Science Societies

Finding the right fit: A better way to model crucial soil water data

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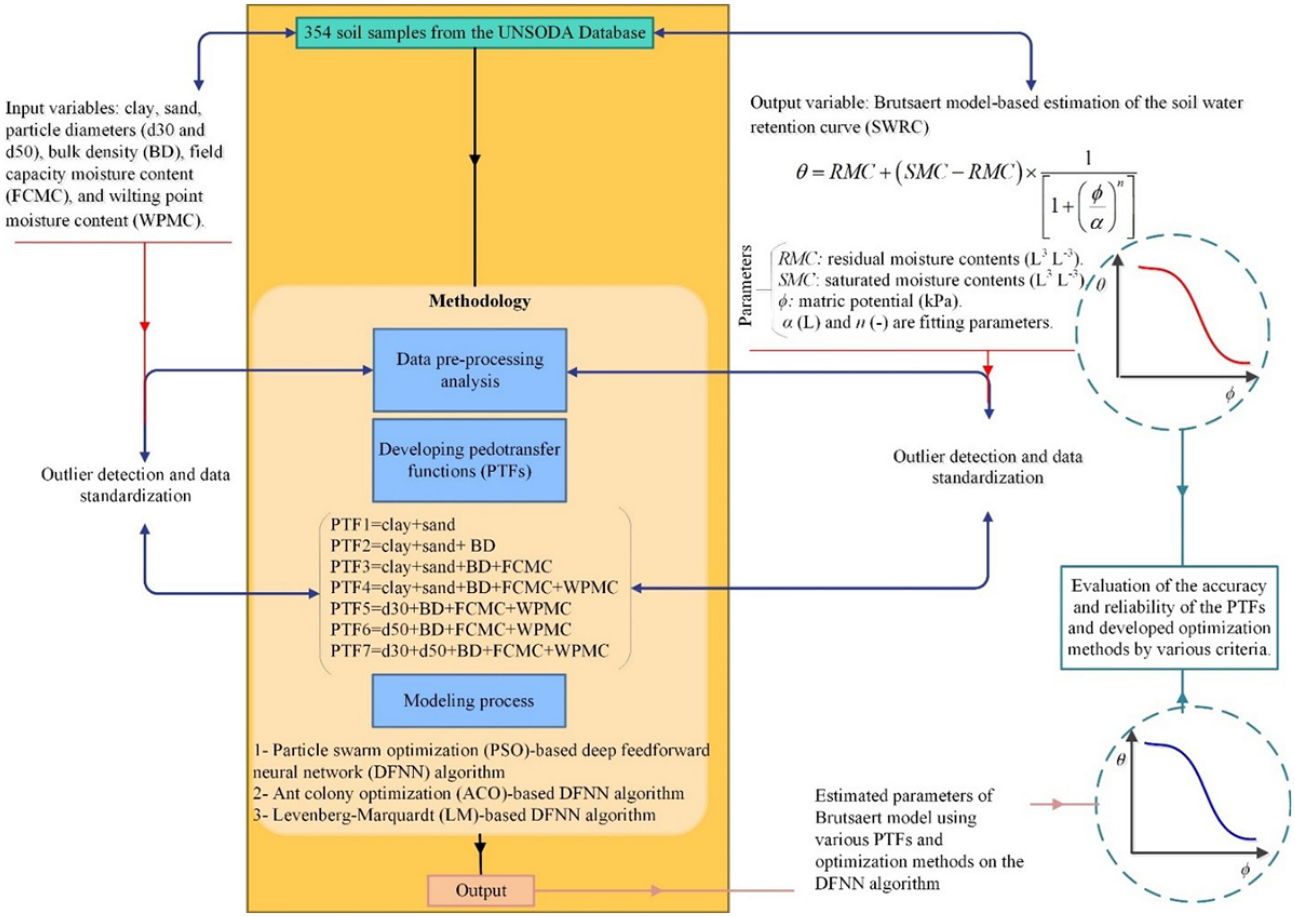

The overall methodology for developing pedotransfer functions (PTFs) using a deep neural network (DNN) with various optimization methods for estimating the soil water retention curve (SWRC). Image courtesy of Yong He, Zhejiang University.

Understanding how soil retains water is fundamental for predicting water movement, crop growth, and contaminant transport. Accurate models of the soil water retention curve (SWRC) are therefore vital for hydrologists and agronomists. Pedotransfer functions (PTFs) can indirectly measure soil hydraulic functions using deep neural networks (DNNs), but model performance depends heavily on the optimization algorithm used during training.

A study published in *Vadose Zone Journal* compared the effectiveness of different optimization methods for training DNNs to estimate SWRCs. The researchers investigated whether a classical numerical method or nature-inspired algorithms would produce more reliable and accurate models. To do this, they tested a common mathematical model, the Levenberg-Marquardt (LM) numerical method, against Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO) algorithms.

The analysis found that the LM algorithm significantly outperformed the other methods, producing the most accurate estimates of soil water content. It proved more reliable and less prone to becoming trapped during the training process. These findings provide clear guidance for scientists developing soil-hydrological models. Using the LM algorithm to train DNNs leads to superior performance, enhancing the capacity to simulate complex soil-water interactions. This advancement supports more accurate predictions in water resource management and environmental protection.

Dig deeper

Rastgou, M., Jin, X., Jiang, Q., Liu, S., Lou, R., Wang, J., Tang, R.,
& He, Y. (2025). Optimizing deep neural networks for estimating soil water retention curves: A comparison of metaheuristic and numerical algorithms. *Vadose Zone Journal*, 24, e70035. https://doi.org/10.1002/vzj2.70035
