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Machine learning algorithms: Modeling the spatiotemporal dynamics of soil moisture under a forested site

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Statement of the Problem: The Atlantic Forest biome is one of the largest biodiversity hotspots in the world which is well-recognized by the ecological services, such as hydrological regulation and natural hazards mitigation. These services are mainly driven by soil moisture. The interactions among forest traits, rainfall patterns, climate, topography, and soil hydrology define the soil moisture spatiotemporal distribution. However, understanding these connections is arduous due to their high nonlinearity. This is even more challenging when extreme droughts are present. Although there are many physically based models, the correct definition of some parameters is an endeavor task. Therefore, machine learning algorithms have been a feasible alternative to model this ecological system tackling the nonlinearity. This study aimed to define the most appropriate machine learning to model the soil moisture spatiotemporal dynamics under an Atlantic forest stand.

Methodology & Theoretical Orientation: Random forest (RF), support vector machine, average neural network, and weighted k-nearest neighbor performance were assessed in a period spanning from 2012 to 2019. Calibration and validation were performed by two approaches: (i) chronological; and (ii) randomized. Explanatory variables were species diversity, diameter at breast height, throughfall, potential evapotranspiration, longitude, slope, and saturated hydraulic conductivity (Ks). Findings: The randomized approach is suitable to model the spatiotemporal dynamics of soil moisture in contrasting weather conditions since it enables machine learning algorithms to generalize. RF performed better than the others highlighting the importance of throughfall as the main driver of soil moisture dynamics. Tree diversity is related to soil water availability whereas Ks and slope were less important.

Conclusion & Significance: Both time-dependent and time-independent variables are important in modeling soil moisture in an Atlantic forest stand. Machine learning is recommended for stressful weather conditions.

Biography

André F. Rodrigues has his expertise in the hydrology of tropical forests with the main focus on understanding the connections among atmosphere, forest, and soil. He has worked with physically based models to simulate the rainfall canopy interception and the soil water movement in drought conditions. Since these connections had demonstrated high nonlinearity, he has dedicated his time to improve the understanding of the spatiotemporal dynamics of ecohydrological variables by means of machine learning algorithms.

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