How Land Use Affects Water Quality in Urban Environments: A NRES Case Study of Little Kitten Creek, Manhattan, Kansas

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Conclusions

The test results showed that the water quality in the urban area was, in fact, different than the natural site. There were some variations in what we expected to find within the Little Kitten watershed. Instead of a huge difference, we discovered the indicators in those three test sites were comparable.

We concluded through this study that urban development does affect surface water quality. We suggest conducting surface water tests throughout the year, testing more often and using more test kits and volunteers (citizen scientists), there would be a very different set of data. More in-depth analysis of samples through lab tests rather than field kits could be more accurate, as there were some questions about the quality of the samples obtained and instrument errors.

Introduction

Citizen science is the use of non-expert citizens in the collection of data for scientific analysis. Citizen science is gaining popularity in the scientific community and can be used to provide large data sets. In our experiment, we took water quality samples using a Hach Test Kit which would be feasible for use by non-expert citizens. We measured common water quality indicators that we used to assess the effectiveness of a watershed for filtering runoff.

The primary purpose of our study is to determine the impacts of land use and land cover on the quality of surface waters. This is an important relationship to establish because of our societal dependence on surface waters for drinking, recreation, household use and irrigation. By establishing relationships between land use, land cover and water quality, we can develop recommendations for watershed management to better protect our surface waters from pollution.

Limitations

Time constraints: Throughout our sampling time period of 6 weeks we concluded that the samples were not sufficient in showing changes in water quality over time. With a sampling period over a year the data might show more variability.

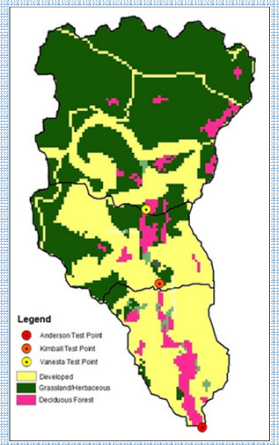
Precipitation: During our sampling period there was little rainfall and the lack of precipitation added to our doubts of sufficient water sampling to show true water quality of an area. Also due to the lack of rainfall the test sites did not have a lot of water movement and in the Vanesta watershed there was only a small area of sitting water to test from.

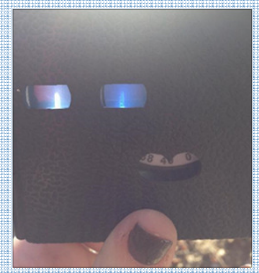
The time of year was also a limitation because there was a large amount of leaves and other debris in the water which could affect the water samples. We also experienced some water freezing which could change the water properties and in turn alter our samples.

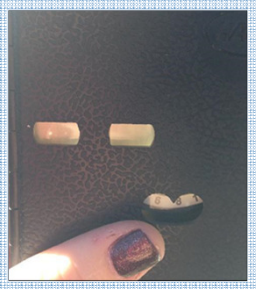
Some additional limitations included lack of test kits to work with, only a few amount of participants and a limited number of test sites.

Study Area

Using a paired watershed analysis approach, Little Kitten Creek watershed was selected as the analysis site. Located in the northwest corner of Manhattan and extending just outside the city's limits, it receives an annual precipitation of 762.0mm. For this study, it was broken into three subwatersheds: Vanesta, Kimball, and Anderson with areas of 414 acres, 184 acres, and 143 acres respectively, resulting in a total area of 741 acres. The limits defined in this analysis provide a total area of 300 hectares, however, it extends slightly below our outlet test point to the confluence of Little Kitten Creek and Wildcat Creek. Data was collected at overpasses where Little Kitten Creek intersects Vanesta Drive, Kimball Avenue, and Anderson Avenue.







Above: Land use and land cover in the Little Kitten Creek Watershed.
Right: Hach test kit comparator box showing changes in Nitrate and Phosphorous in water samples.

Project Focus

How does land use and land cover affect water quality in urban environments?

We hypothesized two outcomes; 1. That as land becomes increasingly developed water quality will decline and 2. That as land cover decreases from development, water quality will decline.

Students of Kansas State's Natural Resource and Environmental Sciences Capstone course chose to conduct basic surface water tests on two watersheds in the Manhattan, Kansas area and compare water quality indicators in both watersheds. The first of the two watersheds is Little Kitten Watershed. Three test sites were chosen along the Little Kitten Creek. The sites were chosen for their increasingly developed land area. The northernmost site was the least developed, containing mostly grassland, the central site more residential and the southernmost test site was mostly urban developments.

The second watershed chosen for testing was Kings Creek, a natural site located on the Konza Prairie Research and Biological Station as a control site to compare with the more developed site.

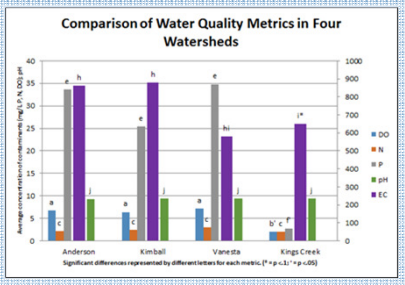
A very simple water quality tool kit was used by non-experts to gather the information. The purpose of this method was to show that non-expert citizens could contribute to future study of watershed quality.

Methods & Results

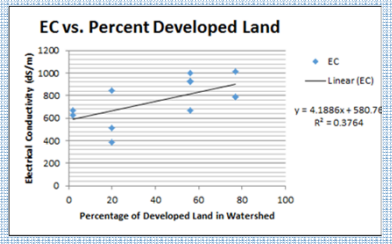
Five samples were collected from each Little Kitten Creek test point, and two from Kings Creek, over a six week period from the end of October to beginning of December. The HACH®Surface Water Test kit was used to test samples on site. Air temperature, water temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), nitrogen (N), phosphorus (P), and turbidity. The average of each result was computed. Averages of P, N and DO were compared between each subwatershed and Kings Creek.

For the purposes of our study, the citizen scientists that participated during the Fall of 2014 were all college students and members of our research group, with the exception of one set of tests which was assisted by a fourth grade student.

No significant differences were observed between the test sites for pH and N levels. In addition, in comparison of the P, N and DO levels in the subwatersheds no significant difference was observed between the vanesta, anderson and kimball subwatersheds. When compared to the control site at King's Creek, the control showed significantly lower levels for the P, EC, and DO measurements. Levels of development in each individual watershed were also compared to the water quality indicators to determine if there were any significant correlations between water quality indicators and increasingly developed land. The only significant interaction observed was between percent developed land in a watershed and EC



A comparison of P, N, Ph, DO and EC in the individual watersheds.



Correlation between percent developed land and electrical conductivity in increasingly urban watersheds.