Syllabus

Course Title

Economics of Climate Change: Case Studies and Best Practices in the Water Sector

General Information

General description of the required education/training, outlining the main objectives and explaining the necessity of the education/training at the organizational/country/regional level

The impact of global climate change on the water resources sector is manifested as follows: the water availability of rivers and the capacity of groundwater aquifers are changing, the frequency and intensity of hazardous hydrometeorological phenomena (floods, high-water events, droughts) are increasing, the availability of water for the country's economic complex during low-water periods and years is decreasing, etc. These changes cause economic problems in the water sector and related industries. In southern Ukraine, a deficit of water resources, the drying up of small and medium-sized rivers, the shallowing and salinization of estuaries, deterioration of the quality of surface and groundwater, and limited access to clean drinking water are projected. During the study of the discipline, methods and methodologies that were developed at the Faculty of Hydrometeorology and Ecology of Odesa I. I. Mechnikov National University (ONU) and subsequently used to solve economic and social problems of the water sector under conditions of climate change and significant water-management transformations in river basins will be presented. The main attention is paid to the North-Western Black Sea region.

The objectives include the following: assessment of changes in Ukraine's water resources at present and in the future under conditions of global warming, strengthening of the consequences of anthropogenic impact on river basins subject to water-management transformations, determination of the risks of depletion of water resources, establishment of the optimal scale of water-management transformations (irrigation, drainage, creation of artificial water bodies, restoration of the freshwater balance), prediction of possible water conflicts, and others.

Audience

The main target audience of the course and any secondary audience, if it may influence decisions regarding the structure or content of the course

Expected level of knowledge and skills of the main audience (current or minimally required), as well as other factors (for example, cultural characteristics, level of technical training, access to the Internet) that should be considered when planning the course, as they may affect the choice of teaching methods, materials, and approaches to interaction with the audience

Master's students studying, first of all, in the specialties E2 "Ecology", E4 "Earth Sciences", G2 "Environmental Protection Technologies", C6 "Geography and Regional Studies", as well as future specialists in climate-dependent sectors of the economy – G "Engineering, Manufacturing and Construction", H "Agriculture, Forestry, Fisheries and Veterinary Medicine", I "Healthcare and Social Protection".

Representatives of management personnel and teachers who are upgrading their qualifications on the topic of adaptation to climate change in various sectors of Ukraine's economy may also participate in the training.

Competencies

Training needs at the individual or organization/country/regional level, as well as a description of how these needs were identified and recognized as relevant.

Competencies targeted by the training.

- Be able to formulate a mathematical problem, process and systematize the initial information, perform an analysis of the results in accordance with existing mathematical models of runoff, and adapt them to possible anthropogenic changes in runoff formation conditions in the catchments of water bodies of various water-management purposes and changes in global and regional climate.
- Apply the results of regional modeling of climate change under certain scenarios to assess changes in water resources and their consequences in accordance with the proposed methods and methodologies.

Learning outcomes and performance criteria

Learning outcomes and performance criteria formulated with regard to the knowledge and skills to be acquired during the training process.

Learning outcomes for the educational component:

LO1. Explain that climate change affects not only the quantitative status of water resources, but also aquatic ecosystems as a whole, causing socio-economic problems in the water sector and related industries.

LO2. Discuss the impact of climate change on the quantitative and qualitative status of water resources, possible consequences for water supply and water consumption, agriculture, hydraulic engineering, fisheries, and navigation.

Effectiveness criteria:

Determine the possible consequences of changes in water resources as a result of climate change for the water sector and related industries (according to the results of mathematical model simulations under the respective scenarios).

Course Content

Provide a content outline that corresponds to the learning objectives and outcomes. This may be a course outline as it will be presented to students, but not necessarily a complete curriculum.
Include a general list of all topics that you consider necessary to cover. If you believe it would help clarify the scope, indicate what will NOT be covered.

MODULE 1. Water and environmental problems under climate change and their impact on the economy

1.1. Consequences of the impact of climate change on water resources and related economic sectors

1.2. Water scarcity and the level of water stress under climate change and war

1.3. Nutrient pollution, eutrophication, and their consequences

1.4. PRACTICAL WORK No. 1 Assessment of the impact of drainage reclamation on river runoff characteristics at the beginning of the 21st century (using the Zhytomyr Polissia region as an example)

1.5. PRACTICAL WORK No. 2 Changes in low-flow characteristics and environmental flows at the beginning of the 21st century under the influence of climate change

MODULE 2. Practices for solving hydro-ecological problems of the North-Western Black Sea region

2.1. Hydraulic engineering reclamation (irrigation, drainage, creation of artificial water bodies) under climate change

2.2. Hydro-ecological problems of the Kuyalnyk Estuary and ways to solve them

2.3. PRACTICAL WORK No. 4 Determination of the optimally permissible water surface areas of artificial water bodies in catchments under baseline and scenario conditions based on the climate–runoff model

2.4. PRACTICAL WORK No. 5 Determination of freshwater inflow from the rivers of the North-Western Black Sea region to estuaries, rivers, and the sea under baseline and scenario conditions based on the "climate–runoff" model

2.5. PRACTICAL WORK No. 6 Assessment of changes in the mineralization of the water of the Velykyi Kuyalnyk River depending on runoff characteristics under baseline and scenario conditions

Learning Solutions and Methods of Implementation

List the learning solutions (teaching methods) that will be used and explain why they were chosen. For example: classroom learning, online learning, blended learning, workplace learning, online resources for selfstudy, coaching or mentoring, etc.

To achieve the planned learning outcomes, the course will employ a comprehensive set of learning solutions that will ensure diversity in the educational process, flexibility in the format of knowledge acquisition, and a practical focus.

Selected learning solutions

1. **Classroom learning (in-person learning)**
   - **Reasons for selection:** creates opportunities for live interaction between the instructor and participants, promotes discussions, exchange of experience, and development of communication skills.
   - **Implementation:** lectures, seminars, group discussions.
2. Online learning
   - **Reasons for selection:** provides accessibility for participants regardless of their location and allows the use of interactive digital tools.
   - **Implementation:** synchronous sessions in the form of video conferences and asynchronous materials (lecture recordings, interactive tests).
3. **Blended learning**
   - **Reasons for selection:** combining in-person and online formats allows participants to benefit both from direct interaction and from convenient remote access to resources.

- Implementation: in-person training + online assignments for independent work.

4. **On-the-job training**
   - **Reasons for selection:** allows participants to immediately apply the acquired knowledge in a professional context and increases the practical value of the training.
   - **Implementation:** completion of practical assignments and projects in real-world conditions.
5. **Online resources for self-directed learning**
   - Reasons for selection: promote the development of self-organization skills and provide an individualized learning pace.
   - Implementation: platforms with electronic textbooks, video lectures, and interactive assignments.
6. **Coaching and mentoring**
   - **Reasons for selection**: support an individual approach, allow participants to receive feedback, and develop professional and personal competencies.
   - **Implementation:** individual consultations, mentoring by experts.

Justification for the choice

Combining the specified learning solutions will allow:

- to cover different learning styles and formats;
- to combine theory with practice;
- to ensure flexibility and accessibility of the educational process;
- to create conditions for the personal and professional development of participants.

Thus, combining classroom, online, and practice-oriented learning will ensure the most effective achievement of the planned learning outcomes.

Learning Strategies

Consider which learning strategies you will use. Provide justification for why you intend to apply them, including reasons why they will help participants achieve the planned learning outcomes.
Combine different learning strategies to create a diverse learning environment that accommodates different learning styles of participants. This will increase the effectiveness of learning and help achieve the planned learning outcomes. This section does not require a detailed description of specific activities.

During the implementation of the course, a combination of different learning strategies will be used, aimed at ensuring maximum effectiveness in mastering the material and achieving the planned learning outcomes. Taking into account the diversity of participants' learning styles (visual, auditory, kinesthetic, reflective), the selected approaches will ensure multifaceted interaction with the learning material.

Learning strategies used

1. **Active learning**
   Will ensure participants' engagement in the learning process through analysis, discussion, and practical application of knowledge. This approach will contribute to the development of critical thinking and a deeper understanding of the material..
2. **Group collaboration (collaborative learning)**
   Working in small groups will help participants develop teamwork, experience-sharing, and collective decision-making skills. This will increase learning effectiveness through different perspectives and peer learning.
3. **Problem-based learning (PBL)**
   Participants will solve practical tasks and analyze real-life cases. This will allow them to transfer the acquired knowledge into a professional context, contributing to the development of analytical, decision-making, and creative thinking skills.
4. **Reflective learning**
   Will provide time for self-analysis, self-assessment, and reflection on individual progress. This will help participants identify their strengths and areas for development, as well as increase their motivation for further learning.
5. **Multimodal approaches**
   The use of information and communication technologies (presentations, interactive platforms, visualizations, videos) will ensure a variety of ways of presenting the material and contribute to better retention of information.

Justification for the choice of strategies

Combining the above approaches will make it possible to create a balanced learning environment that:

- meets different learning styles;
- combines theory and practice;
- promotes the development of both individual and teamwork skills;
- develops competencies necessary for applying knowledge in real-world conditions.

Thus, the selected strategies will contribute to achieving the planned learning outcomes and increasing the effectiveness of the educational process.

Learning Activities

Describe the main learning activities that will be included, such as lectures, readings, case studies, discussions, exercises, practical assignments, simulations, role-playing games, etc.
Also describe the roles of instructors and students during these activities.

The course includes 36 contact academic hours – 24 hours of lectures and 12 hours of practical classes (40%), while 54 hours are allocated to students' independent work (60%). The course incorporates a variety of learning activities designed to integrate theoretical knowledge with practical skills. This will enable participants not only to acquire information but also to learn how to apply it in real-world contexts.

Main learning activities:

1. **Lectures**
   - **Objective:** to provide basic knowledge, key concepts, and theoretical foundations of the topic.
   - **Role of the instructor:** organizer and source of knowledge, explains the material and structures key ideas.
   - **Role of students:** active listeners who take notes and ask clarifying questions.
2. **Analysis of literature and recommended materials**
   - **Objective:** to deepen understanding of the topic and develop the ability to work with academic and professional sources.
   - **Role of the instructor:** provides a list of literature and methodological guidelines for independent study.
   - **Role of students:** read, take notes, and prepare key points for further discussion.
3. **Case studies (analysis of practical cases)**
   - **Objective:** to apply theoretical knowledge to specific situations and develop analytical and decision-making skills.
   - **Role of the instructor:** discussion moderator who presents the case and guides the discussion.
   - **Role of students:** analyze the situation, propose solutions, and justify their positions.
4. **Practical tasks and exercises**
   - **Objective:** to consolidate knowledge through the completion of specific tasks and develop practical skills.
   - **Role of the instructor:** explains instructions and provides feedback.
   - **Role of students:** complete individual or group assignments.

Summary

The combination of lectures, reading, case studies, discussions, and practical activities ensures a **balance between knowledge acquisition and skills development**, as well as promotes active student participation in the learning process.

- **Instructors** act not only as sources of knowledge but also as facilitators, mentors, and moderator.
- **Students** become active participants who take responsibility for their own learning and outcomes.

Assessment of Learning

Describe the assessment plan for participants before, during, and/or after the course, including tests, exercises, activities, and projects that will be assessed. Indicate whether self-assessment or peer assessment will be used.

During the learning process, various forms of assessment will be applied, which will enable comprehensive monitoring of participants' progress and ensure the achievement of the planned learning outcomes.

1. Surveys (short discussions with the instructor after lectures)

- **Objective:** to check understanding of key concepts and provide an opportunity to clarify unclear points.
- **Link to learning outcomes:** helps consolidate material immediately after its presentation and develops oral argumentation skills.

2. Self-assessment (mini-test after the first module)

- **Objective:** enables participants to independently determine their level of understanding and identify weak areas for further work.
- **Link to learning outcomes:** develops self-reflection skills and encourages revisiting and revising the material.

3. Formative assessment during the course (practical exercises with instructor feedback)

- **Objective:** to monitor progress and the ability to apply knowledge in practice.
- **Link to learning outcomes:** gradually builds competencies and provides feedback for improvement.

4. Summative assessment after the course (final test after each module)

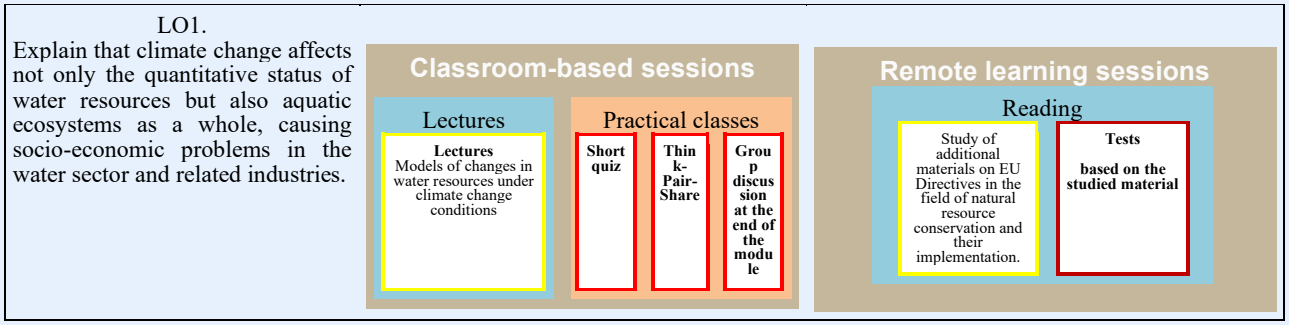
- **Objective:** to assess the level of acquisition of key knowledge and integrate the learned information.
- **Link to learning outcomes:** confirms that participants have achieved the required level of knowledge for progression or course completion.

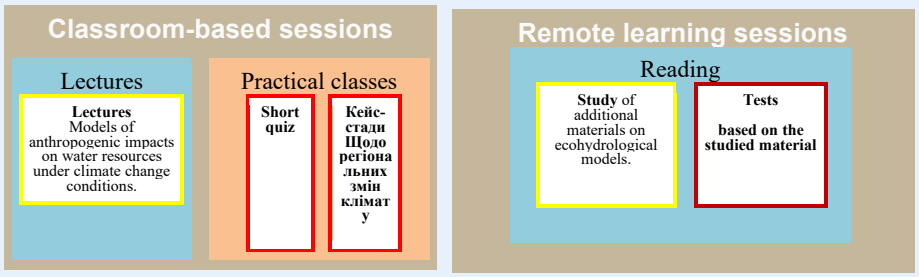
Thus, the combination of surveys, self-assessment, formative, and summative assessment allows to:

- ensure continuous monitoring of progress;
- provide participants with tools for self-development;
- guarantee that final outcomes correspond to the stated course objectives.

Storyboard of Learning (Learning Storyboard)

Use this to create a visual scenario of your blended learning activity



LO2. Discuss the impact of climate change on the quantitative and qualitative status of water resources, and the possible consequences for water supply and water consumption, agriculture, hydraulic engineering, fisheries, and navigation.	

Learning resources and tools

List the available resources that will be used for different types of learning activities and recommended to students.

Describe the technologies that will be used to implement learning solutions, including educational technologies and operational equipment (hardware, software, collaboration tools).

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9. Звіт про науково-дослідну роботу розроблення сценаріїв зміни кліматичних умов в Україні на середньо- та довгострокову перспективу з використанням даних глобальних та регіональних моделей, 2013. – 121 с.

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