Satellite Remote Sensing of Chlorophyll *a* in Support of Nutrient Management in the Neuse and Tar-Pamlico River Estuaries

Darryl J. Keith

The North Carolina Environmental Management Commission (EMC) has adopted as a water quality standard that chlorophyll *a* concentration should not exceed 40 ug/L in sounds, estuaries and other slow-moving waters. Exceedances require regulators to develop a Total Maximum Daily Limit (TMDL) for nutrients in that water body. For the Neuse River, in 1996, load reductions were placed into North Carolina law to reduce the extent and duration of algal blooms (Session Law 1995, Section 572). In Phase II, the chlorophyll *a* criterion was used as the endpoint to manage total nitrogen concentrations, and TMDL compliance would be achieved if Chl *a* exceedances occurred in fewer than 10% of the samples collected in a specified area and time. For the Tar-Pamlico River, in 1989, Phase I consisted of the development of a nutrient trading framework, the development of an empirical model to estimate loading to the estuary and an evaluation of existing water treatment plants. Phase II consisted of refining model loading calculations and wetlands restoration.

The application of remote sensing techniques to water quality assessment in the Neuse River estuary and Pamlico Sound began in the mid-1980s with the objective of using satellite or aircraft data to assist government agencies establish and monitor water quality (e.g., for TMDLs), enforcing water quality-related environmental regulations, and understanding the environmental impacts of the land-use practices in coastal waters. Remote sensing techniques have yet to be applied to the Tar-Pamlico estuary. It was agreed, during an October 2009 workshop, held to discuss incorporating satellite Chl *a* concentration into the NC decision process, that the high temporal and spatial resolution of the MERIS chl *a* product could be beneficial to the State of NC during any future development of water quality regulations based on “phytoplankton density”, to support retrospective analysis for the potential development of new nutrient regulations or revisions of the current TMDL, and to site future in-situ monitoring locations and detect unknown bloom events.

In this study, MERIS chlorophyll *a* data from 2006 – 2009 is used to conduct a retrospective analysis of the NC standard for water quality and TMDL for total nitrogen in the Neuse and Tar-Pamlico River estuaries. The study seeks to answer the following: 1) what is the relationship between chlorophyll and total nitrogen in east coast estuaries and the Neuse River estuary in particular?; 2) can the amount of estuarine acres impaired by chlorophyll be determined using MERIS derived data?; 3) can TMDL compliance and chlorophyll exceedances in the Neuse and Tar-Pamlico River estuaries be assessed at daily and annual time scales from MERIS imagery?; and 4) which summary statistic of chlorophyll *a* concentrations (sample mean, median, and 90^{th} percentile values) is the most useful for determining TMDL violations and to support environmental compliance monitoring?