

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
ADMIRAL MAKAROV NATIONAL UNIVERSITY OF SHIPBUILDING

Faculty of Marine Economics and Ecology
Department of Ecology and Environmental Protection Technologies



APPROVED

Restor for Academic Affairs

S. O. SLOBODYAN

PROGRAM OF THE DISCIPLINE
AGRICULTURE AND CLIMATE-ADAPTIVE LAND USE SYSTEMS

РОБОЧА ПРОГРАМА НАВЧАЛЬНОЇ ДИСЦИПЛІНИ
СІЛЬСЬКЕ ГОСПОДАРСТВО ТА СИСТЕМИ ЗЕМЛЕКОРИСТУВАННЯ,
АДАПТОВАНІ ДО ЗМІНИ КЛІМАТУ

Level of higher education: second (master's) level

Type of discipline: elective

Language of instruction: English

Mykolaiv – 2026

Programme of the academic discipline "Agriculture and Climate-Adaptive Land Use Systems"

"11" 08 2026. – 18 p.

Developers: The programme was developed within the framework of the international CRES-Network project, "Climate Change Resilient Natural Resource Management Network", implemented by Ukrainian universities in cooperation with TUD Dresden University of Technology and Brandenburg University of Technology Cottbus-Senftenberg, by a team of authors representing:

- **Admiral Makarov National University of Shipbuilding:** PhD in Economics, Associate Professor O. A. Litvak; Doctor of Technical Sciences, Professor G. G. Trokhymenko;

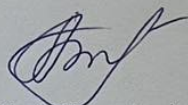
- **Kharkiv National Automobile and Highway University:** Doctor of Technical Sciences, Professor N. V. Vnukova; PhD in Economics, Associate Professor M. V. Barun; PhD in Biology, Associate Professor N. V. Prokopenko; PhD in Technical Sciences, Associate Professor N. S. Tsapko; PhD in Technical Sciences Yu. S. Kaliuzhna; Senior Lecturer S. O. Koversun;

- **Sumy State University:** Doctor of Technical Sciences, Professor L. D. Plyatsuk; Doctor of Technical Sciences, Professor L. L. Hurets; PhD in Technical Sciences, Associate Professor Ye. V. Bataltsev; PhD in Technical Sciences, Associate Professor R. A. Vaskin; PhD in Technical Sciences, Associate Professor I. O. Trudova.

The draft programme of the academic discipline "Agriculture and Climate-Adaptive Land Use Systems" was considered at a meeting of the Department of Ecology and Environmental Technologies.

Minutes No. 5 of 13 May 2026.

Head of the Department

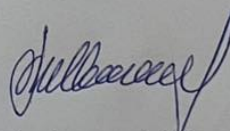


Ganna TROKHYMENKO

The draft programme of the academic discipline "Agriculture and Climate-Adaptive Land Use Systems" was considered by the Methodological Commission of the Faculty of Marine Economics and Ecology

Minutes No. 5 of 16 May 2026.

Chair of the Methodological Commission



Viacheslav IVATA

The draft programme of the academic discipline "Agriculture and Climate-Adaptive Land Use Systems" was agreed with the Education Department.

Head of the Department



Andriy LABARTKAVA

The programme of the academic discipline "Agriculture and Climate-Adaptive Land Use Systems" was approved by the Academic and Methodological Council of Admiral Makarov National University of Shipbuilding.

Minutes No.6 of 24 June 2026.

Chair of the Academic and Methodological Council



Serhiy SLOBODYAN

Contents

Introduction	4
1. Description of the academic discipline	5
2. Purpose of studying the academic discipline	6
3. Prerequisites for studying the academic discipline	6
4. Expected learning outcomes	6
5. Academic discipline programme	7
6. Teaching methods, tools for assessing learning outcomes, and methods of their demonstration	12
7. Forms of ongoing and final assessment	13
8. Criteria for assessing learning outcomes	16
9. Tools, equipment, and methodological support used in the academic discipline.	16
10. Recommended information sources	17

INTRODUCTION

Abstract

The academic discipline “Agriculture and Climate-Adaptive Land Use Systems” is aimed at developing students’ modern knowledge of the use, monitoring, protection, and restoration of agricultural land under climate-related, anthropogenic, and technogenic challenges. The discipline covers natural systems and soil resources of Ukraine, the current state and dynamics of chernozem soils, issues of efficient land use in the agricultural sector, the impact of climate change on agricultural land productivity, as well as the consequences of anthropogenic and technogenic transformations of agricultural landscapes.

Particular attention is paid to the development of land use systems adapted to climate change, the application of soil quality monitoring tools, the assessment of erosion processes, the reclamation of disturbed lands, the development of protective afforestation, and the implementation of nature-based and management solutions in agricultural land use. The discipline has an applied focus and involves practical assignments related to the analysis of environmental indicators of land use, soil condition assessment, the development of adaptation measures, and the justification of prospects for the sustainable development of agricultural areas.

Keywords: agriculture, land use, climate change, soil resources, agricultural landscapes, soil monitoring, land reclamation, agricultural sector adaptation.

Анотація

Навчальна дисципліна «Сільське господарство та системи землекористування, адаптовані до змін клімату» спрямована на формування у здобувачів вищої освіти сучасних знань щодо особливостей використання, моніторингу, охорони та відновлення сільськогосподарських земель в умовах кліматичних, антропогенних і техногенних викликів. У межах дисципліни розглядаються природні системи та ґрунтові ресурси України, сучасний стан і динаміка чорноземів, проблеми ефективного землекористування в аграрному секторі, вплив зміни клімату на продуктивність сільськогосподарських земель, а також наслідки антропогенних і техногенних трансформацій агроландшафтів.

Особлива увага приділяється формуванню систем землекористування, адаптованих до змін клімату, застосуванню інструментів моніторингу якості ґрунтів, оцінюванню ерозійних процесів, рекультивації порушених земель, розвитку захисного лісорозведення та впровадженню природоорієнтованих і управлінських рішень у сфері аграрного землекористування. Дисципліна має прикладну спрямованість і передбачає виконання практичних завдань, пов’язаних з аналізом екологічних показників землекористування, оцінюванням стану ґрунтів, розробленням адаптаційних заходів та обґрунтуванням перспектив сталого розвитку аграрних територій.

Ключові слова: сільське господарство, землекористування, зміни клімату, ґрунтові ресурси, агроландшафти, моніторинг ґрунтів, рекультивація земель, адаптація аграрного сектору.

1. Description of the academic discipline

Indicator	Description
Degree	Master's degree
Elective course list*	Elective course 4
Year of study and semester	First year of study, second semester
Language(s) of instruction	English
Mode of study	Full-time education
Course workload, ECTS credits/hours	6/180
Distribution of hours by type of study activity	
Full-time mode	Lectures – 30 hours; practical classes – 30 hours; independent work – 120 hours
Part-time mode	—
Form of final assessment	Credit
Web address of the academic discipline work programme on the University website	https://nuos.edu.ua/studentu/vibirkovi-kursi/

* In accordance with Clause 2.4 of the *Regulations on elective disciplines at Admiral Makarov National University of Shipbuilding*.

2. Purpose of studying the academic discipline

The purpose of studying the academic discipline “Agriculture and Climate-Adaptive Land Use Systems” is to provide students with systematic knowledge and practical skills in assessing the condition of agricultural land, analysing the impacts of climatic, anthropogenic, and technogenic factors on soil resources and agricultural landscapes, and substantiating environmentally sound and sustainable approaches to land use management under climate change.

The discipline is aimed at developing students’ ability to apply modern soil quality monitoring methods and tools for assessing erosion processes, land degradation, and soil pollution, as well as to develop adaptation measures designed to enhance the resilience of agricultural areas, restore disturbed land, preserve soil fertility, and ensure the sustainable development of agricultural land use.

3. Prerequisites for studying the academic discipline

There are no prerequisites for studying the academic discipline.

4. Expected learning outcomes

Studying the academic discipline involves the formation and development of the following learning outcomes in higher education students:

- to know the basic concepts of natural systems, the classification of Ukraine’s soil resources, the factors influencing their formation, and current issues in the use of agricultural land;
- to understand the impacts of climatic, anthropogenic, and technogenic factors on soil condition, agricultural land productivity, and the transformation of agricultural landscapes;
- to possess knowledge of the development of land use systems adapted to climate change, as well as the main approaches to land reclamation, protective afforestation, and the restoration of disturbed land;
- to possess skills in applying modern methods of soil quality monitoring and agroecological land assessment;
- to be able to analyse environmental indicators of land use, assess the risks of soil degradation, erosion, and pollution, and justify measures for the sustainable use and restoration of agricultural land;
- to develop proposals for adapting agricultural land use to climate change, taking into account natural, environmental, socio-economic, and management factors.

5. Academic discipline programme

Content module 1. Theoretical foundations and current issues of agricultural land use under climate change

Topic 1. Concepts of natural systems and classification of soil resources in Ukraine and factors influencing their formation [1], pp. 15–45; [3], pp. 12–20.

Topic 2. Assessment of the global chernozem resource considering their condition, area, and dynamics of changes [1], pp. 46–110; [3], pp. 15–35; [4], Ch. 2.

Topic 3. Current challenges in the field of global agricultural land use [3], pp. 1–45; [5], pp. 1–40.

Topic 4. Modern challenges of efficient land use in the agricultural sector of Ukraine [6], pp. 25–75; [3], pp. 45–75; [7], pp. 15–45.

Topic 5. Impact of climate change on the efficiency of agricultural land use in Ukraine [3], pp. 60–90; [5], pp. 437–520; [7], pp. 20–65.

Topic 6. Assessment of problems of anthropogenic transformations in the agricultural sector of Ukraine [1], pp. 111–155; [4], Ch. 2; [6], pp. 75–115.

Topic 7. Assessment of technogenic transformations in the agricultural sector of Ukraine: problems and consequences (technogenic risks) [1], pp. 150–180; [4], Ch. 3; [5], pp. 345–436.

Content module 2. Land use systems adapted to climate change, monitoring and restoration of agricultural land

Topic 8. Concept of adaptive land use systems in the agricultural sector [3], pp. 90–130; [5], pp. 673–720; [7], pp. 65–95.

Topic 9. Recultivation processes as a key tool for land restoration [3], pp. 110–145; [5], pp. 345–436; [6], pp. 115–150.

Topic 10. Measures to minimize risks: Windbreak plantings and other barriers [3], pp. 125–150; [5], pp. 390–430; [6], pp. 140–165.

Topic 11. Features of adaptation of agricultural land use in Ukraine to climate change [3], pp. 145–170; [5], pp. 437–520; [7], pp. 65–110.

Topic 12. Methodology and tools for monitoring soil quality in the agricultural sector [2], pp. 1–18; [4], Ch. 4; [5], pp. 345–390.

Topic 13. Assessment of the dynamics of changes in soil properties under the influence of agricultural activities and climatic factors [2], pp. 1–18; [4], Ch. 4; [5], pp. 345–390.

Topic 14. Political and socio-economic aspects of adaptation of the agricultural sector to climate change [2], pp. 18–25; [5], pp. 673–755; [7], pp. 90–130.

Topic 15. Prospects for the development of climate-adapted land use systems in Ukraine [2], pp. 20–25; [3], pp. 145–170; [5], pp. 673–755; [7], pp. 110–145.

Thematic plan of the academic discipline

Names of content modules and topics	Number of hours									
	Full-time mode of study					Part-time mode of study				
	Total number of hours	including				Total number of hours	including			
		Lec.	Pract.	Lab.	Indep. work		Lec.	Pract.	Lab.	Indep. work
1	2	3	4	5	6	7	8	9	10	11
Content module 1. Theoretical foundations and current issues of agricultural land use under climate change										
Topic 1. Concepts of natural systems and classification of soil resources in Ukraine and factors influencing their formation	13	2	2	-	9	-	-	-	-	-
Topic 2. Assessment of the global chernozem resource considering their condition, area, and dynamics of changes	13	2	2	-	9	-	-	-	-	-
Topic 3. Current challenges in the field of global agricultural land use	13	2	2	-	9	-	-	-	-	-
Topic 4. Modern challenges of efficient land use in the agricultural sector of Ukraine	12	2	2	-	8	-	-	-	-	-
Topic 5. Impact of climate change on the efficiency of agricultural land use in Ukraine	13	2	2	-	9	-	-	-	-	-
Topic 6. Assessment of problems of anthropogenic transformations in the agricultural sector of Ukraine	13	2	2	-	9	-	-	-	-	-
Topic 7. Assessment of technogenic transformations in the agricultural sector of Ukraine: problems and consequences (technogenic risks)	13	2	2	-	9	-	-	-	-	-
<i>Total for content module 1</i>	90	14	14	-	62	-	-	-	-	-
Content module 2. Land use systems adapted to climate change, monitoring and restoration of agricultural land										
Topic 8. Concept of adaptive land use systems in the agricultural sector	11	2	2	-	7	-	-	-	-	-
Topic 9. Recultivation processes as a key tool for land restoration	11	2	2	-	7	-	-	-	-	-
Topic 10. Measures to minimize risks: Windbreak plantings and other barriers	11	2	2	-	7	-	-	-	-	-
Topic 11. Features of adaptation of agricultural land use in Ukraine to climate change	12	2	2	-	8	-	-	-	-	-
Topic 12. Methodology and tools for monitoring soil quality in the agricultural sector	12	2	2	-	8	-	-	-	-	-
Topic 13. Assessment of the dynamics of changes in soil properties under the influence of agricultural activities and climatic factors	11	2	2	-	7	-	-	-	-	-
Topic 14. Political and socio-economic aspects of adaptation of the agricultural sector to climate change	11	2	2	-	7	-	-	-	-	-

Names of content modules and topics	Number of hours									
	Full-time mode of study					Part-time mode of study				
	Total number of hours	including				Total number of hours	including			
		Lec.	Pract.	Lab.	Indep. work		Lec.	Pract.	Lab.	Indep. work
1	2	3	4	5	6	7	8	9	10	11
Topic 15. Prospects for the development of climate-adapted land use systems in Ukraine	11	2	2	-	7	-	-	-	-	-
<i>Total for content module 2</i>	90	16	16	-	58	-	-	-	-	-
<i>Total for the course</i>	180	30	30	-	120	-	-	-	-	-

Topics of practical classes

No.	Topic	Number of hours	
		Full-time mode	Part-time mode
Content module 1. Theoretical foundations and current issues of agricultural land use under climate change			
1	Topic 1. Analysis of Ukrainian Soil Types and Formation Factors	2	—
2	Topic 2. Environmental monitoring of soils. Soil degumification	2	—
3	Topic 3. Agroecological assessment of soils	2	—
4	Topic 4. Analysis of environmental indicators of efficient land use	2	—
5	Topic 5. Assessment of Climate Change Impacts on Agricultural Land Productivity in Different Regions of Ukraine	2	—
6	Topic 6. Calculation of the regulatory monetary valuation of agricultural land	2	—
7	Topic 7. Assessment of anthropogenic pollution of agricultural soils	2	—
Total for content module 1		14	—
Content module 2. Land use systems adapted to climate change, monitoring and restoration of agricultural land			
8	Topic 8. Development of a Conceptual Framework for Adaptive Regional Land Use	2	—
9	Topic 9. Methods of biological reclamation: assessment of plant indicators of restoration	2	—
10	Topic 10. Design a scheme of windbreak placement for a specific landscape	2	—
11	Topic 11. Assessment of agricultural land productivity using NDVI and climate data	2	—
12	Topic 12. Practical application of soil quality assessment methods: sampling and laboratory analysis	2	—
13	Topic 13. Assessment of the intensity of erosion processes on agricultural lands	2	—
14	Topic 14. Analysis of policy instruments and management decisions for agricultural sector adaptation to climate change	2	—
15	Topic 15. Designing a Climate-Adaptation Plan for a Farm in Southern Ukraine	2	—
Total for content module 2		16	—
Total hours		30	—

Topics for independent work

No.	Topic	Number of hours	
		Full-time mode	Part-time mode
Content module 1. Theoretical foundations and current issues of agricultural land use under climate change			
1	Topic 1. Prepare a brief report on key factors influencing soil formation in your region	2	—
2	Topic 2. Spatial monitoring of chernozem soil changes using remote sensing and GIS technologies	2	—
3	Topic 3. Transformation of agricultural landscapes under the influence of climate change.	2	—
4	Topic 4. The main contemporary approaches to improving the efficiency of land use.	2	—
5	Topic 5. Adaptation of Agricultural Land Use Systems in Ukraine to Climate Change: Case Studies and Innovative Practices	2	—
6	Topic 6. Socio-economic consequences of anthropogenic pressure on agricultural landscapes of Ukraine	2	—
7	Topic 7. Modernisation of mechanisms to reduce anthropogenic impact on agricultural land	2	—
Total for content module 1		14	—
Content module 2. Land use systems adapted to climate change, monitoring and restoration of agricultural land			
8	Topic 8. Summarize key elements of adaptive management in agriculture	2	—
9	Topic 9. Monitoring the effectiveness of reclamation measures	2	—
10	Topic 10. Study best practices of protective afforestation in dry regions	2	—
11	Topic 11. Analysis of the features of agricultural land use adaptation to climate change in Ukraine	2	—
12	Topic 12. Comparative analysis of modern soil monitoring tools (field sensors, remote sensing, GIS)	2	—
13	Topic 13. Using climate models and scenarios to predict changes in soil properties	2	—
14	Topic 14. Socio-economic barriers and incentives for the adoption of climate-adaptive practices by farmers	2	—
15	Topic 15. Policy and Economic Incentives for Agroforestry Implementation in Ukraine	2	—
Total for content module 2		16	—
Total hours		30	—

Independent work

Distribution of independent work hours for full-time students:

- preparation for lectures – *1 hour per lecture*;
- preparation for practical classes – *2 hours per class*;
- preparation for assessment activities – *30 hours per assessment*.
-

Independent work assignments

No.	Type of independent work	Number of hours	
		Full-time mode	Part-time mode
1	Preparation for lectures	15	—
2	Preparation for practical classes	30	—
3	Preparation for ongoing module assessment	15	—
4	Independent study of selected topics of the academic discipline	30	—
5	Preparation for the final credit assessment	30	—
<i>Total</i>		120	—

6. Teaching methods, tools for assessing learning outcomes, and methods of their demonstration

The following teaching methods are used:

for all types of classes:

- work with literature – studying various types of sources aimed at acquiring and consolidating new knowledge, developing skills and competencies, and implementing control and corrective functions within formal, non-formal, and informal education;
- explanation – a verbal presentation of cause-and-effect relationships and patterns in the development of nature, human society, and human thought;
- discussion – an exchange of views on a specific issue aimed at acquiring new knowledge, strengthening one's own position, and developing the ability to substantiate and defend it;
- debate – a purposeful comparison of different viewpoints on scientific or social issues aimed at developing students' evaluative judgements and strengthening their worldview positions;

for lectures:

- lecture – an oral presentation of educational material characterised by a considerable amount of information, complex logical structures, and a concentration of concepts, arguments, and generalisations;

- guided conversation – a question-and-answer method aimed at encouraging students to recall previously acquired knowledge and gain new knowledge through independent reflection, conclusions, and generalisations;
- illustration – the presentation and perception of objects, processes, and phenomena in symbolic form through posters, maps, photographs, diagrams, and other visual materials;

for practical classes:

- practical work – a method of deepening and consolidating theoretical knowledge and verifying scientific conclusions;
- didactic game – a specially designed situation or model of reality aimed at developing specific practical skills and abilities.

The assessment tools and methods used to demonstrate learning outcomes include completing assignments during practical classes, a module test, and the final credit assessment.

7. Forms of ongoing and final assessment

Students' academic achievements are assessed according to the University's 100-point grading system.

The final grade for the academic discipline consists of the results of ongoing assessment and the grade awarded for the final credit assessment. Each component has a defined weighting in the overall assessment system. A student may earn up to 60 points through ongoing assessment. This component includes grades received during the semester for work in practical classes and for the ongoing module assessment.

The final credit assessment accounts for 40 points in the overall grading system. The final grade for the academic discipline is calculated as the sum of the ongoing assessment scores and the score obtained for the final credit assessment.

Ongoing assessment is conducted during each practical class and on the basis of completed independent work assignments. It involves assessing students' theoretical knowledge of the relevant topic, including material studied independently, as well as the practical skills demonstrated while completing practical assignments.

Credits for the academic discipline may be awarded only after the learning outcomes specified in the academic discipline programme have been achieved, as confirmed by one of the positive grades established by the applicable regulations.

Forms of assessment of students' learning outcomes and assessment criteria

Practical classes

Number of points	Assessment criteria
3	The assignment is completed within the established deadline and independently. The aims and objectives are clearly formulated. The student independently identifies the type of task and applies an appropriate and rational method to solve it. The report complies with the established requirements and contains well-substantiated conclusions.
2	The assignment is completed independently but after the established deadline. The student performs the practical work in accordance with the instructions, occasionally requiring consultation with the instructor. The report complies with the established requirements.
1	The assignment is completed after the established deadline. The student performs the practical work under the instructor's guidance. The report contains inaccuracies in the conclusions and errors.
0	The assignment has not been completed.
<i>The maximum score for this component of the academic discipline is 45 points: 15 practical assignments worth 3 points each.</i>	

Ongoing module assessment in the form of testing

Correct answers, %	100	90	80	70	60	50	40	30	20	10
Points	15	14	12	11	9	8	6	5	3	2
<i>The maximum score for this component of the academic discipline for full-time students is 15 points for one module test.)</i>										

Final assessment in the form of a final credit assessment

The final assessment consists of written responses to test tasks and two assessment questions.

Testing (20 points)

Correct answers, %	100	90	80	70	60	50	40	30	20	10
Points	20	18	16	14	12	10	8	6	3	1

Assessment question (one question – 10 points)

Number of points	Assessment criteria
9–10	A correct answer demonstrating knowledge of the material, logical and consistent presentation, relevant examples, calculations where necessary, and a well-substantiated conclusion.
7–8	A correct answer, but the presentation lacks consistency.
5–6	A correct answer, but the presentation lacks consistency, and no examples or justification of the conclusion are provided.
3–4	An incorrect answer; however, some knowledge of the material and command of the key terminology are demonstrated.
1–2	An incorrect answer.
0	No answer is provided.

Form of assessment	Maximum number of points	
	Full-time mode	Part-time mode
Work in practical classes	15 × 3 points = 45 points	–
Ongoing module assessment	1 × 15 points = 15 points	–
Final assessment (final credit assessment)	40 points	–
Total	100 points	–

8. Criteria for assessing learning outcomes

Programme component		Full-time mode of study		Part-time mode of study	
		Type of work	Number of points	Type of work	Number of points
Content module 1	T1	Practical assignment No. 1	3	—	—
	T2	Practical assignment No. 2	3	—	—
	T3	Practical assignment No. 3	3	—	—
	T4	Practical assignment No. 4	3	—	—
	T5	Practical assignment No. 5	3	—	—
	T6	Practical assignment No. 6	3	—	—
	T7	Practical assignment No. 7	3	—	—
Ongoing module assessment		Test tasks	15	—	—
Content module 2	T8	Practical assignment No. 8	3	—	—
	T9	Practical assignment No. 9	3	—	—
	T10	Practical assignment No. 10	3	—	—
	T11	Practical assignment No. 11	3	—	—
	T12	Practical assignment No. 12	3	—	—
	T13	Practical assignment No. 13	3	—	—
	T14	Practical assignment No. 14	3	—	—
	T15	Practical assignment No. 15	3	—	—
Final assessment		Final credit assessment	40	—	—
Total points		-	100	—	—

9. Tools, equipment, and methodological support used in the academic discipline

1. Multimedia projection equipment and a laptop for presentations using Microsoft PowerPoint.
2. Methodological materials for practical assignments.
3. Textbooks, scientific literature, and other educational resources.

10. Recommended information sources

Core references

1. Balyuk, S. A., Medvedev, V. V., Solovey, V. B., Vorotyntseva, L. I., & Yanse, L. A. (2021). *Ukrainian chernozem – 140 years after V. V. Dokuchaev: Current state, evolution and management: Monograph*. DISA PLUS. (in Ukrainian)
2. European Commission. (2021). *EU Soil Strategy for 2030: Reaping the benefits of healthy soils for people, food, nature and climate* (COM (2021) 699 final). Brussels.
3. Food and Agriculture Organization of the United Nations. (2021). *The state of the world's land and water resources for food and agriculture: Systems at breaking point*. FAO.
4. Food and Agriculture Organization of the United Nations, & United Nations Environment Programme. (2021). *Global assessment of soil pollution: Report*. FAO. <https://doi.org/10.4060/cb4894en>
5. Intergovernmental Panel on Climate Change. (2022). *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*. IPCC.
6. Organisation for Economic Co-operation and Development. (2020). *Towards sustainable land use: Aligning biodiversity, climate and food policies*. OECD Publishing. <https://doi.org/10.1787/3809b6a1-en>
7. World Bank. (2021). *Ukraine: Building climate resilience in agriculture and forestry*. World Bank Group.

Supplementary references

1. Balyuk, S. A., Vorotyntseva, L. I., Solovey, V. B., & Shymel, V. V. (2023). Realities of the current state, evolution, preservation and sustainable management of Ukrainian chernozems. *Bulletin of Agricultural Science*, (3), 5–13. <https://doi.org/10.31073/agrovisnyk202303-01> (in Ukrainian).
2. Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, 29, 42539–42559. <https://doi.org/10.1007/s11356-022-19718-6>.
3. AI4SoilHealth Project. (2024). *Indicators for soil degradation and method testing* (Deliverable D3.3). AI4SoilHealth. <https://ai4soilhealth.eu/wp-content/uploads/2025/09/D3.3-Indicators-for-soil-degradation-and-method-testing-v1.pdf>.
4. Moldavan, L., Pimenowa, O., Wasilewski, M., & Wasilewska, N. (2023). Sustainable development of agriculture of Ukraine in the context of climate change. *Sustainability*, 15(13), 10517. <https://doi.org/10.3390/su151310517>.
5. Nepomoceno, T. A. R., & Carniatto, I. (2023). Correlations between climate resilience in family farming and sustainable rural development: A scoping review. *Ambio*, 52, 1233–1247. <https://doi.org/10.1007/s13280-023-01848-x>.
6. Pozniak, S. P., & Hnatyshyn, M. A. (2021). Global initiative “4 PER 1000” and opportunities for its implementation in Ukraine. *Ukrainian Geographical Journal*, 2(114), 11–19. <https://doi.org/10.15407/ugz2021.02.011> (in Ukrainian).

7. Willer, H., Trávníček, J., & Schlatter, B. (Eds.). (2025). *The world of organic agriculture: Statistics and emerging trends 2025*. Research Institute of Organic Agriculture FiBL; IFOAM – Organics International.

Internet information resources

1. FAO Open Knowledge Repository – an electronic repository of publications, reports, and methodological materials of the Food and Agriculture Organization of the United Nations. URL: <https://openknowledge.fao.org/>
2. FAO Global Soil Partnership – an information resource on the Global Soil Partnership, sustainable soil management, and monitoring of soil resources. URL: <https://www.fao.org/global-soil-partnership/>
3. IPCC – the official website of the Intergovernmental Panel on Climate Change, containing reports on climate change, land use, adaptation, and climate change mitigation. URL: <https://www.ipcc.ch/>
4. ISRIC – World Soil Information – an international information system on global soil resources, digital soil maps, and soil databases. URL: <https://www.isric.org/>
5. European Soil Observatory (EUSO) – an information platform of the European Commission on soil condition, soil resource monitoring, and soil protection policy. URL: https://joint-research-centre.ec.europa.eu/eu-soil-observatory-euso_en
6. EUR-Lex – the official portal of European Union law, containing regulatory documents on soil protection, sustainable land use, organic production, and climate policy. URL: <https://eur-lex.europa.eu/>
7. State Statistics Service of Ukraine – an official source of statistical data on agriculture, crop yields, sown areas, and regional indicators of agricultural sector development in Ukraine. URL: <https://www.ukrstat.gov.ua/>