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A dynamic classification of biogeophysical environments integrating climatic and terrestrial data

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Climate change calls to re-think approaches to environmental surveys and monitoring; we are reminded that abiotic ecosystem properties are not static, and that "biogeophysical landscapes" (i.e. patches with abiotic (e.g. plant growing) conditions homogeneous at a certain resolution) dynamically change their spatial configuration, and these changes are visible at national and/or regional scales even within a decade. The validity of existing environmental/landscape classification widely used for stratified sampling is questioned. The new reality calls for classifications, which are (1) spatially explicit and (2) dynamic (i.e. easily can be easily updated); apparently, it also should be based on (3) credible and easily accessible data, and (4) standard statistical/geospatial techniques available in common GIS packages. This paper presents an attempt to meet these requirements and create a classification of biogeophysical environments at a national scale. It reviews classification schemes created for similar purposes, analyses open climate and DEM datasets made available during the last decade, explains the methodology and data selection, guides through data preparation/analysis and the stratification design, describes the results, and compares them against the classifications previously developed for the region.

The classification was run for Belarus with a primary objective to support forest ecology research and monitoring, and therefore it was designed with a strong emphasis on abiotic conditions significant for southern margins of Boreal zone. The climatic (dynamic) variables selected to the classification included: number of growing degree days baseline 5 and 10°C, annual hydrothermal coefficient (HTC after Seljaninov), growing season lengths (days), annual averages of mean daily temperature, annual sums of mean daily precipitation, growing season precipitation. The original intention was to use gridded datasets of CRU at the University of East Anglia, however a comparison with observations from gauging stations in Belarus not included to the CRU datasets (25 out of total 29) showed that their level of uncertainty is generally too high to account for heterogeneity and spatial dynamics of biogeophysical environment at the nation's scale. For the purposes of the study, a new gridded dataset has been developed. We used daily observations from 105 weather stations (39 for temperatures and 99 for precipitations) in Belarus and neighboring countries. The data sources included the Belarusian Centre for Hydrometeorology, Russian Institute for Hydrometeorology Information, and the EU ENSEMBLES project (Haylock et al. 2008). Most of the information accounting for local re-distribution of water and heat (elevations, slope angles, downhill directions) was extracted from USGS 3 arc second (equal to c.a. 90 m in Belarus) SRTM dataset, also used to calculate a topographic index of hydrological similarity (TOPOINDEX) accounting for topographically determined hydrological conditions (Kirkby & Weyman, 1974). The last component of the "terrain" dataset was the grain-size composition of underlying rocks derived from the 1:500 000 Map of Quaternary Deposits (1986). All the variables were normalised and re-sampled at 1 km resolution; for the climatic variables we ran PCA to decrease the data dimensiality, and then maximum likelihood analysis for the whole dataset. The classification was created for each decade from 1960s to 2000s.