Evaluating Best Management Practices Using Wireless Sensor Networks

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Introduction

The increase in urbanization has taking a toll on the quality of streams. Due to this, there has been an increased concentration of pollutants in urban streams. Pollutants including but are not limited to: herbicides, suspended solids, petroleum hydrocarbons, heavy metals, and pesticides. Storm water best management practices (BMPs) are tactics used to manage or lower pollutant loadings. Examples of BMPs are stormwater ponds used for settling particles and wetlands to remove organic pollutants. Currently, stream water quality is evaluated using a technique called grab sampling where the stream is sampled at a determined interval, which could be every week or every other week. However, this method is not the best because it does not capture the short term spikes of sediment or pollutants that occur during events such as rainstorms that could be problematic. In this project, grab sampling and a system of sensors called wireless sensor networks were used to capture real time data. By using these two techniques, the sort term spikes and how they were removed by the environment were able to be observed.

Method

In this project, the stormwater BMPs will be studied to determine their effectiveness at lowering the amount of pollutants in nearby streams and rivers. Water samples will be collected using grab sampling. These samples will be collected before, during, and after a rain event occurs using ISCO autosamplers. Once the samples have been collected, they will be taken to the laboratory to determine the amount of pollutants in the water. Lastly, using wireless sensor networks (WSNs), real time data will be collected on water quality, and this data will be used to see if using WSNs can predict when pollutants will appear in the water and how long it will take to naturally remove them.

The first task is to collect samples using wireless sensor networks and grab samplers. The Campbell Scientific Data Logger relays information in real time to the Hydrologic Information System (HIS). This system uses the internet to send the data to the Saint Anthony Falls Laboratory (SAFL), University of Minnesota in a format that can communicate with other databases. The WSNs can also be programmed to trigger the ISCO autosamplers during rain events to collect samples to determine affects of the storm to the pond or stream. Once the samples are collected, they can be analyzed in a laboratory to determine the concentration of pollutants.

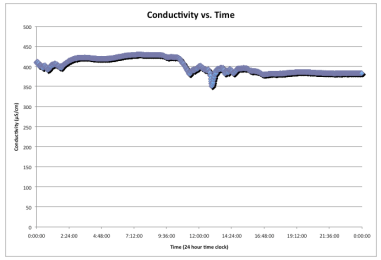
This data will be used to evaluate and to help improve the effectiveness of the storm water BMPs. By understanding the performance of the stormwater BMPs, proper actions can be taken to improve the water quality of urban streams along with the aquatic ecosystems. By using high temporal data from a WSN, real time data can be taken and help predict a spike in pollutants.

Data

Using the ISCO grab sampler and the wireless sensor network (WSN), a variety of data was collected. With the water samples collected over a certain time period, organic pollutants like nitrate, chloride, and phosphate could be measured. Fecal coliform was also measured using the water samples. The WSNs measured water quality every one to five minutes. The WSNs measured: temperature, pH, conductivity, turbidity, and dissolved oxygen.

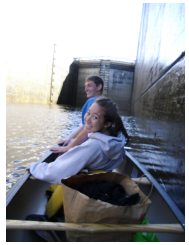
To analyze the data collected, they are graphed against time. Shown below is a graph of what the analyzed graphs would look like generally. Before the rainstorm, the element being analyzed is usually stable. Once the rain begins and throughout the rainstorm, the element is not stable. However, once the rainstorm is over, the water stabilizes once again. Some elements are diluted because of the water entering the stream or pond, but some concentrations increase because the element is found on the streets. One consistant example of concentrations increasing would be fecal coliform. This is because all of the fecal matter runs off of the streets from birds and other animals.

With this data collected, it can be compared to the state's maximum levels to see if the Best Management Practices are working properly.



About the Researcher

Kaitlin Thell is a sophomore in the College of Science and Engineering at the University of Minnesota. She is studying Civil Engineering with an environmental focus. For the past three semesters, Kaitlin has been working in Dr. Arnold's lab with two graduate students studying BMPs in Minneapolis. They have examined three main locations and the Mississippi River within the Minnehaha Watershed District.



Results

One of the BMPs examined was stormwater ponds. They are used to settle particles in a stream and lower turbidity. The second BMP examined was wetlands. The biology of the wetland is used to lower the organic pollutants in the water. It acts as a filter for the water.

One of the problems with only using a pond is the organic pollutants are not filtered out when the stream flows through it. Using only a wetland will cause an increase in turbidity causing cloudy water. An ideal solution to solve both of these problems would be to let the stream flow through a wetland first and the through a pond to settle all of the particles. However, there are some places that do not have enough room to put both of these BMPs into use because of the increase in urbanization. Also, not all streams need both a pond and a wetland because a stream may only have a turbidity problem or an organic pollutant problem.

Conclusion

Urbanization is growing throughout the world. With this increase in urbanization, there is also an increase in surface runoff into streams and ponds. This causes an increase in pollutants in the stream or pond which could damage the long term health of the stream. If the sampling periods were more frequent with on site chemical processing, there would be a better baseline to determine the overall health of the stream in order to keep both the stream and the ecosystem healthy all of the time.