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

IMPLEMENTATION OF CORINE LAND COVER (CLC) IN GEORGIA (KAKHETI AND KVEMO KARTLI REGIONS)

Funded by
the European Union

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Water and Data in Eastern Partner Countries

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Final Report

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ABOUT THIS REPORT

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IMPRINT

Owner and Editor: EU4Environment-Water and Data Consortium

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March 2024

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.

CONTENTS

List of abbreviations

APA……Agency of Protected Areas

B02……Visible blue Spectral Band

B08……Near Infrared Spectral Band

CLC……Land Cover Change

CORINE……The Coordination of Information on the Environment

FAO……Food and Agriculture Organization of the United Nations

GFSIS……Georgian Foundation for Strategic and International Studies

GIS……Geo Information Systems

MMU……Minimum Mapping Units

SDG……Sustainable Development Goals

SNAP……Sentinel Application Platform

UN……United Nations

Key messages

Overall Landscape Character

- Agriculture, in various forms, is the predominant land use in both Kvemo Kartli and Kakheti, emphasizing the importance of this sector for the Georgian economy.
- Despite common trends, regional specializations exist. Kakheti's viticulture prominence and Kvemo Kartli's stronger urban/industrial signature underscore how local conditions and choices shape land use.

Major Trends

- Both regions demonstrate agricultural intensification through the expansion of irrigation. This highlights efforts to boost productivity but carries water resource management implications.
- Kakheti's notable vineyard expansion reinforces its position as a key viticulture region, likely driven by market demand and supportive policies.
- An increase in sparsely vegetated areas raises potential concerns about land degradation. This requires careful investigation to determine the extent of human-induced degradation vs. natural landscape features.

Limitations of the CLC methodology in the Georgian context

- The CLC's single pasture category (code 231) is too broad to accurately represent the seasonal and spatial variations in Georgia's grazing practices. Nomadic and Transhumant Systems are widely practiced in Eastern Georgia so a more nuanced classification is needed to distinguish between: Winter Pastures, Summer Pastures and Other Pastures.

Priorities for Further Study

- Expanding CLC analysis to cover all regions of Georgia is crucial for a comprehensive understanding of land-use changes and their interconnected drivers. In a geographically compact and diverse country like Georgia, environmental and economic factors transcend regional boundaries.
- Field verification is essential to confirm the nature of the sparsely vegetated areas and inform land management strategies.

Executive Summary

This report analyses land cover patterns and transformations within the Georgian regions of Kvemo Kartli and Kakheti, leveraging CORINE Land Cover (CLC) data from 2018 and 2023. Both regions are characterized by extensive agricultural lands, particularly pastures, various types of arable land, and forests. However, Kakheti exhibits a strong viticulture focus with significantly larger areas dedicated to vineyards compared to Kvemo Kartli, while Kvemo Kartli displays a more pronounced urban and industrial footprint.

During the analysed period, both regions underwent agricultural intensification, evidenced by a substantial increase in irrigated land, often converted from pastures and non-irrigated cropland. Kakheti experienced marked vineyard growth, solidifying its position as a viticulture hub. An increase in sparsely vegetated areas across both regions raises the need for further investigation into possible land degradation processes.

This analysis utilized CLC status layers for 2018 and 2023, along with a CLC Change (2018-2023) layer. Data was presented as vector polygons, allowing for precise spatial analysis. Land cover changes were classified by frequency as "Possible," "Rare," or "Improbable," aiding in identifying unusual patterns. A stratified random sampling approach was employed to assess the accuracy of the land cover classifications. Simultaneously, CLC was inspected by the external expert of the project for verification and evaluation.

1. Introduction

The Coordination of Information on the Environment (CORINE) Land Cover (CLC) project represents a significant endeavor to standardize and map how land is utilized across various geographical regions. The European Union initiated the CORINE program to ensure consistent and comparable land cover data throughout its member states (EEA, 2023). Accurate land cover information plays a fundamental role in evidence-based decision-making across numerous domains. It facilitates effective environmental monitoring, supports sustainable land-use planning, guides agricultural development, contributes to biodiversity conservation efforts, and underpins informed policy creation (Feranec et al., 2016).

Land cover, distinct from the concept of land use, refers to the biophysical characteristics observed on the Earth's surface. This includes natural features like forests, grasslands, and water bodies, as well as human-made structures like urban areas, agricultural fields, and infrastructure (Di Gregorio & Jansen, 2000). By tracking changes in land cover over time, researchers and policymakers gain valuable insights into prevailing trends and can assess the impacts of both human activities and natural processes. For instance, CLC data can reveal the extent of deforestation, the rate of urbanization, or the expansion of agricultural lands (EEA, 2023).

The CORINE Land Cover project employs a standardized classification system, ensuring consistent data collection and analysis across different regions and periods (Büttner et al., 2012). This standardized methodology provides a powerful tool for comparative studies and enables the monitoring of environmental changes at both regional and continental scales. The project typically utilizes a combination of satellite imagery, aerial photography, and field surveys to generate detailed and reliable land cover maps. (EEA, 2023)

1.1 Significance

<u>Standardized, High-Quality Data:</u> CORINE Land Cover provides Georgia with a reliable, internationally recognized system for classifying and mapping land cover. (EEA, 2023) This ensures consistency with other European datasets and facilitates cross-border comparisons and collaborations (Büttner et al., 2012).

<u>Tracking Environmental Change:</u> CLC data provides a baseline understanding of Georgia's land cover patterns. With regular updates, policymakers can monitor changes, identify hotspots of deforestation, urbanization, agricultural shifts, or other transformations crucial for effective environmental protection strategies (Feranec et al., 2016).

<u>Informing Land-Use Planning:</u> Precise land cover information is indispensable for sustainable urban and regional development (EEA, 2023). CORINE datasets help identify areas suitable for various uses, balance development needs with the conservation of valuable ecosystems, and manage potential conflicts (Feranec et al., 2016).

Supporting Agricultural Management: Georgia's agricultural sector can significantly benefit from accurate land cover maps. CLC data helps assess land suitability for different crops, track agricultural expansion, optimize irrigation and resource allocation, and understand the impact of agriculture on surrounding landscapes (Büttner et al., 2012).

Biodiversity Conservation: By mapping habitats, forests, wetlands, and other ecological zones, CLC data aids in identifying priority conservation areas in Georgia. This supports efforts to protect endangered species, monitor ecosystem health, and minimize biodiversity loss (Feranec et al., 2016).

Disaster Risk Assessment: Detailed land cover information contributes to identifying areas prone to flooding, landslides, or erosion (Büttner et al., 2012). This analysis supports preventative measures, infrastructure planning, and emergency response protocols.

1.2 Rationale

European Integration: As Georgia explores closer ties with the European Union, aligning with programs like CORINE positions the country for collaboration on environmental initiatives, resource management, and scientific exchange.

Data-Driven Decision Making: The CORINE Land Cover project moves Georgia away from unreliable or fragmented land-use information. It promotes evidence-based policy development across sectors, leading to more informed and impactful decisions.

Addressing Environmental Challenges: Georgia faces various environmental concerns, including deforestation, habitat fragmentation, and changing agricultural practices. The CLC project offers a scientific tool to monitor, understand, and devise strategies to address these challenges (Büttner et al., 2012; Feranec et al., 2016).

Fulfilling Reporting Obligations: CLC data can help Georgia meet international reporting commitments on environmental matters as well as track progress towards Sustainable Development Goals (SDGs) related to land and habitat conservation (UN, 2015).

2. Project Overview

2.1 Objectives

The CORINE Land Cover project in Georgia has three core objectives: to create a comprehensive land cover inventory by generating a high-resolution, standardized land cover map for the Kakheti and Kvemo-Kartli regions in accordance with CORINE classification standards; to monitor land cover change (2018-2023) by establishing a baseline dataset and developing a system for regular updates to track temporal changes in land cover across these regions; and to support informed decision-making by providing policymakers, land managers, researchers, and stakeholders with reliable data to guide decisions concerning land-use planning, environmental protection, resource management, and sustainable development.

2.2 Geographical coverage

The project is focused on the regions of Kakheti and Kvemo Kartli in Georgia. These regions were chosen due to their diversity of ecosystems, rapid development and changes in agriculture and economics. Kakheti, renowned as Georgia's winemaking heartland, boasts fertile valleys and diverse microclimates suitable for a wide range of crops (GFSIS, 2021). Vineyards dominate the Alazani Valley, while orchards, cereal cultivation, and livestock farming also play significant roles. Kakheti's protected areas, including Lagodekhi National Park and the Vashlovani Protected Area, offer havens for biodiversity within its rich landscapes (APA, 2023).

Kvemo-Kartli's agricultural strengths lie in its fertile plains and extensive irrigation systems (GFSIS, 2021). Wheat, barley, vegetables, and livestock production are prominent. Environmental concerns in Kvemo-Kartli include soil salinization, pressures on limited water resources, and the need for erosion control in some areas (FAO, 2016). The region harbors unique ecosystems like the Rustavi semi-desert area and highland grasslands in Tsalka municipality.

Fig.1 CLC Project Area (Kakheti and Kvemo Kartli Regions)

2.3 Project Timeline

The CORINE Land Cover project in Georgia's Kakheti and Kvemo-Kartli regions was executed in three distinct phases between 2023 and 2024:

Phase 1: Data Collection and Pre-processing (01.2023 - 04.2023) This initial phase focused on the acquisition and preparation of essential data sources. Key activities included sourcing high-resolution satellite imagery, conducting necessary radiometric and atmospheric corrections, and any ancillary data compilation (e.g., topographic maps, existing land-use data).

Phase 2: Image Classification and Analysis (04.2023 - 08.2023) The core of the project involved the systematic classification of land cover based on the CORINE methodology. Utilizing both automated and manual interpretation techniques, analysts meticulously categorized the pre-processed imagery.

Phase 3: Quality Assurance and Dissemination (09.2023 - 03.2024) Rigorous quality checks were performed, including statistical accuracy assessments and ground-truthing campaigns. Dissemination efforts ramped up with workshops for stakeholders, the preparation of comprehensive reports, and the release of data in accessible formats.

3. Methodology

The CORINE Land Cover (CLC) project utilized a hierarchical classification system to categorize land cover types at varying levels of detail (Büttner et al., 2012). This system began with five broad classes (artificial surfaces, agricultural areas, forests and semi-natural areas, wetlands, and water bodies) and further divided them into more specific subclasses (e.g., urban areas, different crop types, various forest categories) (EEA, 2023). To classify land cover, analysts interpreted satellite imagery, often in combination with aerial photography and ground-based surveys. The classification process involved identifying areas with homogenous characteristics and assigning them the appropriate CLC code (EEA, 2023).

3.1 Data Collection

The project's success hinged on the acquisition of both primary and ancillary datasets. Primary data consisted of multi-temporal Sentinel-2 satellite imagery (2018-2023), strategically chosen for its high spatial resolution and spectral bands suitable for detailed land cover mapping. To further refine our classifications and provide historical context, we meticulously collected and organized a range of ancillary data. These valuable resources included:

Soviet-Era Topographic Maps: Maps at scales of 1:50,000 and 1:25,000 offered insights into past land-use patterns and landscape features, aiding in the interpretation of potential changes.

Very High-Resolution Satellite Imagery Mosaics (Google and Bing): These mosaics provided an additional layer of visual detail, particularly for complex or heterogeneous areas, supporting the accurate delineation of land cover boundaries.

High-Resolution Aerial Imagery Mosaics: To further refine our land cover classifications and gain a deeper understanding of intricate landscape features, we used the Maps.gov.ge data portal. This resource provided access to aerial mosaics for the years 2022, 2020, 2016, and 2017. While the viewing-only format limited our ability to directly process these images, they offered valuable visual references. This allowed us to cross-check our classifications, particularly in areas of rapid change or complex land-use patterns, leading to greater confidence in our land cover mapping.

Coordinates of Vineyards and Irrigated Areas: Sourced from the Georgian Melioration Service and the National Wine Agency, these datasets were essential for distinguishing key agricultural land uses. Accurately identifying vineyards, a hallmark of Kakheti's landscape, and irrigated areas, crucial for water management analysis, were priorities for the project.

This comprehensive approach to data collection ensured a robust foundation for accurate land cover classification and enhanced our ability to identify nuanced changes over time.

3.2 Data Processing

Software used

To effectively process the collected data and execute the CORINE Land Cover classification and change detection, we employed a suite of specialized software tools:

InterChange: This software, designed specifically for CLC applications, played a central role in our workflow. Its features tailored for land cover classification and change detection streamlined our analysis and ensured adherence to CORINE standards (https://clc2018.taracsak.hu/).

ESA SNAP: Developed by the European Space Agency, SNAP's image processing capabilities were invaluable for tasks such as pre-processing the Sentinel-2 satellite imagery and potentially for conducting advanced spectral analyses (https://step.esa.int).

QGIS: This versatile open-source geographic information system (GIS) provided a powerful platform for data visualization, spatial analysis, and the creation of final cartographic products (https://qgis.org/).

By strategically combining these software tools, we leveraged their individual strengths to achieve accurate, comprehensive, and visually compelling results within the project.

Image processing

To optimize the selected Sentinel-2 images for subsequent classification, we performed essential pre-processing steps. Firstly, images underwent resampling to ensure consistency across datasets and compatibility with our analysis software. We then converted the images to the versatile TIFF format using the Sentinel Application Platform (SNAP).

We strategically selected bands B8 (Near Infrared), B11 (Shortwave Infrared), and B02 (Blue) from the Sentinel-2 multispectral dataset. These bands are particularly valuable for land cover analysis:

- B8 (Near Infrared): Highly sensitive to vegetation health and density, aiding the distinction of different vegetation types.
- B11 (Shortwave Infrared): Effective in delineating water bodies, mapping soil moisture, and differentiating between vegetation and built-up areas.
- B02 (Blue): Useful for enhancing urban features and assisting in the identification of bare soil.

This tailored band combination ensured the resulting images would provide the spectral information necessary to accurately discriminate among the diverse land cover classes present within our study area.

The Photointerpretation Process

The photointerpretation process is a multifaceted endeavor that lies at the heart of accurate land cover mapping. Our approach followed these essential steps:

Delineation: We began by carefully delineating distinct land cover units on the false-color images. These boundaries marked areas of homogenous visual characteristics, representing potential transitions between different land cover classes.

Identification: Drawing upon interpretation keys, extensive ancillary documentation, and high-resolution aerial photographs, we systematically assigned specific CORINE nomenclature to each delineated area. This meticulous process classified land cover types based on spectral patterns, landscape features, and contextual information.

Iterative Controls and Expert Collaboration: Quality control was woven throughout the process. We continually cross-referenced our extrapolation results with multiple information sources, including ancillary data and ground-level knowledge. This iterative approach mitigated the risk of errors due to spectral confusion or misinterpretation of satellite imagery.

Expertise and Collaboration: The success of our photo interpretation process was fundamentally driven by the expertise and judgment of our photo interpreters. Collaboration was encouraged, including consultations with specialists in botany, agriculture, and other relevant fields. This team-based approach fostered nuanced interpretations, resulting in greater accuracy and a deeper understanding of the complex land cover patterns within the study area.

Vectorization

The vectorization process transformed the delineated areas from our photointerpretation into a structured, digital land cover map. We strictly adhered to the requirements outlined in the Updated Guide to Illustrated CLC Nomenclature, the authoritative source for CORINE Land Cover methodology (Büttner et al., 2017). Key parameters that guided our vectorization included:

Mapping Scale: Consistent with CORINE standards, we employed a mapping scale of 1:100,000. This scale provides a suitable level of detail for regional analysis while ensuring the resulting dataset remains manageable for a variety of practical applications.

Minimum Mapping Units (MMUs): Following the guidelines, we set a 25-hectare minimum mapping unit for status land cover areas and 5 ha for areas identified as undergoing change. This ensures that the map captures significant landscape features without becoming overly complex or cluttered.

Polygon Width: To promote visual clarity and map readability, we maintained a minimum polygon width of 100 meters. This helps prevent the creation of excessively fine features that can be difficult to distinguish.

Adherence to these CORINE specifications ensures our land cover map is compatible with other European datasets, facilitating cross-border analysis and collaboration (Büttner et al., 2017). Furthermore, these parameters strike a balance between capturing meaningful landscape patterns and ensuring the map's accessibility for a wide range of users.

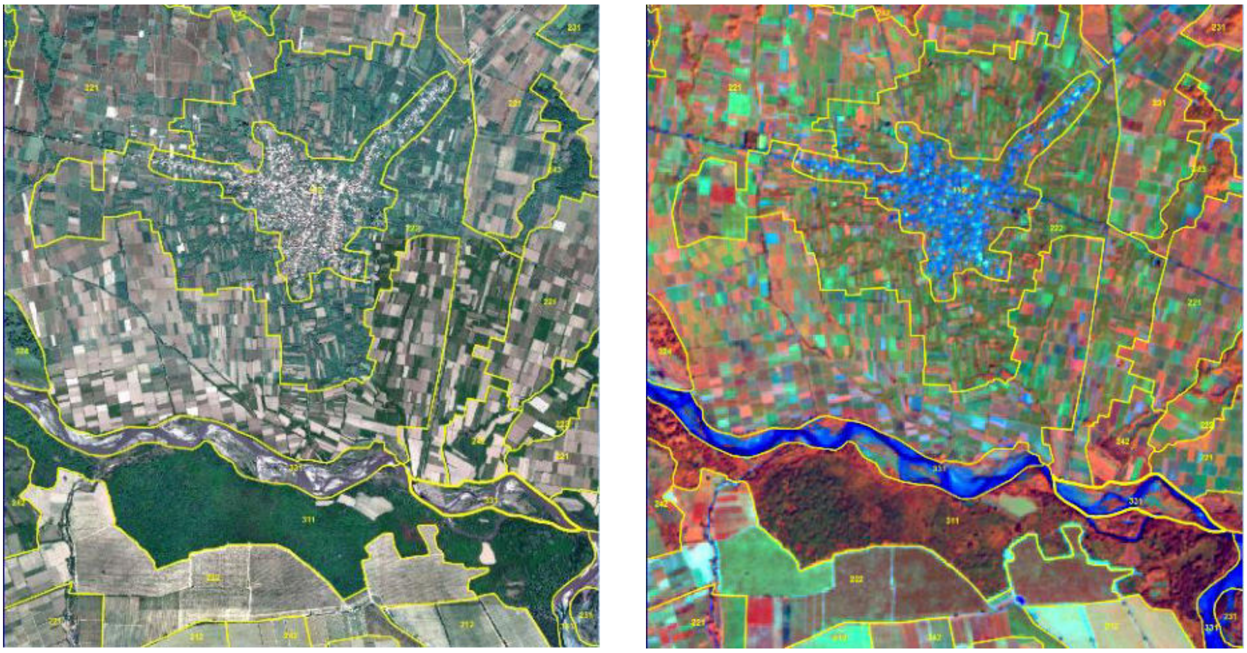

Fig.2. Vectorization Examples: Google Earth Mosaic (Left) vs. Sentinel-2 Multispectral Imagery (Right) - Gavazi, Kakheti Region

3.3 Change detection

We utilized the specialized capabilities of InterChange (Taracsák 2018) software to conduct a comprehensive change detection analysis between land cover maps from different time periods. To gain the most up-to-date understanding of landscape dynamics, we designated the following image datasets:

Status Image: The 2022 land cover classification served as the baseline for our analysis. We further refined this status image by incorporating insights from additional 2023 and 2024 imagery, ensuring it reflected the most current landscape conditions possible.

Change Layer: The 2018 land cover layer, generated through a backdating process, provided the reference point for detecting changes that occurred over the study period.

By overlaying these layers, we systematically identified areas where CORINE land cover codes had shifted, revealing transformations such as urbanization, agricultural changes, and forest dynamics. Additionally, the software's capabilities enabled us to quantify the extent and spatial patterns of these changes, shedding light on the scale, drivers, and potential implications of these land-use transitions within the Kakheti and Kvemo-Kartli regions.

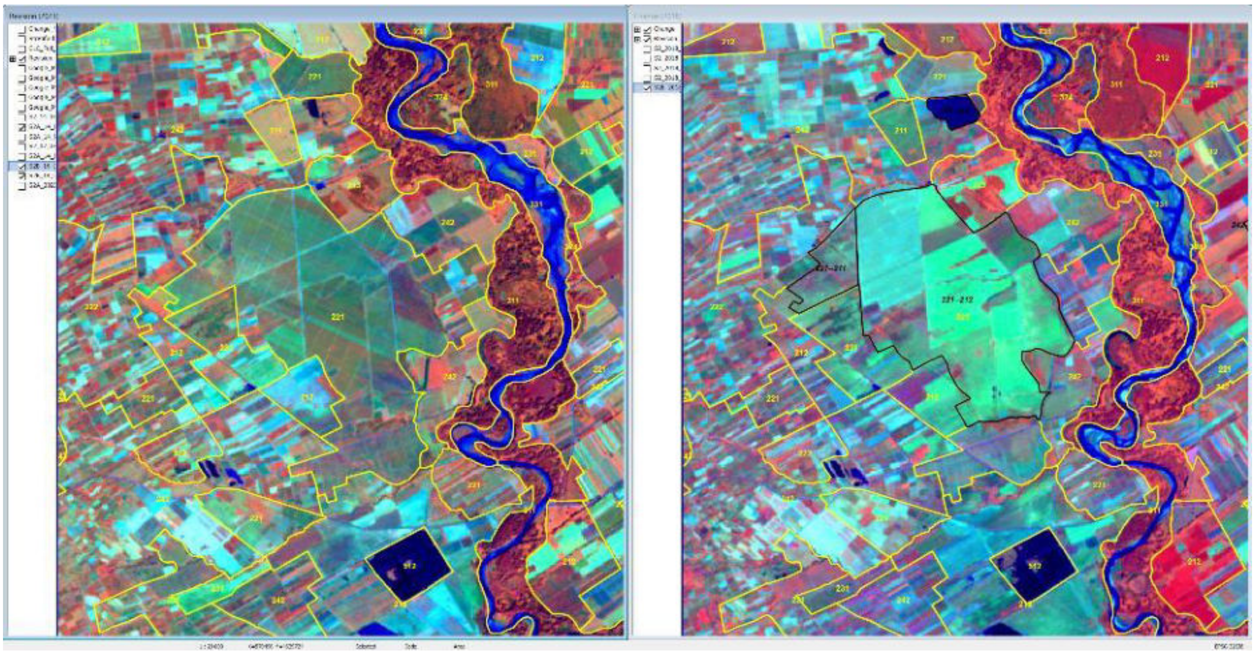

Fig 3. Land Cover Change Analysis (2023-2018): Kakheti Region

Assessment of Land Cover Change by Rarity

Analysis of land cover transformations revealed a clear distinction in the frequency of different change types:

Technical changes: In the context of CORINE Land Cover (CLC), technical change refers to any modification in the land cover classification that doesn't reflect actual changes on the ground. (110 ha) See. (CLC2018 Technical Guidelines, Environment Agency)

Possible Changes Predominate: The majority of observed changes fell into the "Possible Change" category. This comprised 283 distinct change occurrences, encompassing a total area of 21467 hectares. Such widespread changes point to common or expected land-use transitions within the analysed region.

Rare Changes Identified: A smaller subset, consisting of 29 changes and covering 1373 hectares, was classified as "Rare Change." These changes represent less frequent land-use shifts that warrant closer investigation to understand their drivers and potential implications.

Improbable Changes Absent: No "Improbable Changes" were detected within the analysed time frame. This suggests a general consistency in land-use patterns and may indicate a lack of abrupt or unexpected disturbances.

Change Types	Pieces	Area
Technical change	7	110
Possible change	283	21467
Rare change	29	1373
Improbable change	0	0
Code error	0	0

Table 1. Land Cover changes rareness statistics (2023-2018)

4. Key Findings (Analysis)

4.1 Summary of land cover types

An examination of land cover types within the two Georgian regions revealed a diverse landscape with a mix of natural, agricultural, and human-modified areas.

Agriculture Dominance: Agricultural land uses occupied a significant proportion of the analysed territory. Pastures (50914 ha) were the single most extensive land cover type, followed by arable lands – both non-irrigated (118641 ha) and permanently irrigated (147544 ha). This highlights the importance of the agricultural sector within these regions.

Specialized Crops: Vineyards (56677 ha) occupied a notable area, likely reflecting the importance of viticulture in the local economy. Fruit trees and berry plantations were also present, with a smaller share of olive groves (355 ha).

Forest Cover: Forests constituted a significant portion of the landscape. Broad-leaved forest (513833 ha) was the dominant forest type, with areas of coniferous (25251 ha) and mixed forest (12059 ha) also present.

Other Natural and Semi-Natural Lands: Various other natural and semi-natural areas were represented, including natural grasslands (27431 ha), moors and heathland (80205 ha), transitional woodland/shrub (29569 ha), and sparsely vegetated areas (61030 ha). These areas likely contribute to biodiversity and ecosystem services.

Urban and Industrial Footprint: Urban areas, including discontinuous urban fabric (61038 ha), continuous urban fabric (864 ha), and industrial/commercial units (7474 ha), were present. The extent of these land cover types indicates a degree of human development within the regions.

<u>Water Features:</u> Water bodies (8227 ha) and inland marshes (2972 ha) contributed to the landscape mosaic, highlighting potential water resources and wetland habitats.

CLC Codes	Percentage
311	27.7
231	27.1
212	7.9
211	6.4
242	4.8
322	4.3
112	3.3
333	3.2
332	4.3
221	3.05
...	

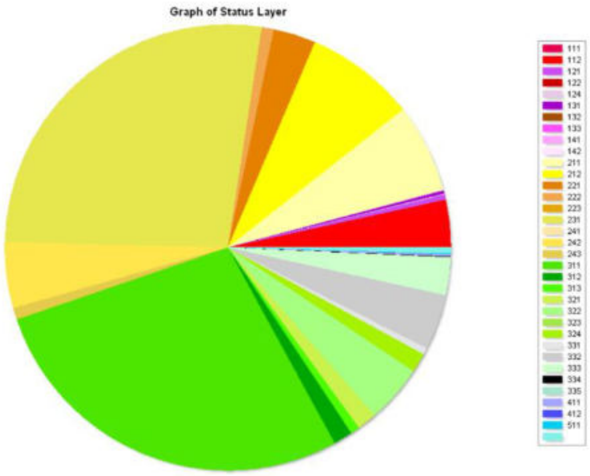

Figure 4. Main CLC class CLC percentage table and graph (2023)

Note: For a comprehensive breakdown of Corine land cover areas in the study areas and average area per land cover type piece, please refer to the attached annexes.

4.2 Contrasting Land Use Patterns and Changes in Kvemo Kartli and Kakheti

This chapter compares land cover patterns and transformations in two diverse Georgian regions, Kvemo Kartli and Kakheti, between 2018 and 2023. CORINE Land Cover (CLC) analysis reveals how differing climates, landscapes, and agricultural specializations shape their unique land use mosaics

Key Distinctions:

Kakheti's Viticulture Focus: Kakheti had a significantly higher proportion of vineyards (221), underscoring its specialization in viticulture. Viticulture is a geographically specific agricultural practice, influenced heavily by climate and soil suitability (Nakhutsrishvili, 2012), While Kvemo Kartli displayed a more pronounced presence of discontinuous urban fabric (112) and industrial/commercial areas (121). The degree of urbanization and viticulture is a key factor distinguishing land use patterns across various regions.

Land Cover Dynamics (2018-2023)

Agricultural Intensification (Both Regions): A considerable shift occurred towards irrigated land (212). This indicates intensified agricultural production in both regions. Irrigation expansion reflects efforts to increase agricultural productivity, but carries implications for sustainable water resource management (FAO, 2016).

Vineyard Expansion (Kakheti): Kakheti saw a distinct growth in vineyards (221). This reinforces the region's continued focus on viticulture. The expansion of specialized crops aligns with trends of agricultural intensification and can be driven by market demand and policies.

Potential Land Degradation: Both regions experienced an increase in sparsely vegetated areas (333). This trend warrants further investigation to understand potential connections to land degradation processes. Land degradation is a complex issue arising from both natural factors and human activities, such as overgrazing or unsustainable agricultural practices.

Contextualizing the Analysis

Climate-Driven Differences: Contrasting paces and types of agricultural conversion result from differences in climatic and soil suitability across these diverse landscapes. Climate and topography are fundamental drivers of land use potential and agricultural choices (Nakhutsrishvili, 2012).

Economic Forces: Market demand for specific products and agricultural policies likely influenced the observed specialization and expansion of particular land uses. Economic factors and policies interact with geographic characteristics to strongly shape land use decisions (FAO, 2016).

Land cover patterns in the two regions reflect a combination of natural limitations alongside human choices in agriculture and development.

4.3 Major trends or changes identified in land cover 2018-2023

Analysis of CORINE Land Cover data for the Georgian regions revealed significant shifts in land use patterns between 2018 and 2023. Key trends and their potential implications included:

Agricultural Intensification and Land Degradation Concerns

A substantial area of land transitioned from non-irrigated arable land (code 211) to irrigated land (code 212), signaling the intensification of agriculture. This, coupled with conversions from other land cover types (e.g., forests, grasslands, sparsely vegetated areas) to irrigated agriculture, suggests potential risks: Increased water demand could strain resources in the long term (FAO, 2016), Inappropriate irrigation practices in areas previously less intensively cultivated might exacerbate soil salinization or erosion, leading to degradation (FAO, 2016).

Expansion of Vineyards

While vineyards (code 221) were not the dominant land cover change, their expansion in certain areas was noted. This reflects the continued importance of the viticulture sector in Georgia's economy (GFSIS, 2021). Careful attention to sustainable practices is needed if this trend persists, ensuring long-term soil health and water resource management.

Forest Dynamics and Degradation Risks

Some deforestation occurred, primarily involving conversions of forest cover (codes 311, 312) to agricultural land (codes 212, 231) or urban uses. This loss of forest cover has implications for biodiversity and potential soil erosion (Feranec et al., 2016).

There were also instances of land transitioning into forest categories (e.g., 411 to 212), suggesting reforestation or regeneration efforts. Continued monitoring is needed to gauge net forest cover change.

Urban and Infrastructure Growth

Modest increases in discontinuous urban fabric (code 211) and industrial/commercial units (code 121) were observed, likely a result of development pressures. This trend underscores the need for sustainable urban planning that minimizes the impact on surrounding natural areas and agricultural lands (EEA, 2023).

Land Degradation Signals

Of particular concern is the increase in Sparsely Vegetated Areas (code 333). Significant transitions into this category occurred from grasslands, natural areas (codes 322, 324), and even previously irrigated lands. This could be a stark indicator of: Overgrazing and land mismanagement undermining vegetative cover. Water scarcity leading to the abandonment of previously productive lands (FAO, 2016), Soil erosion and degradation processes limiting vegetative growth (Feranec et al., 2016).

Note: See the tables in the appendices for more information.

4.4 CLC Deliverables

The CLC project provides essential data on land cover and its changes for the year 2023. This information is delivered in two key vector shapefile layers:

CLC_2023 Status Layer (CLC_2023_status.shp):

This layer presents a snapshot of the land cover in 2023. Each feature in the layer is a vector polygon representing an area with a homogenous land cover type. Key Attributes:

- **CLC_2023:** Numerical code specifying the land cover type (e.g., 231 for pastures, 311 for broad-leaved forests)
- **LABEL 1, LABEL 2, LABEL 3:** Text descriptions of the land cover class at different levels of detail (for reference)

CLC_2018 Status Layer (CLC_2018_status.shp):

This layer depicts the land cover status in 2018. It was derived by combining the CLC 2023 layer with the CLC Change (2018) layer. Each feature in this layer is a vector polygon representing a contiguous area with the same land cover type. Key Attributes:

- **CLC_2018:** A numerical code denoting the specific land cover type (e.g., 231 represents pastures, 311 represents broad-leaved forests).
- **LABEL 1, LABEL 2, LABEL 3:** Provide textual descriptions of the land cover class at increasing levels of detail, assisting with interpretation.

CLC_2023 Change Layer (CLC_2023_change.shp): This layer highlights areas where land cover changed between 2018 and 2023. Attributes:

- **CLC_2018:** CLC code of the land cover type in 2018
- **CLC_2023:** CLC code of the land cover type in 2023
- **CLC2023_s:** CLC subclass of the land cover type in 2023 (Represents existing (<25 ha) area under technical change in mixed classes (e.g. 242 complex cultivation pattern).
- **AREA:** The size of the area that has undergone the change
- **LABEL:** Shows changes in land cover (2018-2023)
- **T_Change** Value 1 indicates technical change

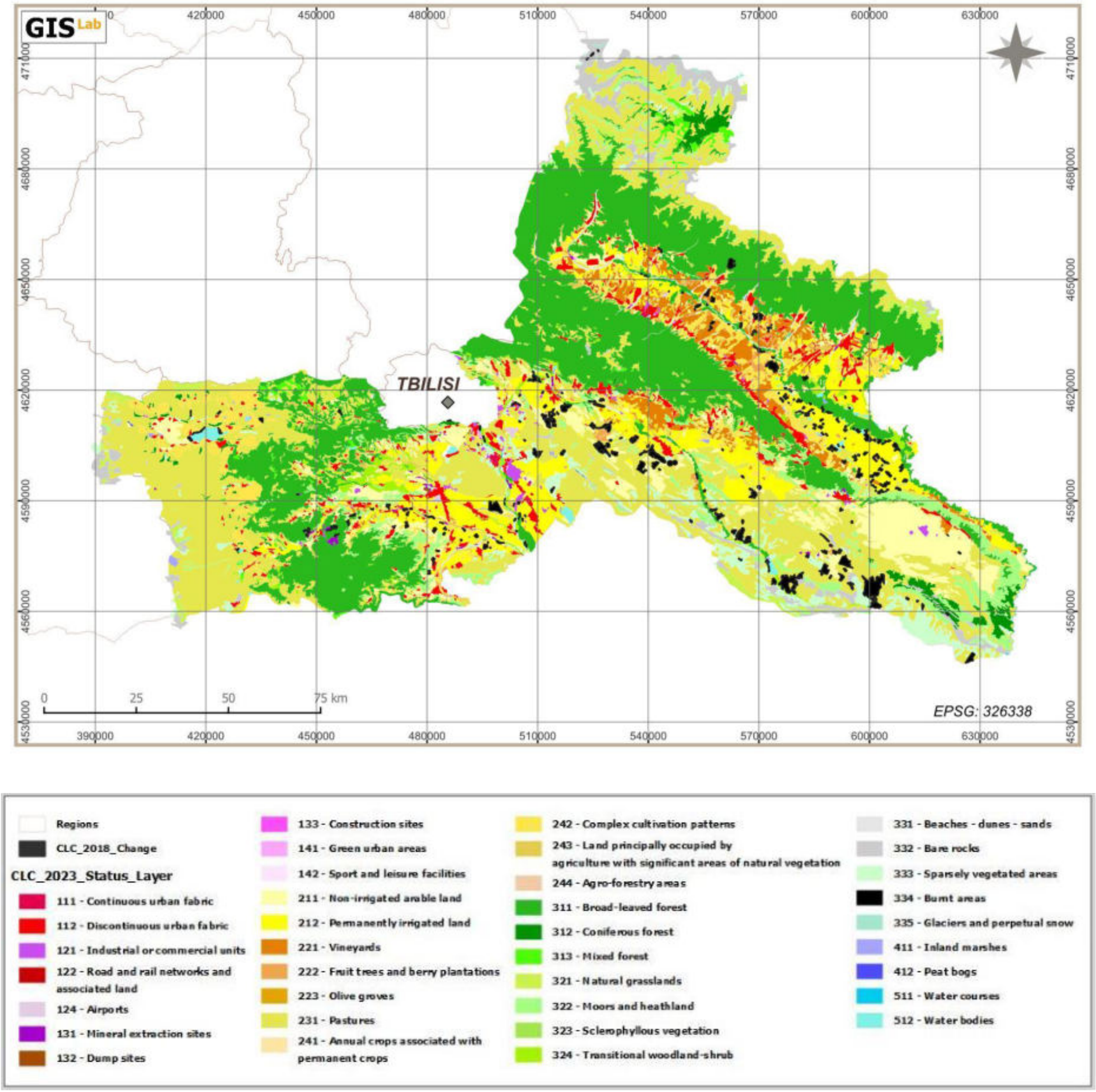

Figure 4. CLC Status Map (2023) with Change layer (Black polygons)

5. Challenges and Limitations

5.1 Difficulties Encountered in Collecting, Processing, or Analysing Data

During the project, we encountered several challenges in the data collection, processing, and analysis phases that impacted the precision of our land cover classifications. Key difficulties included:

Limited Supplementary Data: While Sentinel-2 imagery and Google Earth's high-resolution mosaics were invaluable, they lacked sufficient context for our needs. The absence of a comprehensive nut cadaster posed a significant challenge in distinguishing between vineyards and nut plantations due to their similarities in appearance. This resulted in some uncertainty in accurately classifying these land-use types. Likewise, the lack of a fruit cadaster hindered our efforts to differentiate specific fruit tree types with precision.

Challenges with Specific Land Cover Types:

Olive Groves: Identifying olive groves proved difficult as many are either young and undetectable in satellite imagery or misclassified as fruit tree plantations.

Pastures: Georgia's unfenced pastures, often found in natural landscapes, made distinguishing them from ungrazed natural vegetation areas challenging, creating the potential for misclassification. The identification of heavily degraded pastures as sparsely vegetated areas added further complexity.

Inland Marshes: Degraded inland marshes in dry periods were difficult to distinguish from pastures, necessitating the use of temporal imagery to improve classification accuracy.

5.2 Strategies to Address Challenges

To mitigate these difficulties, we employed several strategies:

Integrating Available Datasets: Incorporating available data sources such as the wine cadaster, even with their limitations, significantly improved the accuracy of our classifications.

Temporal Analysis: Using images from different seasons in the case of inland marshes and pastures aided in distinguishing these land cover types from each other.

5.3 Limitations of the CLC methodology in the Georgian context

While the CORINE Land Cover (CLC) methodology offers a valuable standardized framework for land cover mapping, it has specific limitations when capturing the diverse pasture systems in Georgia.

Key Limitation: Pasture Classification

The CLC's single pasture category (code 231) is too broad to accurately represent the seasonal and spatial variations in Georgia's grazing practices. (https://mepa.gov.ge/Ge/Files/ViewFile/53687) Nomadic and Transhumant Systems are widely practiced in Eastern Georgia) so a more nuanced classification is needed to distinguish between:

- **Winter Pastures:** Lowland pastures primarily used during the winter months, a significant component of nomadic and transhumant livestock systems. Proposed Refinement: 2311 Winter pastures.

- **Summer Pastures:** High-mountain pastures crucial for seasonal grazing, often characterized by distinct ecological conditions compared to winter pastures. Proposed Refinement: 2312 Summer pastures

- **Other Pastures:** This category would encompass year-round near-settlement pastures, pastures associated with livestock farms, and any other pasture types that don't neatly fit into the winter or summer designations. Proposed Refinement: 231 pastures

Benefits of Refinement

This revised classification would:

- **Reflect Diverse Grazing Patterns:** Better capture the unique dynamics of Georgian livestock systems.
- **Facilitate Land Management Analysis:** Enable more targeted analysis of land use patterns, grazing pressures, and the ecological impacts of different pasture types.
- **Inform Policy Development:** Provide policymakers with more accurate data to guide agricultural and land management decisions.

6. Quality Assurance

6.1 External Control and Verification

A draft version of the CLC was sent to the external expert of the project for verification and evaluation (50x50 km by region). The experts provided a detailed verification report that outlined their findings.

This collaboration allowed us to address potential shortcomings within our classification. In the event of serious systematic misclassifications or omissions, the CLC map underwent quality improvement revisions. Any feedback or remarks from the experts were integrated to update and finalize the CLC maps, ensuring a higher degree of accuracy.

See annexes for further information: Georgia CLC2023 verification Report - Part I and II

6.2 Ground-truthing procedures and results

To validate our land cover classifications and address uncertainties in satellite image interpretation, we conducted ground-truthing across 64 locations in the Kvemo Kartli and Kakheti regions during July-September 2023.

Fieldwork prioritized agricultural areas to accurately differentiate vineyards, fruit/berry plantations, and olive groves. We focused on locations where younger plantations might lack distinctive vegetation signatures in satellite imagery. In remote or inaccessible areas, we contacted local residents in different municipalities to supplement on-the-ground observations.

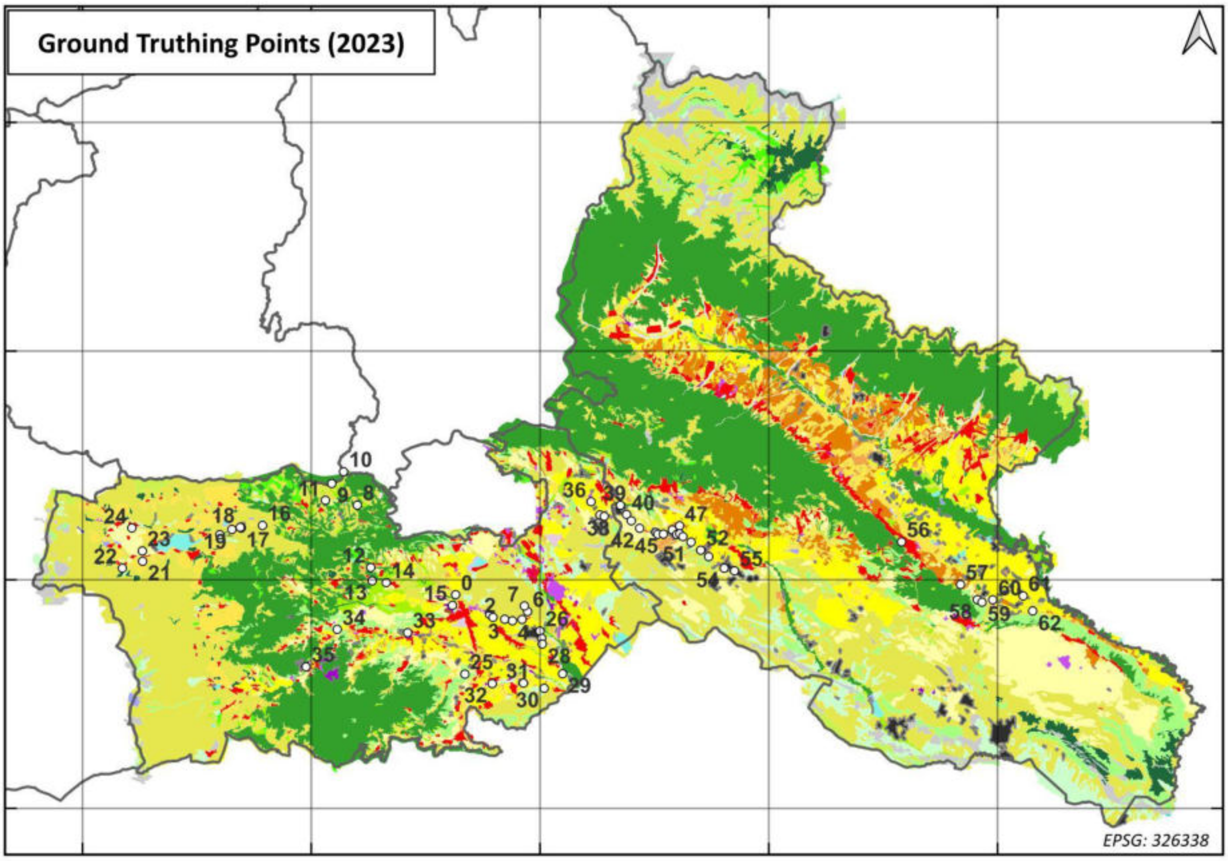

Fig.6 Ground-truthing locations in the Kvemo Kartli and Kakheti regions.

Fig. 7. Olive Groves-223 (Left) and Natural Grassland-321 (Right)


Fig. 8. Sparsely vegetated areas- 333 (Left) and Complex cultivation patterns 242 (Right)


Fig. 9. Mineral extraction sites - 131 (Left) and Pastures -231 (Right)

Key Findings

Young Plantations: Ground-truthing was particularly valuable in identifying olive groves (code 223), a relatively new agricultural practice in Georgia.

Irrigated Lands: Fieldwork aided in detecting areas of permanently irrigated land (code 212) that were not evident from satellite imagery alone.

Natural/Semi-Natural Areas: Ground-truthing helped refine distinctions between moors and heathland (code 322), transitional woodland/shrub (code 324), and broad-leaved forest (code 311) in select locations.

Outcomes

Ground-truthing played a crucial role in refining our land cover analysis. Field observations and local consultations directly benefited the project in the following ways:

By verifying satellite image interpretations on the ground, we were able to make necessary corrections and adjustments to our land cover classifications. This was particularly important in areas featuring young plantations with less distinct spectral signatures, small-scale or obscured irrigation practices, and landscapes where differentiating natural vegetation types proved challenging.

Combining ground-truthing with insights from local residents offered valuable context on specific agricultural practices, emerging land-use trends (such as the adoption of olive groves), and the complexities of land use patterns across the study area. This knowledge deepened our understanding of the interplay between landscape characteristics and human activities.

6.3 CLC: Precision, Advantages, and Disadvantages at 1:100,000 Scale

CORINE Land Cover (CLC) maps provide standardized, pan-European datasets for land use analysis and decision-making. Understanding the precision, strengths, and limitations of these maps, particularly at the 1:100,000 scale, is crucial for their effective use (EEA, 2023).

Precision

The 1:100,000 mapping scale means one unit on the map represents 100,000 of the same units on the ground (e.g., 1 cm on the map equals 1 km in reality). This offers a moderate level of detail. CLC maps have a Minimum Mapping Unit (MMU) of 25 hectares, implying land cover features smaller than this may not be individually represented, potentially simplifying real-world complexities (Büttner et al., 2017). Additionally, CLC uses a 100-meter minimum width for polygons, which can affect the visual representation of narrow or linear landscape features.

Advantages

CLC's consistent methodology across European union and east partnership countries facilitates comparative analysis and cross-border collaboration (EEA, 2023). The 1:100,000 scale provides a good balance between regional overviews and the ability to discern major land use patterns. Furthermore, CLC datasets are often freely available, enhancing their use for various applications.

Disadvantages

The 1:100,000 scale may lack the granularity needed for detailed local land-use planning or analysis of small-scale landscape features. The MMU and polygon width limitations can lead to the generalization of heterogeneous landscapes, obscuring smaller but potentially important features (Büttner, et al., 2017). CLC updates occur at multi-year intervals, potentially hindering the ability to capture rapid land-use changes

7. Recommendations for Decision-Makers

A detailed examination of land cover changes between 2018 and 2023 in the Kakheti and Kvemo-Kartli regions of Georgia reveals dynamic patterns with implications for land use planning, resource management, and agricultural development. Below are key recommendations for decision-makers:

7.1 Urbanization and Land Use Planning

Manage Growth Strategically**:** The significant conversion of various land types into urban areas (codes 211, 221) underscores the need for proactive urban planning. Prioritize the development of compact, mixed-use urban forms to reduce sprawl and protect valuable agricultural land (EEA, 2023).

Preserve Green Spaces: The loss of some natural and semi-natural areas (e.g., potential conversions from codes 311, 324) highlights the importance of incorporating parks, greenbelts, and urban forests into development plans to enhance livability and protect biodiversity (EEA, 2023).

7.2 Agricultural Shifts & Sustainability

Irrigation and Water Management: The substantial increase in irrigated land (code 231) indicates an intensification of agriculture. Invest in water-efficient irrigation technologies, monitor water usage, and develop drought preparedness plans to ensure sustainable water use in light of potential climate variability (FAO, 2016).

Supporting High-Value Crops: Continued support for viticulture (vineyards) in the Kakheti region is important, as it is a high-value niche crop (GFSIS, 2021). Explore the potential for other specialized fruit and vegetable crops suited to the local climate and market conditions.

Soil Health and Erosion: The potential conversion of some forest and natural areas (codes 311, 411) into agricultural land highlights the need to prioritize soil conservation practices, and prevent erosion-prone land from being converted to intensive agriculture (FAO, 2016).

7.3 Forest and Natural Area Conservation

Combat Deforestation**:** While some reforestation or regeneration efforts are evident (e.g., transitions to code 411), there are also instances of forest land conversion. Analyze the drivers of deforestation and implement policies to protect remaining forests, especially in high-altitude zones (Feranec et al., 2016).

Ecological Land Management**:** Encourage agroforestry practices that integrate trees into agricultural landscapes and promote the restoration of degraded natural areas (e.g., transitions away from code 333) to enhance biodiversity and ecosystem services (Feranec et al., 2016).

7.4 Limitations and Further Analysis

Data Resolution: The CORINE Land Cover dataset provides a valuable overview, but its resolution may not capture fine-scale changes or the nuances of specific crop rotations. Local agricultural statistics could supplement this analysis.

Drivers of Change: Investigate the socioeconomic factors behind the observed land cover changes. Population growth, infrastructure development, market demand, and agricultural policies all influence land-use decisions.

7.5 Call to Action

Decision-makers are encouraged to use land cover change data as a powerful tool to:

Guide sustainable land use planning that balances economic growth, environmental protection, and the well-being of communities (EEA, 2023).

- Invest in regular land cover monitoring to support evidence-based and adaptive management strategies.
- Facilitate collaboration between government agencies, researchers, and land users to ensure effective implementation of policies.

8. Conclusion

The CORINE Land Cover (CLC) project in Georgia's Kakheti and Kvemo-Kartli regions has successfully established a standardized baseline for land use analysis. Adherence to CLC methodology ensures compatibility with European datasets, facilitating regional collaborations (EEA, 2023). Key findings highlight ongoing urbanization, the intensification of agriculture with increased irrigation, and dynamic forest cover changes. These insights provide a valuable foundation for evidence-based decision-making in the following areas:

Sustainable Land Use Planning: CLC data informs proactive urban development strategies, balancing growth with the protection of natural areas and the creation of livable cities.

Agricultural Policy and Water Management: The observed agricultural shifts necessitate a focus on sustainable water use, the promotion of water-efficient practices, and data-driven crop selection for economic growth.

Forestry and Biodiversity Conservation: Analysis of forest cover trends will underpin forest management decisions for long-term timber resources and the protection of priority conservation zones (Feranec et al., 2016).

Limited additional data for some land cover types, such as fruit and nut orchards, highlight the need for detailed inventories to be made public. Furthermore, the unique characteristics of Georgia's grazing practices led to the refinement of the CLC pasture classification. Regular monitoring of land cover change is essential for tracking long-term dynamics and informing adaptive management strategies.

Overall, the CLC project has enhanced the understanding of land use patterns within Kakheti and Kvemo-Kartli. It sets a valuable precedent for replicating this methodology across other regions of Georgia, facilitating informed decision-making at the national level.

9. References

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10. Annexes

1. Land Cover Changes during 2018-2023 (24)

Year 2023	Year 2018	Piece	Total Area (Ha)	Average Area (Ha)	Rareness
121	322	1	56	56	2
121	211	1	17	17	1
131	231	3	29	10	1
131	311	6	169	28	1
131	322	3	54	18	1
131	331	2	103	52	1
131	211	1	10	10	1
131	324	2	53	27	1
131	131	1	13	13	0
132	131	1	26	26	2
133	322	1	57	57	2
133	211	1	81	81	2
142	242	1	23	23	2
142	312	1	21	21	2
211	231	19	1604	84	1
211	212	5	960	192	1
211	333	1	306	306	2
211	324	1	9	9	1
211	211	1	7	7	0
212	411	2	32	16	1
212	211	15	1877	125	1
212	231	48	2350	49	1
212	512	6	82	14	1
212	222	1	16	16	1
212	324	1	42	42	1
221	231	4	84	21	1
221	211	11	809	74	1
221	243	1	52	52	1
221	212	13	837	64	1
221	324	1	7	7	1
222	211	24	2371	99	1
222	212	22	1019	46	1
222	231	18	1326	74	1
222	242	1	28	28	1
222	333	2	91	46	2
222	324	3	85	28	1

222	222	1	20	20	0
223	212	1	136	136	2
231	324	1	10	10	1
231	512	6	99	16	1
231	211	5	387	77	1
231	411	1	9	9	1
231	221	1	20	20	1
231	333	1	25	25	2
231	231	2	46	23	0
231	132	1	14	14	1
242	243	1	5	5	1
242	231	3	192	64	1
242	212	1	9	9	1
242	211	2	51	25	1
242	222	1	8	8	1
243	311	2	22	11	1
243	512	1	20	20	1
311	331	2	33	16	2
311	512	1	18	18	1
311	324	2	23	11	1
312	324	1	30	30	1
324	334	1	12	12	1
324	512	1	19	19	1
324	311	1	30	30	1
324	331	2	20	10	1
324	312	1	27	27	1
324	324	1	14	14	0
331	311	1	8	8	1
331	324	4	58	14	1
331	231	1	12	12	1
332	335	3	71	24	1
333	231	12	5544	462	1
334	311	1	371	371	1
334	312	1	36	36	1
411	512	3	136	45	1
411	231	1	10	10	1
512	333	5	168	34	1
512	211	4	173	43	2
512	411	9	237	26	2
512	212	1	18	18	2
512	324	1	34	34	2
512	231	1	55	55	2
512	512	1	10	10	0

2. Land Cover Areas in 2023 (24)

Land cover types	CLC-Code 2023(24)	Piece	Area (ha)
Continuous urban fabric	111	4	864
Discontinuous urban fabric	112	355	61038
Industrial or commercial units	121	73	7474
Road and rail networks and associated land	122	1	27
Airports	124	4	1324
Mineral extraction sites	131	37	3714
Dump sites	132	11	536
Construction sites	133	3	164
Green urban areas	141	7	444
Sport and leisure facilities	142	12	674
Non-irrigated arable land	211	315	118641
Permanently irrigated land	212	196	147544
Vineyards	221	210	56677
Fruit trees and berry plantations	222	164	16069
Olive groves	223	3	355
Pastures	231	584	502914
Annual crops associated with permanent crops	241	1	63
Complex cultivation patterns	242	418	89561
Land principally occupied by agriculture, with significant areas of natural vegetation	243	171	17120
Broad-leaved forest	311	165	513833
Coniferous forest	312	86	25251
Mixed forest	313	58	12059
Natural grassland	321	61	27431
Moors and heathland	322	347	80205
Sclerophyllous vegetation	323	1	149
Transitional woodland/shrub	324	217	29569
Beaches, dunes, sands	331	37	8289
Bare rock	332	113	57227
Sparsely vegetated areas	333	201	61030
Burnt areas	334	2	407
Glaciers and perpetual snow	335	8	693
Inland marshes	411	28	2972
Peatbogs	412	1	80
Water courses	511	2	829
Water bodies	512	54	8227

3. Georgia CLC2023 verification report – part I.

I. Metadata

DATASET(S)	CLC2023 and CLC-Change$_{2018\text{-}2023}$
Country	**Georgia**
Type of verification	remote verification
Institution carrying out the work	Geo-Information System Laboratory
Method of production	standard, according to CLC Technical Guidelines
Name / ID WU(s) (Working Unit(s))	GE_KA
Number of VWUs verified	2
Total area of the VWU(s)	2512 km^2
Percent total area of the VWU(s) relative to country	3,7 %
Software used for verification	CLC2023 Support Package: InterCheck 4.1.1
Additional supporting data	Google Earth time series
Comments on additional supporting data	Good recent (~2017-18 and ~2021-24) coverage of GE data
Data preparation by	Barbara Kosztra, Lechner, barbara.kosztra@lechnerkozpont.hu (setting up InterCheck project file);
Verification done by	Barbara Kosztra, Lechner, barbara.kosztra@lechnerkozpont.hu
Start date of verification	12.06.2024
End date of verification	14.06.2024
Date and place of writing the report	14.06.2024, Budapest

II. Tabular summary

CLC2023

Verification working unit	**Evaluation (A, CA or R)**	Comment
GE_KA	A	Well mapped in general, no major systematic issues are discovered. Few omitted 22x and some mixing between complex and pure agricultural classes is discovered. Separation of 231 / 243 / 322 can be improved. Improve the connection of gravelly riverbed (331) polygons. Classes 332 and 333 require systematic revision, as the share of bare surface is overestimated. Make sure that spring/autumn images are also used! Correction in some cases needed to ensure correct change data.

<table>
<tr><th colspan="3">CLC-Change₂₀₁₈₋₂₀₂₃</th></tr>
<tr><th>Verification working unit</th><th>Evaluation (A, CA or R)</th><th>Comment</th></tr>
<tr><td>GE_KA</td><td>CA</td><td>The concept and method of change mapping is generally well understood and technically well applied.
Changes of permanent crops (221, 222) require a re-check – omitted parts are found, while overestimation also occurs (partly due mistake in CLC2023)
Revise ALL changes of mosaic classes 242 and 243 and re-code changes according to the real process as visible on the satellite images.
Non-changed parts >5 ha should be cut and deleted from change polygons.
Apply technical changes where recommended (and where needed).</td></tr>
</table>

Evaluation grades	**Explanation**
A (Accepted)	no major mistakes were found
CA (Conditionally Accepted)	several mistakes, but relatively easy to correct
R (Rejected)	several, different types of mistakes, or most of changes omitted; more work is needed to correct

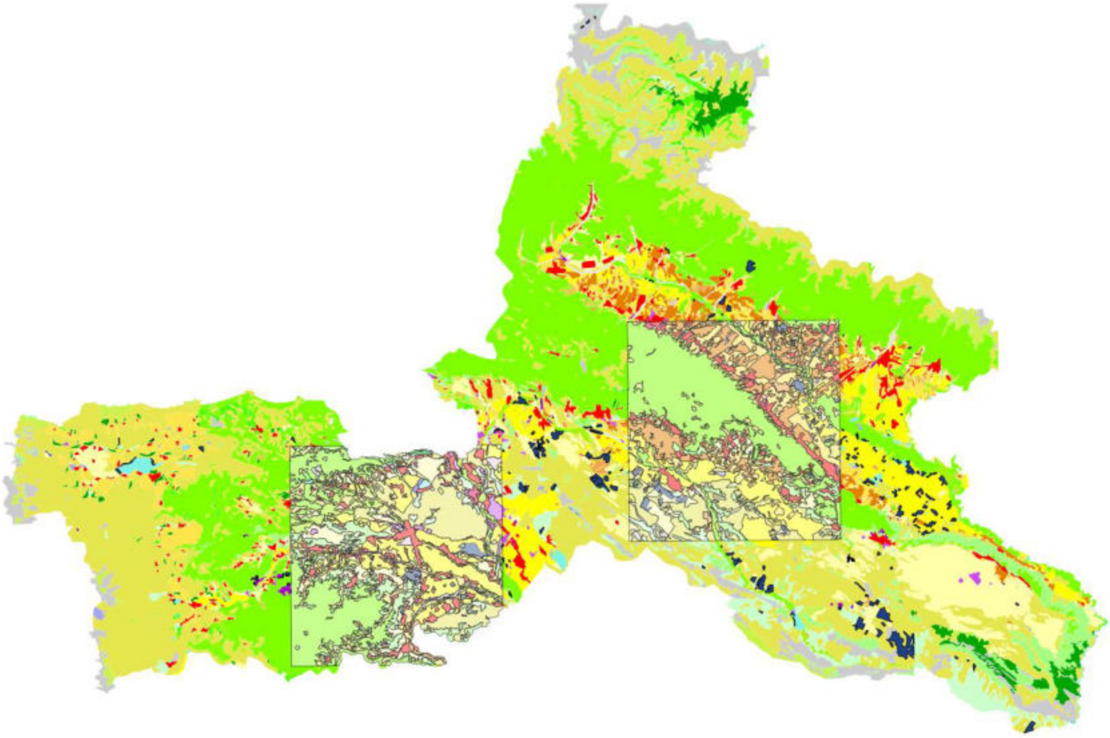


Figure 1 Overview of CLC2023 layer in Georgia and VU-s verified (left: KK- Kvemo Kartli region, right: KA – Kakheti region). This report deals with Kakheti region VU.

III. Implementing corrections

Study the remarks of the Technical Team provided in remark_r.shp and remark_c.shp files and the detailed evaluation in Annex I.
Only a fraction of the mapping area is verified. Correction of frequent / systematic mistakes should be applied not only at polygons with remarks, but **the entire mapping area needs to be revised.**
Invest efforts to understanding messages included in remark files and do not just mechanically implement the proposed corrections. Consider verification as a learning process with the main purpose of improving the quality of the database. If you are in doubt how to understand a remark, **consult with a colleague** in your team or email the CLC Technical Team expert who did the verification.
Preparing deliveries: make sure that delivered datasets are free from topological mistakes (no overlaps, no holes, no multipart polygons, no neighbouring polygons with same code) and that they comply with main technical specifications (MMU=25 ha for CLC2023, MMU=5 ha for CLC-change

IV. Additional information

Annexes	Annex-1 (attached to this report) includes detailed results of the verification for the verified WU.
Remark file	Remarks regarding the verification are attached in a shapefile point coverages: remark_r.shp file contains remarks referring to the CLC2023 database, remark_c.shp contains remarks related to CLC-Change$_{2018\text{-}2023}$ database.

Annex 1

Overall characterisation

GE_KA	
SATELLITE IMAGES	
IMAGE2018	Sentinel-2: 1 July 2018,
Comments on IMAGE2018	Good quality image, but only one season taken in 2018
IMAGE2023	Sentinel 2: 14 August, 2 November 202
Comments on IMAGE2023	Good quality multi-seasonal imagery taken in 2023

TECHNICAL CORRECTNESS CLC2023	
code errors	none
size errors	polygons <25 ha: none (53 accepted, as being on WU border)
merge errors	none
shape errors	number of polygons having width << 100 m: 7

topological errors	multipart polygons: 20 --- corrected: 36 polygon(s) added;
	polygons with invalid topology repaired: 1;
	holes in Revision layer: 2 --- corrected: 2 polygon(s) added;

TECHNICAL CORRECTNESS CLC-Change$_{2018-2023}$	
code errors	none
size errors	polygons <5 ha: 2 accepted, as being on WU border
merge errors	none
shape errors	number of polygons having width << 100 m: 2
topological errors	none

STATISTICAL CHARACTERISATION

SUMMARY STATISTICS, CLC2023

CODE2023	PIECE	AREA	AVERAGE
0	1	0	0
111	2	280	140
112	62	14 660	236
121	11	479	44
131	1	54	54
141	3	93	31
142	2	118	59
211	58	12 385	214

SUMMARY OF CLC-CHANGE$_{2018-2023}$

72 polygons, 4 375 ha, 1,74% of WU

CODE2018	CODE2023	PIECE	AREA
242	142	1	23
212	211	2	871
231	211	6	694
324	211	1	57
324	212	1	34
231	212	8	156
411	212	1	11

212	50	29 805	596
221	98	31 945	326
222	45	5 429	121
223	1	55	55
231	120	33 171	276
242	127	27 310	215
243	57	4 338	76
311	37	73 983	2 000
312	1	43	43
313	3	58	19
322	43	8 195	191
324	22	1 868	85
331	12	1 916	160
332	6	1 169	195
333	15	3 137	209
334	1	61	61
411	5	411	82
512	9	295	33

211	212	1	78
512	212	1	21
222	212	1	16
231	221	2	36
512	221	1	21
211	221	3	454
243	221	2	66
212	221	7	675
211	222	4	251
212	222	4	187
231	222	4	303
242	222	1	28
324	222	2	20
512	231	2	34
211	231	2	33
311	242	1	6
212	242	4	154
231	242	4	72
512	242	1	19
411	243	1	15
212	243	1	7
231	411	1	14
242	512	1	8
212	512	1	8

Detailed results of the verification

GE_KA	
Thematic control – CLC2023	
Issue / class	**Finding / proposal**
Sampling strategy	All classes were checked. Classes with <30 polygons were fully revised, others sampled to 20-30 polygons. Class 322 was also fully checked.
General problems / issues	None. Very good quality datasets both in terms of geometry and classification.
111, 112 – Urban fabric	Class 111 should have > 80% sealing, areas with 30-80% should be reclassified as 112 Remove <<30% built up parts from 112 and re-code them as 242 Small (<25 ha) woody area on city edge better to merge to 231, instead of 112 (semantically closer to grassland than to artificial area)
121 – Industry and commercial areas	Class 121 is applied well. Road crossing is better to be merged to into adjacent 121 instead of to 242.
131 – Mineral extract sites	The single polygon is a gravel mine on the riverbank. It is hard to separate 131 from natural river bed (331) here, which might be the reason for a small part of 131 omitted.
141 – Urban green 142 – Sport and recreation	Both classes are well applied and correctly delineated
211, 212 – Non-irrigated and irrigated arable land	Separation of irrigated and non-irrigated arable land is consistent and explicable by imagery. In a few cases use of 212 seemed questionable (no sign of lush vegetation on any image). Make sure that irrigated plantations (221, 222) are separated from 212.
221 – Vineyards 222 – Fruit trees 223 – Olive groves	Both types of plantations are well mapped, minor omission found only (mostly inside 212 and 242). From large 221s separate >25 ha patches where vine parcels do not dominate by >50%, here proposed code is 242. Small 222 better to be merged to 221 instead of merged to 212. The single 223 might be a mistyping. If not, confirmation is needed.

231 - Pastures	Class is properly used for different types of pastures, wet meadows, as well as for degraded grasslands. Remove parts where low-growing woody vegetation dominates, use code 324 here. Where grasslands are intermixed with small forest patches and natural rivers, code 243 is proposed instead of 231.
242 – Complex cultivation patterns	Generally well applied, occasionally and for smaller areas separation from 22x and 43 can be improved.
243 - Agriculture with significant areas of natural vegetation	Minor omitted 243 parts inside 211, 231, 242 are found. From 243 remove those mosaicked agricultural areas where the share of natural patches is insignificant. Note that it is enough to have one agricultural component in the agri-natural mosaic, thus where agricultural grasslands are intermixed with small forest patches and natural rivers, code 243 should be used.
311 – Deciduous forest 312, 313 – Coniferous / mixed forests	Well mapped. Small omitted 313 is found inside 311. Use April and November images when deciduous trees are already leafless, to find patches of coniferous forest (>75% conifers) and mixed forest (25-75% conifers).
322 – Moors and heathland	This class is used for permanent, climax stage low woody vegetation, not being able to develop into a forest due to climatic conditions. The issue of coding shrub-dominated areas was long discussed during the previous CLC pilot. In this project, in general, the separation of 322 from 324 looks consistent and reasonable (all 322 polygons were checked). Few examples look to be in gradual process of woody succession based on GE imagery. 322 is applicable for climax stage shrubby vegetation, where development to forest is not possible due to climatic/soil conditions. Where gradual development towards forest is visible, code 324 is proposed. Where along-contour-line rows of afforestation are visible, also use 324. Also, make use that agri-natural mosaics are removed as 243 from large 322 polygons.
324 – Transitional woodland-shrub	A typical example of using this class is areas of natural succession (abandoned grassland or plantation). Cut 231 from 324 where succession has not led yet to the dominance of woody vegetation. Do not use 324 either for grassland with some forest patches, there 231 and 243 are proposed, respectively.
331 – Beaches, dunes, sand	River's gravel beds are well mapped as 331. Minor parts >100 m are omitted only – note, that these can be connected to existing 331 even if small (few hundred meter) stretches between them are narrower than 100 m

332 – Bare rock	332 is applicable for <10% vegetated areas. Cut areas where >10%, but <50% vegetation is present, and use the right code is 333.
333 -Sparsely vegetated areas	Some od 333 are partly covered by sparse grass (>50% vegetation cover), Separate these parts as 231. Use autumn/spring image to identify these parts.
334 – Burnt areas	334 is applicable for freshly burnt natural woody vegetation. Here former vegetation was mostly grass (not mapped as 334 when burnt, because it regenerates quickly). A small patch was shrub but even there black colour of recent burn is not visible any more.
411 – Wetland	Correctly mapped.
512 - Lakes	An omitted >30 ha 512 found inside a 243.
Total number of remarks:	65
Evaluation:	**Accepted (A)**
Reasoning	**Well mapped in general, no major systematic issues are discovered.** **Few omitted 22x and some mixing between complex and pure agricultural classes is discovered. Separation of 231 / 243 / 322 can be improved. Improve the connection of gravelly riverbed (331) polygons. Classes 332 and 333 require systematic revision, as the share of bare surface is overestimated. Make sure that spring/autumn images are also used!** **Correction in some cases needed to ensure correct change data.**

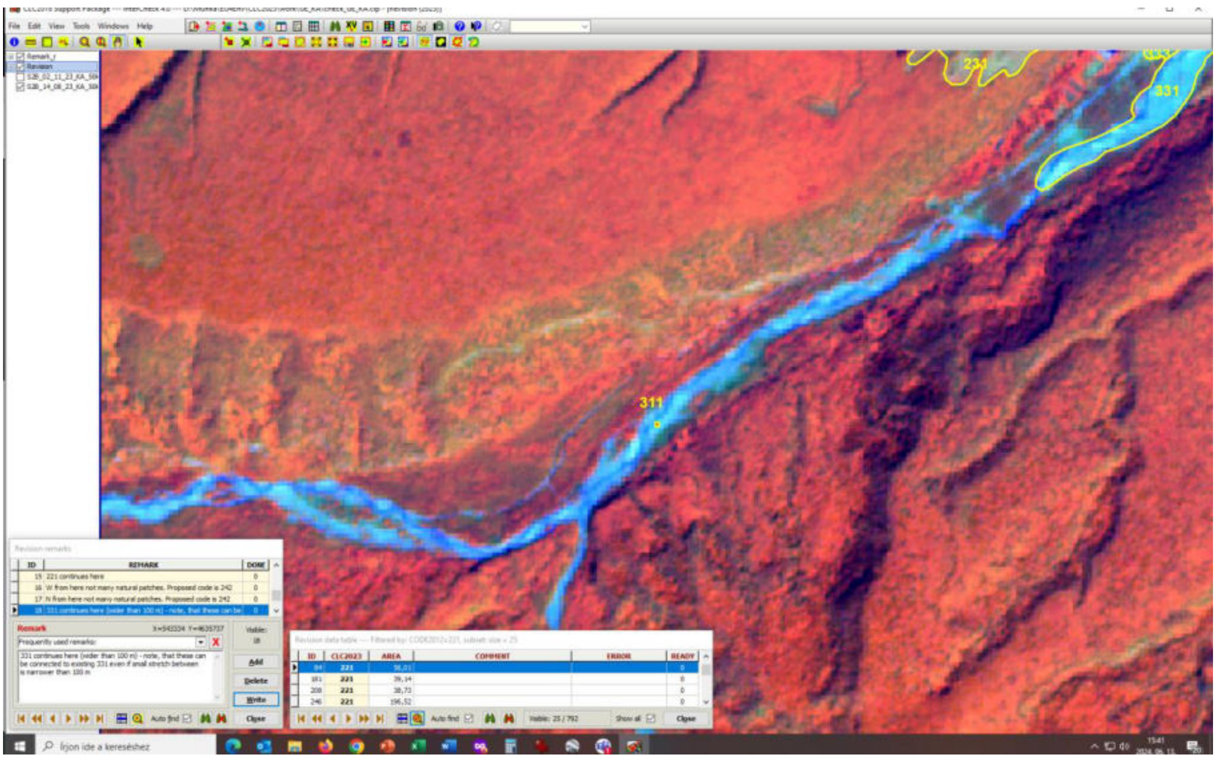
Thematic control – CLC-Change$_{2018\text{-}2023}$	
Sampling strategy	CLC-Change$_{2018\text{-}2023}$ dataset contains 72 change polygons, all of which were checked.
General problems / issues	Change processes are well identified in most cases, however omitted changes occur. >5 ha non-changed parts should be removed from change polygons. Technical changes are not applied.
Change process	**Finding**
Urban sprawl	The singe increase of sport and recreation (242-142) is correct
Arable-pasture rotation	<u>Change from pasture to arable land</u> (231-211/212): Small part of one 231-211 is omitted. One change is questionable, looks arable already on 2017 images in GoogleEarth. In case of one omitted 231-211, a correction of 211/231 separation in CLC2023 is needed before mapping the missing change.

	Change from arable land to pasture (211/212-231): Both 211-231 are partly false (to be cut and coded as technical change 211-211) or wrongly coded (324-211 is the correct code)
Changes of irrigated / non-irrigated arable land	212-211 and 211-212 changes are both correct.
Changes in permanent crops	Removal of plantations: 222-212: acceptable; New plantations (211/231-222) Some 21x-221 polygons are overestimated in area. Cut and delete non-changed area where 221 already in 2018. Omitted 21x-221 are also found. In some cases, CLC2023 also needs correction. 211/212/231-222 are correct. Both 324-222 are correct, too.
Changes of agricultural mosaics	Inside 242 and 243 polygons, the real change should be mapped e.g. 212-221 instead of 212-242; 231-211 instead of 231-242; 512-324 instead of 512-243 etc. Often no changed should be mapped at all (211, 221 or 231 in both dates). Note that change code can be different from “mother polygon’s” code.
Forestry changes – clearcuts and forest regrowth	No such changes have been mapped. No omissions found.
Changes of natural grasslands and woodland/shrub	324-211: The single such change is mostly false, 324 in both dates (CLC2023 code is also wrong, should be 243). A small part of polygon should be kept as 324-211.
Changes of wetlands and water bodies	411-212: mapped change is correct. Two disappearing lakes (512-231) are correct, one 512-211 is actually 512-243 (some parts of lake remain there). The 231-411 change is false, area is 231 in both dates. The wet patch visible on november image is only a seasonal inundation. Real wetland shows wetness also during summer months.
Technical changes	Technical changes are not applied, although would be needed in several cases. Omitted 231-231 found. Together with neighbouring 231-212 they will make up a >25 ha 231 polygon in CLC2018. Part of one 324-212 polygon is 324 in both dates. Separate 324-324 (technical change) there.

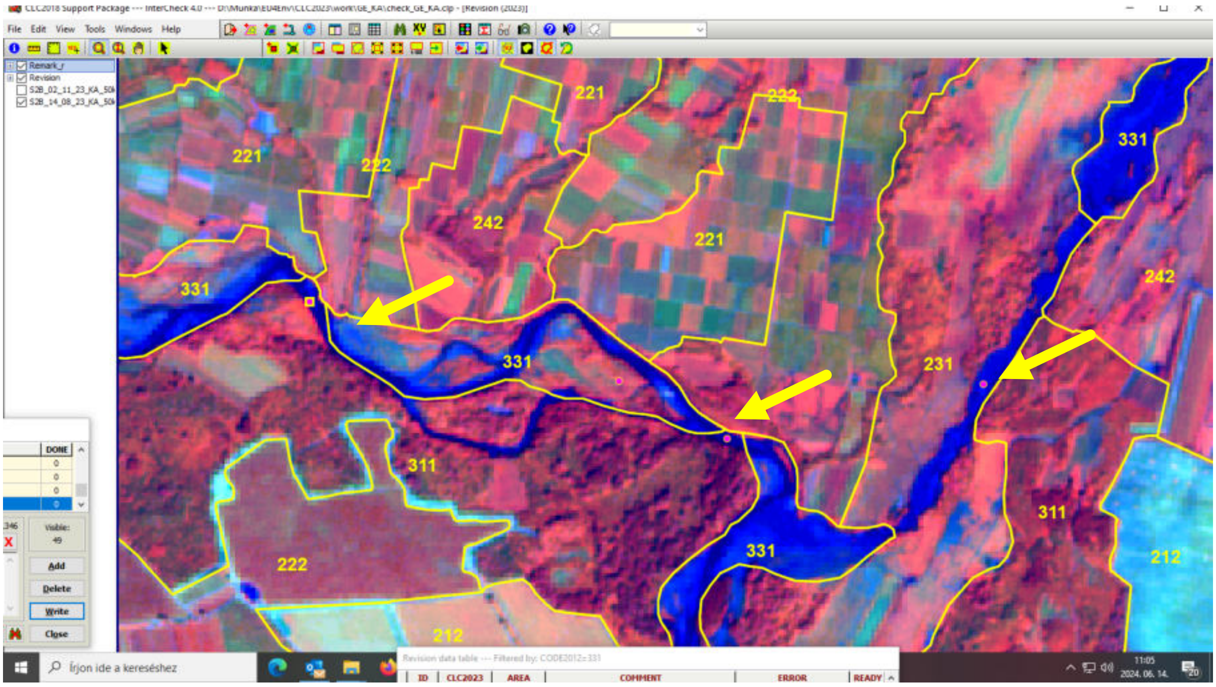
	Omitted 512-512: together with neighbouring 212-512 they will make up a >25 ha 512 polygon in CLC2018.
Total number of remarks:	34
Evaluation:	**Conditionally Accepted (CA)**
Reasoning	**The concept and method of change mapping is generally well understood and technically well applied.** **Changes of permanent crops (221, 222) require a re-check – omitted parts are found, while overestimation also occurs (partly due mistake in CLC2023)** **Revise ALL changes of mosaic classes 242 and 243 and re-code changes according to the real process as visible on the satellite images.** **Non-changed parts >5 ha should be cut and deleted from change polygons.** **Apply technical changes where recommended (and where needed).**

Detailed remarks are provided in remark_r.shp and remark_c.shp files.

Screen-shot(s) to demonstrate significant or frequent problems



Example 1 River's gravel beds are well mapped as 331. Minor parts >100 m are omitted only – note, that these can be connected to existing 331 even if small stretches between are narrower than 100 m



Example 2 Keep connected the 331 representing river's gravel beds (see magenta dots, marked by yellow arrows)

4. Georgia CLC2023 verification report – part II.

I. Metadata

DATASET(S)	CLC2023 and CLC-Change$_{2018-2023}$
Country	**Georgia**
Type of verification	remote verification
Institution carrying out the work	Geo-Information System Laboratory
Method of production	standard, according to CLC Technical Guidelines
Name / ID WU(s) (Working Unit(s))	GE_KK
Number of VWUs verified	1
Total area of the VWU(s)	2 276 km^2
Percent total area of the VWU(s) relative to country	3,2 %
Software used for verification	CLC2023 Support Package: InterCheck 4.1.1
Additional supporting data	Google Earth time series
Comments on additional supporting data	Good recent (~2017-18 and ~2021-24) coverage of GE data
Data preparation by	Barbara Kosztra, Lechner, barbara.kosztra@lechnerkozpont.hu (setting up InterCheck project file);
Verification done by	Barbara Kosztra, Lechner, barbara.kosztra@lechnerkozpont.hu
Start date of verification	17.06.2024
End date of verification	19.06.2024
Date and place of writing the report	19.06.2024, Budapest

II. Tabular summary

CLC2023		
Verification working unit	**Evaluation (A, CA or R)**	Comment
GE_KK	CA	Well mapped in general, however a few systematic issues are discovered. Full revision of the following classes is needed (in all WUs), also for avoiding omission of changes: 131 – more precise delineation; 331 – separation of river gravelbeds from vegetated surface (mostly 324 or 333); 332 – all are >10% vegetated, to be recoded to 333, sometimes to 231 or 322/324, The share of bare surface is generally overestimated. Separation of 112/21x/242 for mosaics of greenhouses, agriculture and residential houses should be improved. can be improved. Improve the connection of gravelly riverbed (331) polygons. Separation of 231, 322, 243 and 21x/22x from 242can also be improved.

CLC-Change$_{2018-2023}$		
Verification working unit	**Evaluation (A, CA or R)**	Comment
GE_KK	CA	The concept and method of change mapping is generally well understood and technically well applied. However, a considerable number of changes (25!) were found missing, related mostly to mines (131), free-flowing rivers (331, 511) and – less extent – irrigated land and plantations. FULL checking of the surroundings of 131 and 331 in ALL working area is recommended, with revision of delineation of these classes, followed by mapping of omitted changes.

Evaluation grades	**Explanation**
A (Accepted)	no major mistakes were found
CA (Conditionally Accepted)	several mistakes, but relatively easy to correct
R (Rejected)	several, different types of mistakes, or most of changes omitted; more work is needed to correct

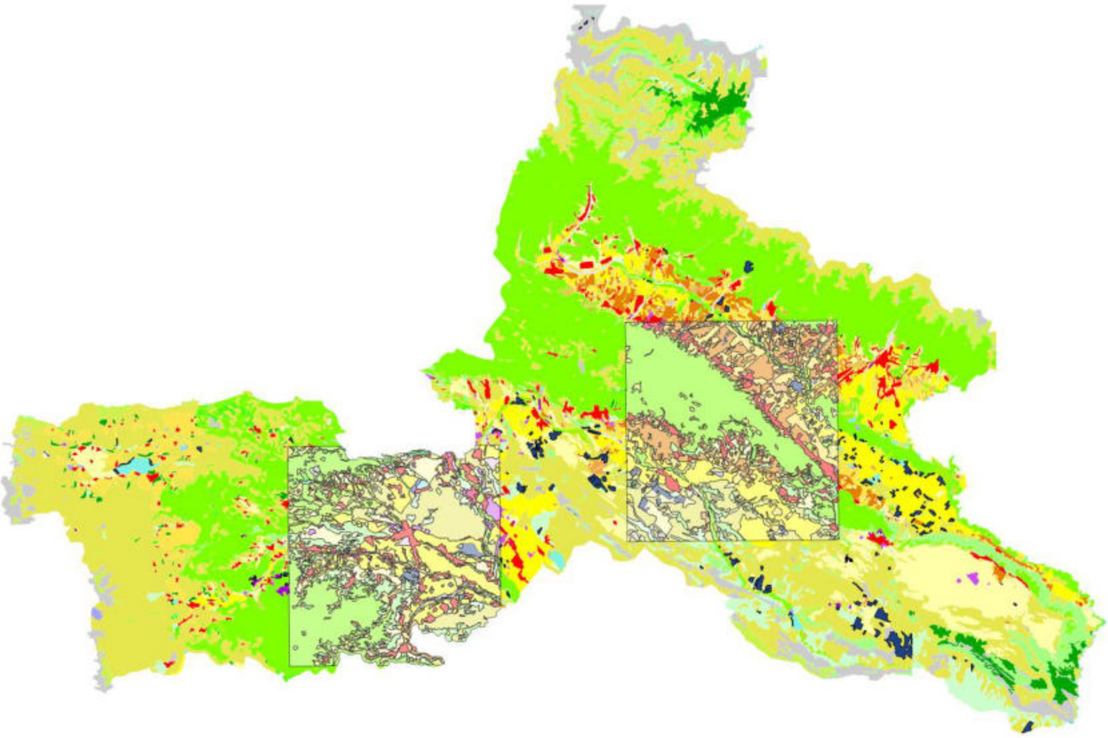


Figure 1 Overview of CLC2023 layer in Georgia and VU-s verified (left: KK- Kvemo Kartli region, right: KA – Kakheti region). This report deals with Kvemo Kartli region VU.

III. Implementing corrections

Study the remarks of the Technical Team provided in remark_r.shp and remark_c.shp files and the detailed evaluation in Annex I.
Only a fraction of the mapping area is verified. Correction of frequent / systematic mistakes should be applied not only at polygons with remarks, but **the entire mapping area needs to be revised.**
Invest efforts to understanding messages included in remark files and do not just mechanically implement the proposed corrections. Consider verification as a learning process with the main purpose of improving the quality of the database. If you are in doubt how to understand a remark, **consult with a colleague** in your team or email the CLC Technical Team expert who did the verification.
Preparing deliveries: make sure that delivered datasets are free from topological mistakes (no overlaps, no holes, no multipart polygons, no neighbouring polygons with same code) and that they comply with main technical specifications (MMU=25 ha for CLC2023, MMU=5 ha for CLC-change

IV. Additional information

Annexes	Annex-1 (attached to this report) includes detailed results of the verification for the verified WU.
Remark file	Remarks regarding the verification are attached in a shapefile point coverages: remark_r.shp file contains remarks referring to the CLC2023 database, remark_c.shp contains remarks related to CLC-Change$_{2018-2023}$ database.

Annex 1

Overall characterisation

GE_KK	
SATELLITE IMAGES	
IMAGE2018	Sentinel-2: 1 July, 18 September 2018, 29 July 2019
Comments on IMAGE2018	Good quality multi-seasonal imagery
IMAGE2023	Sentinel 2: 14 August, 8 October 2023
Comments on IMAGE2023	Good quality multi-seasonal imagery taken in 2023
TECHNICAL CORRECTNESS CLC2023	

code errors	none
size errors	polygons <25 ha: none (34 accepted, as being on WU border)
merge errors	none
shape errors	number of polygons having width << 100 m: 9

topological errors	multipart polygons: 12 --- corrected: 25 polygon(s) added;
	holes in Revision layer: 2 --- corrected: 2 polygon(s) added;
	overlapping polygons: 1 --- corrected;
	sliver polygon(s): 2 --- merged;

TECHNICAL CORRECTNESS CLC-Change$_{2018-2023}$	
code errors	none
size errors	polygons <5 ha: 1 (2 accepted, as being on WU border)
merge errors	none
shape errors	number of polygons having width << 100 m: 1
topological errors	none

STATISTICAL CHARACTERISATION

SUMMARY STATISTICS, CLC2023

CODE2012	PIECE	AREA	AVERAGE
111	2	612	306
112	103	16 403	159
121	24	3 137	131
122	1	48	48
124	2	1 108	554
131	20	1 570	79
132	7	346	49
141	2	225	113
142	8	406	51
211	95	19 970	210
212	59	35 897	608
221	18	1 041	58
222	36	2 165	60
231	128	45 411	355
242	72	7 677	107
243	30	3 871	129

SUMMARY OF CLC-CHANGE$_{2018-2023}$

31 polygons, 4 375 ha, 1,28% of WU

CODE2018	CODE2023	PIECE	AREA
331	131	1	49
212	131	1	8
211	132	1	4
212	211	3	68
211	212	2	1 904
212	221	2	54
212	222	8	326
211	222	8	367
221	231	1	20
231	242	1	54
331	311	1	5
331	324	2	64

311	29	49 288	1 700
312	4	535	134
313	4	433	108
321	5	366	73
322	64	17 445	273
324	60	10 680	178
331	5	1 533	307
332	16	1 786	112
333	20	4 475	224
411	2	216	108
412	1	315	315
511	1	39	39
512	4	673	168

Detailed results of the verification

GE_KK	
Thematic control – CLC2023	
Issue / class	**Finding / proposal**
Sampling strategy	All classes were checked. Classes with <30 polygons were fully revised, others sampled to 20-30 polygons.
General problems / issues	The 100 m MMU is not always followed: >100 omitted parts of 331 and 511 found. Some classes require systematic revision.
111, 112 – Urban fabric	Class 111 should have > 80% sealing, parts with 30-80% built-up density (>20% green) should be reclassified as 112. Assessing green cover can be tricky for blocks of houses type of housing areas (***Example 1***). The mosaic of greenhouses, different crops and residential houses has a misleading pattern on satellite images, looking like 112. However, built-up density is <30%, the area should be coded as 242 (***Example 2***). Check 112s in the surroundings of marked polygons. In general, remove <<30% built up parts from 112 and re-code them as 242. Vegetation covered areas inside built-up area should be separated and coded as 141 (even if not a formal park). Optionally, class 231 can also be used (degraded grass). From 112 cut university and merge to neighbouring 121.
121 – Industry and commercial areas	Class 121 is applied well (also for abandoned industrial/military(?) areas). Remove agriculture from abandoned industry polygons. <25 ha road crossings are better to be merged to into adjacent 121 instead of to 2xx. One 121 is questionable (no sign of any built-up). There are some airplanes visible on GE imagery. If this is a grassy-runway airport, code 142 should be applied. 121 is applicable only if this is a military area. (***Example 4***)
122 – Roads and railways	The single 122 mapped is far too much exaggerated in size! Remove 231 and 324 from polygon. Real size is hardly bigger than 20 ha...
124 - Airports	The two 124s are properly delineated.
131 – Mineral extraction sites 132 – Dump sites	Precise delineation of 131 is needed, which is also important for proper delineation of changes. (***Example 5***) Gravel mining on riverbanks is generally well mapped. However, exaggeration occurs in some cases. Instead of 131, in some cases separation of 331, 324 and 511 (with some exaggeration) is proposed. In the commented cases only a minor part of polygons is actually used for gravel extraction.

	Separation between 331/324 and 131 is also important for avoiding the omission of changes, that are frequent along free-flowing rivers. (Example 6) Also, make sure that abandoned parts of mines are separated and coded according to their actual land cover (usually 324, 333 or 231). Dump sites are properly mapped
141 – Urban green 142 – Sport and recreation	Both classes are well applied and correctly delineated. A small omitted part of a golf course found. One place looks like an archaeological site (Arkevani Basilika). If so, it is 142 in CLC, so should be merged to 112 instead of 243.
211, 212 – Non-irrigated and irrigated arable land	Separation of irrigated and non-irrigated arable land is usually. In a few cases use of 212 seemed questionable, in a few other examples 211 neighbouring 212 looked very similar (=irrigated). Proposed to use class 242 (instead of 212) for the mosaic of different crops, greenhouses and residential houses (***Example 3***) Draw border between natural vegetation and agriculture more precisely. <25 ha 321 on the border is to be generalized into 322 instead of 211. From 242 separate 211/212 where arable land dominates by >75%.
221 – Vineyards 222 – Fruit trees	Both types of plantations are well mapped, minor omission found only (mostly inside 212 and 242).
231 - Pastures	Class is properly used in general. Small 322 between 231 and 311 should be generalized into 311 (natural) instead of 231 (agri). Where grasslands are intermixed with small forest patches and natural rivers, code 243 is proposed instead of 231.
242 – Complex cultivation patterns	Try to reduce 242 area. From large 242 separate >25 ha 221/222 where vines/fruits trees dominate by >50%, and keep the rest as 211/212. From 242 separate 211/212 where arable land dominates by >75%. From 242 separate 243 where agriculture does not dominate.
243 - Agriculture with significant areas of natural vegetation	Minor omitted 243 parts inside 211, 231, 242 are found. From 243 remove those mosaicked agricultural areas where the share of natural patches is insignificant. Note that it is enough to have one agricultural component in the agri-natural mosaic, thus where agricultural grasslands are intermixed with small forest patches and natural rivers, code 243 should be used.
311 312, 313 – Forests	Well mapped.

321 – Natural grassland	Class is well applied. One large 231 looks 321. Separate 321 from 322 where shrubby vegetation does not dominate over natural herbaceous cover
322 – Moors and heathland	This class is used for permanent, climax stage low woody vegetation, not being able to develop into a forest due to climatic conditions. The issue of coding shrub-dominated areas was long discussed during the previous CLC pilot. In this project, in general, the separation of 322 from 324 looks consistent and reasonable (all 322 polygons were checked).
324 – Transitional woodland-shrub	A typical example of using this class is areas of natural succession (abandoned grassland or plantation). Cut 231/321 from 324 where succession has not led yet to the dominance of woody vegetation. On case looks typical 322 – check on GE.
331 – Beaches, dunes, sand	River’s gravel beds are in general correctly mapped as 331. Some parts >100 m are omitted only – note, that these can be connected to existing 331 even if small (few hundred meter) stretches between them are narrower than 100 m. For wide riverbeds not fully covered by gravel, use code 333 and 331 only for the river part. Code 331 should be used for >90% bare area, on the commented area there is sparse vegetation. Precise delineation is also needed for finding changes (see ***Example 6***). In a few cases 243 is the correct code for parts of 331 polygons. Revise **ALL** 331 along rivers!
332 – Bare rock	332 is applicable for <10% vegetated areas. None of the 332 polygons were actually bare rock, all contained 10-50% vegetation, to be mapped as 333, or even more (231, 322). The class requires full revision (in all working units). Use Google Earth, too to have a better estimate of vegetation. **Example 9** Two 332s seem to be mistyped 322.
333 -Sparsely vegetated areas	Some of 333 are partly covered by sparse grass or shrub (>50% vegetation cover). Separate these parts as 231/322. Check also autumn images, as vegetation is burnt dry by sun in summer, therefore is not detectable.
411, 412 – Wetlands	The two 411 look correct. The single 412 is questionable. Class 412 is applicable for peatbogs, which usually appear on wet climate. This looks like an inland salt marsh, mapped as 411
511 - Rivers	Separate River Kura, as it is >100 m wide in long sections (***Example 1***). In order to keep connectivity of rivers narrower part can also be kept as part of polygon. Revise all rivers.

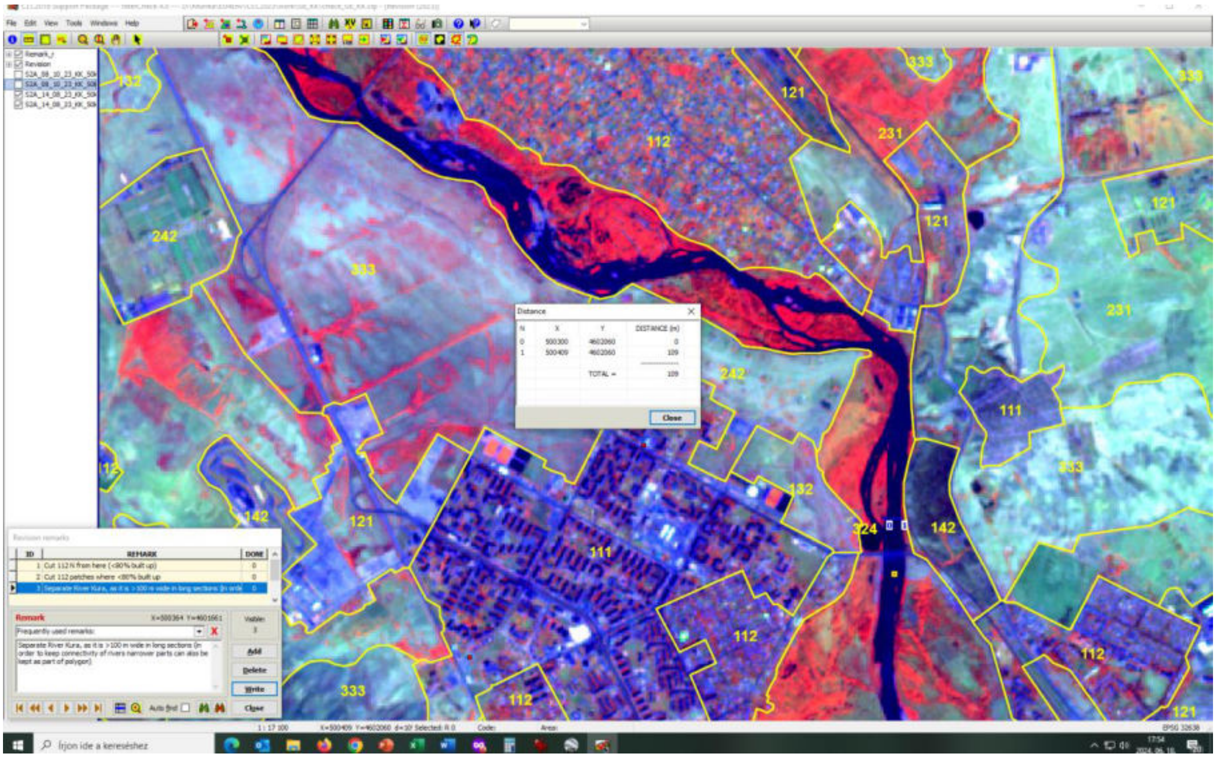
512 - Lakes	Mapped lakes are correct.
	103
Evaluation:	**Conditionally Accepted (CA)**
Reasoning	**Well mapped in general, however a few systematic issues are discovered.** **Full revision of the following classes is needed (in all WUs), also for avoiding omission of changes:** **131 – more precise delineation;** **331 – separation of river gravelbeds from vegetated surface (mostly 324 or 333)** **332 – all are >10% vegetated, to be recoded to 333, sometimes to 231 or 322/324; as the share of bare surface is overestimated** **Separation of 112/21x/242 for mosaics of greenhouses, agriculture and residential houses should be improved. can be improved. Improve the connection of gravelly riverbed (331) polygons. Separation of 231, 322, 243 and 21x/22x from 242can also be improved.**

Thematic control – CLC-Change$_{2018\text{-}2023}$	
Sampling strategy	CLC-Change$_{2018\text{-}2023}$ dataset contains 31 change polygons, all of which were checked.
General problems / issues	Many omitted changes occur, comparable in number to mapped ones (31 mapped, 25 missing). Some changes need to be revised regarding coding or delineation (non-changed parts removed)
Change process	**Finding**
Changes of mines and dump sites	Mapped extension of mines and dumps (212-131, 212-132) are correct. Mapped 331-131 looks rather 333-131 (the are was not fully bare, but sparsely vegetated in 2018). Omitted removal of a (construction rubbish?) dump site found: 132-231. Omitted changes along free-flowing rivers are found, e.g. 331-131 (***Example 6***) Omitted changes of a new mine (324-131) (***Example 7***) or mine extension (231-131, 311-131). Revise **ALL** 131 to find missing changes! Outline of 131 in CLC2023 needs to be corrected first.
Changes of sport and recreation	A small omitted change related to golf course construction (133-142) found.
Changes of irrigated / non-irrigated arable land	Mapped 212-211 look reasonable. One large 211-212 is questionable, must be confirmed using ancillary data. No visible difference between images of the two reference years. In the other large 211-212 change polygon outline does not follow natural/parcel boundaries. It seems a part of change is missing (maybe mother polygon was only partly taken over in InterChange).

	Omissions 211-212 are found.
Changes in permanent crops	Removal of plantations: 221-231 acceptable; New plantations (21x/231-222) 211/212-222 and 211-221 are all correct. Omitted 231-221 and 324-222 found.
Changes of agricultural mosaics	Inside 242 and 243 polygons, the real change should be mapped e.g. 231-211 instead of 231-242. Note that change code can be different from "mother polygon's" code.
Forestry changes – clearcuts and forest regrowth	No such changes have been mapped. No omissions found.
Changes of wetlands and water bodies (including river's gravelbeds)	The only 331-311 should be corrected to 331-324, as a fully developed forest cannot grow up from nothing in 5 years. Such change happens in the two "steps": first 331-324, then 324-311. One mapped 331-324 is correct, the other is partly false, as a part was 324 already in 218, remove this from change polygon. Separation of 331 and 324 should be corrected in CLC2023 before mapping changes! (***Example 8***) Most changes related to free-flowing rivers are missing. Remember to check and map the process of gravel bed replacing vegetation (3xx-331) (and vice versa) during and after floods. In order to able to do so, make sure that 331 is precisely delineated (vegetation separated) in CLC2023. These changes are indicators of natural rivers, therefore they represent important information. (***Example 6***) Revise **ALL** 331 along rivers!
Technical changes	Technical changes are not applied, no missing ones found either.
Total number of remarks:	31
Evaluation:	**Conditionally Accepted (CA)**
Reasoning	**The concept and method of change mapping is generally well understood and technically well applied.** **However, a considerable number of changes (25!) were found missing, related mostly to mines (131), free-flowing rivers (331, 511) and – less extent – irrigated land and plantations.** **FULL checking of the surroundings of 131 and 331 in ALL working area is recommended, with revision of delineation of these classes, followed by mapping of omitted changes.**

Detailed remarks are provided in remark_r.shp and remark_c.shp files.

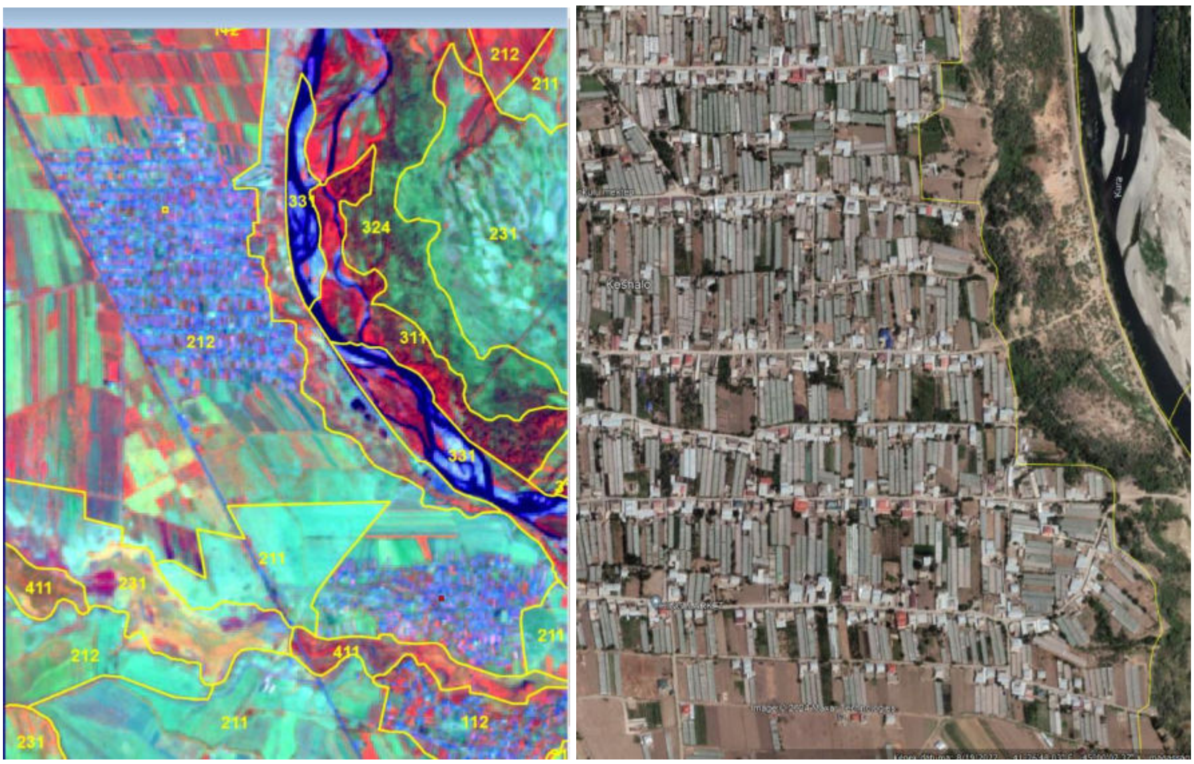
Screen-shot(s) to demonstrate significant, typical or interesting problems



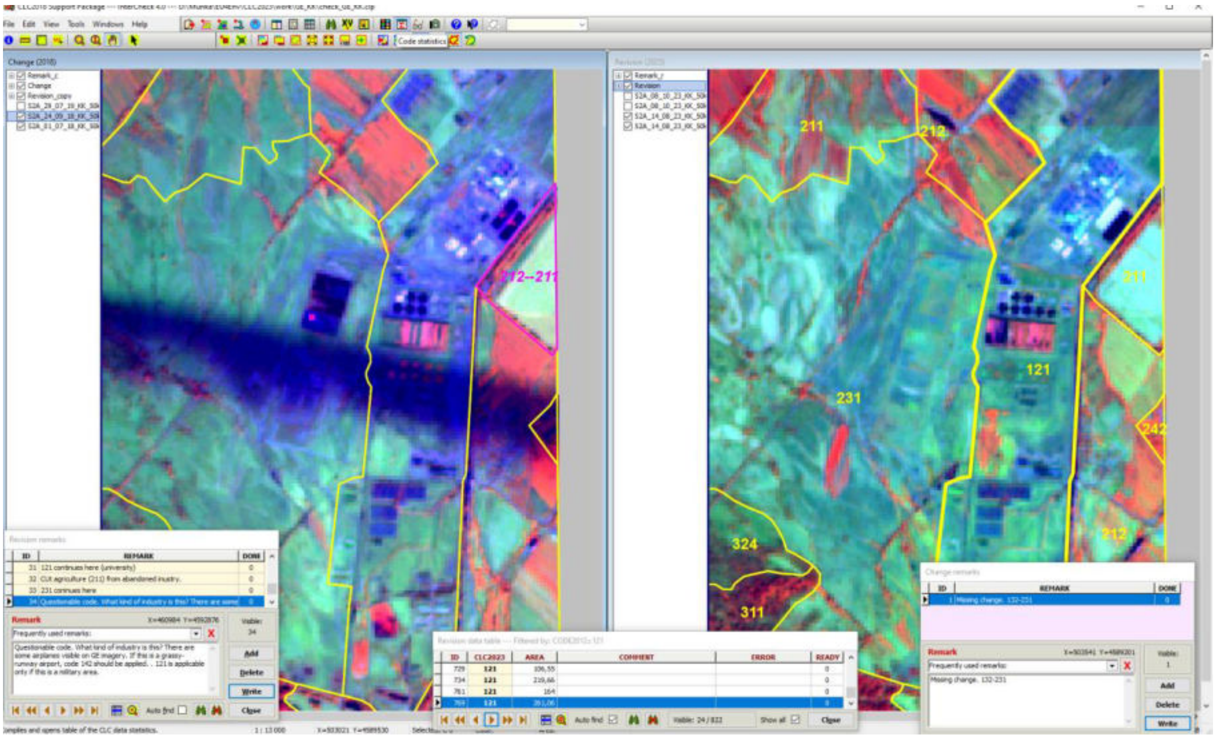
Example 1

1) Separate River Kura, as it is >100 m wide in long sections (109 m at the place of cursor). In order to keep connectivity of rivers narrower part can also be kept as part of polygon. Also, 10-15% exaggeration of width is acceptable to make sure that such important landscape feature is part of the dataset.
2) Assessing green cover can be tricky for blocks of houses type of housing areas. Class 111 should have > 80% sealing, parts with >20% green cover should be reclassified as 112.

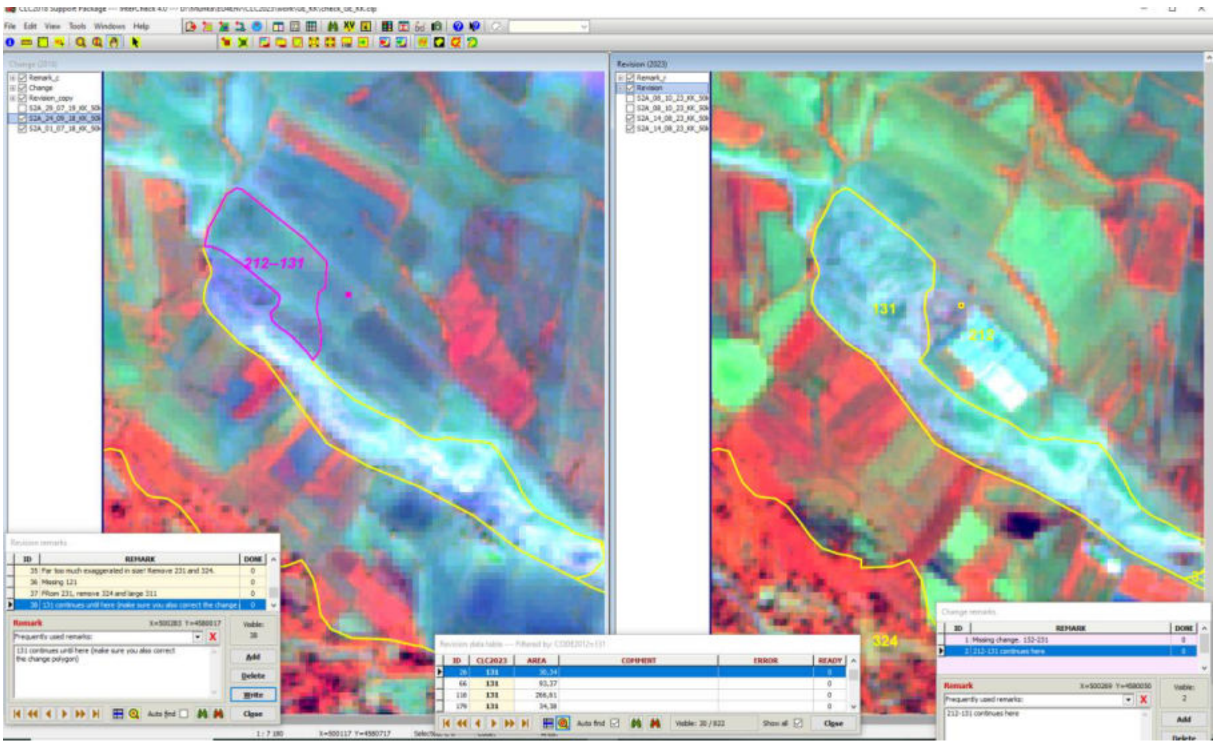
Example 2 The mosaic of greenhouses, different crops and residential houses has a misleading pattern on satellite images, looking like 112. However, built-up density is <30%, the area should be coded as 242.



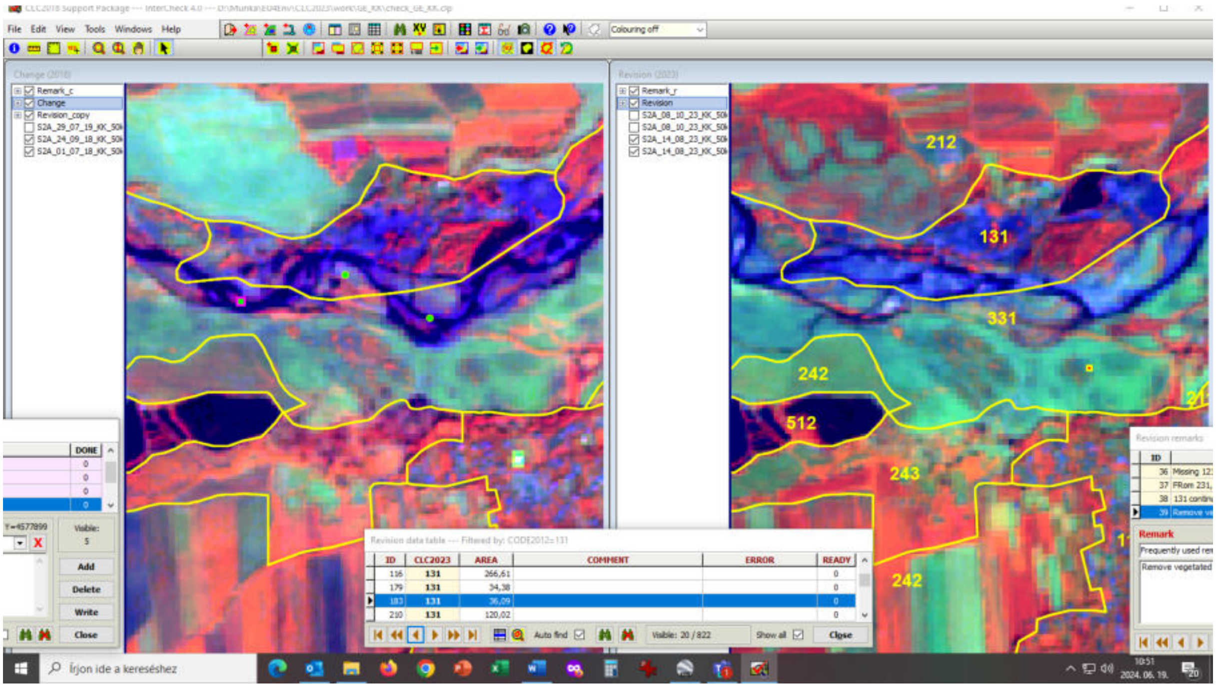
Example 3 Consider using class 242 Instead of 212) for the mosaic of different crops, greenhouses and residential houses



Example 4 Missing change:132-231

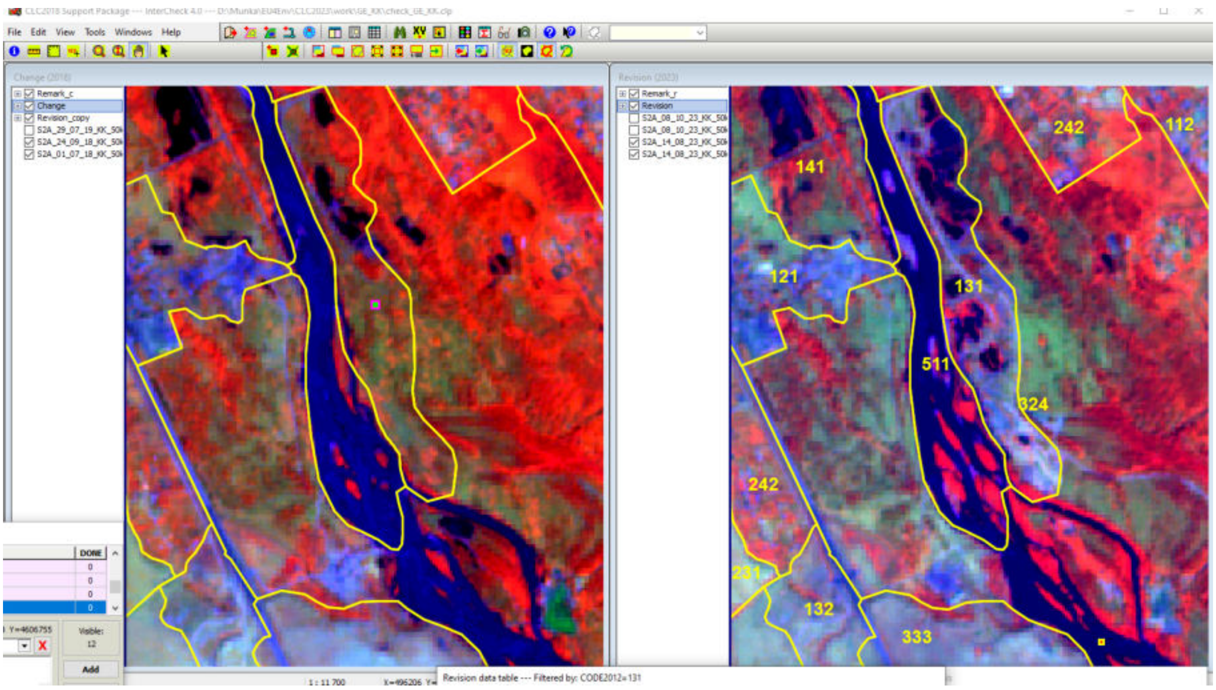


Example 5 More precise delineation of 131 is needed (see missing part marked by yellow dot on the right), which is also important for proper delineation of changes (see missing part of 212-131 marked by magenta dot on the left).

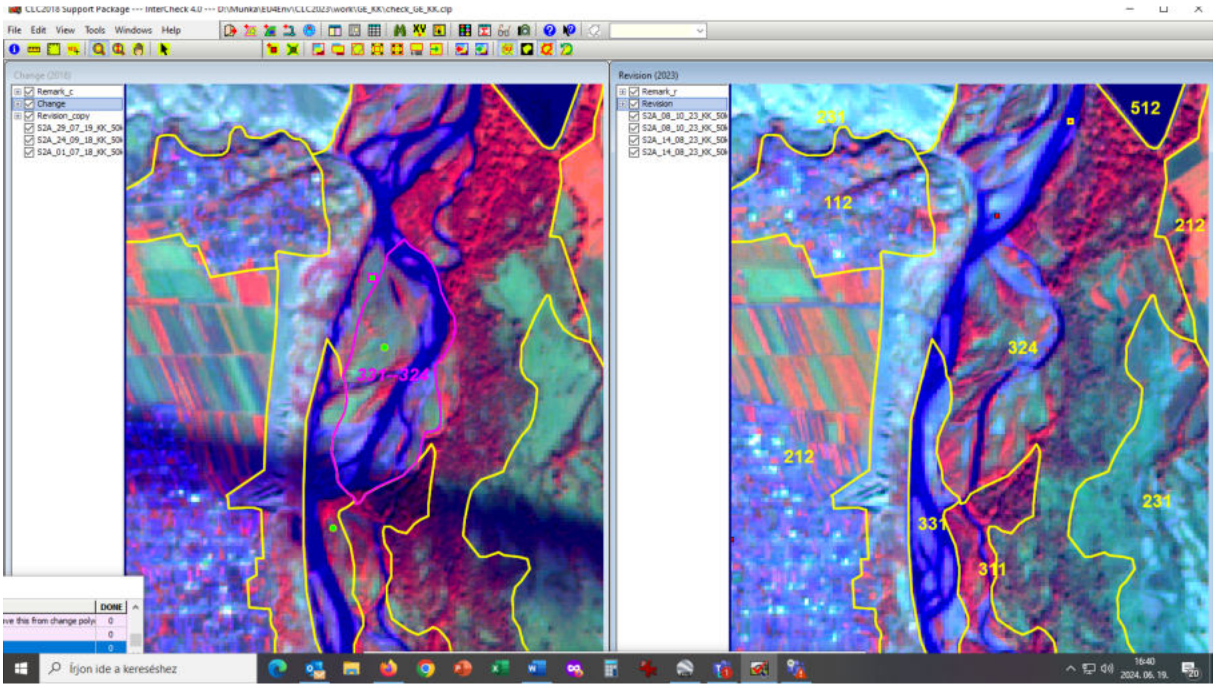


Example 6 Most changes related to free-flowing rivers are missing. Remember to check and map the process of gravel bed replacing vegetation (3xx-331) (and vice versa) during and after floods - see green dots S from river in the left window. In order to able to do so, make sure that 331 is precisely delineated (vegetation separated) in CLC2023 – see yellow dot in the right window These changes are indicators of natural rivers, therefore they represent important information.

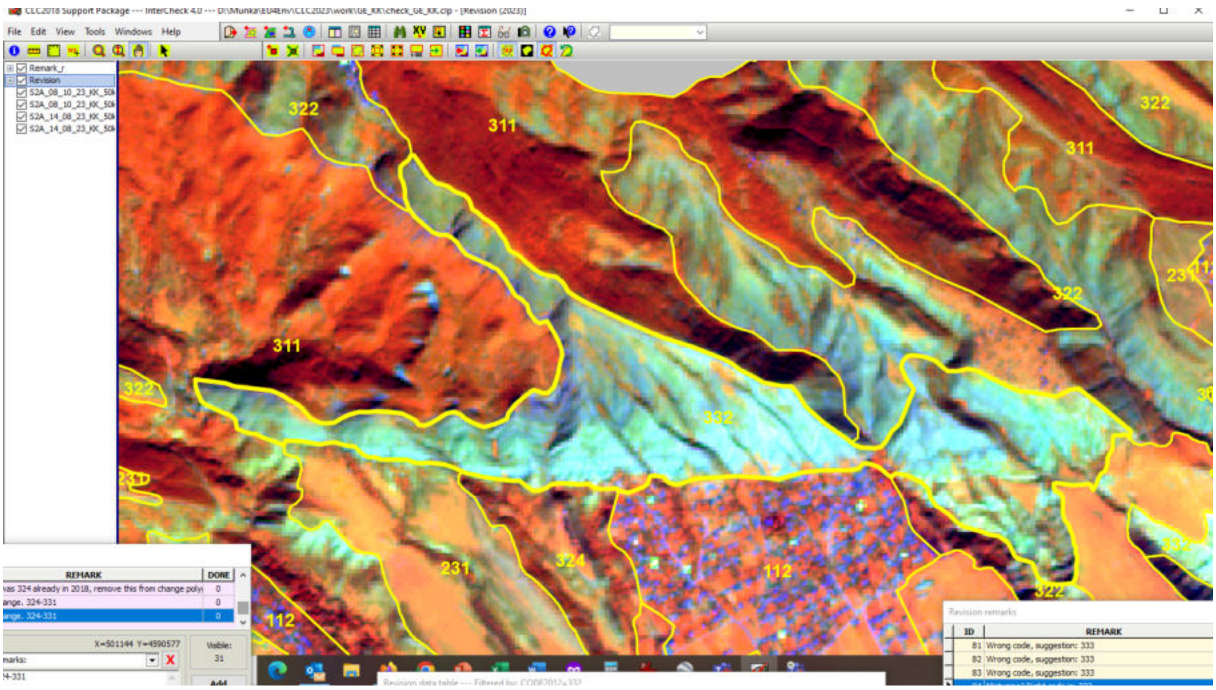
The green dot N from river indicates an omitted change between river and mining (331-131)

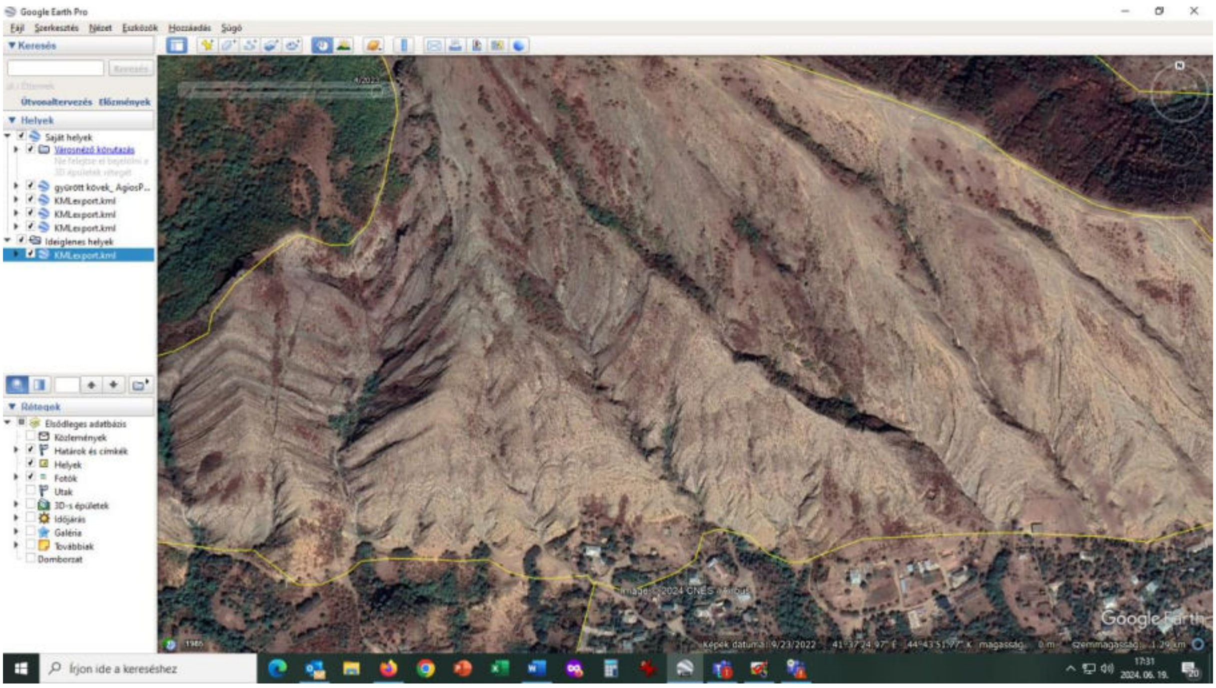


Example 7 Missing change: new mine (324-131) the whole 131 polygon is new. In right window (yellow dot) omitted part of river (511) is detected.



Example 8 Lack of precise separation of 331 from 324 in CLC2023 (right window), leads to omitted changes 32-331 and false change (non-changed 324 area mapped as 331-324) in CLC-Change (green dots in left window).





Example 9 Class x332 is applicable for <10% vegetated areas. None of the 332 polygons were actually bare rock, all contained 10-50% vegetation, to be mapped as 333, or even more (231, 322).

The class requires <u>full revision</u> (in all working units). Use Google Earth, too to have a better estimate of vegetation.

5. Corine Land Cover types (English/Georgian)

1. **Artificial Surfaces - ხელოვნური ტერიტორიები**
   1.1. Urban fabric
   1.1.1.Continuous urban fabric - უწყვეტი ურბანული ქსოვილი
   1.1.2.Discontinuous urban fabric - ფრაგმენტირებული ურბანული ქსოვილი
   1.2. Industrial, commercial and transport units -*ინდუსტრიული, კომერციული და სატრანსპორტო ერთეულები*
   1.2.1.Industrial or commercial units - ინდუსტრიული ან კომერციული ერთეულები
   1.2.2.Road and rail networks and associated land - გზები, სარკინიგზო ქსელი და მათთან დაკავშირებული მიწები
   1.2.3.Port areas-საპორტო ტერიტორიები
   1.2.4.Airports- აეროპორტები
   1.3. Mine, dump and construction sites - მაღაროები, ნაგავსაყრელები და სამშენებლო ადგილები
   1.3.1.Mineral extraction sites - წიაღისეულის მოპოვების ადგილები
   1.3.2.Dump sites - ნაგავსაყრელები
   1.3.3.Construction sites - სამშენებლო ადგილები
   1.4. Artificial, non-agricultural vegetated areas- ხელოვნურად გამწვანებული, არასასოფლო-სამეურნეო ტერიტორიები.
   1.4.1.Green urban areas - გამწვანებული ურბანული ტერიტორიები
   1.4.2.Sport and leisure facilities - სპორტული და სარეკრეაციო ტერიტორიები
2. **Agricultural areas - სასოფლო-სამეურნეო ტერიტორიები**
   2.1. Arable land - სახნავ-სათესი მიწები
   2.1.1.Non-irrigated arable land - ურწყავი მიწები
   2.1.2.Permanently irrigated land - სარწყავი მიწები
   2.1.3.Rice fields - ბრინჯის პლანტაციები
   2.2. Permanent crops - მრავალწლოვანი ნარგაობები
   2.2.1.Vineyards - ვენახები
   2.2.2.Fruit trees and berry plantations - ხეხილისა და კენკროვანების ბაღები
   2.2.3.Olive groves - ზეთისხილის ბაღები
   2.3. Pastures - საძოვრები
   2.3.1.Pastures - საძოვრები
   2.4. Heterogeneous agricultural areas - არაერთგვაროვანი სასოფლო-სამეურნეო მიწები
   2.4.1.Annual crops associated with permanent crops - მრავალწლოვან ნარგავებთან დაკავშირებული ერთწლოვანი კულტურები
   2.4.2.Complex cultivation patterns - კომპლექსური სასოფლო-სამეურნეო მიწები
   2.4.3.Land principally occupied by agriculture, with significant areas of natural vegetation - სასოფლო-სამეურნეო მიწებისა და ბუნებრივი მცენარეულობის კომპლექსი.
   2.4.4.Agro-forestry areas- აგრო-სატყეო მიწები

3. **Forest and seminatural areas - ტყე და ნახევრად ბუნებრივი ტერიტორიები**
   3.1. Forest- ტყე
   3.1.1.Broad-leaved forest - ფართოფოთლოვანი ტყე
   3.1.2.Coniferous forest - წიწვოვანი ტყე
   3.1.3.Mixed forest - შერეული ტყე
   3.2. Shrub and/or herbaceous vegetation associations - ბუჩქნარი და/ან ბალახოვანი მცენარეების ასოციაციები
   3.2.1.Natural grassland - ბუნებრივი ბალახოვანი მცენარეულობა
   3.2.2.Moors and heathland - ალპური ბუჩქნარები და ხავსიანი დაჯგუფებები
   3.2.3.Sclerophyllous vegetation - სკლეროფილური მცენარეულობა
   3.2.4.Transitional woodland/shrub - გარდამავალი ტყე-ბუჩქნარი
   3.3. Open spaces with little or no vegetation - ღია სივრცეები განუვითარებელი ან მცირედ განვითარებული მცენარეულობით
   3.3.1.Beaches, dunes, sands - ზღვის ნაპირი, დიუნები, ქვიშები
   3.3.2.Bare rock - კლდე-ნაშალი
   3.3.3.Sparsely vegetated areas - მეჩხერი მცენარეულობა
   3.3.4.Burnt areas - ნახანძრალები
   3.3.5.Glaciers and perpetual snow - მყინვარები და მუდმივი თოვლის საფარი
4. **Wetlands - ჭარბტენიანი ტერიტორიები**
   4.1. Inland wetlands - ჭარბტენიანი ტერიტორიები
   4.1.1.Inland marshes - ჭაობები
   4.1.2.Peatbogs - ტორფიანი ჭაობები
   4.2. Coastal wetlands - ზღვისპირა ჭაობები
   4.2.1.Salt marshes - მლაშე ჭაობები
   4.2.2.Salines - მლაშობიანი წყალსატევები
   4.2.3.Intertidal flats - ზღვის მიმოქცევის არე
5. **Water bodies - წყლის ობიექტები**
   5.1. Inland waters -შიდა წყლები
   5.1.1.Water courses - მდინარეები და არხები
   5.1.2.Water bodies - ტბები და წყალსატევები
   5.2. Marine waters - საზღვაო წყლები
   5.2.1.Coastal lagoons - სანაპირო ლაგუნები
   5.2.2.Estuaries - ესტუარები
   5.2.3.Sea and ocean - ზღვა და ოკეანე

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