Syllabus

Course Title

Mitigation and adaptation strategies to climate change in urban systems (MAS CM)

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

This course is aimed at developing a systemic understanding of climate challenges for urban systems and mastering practical tools for adaptation and the reduction of greenhouse gas emissions. The course examines both the impacts of climate change on the urban environment and ways to minimize them through the implementation of low-carbon solutions. It is designed to prepare specialists capable of integrating climate considerations into the strategic and spatial planning of urban and community development.

The aim of the course is to train professionals capable of integrating strategic mitigation solutions into the planning of urban infrastructure, energy systems, and municipal services. The need for such training is driven by the increasing risks of extreme weather events, heat waves, flooding, and other climate hazards that directly affect the safety and well-being of urban populations.

At the level of organizations, communities, and the state, the course will help ensure more efficient resource management, reduction of economic losses, and fulfillment of Ukraine's international commitments in the field of climate policy.

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

The main target audience of the course includes students of master's programs in the fields of ecology, environmental protection technologies, urban studies, urban management, energy, public administration, and governance. The course will also be useful for representatives of local government bodies, employees of municipal enterprises, and urban planning specialists.

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.

The course develops in participants competencies such as the ability to perform systemic analysis of climate processes, assess risks and vulnerability of urban infrastructure, and make managerial decisions in the field of climate change adaptation and mitigation, as well as the ability to work with information resources and analytical data.

Professional competencies include: analysis of climate risks in urban areas, assessment of the vulnerability of urban infrastructure to climate change, application of climate change adaptation tools, development of strategies to enhance the climate resilience of cities, and integration of climate aspects into urban planning and management.

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.

The learning outcomes foresee that participants will acquire up-to-date knowledge about climate risks, vulnerability, and the adaptive capacity of urban systems, as well as an understanding of the principles for integrating adaptation measures into local policy, spatial planning, and urban infrastructure management. They will be able to conduct comprehensive analyses of climate threats across different sectors (energy, transport, water resources, housing and utilities, public health), identify priority areas for intervention, and apply modern tools for vulnerability and risk assessment.
In addition, participants will gain a systemic understanding of greenhouse gas emission processes, their structure, and the role of different economic sectors in the global and national emissions balance. They will be able to explain the physical and economic foundations of low-carbon development, work with concepts such as CO_2 equivalent, global warming potential, and carbon footprint, and analyze major emission sources in urban systems.

Participants will acquire practical skills in greenhouse gas emissions assessment, including at the level of individual sectors or activity types, using simplified calculation approaches and statistical data. They will be able to compare different technological and managerial solutions in terms of their emission reduction effectiveness, particularly in energy, transport, industry, waste management, and land use.

Special attention is given to developing the ability to integrate adaptation and mitigation measures into a unified system of climate-oriented governance. Participants will learn to identify synergies and potential conflicts between adaptation and decarbonization (for example, between cooling energy demand and rising emissions), and to justify integrated solutions that simultaneously enhance resilience and reduce carbon footprints.

As a result of the course, participants will be able to develop proposals for adaptation and low-carbon solutions using both engineering and nature-based approaches, as well as economic and governance instruments. An important outcome will be the ability to prepare a basic integrated climate plan (or its components) for a city or territorial community, including both adaptation and

greenhouse gas mitigation measures, taking into account available resources, institutional constraints, and the political context.

The criteria for learning effectiveness are the participants' ability to:

- explain the key climate challenges for the urban environment in Ukraine and their impact on infrastructure functioning and population quality of life;
- analyze the structure and sources of greenhouse gas emissions at global, national, and local levels and interpret relevant statistical data;
- apply basic approaches to assessing carbon footprint and CO_2-equivalent emissions for individual sectors or projects;
- justify the selection of adaptation strategies for specific urban sectors, taking into account their vulnerability and priority level;
- compare and make reasoned choices of low-carbon technologies and solutions in energy, transport, industry, and other sectors;
- identify synergies and conflicts between adaptation and climate change mitigation measures and propose coherent integrated solutions;
- develop practical recommendations, analytical briefs, or mini-projects that combine adaptation and decarbonization measures;
- demonstrate skills in applying acquired knowledge using examples from real Ukrainian cities or territorial communities;
- justify policy and management decisions in climate policy, considering economic, social, and environmental factors.

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.

The course consists of two modules that address the two main aspects of responding to climate change—adaptation and mitigation.

Module 1. Adaptation Strategies

1. Climate challenges for the urban environment in Ukraine
   This topic covers climate threats to urban areas, the urban heat island phenomenon, the vulnerability of urban infrastructure (transport, energy, water supply and wastewater systems), and the social aspects of climate change impacts on different population groups within cities.
2. Tools and approaches to urban adaptation
   This topic examines nature-based solutions, engineering and technical measures, energy efficiency, and the role of spatial planning in urban adaptation.
3. Practice and policy of urban adaptation in Ukraine

This topic addresses strategies and approaches to urban adaptation at national, regional, and local levels, the development of local adaptation plans, financing instruments, and community participation in adaptation planning.

Module 2. Solutions Related to Greenhouse Gas Emission Reduction

1. Fundamentals of low-carbon development
   This topic covers the basic principles of low-carbon development as a key direction of modern climate policy. It introduces the main greenhouse gases, their physical nature, global warming potential, and methods for comparing emissions using CO_2 equivalents. Special attention is given to the concepts of carbon footprint and carbon intensity of energy as tools for assessing the climate impact of activities.
2. Low-carbon solutions in the energy sector
   This topic focuses on the energy sector as a major source of greenhouse gas emissions and explores ways to reduce them. It covers technological and managerial solutions, including renewable energy development, energy efficiency improvements, modernization of heat generation systems, and optimization of energy consumption. Approaches to assessing the carbon intensity of different fuels and electricity generation are also considered, as well as opportunities for decarbonizing urban energy systems considering technical and economic constraints.
3. Sources of greenhouse gas emissions and low-carbon solutions in urban systems
   This topic examines the main sources of greenhouse gas emissions in urban systems, including energy, transport, housing and utilities, waste, and land use. It analyzes the specific characteristics of emissions in urban environments and their contribution to the overall balance. Practical low-carbon solutions for cities are discussed, including sustainable transport development, energy-efficient buildings, waste management, and the implementation of nature-based approaches. Special attention is given to integrating these solutions into municipal planning and community development policies.

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 self-study, coaching or mentoring, etc.

The course is delivered in a distance learning format that uses modern digital educational technologies. This approach has been chosen in order to ensure flexibility of the learning process, enable participants to combine studies with professional activities, and effectively develop both theoretical knowledge and practical analytical competencies.

The course applies the following learning solutions:

- Video lectures, in which theoretical material is presented, basic concepts are introduced, and cause-and-effect relationships between climate processes, vulnerability, and greenhouse gas emissions are explained. This format allows for a systematic structuring of knowledge and provides a unified methodological framework for all participants.

- Online materials (textual and presentation-based), which enable learners to study at their own pace, revisit complex topics, and deepen their understanding. This tool is particularly important for adult learners and professionals who combine education with work.
- Practical assignments and analytical exercises, focused on applying acquired knowledge to real or near-real situations in urban systems. These include tasks related to climate risk assessment, greenhouse gas emissions analysis, or the selection of adaptation and low-carbon solutions. This format supports the development of applied competencies and decision-making skills.
- Independent study, which includes reviewing course materials, analyzing additional sources (reports, scientific articles, statistical data), and preparing individual or group assignments. Self-directed learning is a key element in developing critical thinking and independent analytical abilities.
- Webinars and online discussions, which ensure interactive communication between participants and instructors. These sessions are used to analyze case studies, discuss alternative approaches to problem-solving, and develop the ability to argue and defend one's position.
- Case-based learning, implemented through the analysis of Ukrainian and international city examples. This approach helps participants better understand practical aspects of adaptation and decarbonization while considering contextual differences between territories.
- Elements of project-based learning, which involve the development of mini-projects or analytical briefs (for example, components of adaptation plans or emission reduction measures for a specific community). This fosters the integration of knowledge from different course topics and develops strategic planning competencies.

The combination of these learning solutions creates a multidimensional educational environment that accommodates different learning styles, increases participant engagement, and ensures the achievement of the intended 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.

The course applies a combination of different learning strategies, which enables the creation of a holistic educational environment focused both on the acquisition of theoretical knowledge and on the development of practical skills and competencies required for work in the field of climate-oriented municipal governance. The selection of these strategies is driven by the interdisciplinary nature of the course, which integrates natural, technical, and managerial aspects, as well as the need to train participants to work with uncertainty, complex systems, and real-world data.
Lecture-based analytical learning is used to establish a fundamental theoretical basis, systematize knowledge, and explain complex interrelations between climate processes, urban system

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vulnerability, and greenhouse gas emissions. This approach ensures structured content delivery and provides a foundation for deeper subsequent analysis.

Problem-based learning (PBL) is aimed at developing the ability to address real-world challenges typical of urban systems under climate change. It enables participants to formulate problems, analyze their causes and consequences, and identify evidence-based solutions, which is critical for professionals involved in decision-making processes.

Project-based learning (PjBL) ensures the integration of knowledge from different course topics and develops practical strategic planning skills. Within this strategy, participants learn to design comprehensive solutions that combine adaptation and climate change mitigation measures, closely reflecting real professional tasks.

Case-based learning is used for the analysis of specific city and community examples, allowing participants to consider contextual factors, compare different approaches, and evaluate the effectiveness of implemented solutions. This facilitates the transfer of theoretical knowledge into practice and strengthens analytical thinking skills.

Discussion-based methods (debates, group discussions, and collaborative interaction) foster communication competencies, the ability to argue and justify one's position, and the capacity to consider multiple perspectives. These skills are particularly important for stakeholder engagement and decision-making in complex socio-economic contexts.

The combination of these strategies takes into account different learning styles (analytical, practical, reflective), increases learner engagement, and ensures the achievement of the intended learning outcomes. This approach also supports the development of not only knowledge but also professional competencies necessary for effective work in climate change adaptation and urban decarbonization.

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 main learning activities of the course are designed to ensure a combination of theoretical training with the practical application of knowledge, as well as active engagement of participants in analytical and discussion-based work. The diversity of learning formats allows the educational process to be adapted to different learning styles and promotes deeper understanding of the material.
The main learning activities include:

- Lectures with multimedia presentations, during which the theoretical foundations of the course are systematically presented, including climate risks, urban system vulnerability, and the principles of adaptation and decarbonization. The lectures are supported by visual

materials (diagrams, graphs, maps), which facilitate understanding of complex processes and interrelationships.

- Guided reading of academic and scientific materials, which involves independent or structured study of analytical reports, scientific publications, and policy documents in the field of climate policy. This helps develop information literacy and critical analysis skills.
- Case analysis of Ukrainian and international cities, where participants examine real examples of the implementation of adaptation and low-carbon solutions. This approach allows for the assessment of different strategies, consideration of local contexts, and transfer of knowledge into practical application.
- Work with open climate and statistical data, including the use of real datasets to assess climate risks, analyze greenhouse gas emissions, or determine the vulnerability of specific sectors. This develops applied analytical skills and data handling competencies.
- Practical tasks and analytical exercises, focused on solving specific problems related to risk assessment, selection of adaptation measures, or analysis of emission reduction options. These tasks simulate real professional situations and support decision-making skill development.
- Group discussions and debates, which allow participants to exchange ideas, justify their positions, and consider alternative approaches. This is particularly important for developing competencies in stakeholder engagement and interdisciplinary teamwork.
- Simulation and role-playing elements (where applicable), which model decision-making processes in climate policy at the community or city level. Participants may take on roles of different stakeholders (public authorities, business, civil society), which helps them better understand the complexity of governance processes.
- Preparation of analytical reports or mini-projects, which involve summarizing acquired knowledge and applying it to develop practical recommendations. These may include elements of adaptation plans or emission reduction measures for a specific territorial community.

The role of the instructor is not limited to knowledge transfer but also includes creating a learning environment that stimulates analytical thinking and active learner participation. The instructor acts as both an expert and facilitator: explaining theoretical concepts, structuring content, moderating discussions, guiding case work, and providing консультаційна підтримка during practical tasks and projects.

Participants, in turn, play an active role in the learning process. They participate in discussions, analyze data, work with information sources, complete individual and group assignments, formulate conclusions, and propose solutions. This approach fosters responsibility for one's own learning, develops critical thinking, and enhances the ability to apply knowledge in professional practice.

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. Explain how the assessment is linked to the learning outcomes.

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Assessment of learning outcomes is carried out in stages throughout the course and is aimed at assessing both theoretical knowledge and practical analytical skills of participants. It includes continuous assessment during the learning process and final assessment based on the completion of practical assignments.

Ongoing assessment is implemented through:

- testing on theoretical material, which allows verification of understanding of key concepts, processes, and approaches in the field of climate change adaptation and mitigation;
- completion of individual practical exercises and analytical tasks within the course topics.

The main component of assessment is the completion of practical assignments, which involve:

- data collection, processing, and interpretation;
- performing calculations (including estimates of greenhouse gas emissions or climate indicators);
- application of spatial analysis methods;
- use of multi-criteria and matrix evaluation approaches;
- development of elements of project proposals;
- justification of adaptation and low-carbon solution choices.

Final assessment is based on a comprehensive practical assignment or mini-project that integrates knowledge from both course modules and demonstrates the ability of participants to apply it in the context of a specific community or city.

Within the course, elements of self-assessment and peer assessment may be used, particularly during discussions of practical work results, which contributes to the development of critical thinking, reflection, and the ability to evaluate alternative approaches.

Assessment is directly linked to the learning outcomes, as all tasks are designed to evaluate participants' ability to analyze climate risks, assess greenhouse gas emissions, justify management decisions, and develop practical proposals to enhance climate resilience and reduce the carbon footprint of urban systems.

Storyboard of Learning (Learning Storyboard)

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

Learning in each module is organized as a sequence of activities and achieved outcomes:

- Theoretical introduction (lectures, videos)
- Analysis of examples and case studies
- Completion of practical assignments
- Discussion of results
- Final assessment.

Stage	Module 1	Module 2	Result
Introduction	Climate risks	Basics of emissions	Basic understanding
Analysis	Vulnerability	GHG sources	Analytical skills
Solution	Adaptation measures	Low-carbon solutions	Strategy selection
Practice	Risk assessment	Emission assessment	Applied skills
Assessment	Assignment + test	Assignment + test	Knowledge assessment

Learning Resources and Tools

To ensure high-quality learning and the development of practical skills, the course uses a variety of information resources and digital tools that correspond to modern approaches to climate risk analysis and greenhouse gas emissions reduction.

Main resources:

- Scientific articles in urban studies, climatology, and climate impact assessment, which help develop a contemporary scientific understanding of processes in the urban environment;
- IPCC reports, which provide consolidated international approaches to assessing climate risks, vulnerability, and decarbonization;
- International studies on urban adaptation and low-carbon development, including examples of nature-based solutions and technological innovations;
- National climate strategies and policies of Ukraine, including documents in the field of adaptation and greenhouse gas emissions reduction;
- Regional and local strategic documents (community development strategies, adaptation plans, SECAP), used as a basis for practical assignments and case studies;
- Open climate and statistical data used for analyzing temperature regimes, precipitation, greenhouse gas emissions, energy consumption, and other indicators.

Technologies and tools:

- Distance learning platform (Moodle), used for organizing the learning process, hosting materials, testing, and assessment;
- Online climate data databases, including resources such as the Copernicus Climate Change Service, providing access to observational and model climate data for practical assignments;
- Geographic Information Systems (notably QGIS), used for spatial analysis, working with raster and vector data, and assessing climate risks and territorial vulnerability;
- Spreadsheets and data processing tools (Excel, Google Sheets) for calculations, multi-criteria and matrix analysis;
- Collaboration and file-sharing platforms (Google Drive, shared documents) for effective group work during practical tasks and projects;
- Data visualization tools used to create graphs, charts, and maps for presenting analytical results.

The use of these resources and technologies ensures access to up-to-date scientific and practical information, supports the development of data analysis skills, and enables learners to master tools directly applicable in professional practice in the field of climate change adaptation and greenhouse gas emissions reduction at the level of cities and local communities.