NEWEA Student Scholarship Recipients' Essays

2016 Recipients (presented at the 2017 Annual Conference in January)

Essay Question: *Stormwater management has become an integral aspect for sustainable water management in urban areas. Please discuss the recent advances in this area and the role you could play, as a researcher/engineer, to provide holistic approaches for stormwater management and guidance for planners and law makers in governmental agencies to better facilitate sustainable water management in urban environments.*

Zhiheng Xu
University of Connecticut
Graduate Student Scholarship

With the increasing population, rapid urbanization, ecological environment deterioration, and serious water pollution, the quality and quantity of fresh water become crucial to human beings. Effective utilization of stormwater, one essential part of the water cycle, becomes critical for sustainable water management in the urban environment.

Pollutants carried in stormwater runoff have raised severe concerns for the integrated water management of stormwater. This is especially the case along the coast of the United States, where polluted stormwater runoff from roads and highways is the largest source of water pollution. To provide effective precaution strategies and minimize the pollution impacts, real-time *in situ* monitoring of stormwater is an imminent topic in water quality engineering fields. During my doctorate research, I have developed a novel sensing technology milli-electrode array (MEA) capable of simultaneous monitoring of multiple water quality related parameters and thus making real-time *in situ* stormwater monitoring possible. Briefly, MEAs are fabricated by precisely printing multiple millimeter-sized electrodes on a flexible thin film using inkjet-printing technology. Compared to expensive though ineffective probes/sensors (more than $1,000 to $50,000 per sensor) that can only measure a single parameter at a single point, MEA possesses unbeatable advantages of easy fabrication, high accuracy, low cost (<$1/sensor), and easy deployment and replacement. By aligning multiple pieces of MEA sensors in a row, contaminant fate in stormwater can be profiled at a high spatial-temporal resolution, greatly enhancing the monitoring capability and unveiling the stormwater quality *in situ* for pollution control and public health. I have successfully conducted the lab-scale 1-month tests of MEA sensors in storm water, and the results clearly showed the real-time *in situ* monitoring capability of MEAs for multiple parameters (e.g., oxygen, pH, temperature, conductivity, and chloride). This frontier research has received attention nationwide and was published in a high-impact journal (*Sensors and Actuators B: Chemistry*, Impact Factor: 5.0). This breakthrough research has led to a pilot-scale water quality monitoring.

Besides stormwater quality, stormwater transfer in soil is also critical for water quality and quantity. I have developed novel millimeter-sized soil moisture sensors (MSMS) using CD-etching technology. This small, thin MSMS can be directly inserted into soil layers without disturbing soil structure which fundamentally solves the severe disturbance problem of heavy soil sensors. Furthermore, multiple pieces of MSMS inserted vertically along soil depth can obtain the soil moisture at high resolution. None of any other soil sensors have this unique feature. MSMS can monitor stormwater quality and quantity during the infiltration process, something critical to integrated water management. I have successfully conducted the lab-scale tests of MSMS *in situ*, monitoring water content in different types of soils, which is, to the best of my knowledge, the first national study of soil moisture profiling.

Overall, my pioneering research of water quality sensors greatly enhances my understanding of stormwater monitoring, treatment, and management. Stormwater becomes one valuable treasure to human beings due to its large amount. Multidisciplinary knowledge is required to achieve a sustainable water usage for a bright future for our descendants' hands in hands!

Evelyn Grainger
Worcester Polytechnic Institute
Undergraduate Scholarship

Flood maps outlining the flood zones of 10-, 50-, and 100-year storms are being updated as global climate change is believed to be increasing the frequency and intensities of these flooding events. As the population density of cities increases and urban sprawl spreads to areas that were once rural, impervious surfaces such as buildings, parking lots, and roads are intensifying the quantity of water that cannot be adsorbed by the land. These two factors, climate change and population growth, have made stormwater management critical to the safety, economic stability, and health of people living around flood boundaries.

My experience with stormwater management has focused primarily on capture and reuse methods with rainwater harvesting in rural Guatemala, where rainwater is used to sustain community members' potable water supply through the dry season. Capture and reuse systems are versatile in size and purpose. While this solution is not practical for developed urban areas of the United States, capture and reuse methods are becoming increasingly popular in urban areas. In 2015, I worked with an interdisciplinary team of engineering students to design and assist Tatnuck Elementary School with the implementation of a community garden with a rainwater harvesting system. We completed calculations to determine the storage and roof size needed for rainwater to support the garden. While these two forms of stormwater management were small scale and had little impact on the stormwater runoff, they prove the versatility of rainwater harvesting methods. Capture and reuse methods can also vary in size. At my university, a large water collection system was created for the development of new athletic fields when they found that the runoff volume caused by the modification of pervious land to impervious fields would be problematic to combined sewage overflows. This system collects water falling on the turf fields in a large cistern beneath a parking area. While the water is not reused, it is stored until it can be released to the sewer system, allowing the water to be treated without overflowing the wastewater treatment system during peak flow.

The success of stormwater management, capture, and reuse, or others such as green roofs, pervious pavement, or bioretention ponds, is not dependent on solely the innovative technologies but more importantly on the appropriate application of these technologies, and inclusion of community and policy makers in the solutions. Rainwater harvesting is far from an emerging technology, but its concept has been adapted and improved, meeting the needs of large site designs that modify peak flows, gardens, and people without access to potable water.

As this crisis intensifies, causing more detrimental impacts to health, safety, and the economy of American cities, there will be a need not only for civil engineers to work on designing stormwater management programs that consider the different technology options but also for community and policy education members to advocate for stormwater management practices. With my strong civil engineering and social science background, I understand the interconnected relationship between people and infrastructure. Through this I believe I can work to design, implement, and educate to improve local communities through improved stormwater management practices.