performance Measures
  Developing representative models of river basin water resources, uses, and stakeholder interests; developing stakeholder-relevant performance criteria and metrics; formulating alternative management options and scenarios.
  - *Homework 3:* Multi-objective tradeoffs (individual assignment)
- Lectures 16-20: Evaluation of Management Scenarios under the Historical Climate
  Simulation of river basin response to alternative water management scenarios and demand projections; identification of water supply-demand gaps; performance evaluation; derivation of multi-objective tradeoffs; risk and resilience. Case studies.

Semester Break

- Lectures 21-22: Climate and Hydrologic Change
  The climate system, Earth's radiative budget, drivers of climate change (greenhouse gas emissions); climate feedbacks and tipping points; General circulation models (GCMs), greenhouse gas emission scenarios, and future climate projections. Need for bias correction and spatial downscaling of GCM projections, GCM databases, IPCC. Climate change impacts on the water cycle—rainfall, evaporation, soil moisture, groundwater aquifer recharge, streamflow. Real life case studies.
  - *Comprehensive Project:* Assessing river basin impacts under climate and socio-economic change and adaptation strategies.
- Lectures 23-25: Water Resources Impacts of Climate and Hydrologic Change
  Pathways of hydro-climatic change impacts on water resources. Impacts due to changing water supplies; impacts due to changing water, energy, and environmental demands. Real-world case studies.
- Lectures 26-28: Water Resources Adaptation to Climate and Socio-economic Change
  IWRP/M assessments under future climate and socio-economic scenarios. Formulation of water development and/or management alternatives to address potential gaps between future supplies and demands. Scenario assessments, characterization of sectoral and regional risk-based tradeoffs, stakeholder consensus building, shared vision adaptation strategies. Examples of best practices in shared vision planning and management.
- Lectures 29-31: Introduction to Water Resources Optimization Methods

Relative strengths, weaknesses, and complementarities of optimization versus simulation approaches to water resources management. Typology of water resources problems and applicable optimization methods. Features of problems that can be solved through Linear Programming, Dynamic Programming, and Stochastic Optimization methods. Decision Support Systems (DSS). Real life examples where optimization methods are naturally applicable.