Trace Metal Analysis of Little Arkansas River as Urbanization Increases Nearing Wichita, KS

Jacob T Sinclair
Faculty: William Parcell

Department of Geology, Fairmount College of Liberal Arts and Sciences

Abstract. The Little Arkansas River originates in areas of high agriculture use and flows to areas of increasing population and urbanization. As the urbanization increases especially between Valley Center KS and Wichita KS the health of the river is degraded and 303d listed endangering aquatic life and limiting resource use. Using EPA collected data for statistical analysis to determine parameters of interest heavy metal concentrations will be determined and linked to a visual site analysis. From the results, amount of degradation can be determined and related to past samples indicating danger to aquatic life and resource limitations for anthropogenic use. Research is continuing to determine spatial concentrations of trace metals and sediment with differing stream discharge related to urbanization.

1. Introduction

The Little Arkansas River is a valuable resource that serves many people across central Kansas from watering crops and recharging groundwater to sources of drinking water. There are an estimated 444,741 people that live within the major cities of the watershed with the majority of in Wichita and estimated total population of the basin is 637,419 in the whole basin as of 2009 (Little Arkansas River Watershed, 2011). It is very important especially as populations increase to preserve water bodies, especially those in which we rely. Pollution and overuse of the resources not only reduces the use of the resource for drinking or crop water but it also contaminants the system with metals and pesticides further reducing the resources use for food procurement. There have been extensive studies of the Little Arkansas River involving the water soluble organic compound Atrazine, placing it on the 303d list (KDHE, 2012), as the primary contaminant but little has been done on trace metal concentrations, especially the relation between total and dissolved load associated with sediment transport during flow events. The Arkansas River provides a great

The purpose of this study is to use minimal monetary resources and existing data to determine spatial trace metal concentration of the Little Arkansas River as urbanization increases from Valley Center KS to Wichita KS. Using a multi-disciplinary approach of pre-collected chemical data to conserve cost and visual assessment data collected at the associated monitoring sites the overall river health will be determined.

2. Methods

1. RCE site characterization

A multi parameter visual stream assessment called an RCE (riparian, channel, and environmental) prepared by Norris 1997 and Peterson 1992 was conducted at each of the locations where data was used for statistical analysis in addition to one further downstream. The RCE has shown consistent and reliable results over years of use at Western Carolina University on a variety of streams and uses three main features of the waterway to give an overall number for stream health. The three observed characteristics are the land use, physical structures of the stream, and biota. The final overall score for each site can range from 15 to 340 and have associated verbal rankings of excellent to poor quality. All sites were visited during dry weather and base flow stream conditions within two days. Overall visual site observations were documented at the time of the RCE.

2. Numeric chemical Data

Chemical and sediment data was downloaded for the main sites on the Little Arkansas River in the cities of Valley center and Wichita. These sites contain substantial data that can be used in statistical calculations with little manipulation. The data was downloaded from EPA Storet data repository on September 27th of 2013. The data was broken down by site using sites SC 728 in Wichita and site SC 282 in Valley center. After the sites were split apart

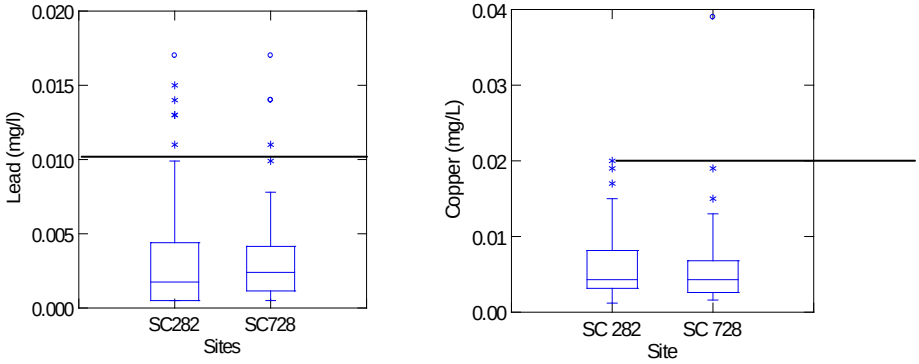
from the downloaded database the parameters for analysis were selected. Non-detects values were counted as half of the lowest detected value. The parameters of interest include sediment, chemical, and trace metal concentrations.

3. Results

Using formulas for hardness dependant variables provided in Kansas Surface Water Quality Standards, Tables of Numeric Criteria health standards for aquatic life were calculated. Using the average hardness of the little Arkansas across both sites for the entire monitoring period and a water effect ratio of 1 as recommended by KDHE 2004 the criteria from table 1 were calculated for the Little Arkansas River.

Table 1: Table of calculated water criteria using table 1b of hardness dependant aquatic life support criteria from Kansas Surface Water Quality Standards, Tables of Numeric Criteria

Element	Effect type	Criteria
Cr	Acute	3.80
	Chronic	0.18
Pb	Acute	0.26
	Chronic	0.01
Cu	Acute	0.03
	Chronic	0.02
Zn	Acute	0.26
	Chronic	0.26



Figures 1 and 2: Demonstrate two parameters of interest to the study and the relation to the state criteria for chronic effects.

3. Conclusions

Using the multi-disciplinary approach used in this study with combining the use of a visual and chemical analysis of the Little Arkansas River the overall health shows distinct trends. As the river flows from upstream around Valley Center towards Wichita the quality of the water and the aquatic habitat are negatively affected by the major change of landuse within the basin from rural to urban as the river approaches Wichita. While higher up in the basin there may be large areas of agriculture use that allows for higher concentrations of non-point sources (Allen, 2004) the increase of point source runoff from urbanization has a dramatic effect of water quality over a very short distance.

The visual observations from the RCE showed that there was a dramatic and fast change in the habitat characterization. The overall score dropped by nearly one forth by site SC 728 and then by half upon reaching site LA 1. The landuse, physical habitat, and biota all decreased at each site as urbanization increases in the downstream direction. The chemical data does show changes in water quality with the increase of urbanization and point source discharge locations but not to the extent shown by the RCE.

4. Acknowledgements

Special thanks go to project advisor Dr. Parcell of Wichita State University for his helpfulness throughout the project. The continuation of the project could not have happened without Dr. Allen and the award of the June Stone Allen Fellowship.

5. References

[1] Little Arkansas River Watershed; Watershed Restoration and Protection Strategy. Kansas State University, Kansas Department of Health and Environment, Kansas Center for Agriculture and the Environment. 2011.
[2] KDHE. Kansas 303d list. 2012.
[3] Norris, M., Adaptation of the riparian, channel and environmental inventory for use by high school students and for use on small streams of the French Creek Watershed (senior thesis). 1997.
[4] Petersen, Robert, The RCE: a riparian, channel, and environmental inventory for small streams in the agricultural landscape: Freshwater Biology, Vol. 27, pp. 295-306. 1992.
[5] KDHE. Kansas Surface Water Quality Standards. Tables of Numeric Criteria. 2004.
[6] Davis, Allen J., Landscapes and riverscapes: The incluence of land use on stream ecosystems. Annual Review of Ecology, Evolution, and Systematics, Vol. 35, pp. 257-284. 2004.