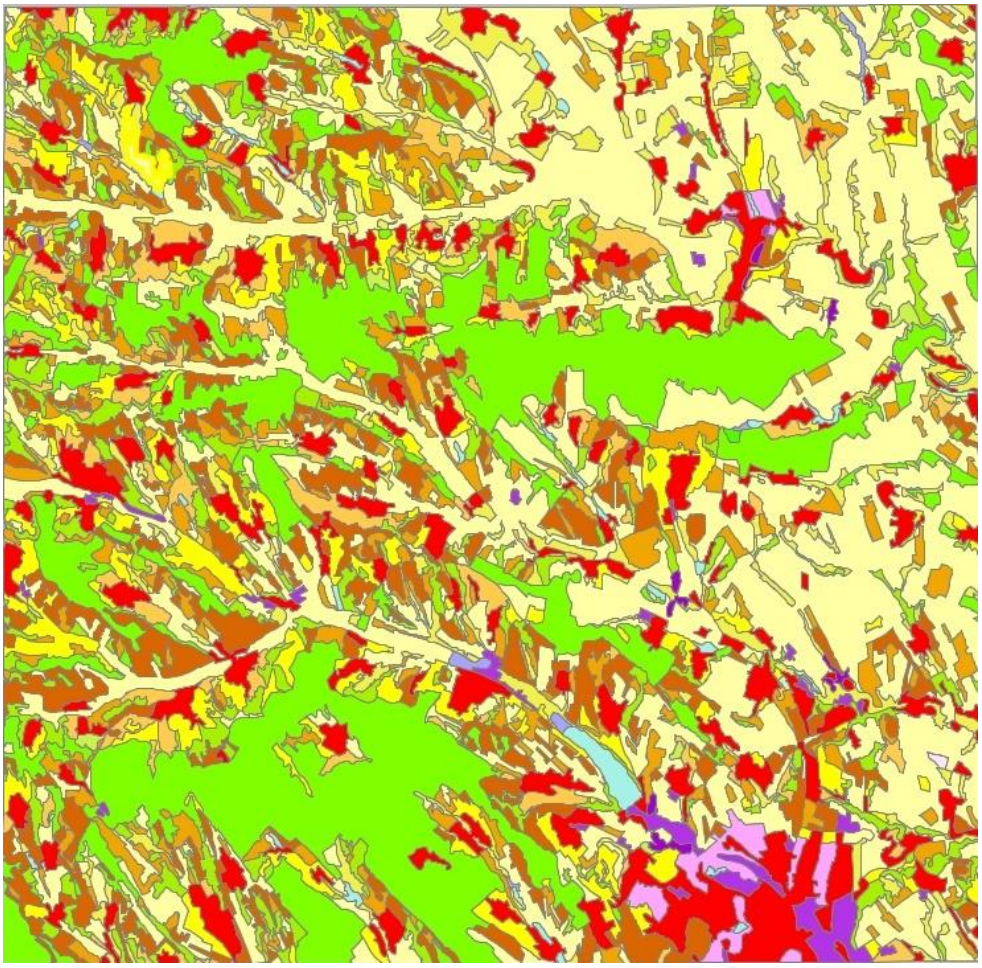
Final Report

Expert support and technical assistance for the implementation of the pilot project extending the CORINE Land Cover (CLC) methodology in the Republic of Moldova

(Reference number: BE-003715)



Agency for Land Relations and Cadastre of the Republic of Moldova/
State Enterprise Institute of Geodesy, Engineering Research and Cadastre "INGEOCAD"

Project manager: Maria Ovdii, Dr. Ing

12 December 2019

The present report is part of the EU funded 'ENI SEIS II' project implemented by EEA with support from ETC/ULS

Table of contents

1. Background

Cooperation between the EEA and the six Eastern Partnership countries (Armenia, Azerbaidjan, Belarus, Georgia, Republic of Moldova and Ukraine) is established through the EU-funded regional project "Implementation of the Shared Environmental information System principles and practices in the Eastern Partnership countries" (the ENI SEIS II East Project).

Activity 2.3 of the ENI SEIS II East Description of Action[1] "**Pilots on extending CORINE Land Cover (CLC) methodology to areas of the partner countries**" is a step to facilitate the access to, and use of, some spatial data required for SEIS implementation at national level. This activity also allows direct links to related initiatives and programmes at the European level; namely the on-going work to produce the 2018 update of the CLC layers in the EEA39 countries, and services provided through the Copernicus Programme (activities are to be implemented in close dialogue and cooperation with the Copernicus activities led by the EEA).
The European Topic Centre on Urban, Land and Soil Systems (ETC/ULS) assists the EEA for the implementation of Activity 2.3 of the ENI SEIS II East. **The coordinating unit for the ETC/ULS is the Environment Agency Austria.**

Expert support and technical assistance for the implementation of pilot project expending the CORINE: Land Cover (CLC) methodology in the six Eastern Partnership countries was provided by the European Topic Centre on Urban, Land and Soil Systems (ETC/ULS) **under joint contracting with the Copernicus programme.**

Coordination of country-level activities is ensured by two formally appointed National Focal Points (NFPs), from the Ministry of Agriculture, Regional Development and Environment and National Bureau of Statistics in the case of the Republic of Moldova. The Ministry of Agriculture, Regional Development and Environment (MARDE) does not currently have remote sensing experts, needed for some of the tasks under the CLC activity. For these services in remote sensing, MARDE relies on the Agency for Land Relations and Cadastre of the Republic of Moldova throw its State Enterprise Institute of Geodesy, Engineering Research and Cadastre "INGEOCAD", as production unit.

Similarly to other EEA member countries, the steps for the full implementation of the CLC pilot project in the Republic of Moldova are defined in the **Technical specifications for the CORINE Land Cover (CLC) pilot projects implemented in the Eastern Partnership countries (2017-2019)**:

- Mapping the CLC status layer over the pilot area; due to the special situation in the Republic of Moldova that the CLC2000 status layer exists Revision of the existing CLC2000 status layer covering the pilot area using verification remarks of ETC/ULS
- Mapping the CLC-change layer over the pilot area; correction of the layers by following verification remarks of ETC/ULS
- Generating the updated CLC 2018 status layer for the pilot area;
- A report about the work.

In the Republic of Moldova the CLC pilot project has been financed by the Environment Agency Austria under the contract BE-003715.

[1] http://enpi-seis.pbe.eea.europa.eu/workplan/eni-seis-ii/eni-seis-ii-east-description-action-public-version

2. Databases used in the project

The total area of CLC pilot project in the Republic of Moldova is 3158 km^2.

Four high-resolution satellite images taken by the ESA Sentinel-2 satellite in 2017 and 2018, selected and prepared by ETC-ULS partner BFKH were available for the project to cover the pilot area. The multi-seasonal imagery provides an excellent basis for the change mapping exercise over an 18-year long period.

The CLC pilot project in the Republic of Moldova is based primarily on the high resolution (HR) satellite image coverage IMAGE2018. The IMAGE2000 HR satellite image coverage, digital topographic maps, orthophoto imagies and other Reference geospatial data were used to map land cover changes between 2000 and 2018.

An overview of the databases used in the project is shown in Table 1.

Table 1 Overview of databases used in the project

Name	Data type	Resolution	Reference year	Data source
CLC2000				
IMAGE2000	Landsat-5 TM	30m	14May2000, 06June2000, 22June2000	EEA
IMAGE2018	Sentinel-2	10m	31August2017, 11May2018, 14August2018, 20September2018	EEA
CLC2000	CORINE 2000 land cover database	25 ha, 100m	2000	MEM
Topo maps	Topographic maps scale 1:50.000	vector	2012	ALFC
Orthophoto 2007	True colour aerial ortho-photos	0.4m	2007	ALFC
Orthophoto 2016	True colour aerial ortho-photos	0.2m	2016	ALFC

2.1. IMAGE2018

CLC2018 project aims to provide a satellite data coverage for the Pilot area to be mapped in order to support high quality photo-interpretation.

Table 2 Satellite images in the IMAGE2018 database covering CLC pilot project in the Republic of Moldova.

coverage	
Sensor	**Acquisition date (m/d/y)**
Sentinel-2A	31/08/2017
Sentinel-2A	11/05/2018
Sentinel-2A	14/08/2018
Sentinel-2A	20/09/2018

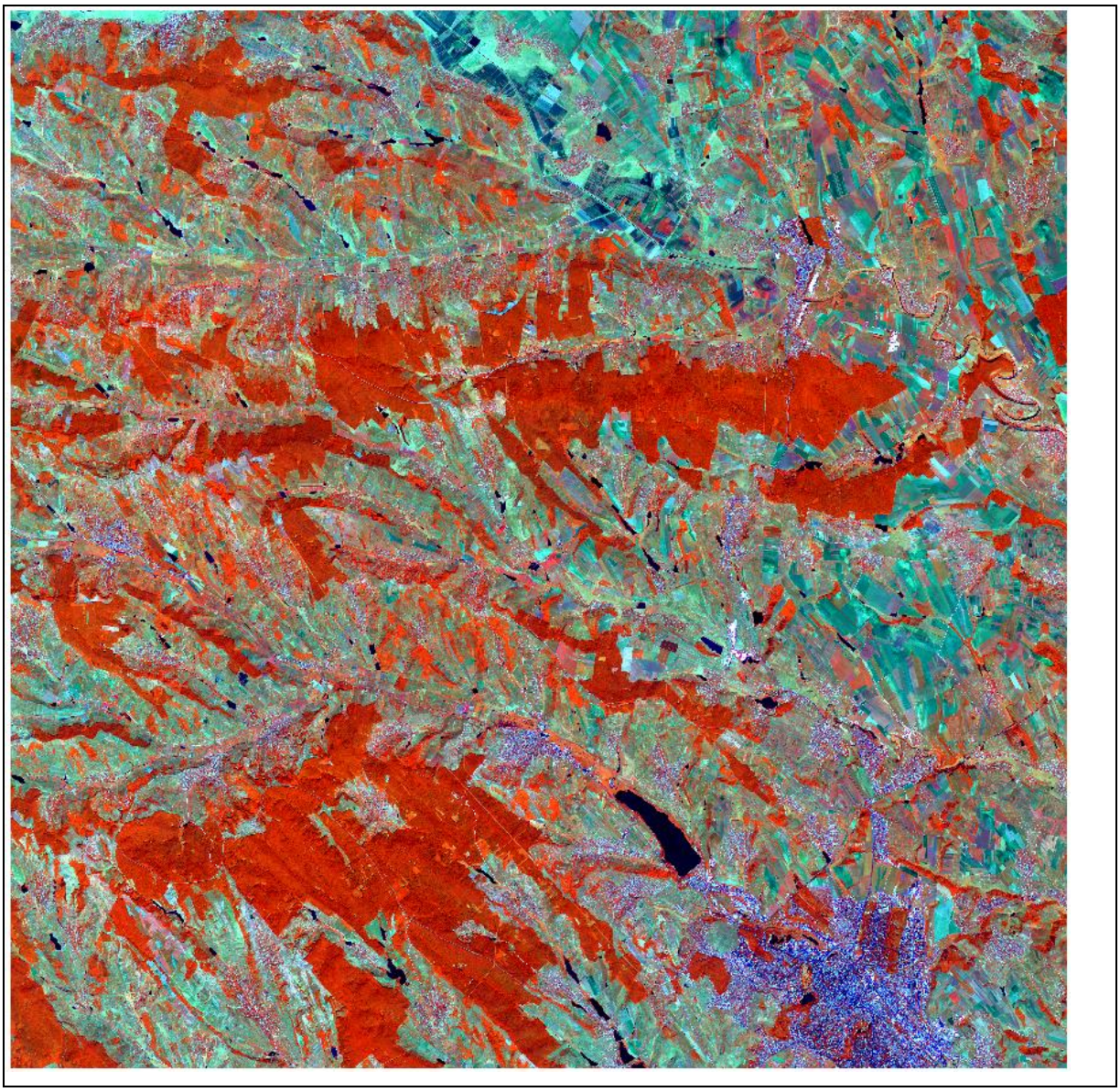


Figure 1 IMAGE2018 covering CLC pilot project in the Republic of Moldova

2.2. IMAGE2000

IMAGE2000 data are ortho-corrected Landsat-5 satellite images taken in 2000 covering the pilot area project.

Table 3: Satellite images in the IMAGE2000 database covering CLC pilot in Moldova

Sensor	Path-row	Acquisition date
Landsat-5	181-27	14/05/2000
	182-27	14/05/2000
	182-27	22/06/2000

2.3. CLC2000

The CLC 2000 in Moldova was produced by Thechnical University of Moldova. The project was funded by Ministry of Environment of Moldova. The goal was to produce a CLC database covering the country for the year 2000[2] according to European specification. The project manager, Dilan Vitalie (member of the present NT) got a training in CLC methodology at the University of Iasi[3], Romania. The results were controlled by Iasi University. Part of the existing

[2] database called as CLC2000_MD

[3] Iasi University is a regular partner institution in Romanian CLC production. They provide photo-interpretation support to the responsible national organisation in Romania.

CLC2000_MD dataset, covering the pilot area was made accessible for verification by ETC-ULS. Checking of the data revealed that the CLC2000 database was technically not fully compliant to the specifications, and related satellite images (taken in year 2000) were not available. ETC-ULS partners GISAT and BFKH solved the technical problems of CLC2000 and downloaded the Landsat TM satellite images taken in 2000 (that had been used to create the CLC2000_MD dataset). The CLC2000_MD interpretation for the pilot area has been verified. Outcome of the verification is that CLC2000_MD data are suitable to continue with revision of CLC2000 and mapping CLC-Change.

2.4. Topographic maps

1:50.000-scale vector topographic maps database, reference years between 2000 and 2012, have been provided by the Agency for Land Relations and Cadastre of Moldova.

2.5. Ortho-photos

Ortho-photos taken in years 2007/2016 at 0.4 m and 0.2 m resolution respectively have been used as ancillary data for change mapping and as the base reference imagery for the accuracy assessment of the HR soil sealing database. The ortho-photos have been provided by the Agency for Land Relations and Cadastre of Moldova. Reference year of the ortho-imagery is shown in Figure 2.

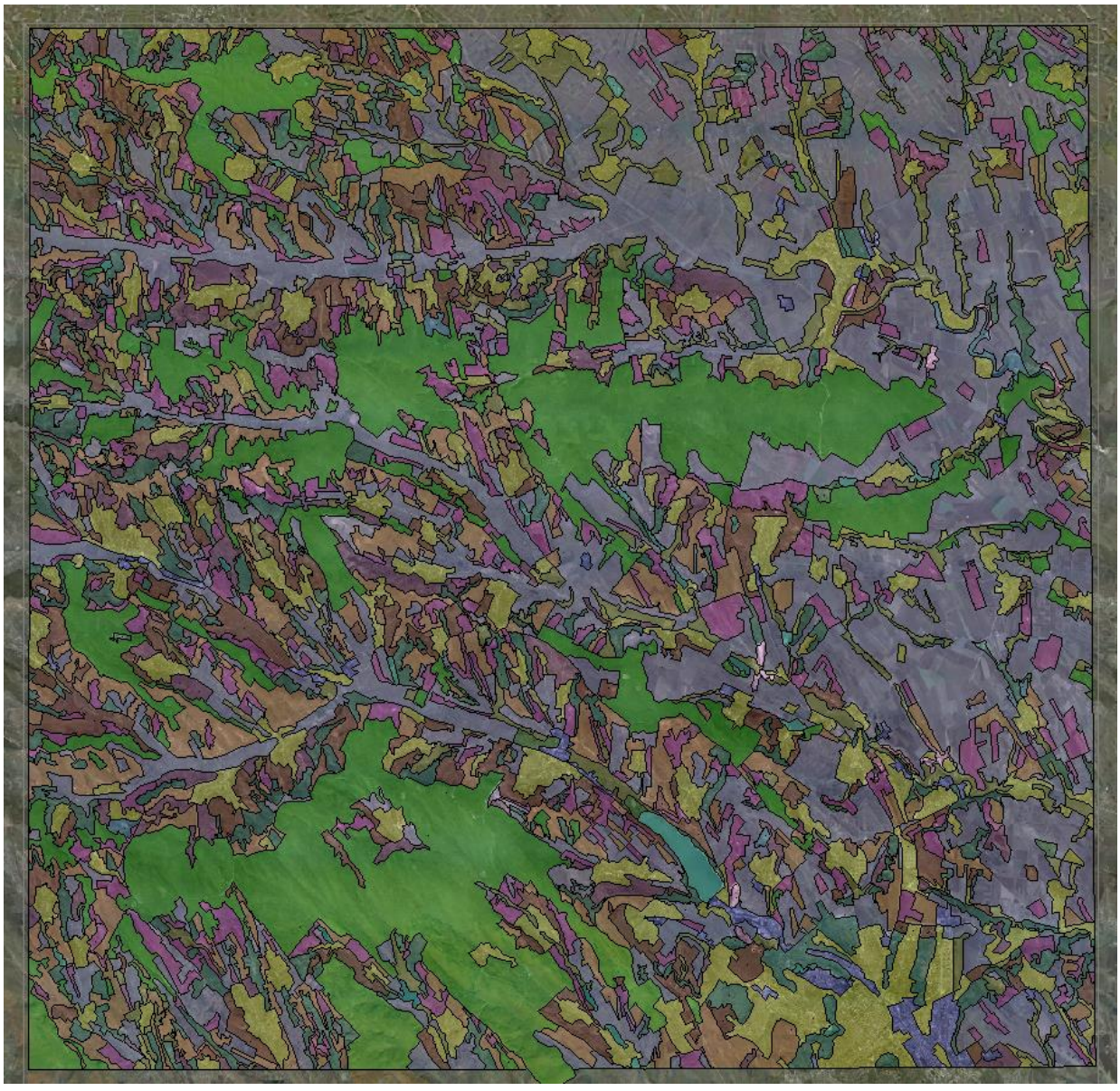


Figure 2 2016 acquisition year of the reference ortho-photos

3. Organization of the work at national level

3.1. Milestones

Milestones of the project are presented in Table 4.

Table 4 Milestones of the CLC pilot project in the Republic of Moldova

No	Date (m/d/y)	Description
1	06/13/2019	A contract between S.E. INGEOCAD and ETC-ULS[4] has been signed to implement the CLC pilot in Moldova.
2	09/24/2019	1st verification by the **ETC-ULS**
3	10/02/2019	2nd verification by the **ETC-ULS**
	12/02/2019	3nd (extra) verification by the **ETC-ULS**
4	12/12/2019	Delivery of final results to EEA's Central Data Repository

3.2. CLC2018 training

Having the CLC2000_MD dataset available, instead of the planned two training missions[5] only a single mission that included the 4 day CLC training cours on mapping CLC and CLC changes, conducted by ETC-ULS (Mr. György BÜTTNER, and Mr. Christopher PHILIPSEN) was provided for Moldova in the period 09-12 July 2019.
Venue: Agency for Land Relations and Cadastre of Moldova, 48 Serghei Lazo str, office 318, Chisinau, MD 2004.

The latest version of InterChange software has been designed to support the CLC2018 project of the EEA, meaning revision of CLC2000 and mapping CLC-Changes between 2000 and 2018. The software has been provided by the ENI project to support mapping changes between any two years (2000 and 2018) and provide possibility to change mapping backward in time, i.e. starting with creating a recent status layer and mapping changes back in time (applied by the other ENI countries where CLC2000 is not available). InterChange is offered free of charge to the ENI participants, but users are requested to register (registration document was provided). Using InterChange in revision of CLC2000 status layer and mapping CLC changes over the pilot area was recommended, but not obligatory.

Capabilities of InterChange module of the CLC2018 Support Package were demonstrated on the CLC pilot area by using three Landsat TM satellite images taken in May and June of 2000 and four Sentinel-2 satellite images taken in 2017 and 2018.

Ten Moldovan experts have participated on the training course, including five National Team (N/T) members. The training was run by two ETC-ULS experts: Christopher PHILIPSEN and György BÜTTNER.

List of participants:

Nr.	Name, Surname	Position	Institution
1	Maria OVDII	project manager, national team (NT)	ALRC
2	Svetlana ZAHARCHINA	photointerpreter, member of NT	S.E. INGEOCAD
3	Natalia CURDOGLO	photointerpreter, member of NT	S.E. INGEOCAD
4	Igor PAHARIKOV	GIS expert, member of NT	S.E. INGEOCAD
5	Dilan VITALIE	expert, member of NT	ONG "OIKUMENA"
6	Pavel IVANENCO	engineer, Geodesy, Mapping and GIS Department	ALRC
7	Tamara RUDENCO	head of National Geospatial Centre	ALRC
8	Ivan DANII	deputy head of Geodesy, Mapping and	ALRC

[4] represented by the leading consortium partner, the Austrian Environment Agency

[5] Technical specifications for the CORINE Land Cover (CLC) pilot projects implemented in the Eastern Partnership countries (2017-2019)

		GIS Department	
9	Dumitru SOBOLEV	Deputy head of Natural Resources Monitoring Division	Environmental Agency of Moldova
10	Maria TARIGRADEAN	SEIS assistant	
11	Christopher PHILIPSEN	CLC expert	ETC ULS/ CLC Technical Team
12	György BÜTTNER	CLC expert	ETC ULS/ CLC Technical Team

Participants of the training course got hands-on experience in handling various functions of the software: like delineation of CLC polygons, correcting a polygon boundary, fast estimation of area and width, error checking and correction, statistics calculation, image enhancement (optimization of the displayed image extent for photointerpretation) etc.

During practical sessions photointerpreters of the NT learnt to execute the following interpretation steps:

- finding and classifying polygons having 0 code (remnant of removed topological mistakes);
- finding and correcting merge errors (probably remnant of removed topological mistakes);
- systematic thematic checking of CLC2000 (by thematic code and "overall" by moving and analysing the displayed extent (proposed display scale: around 1: 50.000);
- understanding and implementing corrections proposed in revision remarks;
- writing comments to a polygon (e.g. additional data needed).

Google Earth (GE) time series was the only available ancillary (in-situ) data, which is linked to the displayed extent of satellite images. GE coverage is excellent for the recent (2018) land cover status. However, only few parts of the pilot area are covered by GE-images taken around 2000. As a consequence, validation of CLC2000 by GE data might become sometimes difficult and proper in-situ data are recommended. When using GE imagery, photointerpreter must not forget about checking the image acquisition date. Also the image dates indicated in GE might be incorrect, therefore in case of contradiction between IMAGE2000 or IMAGE2018 and GE, have to consider the satellite image as valid information. Avoid simultaneous use of InterChange and another GIS software (e.g. ArcGIS) as this might destroy databases.

The CLC Support Package (with the User's Manual), moreover the InterChange project file including CLC2000, IMAGE2000 and IMAGE2018 data for the pilot area were copied onto the computer of the National Team which was used in implementing the project. Setting up the software and the project file had been demonstrated.

During the training course the following documents and data were handed over to the Moldovan National Team:

1. Introduction to CORINE Land Cover (ppt)
2. Practicalities: setting up the CLC pilot in MD (ppt)
3. CLC Nomenclature Illustrated Guide (pdf)
4. Technical Guidelines-CLC2018 (pdf)
5. CLC2000 verification report – MD pilot area (doc)
6. CLC2000 verification remarks – MD pilot area (shp file)
7. Results of 1st verification (ppt)
8. Principles of CLC-Change mapping (ppt)
9. Manual of CORINE Land Cover Changes (pdf)
10. CLC Support Package (latest standard release), install file (zip) incl. Users' Manual
11. InterChange project file covering the pilot study in Moldova.
12. Registration document, CLC Support Package.

Milestones of Training Agenda is presented in **Table 5.**

Table 5. Milestones of Training Agenda of CLC pilot project in the Republic of Moldova

9 July 2019	
15.00 – 15.15	Welcome and introduction of participants (MD/ETC)
15.15 – 16.00	Introduction to CORINE Land Cover (ETC)
16.00 – 16.25	Practicalities: setting up the CLC pilot in MD (ETC/MD)
16:25 – 16:45	*Coffee break*
16:45 – 18:00	The standard European CLC nomenclature – I. Artificial surfaces (ETC)

10 July 2019	
9.00 – 10.30	The standard CLC nomenclature - II**.** Agriculture (ETC)
10.30 – 10.45	*Coffee break*
10.45 – 12:00	The standard European CLC nomenclature - III**.** Forests and seminatural areas (ETC)
12.00 – 13.00	*Lunch break*
13.00 – 13.30	The standard European CLC nomenclature - IV**.** Wetlands and Water (ETC)
13.30 – 15:15	Introduction to CLC2018 Support Package (ETC)
15.15 – 15.45	*Coffee break*
15.45 – 17:30	Discussion of project's approach and the verification results of CLC2000_MD
17:30 – 20:00	Short field trip North of Chisinau, offered by the project manager of the NT
11 July 2019	
9:00 – 10.30	Practical CLC mapping exercise using the InterChange tool for the pilot area in MD; revision of CLC2000; technical corrections (ETC/MD)
10.30 – 10.45	*Coffee break*

10.45 – 12:00	Practical CLC mapping exercise using the InterChange tool for the pilot area in MD; revision of CLC2000; technical and thematic corrections (ETC/MD)
12.00 – 12.30	*Lunch break*
12.30 – 15.30	Practical CLC-Change mapping exercise using the InterChange tool for the pilot area in MD; thematic corrections (ETC/MD)
15.30 – 16.30	Principles of CLC-Change mapping (ETC)
12 July 2019	
8:30 – 10.25	Practical CLC-Change mapping exercise using the InterChange tool for the pilot area in MD; mapping changes (ETC/MD)
10.25 – 10.40	*Coffee break*
10.40 – 11.25	Conclusions and the next steps (ETC/MD)

3.3. CLC National Team (N/T)

Table 6 shows the National team (N/T) participating in CLC pilot project in Moldova.

Table 6 National Team (N/T) CLC pilot project in the Republic of Moldova

No.	Task	Subtask	Position / expertise	Responsible(s)
1	**Preparation of databases for the photo-interpretation**			
1.1	Preparation of databases for the photo-interpretation	Preparation of input raster and vector databases and subsetting into working units	Image processing / GIS experts	Ms. S. Zaharchina Ms. Natalia Curdoglo Mr. I. Paharikov
2	**Mapping land cover changes**			
2.1	Mapping land cover changes	Interpretation of changes	Photo-interpreters	Ms. S. Zaharchina Ms. Natalia Curdoglo
2.2		Database integration (CLC2000, CLC_Changes)	GIS expert	Ms. S. Zaharchina
3	**Quality control / quality assurance**			
3.1	Quality control / quality assurance, meta data	QA/QC of photo-interpretation sheets (thematic)	Leading photo-interpreters	Ms. S. Zaharchina
3.2		QC/QA of databases (technical)	GIS experts	Mr. I. Paharikov Mr. V. Dilan
3.3		Final QC/QA	Project manager	Ms. Maria Ovdii
4	**Validation of the HR Soil Sealing database**			
4.1	Validation of the HR Soil Sealing database	Preparation of the databases	GIS experts	Mr. I. Paharikov Mr. V. Dilan
4.2		Checking validation samples	Photo-interpreters	Ms. S. Zaharchina Ms. Natalia Curdoglo
4.3		Evaluation of the results, reporting	Project manager	Ms. Maria Ovdii
5	**Management**			
5.1	Management	National project management	Project manager	Ms. Maria Ovdii

3.4. Processing methodology, software

3.4.1. Methodology of mapping

The methodology of mapping is in conformity with the technical specifications for the CORINE Land Cover (CLC) pilot projects implemented in the Eastern Partnership countries (2017-2019), prepared by the EEA and the European Topic Centre on Urban, Land and Soil Systems (ETC/ULS) as part of the ENI SEIS II East Project, October 2017.

The methodology consists of the following main steps:

- Mapping the CLC status layer for the pilot area; due to the special situation in the Republic of Moldova (the CLC 2000 status layer exists) instead of mapping a status layer, the CLC 2000 layer was revised;
- Mapping the CLC –change layer for the pilot area;
- Generating the backdated status layer for the pilot area; in the case of the Republic of Moldova the updated CLC 2018 layer was produced;
- Final quality control of deliverables: CLC-Changes and CLC2018.
- Writing the report about the works performed.

3.4.2. Photointerpretation

Like in many other participating countries, InterChange 2.1 tool (running under ESRI ArcView 3.2) was used for revision of CLC2000 and mapping of changes.

According to the European methodology, all changes larger than 5 ha have been delineated, not depending on their location. Efforts were taken to map "real" changes concerning attributes and area. The technical change attribute was also frequently used to support creation of realistic CLC2006 database.

CLC2018 is the first CLC project in the Republic of Moldova when photointerpreters had systematic access to digital orthophotos. This resulted in many corrections on CLC2000, especially regarding plantations: vineyards (221), orchards (222) and forests (324). Photointerpretation was done according to the recomendatios of ETC/ULS experts:

Step-1: Correcting technical mistakes of CLC2000 (zero coded polygons, neighbour polygons with the same code, polygons being <25 ha in size, major shape errors of features significantly below 100m width) indicated by InterChange (*error checking*).

Step-2: Studying and implementing the thematic corrections done by ETC-ULS. Availability of relevant reference data (especially aerial photographs taken around year 2000) was highly beneficial. When modifying CLC2000, the CLC nomenclature was taken into account. Concerning thematic corrections, during verification was considered that only a sample (about 10%) of polygons has been checked.

Step-3: Systematic checking of the entire CLC2000 layer, especially to reveal invalid codes. This was done by evaluating each polygon of a given class (*search by class function*) or checking the entire area at a fixed scale (ca. 1:30.000). IMAGE2018 was useful to understand better certain polygons because of its better spatial resolution.

Step-4: Changing the mapping was done by evaluating each polygon of a given class, especially changing prone classes (e.g. 112, 131, 133,311, 324...) (*searching by class function*) or checking the entire area at a fixed scale (ca. 1:20.000). Revision continued in parallel with mapping CLC-Change. If a change was detected, it was mandatory to revise CLC2000 first (if needed) and mapping the change afterwards.

Steps for the photointerpretation:

- One of the two photointerpreters was responsible for systematic revision of CLC2000.
- The second photointerpreter was responsible for mapping CLC-Change and the associated residual revision of CLC2000.

The two photointerprers cross-checked each-other's work. InterCheck software (part of the CLC2018 Support Package) was used for checking.

3.4.3. Generating the CLC2018 database

Having the CLC-Change database completed, CLC2018 was generated in a semi-automated process:

$CLC2018 = CLC2000_{revised} (+) CLC\text{-}Change_{2000\text{-}2018}$

Where CLC2018 means the CLC database for 2018 (MMU=25 ha, width of linear elements=100 m);

$CLC2000_{revised}$ means the controlled / revised CLC2000 database (MMU=25 ha, width of linear elements=100 m);

$CLC\text{-}Change_{2000\text{-}2018}$ means the CLC changes between 2000 and 2018, delineated by the mapping process (MMU=5 ha, width of linear elements=100 m);

(+) means an operation having GIS components and photointerpretation components.

The automated component was implemented in an AML programme (developed by FÖMI as part of ETC-LUSI activities). The programme integrates the $CLC2000_{revised}$ and $CLC\text{-}Change_{2000\text{-}2018}$ databases, then the small (<25 ha) polygons were generalised according to a priority table. As an option polygons "almost" reaching the 25 ha limit (e.g. larger than 23.5 ha) was generalised by a photointrepreter, as method for Moldova.

3.5. Internal quality control, results

The revised CLC2000 and CLC-Change (2000-2018) databases were 100% quality controlled by the leading photo-interpreters. In case where mistakes had been discovered, the interpretation with written comments on polygon level was sent back to the interpreter for correction.

3.6. External quality control, results

The CLC Technical Team of the ETC ULS verified the results of the photo-interpretation, the revised CLC2000 and CLC-Change databases. The pilot project area were checked as seen on Figure 3.

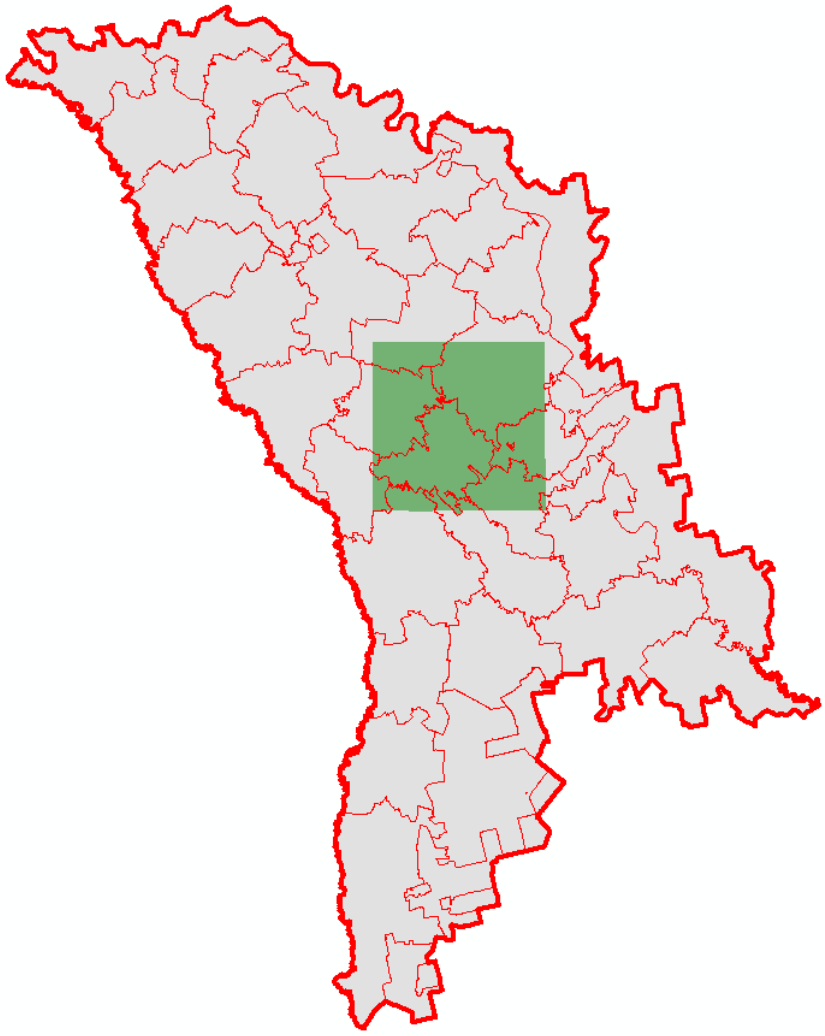


Figure 3 Pilot project area

Some remarks were given on technical quality during the verification missions, and some other remarks were given concerning specific and systematic thematic mistakes (misinterpretation). Both specific and systematic mistakes were corrected.

3.7. Main difficulties and their solutions

The main difficulties during the pilot project implementation were the following:

CLC 2000 revision took longer time than was planned. Reasons:

1) neecessity to create additional polygons with areas more than 25 hectares (1599 old data/ 1838 new data) – 15% polygons where added.

2) the need for boundary corrections (shift greater than 100 meters) 46.30% of vertex were changed, 17.98% were deleted.

3) the need to re-group and analyze the shape of polygons.

4) correction of topology errors.

Revision changed areas are showed in Figure 4.

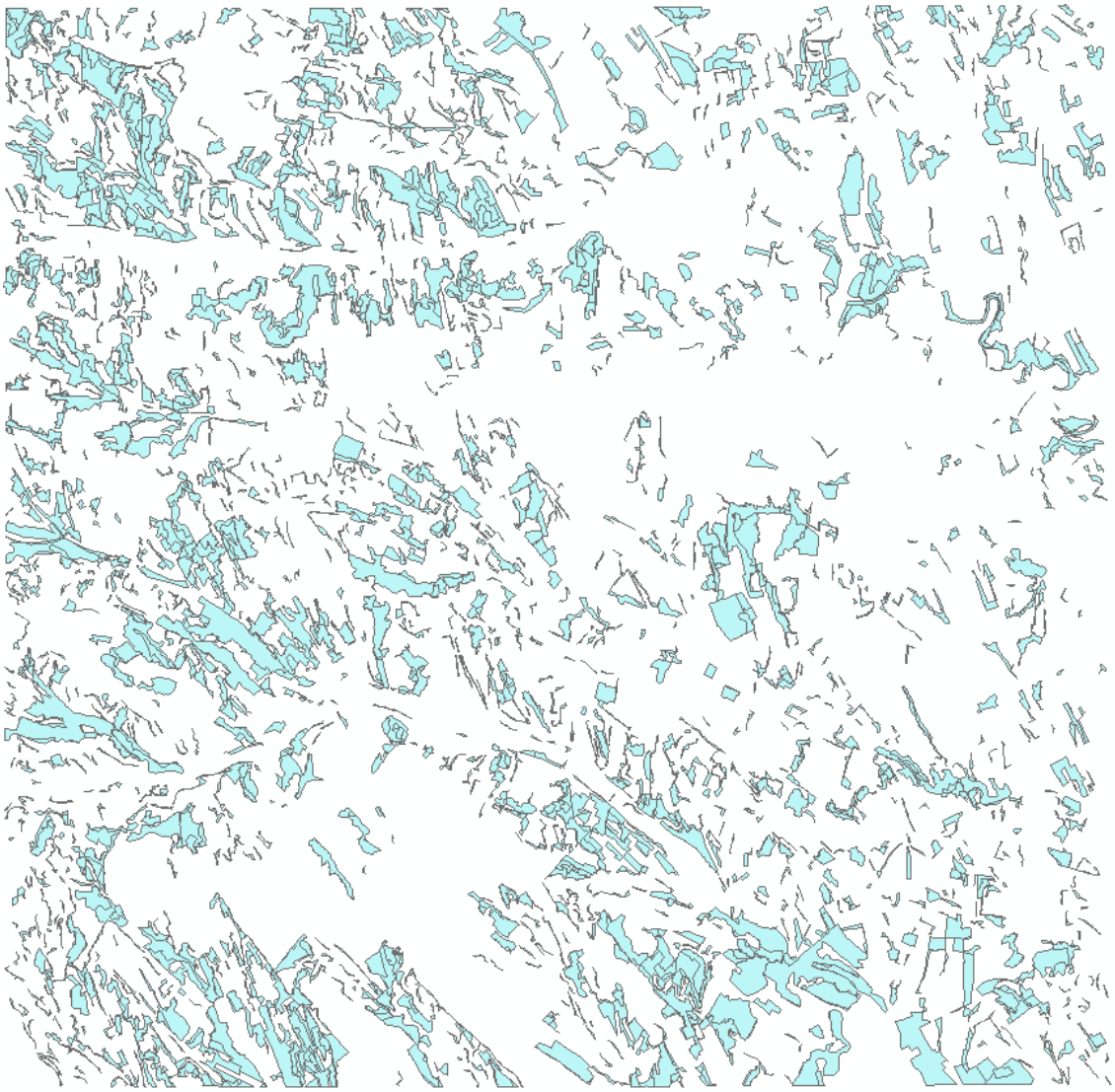


Figure 4 Revision changed areas

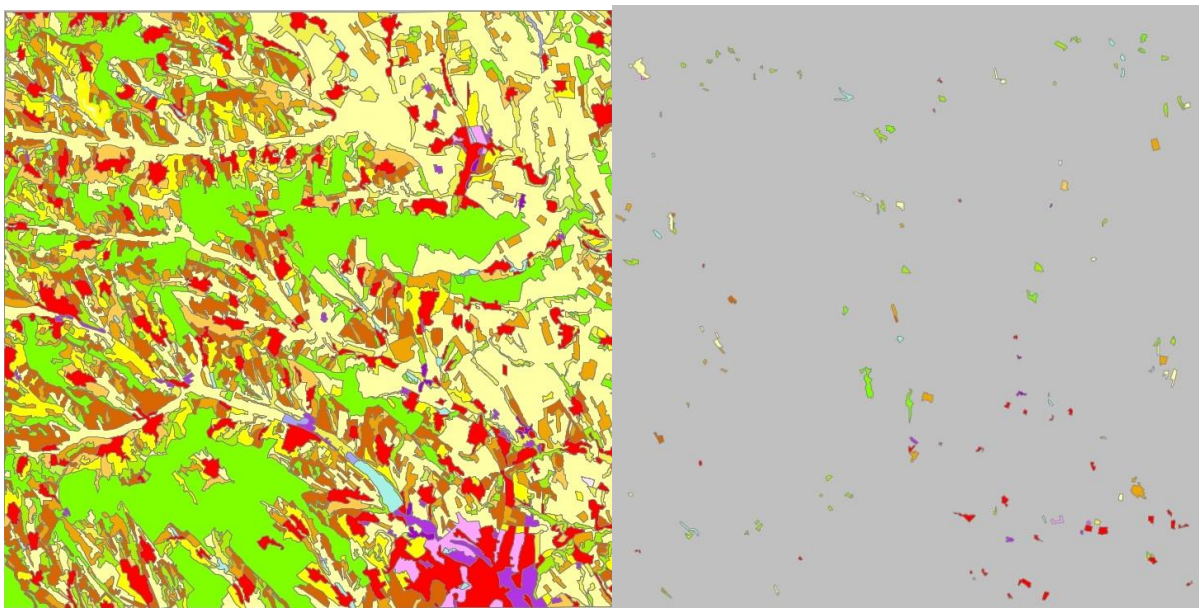
3.8. Internal validation

No internal validation has been performed yet.

4. Results

4.1. CLC-changes

The map of CLC-changes (2000-2018) is shown on Figure 5.



Revised CLC2000 CLC-Change (2000-2018)

Figure 5 CLC-changes (2000-2018) map of pilot project area

Dominant land cover changes (level-3) providing 50% of all changes are listed in Table 6.

Table 6 Dominant CLC-changes between 2000 and 2018

Change	Explanation of the evolution process	Area, ha	Area, percent of total changes	Area, cumulative percent
222-211	Orchards, fruit-tree plantations converted to arable land	427,92	12,64%	12,64%
211-222	Arable land converted to vineyards	340,08	10,04%	22,68%
211-112	Arable land converted to discontinuous urban fabric	299,35	8,84%	31,52%
324-311	Growth of broad-leaved forest	255,14	7,53%	39,05%
311-324	Clear-cutting of broad-leaved forest	247,79	7,32%	46,37%
242-112	Complex cultivation patterns to discontinuous urban fabric	188,76	5,57%	51,94%
231-512	New water bodies	181,03	5,35%	57,29%
211-324	Afforestation on arable land	148,86	4,40%	61,68%
221-112	Vineyards converted to discontinuous urban fabric	125,94	3,72%	65,40%
221-211	Vineyards converted to arable land	111,11	3,28%	68,68%
211-221	Arable land converted to vineyards	103,12	3,04%	71,73%
242-222	Complex cultivation patterns converted to rchards, fruit-tree plantations	102,08	3,01%	74,74%
243-324	Afforestation on land principally occupied by agriculture, with significant areas of natural vegetation	98,66	2,91%	77,65%
231-324	Afforestation on pastures, meadows and other permanent grasslands under agricultural use	88,01	2,60%	80,25%
221-324	Afforestation on vineyards	74,63	2,20%	82,46%

411-512	Inland marshes to water courses	55,39	1,64%	84,09%
141-112	Green urban areas to discontinuous urban fabric	52,56	1,55%	85,65%
221-243	Vineyards converted to land principally occupied by agriculture, with significant areas of natural vegetation	44,74	1,32%	86,97%
222-324	New orchards, fruit-tree plantations on transitional woodland	43,55	1,29%	88,25%
211-141	Arable land converted to green urban areas	39,31	1,16%	89,41%
231-131	Mineral extraction sites on pastures, meadows and other permanent grasslands under agricultural use	28,92	0,85%	90,27%

Based on detailed CLC change statistics, table 6, entries and their balance, and dynamics for each class have been produced. This summarizes the evolution of land cover in pilot area between 2000 and 2018.

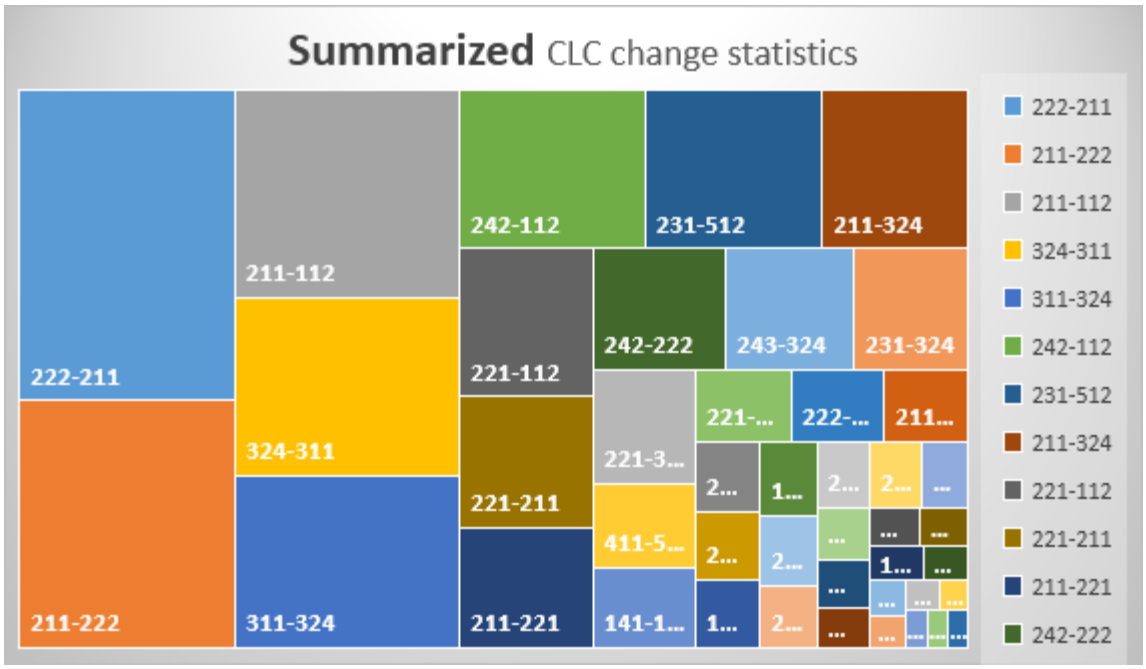


Figure 6 CLC-change statistic

Comparing net changes of class areas, the largest increase is observed in gardens, plantations of fruit trees converted into arable land and from arable land to gardens, plantations of fruit trees.

- The majority of artificial surfaces classes increased between 2000 and 2018.
- The largest net area increase was observed in the orchards, fruit-tree plantations (222), followed by the discontinuous arable land (221) and discontinuous urban fabric (112).

4.2. CLC2018

The CLC2018 map of the country is presented on Figure 7. The associated statistics are shown in Table 7. Arable land (211) is the largest category (30.11% of total area), followed by discontinuous urban fabric (10.49%) and orchards, fruit-tree plantations (7.49 %). Orchards, fruit-tree plantations include the largest number of polygons (298), followed by arable land (226) and vineyards (224).

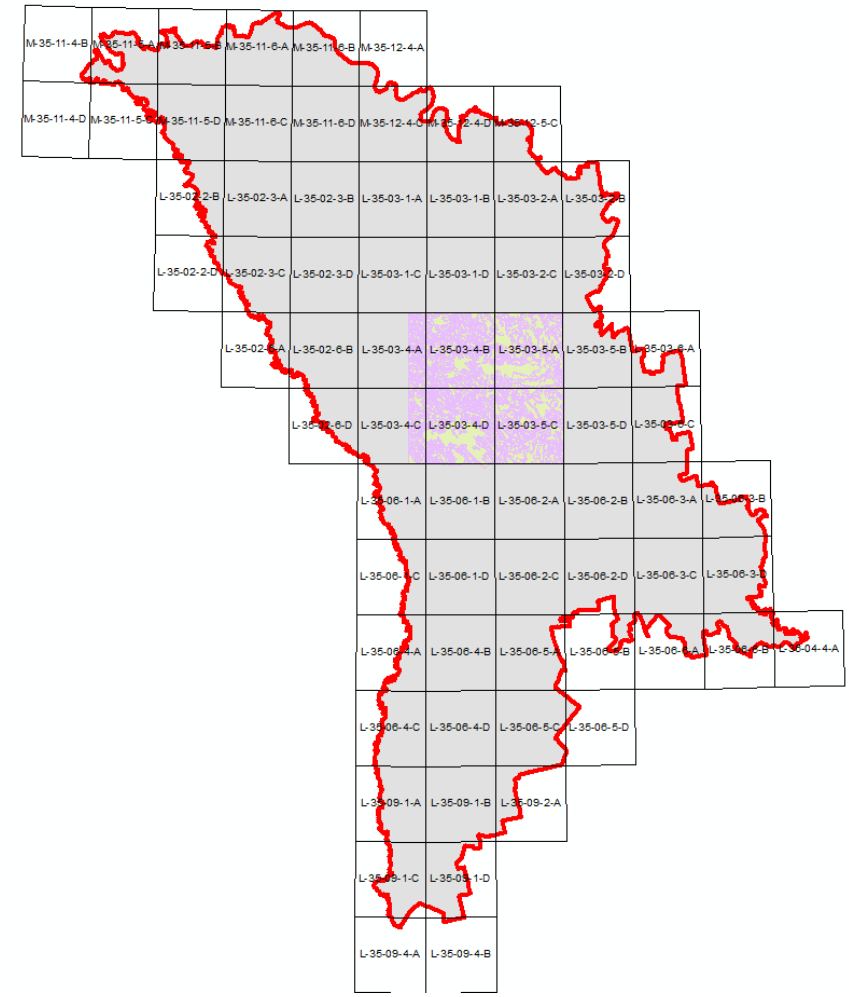


Figure 7 CLC2018 map of pilot area

Table 7 CLC2018 statistics

code	No of polygons	Area ha	Percent of total
112	185	33115,77	10,49%
121	36	3126,82	0,99%
131	8	536,99	0,17%
141	10	2380,73	0,75%
142	1	62,64	0,02%
211	226	95087,49	30,11%
221	224	29993,98	9,50%
222	298	23644,19	7,49%
231	207	17039,33	5,40%
242	157	19681,66	6,23%
243	111	11027,67	3,49%
311	101	57730,27	18,28%
313	1	58,91	0,02%
321	9	856,31	0,27%
324	221	18560,72	5,88%
333	6	246,68	0,08%
411	8	474,71	0,15%
512	36	2154,42	0,68%
Sum	**1845**	**315779,26**	**100,00%**

5. Deliverables

In accordance of the contract for work and services Reference number: BE-003715 the following deliverables covered by the pilot areas:

- Quality controlled revised CLC 2000 status layer.
- CLC-Change layer produced
- CLC 2018 status layer
- Final Report

All spatial data presented in ESRI Arcinfo shapefile format with polygon topology.

6. Conclusions

The CLC pilot project in the Republic of Moldova is characterised by 18 out of 44 CORINE land cover classes. The main land cover in CLC pilot project in Moldova covers agricultural lands (pastures, arable land and complex cultivation patterns (62.2%)). However, the surface area occupied by urban areas has increased to 11.5%. Land classified as semi-natural and forest areas occupies around 24.2% of the pilot territory.

The total area that has changed its land cover between 2000 and 2018 is 1.07% within the pilot territory.

CLC-Changes2000-2018 database was derived by visual comparison of IMAGE2000 and IMAGE2018 based on CLC2000. All changes fulfilling the mapping criteria (> 5 ha, > 100 m boundary displacement) were delineated.

The CLC2018 database was produced by combining the CLC2000revised and CLC-changes2000-2018 databases in ArcGIS, followed by a semi-automated process to eliminate polygons smaller than 25 ha.

New CLC update will take into account national initiatives to avoid duplications and to increase the use of the database. However, this will have consequences for the comparability of the databases.

Multi-temporal analysis can be useful in dynamic countries as the Republic of Moldova. However, the images must be of different seasons in one year to make optimal use of the possibilities of multi-temporal analysis.

Based on CLC Pilot project, it is necessary to cover all territory of the Republic of Moldova CORINE Land Cover and integrate in European CORINE Land Cover.

On the basis of the pilot project, the national team received the methodology, knowledge and necessary skills for CORINE land cover creation. This provides an opportunity for its application in the implementation of the CLC project for the entire territory of the country.

References

Büttner, G., Maucha, G., Kosztra, B. 2002. Towards agri-environmental indicators using land cover changes derived from CORINE Land Cover data; in: Building Agro Environmental Indicators – Focussing on the European area frame survey LUCAS; JRC-EEA-EUROSTAT; EUR Report 20521 EN, 2002

Büttner, G., Ch. Philipen -Report on the CLC Training mission, ENI SEIS II East Project / Moldova, 9-12 July 2019

Büttner, G., Kosztra, B. 2007. CLC2006 Technical Guidelines, EEA Technical Report 17/2007.

Heymann, Y., Steenmans, Ch., Croissille, G., Bossard, M., 1994. CORINE Land Cover. Technical Guide. EUR12585 Luxembourg Office for Official Publications of the European Communities.

Taracsák, G. 2003: CLC2000 Support Package – InterChange 1.1, Users manual, FÖMI.

Technical specificatios for the CORINE Land Cover (CLC) pilot projects implemented in the Eastern Partnership countries (2017-2019), prepared by the EEA and the European Topic Centre on Urban, Land and Soil Systems (ETC/ULS) as part of the ENI SEIS II East Project, October 2017.