MODELING SOIL-GAS DIFFUSIVITY IN UNDISTURBED SOILS: A LITERATURES STUDY

MMT Lakshani*[1], TKKC Deepagoda[2]

[1]Postgraduate, Dept. of Civil Engineering, Faculty of Engineering, University of Peradeniya, 20400 Peradeniya, Sri Lanka

[2]Senior Lecturer, Dept. of Civil Engineering, Faculty of Engineering, University of Peradeniya, 20400 Peradeniya, Sri Lanka

Abstract: Accurate prediction of soil- gas diffusivity (D_p/D_o: where D_p and D_o are gas diffusion coefficients in soil and free air, respectively) and its variation with soil physical conditions is important for understanding soil aeration and subsurface greenhouse gas emissions and thereby to characterize essential soil functional services in terrestrial ecosystems. Since measuring D_p/D_o is instrumentally challenging and requires maintaining controlled boundary conditions, it is common to use predictive models to estimate D_p/D_o from easily measurable soil properties such as air-filled porosity (ε) and soil total porosity (Φ). Literature abounds studies using repacked soils for estimating soil-gas diffusivity, however they are unlikely to mimic realistic conditions in the subsurface. In this study, literature data on soil-gas diffusivity measured in undisturbed soils sampled from differently characterized Danish soil profiles (total of 150 undisturbed soil samples) were used to test a series of descriptive/predictive models available for D_p/D_o. The selected soils represent a wide range of natural and anthropogenic origins, including agricultural soils, forest soils, urban soils, landfill cover soils, etc. The measurements were within a selected range of matric potentials (−10 to −500 cm H_2O) typically occurring in subsurface. Measurements of D_p/D_o were made using O_2 as the experimental gas in a classical one-chamber diffusion apparatus. Soil-matric potentials were adjusted using a sandbox with a hanging water column. A model comparison was conducted using two basic statistical indices to select best models describing the selected soils. The results show that some simple and earliest models outcompeted few recently developed models while widely used model developed using repacked soils made a significant overprediction of undisturbed data. Results highlighted the importance of using undisturbed soil data for better representation of realistic conditions and adaptive gas diffusivity models which can be customized for specific soil types. Overall, the models provide a useful numerical insight for predicting diffusive gas migration in undisturbed soils and their potential links on soil physical parameters.

Keywords: Soil density; Soil gas diffusivity; Soil types; Predictive models