Water Quality

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NRS 509

I am getting my Masters degree in Civil and Environmental Engineering and doing research on the effects of climate change on water resources and public health. My advisor and I are particularly interested in the effects of these things in coastal Megacities (+10 million people) such as Dhaka, Bangladesh; Jakarta, Indonesia; Lagos, Nigeria; and others. Unplanned urban growth is one of the main problems in these megacities because it means that people are living in slums that are not connected to the city’s water and wastewater infrastructure systems. Without the proper water and wastewater systems people become vulnerable to waterborne and vector borne diseases such as cholera, dengue fever, and malaria to name a few. Most of the people in this field are public health professionals, but we are trying to bring an engineering perspective to these health problems. Health professionals are focused on vaccination as the solution to these diseases, however, it’s impossible to vaccinate everyone in these areas because there are just too many people. In addition, these vaccines have a very limited effective life, usually between 2-5 years, which means once you get through vaccinating everyone in one country you have to start all over again in the same place. Another thing to consider is that there are only a limited number of vaccines produced every year and therefore only a limited number of people who can be helped, and with disease burdens as high as they are, it’s not an efficient way to solve this global issue.

One way that GIS is a useful tool for us is that it allows us to show the spatial relationship between water quality and Land Cover and Land Use (LCLU). In almost all of the cases I investigated water quality data came from government agencies such as the EPA and Department of Natural Resources. Remote sensing was crucial in obtaining LCLU data. Aerial photography, Landsat TM and Landsat TM+ were used in every case I looked at. Remote sensing is also a great way for us to obtain data on precipitation and temperature so that we can see how the global climate is changing. These changes are important because there are correlations between floods, droughts, water quality, and health. GIS tools for interpolating such as kriging and Inverse Distance Weighting were very important for filling in the gaps between sample points.

The case study by Borges et al. 2014 on the Cunha Canal in Rio de Janeiro, Brazil was a perfect example of how all of these things tie in. As shown in their graphics, the area is dotted with slums, industrial facilities, and mines. An urban planning committee in the city had a waste water treatment plant (WWTP) installed in one of the slums so that the residents would no longer dispose of their sewage in the canal. They then used GIS to map remote sensing data and show how the levels of several contaminants changed before and after the WWTP was implemented. If the water quality in these areas is that bad, then the health conditions are probably equally dismal. Not to mention the effect this is having on the environment. Graphics like these are great because we can show them to public health professionals and say, hey look at this, the WWTP made a difference but installing one wasn’t enough to fix the problem. We need to invest in this kind of infrastructure not only for the sake of the people who live in these slums, but also for the environment.
In conclusion, I think that GIS and remote sensing have a strong future in the climate change, water resources, and public health sectors. GIS can help us show the rest of the world why our approach is important by producing graphics, and showing correlations between water quality and LCLU in a way that is simple yet effective and easy to understand. Remote sensing is equally important because that is where the majority of our data is coming from. Precipitation, temperature, and LCLU data are crucial in making the GIS graphics. In addition, remote sensing allows us to collect and access data from all over the world without having to travel there or know someone who is stationed there and can collect data for us. As a student, that makes my research much faster and easier!

Annotated Bibliography


   In this paper Adhikary et al describe how GIS can be used to monitor groundwater quality, and in turn how that information is useful for planning sustainable use and for irrigation. The study took place in Delhi, India and identified areas where groundwater could be recharged and where it was vulnerable to contamination. Interestingly enough, ground water in India is naturally of poor quality because of a shallow depth saline aquifer. They used this information to map out the groundwater quality parameters, using kriging to estimate the area between sampling points. This work is particularly important because farming is the livelihood for many people living in rural areas, and the contamination can be harmful to crops. Overall, I felt like this was a great example of how GIS can be used in water resources and particularly in areas with sustainability and contamination issues.


   I found this paper particularly interesting because it was about the region that I am from- the Lower Eastern Shore of Maryland. The goal of Aighewi et al.’s study was to link Land Cover/Land Use with contamination of the watersheds. Somewhat surprisingly to me, they found that there was an increase in urban areas and a decrease in agricultural land (the area is very rural - corn, soybean, and chicken farming are the main industries), and despite that, there was a decrease in water contamination. It seems that the runoff from impervious urban areas was less harmful than the runoff from fertilized agricultural land (chicken manure is a major fertilizer). They used aerial photography in conjunction with Landsat TM data to determine land use and gathered water quality data from the Maryland Department of Natural Resources and the EPA.

This paper linked very well with my personal research on water resources and public health in slums. An urban program in this area implemented a Waste Water Treatment Plant (WWTP) to reduce pollutants and waste in one of the slums along the Cunha Canal in Rio de Janeiro, Brazil. They showed the levels of several contaminants before and after the WWTP was built and used GIS to map those areas to give an idea of how the contaminants spread out from the slum. The group used Inverse Distance Weighted to interpolate between their sample points. Papers like this are very important because they can be used with public health officials to show the value of investing in infrastructure and not just vaccines.


This article on Land Cover and Land Use was unique because it did the opposite of what most articles on the subject do. Instead of being about the urbanization of a forest/lake area, it was the conservation of the area. Lake Issaqueena near Clemson South Carolina was once surrounded by farms, but because it was over used the soil degraded and people began to change the way they used the land. It became pastures for animals, and then mostly forest cover due to conservation policies. Many of the characteristics of the pond changed, for example temperature because of increased shade and lower levels of contaminants from less runoff. The authors explained that it is important to have studies on reverse urbanization as well as urbanization.


This article was different from the others I read because it dealt with water quality but not the correlation with LCLU. Instead, Srinivasan and Arnold investigated ways to model water quality in the upper part of the Seco Creek watershed in Texas using the GIS tool Geographic Resources Analysis Support System (GRASS). They found that their model was very effective, and that the simulated values were very close to the measured values. They also pointed out that GIS made the modeling process faster and simpler. This case study is a great example of how technology has made projects like this less time consuming and more effective!


In this article Tong and Chen used GIS to combine large databases in order to identify spatial trends and relationships. They combined hydrologic data from HUC and LU data from Landsat TM with an assessment tool called Better Assessment Science Integrating Point and Nonpoint Sources (BASINS). They mapped areas with high contamination levels and did a spatial analysis to look for relationships with LCLU. As expected there was a significant correlation between the
water quality in watersheds and LCLU. What was interesting about this study was the fact that they were taking existing databases and just merging them together and not going out and getting new data. It just goes to show what you can do with the amount of information we already have at our disposal.