The Ripple Effect: Climate Change and the Future of Water

- short, credit bearing course -

General information
Number of ECTS: 2
Language: English
Modality: Online sessions
Proposed period: Winter Semester 2027 (October 6-8 2027)
Duration: 3 days online sessions (lectures and final test)
Target groups: undergraduate, master and PhD students
Number of Participants: 40 online
Prerequisites: motivation letter

Lecturers: **Dr Dragana Tomašević Pilipović**, Full Professor, Faculty of Sciences University of Novi Sad
Dr Milena Bečelić-Tomin, Full Professor, Faculty of Sciences University of Novi Sad
PhD Laura Valenzuela Ávila, University of Alcalá, Spain

Course Description:

This course explores the complex interactions between climate change and water systems, combining scientific understanding with practical problem-solving approaches. Participants will study river flows, groundwater, floods, and droughts, while examining the impact of climatic extremes such as storms, and prolonged dry periods. The course emphasizes sustainable water resource management in the context of climate change, analyzing policies at local, national, and EU levels, including the EU Water Framework Directive and adaptation strategies. Through case studies, students will engage with urban water planning, resource-scarce communities, and the transition from reactive to preventive management practices. The course employs an interdisciplinary, interactive, and student-centered approach to prepare participants for addressing real-world challenges in water management under changing climatic conditions.

Course Aims:

The Ripple Effect: Climate Change and the Future of Water aims to provide students with a comprehensive understanding of how climate change affects global and regional water systems and to develop the capacity to design sustainable solutions for water management. The course explores the intersection of climate science, water pollution, and environmental policy, emphasizing the role of water as a critical resource for health, ecosystems, and socio-economic stability.

Students will examine the hydrological cycle in the context of climate variability, focusing on river dynamics, groundwater systems, floods, droughts, and the increasing frequency of extreme weather events.

By integrating scientific knowledge with governance and policy frameworks, the course seeks to build competencies in sustainable water resource management under changing climatic conditions. Particular attention is given to EU policies and strategies, to understand how transnational cooperation shapes water governance. Students will engage with case studies addressing urban water planning, management in resource-scarce communities, and the transition from reactive to preventive approaches in water policy and planning.

Through interactive learning methods, and collaborative problem-solving exercises, participants will develop critical thinking and interdisciplinary skills applicable to real-world environmental challenges. The course emphasizes the importance of equitable access to water, resilience-building, and policy innovation, preparing students to contribute to sustainable water management strategies that support both global health and climate resilience.

Key Topics:

- Hydrological cycle: river systems, groundwater, floods, and droughts.
- Water pollution
- Climate extremes and their impact on water resources.
- Water resource management in the context of climate change.
- Policies and governance frameworks
- Urban water planning and sustainable infrastructure.
- Managing water in resource-limited and vulnerable communities.
- Transition from reactive to preventive water management.
- Water, health, and sustainability in the era of global climate challenges.

Learning Outcomes

Upon successful completion of the course, students will be able to:

- Explain and demonstrate understanding of the fundamental principles of hydrological cycle, including river flows, groundwater systems, floods, and droughts, and describe how these processes are affected by climate variability and change.
- Apply scientific and analytical methods to assess the impacts of climatic extremes-such as storms, and prolonged droughts-on water availability, quality, and ecosystem health.
- Analyze different approaches to sustainable water resource management, identifying effective strategies for balancing environmental and social priorities in changing climatic conditions.
- Evaluate key water governance and policy frameworks, including the EU Water Framework Directive, national adaptation strategies, and international environmental agreements, in terms of their effectiveness and implementation challenges.
- Design innovative and context-sensitive solutions for urban water planning and management in resource-limited or climate-vulnerable communities, emphasizing preventive and adaptive measures.

- Integrate scientific, policy, and ethical perspectives to assess the interconnections between water management, global health, and sustainable development, recognizing water as a determinant of public health and social equity.
- Collaborate effectively in interdisciplinary and multicultural teams to develop and present evidence-based proposals addressing real-world water and climate challenges.

Teaching Methods

The course applies a combination of interactive, student-centered, and inclusive teaching methods to engage participants with both theoretical and practical aspects of climate and water management.

Interactive lectures introduce key scientific and policy concepts, complemented by **case studies** and **problem-based learning** to connect theory with real-world water and climate challenges. **Group work** encourages interdisciplinary collaboration, allowing students from diverse backgrounds to jointly analyze case studies, develop management strategies, and present collective solutions.

Practical exercises and simulations provide hands-on experience with decision-making processes related to water governance, climate adaptation, and sustainability planning. Structured **discussions and debates** foster critical thinking and communication skills by exploring multiple perspectives on complex environmental and social issues.

Throughout the course, **reflective and inclusive learning practices** ensure that all participants can actively contribute, with flexible formats and feedback opportunities that accommodate different learning styles. The **capstone project** integrates acquired knowledge and skills, culminating in the design and presentation of a sustainable water management proposal.

Course content

Session 1: **Climate Change and Hydrological Systems**

- *Introduction to Hydrology, Pollution, and Climate Impacts*

Lecture: Overview of key hydrological processes — including river flows, pollution, groundwater systems, floods, and droughts — and how these are influenced by climate change.

Interactive Exercise: Students work in small groups to map the water cycle across different climatic regions and identify the potential impacts of extreme weather events. Each group presents findings and discusses implications for water availability and ecosystem health.

- *Impact of Climatic Extremes on Water Resources*

Lecture: Analysis of the effects of recent floods, droughts, or storms on local communities, agriculture, and urban infrastructure.

Group Discussion: Students evaluate strategies used to mitigate damage and enhance resilience, highlighting differences in responses across regions and socio-economic contexts.

- *Risk Assessment and Vulnerability Analysis*

Lecture: Overview of methodologies for assessing water-related risks in selected areas.

Group Debate: How should communities prioritize resources between reactive emergency responses and long-term preventive planning?

Session 2: **Water Resource Management and Governance**

- *Sustainable Water Resource Management*

Lecture: Principles of integrated water resource management, focusing on balancing environmental, social, and economic needs.

Interactive Exercise: Students analyze a river basin or urban water system to identify pressures on water resources and propose management interventions.

- *Policy and Governance Frameworks*

Case Study: Examination of the EU Water Framework Directive and related Directives, national adaptation plans, and local water governance policies.

Group Discussion: Evaluate the effectiveness of policy measures and the challenges of implementation in urban versus rural settings.

- *Water, Health, and Social Equity*

Practical Task: Assess how access to water affects public health and vulnerable populations.

Group Exercise: Design strategies to improve equitable access to water while promoting sustainability and resilience.

Session 3: **Applied Solutions and Future Planning**

- *Urban Water Planning and Climate Adaptation*

Lecture: Best practices for urban water management, infrastructure resilience, and preventive measures against floods and droughts.

Interactive Exercise: Students develop a mini-plan for a city to adapt to projected climate impacts on water supply.

- *Light-Assisted Advanced Oxidation Processes for Sustainable Water Treatment in a Changing Climate*

Lecture / Guest Lecture: Introduction to photocatalytic and light-assisted oxidation processes (e.g., TiO_2 photocatalysis, UV/H_2O_2 systems) and their role in removing contaminants under climate stress.

Case Study or Demo: Examples of pilot projects or lab-scale systems using sunlight or artificial UV for sustainable purification.

Group Activity: Students evaluate environmental, economic, and scalability aspects of such technologies in urban vs. rural or developed vs. developing regions.

- *Designing Preventive and Innovative Solutions*

Practical Task: Teams develop a water management proposal incorporating preventive measures, policy compliance, and sustainability principles.

Presentation: Groups present their proposals for peer and professor feedback, simulating stakeholder engagement.

Literature

1. Caretta, M. A., Mukherji, A., Arfanuzzaman, M., Betts, R. A., Gelfan, Y., Hirabayashi, Y., Lissner, T. K., Liu, J., Lopez Gunn, E., Morgan, R., Mwanga, S., & Supratid, S. (2022). Water. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 551–712). Cambridge University Press. https://doi.org/10.1017/9781009325844.006
2. Douville, H., Raghavan, K., Renwick, J., Allan, R. P., Arias, P. A., Barlow, M., Cerezo-Mota, R., Cherchi, A., Gan, T. Y., Gergis, J., Jiang, D., Khan, A., Pokam Mba, W., Rosenfeld, D., Tierney, J., & Zolina, O. (2021). Water cycle changes. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou (Eds.), *Climate change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1055–1210). Cambridge University Press. https://doi.org/10.1017/9781009157896.010
3. van Vliet, M. T. H., Thorslund, J., Strokal, M., Hofstra, N., Flörke, M., Ehalt Macedo, H., Nkwasa, A., Tang, T., Kaushal, S. S., Kumar, R., van Griensven, A., Bouwman, L., & Mosley, L. M. (2023). Global river water quality under climate change and hydroclimatic extremes. *Nature Reviews Earth & Environment, 4*, 687–702. https://doi.org/10.1038/s43017-023-00472-3
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5. United Nations. (2015). *Sendai framework for disaster risk reduction 2015–2030* (Resolution A/RES/69/283). United Nations General Assembly. https://digitallibrary.un.org/record/795443

Course Design and Assessment Criteria

1. **Tests (40%)**
    - **Multiple-Choice Test (20%)**

        - Administered after Session 1; covers key concepts related to climate change, water resources, and environmental policy.
        - Topics include climate science fundamentals, the hydrological cycle, pollution impacts, and international water governance frameworks.
        - *Objective:* Assess students' understanding of core scientific concepts and sustainability principles.
    - **Short Answer/Essay Test (20%)**
        - Conducted after Session 3; focuses on applying critical thinking to real-world challenges.
        - Questions address course case studies such as impacts of climate change on water availability, policy responses, and community adaptation strategies.
        - *Objective:* Evaluate the ability to synthesize knowledge and propose solutions for sustainable water management.
2. **Active Participation (40%)**
    - **Group Exercises and Case Studies (40%)**
        - Students collaborate to analyze water-related challenges, assess trade-offs, and develop policy recommendations.
        - Participation is assessed based on contribution, analytical rigor, and teamwork.
3. **Final Project (20%)**
    - **Capstone Project (20%)**
        - Teams design a comprehensive water management strategy for a hypothetical region or organization.
        - The project should address climate resilience, sustainability, social inclusion, and policy compliance.
        - *Deliverables:* Written report and oral presentation.
        - *Assessment Focus:* Practical application of knowledge, strategic thinking, and feasibility of proposed solutions.

Grades and Marking Scale

- **Fail (0–49%)**
  The student did not demonstrate sufficient understanding of climate change and water management concepts or did not actively participate in group exercises. Students must retake assessments or complete additional tasks to pass.
- **Pass (50% and above)**
  The student demonstrates satisfactory understanding of course material and actively engages in discussions and projects. Feedback will be provided to support further improvement.

Overall Assessment Criteria

- Understanding of Key Concepts — demonstrated through tests and class participation.
- Engagement and Collaboration — evaluated via group exercises, workshops, and presentations.
- Application of Knowledge — assessed through the final project, reflecting the ability to design practical strategies for water management under climate change.

Lecturers:

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