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LAND COVER LAND USE CHANGE (LCLUC) WITH REMOTE SENSING: STATE-OF-THE-ART REVIEW

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Abstract

In this work existing major initiatives on LCLUC, overview of methodological aspects (state-of the art review) and future developments in the domain of LCLUC are described.

Keywords: land cover, land use, validation, LCLUC, global environmental products .

Land cover (LC) maps are one of the terrestrial Essential Climatic Variables (ECVs) and are widely used in different applications including assessing impact of climate change, environment monitoring, agriculture, disaster risk assessment, to name a few. Remote sensing images from space have always been an obvious and promising source of information for LC mapping, studying its changes and trends, and improving understanding of human interactions with the environment. NASA's LCLUC Program is one of the largest to use remote sensing images «*to develop the capability for periodic global inventories of land use and land cover from space, to develop the scientific understanding and models necessary to simulate the processes taking place, and to evaluate the consequences of observed and predicted changes at local to global scales*» [1, 2]. ESA has initiated the Climate Change Initiative (CCI) in order to use satellite observations to generate LC ECV [3, 4]. At present, many global land cover products are available with the most recent ones being GLC-SHARE [5], MODIS Global Land Cover Type product [6], GlobCover [7], GlobeLand30 [8]. Among class specific global maps it is worth mentioning the global map of forest cover, forest loss and gains developed at University of Maryland [9], and a harmonized global cropland extent map developed by IIASA [10].

However, it is recognized that there is a major discrepancy in existing LC products [11] and corresponding uncertainties and errors are either not known or given without statistically justified estimates. Recent studies have shown that when global land cover products are compared [12], there are significant amounts of spatial disagreement across land cover types and semantic differences in the legend definitions. The use of different satellite sensors, different classification methodologies and the lack of sufficient in-situ data are reasons for this disagreement. Also, validation of global products usually included limited number of reference data without statistical justification and without confidence intervals that necessary when performing, for example, climate change modelling [13]. That is why much attention has recently been paid to validation efforts at regional scale. One of such initiative is The South Central and Eastern European Regional Information Network (SCERIN) project of the Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) project of the Global Terrestrial Observation System (GTOS) where Ukrainian region is represented by Space Research Institute NAS Ukraine & SSA Ukraine (SRI NASU-SSAU).

In Ukraine, major efforts on LC mapping from satellite imagery at national scale have been made by SRI NASU-SSAU. SRI has developed LC maps at 30 m spatial resolution for three different epochs: 1990, 2000, and 2010 (Fig 1) [14, 15]. They utilized an open archive of Landsat imagery and state-of-the-art machine learning techniques for maps generation. These maps proved to be more accurate than existing global LC maps [14] emphasizing the need for regional activities on LCLUC mapping, analysis and validation.

In presentation, we will review existing major initiatives on LCLUC, overview methodological aspects and discuss future developments in this domain.

References

1. Justice, C., Gutman, G., & Vadrevu, K. P. (2015). NASA land cover and land use change (LCLUC): An interdisciplinary research program. Journal of environmental management, 148, 4-9.
2. Gutman, G., Janetos, A. C., Justice, C. O., Moran, E. F., Mustard, J. F., Rindfuss, R. R., ... & Cochrane, M. A. (Eds.). (2004). Land change science: Observing, monitoring and understanding trajectories of change on the earth's surface (Vol. 6). Springer Science & Business Media.
3. Bontemps, S., Herold, M., Kooistra, L., Van Groenestijn, A., Hartley, A., Arino, O., ... & Defourny, P. (2012). Revisiting land cover observation to address the needs of the climate modeling community. Biogeosciences, 9(6), 2145-2157.

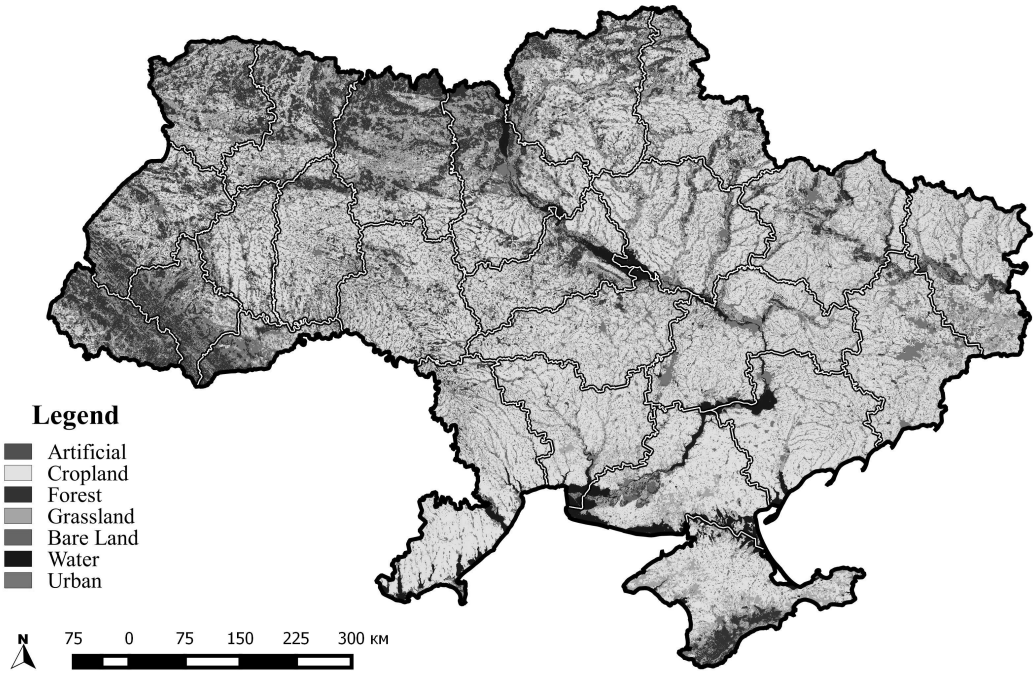

Fig. 1. Land cover map for the territory of Ukraine for 2010

4. Li, W., Ciais, P., MacBean, N., Peng, S., Defourny, P., & Bontemps, S. (2016). Major forest changes and land cover transitions based on plant functional types derived from the ESA CCI Land Cover product. International Journal of Applied Earth Observation and Geoinformation, 47, 30-39.
5. Latham, J.; Cumani, R; Rosati, I.; Bloise, M. FAO Global Land Cover (GLC-SHARE) BetaRelease 1.0 Database, FAO, 2014.
6. Friedl, M. A., Sulla-Menashe, D., Tan, B., Schneider, A., Ramankutty, N., Sibley, A., & Huang, X. (2010). MODIS Collection 5 global land cover: Algorithm refinements and characterization of new datasets. Remote Sensing of Environment, 114(1), 168-182.
7. Bicheron, P.; Defourny, P.; Brockmann, C.; Schouter, L.; Vancutsem, C.; Huc, M.; Bontemps, S.; Leroy, M.; Achard, F.; Herold, M.; et al. GLOBCOVER Products Report Description and Validation Report; MEDIAS: Toulouse, France, 2008.
8. Gong, P., Wang, J., Yu, L., Zhao, Y., Zhao, Y., Liang, L., ... & Li, C. (2013). Finer resolution observation and monitoring of global land cover: First mapping results with Landsat TM and ETM+ data. International Journal of Remote Sensing, 34(7), 2607-2654.
9. Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., ... & Kommareddy, A. (2013). High-resolution global maps of 21st-century forest cover change. science, 342(6160), 850-853.
10. Fritz, S., See, L., McCallum, I., You, L., Bun, A., Moltchanova, E., ... & Havlik, P. (2015). Mapping global cropland and field size. Global change biology, 21(5), 1980-1992.
11. Fritz, S., See, L., You, L., Justice, C., Becker-Reshef, I., Bydekerke, L., ... & Gilliams, S. (2013). The need for improved maps of global cropland. Eos, Transactions American Geophysical Union, 94(3), 31-32.
12. Giri, C., Pengra, B., Long, J., & Loveland, T. R. (2013). Next generation of global land cover characterization, mapping, and monitoring. International Journal of Applied Earth Observation and Geoinformation, 25, 30-37.
13. Pitman, A. J., de Noblet-Ducoudré, N., Cruz, F.T., Davin, E.L.,Bonan, G.B., Brovkin, V., ... & Van Den Hurk, B. J. J. M. (2009). Uncertainties in climate responses to past land cover change: First results from the LUCID intercomparison study. Geophysical Research Letters, 36(14).
14. Lavreniuk, M., Kussul, N., Skakun, S., Shelestov, A., & Yailymov, B. (2015, July). Regional retrospective high resolution land cover for Ukraine: Methodology and results. In Geoscience and Remote Sensing Symposium (IGARSS), 2015 IEEE International (pp. 3965-3968). IEEE.
15. Lavreniuk, M. S., Skakun, S. V., Shelestov, A. J., Yalimov, B. Y., Yanchevskii, S. L., Yaschuk, D. J., & Kosteckiy, A. Ì. (2016). Large-Scale Classification of Land Cover Using Retrospective Satellite Data. Cybernetics and Systems Analysis, 52(1), 127-138.