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GEOG 591

4/30/2021

Final Project Report

**Title:** Urban Infrastructure Impact on Nitrogen Pollution

**Individual Contribution Description:** Kriddie

**Problem Statement:**

The USEPA identifies nitrogen pollution as one of America’s most widespread and challenging environmental problems (USEPA 2002). Nitrogen is a major pollutant to surface waters in part due to surface runoff and other inputs from urban areas. However, the relationship between nitrogen loading and specific elements of the urban landscape is not well defined. Ellerbe Creek is a local, highly urbanized river network that flows through downtown Durham and empties into Falls Lake, a major source of drinking water for Durham and Raleigh residents. This river is listed as impaired by the EPA and as such, the City of Durham is obligated to reduce the nitrogen load carried by the river to Falls Lake. In this rapidly developing area, the need for science-based policy regarding development’s impact on water quality is immediate. In this project, I will examine the relationship between urban infrastructure and water quality by asking the question, *how does urban land use and infrastructure in a watershed influence nitrogen pollution in rivers*?

I will perform spatial analysis of Ellerbe Creek Watershed that can be paired with water quality data that will be collected in late April or early May. The purpose of the data set is to provide stakeholders with a survey of nitrogen pollution sources within impacted Ellerbe Creek watershed. Spatial analysis preformed for this project will inform selection of sampling sites by identifying locations that represent the range of land use patterns found within the watershed.

**Related Literature:**

Urban runoff is a leading sources of water quality degradation in surface waters of the United States (USEPA 2002). Urbanization causes a suite of changes to the hydrology, chemistry, and biology of the receiving river system. Conversion of watershed land to impervious surfaces and expansion of stormwater infrastructure drives increases in nutrient loading, hydrograph flashiness, and total suspended solids (Walsh et al., 2005). Nutrient pollution, particularly in the form of inorganic nitrogen, has degraded freshwater and estuary ecosystems by stimulating algae blooms that lead to anoxic zones and fish kills. Excess nitrogen may reach toxic levels, stressing aquatic organisms and decreasing the quality of drinking water. As a result, nitrogen pollution has a significant impact, directly and indirectly, to human health and the economy (Bernhardt et al., 2008; Camargo & Alonso 2006).

In urban settings, excess nitrogen enters the environment through human activities including the addition of lawn fertilizers, automobile emissions, and mismanagement of wastewater. (Carpenter et al., 1998). Studies have found population density and urbanization to be drivers of nitrogen loading (Hatt et al., 2004; Peierls et al., 1991; Cole et al., 1993) and cities to be hotspots of nitrogen pollution (Zhang et al., 2015). However, clear connection between nitrogen loading and land-use does not always bare out in research (Novotny & Olem 1994; Hatt et al. 2005; Brezonik & Stadelmann 2002). Connection between specific land-use variables and nitrogen loading is needed to inform city planners and water resources managers as they strike a balance between development and water quality.

Studies have identified various urban landscape features that may drive nitrogen loading. Nitrogen loading has been associated with increased connectivity between runoff and rivers due to stormwater infrastructure and roadways (Wollheim et al., 2005). Roads themselves have been cited as sources of nitrogen pollution (Hatt et al., 2002). Studies have also observed septic systems to have a strong relationship with nitrogen concentrations (Hatt et al. 2005; Bernhardt et al., 2008). On the flip side, riparian greenways and constructed wetlands have been found to reduce nitrogen loading (Batbayar et al. 2019; Vymazal 2011).

**Data Collection**

*Elevation Data:* Elevation data was needed to delineated watersheds boundaries. Elevation data was obtained from, The National Map, a program run by USGS. It provides "Topographic Information for the Nation," which included Digital Elevation Models collected using Lidar. We downloaded elevation data at a resolution of 1/3 arc second for Durham County, NC.

*Sewers:* Durham GIS & Stormwater Division maintains records of construction project boundaries, impervious areas, sanitary sewer system and stormwater system. Some of these shapefiles were available through the OpenDurham website, a online portal maintained by Durham County that provides open access data to the public. Other shapefiles were obtained by request through Durham County GIS and Stormwater Division.

*Land Cover/Land use:* The National Land Cover Database (NLCD) provides nationwide land cover data. Data is derived from Landsat data, which is collected at 30-meter resolution. Data set was produced every 2 to 3 years from 2001 to 2016. It was created by Multi-Resolution Land Characteristics (MRLC) Consortium, a partnership of Federal agencies led by the U.S. Geological Survey. We downloaded a raster layer developed in 2016.

**Methodology**

**Programming design**

**Results discussion**

**Project evaluation, future extension/improvement possibilities**