IMPROVING THE PREDICTION OF SEDIMENT PARTICLE SIZE FOR ENGINEERING VEGETATIVE FILTER STRIPS

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Vegetative Filter Strips (VFS), areas of dense vegetation implanted between a disturbed source area (agricultural or urban) and receiving surface water body, are one of the most used mitigation measures to reduce pesticides and other runoff pollutants. One of the means of transport of these substances is by the mobilization of eroded sediments on which the chemicals are adsorbed to, after sediment detachment by the kinetic energy of the rain or irrigation. VFS reduce the overland flow speed and facilitate sedimentation and soil infiltration, effectively reducing the surface pesticide load arriving to water bodies. When modeling the required VFS characteristics to achieve a desired pesticide reduction level, an important controlling factor is the median particle diameter (d50) of the eroded sediment entering the VFS. However, d50 measurements are rare and costly to obtain. Current methods to estimate expected d50 values consider d50 as a fixed property depending on the soil characteristics (texture and organic matter) in the source area, disregarding complex hydrological and sedimentological processes that in fact result on dynamic d50 values at the same location during different runoff events. To incorporate these complex dynamics in the d50 estimation, a new dimension-reduction approach is developed consisting of a compilation of a detailed database of existing d50 data with over 30 potential predictors, artificial intelligence (machine learning, ML) as an interpolator of the dataset, global sensitivity analysis (GSA) using the ML interpolator for high-dimensional variance-decomposition of the dataset and selection of important variables and their interactions, and regression modeling on the reduced subset of important variables. Firstly, the relationship of the predictors and the d50 is explored through two tree ML ensembles (random forest and extreme gradient boosting). To prove the ability of this method to identify interactions among the predictors, a test case is presented in which data generated from a highly non-linear function under different noise assumptions is fitted with tree ensembles and the sensitivity measures are compared to those produced by GSA and the analytical solutions. A generic multiple linear regression (MLR) d50 equation is proposed from a compiled dataset of d50 measures and predictors with high prediction (NSE=0.8). The resulting d50 equation has been implemented in the next version of the vegetative filter strips model VFSMOD and coupled within the tool SWAN for pesticide exposure assessment used in the EU regulatory approval process.

PRESENTER BIO: Alvaro is a 3rd year PhD student at the Agricultural and Biological Engineering Department, UF. He holds a MSc in Hydrology, and his current research focuses on complex system modeling and analysis through computer simulations and machine learning, especially in environmentally driven human migration.