EU4Environment in Eastern Partner Countries:
Water Resources and Environmental Data (ENI/2021/425-550)

UKRAINE CLC2023 FINAL REPORT

Status and Change layers

Funded by
the European Union

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ABOUT THIS REPORT

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ABOUT EU4ENVIRONMENT – WATER RESOURCES AND ENVIRONMENTAL DATA

This Programme aims at improving people's wellbeing in EU's Eastern Partner Countries and enabling their green transformation in line with the European Green Deal and the Sustainable Development Goals (SDGs). The programme's activities are clustered around two specific objectives: 1) support a more sustainable use of water resources and 2) improve the use of sound environmental data and their availability for policy-makers and citizens. It ensures continuity of the Shared Environmental Information System Phase II and the EU Water Initiative Plus for Eastern Partnership programmes.

The Programme is implemented by five Partner organisations: Environment Agency Austria (UBA), Austrian Development Agency (ADA), International Office for Water (OiEau) (France), Organisation for Economic Co-operation and Development (OECD), United Nations Economic Commission for Europe (UNECE). The action is co-funded by the European Union, the Austrian Development Cooperation and the French Artois-Picardie Water Agency based on a budget of EUR 12,75 million (EUR 12 million EU contribution). The implementation period is 2021-2024.

https://eu4waterdata.eu

CONTENTS

List of abbreviations

ADA..... Austrian Development Agency
BQE..... Biological Quality Elements
DoA..... Description of Action
DG NEAR..... Directorate-General for Neighbourhood and Enlargement Negotiations of the European Commission
EaP..... Eastern Partners
EC..... European Commission
EECCA ..... Eastern Europe, the Caucasus and Central Asia
EMBLAS ..... Environmental Monitoring in the Black Sea
EPIRB ..... Environmental Protection of International River Basins
ESCS..... Ecological Status Classification Systems
EU ..... European Union
EUWI+..... European Union Water Initiative Plus
GEF ..... Global Environmental Fund
ICPDR..... International Commission for the Protection of the Danube River
INBO ..... International Network of Basin Organisations
IOW/OIEau ..... International Office for Water, France
IWRM ..... Integrated Water Resources Management
NESB ..... National Executive Steering Board
NFP ..... National Focal Point
NGOs ..... Non-Governmental Organisations
NPD..... National Policy Dialogue
OECD..... Organisation for Economic Cooperation and Development
RBD..... River Basin District
RBMP..... River Basin Management Plan
Reps..... Representatives (the local project staff in each country)
ROM ..... Result Oriented Monitoring
ToR ..... Terms of References
UBA..... Umweltbundesamt GmbH, Environment Agency Austria
UNDP..... United Nations Development Programme
UNECE..... United Nations Economic Commission for Europe
WFD..... Water Framework Directive

Country Specific Abbreviations Armenia

EMIC ..... Environmental Monitoring and Information Centre (until January 2020)

HMC..... Hydrogeological Monitoring Centre (since February 2020)

MNP..... Ministry of Nature Protection

SCWS ..... State Committee on Water Systems

SWCIS ..... State Water Cadastre Information System of Armenia

WRMA ..... Water Resources Management Agency

Country Specific Abbreviations Azerbaijan

Azersu JSC..... JSC Water Supply and Sanitation of Azerbaijan

MENR..... Ministry of Ecology and Natural Resources

WRSA..... Water Resources State Agency of Ministry of Emergency Situations

Country Specific Abbreviations Georgia

MENRP..... Ministry of Environment and Natural Resources Protection

NEA..... National Environment Agency

NWP..... National Water Partnership

Country Specific Abbreviations Moldova

AAM..... Agency “Apele Moldovei”

AGMR ..... Agency for Geology and Mineral Resources

AMAC..... Association of Apacanals

ANRE..... National Agency for Economic Regulation of the Energy Sector (also regulates WSS)

EAM ..... Environment Agency Moldova

MoAgri..... Ministry of Agriculture (of the Republic of Moldova)

MoENV ..... Ministry of Environment (of the Republic of Moldova)

Moldova ..... Republic of Moldova

SHS..... State Hydrometeorological Service

Country Specific Abbreviations Ukraine

MENR..... Ministry of Ecology and Natural Resources

NAAU ..... National Accreditation Agency of Ukraine

SAWR..... State Agency of Water Resources

SEMS..... State Environment Monitoring System

UkrHMC..... Ukrainian Hydrometeorological Center

Key messages

With the help of CORINE Land Cover methodology it is possible to perform the constant monitoring of land cover changes in the Carpathian Mountains that might be inflicted by climate change or anthropogenic activity. Implementation of such monitoring is crucial for understanding the processes that are ongoing in the area of interest and helps develop a plan of actions on how to use the land more effectively, prevent any emergencies, forest dieback, assess any possible risks etc. It also contributes to ensuring the movement towards the sustainable development goals. An important step would also be to make the land-use / land-cover information available for public, for stakeholders, for local authorities etc. With the implementation of Corine Land Cover methodology into routine monitoring process on the national level the new stage of quality of the land monitoring can be achieved.

Executive Summary

PART I. STATUS LAYER 2023

1.1. Images 2023

In the AOI, seven tiles have been covered: T34UGV, T34UFV, T34UGU, T34UFU, T34UEU, T35ULP, T35ULQ

Data from Sentinel-2 satellites was used: T34UGV (17 March 2023, 19 August 2022, 09 November 2022, 22 July 2022, 27 March 2022); T34UFV (17 March 2023, 19 August 2022, 25 July 2022, 27 March 2022, 17 November 2021); T34UGU (19 March 2023, 17 March 2023, 09 November 2022, 19 August 2022, 25 July 2022, 22 July 2022, 27 March 2022), T34UFU (17 March 2023, 19 August 2022, 25 July 2022, 27 March 2022), T34UEU (17 March 2023, 19 August 2022, 25 July 2022, 27 March 2022), T35ULP (09 November 2023, 19 March 2023, 22 July 2022), T35 ULQ (09 November 2023, 19 March 2023, 22 July 2022).

Good quality, relatively cloud-free multi-temporal imagery. Full coverage for all scenes.

1.2. Reference (in-situ) data

Reference data included topographic map of Ukraine scale 1:50000, aerial orthophotos, time series images on Google Earth App and local geo-tagged photos.

PART II. CHANGE LAYER 2018

2.1. Images 2018

Data from Sentinel-2 satellites was used: T34UGV (31 July 2017, 01 October 2017, 12 April 2018, 22 April 2018), T34UFV (30 August 2017, 19 October 2017, 22 April 2018), T34UGU (02 August 2017, 16 October 2017, 09 April 2018), T34UFU (15 August 2017, 08 November 2017), T34EUE (15 August 2017, 28 November 2017), T35ULP (02 August 2017, 01 October 2017, 04 April 2018), T35ULQ (02 August 2017, 01 October 2017, 04 April 2018).

2.2. Reference (in-situ) data

Reference data included topographic map of Ukraine scale 1:50000, aerial orthophotos, time series images on Google Earth App and local geo-tagged photos.

PART III. ORGANIZATION OF THE WORK AT NATIONAL LEVEL

3.1. Milestones

All work consists of the following successive stages:

1) Selection of the image and its date to create the status layer, discussion of its characteristics with the European Topic Centre (ETC) experts, creation of a composite image for photointerpretation;
2) Photointerpretation of an image;
3) Creation of the CLC2023 status layer by visual photointerpretation, joint work of the photo interpreter with other experts for unambiguous selection of classes;
4) Checking the status layer and elimination of the errors, transferring it to ETC/DI experts for external verification;
5) External verification of status layer
6) Revision of the CLC2023 status layer based on external verification results
7) Selection of the image and its date to create the CLC-Change layer discussing its characteristics with ETC/DI experts' creation of a composite image for photointerpretation;
8) Creation of the CLC-Change$_{2018\text{-}2023}$ layer by backdating, with parallel correction of residual mistakes in CLC2023 status layer;
9) Internal check for errors and transfer of CLC-Change layer to the ETC experts for external verification;
10) External verification of change layer
11) Correction of the final version of CLC2023 status layer and CLC-Change$_{2018\text{-}2023}$ layer based on external verification results
12) Creation of seamless CLC2023 status layer and CLC-Change$_{2018\text{-}2023}$ layer by edge-matching of along tile borders
13) Creation of CLC2018 status layer;
14) Writing a report on the performed work.

3.2. Processing methodology, software

3.2.1. Methodology of mapping

Mapping methodology is visual photo-interpretation, applying the 'change mapping first' approach, in line with main principals of Corine Land Cover project. The methodology is in conformity with the CLC Technical Guidelines issued by the ETC.

The territory of pilot area chosen because of predicted many changes over the period and the importance of mapping of the Carpathian Mountains. (Figure1).

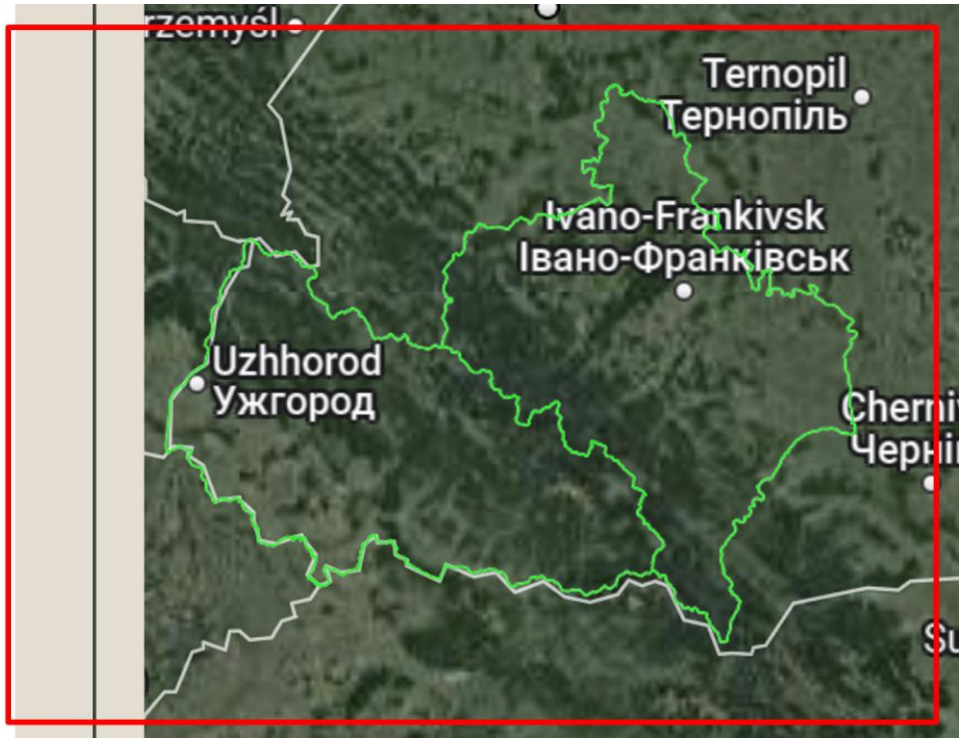

Figure 1: The AOI (Zakarpattia and Ivano-Frankivsk oblasts), covering most of the Carpathians selected by the Ukrainian National Team is overlaid in green

The methodology consists of the following main steps:

- Preparing satellite imagery to support mapping CLC2023;
- Producing CLC2023 layer for tiles;
- Internal and external (ETC/DI) thematic and technical quality control of verification samples, with feedback to interpreters;
- Correction (revision) of CLC2023;
- Preparing satellite imagery to support mapping CLC2018;
- Delineation of land cover changes between 2023 and 2018 (CLC-Change$_{2018\text{-}2023}$) using satellite images and ancillary data for tiles, with parallel correction of residual mistakes in CLC2023;
- External (ETC/DI) verification of CLC-Change$_{2018\text{-}2023}$ and CLC2023 for samples
- Correction of CLC-Change$_{2018\text{-}2023}$ and CLC2023 based on external verification results
- Production of seamless CLC2023 and CLC-Change$_{2018\text{-}2023}$ by edge-matching along tile borders
- Producing backdated seamless CLC2018 by means of semiautomatic generalisation in GIS;
- Final technical quality control of deliverables: CLC- Change$_{2018\text{-}2023}$, CLC2018, CLC2023.

3.2.2. Photointerpretation

Like other participating countries, Ukrainian National Team is using CLC Support Package (Version 4.1.1) module InterChange for creation and revision of CLC2023 and CLC2018 and mapping of changes, and InterCheck module for verification

According to the European methodology, Minimum Mapping Unit (MMU) for status layers is 25 ha, MMU for all changes is 5 ha. All real changes are delineated, not depending on their location.

3.2.3. Control by ancillary in-situ data

To control by in-situ data NT used backdated images from Google Earth App and aerial orthophotos, also some geotagged photos were useful while delineation.

3.2.4. Internal quality control, results

The revised CLC2023 and CLC-Change$_{2018\text{-}2023}$ databases were quality controlled by the leading photo-interpreter. In case mistakes had been discovered, the interpretation with written comments on polygon level was sent back to the interpreter for correction.

3.2.5. External quality control (verification), results

CLC2023: The CLC Technical Team of the ETC verified the results of the photo-interpretation of the CLC2023 database for tile 34UFV. The results of mapping CLC2023 over the tile was acceptable for continuation of work with mapping CLC change. The overall evaluation was 'conditionally accepted. Evaluation was summarized as follows:

"Well mapped in general, however, thematic detail of the interpretation is not sufficient. Non-relevant classes were not found. The following improvements are expected: provide more detail to 112 polygons (discontinuous urban fabric) by excluding non-built-up areas (242); improve agriculture classes by better separating 211 (non-irrigated arable land), pasture (231) classes, improve the delineation between forest classes (311, 312, 313) and agriculture-natural mosaic or grasslands (243, 242, 231). Improve the classification of the 321 class (natural grassland) that were mistakenly mapped as 231. Improve precision of forest (31x) - clear cut (324) separation."

A sample tile (T34UFV) of the CLC2023 map was submitted for 1st verification by the Ukrainian National Team. According to the verification report, pilot's area delineation and interpretation was conditionally accepted. Some remarks were given on technical quality during the 1st verification mission, and some other remarks were given concerning specific and systematic thematic mistakes (misinterpretation). CLC2023 subsequently re-checked and both specific and systematic mistakes were corrected.

Note that verification of change data also includes some level of checking the CLC2023 status layer.

CLC-Change$_{2018\text{-}2023}$: The CLC Technical Team of the ETC verified the results of the photo-interpretation of the Change database for tile T35ULQ, T35ULP, T34UEU and T34UGU. The results of mapping the 2018 – 2023 changes were acceptable for creating a backdated 2018 map. The overall evaluation was "accepted" and "conditionally accepted".

Sample tiles (T34UGU, T34UPL, T34ULQ, T34UEU) of the CLC-Change map were submitted for 2nd (change) verification by the Ukrainian National Team. According to the verification report, area change mapping delineation was accepted with minor remarks.

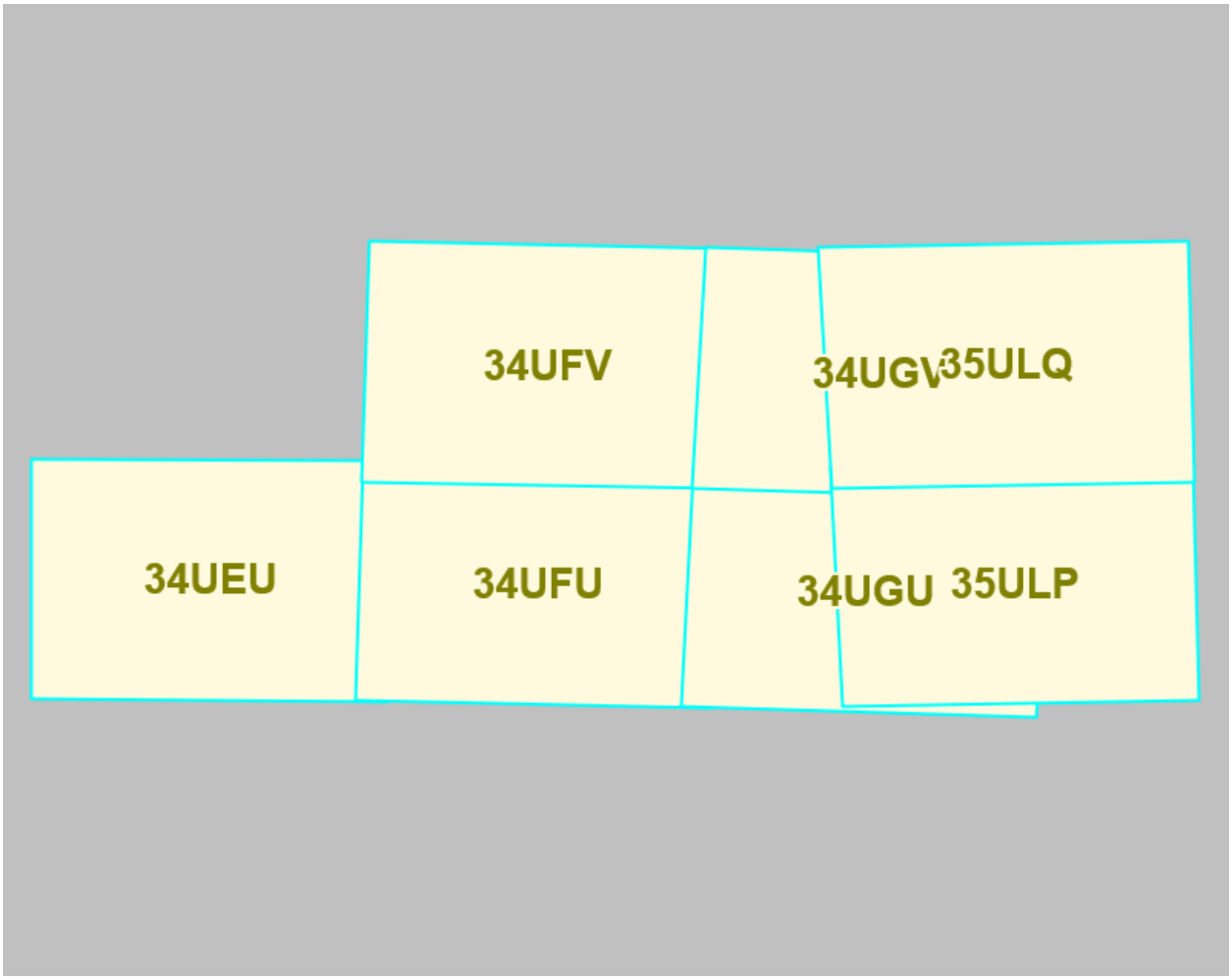

Figure 2: The map of tiles used in the project

3.2.6. Main difficulties and their solution

The main difficulty was preparing the appropriate imagery, with no clouds/snow especially in spring/autumn images, while that happens often in the mountains in the mentioned seasons. Also, the NT had lack of fresh orthophotos over the territory of Ukraine, which may be caused by martial law in Ukraine, which makes it difficult to find a proper solution. Still, this problem can be solved by using national cadaster database and up-to-date GoogleEarth images.

PART IV. RESULTS

4.1. Statistics

CLC2023 statistics: based on detailed CLC status layer statistics, the table that includes the distribution of classes that are present in the AOI. The results are shown separately for each oblast as well as in total numbers.

Class code	Class name	Zakarpattia oblast (sq km)	Ivano-Frankivsk oblast (sq km)	Total area (sq km)
111	Continuous urban fabric	-	0,6	0,6
112	Discontinuous urban fabric	468,1	738,0	1206,1
121	Industrial or commercial units and public facilities	28,6	56,5	85,1
122	Road and rail networks and associated land	3,7	-	3,7
124	Airports	1,2	7,2	8,4
131	Mineral extraction sites	3,9	6,5	10,4
132	Dump sites	0,7	-	0,7
133	Constructions sites	0,3	0,8	1,1
141	Green urban areas	2,4	1,7	4,1
142	Sport and leisure facilities	3,6	5,5	9,1
211	Non-irrigated arable land	1077,5	2589,6	3667,1
221	Vineyards	10,4	-	10,4
222	Fruit tree and berry plantations	17,8	10,8	28,6
231	Pastures, meadows and other permanent grasslands under agricultural use	587,8	668,0	1255,8
242	Complex cultivation patterns	885,2	1379,7	2264,9
243	Land principally occupied by agriculture with significant areas of natural vegetation	1785,4	1491,4	3276,8
311	Broad-leaved forest	3658,4	1427,9	5086,3
312	Coniferous forest	1174,9	2859,6	4034,5
313	Mixed forest	2077,5	1841,5	3919
321	Natural grassland	178,1	40,3	218,4
322	Moors and heathland (dwarf pine)	22,0	65,6	87,6
324	Transitional woodland / shrub	713,5	561,7	1275,2

331	Beaches, dunes and sand planes	1,0	-	1
332	Bare rock	-	5,5	5,5
333	Sparsely vegetated areas	1,7	12,1	13,8
411	Inland marshes	10,5	37,0	47,5
412	Peat bogs	0,5	-	0,5
511	Water courses	28,9	81,3	110,2
512	Water bodies	16,7	45,0	61,7
Total		**12760,3**	**13933,8**	**26694,1**

CLC2018 statistics:

Class code	Class name	Zakarpattia oblast (sq km)	Ivano-Frankivsk oblast (sq km)	Total area (sq km)
111	Continuous urban fabric	-	0,6	0,6
112	Discontinuous urban fabric	468,3	737,8	1206,1
121	Industrial or commercial units and public facilities	27,2	53,2	80,4
122	Road and rail networks and associated land	3,7	-	3,7
124	Airports	1,0	7,2	8,2
131	Mineral extraction sites	3,8	6,5	10,3
132	Dump sites	0,7	-	0,7
133	Constructions sites	0,4	1,1	1,5
141	Green urban areas	2,4	1,7	4,1
142	Sport and leisure facilities	3,6	5,5	9,1
211	Non-irrigated arable land	967,2	2289,7	3256,9
221	Vineyards	11,9	-	11,9
222	Fruit tree and berry plantations	16,1	10,5	26,6
231	Pastures, meadows and other permanent grasslands under agricultural use	668,5	835,4	1503,9
242	Complex cultivation patterns	915,8	1515,5	2431,3
243	Land principally occupied by agriculture with significant areas of natural vegetation	1785,6	1490,0	3275,3
311	Broad-leaved forest	3665,9	1431,7	5097,6
312	Coniferous forest	1218,2	2879,1	4097,3
313	Mixed forest	2082,4	1852,1	3934,5
321	Natural grassland	178,0	40,3	218,3
322	Moors and heathland (dwarf pine)	22,0	65,6	87,6
324	Transitional woodland / shrub	658,9	530,7	1189,6
331	Beaches, dunes and sand planes	1,0	-	1
332	Bare rock	-	5,5	5,5
333	Sparsely vegetated areas	1,7	12,1	13,8
411	Inland marshes	9,9	37,1	47

412	Peat bogs	0,5	-	0,5
511	Water courses	29,0	80,9	109,9
512	Water bodies	16,6	44,3	60,9
Total		12760,3	13933,8	26694,1

CLC Change statistics:

Change label (2018-2023)	Area of change type (ha)
112--133	10,23
112--211	5,49
112--231	6,87
112--242	13,07
112--243	11,5
112--324	6,09
121--133	54,01
121--211	35,22
121--222	9,91
121--231	438,3
121--242	26,71
121--243	18,95
121--324	64,98
124--231	25,21
131--211	7,33
131--231	13,8
131--242	5,89
131--243	5,47
131--324	5,59
133--231	25,67
133--243	8,83
141--231	9,53
142--231	11,74
211--121	47,32
211--131	28,42
211--221	193,71
211--222	96,91
211--231	23615,92
211--242	18183,7
211--243	656,92
211--324	460,3
221--211	46,75
222--211	263,5
222--231	104,24
222--242	6,53
222--324	33,65
231--211	910,41
231--222	19,86
231--242	1485,76
231--243	25,11
231--312	63,9
231--313	32,71
231--324	13,3
231--512	26,76
242--112	15,83
242--121	51,12
242--211	187,62
242--222	5,97
242--231	1568,25
243--211	27,17
243--222	11,21
243--231	399,8
243--242	36,54
243--311	68,98
243--312	238,85
243--313	51,98
243--324	21,7
243--511	19,63
311--112	36,63
311--242	41,65
311--243	50,65
311--313	562,31
311--324	149,07
311--511	93,18
312--243	14,78
312--313	10,87
312--324	357,22
313--231	9,74
313--243	34,33
313--311	100,08
313--312	436,05
313--324	65,94
324--222	25,4
324--231	319,85
324--243	220,25
324--311	1 897,24

324--312	5685,87
324--313	1482,11
324--331	9,64
324--511	37,39
331--324	13,66
411--231	64,79
411--512	21,8
511--211	6,45
511--243	33,03

511--311	52,9
511--324	97,9
512--121	7,97
512--231	55,03
512--243	10,03
512--312	9,8
512--324	22,03
512--411	15,89
Total	**61 892,25***

*Not including the technical change. The technical change area is 1943,95 ha.

The total percentage of change area compared to total area is 2,3%.

4.2. Time table

Time	Organisation (venue)	People met	Project expert(s)	Comments
13-14 March 2023	Online CORINE Kick-off meeting	Ministry of Environment Protection and Natural Resources of Ukraine, Ministry for Communities, Territories and Infrastructure Development of Ukraine, Ministry of Economy of Ukraine, Space Agency of Ukraine, State Service of Ukraine for geodesy, cartography and cadastre, Ministry of Digital Transformation of Ukraine, State Agency of Water Resources, State Agency of Forest Resources, State Statistic services, State Enterprise "Center of the State Land Cadaster", NUBiP, National Academy of Agrarian Sciences, Environment Agency Austria, European Environment Agency	Barbara Kosztra, Sergiy Zibtsev, Oleksii Petrov, Iryna Zibtseva, Iryna Melnyk, Dmytro Averin	Kick-off meeting for the UA CLC Carpathian project
18 May 2023	Kyiv	Iryna Zibtseva, Oleksii Petrov	Iryna Zibtseva, Oleksii Petrov	Imagery for Tile 1 were acquired
15 June 2023	Online Meeting of the	Barbara Kosztra, Iryna Zibtseva, Oleksii Petrov	Barbara Kosztra, Iryna Zibtseva, Oleksii Petrov	Common mistakes were discussed, questions on interpretation of

	interpretation experts			certain classes were considered.
31 July 2023	Kyiv	Iryna Zibtseva, Oleksii Petrov	Iryna Zibtseva, Oleksii Petrov	Imagery for Tile 2 were acquired Updated tiles for Tile 1 (cloudless, snowless)
29 August 2023	Kyiv	Iryna Zibtseva, Oleksii Petrov	Iryna Zibtseva, Oleksii Petrov	Imagery for Tile 3 were acquired Discussion of the overall progress
23 January 2024	Kyiv	Iryna Zibtseva, Oleksii Petrov	Iryna Zibtseva, Oleksii Petrov	Imagery for Tile 4 were acquired
7-8 February 2024	Online Output 2.2 Land Monitoring	Ukrainian National Team, Ministry of Environment Protection and Nature Resources, Ministry of Territorial Administration and Infrastructures, Ministry of Economy, Space Agency of Ukraine, State Service of Ukraine for geodesy, cartography and cadaster, State Agency of water resources, State Statistic services, Environment Agency Austria, NUBiP, REEFMC, URIFFM	Sergiy Zibtsev, Oleksii Petrov, Iryna Zibtseva, Iryna Melnyk, Dmytro Averin	Discussion of interim results of the CLC mapping, training on applying GIS and RS methods
27 March 2024	Kyiv	Iryna Zibtseva, Oleksii Petrov	Iryna Zibtseva, Oleksii Petrov	Imagery for Tiles 5, 6, 7 were acquired
9 May 2024	Kyiv	The entire National Team	NT	Discussion of the Status layer, the challenges while completing.
21-22 May 2024	Tbilisi, Georgia	The NT of the participant countries	Iryna Zibtseva	Presenting of the results of the mapping the AOI
3 June 2024	Kyiv	The entire National Team	Iryna Zibtseva, Oleksii Petrov	Discussion on the start of change mapping and acquiring the

				imagery for mapping changes
10 June 2024	Kyiv	The entire National Team	Iryna Zibtseva, Oleksii Petrov	Discussion of interim results of the CLC change mapping
28 June 2024	Kyiv	The NT experts, colleagues from NUBiP and Agroresurssystems	Iryna Zibtseva	Training on applying the CORINE methodology for mapping land cover changes.
23 July 2024	Kyiv	The entire National Team	Iryna Zibtseva, Oleksii Petrov	Discussion of the Change layer, the challenges while completing, future steps.
1 August 2024	Kyiv	The entire National Team	Iryna Zibtseva, Oleksii Petrov, Sergiy Zibtsev	Preparing and sending the final report.

The following results were achieved after all the steps were completed:

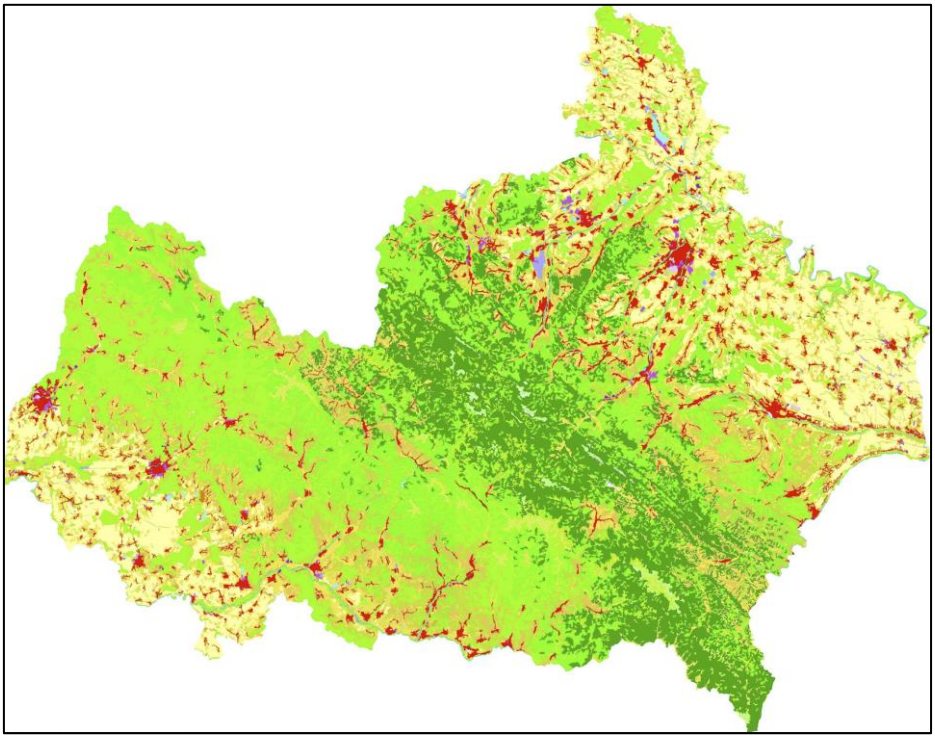

Figure 3: CLC2023 map of the AOI

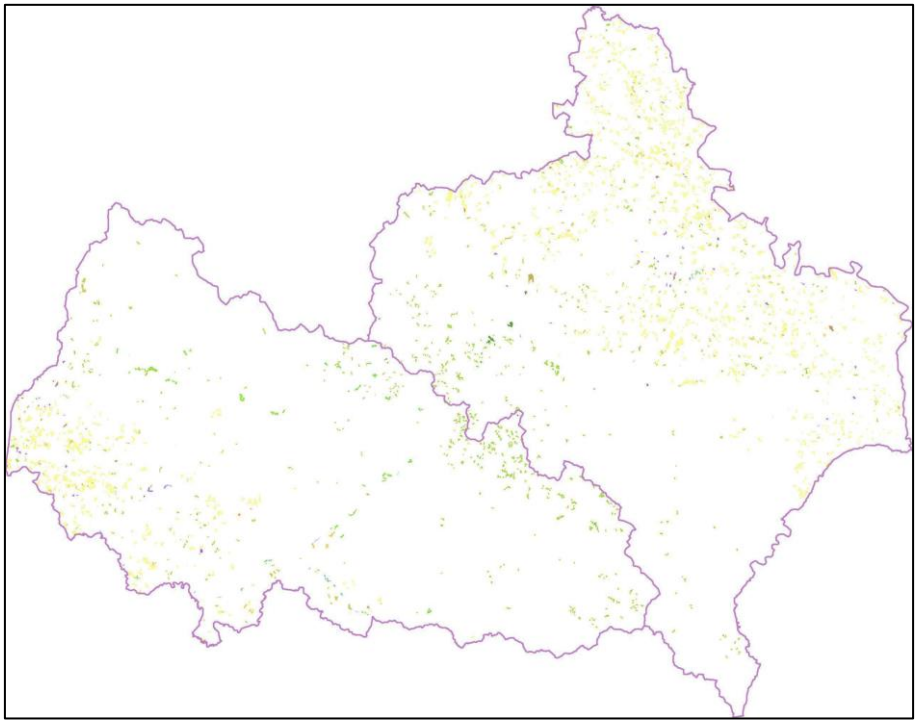

Figure 4: The CLC Change layer for the AOI

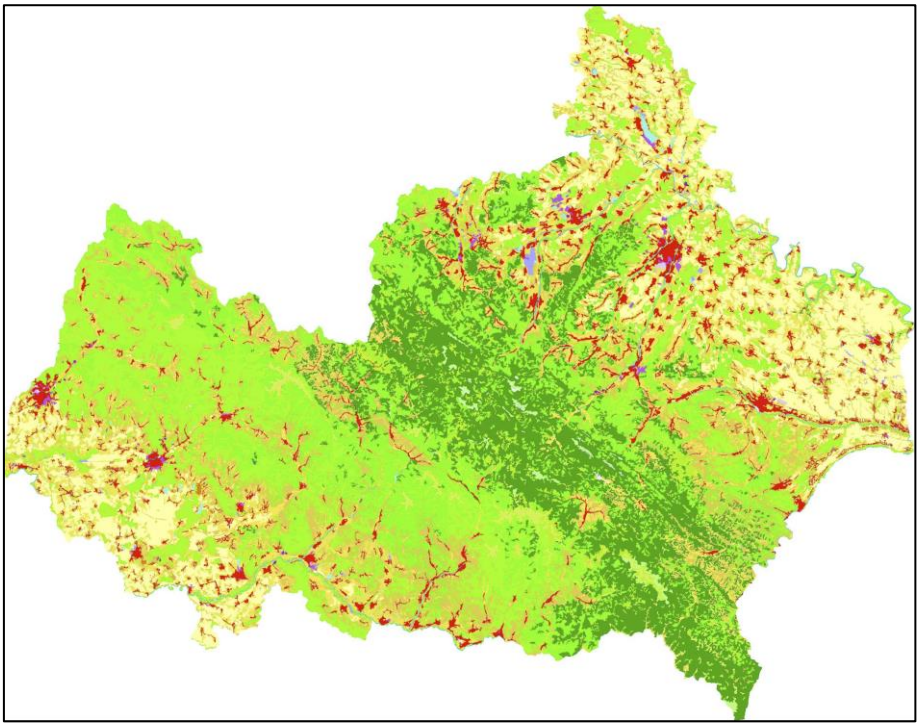

Figure 5: Achieved CLC2018 map of the AOI

Next steps / to do's

STEP/TASK	RESPONSIBILITY	DEADLINE
Publishing the maps and report	Sergiy Zibtsev, Oleksii Petrov	30 November 2024

Annexes

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Water and Data in Eastern Partner Countries

www.eu4waterdata.eu

Implementing partners

umweltbundesamt
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Austrian Development Agency

OiEau International Office for Water

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