Exploring Citizen Science Use of Monitoring Urban vs. Agricultural Watersheds in the Kansas Flint Hills

Theresa Collins[1], Connor Kijowski[2], Caleb McCarty[3], Brandi McCoy[4]

[1]Department of Civil Engineering, [2]Department of Geography, [3]Department of Horticulture and Natural Resources, and [4]Department of Animal Sciences and Industry

Introduction

Surface water is experiencing large quantities of pollutants due to runoff, the effects of which are detrimental to individual watersheds as well as large ecosystems. Urban and agricultural areas have major issues with runoff, however, the quantity and quality of runoff can differ. Urban watersheds show higher levels of nitrogen verses agricultural watersheds that are higher in phosphorus. These impacts are partly due to over-fertilization which damages the environment and is a contributor of unnecessary costs to landowners. One way to combat these effects is by creating awareness to and educating landowners of local water pollution issues. Citizen Science is one method of involving the public in data collection and thus promoting involvement in local environmental issues. The objective of this project was to develop water sampling processes that could be easily translated into use by everyday concerned citizens.

Research Question and Hypothesis

Is there a significant difference in surface water quality between developed and agricultural watersheds within the Flint hills ecoregion?

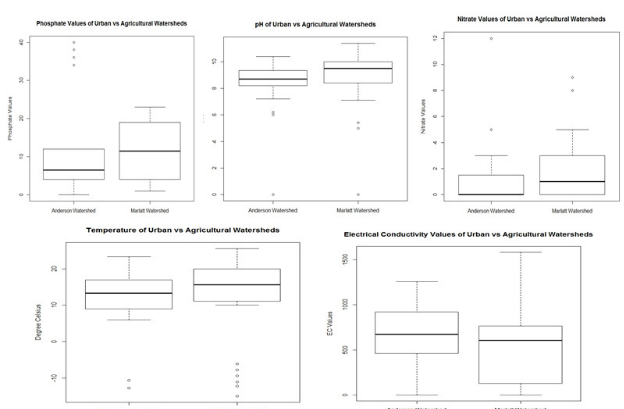
Hypothesis

There is no significant difference in selected surface water quality parameters between urban and agricultural watersheds.

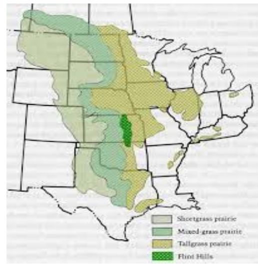
Methods/Study Area

- Fall 2016 water samples were collected from 6 locations from watersheds in the Manhattan, Kansas area
  - Locations included: The Konza Prairie, Little Kitten Creek at Anderson, Little Kitten Creek at Kimball, and two locations at the KSU North Agronomy Farm
  - Watersheds were defined based on land cover types and percentage relative to total acreage
  - Anderson watershed served as the base for "urban" water
  - Marlatt watershed, near the North Agronomy Farm, base for the "agricultural" water.
  - Marlatt watershed contains 22% agricultural land, whereas Anderson contains no agricultural land
  - Marlatt watershed is approximately 400 acres larger than Anderson watershed
- Data collected during previous years were included to increase the number of samples.
- Water was tested using Hach Water Analysis kits provided by Kansas State University
  - Tests included: temperature, electrical conductivity, pH, phosphorus, nitrogen, ammonium-nitrogen, and turbidity
  - Tests were completed during various weather conditions including after major rainfall events and periods of no precipitation.
- ArcGIS and R-Programming were used to create visual graphics and statistical analysis
  - Boxplots, histograms, and the Kolmogorov-Smirnov test were prepared using 'R' and compared temperature, pH, phosphorus, nitrate and electrical conductivity values between the two watersheds

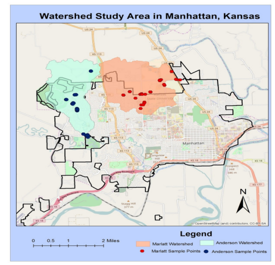
Boxplot Comparisons of both Study Areas



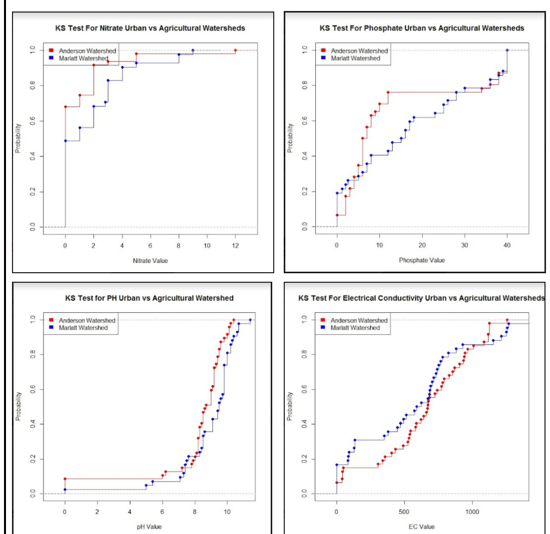
Flint Hills Region



Study Areas



KS Tests comparing Urban and Agricultural Watersheds



Pollutant	Test Statistic (D)	Probability
Electrical Conductivity	0.175	0.4995
pH	0.325	0.018*
Nitrate	0.23	0.18
Phosphate	0.33	0.015*

Results from the Kolmogorov-Smirnov tests for the pollutants electrical conductivity, pH, nitrate, and phosphate. Probabilities highlighted by an * indicate a statistically significant difference at a 95% confidence level.

Results

Marlatt (Agriculture)

- Elevated levels of every tested variable except electrical conductivity, when compared to Anderson (urban)
- Significantly different of values for phosphorus and pH (95% confidence)
- Overall range of values higher, indication of more variability
- Larger range and more outliers for all five tests

Anderson (Urban)

- Electrical conductivity had a higher median value and overall quartile range according to the boxplot data
- The median value, and the upper quartile range are lower for the phosphorus, nitrate, and pH and temperature.

Discussion

There were occurrences that hindered total confidence in the overall validity of the results. The electrical conductivity meters, along with the pH meters, had issues with consistency and accuracy on a few occasions. As a result, those specific data points were either not included or were noted as outliers. In addition, the tests for nitrates and phosphates use a color wheel that is used to compare the color of the tested water with a reference for determining an approximate quantity of said nutrients. The perceived reading from an untrained individual can have an indeterminate potential for error.

Implementation of citizen science to monitor water quality, whether in an urban or in a rural setting, can be successful. Recommendations for future success would be the development and communication of clear data collection processes with hands-on training of proper data collection.

Future research in this area is needed for better understanding of urban and agricultural watersheds. Larger collections of data from various times of the year might also be very valuable. Citizen Science efforts could greatly enhance future data collection for this research.

Conclusion

The question of whether there is a significant difference in surface water quality between agricultural and urban watersheds was found to have mixed results. A trend in higher values in the Marlatt (agricultural) watershed was found for all tested variables besides electrical conductivity. Marlatt had a broader range of electrical conductivity values but the median was lower. These variations could be due possibly to agricultural practices and the timing in between fertilizer applications. Homeowner's over application of fertilizer and the application timing could increase the EC values as well.

Also, phosphorus and pH were found to be significantly higher in the agricultural watershed versus the urban watershed with a 95% certainty according to the KS Test statistical analysis. Higher phosphorus could be explained by the type of fertilizer used for crops versus for turfgrass. Phosphorus-rich fertilizers are common practice in agriculture and uncommon in turfgrass due to a phosphorus surplus in established turfgrasses. pH values are also raised where phosphorus fertilization takes place which could answer why both of these factors are elevated in an agricultural watershed.

The Fall 2016 sampling period found much lower amounts of phosphorus, but steady amounts, compared to previous year's sampling across all sampling sites. This may be due to a consistently rainy season. During a dry spell, phosphorus may build up in the soil leading to no tested values until a rainfall which would bring elevated levels of phosphorus into the surface water via runoff. This claim follows the trends in data between sampling years. The reasoning for elevated pH and phosphorus in the agricultural watershed have some logical reasoning behind them but require more research to produce concrete conclusions.

Relevant References

Bährle-Rapp, Marina. "Diammonium Phosphate." Springer Lexikon Kosmetik Und Körperpflege (2007): 17. Nutrient Source Specific. International Plant Nutrition Institute. Web.

Conrad, Cathy C., and Krista G. Hilchey. "A Review of Citizen Science and Community-Based Environmental Monitoring: Issues and Opportunities." Environmental monitoring and assessment 176.1-4 (2011): 273-91.ProQuest. Web. 22 Sep. 2016.

Dickinson, Janis L, Shirk Jennifer, Bonter David, Bonney Rick, Crain Rhiannon L, Martin Jason, Phillips Tina, and Purcell Karen. "The Current State of Citizen Science as a Tool for Ecological Research and Public Engagement." Frontiers in Ecology and the Environment 10.6 (2012): 291-97. Web.

"Kansas State University." Fertilizing | General Lawn Maintenance | Lawn Problem Solver | Kansas State University. N.p., n.d. Web. 13 Dec. 2016.