

Editorial

Special Issue on Applied Research on Water Treatment by Onsite Wastewater Management and Agricultural and Stormwater Control Measures at Varying Spatial Scales

Guy Iverson *  and Charles P. Humphrey, Jr. 

Environmental Health Sciences Program, Department Health Education & Promotion, East Carolina University, Carol Belk Building, Mail Stop 529, Greenville, NC 27858, USA; humphreyc@ecu.edu

* Correspondence: iversong18@ecu.edu

1. Introduction

Human population growth has led to increased wastewater generation and discharges, land clearing and fertilization for food production, and impervious surfaces associated with housing and road construction. These anthropogenic activities result in the increased runoff of nutrients, sediment, bacteria, heavy metals, pharmaceuticals and personal care products, and/or other contaminants to water resources [1–6]. Studies have documented that humans, via land use modification, affect the fate and transport of pollutants at varying spatial scales, which underpin the need for effective methods to track pollutant transport and for management strategies to improve water quality, especially within pollution-sensitive watersheds that serve large population centers. Much more work is needed to improve methods of measuring pollutant fate and transport and to further the understanding of water treatment methods and practices as human population and pollutant generation and runoff increase.

2. Advancing Water Treatment Practices: Perspectives on Agricultural, Stormwater, and Wastewater Management and Future Work

This Special Issue (SI) incorporates advancements in water treatment practices in the context of agricultural, stormwater, and wastewater management at varying spatial scales. The studies herein focused on quantifying fate and transport of pollutants from various land uses or the pollutant treatment efficacy of a control measure that may be retrofitted to existing properties to enhance natural treatment processes. These data may prove valuable to natural resource managers, policymakers, and other researchers interested in assessing environmental impact and strategies to mitigate environmental degradation from human activities that affect the bioavailability of pollutants, especially within water resources. In this SI, there were six manuscripts that were selected for publication [7–12].

Two of the studies in the SI focused on agricultural water management issues [7,8]. The first study, authored by Radzevičius et al. [7], focused on developing a simple and reliable method to use ultraviolet/visual spectrometry to monitor common water quality parameters in water from root vegetables washing and wastewater treatment processes within on-farm packhouses. They found that suspended solids, organic substances, nitrogen, phosphorus, and pathogenic microorganisms were the main threats to water quality. This study concluded that ultraviolet/visual spectrometry were a potentially effective replacement to traditional water sampling techniques, especially at the 320 nm wavelength. The second study, authored by Sarazen et al. [8], evaluated the efficacy of an agricultural control measure that received runoff from a silage storage bunker. They studied a combined moving-bed biofilm reactor and denitrifying woodchip bioreactor to remove masses of total nitrogen (TN), total phosphorus (TP), and soluble reactive phosphorus (SRP) from dairy farm drainage. They found that the entire treatment system reduced 76% of TN, most



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of which occurred in the bioreactors. The authors found that the system was not as effective at removing TP (26% reduction) and SRP (19% reduction) masses.

The next two studies featured in the SI characterized the efficacy of control measures to treat pollutants from stormwater [9] or industrial wastewater [10]. Research by Humphrey and Iverson [9] quantified the removal efficiency of total dissolved nitrogen (TDN) in urban runoff after converting a dry detention basin into a stormwater wetland. The TDN treatment efficiency increased from 0% to 63% after the wetland conversion. Data from high-frequency physicochemical loggers showed that the hydrologic retention time increased, dissolved oxygen, and the oxidation reduction potential decreased, creating an environment that was more conducive to nitrogen removal via denitrification. The next study, authored by Cantamessa et al. [10], studied the efficacy of a constructed wetland to treat pyroligneous liquor waste from a gasification plant. In this study, the authors inoculated the constructed wetland with arbuscular mycorrhizae fungi (AMF) and plant-growth-promoting bacteria (PGPB) to enhance interactions between plants and microflora in the rhizosphere to maximize phytoremediation. Results from the field experiment suggest that using AMF and PGPB in a constructed wetland can enhance the phytoremediation of water-quality contaminants. However, the authors found that ammonium–nitrogen concentrations increased between inflow and outflow, suggesting their wetland may act as a source of nitrogen. Both these studies highlight the versatility of wetland applications in bioremediation of pollutants from human land uses.

The final two studies in the SI characterized the treatment of fecal indicator bacteria by onsite wastewater treatment systems (OWTSs) [11,12]. Vepraskas et al. [11] developed a unique method for estimating the required thickness of saprolite (weathered rock subsoil common in Piedmont and Mountain regions) to completely remove *Escherichia coli* from septic tank effluent in soil textures ranging from clay loam to sand. Results from their study indicated that a mean thickness of 58 cm (range: 35 to 113 cm) was required to completely filter *E. coli* from wastewater. The authors found that the silt percentage was the best indicator to estimate the necessary thickness for safe wastewater disposal. If OWTSs are designed with inadequate separation distances, *E. coli* in wastewater effluent may not be completely filtered and the incompletely treated effluent can pollute groundwater underlying the OWTS. If *E. coli* is not removed within the groundwater system, it may discharge into surface water downgradient from active OWTSs. The final study, authored by Iverson et al. [12], compared the concentrations and exports of *E. coli* and *Enterococcus* spp. (henceforth referred to collectively as fecal indicator bacteria (FIB)) from watersheds served by various wastewater treatment technologies. The authors found that the watersheds with the highest density of OWTSs (approximately 0.4 systems ha⁻¹) contained greater FIB concentrations and exports relative to the watersheds with the lowest densities; however, only differences in FIB concentrations were statistically significant. The results from this study suggest that OWTSs can affect water quality at the watershed scale, especially when watersheds contain elevated densities of OWTSs. Both the studies included in this SI emphasize the role that OWTS can play in the delivery of FIB to water resources. Inadequate filtration at the site scale can result in watershed-scale impacts, especially if there are numerous OWTSs with incomplete FIB filtration located in the same watershed.

The articles included in this SI advance the study of water treatment and management of pollutants that enter water resources from agricultural, stormwater, or wastewater sources. Despite these advancements, there remains much work to improve water treatment and management. Future work should continue refining methods of tracking water pollutants, enhancing the pollutant removal capacity of control measures, applying control measures in areas where efficacy data are limited or absent, identifying pollution-sensitive watersheds, assessing the cost–benefit of adapting control measures, and evaluating policy-making processes in watersheds sensitive to pollution.

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