

Syllabus

Course Title

Climate Change Mitigation and Adaptation Strategies in the Water Management Sector (MAS WM)

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

Modern climate change poses significant challenges for water resources management, environmental safety, and sustainable development at global, regional, and national levels. Rising temperatures, changing precipitation patterns, and an increased frequency of extreme weather events (droughts, floods, heatwaves) lead to transformations in the hydrological cycle, deterioration of water quality, and reduced water availability. Under these conditions, there is a growing need to train specialists capable of effectively responding to climate risks and implementing modern approaches to water resources management.

The necessity of this training is driven by the need to develop a comprehensive, interdisciplinary approach to addressing climate change adaptation challenges. At the level of organizations (public authorities, water management enterprises, research institutions), there is a demand for specialists who possess knowledge of climate risk assessment, planning of adaptation measures, use of modern information platforms, and evidence-based decision-making. The implementation of tools used in the European Union is particularly relevant, especially adaptation support information systems such as Climate-ADAPT.

At the national level (Ukraine), the relevance of this training is determined by the presence of systemic environmental problems, including water pollution, ecosystem degradation, insufficient wastewater treatment, and an inefficient environmental control and monitoring system. An additional factor is the impact of global climate change, manifested in rising temperatures, increasing aridity, changes in the water balance, and a higher risk of extreme hydrological events. In this context, the implementation of the Environmental Security and Climate Change Adaptation Strategy of Ukraine until 2030 becomes particularly important, requiring trained professionals and scientifically grounded solutions.

At the regional level (particularly in areas with high water management pressure), there is a need to implement integrated water resources management, develop climate services, early warning systems, and nature-based solutions. This includes watershed management, ecosystem restoration, improved water use efficiency, and adaptation of infrastructure to climate change.

The main objective of the training is to develop students' systemic understanding of the impacts of climate change on water resources and to build practical skills in climate risk assessment, planning adaptation measures, and implementing innovative solutions. The training is also aimed at developing competencies in integrated water resources management, application of circular economy principles, decarbonization of the water sector, and the use of modern digital and analytical tools.

Special attention is given to studying European experience, particularly EU policies in the field of water resources and climate change adaptation, as well as practical case studies on the implementation of nature-based solutions in cities and regions. This allows adaptation of best practices to the Ukrainian context and supports integration into the European scientific and governance space.

Thus, the proposed training is essential for enhancing the professional level of specialists, strengthening the institutional capacity of organizations, and ensuring effective implementation of national and regional climate adaptation policies. Its implementation will contribute to increasing the resilience of the water sector, reducing climate risks, and achieving sustainable development goals.

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 primarily studying in the specialities E2 "Ecology", E4 "Earth Sciences", G2 "Environmental Protection Technologies", and C6 "Geography and Regional Studies", as well as future specialists in climate-dependent sectors of the economy, including G "Engineering, Manufacturing and Construction", H "Agriculture, Forestry, Fisheries and Veterinary Medicine", and I "Health Care and Social Welfare".

Representatives of managerial staff and academic personnel may also participate in the training, upgrading their qualifications in the field of climate change adaptation across various sectors of the Ukrainian economy, in particular in the water management sector.

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.

Based on economic assessments, provide action-oriented recommendations for the development and improvement of adaptation and mitigation strategies that enhance resilience and reduce negative impacts.

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 of the educational component:

LO3. Develop and propose effective adaptation strategies that address specific climate risks, integrating the principles of resilience and sustainable development to enhance the adaptive capacity of affected communities.

LO5. Develop and propose low-carbon solutions across various sectors, including energy, agriculture, and business, incorporating innovative technologies and policies to achieve significant reductions in greenhouse gas emissions.

LO6. Analyze the implications of climate justice in the development and implementation of adaptation strategies, ensuring equitable and inclusive outcomes.

Performance criteria:

Develop climate change adaptation and mitigation strategies **to enhance the resilience of communities, economic sectors, and ecosystems.**

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: Adaptation Strategies

1.1. The European Climate Adaptation Platform (CLIMATE-ADAPT): tools and practices

1.2. The Environmental Security and Climate Change Adaptation Strategy of Ukraine until 2030

1.3. Climate adaptation practices at the local level: Czechia and Ukraine

1.4. Practical assignment (Case Study) for Module 1

Topic: “Local climate change adaptation practices (based on the example of Brno, Czechia, and Ukrainian cities)”

Module 2: Solutions for Promoting Low-Carbon Development

2.1. Circular water resources management

2.2. Sustainable water resources management for achieving zero-carbon emissions in the water sector

2.3. Practical assignment for Module 2

Topic: “Development of a decarbonization strategy and implementation of a circular model for a hypothetical water utility”

Module 3: Assessment of Adaptation Needs and Climate Justice

3.1. Assessment of adaptation needs and climate justice in the water sector

3.2. Practical assignment for Module 3

Topic: “Assessment of adaptation needs and climate justice in the water sector”

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.

To achieve the planned learning outcomes, the course will apply a set of learning solutions that ensure diversity in the educational process, flexibility in knowledge acquisition formats, and a strong practical orientation.

Selected learning solutions

1. Classroom-based learning (in-class instruction)

- **Reasons for selection:** creates opportunities for direct interaction between the instructor and participants, promotes discussion, exchange of experience, and development of communication skills.
- **Implementation:** lectures, seminars, group discussions.

2. Online learning

- **Reasons for selection:** ensures accessibility for participants regardless of location and enables the use of interactive digital tools.
- **Implementation:** synchronous sessions via video conferencing and asynchronous materials (lecture recordings, interactive tests).

3. Blended learning

- **Reasons for selection:** the combination of face-to-face and online formats allows participants to benefit both from direct interaction and the convenience of remote access to resources.
- **Implementation:** in-person training sessions + online assignments for independent work.

4. On-the-job training

- **Reasons for selection:** enables participants to immediately apply acquired knowledge in a professional context, increasing the practical value of learning.
- **Implementation:** completion of practical tasks and projects in real working conditions.

5. Online self-study resources

- **Reasons for selection:** support the development of self-organization skills and ensure an individualized learning pace.
- **Implementation:** platforms with e-textbooks, video lectures, and interactive assignments.

6. Coaching and mentoring

- **Reasons for selection:** support an individualized approach, allow participants to receive feedback, and foster both professional and personal competencies.
- **Implementation:** individual consultations and mentorship from experts.

Rationale for the selection

The combination of the selected learning solutions will make it possible to:

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

Thus, the combination of classroom-based, online, and practice-oriented learning approaches enables a more effective, flexible, and learner-centred educational process.

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 knowledge acquisition and achieving the planned learning outcomes. Taking into account the diversity of participants' learning styles (visual, auditory, kinesthetic, reflective), the selected approaches will provide multifaceted interaction with the learning material.

Strategies used

- 1. Active learning**
Will ensure participants' engagement in the process through analysis, discussion, and practical application of knowledge. This approach will promote critical thinking and a deeper understanding of the material.
- 2. Collaborative learning (group work)**
Work in small groups will help participants develop teamwork skills, exchange experience, and form collective solutions. This will enhance learning effectiveness through different perspectives and mutual learning.
- 3. Problem-based learning (PBL)**
Participants will solve practical tasks and analyze real-life cases. This will enable the transfer of acquired knowledge into a professional context, supporting the development of analytical skills, decision-making, and creative thinking.
- 4. Reflective learning**
Will include 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 content delivery formats and improve information retention.

Rationale for selecting the strategies

The combination of the selected approaches will make it possible to create a balanced learning environment that:

- accommodates different learning styles;
- integrates theory and practice;
- supports the development of both individual and teamwork skills;
- builds competencies required to apply knowledge in real-world contexts..

Thus, the selected strategies will contribute to achieving the planned learning outcomes and enhancing the overall 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.

Explain how the assessment is linked to the learning outcomes.

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)

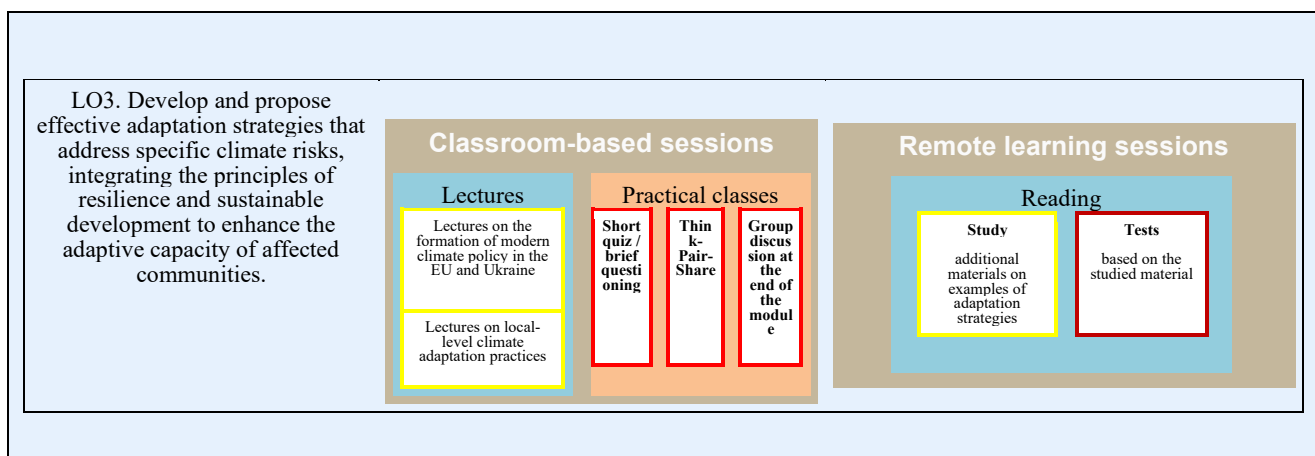
- **Objective:** to assess the level of acquisition of key knowledge and integrate the learned information.
- **Link to learning outcomes:** confirms that participants have achieved the required level of knowledge for progression or course completion.

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



LO5. Develop and propose low-carbon solutions across various sectors, including energy, agriculture, and business, incorporating innovative technologies and policies to achieve significant reductions in greenhouse gas emissions.

Classroom-based sessions

Lectures

Лекції присвячені сучасним підходам до сталого управління водними ресурсами в контексті досягнення нульового рівня викидів вуглецю у водній галузі.

Practical classes

Short quiz / brief questioning

Case study
Use of the Seim predictive system

Remote learning sessions

Reading

Study

Additional materials on the role of wastewater treatment and reuse as a key tool for reducing pressure on natural water resources..

Tests

based on the studied material

LO6. Analyze the implications of climate justice in the development and implementation of adaptation strategies, ensuring equitable and inclusive outcomes.

Classroom-based sessions

Lectures

Лекції щодо ключових аспектів адаптації водного сектору до змін клімату та впровадження принципів кліматичної справедливості

Practical classes

Short quiz / brief questioning

Case study
Assessment of adaptation needs and climate justice in the water sector

Remote learning sessions

Reading

Study

Additional materials on climate adaptation in the water sector

Tests

based on the studied material

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).

1. Blöschl G. et al. Changing climate both increases and decreases European river floods. *Nature*. 2019. Vol. 573. P. 108-111. <https://doi.org/10.1038/s41586-019-1495-6>
2. Blöschl G. et al. Changing climate shifts timing of European floods. *Science*. 2017. Vol. 357. P. 588-590 <https://doi.org/10.1126/science.aan2506>. 2017
3. Bouwer L.M. Have disaster losses increased due to anthropogenic climate change? *Bull. Am. Meteorol. Soc.* 2011. Vol. 93. P. 39-46.
4. Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems / Edited by: P.R. Shukla, J. Skea, R. Slade et.al. IPCC, 2019. 36 p.
5. Coumou D., Rahmstorf S. A decade of weather extremes. *J. Nat. Clim. Change*. 2013. Vol. 3. P. 491-496.
6. CRED. Natural Disasters 2019. Brussels: CRED; 2020. This document is available at: https://emdat.be/sites/default/files/adsr_2019.pdf
7. Dottori F. et al. Increased human and economic losses from river flooding with anthropogenic warming. *J. Nat. Clim. Change*. 2018. 8(9). P. 781-786. <http://dx.doi.org/10.1038/s41558-018-0257-z>
8. Estimating monetary damages from flooding in the United States under a changing climate / C. Wobus et al. *Martinich Journal of Flood Risk Management*. 2014. Vol. 7. P. 217-229.
9. European Commission & EEA. European Climate Risk Assessment (ECRA 2024). 2024 [Electronic resource]. – Available at: <https://climate->

adapt.eea.europa.eu/en/metadata/publications/european-climate-risk-assessment-ecra-2024

10. European Commission. EU Strategy on Adaptation to Climate Change. Brussels, 2021 [Electronic resource]. – Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0082>
11. European Commission. LIFE Programme: Best practices in climate adaptation projects [Electronic resource]. – Available at: https://cinea.ec.europa.eu/programmes/life/life-climate-action_en
12. European Commission. The European Green Deal [Электронный ресурс]. – Режим доступа: https://ec.europa.eu/clima/eu-action/european-green-deal_en
13. European Environment Agency (EEA). Climate change adaptation in Europe [Electronic resource]. – Available at: <https://www.eea.europa.eu/themes/climate-change-adaptation>
14. European Environment Agency. Climate change adaptation and water management in Europe: Challenges and opportunities. Luxembourg: Publications Office of the EU, 2018 [Electronic resource]. – Available at: <https://www.eea.europa.eu/publications/cc-adaptation-water-management>
15. European Environment Agency. Climate-ADAPT Platform [Electronic resource]. – Available at: <https://climate-adapt.eea.europa.eu>
16. European Parliament and Council. Floods Directive (2007/60/EC) [Electronic resource]. – Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007L0060>
17. European Parliament and Council. Water Framework Directive (2000/60/EC) [Electronic resource]. – Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060>
18. Extreme hydrological phenomena in the forest steppe and steppe zones of Ukraine under the climate change / Valeriya Ovcharuk et al. *Published by Copernicus*

Publications on behalf of the International Association of Hydrological Sciences.
2020. Vol. 383. P. 229-235. <https://doi.org/10.5194/piahs-383-229-2020>

19. Food and Agriculture Organization of the United Nations (FAO). Climate Change [Electronic resource]. – Available at: <https://www.fao.org/climate-change/>
20. Food and Agriculture Organization of the United Nations. Coping with water scarcity in agriculture. Rome, 2017 [Electronic resource]. – Available at: <https://www.fao.org/3/i3015e/i3015e.pdf>
21. Hydrological impacts of moderate and high-end climate change across European river basins / Lobanova A. et al. *Journal of Hydrology: Regional Studies*. 2018. Vol. 18. Pp. 15-30. <https://doi.org/10.1016/j.ejrh.2018.05.003>
22. Intergovernmental Panel on Climate Change (IPCC). Global Warming of 1.5°C. Special Report, 2018 [Electronic resource]. – Available at: <https://www.ipcc.ch/sr15/>
23. Intergovernmental Panel on Climate Change. Sixth Assessment Report (AR6): Impacts, Adaptation and Vulnerability. Cambridge: Cambridge University Press, 2022 [Electronic resource]. – Available at: <https://www.ipcc.ch/report/ar6/wg2>
24. Interreg Europe. Climate adaptation and water management projects [Electronic resource]. – Available at: <https://www.interregeurope.eu/>
25. Joint Research Centre. Droughts and Water Scarcity in Europe. Brussels, 2020 [Electronic resource]. – Available at: https://joint-research-centre.ec.europa.eu/publications/droughts-and-water-scarcity-europe_en
26. Kouidri Sofiane et al. Long-term seasonal characterization and evolution of extreme drought and flooding variability in northwest Algeria. *Meteorology, Hydrology and Water Management*. 2019. Vol. 7. Issue 3. P. 63-71. <https://doi.org/10.26491/mhwm/106101>

27. Mallakpour, G. Villarini. The changing nature of flooding across the central United States. *J. Nat. Clim. Change*. 2015. Vol. 5. P. 250-254.
<https://doi.org/10.1038/nclimate2516>
28. Migliorini M. et al. Data interoperability for disaster risk reduction in Europe. *Disaster Prevention and Management*. 2019. Vol. 28. No. 6. P. 804-816.
<https://doi.org/10.1108/DPM-09-2019-0291>
29. Neri A. et al. On the decadal predictability of the frequency of flood events across the US Midwest. *Int. J. Climatol.*, 2019. Vol. 39. P. 1796-1804.
<https://doi.org/10.1002/joc.5915>
30. NOAA National Centers for Environmental Information (NCEI) Billion- Dollar Weather and Climate Disasters: Table of Events URL:
<https://www.ncdc.noaa.gov/billions/events/US/2019> (Accessed: 20.06.2021)
31. OECD. Water Risk Hotspots for Agriculture. Paris, 2017 [Electronic resource].
– Available at: <https://www.oecd.org/publications/water-risk-hotspots-for-agriculture-9789264279551-en.htm>
32. RIOCCADAPT Report. Floods and Droughts. In: *Adaptation to Climate Change Risks in Ibero-American Countries* / Edited by: Camilloni, I., V. Barros, S. Moreiras et al. Madrid, Spain. 2020. P. 371-396.
33. Romanowicz, Renata Julita et al. “Climate Change Impact on Hydrological Extremes: Preliminary Results from the Polish-Norwegian Project.” *Acta Geophysica*. 2016. Vol. 64. P. 477-509.
- 34.1. Silva, J.A. Sustainable Water Resource Management to Achieve Net-Zero Carbon in the Water Industry: A Systematic Review of the Literature. *Water* 2025, 17, 2136.
<https://doi.org/10.3390/w17142136>
35. Seddon A.W. and et al. Sensitivity of global terrestrial ecosystems to climate variability. *Nature*. 2016. Vol. 531. P. 229-233.
<https://doi.org/10.1038/nature16986>.
36. Slater L.J., Villarini G. Recent trends in US flood risk. *Geophys. Res. Lett.*, 2016. Vol. 43 (12). Pp. 12,428-12,436. <https://doi.org/10.1002/2016GL071199>

37. Taylor C.M. and et al. Frequency of extreme Sahelian storms tripled since 1982 in satellite observations. *Nature*. 2017. Vol. 544. P. 475-478.
<https://doi.org/10.1038/nature22069>
38. United Nations Development Programme (UNDP). Climate Change and Ukraine [Electronic resource]. – Available at: <https://www.undp.org/ukraine>
39. United Nations Environment Programme. Adaptation Gap Report 2023. Nairobi, 2023 [Electronic resource]. – Available at:
<https://www.unep.org/resources/adaptation-gap-report-2023>
40. Wallemacq P. Economic Losses, Poverty & Disasters: 1998-2017. *Centre for Research on the Epidemiology of Disasters, CRED*. October. 2018. 31 p.
<https://doi.org/10.13140/RG.3.3.35610.08643>
41. World Bank. Climate Change Knowledge Portal: Ukraine [Electronic resource]. – Available at: <https://climateknowledgeportal.worldbank.org/country/ukraine>
42. World Bank. Ukraine Country Climate and Development Report. Washington, 2022 [Electronic resource]. – Available at:
<https://openknowledge.worldbank.org/handle/10986/37619>
43. World Meteorological Organization (WMO). Statement on the State of the Global Climate [Electronic resource]. – Available at: <https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate>
44. Zscheischler J. and et al. A typology of compound weather and climate events. *Nature reviews earth & environment*. 2020. Vol. 1. P. 33-347.
<https://doi.org/10.1038/s43017-020-0060-z>