Syllabus

Course Title

Climate Change Mitigation and Adaptation: Case Studies and Best Practices in Water Management

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

Climate change significantly affects the water cycle and water resource management. It leads to changes in the quantity and intensity of precipitation, the frequency of extreme weather events, an increased risk of floods and droughts, as well as changes in the availability of freshwater. These processes have major implications for public health, economic development, agriculture, and the functioning of natural ecosystems.

The European Union has a well-developed policy framework in the field of water resource management, combining environmental, economic, and social aspects. The implementation of this policy is based on a number of important regulatory documents, in particular the Water Framework Directive, which establishes principles of sustainable water management, and the Floods Directive, which aims at assessing and managing flood risks.

An important role in shaping the EU's modern climate policy is played by the EU Strategy on Adaptation to Climate Change, which defines key directions for increasing the climate resilience of European regions, economies, and infrastructure. One of the main instruments for implementing this strategy is the Climate-ADAPT platform.

The current state of the natural environment in Ukraine is characterized by a number of systemic problems that require comprehensive solutions at the state level. One of the key issues is the insufficient effectiveness of the state supervision and control system in the field of environmental protection. Existing control mechanisms do not ensure proper enforcement of environmental legislation and do not encourage businesses to invest in environmental measures.

To address these problems, Ukraine is implementing the Environmental Security and Climate Change Adaptation Strategy of Ukraine until 2030. The main goal of this strategy is to ensure an environmentally safe living environment for the population, preserve natural ecosystems, and increase the country's resilience to the negative impacts of climate change.

The flood risk management plan for flood-prone areas—where flooding is a natural phenomenon that cannot be avoided and which, under conditions of human activity and climate change, becomes more likely and potentially more damaging—is regulated by Directive 2007/60/EC of the European Parliament and of the Council on the assessment and management of flood risks (https://zakon.rada.gov.ua/laws/show/994_b29/print). The development of the most

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effective flood risk reduction measures (prevention, protection, and preparedness) is possible through coordination of these measures within the entire river basin.

The main features of modern forecasting methods include modelling systems that allow for the mathematical description of random changes in meteorological impacts on catchments, and subsequently the simulation of runoff processes in their temporal development, as well as the creation of spatial forecasting models and the presentation of forecast information in cartographic form. River runoff modelling has become an important element in planning and managing water supply and control systems, as well as in providing river forecasts and warning services of the World Meteorological Organization (WMO).

Modern climate change has become one of the key challenges for cities and communities worldwide. It is at the local level that concrete measures are implemented to reduce the negative impacts of climate change and increase territorial resilience. One of the important international initiatives in this area is the Covenant of Mayors—the world's largest movement of local authorities aimed at achieving climate and energy goals. The initiative brings together thousands of municipalities that voluntarily commit to reducing greenhouse gas emissions by at least 40% by 2030 and implementing climate adaptation measures. In Ukraine, more than 260 municipalities have joined this initiative. The use of green infrastructure, monitoring systems, and international partnerships helps increase the resilience of communities to climate risks and promotes sustainable territorial development.

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 enrolled primarily in the following fields: 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", and I "Healthcare and Social Welfare".

Representatives of managerial staff and academic instructors may also participate in the training to enhance their qualifications in the field of climate change adaptation across various sectors of the Ukrainian economy.

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 actionable 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 for the educational component:

LO4. Integrate knowledge from different disciplines, including economics, politics, science, and technology, to develop comprehensive and effective solutions to climate change.

Performance criteria:

Identify and describe key concepts and contributions from various disciplines (e.g., economics, environmental science, public policy, and technology) relevant to addressing climate change challenges.

LO5. Study real-world examples of successful climate change mitigation and adaptation initiatives, identifying key lessons and best practices that can be applied in relevant contexts.

Performance criteria:

Identify best practices that can be applied in other contexts.

LO6. Integrate knowledge of sector-specific mitigation strategies, adaptation measures, and best practices to develop comprehensive climate action plans tailored to specific geographic regions, economic sectors, or communities.

Performance criteria:

Develop comprehensive climate action plans that address both mitigation and adaptation needs.

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 4: INTEGRATION OF INTERDISCIPLINARY KNOWLEDGE
4.1 European Climate Adaptation Platform (CLIMATE-ADAPT): tools and practices
4.2 Environmental Security and Climate Change Adaptation Strategy of Ukraine for the period up to 2030
4.3 Practical assignment for Module 4
Topic: “Climate change adaptation in the water sector: European experience and Ukrainian realities”

MODULE 5: SYNTHESIS OF BEST PRACTICES FROM SITUATIONAL ANALYSIS
5.1 Prognostic monitoring of hydrological characteristics of spring floods in Ukrainian rivers under climate services
5.2 Probabilistic–stochastic flood modelling as an important component of climate services and integrated water resources management in Ukraine
5.3 Practical assignment for Module 5
Topic: Implementation of a model for long-term territorial forecasts of maximum water discharge during spring floods using the computer system “SEIM”

MODULE 6: DEVELOPMENT OF CLIMATE ACTION PLANS UNDER SPECIFIC CONDITIONS
6.1 Local-level climate adaptation practices: Czech Republic and Ukraine
6.2 Practical assignment (Case Study) for Module 6
Topic: “Local climate adaptation practices (based on the example of the city of Brno, Czech Republic, and Ukrainian cities)”

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 in the course, a comprehensive set of learning solutions will be applied, ensuring diversity in the educational process, flexibility in knowledge acquisition, and practical orientation.

Selected Learning Solutions:

- **Classroom Learning (In-Person Learning)**
  - **Reason for choice:** Provides opportunities for live interaction between the instructor and participants, promotes discussions, exchange of experience, and the development of communication skills.
  - **Implementation:** Lectures, seminars, group discussions.
- **Online Learning**
  - **Reason for choice:** Ensures accessibility for participants regardless of location and allows the use of interactive digital tools.
  - **Implementation**: Synchronous sessions via video conferencing and asynchronous materials (recorded lectures, interactive tests).
- **Blended Learning**
  - **Reason for choice**: Combining in-person and online formats allows participants to benefit from direct interaction while also enjoying the convenience of remote access to resources.
  - I**mplementation**: On-site trainings + online assignments for independent work.
- **On-the-Job Training**
  - **Reason for choice:** Enables participants to immediately apply acquired knowledge in a professional context, increasing the practical value of the learning.
  - **Implementation:** Completion of practical tasks and projects in real working conditions.
- **Online Resources for Self-Directed Learning**
  - **Reason for choice:** Supports the development of self-organization skills and allows individualized pacing of learning**.**
  - **Implementation**: Platforms with e-textbooks, video lectures, interactive exercises.
- **Coaching and Mentoring**
  - **Reason for choice:** Supports an individualized approach, allows participants to receive feedback, and fosters professional and personal competencies.
  - **Implementation:** Individual consultations and mentoring by experts.

Rationale for Selection

The combination of the above learning solutions will enable the course to:

- address different learning styles and formats;
- integrate theoretical knowledge with practical application;
- 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 ensures the most effective 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.

During course implementation, a combination of different teaching strategies will be used to ensure maximum effectiveness of learning and achievement of the intended learning outcomes. Considering the diversity of participants' learning styles (visual, auditory, kinesthetic, reflective), the selected approaches will ensure multifaceted interaction with the learning material.

Used strategies

1. **Active learning**
   This approach ensures participant engagement through analysis, discussion, and practical application of knowledge. It supports the development of critical thinking and deeper understanding of the material.
2. **Collaborative learning (group work)**
   Working in small groups helps participants develop teamwork skills, exchange experiences, and build collective solutions. It enhances learning effectiveness through exposure to different perspectives and peer learning.
3. **Problem-based learning (PBL)**
   Participants solve practical tasks and analyze real-world case studies. This enables the transfer of acquired knowledge into a professional context and supports the development of analytical, decision-making, and creative thinking skills.
4. **Reflective learning**
   This includes time for self-analysis, self-assessment, and reflection on individual progress. It helps participants identify strengths and areas for improvement while increasing motivation for further learning.
5. **Multimodal approaches**
   The use of ICT tools (presentations, interactive platforms, visualizations, videos) ensures diverse formats of content delivery and improves information retention.

Rationale for strategy selection

The combination of these approaches creates a balanced learning environment that:

- accommodates different learning styles;
- integrates theory with practice;
- supports the development of both individual and team skills;
- fosters competencies required for applying knowledge in real-world contexts.

Thus, the selected strategies contribute to achieving the intended 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 learning process includes 36 academic hours of contact time – 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 that ensure the integration of theoretical knowledge and practical skills. This allows participants not only to acquire information but also to learn how to apply it in real-world contexts.

Main learning activities

1. **Lectures**
    - **Purpose:** to provide foundational knowledge, key concepts, and theoretical frameworks of the subject.
    - **Role of the instructor:** an organizer and source of knowledge who explains the material and structures key ideas.
    - **Role of students:** active listeners who take notes and ask clarifying questions.
2. **Literature and recommended materials review**
    - **Purpose:** to deepen understanding of the topic and develop skills in working with scientific and professional sources.
    - **Role of the instructor:** provides a list of literature and methodological guidance for independent study.
    - **Role of students:** read materials, prepare notes, and formulate key points for further discussion.
3. **Case studies (analysis of practical cases)**
    - **Purpose:** to apply theoretical knowledge to real-world situations and develop analytical and decision-making skills.
    - **Role of the instructor:** acts as a discussion moderator, presenting the case and guiding analysis.
    - **Role of students:** analyze the situation, propose solutions, and justify their own viewpoints.
4. **Практичні завдання та вправи**
    - **Purpose:** to consolidate knowledge through task completion and develop practical skills.
    - **Role of the instructor:** provides instructions and 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 skill development, while promoting active student engagement in the learning process.

- Instructors act not only as sources of knowledge but also as facilitators, mentors, and moderators.
- 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 assessment methods will be applied to comprehensively monitor participants' progress and ensure the achievement of the planned learning outcomes.

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

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

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

- **Purpose:** allows participants to independently determine their level of understanding and identify areas that require further study.
- **Connection to learning outcomes:** develops self-reflection skills and encourages revisiting the material.

3. Formative assessment during the course (practical exercises checked by the instructor)

- **Purpose:** to monitor progress and the ability to apply knowledge in practice.
- **Connection to learning outcomes:** enables gradual competency development and provides feedback for improvement.

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

- **Purpose:** to evaluate the level of mastery of key knowledge and the integration of acquired information.
- **Connection to learning outcomes:** confirms that participants have reached the necessary knowledge level to proceed to the next stage or complete the course.

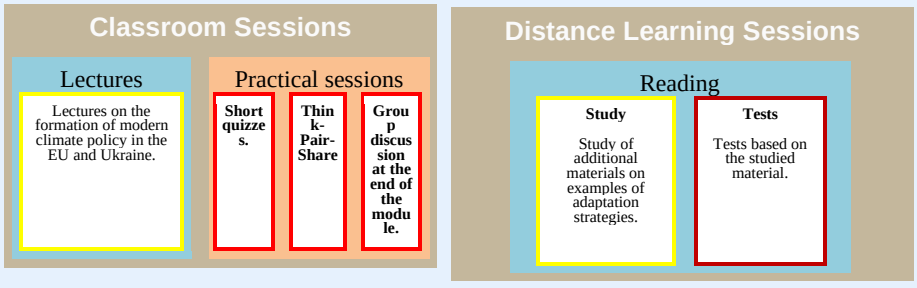
Summary: The combination of quizzes, self-assessment, formative, and summative evaluation allows for:

- continuous monitoring of progress;
- providing participants with tools for self-development;
- ensuring that the final outcomes align with the stated course objectives.

Storyboard of Learning (Learning Storyboard)

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

LO4. Integrate knowledge from various disciplines, including economics, policy, science, and technology, to develop comprehensive and effective solutions for climate change.



LO5. Study real-world examples of successful climate change mitigation and adaptation initiatives, identifying key lessons and best practices that can be applied in relevant contexts.	**Classroom Sessions** Lectures: Lectures on flood risk management plans for flood-prone areas and their modelling, considering floods as a natural phenomenon that cannot be avoided and which, under conditions of human activity and climate change, becomes more frequent and leads to increased adverse impacts and greater damage from inundation. Practical sessions: **Short quizzes.**; **Case study** Regarding the use of the Seim forecasting complex	**Distance Learning Sessions** Reading: **Study of additional materials** On modern methods of probabilistic-stochastic modelling.; **Tests** Tests based on the studied material.
LO6. Integrate knowledge of sectoral mitigation strategies, adaptation measures, and best practices to develop comprehensive climate action plans tailored to specific geographic regions, economic sectors, or communities.	**Classroom Sessions** Lectures: Lectures on local-level climate adaptation practices. Practical sessions: **Short quizzes.**; **Case study** On examples of climate adaptation in communities.	**Distance Learning Sessions** Reading: **Study of additional materials** On climate adaptation in the water sector.; **Tests** 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. Гопченко Е.Д., Овчарук В.А. Формирование максимального стока весеннего половодья в условиях юга Украины : монография. Одесса: ТЭС, 2003. 110 с.
2. Гопченко Є.Д., Лобода Н.С., Овчарук В.А. Гідрологічні розрахунки: підручник для студентів ВНЗ. Одеса : ТЕС, 2014. 483 с.
3. Закон України «Про охорону навколишнього природного середовища» від 25.06.1991 № 1264-XII [Electronic resource]. – Access mode: https://zakon.rada.gov.ua/laws/show/1264-12
4. Інститут водних проблем і меліорації НААН України [Electronic resource]. – Access mode: http://iwpim.com.ua/
5. Кабінет Міністрів України. Стратегія екологічної безпеки та адаптації до зміни клімату до 2030 року: розпорядження від 20.10.2021 № 1363-р [Electronic resource]. – Access mode: https://zakon.rada.gov.ua/laws/show/1363-2021-p
6. Міністерство захисту довкілля та природних ресурсів України. Національний план дій з охорони навколишнього природного середовища України до 2025 року [Electronic resource]. – Access mode: https://mepr.gov.ua/
7. Національний центр стійкості та розвитку [Electronic resource]. – Access mode: https://resilience.org.ua/
8. Овчарук В.А. Максимальний стік весняного водопілля рівнинних річок України : монографія. Одеса : Видавничий дім «Гельветика», 2020. 300 с.
9. Овчарук В.А., Іващенко С. В. Регіональна методика для визначення максимального стоку весняного водопілля річок суббасейну р.Десна в умовах

змін клімату. *Гідрологія, гідрохімія і гідроекологія.* 2020. №1. С. 15-25. http://nbuv.gov.ua/UJRN/glghge_2020_1_4

10. Овчарук В.А., Шакірзанова Ж.Р., Гопцій М.В., Кічук Н.С., Кущенко Л.В. Екстремальновисокий та низький стік на річках Півдня України в сучасних кліматичних умовах. *Другий Всеукраїнський гідрометеорологічний з'їзд* : тези доповідей. Одеса: Одеський державний екологічний університет, 2021. С. 85-86.
11. Писаренко Л.А., Краковська С.В. Основні напрямки сучасних досліджень взаємодії клімату і підстильної поверхні. *Український гідрометеорологічний журнал*. 2020. № 25. С. 38-53. https://doi.org/10.31481/uhmj.25.2020.04
12. Шакірзанова Ж.Р. Довгострокове прогнозування характеристик максимального стоку весняного водопілля рівнинних річок та естуаріїв території України : монографія. Одеса : ФОП Бондаренко М.О., 2015. 252 с.
13. Agha Kouchak A. et al. Climate extremes and compound hazards in a warming world. *Annu. Rev. Earth Planet. Sci.* 2020. Vol. 48. P. 519-548. https://doi.org/10.1146/annurev-earth-071719-055228
14. Akhter A. and Azam S. Flood-Drought Hazard Assessment for a Flat Clayey Deposit in the Canadian Prairies. *Journal of Environmental Informatics Letters.* 2019. Vol. 1(1). P. 8-19. https://doi.org/10.3808/jeil.201900002
15. Baldassarre G. D. Floods in a Changing Climate: Inundation Modelling. International Hydrology Series of Cambridge University Press. 2013. Vol. 1. P. 118-123. https://doi.org/10.1017/CBO9781139088411
16. Bisselink B. et al. Impact of a changing climate, land use, and water usage on water resources in the Danube river basin. *Publications Office of the European Union*, 2018. P. 3-70. https://doi.org/10.2760/89828
17. 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

18. 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
19. Bouwer L.M. Have disaster losses increased due to anthropogenic climate change? *Bull. Am. Meteorol. Soc.* 2011. Vol. 93. P. 39-46.
20. 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.
21. Coumou D., Rahmstorf S. A decade of weather extremes. *J. Nat. Clim. Change*. 2013. Vol. 3. P. 491-496.
22. CRED. Natural Disasters 2019. Brussels: CRED; 2020.This document is available at: https://emdat.be/sites/default/files/adsr_2019.pdf
23. 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
24. 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.
25. European Commission & EEA. European Climate Risk Assessment (ECRA 2024). 2024 [Electronic resource]. – Access mode: https://climate-adapt.eea.europa.eu/en/metadata/publications/european-climate-risk-assessment-ecra-2024
26. European Commission. EU Strategy on Adaptation to Climate Change. Brussels, 2021 [Electronic resource]. – Access mode: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0082
27. European Commission. LIFE Programme: Best practices in climate adaptation projects [Electronic resource]. – Access mode: https://cinea.ec.europa.eu/programmes/life/life-climate-action_en

28. European Commission. The European Green Deal [Electronic resource]. – Access mode: https://ec.europa.eu/clima/eu-action/european-green-deal_en
29. European Environment Agency (EEA). Climate change adaptation in Europe [Electronic resource]. – Access mode: https://www.eea.europa.eu/themes/climate-change-adaptation
30. European Environment Agency. Climate change adaptation and water management in Europe: Challenges and opportunities. Luxembourg: Publications Office of the EU, 2018 [Electronic resource]. – Access mode: https://www.eea.europa.eu/publications/cc-adaptation-water-management
31. European Environment Agency. Climate-ADAPT Platform [Electronic resource]. – Access mode: https://climate-adapt.eea.europa.eu
32. European Parliament and Council. Floods Directive (2007/60/EC) [Electronic resource]. – Access mode: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007L0060
33. European Parliament and Council. Water Framework Directive (2000/60/EC) [Electronic resource]. – Access mode: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060
34. 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
35. Food and Agriculture Organization of the United Nations (FAO). Climate Change [Electronic resource]. – Access mode: https://www.fao.org/climate-change/
36. Food and Agriculture Organization of the United Nations. Coping with water scarcity in agriculture. Rome, 2017 [Electronic resource]. – Access mode: https://www.fao.org/3/i3015e/i3015e.pdf

37. 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

38. Intergovernmental Panel on Climate Change (IPCC). Global Warming of 1.5°C. Special Report, 2018 [Electronic resource]. – Access mode: https://www.ipcc.ch/sr15/

39. Intergovernmental Panel on Climate Change. Sixth Assessment Report (AR6): Impacts, Adaptation and Vulnerability. Cambridge: Cambridge University Press, 2022 [Electronic resource]. – Access mode: https://www.ipcc.ch/report/ar6/wg2

40. Interreg Europe. Climate adaptation and water management projects [Electronic resource]. – Access mode: https://www.interregeurope.eu/

41. Joint Research Centre. Droughts and Water Scarcity in Europe. Brussels, 2020 [Electronic resource]. – Access mode: https://joint-research-centre.ec.europa.eu/publications/droughts-and-water-scarcity-europe_en

42. 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

43. 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

44. 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

45. 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

46. 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)

47. OECD. Water Risk Hotspots for Agriculture. Paris, 2017 [Electronic resource]. – Access mode: https://www.oecd.org/publications/water-risk-hotspots-for-agriculture-9789264279551-en.htm

48. Ovcharuk V.A., Hopchenko Ye.D. The modern method of maximum spring flood runoff characteristics valuation for the plain rivers of Ukraine. *Ukrainian Geographical Journal.* 2018. №3. P. 26-33. https://doi.org/10.15407/ugz2018.03.026

49. Ovcharuk, V. et al. Calculating the characteristics of flash flood on small rivers in the mountainous Crimea. *Geofizika*, 2020. Vol. 37(1). P. 27-43. https://doi.org/10.15233/gfz.2020.37.3

50. 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.

51. *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.*

52. 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.

53. Semenova I., Slizhe M. Synoptic Conditions of Droughtsand Dry Winds in the Black Sea Steppe Province Under Recent Decades. *Front. EarthSci.* 2020. Vol. 8. P. 69. https://doi.org/10.3389/feart.2020.00069

54. 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

55. 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

56. United Nations Development Programme (UNDP). Climate Change and Ukraine [Electronic resource]. – Access mode: https://www.undp.org/ukraine

57. United Nations Environment Programme. Adaptation Gap Report 2023. Nairobi, 2023 [Electronic resource]. – Access mode: https://www.unep.org/resources/adaptation-gap-report-2023

58. 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

59. World Bank. Climate Change Knowledge Portal: Ukraine [Electronic resource]. – Access mode: https://climateknowledgeportal.worldbank.org/country/ukraine

60. World Bank. Ukraine Country Climate and Development Report. Washington, 2022 [Electronic resource]. – Access mode: https://openknowledge.worldbank.org/handle/10986/37619

61. World Meteorological Organization (WMO). Statement on the State of the Global Climate [Electronic resource]. – Access mode: https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate

62. 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