

Data descriptor: Spatial distribution of arable and abandoned land across former Soviet Union countries

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Abstract

© The Author(s) 2018. Knowledge of the spatial distribution of agricultural abandonment following the collapse of the Soviet Union is highly uncertain. To help improve this situation, we have developed a new map of arable and abandoned land for 2010 at a 10 arc-second resolution. We have fused together existing land cover and land use maps at different temporal and spatial scales for the former Soviet Union (fSU) using a training data set collected from visual interpretation of very high resolution (VHR) imagery. We have also collected an independent validation data set to assess the map accuracy. The overall accuracies of the map by region and country, i.e. Caucasus, Belarus, Kazakhstan, Republic of Moldova, Russian Federation and Ukraine, are $90\pm2\%$, $84\pm2\%$, $92\pm1\%$, $78\pm3\%$, $95\pm1\%$, $83\pm2\%$, respectively. This new product can be used for numerous applications including the modelling of biogeochemical cycles, land-use modelling, the assessment of trade-offs between ecosystem services and land-use potentials (e.g., agricultural production), among others.

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References

- [1] Schierhorn, F. et al. Post-Soviet cropland abandonment and carbon sequestration in European Russia, Ukraine, and Belarus. *Glob. Biogeochem. Cycles* 27, 1175-1185 (2013).
- [2] Kurganova, I., De Gerenyu Lopes, V., Six, J. & Kuzyakov, Y. Carbon cost of collective farming collapse in Russia. *Glob. Change Biol.* 20, 938-947 (2014).
- [3] Henebry, G. M. Global change: Carbon in idle croplands. *Nature* 457, 1089-1090 (2009).
- [4] Schierhorn, F. et al. The dynamics of beef trade between Brazil and Russia and their environmental implications. *Glob. Food Sec.* 11, 84-92 (2016).
- [5] Bragina, E. V. et al. Rapid declines of large mammal populations after the collapse of the Soviet Union: Wildlife Decline after Collapse of Socialism. *Conserv. Biol.* 29, 844-853 (2015).
- [6] Kamp, J., Urazaliev, R., Donald, P. F. & Hözel, N. Post-Soviet agricultural change predicts future declines after recent recovery in Eurasian steppe bird populations. *Biol. Conserv.* 144, 2607-2614 (2011).
- [7] Kamp, J. Land management: Weighing up reuse of Soviet croplands. *Nature* 505, 483-483 (2014).
- [8] Kurganova, I., De Gerenyu, V., Lopes & Kuzyakov, Y. Large-scale carbon sequestration in post-agrogenic ecosystems in Russia and Kazakhstan. *CATENA* 133, 461-466 (2015).
- [9] Meyfroidt, P., Schierhorn, F., Prishchepov, A. V., Müller, D. & Kuemmerle, T. Drivers, constraints and trade-offs associated with recultivating abandoned cropland in Russia, Ukraine and Kazakhstan. *Glob. Environ. Change* 37, 1-15 (2016).

- [10] Fritz, S. et al. Downgrading recent estimates of land available for biofuel production. *Environ. Sci. Technol.* 47, 1688-1694 (2013).
- [11] Fritz, S. et al. Cropland for sub-Saharan Africa: A synergistic approach using five land cover data sets. *Geophys. Res. Lett.* 38 (2011).
- [12] Fritz, S. et al. Mapping global cropland and field size. *Glob. Change Biol.* 21, 1980-1992 (2015).
- [13] Defourny, P. et al. Land Cover CCI. Product user guide. V.2 87 (UCL-Geomatics, 2014).
- [14] ROSSTAT. Regions of Russia. Social-economic indicators 2014 (2015).
- [15] Prishchepov, A. V., Radeloff, V. C., Baumann, M., Kuemmerle, T. & Müller, D. Effects of institutional changes on land use: Agricultural land abandonment during the transition from state-command to market-driven economies in post-Soviet Eastern Europe. *Environ. Res. Lett.* 7, 024021 (2012).
- [16] De Beurs, K. M. & Ioffe, G. Use of Landsat and MODIS data to remotely estimate Russia's sown area. *J. Land Use Sci* 9, 377-401 (2013).
- [17] Kraemer, R. et al. Long-term agricultural land-cover change and potential for cropland expansion in the former Virgin Lands area of Kazakhstan. *Environ. Res. Lett.* 10, 054012 (2015).
- [18] Estel, S. et al. Mapping farmland abandonment and recultivation across Europe using MODIS NDVI time series. *Remote Sens. Environ.* 163, 312-325 (2015).
- [19] See L. et al. Harnessing the power of volunteers, the internet and Google Earth to collect and validate global spatial information using Geo-Wiki. *Technol. Forecast. Soc. Change* 98, 324-335 (2015).
- [20] Fritz, S. et al. Geo-Wiki: An online platform for improving global land cover. *Environ. Model. Softw* 31, 110-123 (2012).
- [21] Alcantara, C. et al. Mapping the extent of abandoned farmland in Central and Eastern Europe using MODIS time series satellite data. *Environ. Res. Lett.* 8, 035035 (2013).
- [22] Domingos, P. & Pazzani, M. On the Optimality of the Simple Bayesian Classifier under Zero-One Loss. *Mach. Learn.* 29, 103-130 (1997).
- [23] Friedman, J. H. On Bias, Variance, 0/1-Loss, and the Curse-of-Dimensionality. *Data Min. Knowl. Discov.* 1, 55-77 (1997).
- [24] Frank, E., Trigg, L., Holmes, G. & Witten, I. H. Technical Note: Naive Bayes for Regression. *Mach. Learn.* 41, 5-25 (2000).
- [25] See L. et al. Building a hybrid land cover map with crowdsourcing and geographically weighted regression. *ISPRS J. Photogramm. Remote Sens.* 103, 48-56 (2015).
- [26] FAO. FAOSTAT. (2015). Available at <http://faostat3.fao.org/mes/glossary/E> (Accessed: 10th January 2016).
- [27] Ioffe, G., Nefedova, T. & Zaslavsky, I. From Spatial Continuity to Fragmentation: The Case of Russian Farming. *Ann. Assoc. Am. Geogr* 94, 913-943 (2004).
- [28] Saraykin, V., Yanbykh, R. & Uzun, V. in *The Eurasian Wheat Belt and Food Security*, 155-175 (Springer: Cham, 2017). doi:10.1007/978-3-319-33239-0-10.
- [29] Friedl, M. A. et al. MODIS Collection 5 global land cover: Algorithm refinements and characterization of new datasets. *Remote Sens. Environ.* 114, 168-182 (2010).
- [30] Jun, C., Ban, Y. & Li, S. China: Open access to Earth land-cover map. *Nature* 514, 434-434 (2014).
- [31] FAO. Global Land Cover-SHARE (GLC-SHARE) (2015).
- [32] Schepaschenko, D. et al. A new hybrid land cover dataset for Russia: A methodology for integrating statistics, remote sensing and in situ information. *J. Land Use Sci* 6, 245-259 (2011).
- [33] Hansen, M. C. et al. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science* 342, 850-853 (2013).
- [34] Bartalev, S. A., Plotnikov, D. E. & Loupian, E. A. Mapping of arable land in Russia using multi-year time series of MODIS data and the LAGMA classification technique. *Remote Sens. Lett* 7, 269-278 (2016).
- [35] Kussul, N. N., Lavreniuk, N. S., Shelestov, A. Y., Yailymov, B. Y. & Butko, I. N. Land Cover Changes Analysis Based on Deep Machine Learning Technique. *J. Autom. Inf. Sci* 48, 42-54 (2016).
- [36] Lavreniuk, M., Kussul, N., Skakun, S., Shelestov, A. & Yailymov, B. in *2015 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)* 3965-3968 (2015). doi:10.1109/IGARSS.2015.7326693.
- [37] Rish, I. An empirical study of the naive Bayes classifier. 6 (IBM Research Division, Thomas J. Watson Research Center, 2001).
- [38] Zhang, H. The Optimality of Naive Bayes, in (AAAI Press, 2004).
- [39] Potapov, P. V. et al. Eastern Europe's forest cover dynamics from 1985 to 2012 quantified from the full Landsat archive. *Remote Sens. Environ.* 159, 28-43 (2015).
- [40] Isachenko, A. G. Landscape map of USSR. Scale 1:4 M. (1988).
- [41] Olofsson, P. et al. Good practices for estimating area and assessing accuracy of land change. *Remote Sens. Environ.* 148, 42-57 (2014).

- [42] Agriculture ... Agriculture Census of Georgia 2004. (2005).
- [43] NSSArmenia. Statistical Yearbook of Armenia. 293-313 (National Statistical Service of the Republic of Armenia, 2013).
- [44] SSCAzerbaijan. The agriculture of Azerbaijan. Statistical yearbook. 608 (State Statistical Committee of the Republic of Azerbaijan, 2017).
- [45] Kostevich, I. A. Agriculture of the Republic of Belarus 2009-2013. (National Statistical Committee of the Republic of Belarus (Belstat), 2014).
- [46] Kazakhstan. Kazakhstan in figures. (Commitee on Statistics. Ministry of National economy of the Respublik of Kazakhstan, 2016).
- [47] NBSMoldova. Main indicators in Agriculture. Statistical Yearbook of Moldova. 425-477 (National Bureau of Statistics, 2016).
- [48] FCRE'RF. State (national) report about the state and use of lands of Russian Federation in 2010. (2011).
- [49] Regions. Regions of Ukraine. 2 (State Statistics Service of Ukraine, 2013).
- [50] Lyuri, D. I., Goryachkin, S. V., Karavaeva, N. A. & Nefedova, T. G. Dynamics of agricultural land in Russia and postagrogenic restoration of plants and soils (GEOS, 2010).
- [51] 300 m annual global land cover time series from 1992 to 2015 | ESA CCI Land cover website. Available at <https://www.esalandscover-cci.org/?q=node/175> (Accessed: 10th January 2018).
- [52] Mukhortova, L., Schepaschenko, D., Shvidenko, A., McCallum, I. & Kraxner, F. Soil contribution to carbon budget of Russian forests. Agric. For. Meteorol 200, 97-108 (2015).
- [53] Schepaschenko, D. G., Mukhortova, L. V., Shvidenko, A. Z. & Vedrova, E. F. The pool of organic carbon in the soils of Russia. Eurasian Soil Sci. 46, 107-116 (2013).
- [54] Horion, S. et al. Revealing turning points in ecosystem functioning over the Northern Eurasian agricultural frontier. Glob. Change Biol. 22, 2801-2817 (2016).
- [55] De Jong, R., Verbesselt, J., Zeileis, A. & Schaepman, M. E. Shifts in Global Vegetation Activity Trends. Remote Sens 5, 1117-1133 (2013).
- [56] Zhou, Y. et al. Climate Contributions to Vegetation Variations in Central Asian Drylands: Pre- and Post-USSR Collapse. Remote Sens 7, 2449-2470 (2015).
- [57] Schaphoff, S., Reyer, C. P. O., Schepaschenko, D., Gerten, D. & Shvidenko, A. Tamm Review: Observed and projected climate change impacts on Russia's forests and its carbon balance. For. Ecol. Manag 361, 432-444 (2016).
- [58] Klein Goldewijk, K., Beusen, A., Van Drecht, G. & De Vos, M. The HYDE 3.1 spatially explicit database of human-induced global land-use change over the past 12, 000 years: HYDE 3.1 Holocene land use. Glob. Ecol. Biogeogr 20, 73-86 (2011).
- [59] Kaplan, J. O. et al. Holocene carbon emissions as a result of anthropogenic land cover change. The Holocene 21, 775-791 (2011).
- [60] Ramankutty, N. & Foley, J. A. Estimating historical changes in global land cover: Croplands from 1700 to 1992. Glob. Biogeochem. Cycles 13, 997-1027 (1999).