Dr. Lei Wu, Assistant Professor in the Department of Civil Engineering at Ohio University conducted an Ohio Water Resources Center funded project via USGS 104(b) subaward titled **"Capillary trapping of buoyant particles by cylindrical collectors and its application in transport of floating fertilizers in overland flow."** This project aimed to understand capillary attraction — a particle capture mechanism that plays an important role in the interactions between floating particles and emergent vegetation — in order to shed light on the design of granular fertilizer and the prediction of its transport in surface runoff.

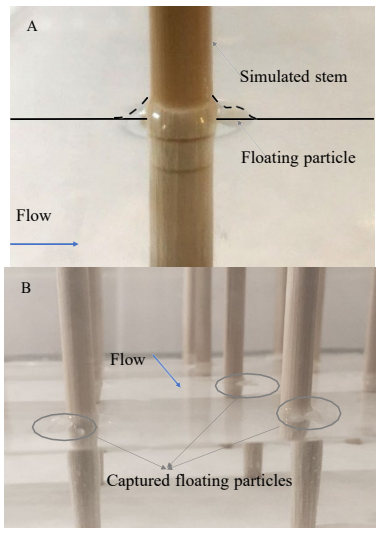

Figure 1. Representative floating particles captured by simulated stems due to capillary force.

Controlled-release fertilizers (CRFs) can be a promising way to increase the utilization efficiency of nutrients while also reducing nutrient pollution from over-fertilization. Minimizing surface water pollution caused by fertilizers requires accurate nutrient transport prediction, but some CRFs are buoyant and can float on the surface of water because of capillary action due to their unique polymer / film coatings. This poses challenges in predicting their transport in the field.

Dr. Wu and her team investigated the key factors governing the capillary attraction between floating particles and stems in a modeled vegetation system (Figure 1). A modified collision model was proposed and validated to predict the capture efficiency ($\eta_!$) of particles by emerging stems under various experimental conditions. The results showed that the $\eta_!$ remained constant when bulk flow velocity of liquid (u) was smaller than particle escape velocity (u_e). The $\eta_!$ decreased drastically with the increase of the bulk flow velocity (Figure 2A). Additionally, particle size had a non-trivial effect on the decrease of $\eta_!$; with increased flow velocity, the $\eta_!$ decreased exponentially for both particles with different densities (Figure 2B). A modified collision equation which accounts for the attraction capacity of the floating particle attached to the stem was developed and validated with experimental observations (Figure 2C).

This research presents useful insights on the optimization of the size and density of CRFs as well as their applications in vegetative filter strips. Further studies with the new collision efficiency model include investigating particle aggregation and oscillation around the stem and the effects of the surface properties of the particle and stem on attachment efficiency.

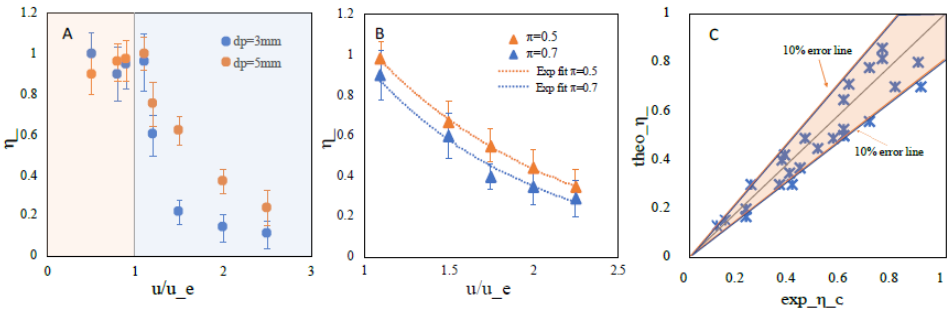

Figure 2. A: capture efficiency ($\eta_!$) as a function of u/u_e. The experiments use polystyrene particles with different diameters (d_p=3mm and d_p=5mm). B: particle density effects on the decrease of $\eta_!$ with increase of flow velocity. C: comparison between the experimental $\eta_!$ and modeled $\eta_!$ by the modified collision equation. Error lines represent 90% confidence intervals.

<u>Researcher Profile</u>: Lei Wu received her Ph.D. from University of Florida in 2013. After finishing her Ph.D., she was a postdoc in the Department of Earth and Environmental Science at the University of Pennsylvania. She is generally interested in understanding how contaminants migrate through environmental media (soil, surface water and groundwater), and how physical, chemical and biological processes can be used to slow their movement and potentially degrade them into less toxic substances.