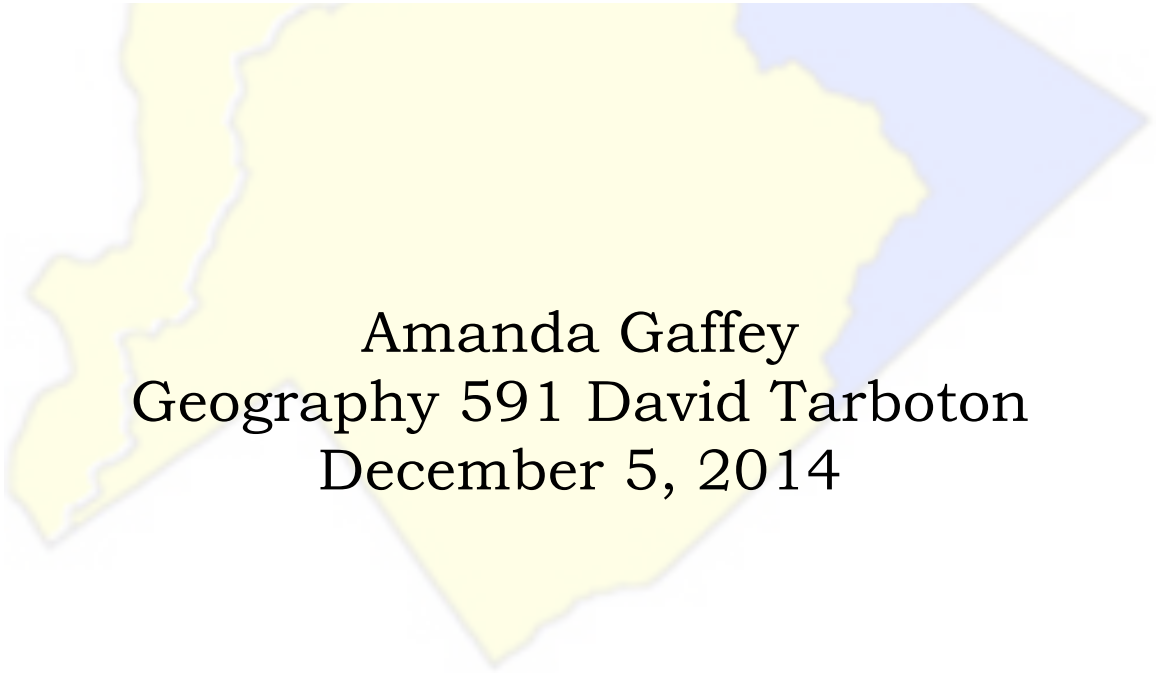
Charlotte, NC: Growth and the Impact on Water Resources



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Introduction

The two main watersheds that flow through the Charlotte Mecklenburg area are the Catawba and Yadkin- Pee Dee River Basins (**Figure 1**).

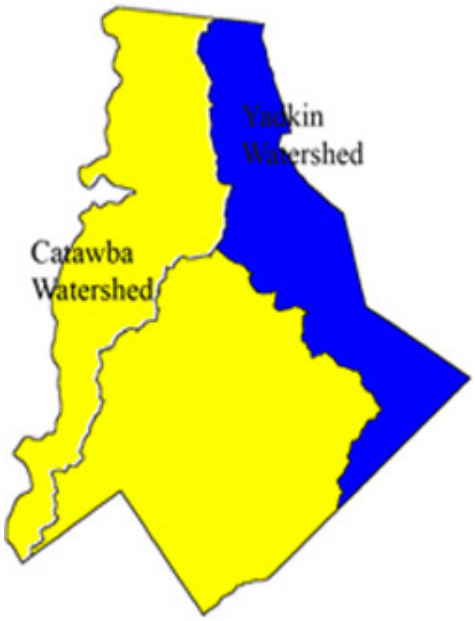

Figure 1: Catawba and Yadkin- PeeDee Watersheds (http://charmeck.org/stormwater/whatsmywatershed/pages/riverwatersheds.aspx).

The Catawba River begins in McDowell County, by the eastern side of the Blue Ridge Mountains, flowing east before turning south to flow into Lake While on the border of North and South Carolina. The Catawba contains the most major dams of any North Carolina River, and the majority of the 224-mile river is comprised of man-made lakes that provide recreation, drinking water, and electricity for the expanding Piedmont area including Charlotte (NC Office of Environmental Education, 2011). The basin also serves as a home to some species found nowhere else, like the Grandfather Mountain Crayfish and other federally endangered species such as the heelsplitter freshwater muscle. The muscle is sensitive to changes in

water quality, making sediment pollution and changes in nutrient levels a major concern and contributor to the mussel's decline (NC Office of Environmental Education, 2011).

Today, the Catawba is the most densely populated river basin in North Carolina, with more than two million people. Charlotte accounts for nearly half of the basin's population with over 730,000 people (NC Office of Environmental Education, 2011). Several areas within the basin show signs of stress from excessive amount of nutrients and other contaminants in storm water runoff, and many are classified as impaired waters (NC Office of Environmental Education, 2011). The national conservation of American Rivers ranked the Catawba River as the most endangered river in America in 2008.

The Yadkin-Pee Dee basin begins near Blowing Rock as the Yadkin River flowing east and then turn south to cut through the dense middle section of North Carolina. It fans through the seven man made reservoirs before changing it's name to the Pee Dee river, which then travels down and exits North Carolina in the area of McFarlan after bisecting the state (NC Office of Environmental Education, 2011). The basin contains a wide variety of habitat types with many rare plants and endangered animals including the shortnose sturgeon, Carolina heelsplitter, and five new mollusk species.

The lower basin of this watershed touches the Charlotte-Mecklenburg metropolitan area. Population growth in addition to the alteration if not total removal of natural areas harms surrounding waters with pollution runoff or drainage (NC Office of Environmental Education, 2011). The heelsplitter muscle has

survived for millions of years, but one of its last refuges runs through the quickly urbanizing area just east of Charlotte. The growth of this metropolitan area could eventually create a solid urban area stripe stretching all the way to Raleigh, having a major influence of the watershed and it's inhabitants (NC Office of Environmental Education, 2011).

Both of these watersheds need attention to ensure their quality and health remains high even with urban growth. The presence of federally listed species means the state must develop and implement site-specific strategies to maintain and improve water quality conditions needed to protect these species. However, the effectiveness or enforcement of these standards can be called in to question with a lack of funding. Therefore, understanding how much of an influence the growing population and urban footprint of the Charlotte area is truly having on these watersheds proves vitally important.

Objective Summary

Urban growth and development can have a major impact on natural systems, especially water systems. In North Carolina, the Charlotte area has been one of great prosperity and expansion over time since the late 1990's. As a result of the growing population and development however, equal amounts of stress have been added to the areas water sources in terms of both sheer water amounts as well as quality. This project will examine Charlotte, NC- specifically centered on Mecklenburg County - to see how its urbanization and growth has altered the main drinking water systems since 2000. Specifically, it will explore how the increased population, pollution like turbidity or nutrients, and increasing the amount of impervious

surfaces have changed the demand and stress put on the community's main water sources.

Methods

The focus of this project was to observe and analyze how growing population and urbanization have altered major water sources for the Charlotte region. To provide a realistic scope, I concentrated on three main topics specifically: overall pollution level changes, population changes and increases in impervious surfaces.

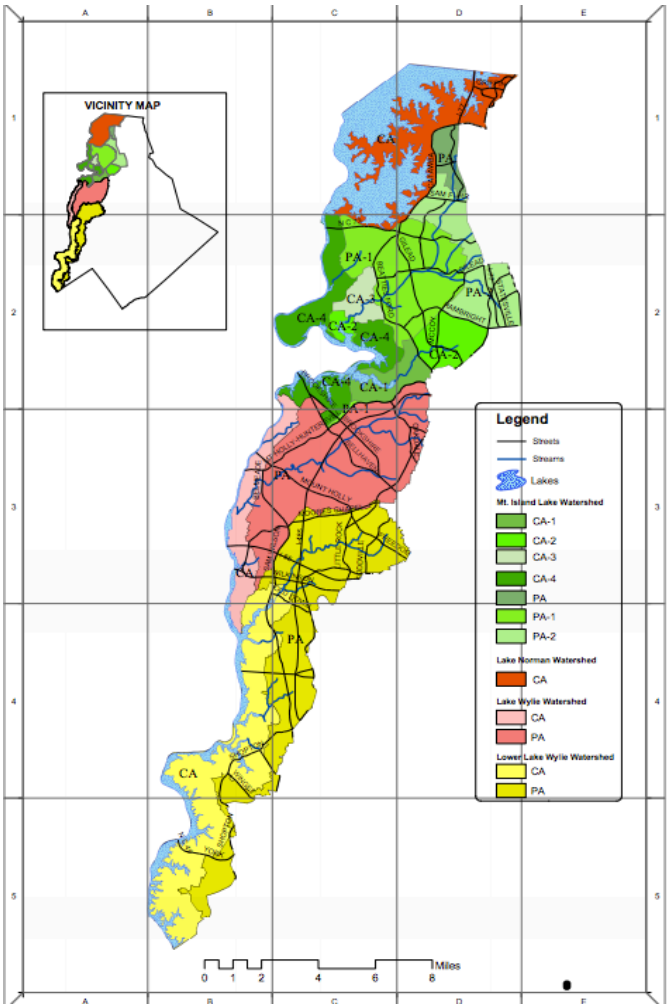

Figure 2: Watershed protection overlay districts for drinking including Mountain Island Lake, Lake Norman, Lake Whylie, and Lower Lake Whylie Watershed.

Pollution levels are often measured or quantified when dealing with drinking water, as communities are highly concerned with the quality of the water they consume. The drinking water sheds in this area are made up in large part by the lakes region (See Figure 2). To start my analysis I accessed the NC OneMap data on overall watersheds in North Carolina as well as the Drinking Watersheds data for the state. After looking at each individually and zooming into the two main focus watersheds for this study, I clipped the layers to only show the area where these two datasets intersected. This gave me a clear picture of the watershed area most essential for drinking water quality cleanliness according to this data source (See Figure 3).

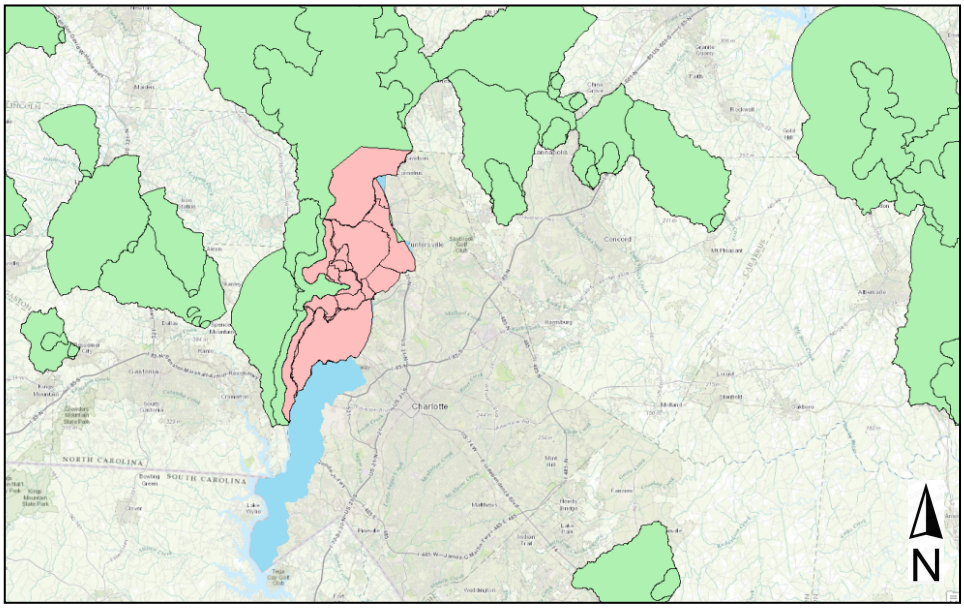

Figure 3: The intersection of NC OneMaps watershed layer (green) with the drinking watershed layer (blue). The new focus area is shown in pink.

With this area clipped out within the Catawba watershed, I added on a nutrient and pollution data set layer obtained from the Charlotte-Mecklenburg Storm Water Services to see what impact data had already been quantified. There

were three sites that fell within the target drinking water area as well as seven others in the Catawba/ Yadkin watershed region (See Figure 4).

The three main points were located on McDowell Creek at Sam Fur Road (MC2: 35.4431, -80.8771), Beatties Ford Road (MC4: 35.3896, -80.9210), and Gar Creek (MC50: 35.3614, -80.8977). The points outside the drinking water area were located at W. Br. Rocky River, Clarke's Creek, Clear Creek, Irvins Creek, Goose Creek, Duck Creek, and Fourmile Creek, which are all within Mecklenburg County. Plotting two points on McDowell creek, which fall within different areas, was noted for comparison as it could offer interesting insights into the levels of development or areas where more stress is occurring and continuing to flow through the system. The Charlotte water data at each of these sites was collected monthly going back as far as 2000 until present, and remains publically available through the county if requested.

With all site points plotted, I analyzed the data at these specific sites to see how they changed over time. In particular, I was interested in whether nutrient or sediment levels have increased, decreased, or remained constant over time, as these are two markers that are often impacted by the land development. I also looked for any patterns related to increase around certain time periods that could match up with high population growth in the area. I chose to look specifically at turbidity and total phosphorus levels at the three main sites within the drinking watershed layer. While the MC2 data was only available from 2005 forward for each month, both MC4 and MC50 contained monthly data from 2000 to present. In further research, the other sites denoted in red could be further explored for patterns as well.

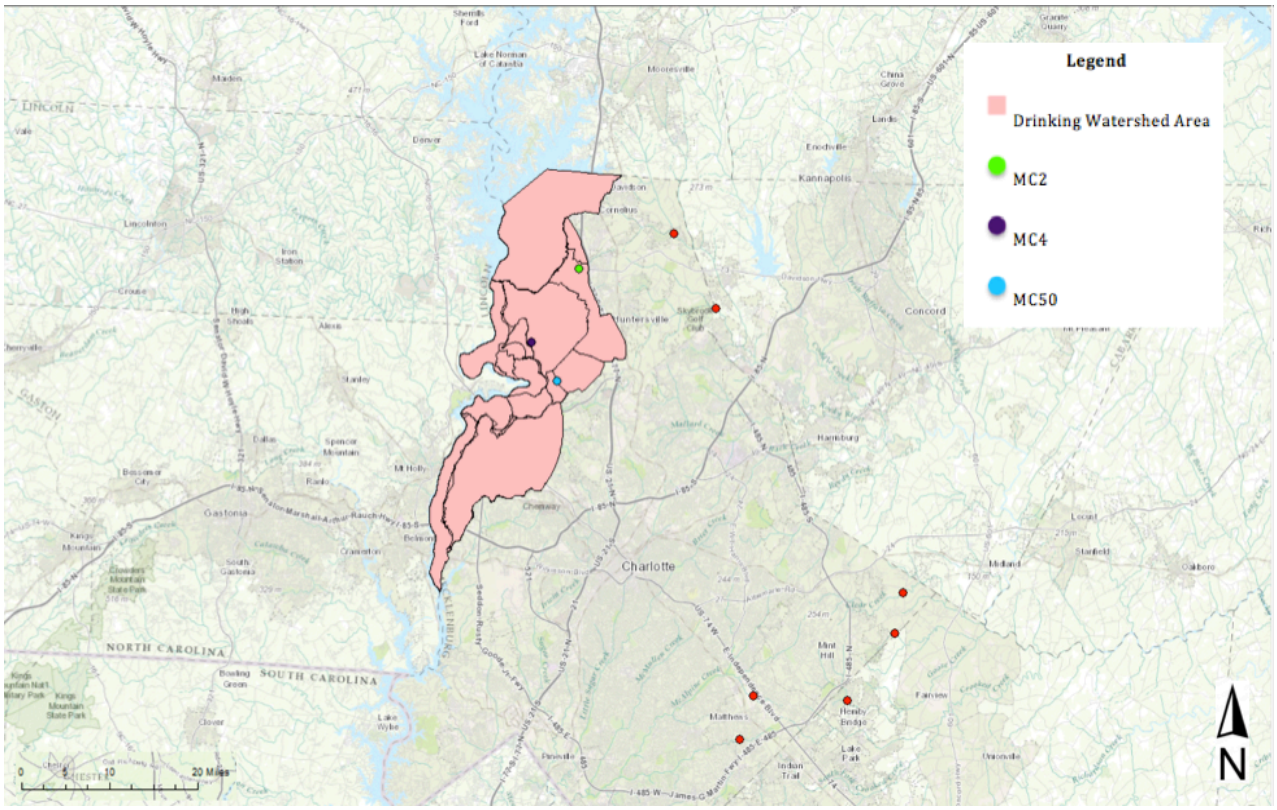

Figure 4: The drinking water intersection area with the Charlotte Mecklenburg pollution area recording points.

Having plotted and prepared the map to look at the changes in pollution levels over time, I moved on to look at population change over time. Using ArcGIS online with ESRI layers I noted the growth in population as well as the average percent growth at three different levels: state, county, and site specific areas within the county. Looking at North Carolina counties in general, and then more specifically within areas of Mecklenburg County since 2000, gave me an overall picture as well as more specific look at population to make sure no assumption were taken for granted without observation.

With the first two focus topics of pollution and population mapped out, I turned to the final factor of impermeable surfaces. I projected this by using a Multi-Resolution Land Characteristic Consortium (MRLC) layer of the National Land Cover Dataset (NLCD) showing commercial change in impervious surface from 2006-2011.

Adding this layer over the same basemap and pollution points allowed me to look at the change in general across the focus county as well as zooming in to compare the pollution data collection sites to check for possible causation.

Analysis and Conclusions

Overall, the results of this project support the concept that urbanization and development often has a negative effect on water sources. Looking at each factor independently and then considering all of them interacting together, it is clear the growth of the Charlotte area has influenced changes within the watersheds that should be tracked and appropriately regulated to ensure the long-term health of these systems.

In analyzing the population map, looking at the values for population change over various years, I was able to see quantitative evidence of the growth of population in Mecklenburg county, beyond just the impression I had that this was occurring based on living there (See Figure 5 and 6). Looking at North Carolina as a whole in Figure 6, it was clear Mecklenburg county has been one of the more quickly growing counties in the state indicating by the darker green color. The current population of the area 974,119, and is estimated to be 1,067,913 by 2019 (ESRI ArcGIS Online). The estimated annual rate of change for Mecklenburg county from now until 2019 is 1.9%, which is a decrease from the 2000-2010 rate of 2.8 but an increase from the 2010-2014 rate of 1.4% (ESRI ArcGIS Online: See Figure 6). This high population growth rate between 2000-2010 also correlates with some of the highest pollution spikes from the city data concerning turbidity and total phosphorus during the same time span to be discussed later.

Also, while the population may not be increasing as rapidly as it was in the early 2000's, this could be misleading, as more people are already present and limited space remains available for large-scale development in these areas. There are some areas of the county that are still growing rapidly while others are stagnant or growing at a slower rate, which makes the overall rate an average of all of these. If this growth is still occurring at key water inflow areas, the impact could be equally if not more impactful, which led to the need to analyze surface development, especially with impervious surfaces. Focusing specifically in the growth around the three main focus sites, growth remains in the light to middle shade blue areas, showing population growth has at least an influence on the area.

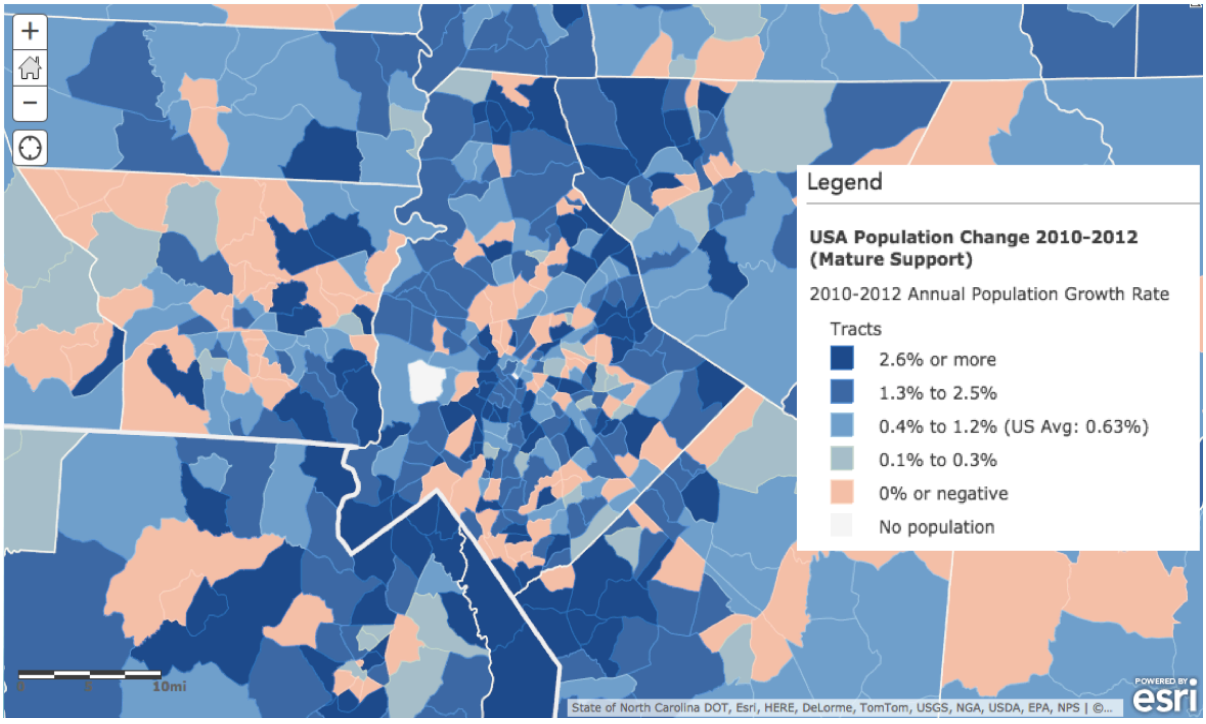

Figure 5: Population Change Map for Mecklenburg County. ArcGIS Online.

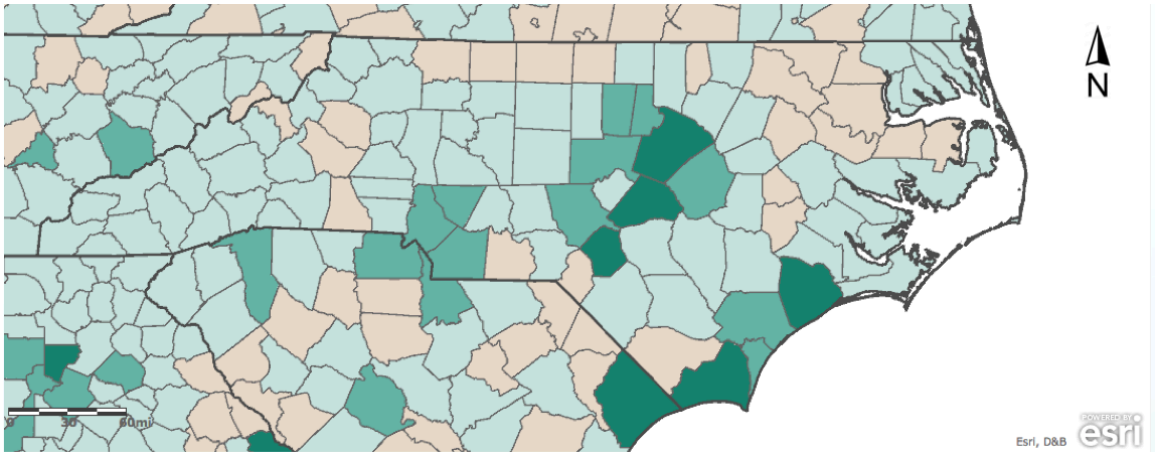

Figure 6: Population Change Map for North Carolina. ArcGIS Online.

The next step in analysis involved interpreting the impervious surface cover. I again looked at the overall county change and then moved to the area specifically around the water quality data collection sites from the county. I had hypothesized the increase in population would lead to a visible change in impervious surface which could also increase pollution or lead to the degradation of the watersheds being studied. Looking at the overall picture of North Carolina development changes proved to be unhelpful for reference or scale, so I only looked more closely at the county and around the pollution data collection sites.

The county overall showed the majority of impervious surface change around center city with change dwindling off toward the boundaries of the area, which was logical and more or less expected. Two of the most densely surrounded data points, meaning they showed significant change, were MC2 and another stream in the southeast part of Mecklenburg County. The highest amount of impervious surface change of the three main target sites within the drinking water area was in MC2, which was interesting as it was the most northern point in the watershed. Figure 7 shows a visual of the impervious land cover change in grey on the map, with the data points highlighted in green, blue, purple or red (See Figure 7).

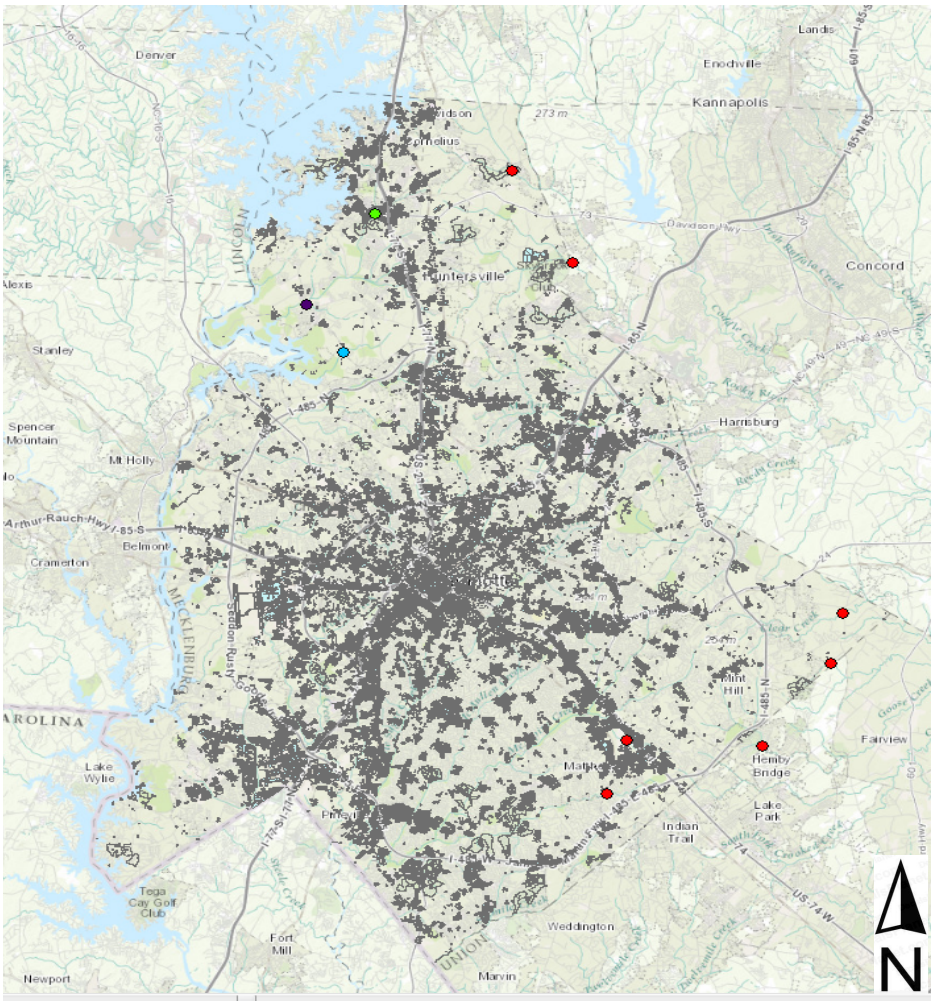

Figure 7: Change in commercial impervious surfaces in Mecklenburg County, NC.

The final part of my analysis focused even more specifically within Mecklenburg County to the three target sites within the drinking watershed to analyze the pollution data. Looking at the plots, there were some visible patterns and effects between the three areas. In plotting excel graphs of both the turbidity and total phosphorus data for the three locations, some clear increases and spikes have occurred since 2000. While the MC2 doesn't have as much comprehensive data as the other two sites, some similar patterns and spikes can be seen even in the more limited data.

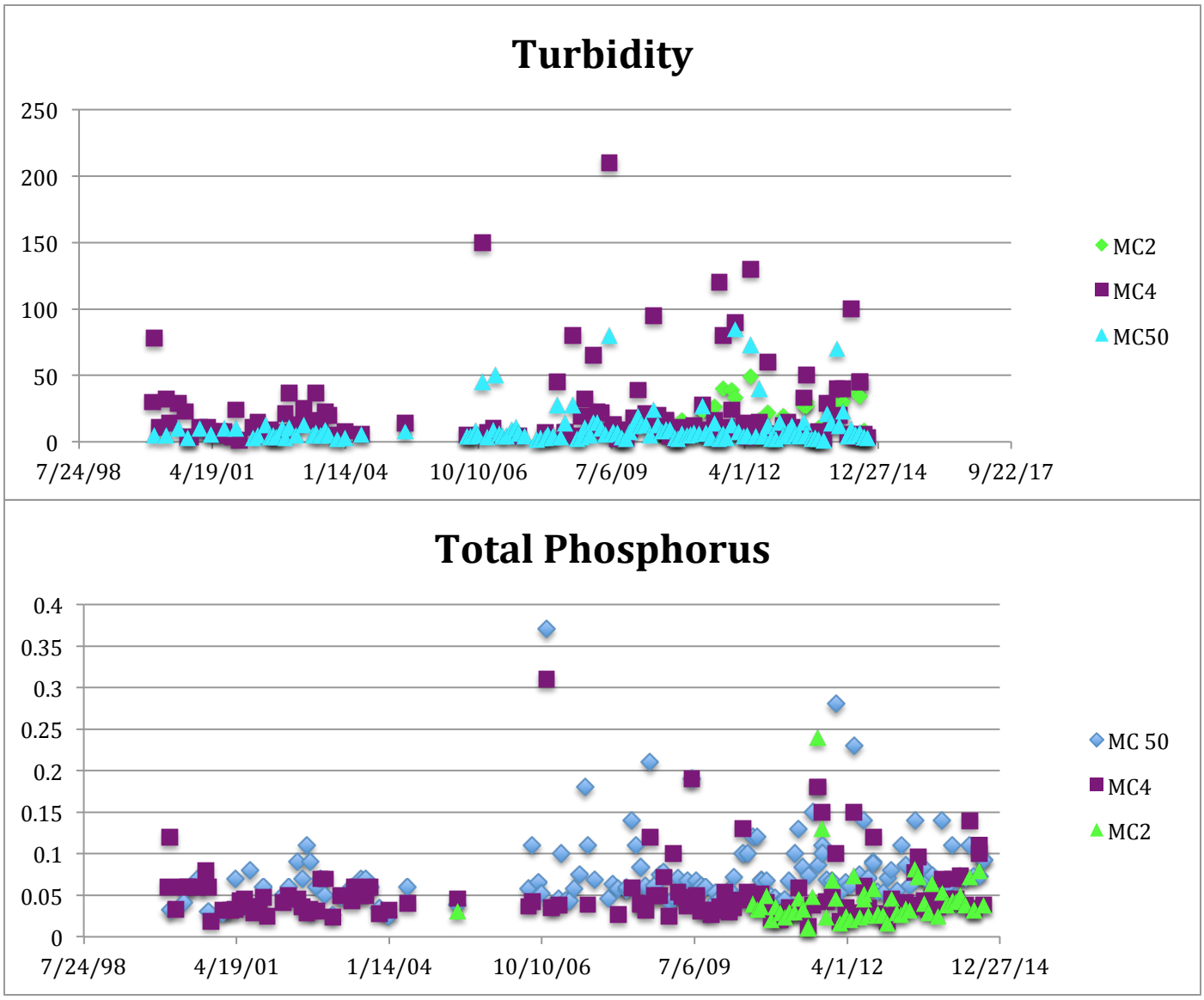

Figure 8: Excel charts showing the Turbidity and Total Phosphorus in three of the monitoring sites from Charlotte Mecklenburg Stormwater. (Data Charlotte Meck: http://charmeck.org/stormwater)

Increased turbidity could be caused by construction in the area, high rainfall and runoff in a certain month, or possibly an increase in soil erosion around the area. The total phosphorus level shows a more steady increase, which could be due to fertilizer or other nutrient runoff from high amounts of developed or treated areas (See Figure 8). However, it should also be noted these monthly or yearly spikes and variations could also be due to weather events, wet or dry years, or other environmental factors. Further research could explore these peaks for more specific

details. While growth and development in the area is a piece of the puzzle, plenty of other factors could be attributed to some of the change.

The development around MC2 on this map, which corresponds well with the 2005-2014 pollution city data, could explain some of the turbidity and phosphorus increase and again gives proof of the growth in the area. According to a report from the Environment North Carolina Research and Policy Center, in the last 20 years, Charlotte lost 25% of cropland and forested area and added 321,000 acres od developed land, increasing the amount of water directly flowing into these watersheds without flowing through other systems first (Environment North Carolina Research & Policy Center, 2007).

Comparing the population change data and impervious surface change data wasn't as beneficial, as the time span differences between the two maps is enough to make the data incompatible for that direct purpose. However, both do indicate the highest area of growth was in the early 2000s, and a decrease was seen from 2000 to present. However, an increase is projected to start again in the coming years, especially if the surrounding Charlotte Metro area is considered.

Overall, the analysis from this project led to the conclusion that urbanization has increased the amount of stress on the Yadkin and Catawba watersheds. Pollution, population increase, and further development of impervious surface could all be components of this increased stress. There are several additional factors that could be studied to further quantify this change, however the need for maintenance, data collection and enforcement of construction and nutrient restrictions remains vital.

Sources

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Data

ESRI ArcGIS Online

NC OneMap

MRLC layer of the National Land Cover Dataset

Charlotte Mecklenburg Storm Data—Charlotte Storm water Services