ASSESSING WATER QUALITY IN THE INDIAN CREEK AND HUNTSVILLE SPRING BRANCH WATERSHEDS

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ABSTRACT

An evaluation of two rapidly growing watersheds in North Alabama has been performed to assess the current state of in-stream water quality conditions. This project is critical because of the lack of information concerning proper management for existing resources within these two watersheds. To date, the Indian Creek and Huntsville Spring Branch watersheds, which are located in Madison, Alabama, are facing an enormous loss of forests and agricultural lands. Notably, urbanization exerts heavy ecological, environmental and climatic pressures on surrounding lands. Therefore, an influx of urban infrastructure to an already vulnerable environment could potentially cause detrimental changes to the aquatic and riparian ecosystems within these watersheds. A multidisciplinary approach was used to evaluate the potential effects of urbanization on the water quality of these two watersheds. In-stream water quality data was collected to assess trends in heavy metal and pesticide concentrations, as well as ecological parameters like, pH, dissolved oxygen and temperature. The impact of land use/land cover was also evaluated through the application of a combination of GIS and Remote Sensing. To date, there is significant variability among the parameters observed within the watersheds, particularly in the distribution of heavy metals. Intensified rainfall and variation in land use cover type also had a significant impact on the observations. These findings will provide vital information on trends in water quality for these watersheds.

Figure 1. Huntsville City Skyline and development of Providence Town Community in the Indian Creek Watershed.

SCIENTIFIC APPROACH

To emphasize a multidisciplinary approach to assessing the impacts of urbanization on water quality in two sub-basins in North Alabama.

Objective: To assess pollutant levels in the Indian Creek and Huntsville Spring Branch Watersheds.

INTRODUCTION

Historically, Alabama has been plagued with environmental problems. According to the EPA Toxics Release Inventory, Alabama has been ranked as high as the sixth most polluted state in the nation. A large number of water bodies in North Alabama fail to attain water quality standards due to the presence of one or more pollutants.

Lack of information concerning proper watershed management and preservation call for a more focused effort to identify polluted waters for the purpose of developing TMDLs and implementing more effective BMPs [4].

A research project conducted using analyzed data from Landsat imagery was used to show changes in landuse/landcover from the mid 1980's through 2000 with projections to the year 2020. The study suggested that 50% of the land in Madison County may be developed by the year 2020 [3]. Additionally, the decision of BRAC (Base Realignment and Closure Commission) to relocate the majority of the nation's missile defense to the city of Huntsville will introduce further stains on these two watersheds (Fig. 5).

Figure 2. Impedance measurements showing presence of fecal coliform near Indian Creek Cattle Farm.


Figure 3. Data collection using the YSI 6600 and discrete sample collection.

RESEARCH STUDY AREA

- The study area consists of two adjacent sub-basins within the Wheeler Lake Watershed with drainage systems that serve as tributaries to the Tennessee River.
- The parent material is karst natured limestone and chert & the soils are reddish, deep and very well-drained. [4]
- Discrete water samples were collected from five locations within each watershed twice per month.
- In-stream water quality data was measured using a mobile YSI 6600 Extended Deployment System (EDS) (Fig.3).
- Standard methods and techniques found in the EPA Standard Methods for the Examination of Water and Wastewater [2] was be used to examine the samples.
- Heavy metal concentrations were determined using ICP-OES and pesticide concentrations were determined using extraction and GC-ECD.

The water quality indicator variables of interest include:

- Coliform Bacteria
- Temperature *
- pH *
– Heavy Metals *
- Dissolved Oxygen *
- Turbidity
- Pesticides*
- Chlorophyll

Data & Sample Analysis

The data is further being analyzed using an integrated geo-spatial approach which will include a compilation of statistical analysis techniques, modeling resources and GIS and Remote Sensing tools.

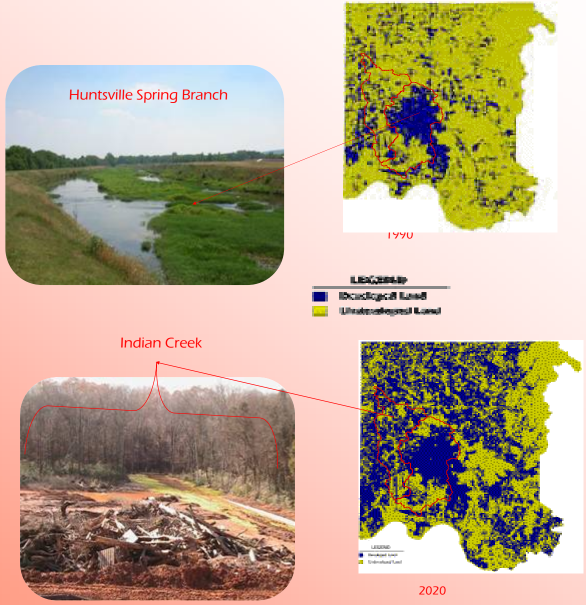

Figure 4. Projected Land Development in Madison County, AL.

FOCUS OF RESEARCH

Many of the areas in these watersheds are inundated or flood prone. Notably, flooding caused by increased urbanization makes it difficult to pinpoint sources of point and non-point source pollution (Fig. 2) [1]. Already plagued by past problems, such as the DDT contamination of the late 1970's, these two watersheds are experiencing accelerated rates of degradation due to increases in surface water pollution, sedimentation and damage to aquatic and riparian areas. (Fig. 5). Several segments of Indian Creek and Huntsville Spring Branch are currently listed on the Clean Water Act 303d List, due to presence of nutrients, organic loadings or some other pollutant. The focus of the study is to identify current impairments and to pinpoint sources of pollution [4].

Figure 5. Sample collection using the YSI 6600 and visual stream assessment..

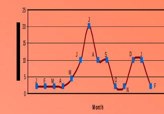

Fig. 6. Turbidity values for Huntsville Spring Branch, January 2005-February 2006.

Table 1. Pesticide concentrations for Indian Creek (IC) and Huntsville Spring Branch (SB) sampling locations.

Pesticides	IC-KS (µg/L)	IC-MR (µg/L)	IC-TN (µg/L)	SB-DT (µg/L)	SB-DK (µg/L)	SB-MR (µg/L)
Aldrin	<0.0400	<0.0400	<0.0400	**0.0133**	<0.0400	<0.0400
Gamma-Chlordane	<0.250	<0.250	<0.250	**0.0257**	<0.250	<0.250
4,4' -DDT	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400
4,4' -DDE	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400
4,4' -DDD	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400
Dieldrin	<0.0400	<0.0400	<0.0400	**0.0712**	<0.0400	**0.0167**
Endosulfan I	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400
Endosulfan 2	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400
Endrin	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400
Heptachlor epoxide	<0.0400	<0.0400	<0.0400	**0.0321**	<0.0400	<0.0400
Methoxychlor	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400

Table 2. Heavy metal concentrations for Indian Creek and Huntsville Spring Branch as affected by location for May of 2006. ND- not detected

Location	Al (mg/L)	Fe (mg/L)	Mn (mg/L)	Cu (mg/L)	Ni (mg/L)	As (mg/L)	Pb (mg/L)	Zn (mg/L)	Se (mg/L)
IC@MR	0.065	0.110	0.044	ND	ND	0.013	ND	0.052	0.003
IC@TN	0.122	0.111	0.019	0.001	0.004	0.028	ND	0.020	0.016
IC@72	0.196	0.159	0.039	0.001	0.001	ND	ND	0.142	0.018
SB@PR	0.847	0.856	0.273	0.003	ND	0.014	0.001	0.176	ND
SB@JN	0.023	0.049	0.48	0.001	ND	0.008	ND	0.093	0.014
SB@DT	0.148	0.068	0.003	0.012	0.021	0.003	0.004	0.637	0.001

Table 3. Heavy metal concentrations for Indian Creek and Huntsville Spring Branch as affected by location for October of 2006. ND- not detected

Location	Al (mg/L)	Fe (mg/L)	Mn (mg/L)	Cu (mg/L)	Ni (mg/L)	As (mg/L)	Pb (mg/L)	Zn (mg/L)	Se (mg/L)
IC@MR	0.300	0.316	0.051	0.001	0.003	ND	ND	ND	ND
IC@TN	0.051	0.065	0.011	0.001	0.002	ND	ND	ND	ND
IC@72	0.251	0.231	0.039	ND	0.001	ND	ND	ND	ND
SB@PR	0.251	0.119	0.046	ND	0.001	ND	ND	ND	ND
SB@JN	0.167	0.112	0.007	0.002	0.003	ND	ND	ND	ND
SB@DT	0.031	0.009	0.002	0.003	0.003	ND	ND	ND	ND

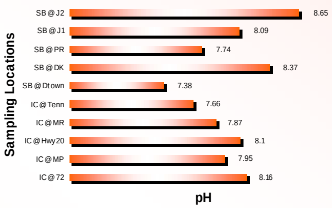

Fig. 7. Average pH values for sampling locations in Indian Creek & Huntsville Spring Branch for 2005-2006.

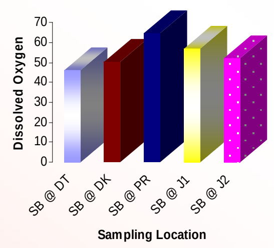

Fig. 8. Average dissolved oxygen levels for Huntsville Spring Branch for 2005-2006.

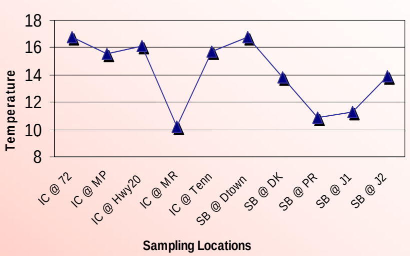

Fig. 9. Average temperature values for sampling locations in Indian Creek & Huntsville Spring Branch for 2005-2006.

RESEARCH FINDINGS

Preliminary results for pesticide distribution indicated that most of the pesticides observed were in concentrations less than 0.0400 *µg/L*. Nonetheless, the presence of Dieldrin and Aldrin were detected at several locations within Huntsville Spring Branch. In particular, Dieldrin was detected at the SB-DT(0.0712 *µg/L) and* SB-MR (0.0167 *µg/L*) location. It is expected that a lower detection limit will aid in detecting lower concentrations of these targeted pesticides, in addition, results from the spring and summer seasons will probably differ from these results, which were obtained from water samples retrieved during the Fall (Table 1).

Tables 2 and 3 show the heavy metal concentrations in both watersheds for May and October of 2006. As indicated, there is variability in heavy metal distribution by sampling location, watershed and month. Noticeably, heavy metal concentrations were highest in May and lower in October of 2006. It is also important to note that concentrations for As, Pb, Zn and Se were not observed in October. Results from other months within the spring and fall seasons also corresponded to these findings. The highest concentrated metals for both watersheds were Al, Fe and Mn. These finding can be attributed to the watersheds' soils and related parent material (geology), which is primarily Tuscumbia Limestone. Interestingly, lower concentrations of more toxic metals such as As and Cu were also observed. The presence of these pollutants is alarming because, even in small concentrations these metals can disrupt aquatic ecosystems by damaging or destroying habitats and the plants and animals that inhabit them, thus reducing biodiversity. In addition, they may accumulate in the food chain and therefore become harmful to humans.

As indicated in Figure 7, the mean values for pH ranged from 7.38 to 8.65, which is comparable to the range for natural water in the U.S. (6.5-8.5). It is also alkaline and highly affected by the prevalent limestone of the this area. Interestingly, the highest and lowest pH values were observed in Huntsville Spring Branch. Notably, fresh water sources with a pH below 5 or above 9.5 may not be able to sustain plant or animal species.

Figure 9, shows the mean water temperature values for the two watersheds. The water temperature ranged from 10 to 17 degrees Celsius. The mean value for IC@MP and SB@PR were considerably lower than those of the other locations. In addition, the dissolved oxygen levels at SB@PR also consistently exceeded those of the other locations. Most aquatic organisms are poikilothermic, "cold-blooded" which means they are unable to internally regulate their core body temperature. Therefore, temperature exerts a major influence on the biological activity and growth of aquatic organisms as well as chemical processes. In addition, many gases, like oxygen become less soluble as water temperature increases (Fig 8). These findings could be attributed to the dense riparian zones surrounding these two locations. Land use conditions and climatic factors may have also contributed to variations in the water quality indicator variables as well.

CONCLUSIONS

The sources of these pollutants into these aquatic environments is a result a variety of sources of non-point source pollution, mainly agriculture and industry. The enormous amount of flooding that takes place within these two watersheds also intensifies the extent of pollution. Heavy metal concentrations tended to be higher in the spring and in the Indian Creek locations. Data for the ecological parameters showed significant variation by season, location and watershed.

ACKNOWLEDGMENTS

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