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Mapping the war-affected landscape of Ukraine using Earth observation data with high resolution

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Abstract:

Remote sensing is a promising technology for monitoring land use/land cover (LU/LC) changes quickly, efficiently, and cost-effectively. Remote sensing based research holds significance, especially in areas that may be too dangerous for scientists to conduct fieldwork on-site. To better understand how armed conflicts affect LU/LC, we analysed high resolution Earth observation data in selected regions in Ukraine. We analysed and classified the direct (size, shape, colour, texture, pattern, etc.) and indirect interpretation signs of landscape objects damaged by the ongoing war. For the purpose of this research, we proposed an extended and modified nomenclature for LU/LC mapping based on the CORINE Land Cover (CLC) database. The latest release of the CLC database for the year 2018 covers 39 countries and consists of 44 LU/LC classes in the third hierarchical level (Kosztra et al., 2019). The modification of the CLC method for identifying and recording LU/LC was based on the concepts and procedures for creating hierarchically higher classes. The proposed CLC nomenclature consists of 89 LU/LC classes in the fourth hierarchical level. To confirm its universal use for detailed mapping of LU/LC and its changes in war-affected regions worldwide, the proposed nomenclature has been tested in a pilot land cover mapping in Ukraine, where the original CLC database is not available. For the pilot land cover mapping, high resolution PlanetScope images were used as the primary tool for visual interpretation. These images supported the identification and delineation of objects of interest, following well-established principles of aerial photo interpretation. While PlanetScope imagery includes eight spectral bands, various combinations of RGB composites and histogram enhancement techniques support the effective identification of proposed war-affected LU/LC classes under varying geographical conditions. The aim of this paper is to present the results of the pilot land cover mapping in the Hostomel settlement using the proposed nomenclature. The classification method was selected taking into account the fact that in many cases, despite the extensive damage, the war-affected areas do not have to be significant in the area (e.g., a collapse of a bridge or destruction of individual buildings) to be assessed with sufficient accuracy by automatic classification. The results of the pilot land cover mapping are presented through cartographic visualisations (e.g., the land cover map of the Hostomel settlement after two years of the ongoing conflict) and the statistical analysis of the LU/LC changes. The individual steps of the preparation of the land cover map are shown in Figure 1. Figure 2 and Table 1 illustrate the advantages of the proposed nomenclature compared to the standard CLC data. For this comparison, we selected the neighbourhood of Ozera village in the Hostomel settlement – an area with the highest number of identified LU/LC classes. Since standard CLC data is not available for Ukraine, third-level LU/LC data were derived using updated CLC nomenclature guidelines (Bossard et al., 2000). The advantage of the proposed extended nomenclature over the standardised CLC is a higher number of LU/LC classes and a lower minimal mapping unit, resulting in higher thematic accuracy of the resulting land cover maps.

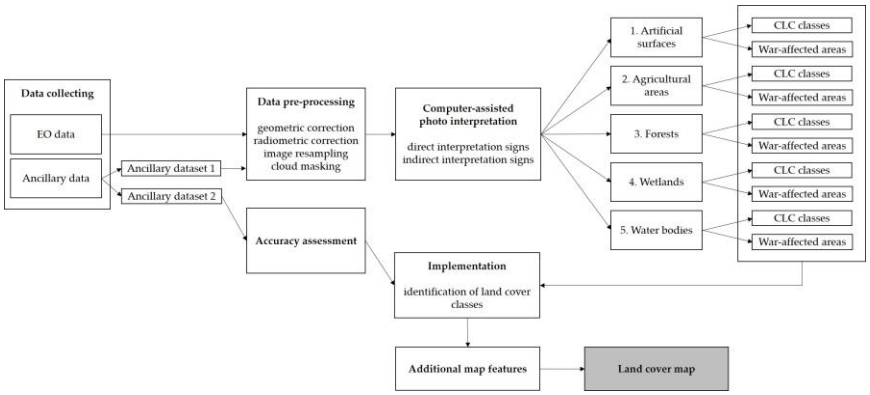

Figure 1. Flowchart of the preparation of the land cover map of the Hostomel settlement.

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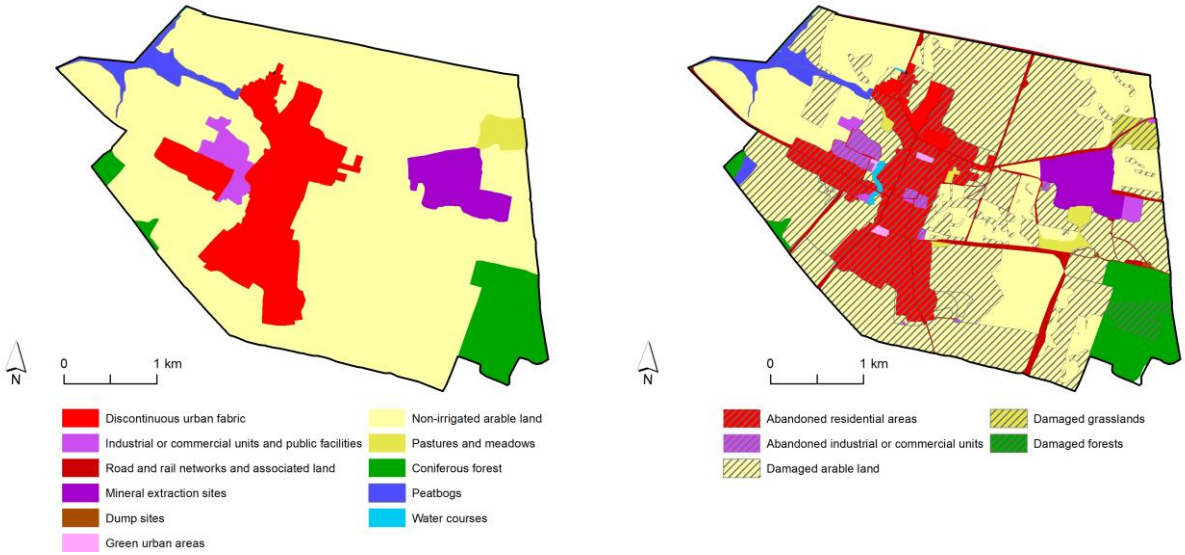

Figure 2. Comparison of LU/LC mapping results using the standard CLC nomenclature (left) and the proposed extended nomenclature (right) in Ozera village.

LU/LC identification according to:	standard CLC nomenclature	proposed extended nomenclature
LU/LC classes in the nomenclature	44	89
Minimal mapping unit	25 hectares / 100 m	0.1 hectare / 2 m
Different LU/LC classes in the selected territory	8	24
Number of polygons in the selected territory	11	206
Mean area of the polygons in the selected territory	203.3	7.1

Table 1. Comparison of LU/LC mapping results using the standard CLC nomenclature and the proposed extended nomenclature

For the accuracy assessment of the pilot LU/LC mapping, a minimum of 10 samples were assessed for each fourth-level class. For the selected polygons, the correct class identification was individually verified using the assigned code. Next, the correctness of the geometry, the detail of the polygon boundary, and the positional accuracy were evaluated. The highest accuracy was recorded for the war-affected classes representing rural landscapes where large homogeneous areas allow accurate identification. The most frequent errors were the confusion between abandoned residential areas and abandoned areas of production and services, or discontinuous built-up areas. The overall accuracy was 94.9%.

The proposed nomenclature provides a valuable framework for understanding and monitoring the environmental impact of conflict. Adopting a more detailed LU/LC classification specific to conflict zones allows the identification of both immediate and long-term environmental changes, such as the destruction of infrastructure, vegetation changes, and shifts in land use patterns. This extended nomenclature facilitates more accurate environmental damage assessments, aids in disaster response, and guides post-conflict reconstruction efforts. Furthermore, it enables the monitoring of recovery trajectories, the identification of regions in need of urgent intervention, and the formulation of policies to restore ecological balance. Ultimately, the nomenclature serves as a tool for decision-makers and humanitarian organisations to coordinate efforts for land restoration in both an effective and sustainable way.

Acknowledgements

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References

Bossard, M., Feranec, J. and Otˇahelˇ, J., 2000. *CORINE land cover technical guide – Addendum 2000. EEA Technical report 40*. European Environment Agency, pp. 105.

Kosztra, B., Büttner, G., Hazeu, G. and Arnold, S., 2019. *Updated CLC illustrated nomenclature guidelines*. European Environment Agency, pp. 126.

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