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Mapping dynamics of soil organic matter in croplands with MODIS data and machine learning algorithms

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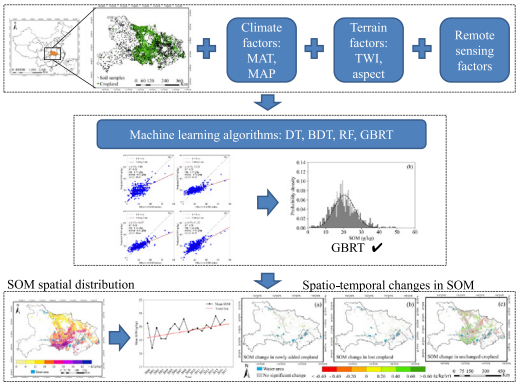
HIGHLIGHTS

- GBRT was a better algorithm for spatially predicting and mapping SOM content in Hubei, China than DT, BDT, and RF.
- Remote sensing reflectance and vegetation indices were proved to be key factors for predicting SOM content.
- The SOM content in the topsoil in 2017 varied from 0.89 to 58.86 g/kg, with a mean value of 20.52 g/kg.
- The mean cropland SOM content of Hubei exhibited a slight increasing trend from 2000 to 2017.

GRAPHICAL ABSTRACT



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ABSTRACT

As an important indicator of soil quality, soil organic matter (SOM) significantly contributes to land productivity and ecosystem health. Accurately mapping SOM at regional scales is of critical importance for sustainable agriculture and soil utilization management and remains a grand challenge. Many studies used soil sampling data and machine learning algorithms to predict SOM at regional scales for a given year, while few studies mapped SOM for multiple years and examined its temporal dynamics. We compared the performance of four machine learning algorithms: decision tree (DT), bagging decision tree (BDT), random forest (RF), and gradient boosting regression trees (GBRT) in mapping SOM in Hubei province, China over the 18-year period from 2000 to 2017. Our results showed that RF and DT had the highest coefficient of determination (R^2) (0.61) and the lowest potential bias (9.48 g/kg), respectively, while GBRT had the lowest mean error (ME) (1.26 g/kg), root mean squared error (RMSE) (5.41 g/kg) and Lin's concordance correlation coefficient (LCCC) (0.72). The SOM map based on GBRT better captured the distribution of the soil sample data than that based on RF. The trained GBRT model and the spatially explicitly data on explanatory variables (e.g., climate, terrain, remote sensing) were used to predict SOM for each 500 m × 500 m grid cell in Hubei for the period from 2000 to 2017. Our results showed that the SOM content of cropland was relatively high in the southeast and relatively low in the north. The SOM content in the topsoil varied from 0.89 to 58.86 g/kg and was averaged at 20.52 g/kg. The mean cropland SOM content of the province exhibited an increasing trend from 2000 to 2017 with an increase of 0. 26 g/kg and a growth

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