FerryMon: Unattended water quality monitoring utilizing advanced environmental sensing on the Pamlico Sound System, North Carolina

P.I.: Hans W. Paerl, University of North Carolina at Chapel Hill, Institute of Marine Sciences, Morehead City, NC

Estuaries are among the most productive and resourceful aquatic ecosystems on Earth. They are critical nurseries for coastal and offshore fisheries and provide a broad range of economic (urban, industrial, agricultural, tourism, fisheries) and societal (recreational, aesthetic) benefits and services. Estuaries receive and process the bulk of freshwater discharges, nutrients and pollutants. Estuaries are also strongly influenced by climatic and hydrologic stressors, including droughts, storms and floods. Clarifying how estuaries respond to these stresses is of importance for understanding processes and mechanisms controlling geochemical and biotic structure, function, and condition of these ecosystems. This understanding can greatly benefit from a spatially and temporally-intensive observational program, which, when coupled to modeling, will help predict future responses to external anthropogenic and climatic (hydrologic) perturbations. North Carolina's Pamlico Sound System (PSS) is the Nation's second largest estuary, and its largest lagoonal ecosystem. It exemplifies the impacts of large climatic perturbations and human development, including nutrient over-enrichment, eutrophication, algal blooms and hypoxia. In combination with an established Modeling and Monitoring Program (ModMon; www.unc.edu/ims/neuse/modmon/), a fleet of North Carolina DOT Ferries serves as a test bed for unattended monitoring of water quality, habitat and ecological condition of the PSS. FerryMon (www.ferrymon.org), deploys multi-parameter (temperature, salinity, pH, dissolved oxygen, turbidity, chlorophyll *a* fluorescence) sensors coupled to discrete sampling of nutrients, organics, diagnostic photopigments and molecular indicators, to assess water quality in a near real-time manner. This test-bed project will enhance FerryMon's ability to detect and quantify algal groups that dominate primary production and bloom dynamics. In-line spectral fluorometers (Algae Online Analyzers (AOAs)) will be installed on a ferry crossing the PSS and a ferry that crosses the PSS's largest sub-estuary, the Neuse River Estuary. An autonomous vertical profiler (AVP), equipped with sensors similar to those on the ferries, will be deployed in the Pamlico Sound providing a vertical dimension to the water quality data being collected by FerryMon. The AOA will provide early, rapid detection and quantification of a key indicator of water quality, algal blooms. It will enhance spatial characterization of trends in water quality and habitat conditions over the entire range of relevant physical, chemical and biological time scales (minutes to months and beyond). This enhanced capability is timely given a protracted period of increased tropical storm and hurricane activity that is impacting estuarine and coastal water quality in unpredictable yet important ways. These improvements will also facilitate calibration, and interpretation of remotely sensed indicators of water quality (e.g., photopigments, turbidity), enabling investigators to "scale up" to the ecosystem-level. Data management, communication and outreach will be upgraded, enabling FerryMon to most effectively and fully integrate with complementary observational programs (Hydrological Observatories, LTERs, NEON, ORION, Coastal GOOS, state, federal and local programs), and to enhance FerryMon's educational and public outreach capabilities. This test bed technology is readily transferable to other estuarine, large lake and coastal ecosystems served by ferries, other "ships of opportunity", moorings and platforms. Improvement in hydrologic and environmental observing platforms will support interdisciplinary studies aimed at identifying, quantifying and distinguishing anthropogenic and climatic drivers of ecological change in large water bodies, which have traditionally been difficult to assess. FerryMon will also train high school, undergraduate/graduate students, technicians and post-doctoral researchers; the next generations of environmental scientists and engineers.