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## **Spatio-temporal modelling of soil organic carbon stock for the support of national level assessment of land degradation neutrality in Hungary**

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The minimum set of indicators recommended for tracking progress towards LDN against a baseline are: land cover, land productivity and carbon stocks above and below ground. While land cover and its change can be and actually is operatively monitored by Earth Observation in a relatively straightforward manner, spatio-temporal assessment of the two other, soil related indicators poses challenges.

Soil organic carbon (SOC) stock in Hungary was first mapped in the frame of Global Soil Organic Carbon Map initiative. The Hungarian Soil Information and Monitoring System was used to create the GSOC product with quantile regression forest, which made the assessment of local uncertainty possible. The map was produced with 500 meter spatial resolution and aggregated for the predefined 1 km grid. Since it used data collected in the first field campaign, in 1994, consequently its estimates represent that year's state.

In 2018 a national report was expected by UNCCD on LDN firstly quantifying trends in carbon stocks above and below the ground. Based on global databases (ESA Climate Change Initiative Land Cover Dataset, SoilGrids250) default values were assigned to countries, which were asked about its acceptance or providing more accurate estimations based on national datasets. Similarly to the global initiative, SOC change estimation was not based on soil reference data dating from two distinct dates, but on the only available spatial prediction and changes of SOC were exclusively attributed to changes in land cover. Corine Land Cover Change maps were used to derive the GSOC estimations for the base year (2000) as well as for the target year (2012) from the original SOC map (representing 1994) according to Trends.Earth tool guidelines. SOC change between 2000 and 2012 was estimated by the difference of the two predictions.

In the next step, the SOM measurements on the samples collected in 2010 in the frame of Hungarian Soil Information and Monitoring System became available to map soil organic carbon stock in the topsoils (0-30 cm) of Hungary for the year 2010. New modelling was carried out based on the experiences of GSOC estimations, the map was produced with 100 m resolution using quantile regression forest for both years. 10-fold cross-validation was used for checking the accuracy of the spatial predictions and uncertainty quantifications. The performance of the spatial

predictions and uncertainty quantifications was appropriate, which was verified by the computed biases, the root mean square errors, accuracy plots and the G statistics. Based on the compiled SOC stock maps, we assessed the spatial and temporal changes of SOC stocks on the whole area of Hungary except artificial surfaces and water bodies. The total SOC stock in the topsoil increased by 27.18 Tg over the respective period. We compared our estimate with others provided by global and continental SOC stock inventories. The comparison pointed out that a SOC stock map compiled by a given country can provide more accurate estimates at national level. We recommend applying the SOC stock map of 1992 as baseline to track and assess SOC stock change in Hungary.