Stormwater Dynamics: The Influence of Rainfall and Soil Characteristics on Soil Erosion Estimates on Construction Sites

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Rainfall-generated soil erosion at highway construction sites is a significant source of contaminants in stormwater discharges, which has serious implications for water quality and regulatory compliance. Accurate estimation of soil erosion is important for designing sufficient temporary sedimentation basins and for developing Storm Water Pollution Prevention Plans (SWPPP). Although the Universal Soil Loss Equation (USLE) and its modifications are used to predict soil erosion, they were originally developed for long-term agricultural land conditions and do not consider the short-duration rainfall erosion events typically occurring at active construction sites. The project designed a rainfall simulator and an inclined flume using various soils to simulate construction site runoff and measured soil erosion in controlled experiments. Empirical regression models and machine learning algorithms were developed and demonstrated to estimate soil erosion more accurately than traditional models. Rainfall intensity was the strongest driver of soil loss. Soil shear strength and compressive strength provided significant resistance to erosion, and the slope had little effect on erosion, given the short lengths studied. These results provided information useful for SWPPP design and practice. The machine learning models identified the nonlinear relationship between erosion and various factors that conventional models could not capture. This research created a framework that can help engineers in designing more reliable plans, and thus protecting ecosystems and public health. The research can also facilitate the adoption of more efficient and environmentally-responsible construction practices.

Awards Won:
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