GIS Management Tools For Estimating Water Quality Changes

Background

Multiple temporal and spatial changes due to urbanization and agricultural changes, but also can be used to help quantify the impacts of these changes on water quality. However, complex interactions between terrestrial and aquatic systems pose challenges to coastal zone managers who need to understand the relationships between land cover and water quality. The National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center developed two geographic information systems (GIS) tools that allow managers to explore these relationships. The Impervious Surface Analysis Tool (ISAT) calculates the percentage of an area covered by impervious surfaces using land cover and population density information. The Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT) estimates pollution and erosion within an analysis using land cover, soils, topography, and precipitation data.

Impervious surface area impacts water quality by preventing infiltration, and increasing runoff and transport rate into surface water bodies. The Center for Watershed Protection described the relationship between impervious cover and stream quality (Figure 1). Low impervious surface cover (<15%) is associated with waters that can support aquatic life but remains sensitive to degradation. As impervious surface cover increases, aquatic life is impacted and, at high percentages of impervious surface cover (>45%), aquatic life is no longer supported. ISAT, which calculates impervious surface cover, adapted this model as a way to interpret the data. Nonpoint source pollution occurs when runoff carries pollutants from land into local waters. The amount of pollution that can be related to the land cover from which the runoff occurred. For instance, grassland or upland forests may have much higher nutrient concentrations due to fertilizer use. N-SPECT calculates and sources from land cover, using relationships that can be customized. N-SPECT calculates the total amount of pollution coming from an area and tracks the pollution at a smaller delineations.

This study used Coastal Change Analysis Program (C-CAP) land cover data from 1990 and 1995 to estimate water quality change in Horry County, South Carolina (Figure 2). The same two land cover data sets were used in ISAT and N-SPECT to create current land cover and associated land classification systems, employed by C-CAP enables the type of multi-temporal analysis.

Conclusions

By using multi-temporal data and two GIS-based tools, we were able to examine the impacts of land cover change on water quality through time. ISAT provides a general understanding of the impacts of change on water quality. N-SPECT quantifies precise impervious areas within defined areas, which allows managers to develop regional land cover changes. While ISAT provides a more detailed examination of the impacts of change on specific pollution and sediment loads. In addition, this tool also manages to detect specific pollution and sediment source areas. Combined, these two terrestrial landscape attributes that are related to water quality in both space and time.

For More Information:
- C-CAP: www.noaa.gov/csc/cwq/isat.html
- ISAT: www.csc.noaa.gov/crs/isat.html
- N-SPECT: www.csc.noaa.gov/crs/nspect.html