Longitudinal Study of Water Quality in Jennings Creek, Bowling Green, Kentucky: Urbanization Impacts on Karst Groundwater


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Abstract

Karst groundwater systems, which occur in areas where caves, sinks, and underground rivers dominate the landscape, are vulnerable to pollution from surface contaminants. In urban areas, like Bowling Green, Kentucky, which is home to extensive caves and groundwater supplies, the immediate transport of heavy metals, organic waste, chemicals, and other pollutants from surface activities into groundwater poses a serious threat. This research project was done to examine the water quality of urban karst sites in Bowling Green, Kentucky at Jennings Creek, which is a local river primarily fed from karst groundwater. Jennings Creek was never tested before this project, although it is an input to the Barren River, the area’s primary drinking water source. Weekly water samples were taken at five sites for six weeks over the summer. Each sample was selected based on its proximity downstream from a primary spring input with a known drainage area and land use. The samples were tested each week for forty-three different parameters related to water quality, which included alkalinity, total organic carbon (TOC), cations, anions, metal concentrations, dissolved oxygen, total chlorine, and E. coli, among others. The results of the data collected indicate different pollutant concentrations based on land use in the area surrounding the spring inputs, with major detrimental changes occurring at the largest spring inputs. Jennings Creek flows into the Barren River, which is a main waterway in Bowling Green used for recreation, fishing, wastewater treatment discharge, and drinking water.

Methodology

Analyses completed at HydroAnalytical Lab followed specific Standard Methods specified by the EPA and included metals, cations, anions, biochemical oxygen demand (BOD), total organic carbon (TOC), alkalinity, and E. coli bacteria. Data were Quality Control (QC) checked through duplicates, standards, and blanks and processed using SigmaPlot 11 to graph the most significant and/or harmful water quality data against precipitation and sample date.

Results

• Water samples were collected from 5 sites along Jennings Creek downstream of spring inputs from May 21 to July 9, 2018.

• Data for pH, specific conductivity (spc), total chlorine, temperature, turbidity, total suspended solids, dissolved oxygen were collected in the field.

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Discussion

• Turbidity measures the clarity of water, or how much sediment there is. The first three sites spiked after rainfall likely from an increase in sediment input with runoff, while sites four and five are industrial areas with regulated discharges.

• Fluoride is an indicator of sanitary water leaks. The first three sites have a high fluoride concentration, so it is possible to assume there is a leak from sanitary water lines.

• Chloride offers industrial cleaners, the high concentrations that appear at sites four and five could be explained by the industrial land use in watersheds that feed these springs.

• Lead and arsenic indicate heavy metal contaminants in waterways. The drinking water standard for arsenic is 0.010 mg/L, during data collection, six different samples tested higher than the arsenic maximum. The appearance of large amounts of lead and arsenic in sites one and five indicate there are more heavy metal contaminants in those areas.

• Nitrates and phosphates are found in fertilizers and plant nutrients. The lack of high concentration of these parameters at sites four and five (agricultural areas) are likely due to dilution from high water volume.

• BOD is the amount of available oxygen in the water. High BOD means there is less oxygen due to oxygen depletion from contaminants. Site four would be the area that is least suitable for aquatic life.

• TOC indicates general stream health and water quality based off organic contaminants, such as agricultural chemicals. TOC is consistent between all five sites, but there is probably more industrial water in the first three sites and higher agricultural contaminants in the last two sites.

• Temperature is very important in water quality, because all other parameters depend on it. When temperature rises, other indicators tend to have higher values and be less precise. Temperature itself depends on the area, time, proximity to springs, amount of solar radiation, etc.

• Another basic water quality indicator is pH, which indicates acidity. If there is a pH spike it could mean there is a contamination, leak, or spill. Similar to other contaminants, pH tends to spike after rainfall, due to higher spring discharge.

• Rainfall is another independent parameter of water quality. Rainfall in surrounding areas can dilute a waterway or cause a spike in contaminant concentrations due to runoff, as exhibited at several of the sites over the study period.

Conclusions

• Water pollutants differ by land use, precipitation events, watersheds, etc., with springs being the main input from sources outside the main runoff area of Jennings Creek.

• Agricultural areas tend to have higher heavy metal concentrations and higher BOD. Industrial and residential areas have more sanitary contaminants. Both types of contaminants are present in Jennings Creek, due to a diversity of land use.

• Dilution of waterways can cause some areas to seem less contaminated than reality, so water volume is important.

• Spring inputs can make it difficult to find the original source of a pollutant, since basins are often unknown, but this study indicates the importance of understanding springsheds in urban karst areas.

• One of the major issues with Jennings Creek water quality is E. coli contamination, especially from residential septic leaks and unregulated farm practices within the springsheds.

• Higher-resolution data collection is needed to better assess how storms influence the water quality.

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