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Modeling the spatial distribution of soil organic carbon and carbon stocks for the Casanare flooded Savannas, Colombia

Javier M. Martín-López[1], Louis Verchot[2], Christopher Martius[3], and Mayesse da Silva[2]
[1]Alliance Bioversity-CIAT / University of Münster, Multifunctional landscapes / Institute of geoinformatics, Cali, Colombia (jmartin.unal@gmail.com)
[2]Alliance Bioversity-CIAT, Multifunctional landscapes, Cali, Colombia
[3]Center for International Forestry Research (CIFOR), Bogor, Indonesia

Flooded savannas are extensive in South America and this study was conducted to assess two digital soil mapping (DSM) approaches to predict the spatial distribution of soil organic carbon (SOC) content and stocks in the Orinoco flooded savannas of Casanare department, located in the eastern plains of Colombia. SOC was estimated using a total of 80 sites sampled at two soil depth intervals (0-10 cm and 10-30 cm). SOC ranged from 0.41% at 0-10 cm and 0.23% at 10-30 cm in drier soils found in continental dunes with sandy textures and low vegetation cover (steppe) to over 14.50% and 7.51% in soils that experienced seasonal flooding located in depressions with loamy textures and flooded savanna vegetation. Predictions of the spatial distribution of SOC were done through Expert Knowledge (EK) and Random Forest (RF) approaches across the study area at 0-10 cm and 10-30 cm soil depth. Both DSM approaches were assessed through root mean square errors, mean absolute errors, and coefficients of determination. Although both DSM approaches performed very well, EK was considered slightly superior to predict SOC in the Casanare flooded savannas. Covariates derived from vegetation coverage, topography, and soil texture properties were identified as key drivers in controlling its distribution at the study area. We found total SOC stocks of 55.07 Mt with a mean density of 83.13 ± 24.32 t ha^{-1} stored in the first 30 cm soil depth, with 12.3% of this being located in the flooded parts of the savanna landscape, which represented only 7.9% of the study area (664,752 ha). This study provides the first effort to systematically quantify SOC stocks in the Casanare flooded savannas and shows the importance of conserving this ecosystem with the aim of avoiding SOC losses and consequent increased CO_2 emissions to the atmosphere. We estimate that the department of Casanare would release an average of 2,42 Mton of CO_2 emissions per year over 30 years if there were large scale conversion of the flooded savannas to intensive agriculture, which corresponds to 62% of the current emissions of the department. At regional level, the impact of a large-scale land use conversion of the flooded Llanos del Orinoco ecosystem area (15 Mha) would represent 1/3 of the current net Colombian CO_2 emission (AFOLU), which makes this region a potentially important source of emissions if correct decisions are not taken regarding the land management.