Interweaving Geochemical and Geospatial Data to Locate Nonpoint Source Zinc Contamination for Utoy Creek, Atlanta, GA

Walker, Ryan

Georgia State University, Department of Geosciences, Atlanta, GA

Introduction

Toxic metals, defined as individual or compound metals that negatively affect people's health, are used by numerous industries and are a prime concern in regard to addressing water quality from urban runoff (US EPA, 1983). Urban runoff ranks as the second highest source of surface pollutants entering rivers (Walker et al., 1999). Urban runoff typically contains significant amounts of toxic metals (Sansalone, 1999) as well as nutrients, sediments, and other anthropogenic compounds (Jang et al., 2005). Up to 50% of the toxic metal content in urban runoff is in dissolved form (Erickson et al., 2013). In natural waters these metals have low solubility and generally are removed by sedimentation or sorption (Pitt et al., 1999). However, as the water becomes more acidic, toxic metals readily dissolve into ion form. In this form toxic metals are generally non-degradable and build up in food chains due to bioaccumulation (Chen & Ray 2001).

Zinc is a particularly troubling toxic metal because it can be detected at frequencies of 90% in urban runoff samples (Rangsivek & Jekel, 2005). This is due to Zinc's diverse anthropogenic usage (Rose et al., 2001). Zinc comes from such sources as: the manufacturing of brass and bronze alloys (Sen & Khoo, 2013), runoff from galvanized roofs (Rose et al., 2001), wear from brake pads (Walker et al., 1999), and wear from tire tread (Councell et al., 2004). Zinc is essential for humans (US EPA, 2005) as well as for plant development (Rout & Das, 2003) at low to moderate levels where it only has low toxicity. At higher concentrations zinc can be toxic to plants (Rout & Das, 2003) and can decimate aquatic communities (USGS, 1993).

Background

The Stormwater Division manager for Fulton County came to GSU looking to see if we could analyze zinc levels in Utoy Creek. Andy Mycroft, the Fulton County manager, had done some research on zinc and wanted to know if a galvanizing plant could be the cause of the high zinc levels they were reading for Utoy Creek. We said it was possible and then came up with a plan to find out where the excessive amounts of zinc are coming from. 62 sites were sampled and chemical analysis was preformed on all samples. Zinc levels were compared to base line zinc levels. Combining geospatial and geochemical data in this area should allow for narrowing of location of the non-point source zinc contamination.

Field and Lab Methods

Nonmetallic tools were utilized to collect streambed sediment during low flow stream discharge. Equal amounts of sediment were collected from each bank and combined at each site. Each sample was wet sieved to collect the less than 63 µ sediment which were then freeze dried to prep for chemical analysis. Acid digestion was preformed and samples were run through Atomic Absorption Spectroscopy.

Utoy Creek

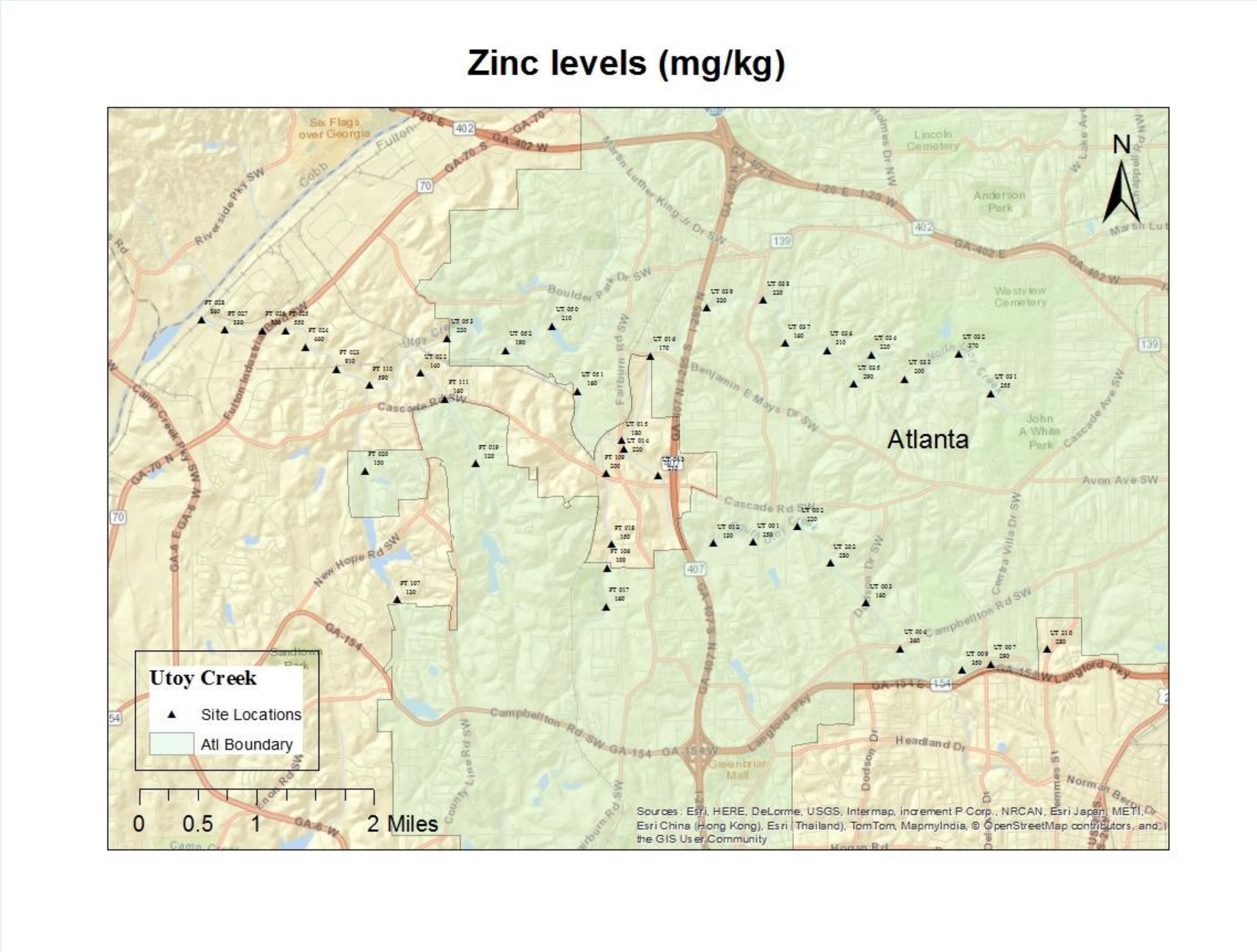
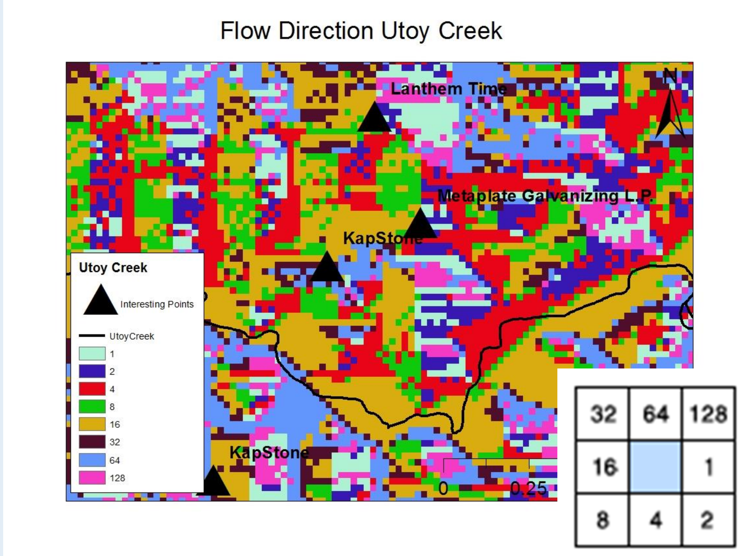
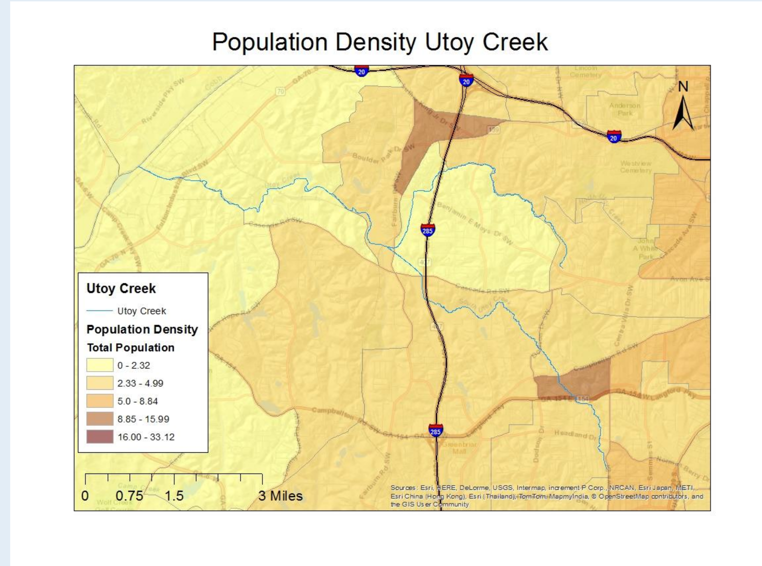


Figure 1. Utoy Creek with all of the sampling sites labeled with their site numbers as well as what concentration of Zinc that was recorded.

Current Research





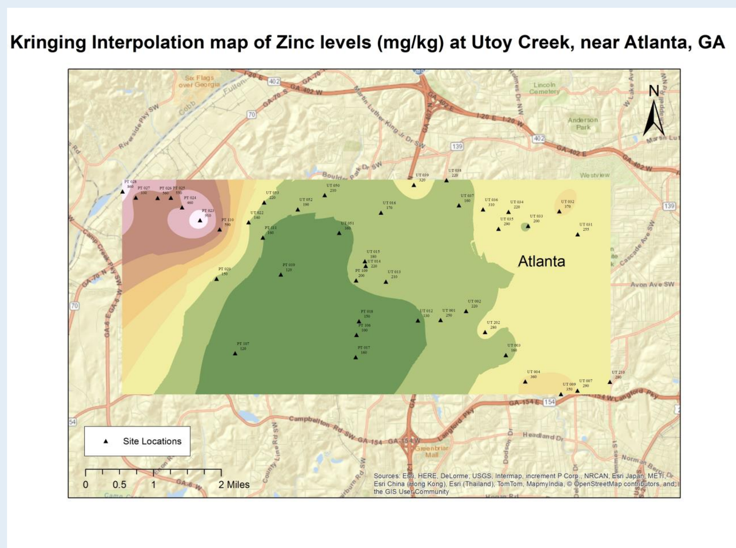


Figure 2. Close up view of Flow Direction map focusing on the Metaplate Galvanizing plant.
Figure 3. Population density for Utoy Creek Study Site. Data is Normalized by Area.
Figure 4. Kringing Interpolation Map of Utoy Creek focusing on Zinc Levels in mg/kg.

Conclusion

The data clearly shows that some of the high zinc levels are coming from the Metaplate Galvanizing plant. The high levels of zinc coming from the northern and southern arms of Utoy Creek could be coming from areas of dense populations but still remains unclear. Further studies showing traffic density around these areas could help clarify this.

Future Research

Comparative Analysis

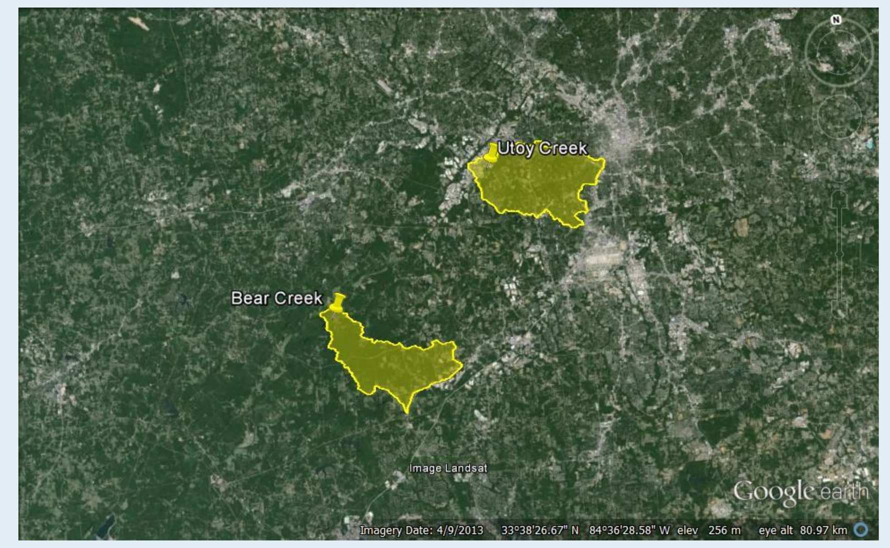


Figure 5. Google Earth Image of highlighted watersheds for Utoy Creek and Bear Creek.

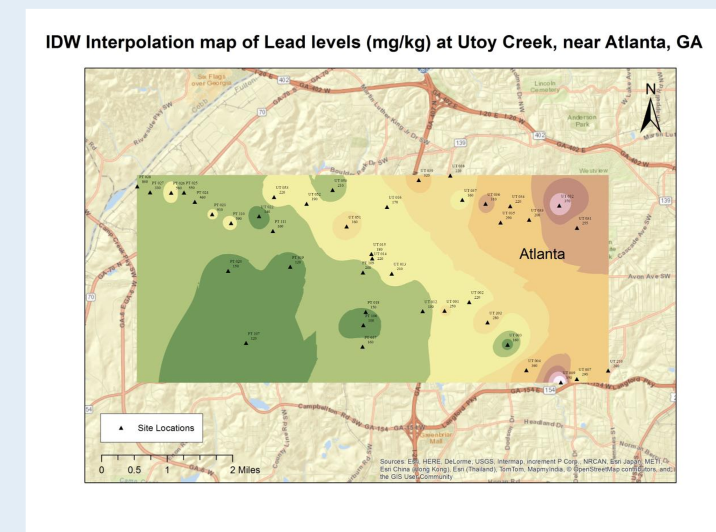


Figure 6. Inverse Distance Weight Interpolation map of Utoy Creek focusing on Lead levels in mg/kg.

References

Chen, Dingwang, and Ajay K. Ray 2001. Removal of Toxic Metal Ions from Wastewater by Semiconductor Photocatalysis. Chemical Engineering Science 56(4). 16th International Conference on Chemical Reactor Engineering: 1561–1570.

Councell, T.B., & Duckenfield, K.U. 2004. Tire-Wear Particles as a Source of Zinc to the Environment. Environmental Science & Technology 38(15): 4206–14.

Erickson, Andrew J., Peter T. Weiss, and John S. Gulliver 2013. Optimizing Stormwater Treatment Practices: A Handbook of Assessment and Maintenance. Springer Science & Business Media.

Pitt, Robert, Shirley Clark, and Richard Field 1999. Groundwater Contamination Potential from Stormwater Infiltration Practices. Urban Water 1(3): 217–236.

Rangsivek, R., and M. R. Jekel 2005. Removal of Dissolved Metals by Zero-Valent Iron (ZVI): Kinetics, Equilibria, Processes and Implications for Stormwater Runoff Treatment. Water Research 39(17): 4153–4163.

Ren, J., & Packman, A. I.. 2004. Stream-Subsurface Exchange of Zinc in the Presence of Silica and Kaolinite Colloids. Environmental Science & Technology. 38(24): 6571–6581.

Rose, S. 2002. Comparative Major Ion Geochemistry of Piedmont Streams in the Atlanta, Georgia Region: Possible Effects of Urbanization. Environmental Geology 42(1): 102–113.

Rout, G., Das, P.E.. 2003. Effect of Metal Toxicity on Plant Growth and Metabolism: I. Zinc. Agronomie, EDP Sciences. 23(1): 3-11.

Sansalone, John J. 1999. Adsorptive Infiltration of Metals in Urban Drainage — Media Characteristics. Science of the Total Environment 235(1–3): 179–188.

Sen, T.K., & Khoo, C.. 2013. Adsorption Characteristics of Zinc (Zn 2+) from Aqueous Solution by Natural Bentonite and Kaolin Clay Minerals: A Comparative Study. Computational Water, Energy, and Environmental Engineering. 2(03): 1-6.

Walker, William J., Richard P. McNutt, and CarolAnn K. Maslanka 1999. The Potential Contribution of Urban Runoff to Surface Sediments of the Passaic River: Sources and Chemical Characteristics. Chemosphere 38(2): 363–377.

US EPA. 1983. Results of the nationwide urban runoff program 1.
USGS. 1993. Zinc Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Biological Report 10. Contaminant Hazard Reviews Report 26.