

# CHAPTER 1

## INTRODUCTION

Wetland loss in Louisiana is a well-documented issue with numerous processes cited as responsible. These processes range from natural causes such as sea level rise and geological subsidence, to anthropogenic factors such as dredged canals and associated spoil banks, decline of river-borne suspended sediments, and Mississippi River levee construction (Templet, 1988). In some cases, salt-water intrusion has also been suggested as a possibility (Turner, 1997). Various strategies have been proposed to counteract these processes. Among them is the diversion of Mississippi River flow into degraded wetland areas, impounding areas to prevent salt-water intrusion, and reducing or eliminating anthropogenic hydraulic modifications to the wetland system. Hypothesized benefits of diversions include increased mineral sediment deposition, increased nutrient influx, and decreased salinity and decreased phytotoxins (Templet, 1988).

The wetlands along the southern shore of Lake Maurepas are one example of this stressed regional wetland ecosystem. While the loss is significantly less than coastal wetlands (USGS, 1996), concern exists about the long term health of this ecosystem since these wetlands are susceptible to the previously mentioned processes (Templet, 1988). One proposed remedy for this strained ecosystem is to divert Mississippi River water through an existing canal system to provide a fresh influx of sediments and nutrients to the swamp. This technique has been implemented in other sections of the lower Mississippi, but the benefits are still being studied.

Currently, one lower Mississippi River diversion structure is operational with the express purpose of diverting river water to improve habitat. This diversion is located south of New Orleans at Caernarvon on the eastern side of the Mississippi River. The structure has a maximum flow rate of 8000 ft<sup>3</sup>/sec (227 m<sup>3</sup>/sec) and an outflow channel approximately 1.5 miles (2.4 km) long. Another structure was recently opened at Davis Pond 22 miles (35 km) upstream from New Orleans and is designed to divert up to 10,650 ft<sup>3</sup>/sec (300 m<sup>3</sup>/sec) into Barataria Basin. A third diversion is planned within the Bonne Carre spillway 33 (53 km) miles upstream from New Orleans. The preliminary design calls for a diversion of up to 25,000 ft<sup>3</sup>/sec (708 m<sup>3</sup>/sec) into Lake Ponchartrain, though the final details have yet to be negotiated between the state of Mississippi, the state of Louisiana, and the Corps of Engineers (USACE, 1998).

Impacts from the operational Caernarvon diversion have been favorable. Since it opened in 1991, areas downstream from the Caernarvon structure show an increase in freshwater vegetation, a decrease in saltwater vegetation, and a net increase of 406 acres of marshland (USACE, 1998). The important thing to note is that the purpose of the Caernarvon and Davis Pond structures is to divert water into estuarine wetland ecosystems, whereas the focus of this study is the diversion of river water into Maurepas Swamp, a palustrine wetland ecosystem. Successful diversion into one type of ecosystem (e.g., estuary) does not necessarily imply that such a scheme will be successful for a different type of ecosystem (e.g., swamp).

This investigation of the impacts associated with Mississippi River diverted water into the Maurepas Swamp utilized four models: HEC RAS 3.0, QUAL2E, RMA2, and RMA4. All are established and tested models previously applied to hydrologic and

nutrient investigations. HEC RAS 3.0 and QUAL2E are one-dimensional models that can simulate hydraulics and water quality respectively. RMA2 and RMA4 are two-dimensional models used to simulate hydraulics and material transport.

A sequential process was used to model this system (Fig. 1). First, HEC RAS 3.0 was used to determine the maximum flow rate that may be carried through the existing canal to the swamp without overbank flow or excessive scour. QUAL2E was then applied to determine nutrient consumption, specifically organic nitrogen, based on flow rates determined by HEC RAS 3.0. The flow rate calculated by HEC RAS 3.0 was also used as a flow boundary for the RMA2 simulations of two dimensional flow through a portion of the swamp. The flow field calculated by RMA2 was then used to drive the RMA4 model to simulate nutrient transport through the swamp.

The objectives in this study were the following: (1) to evaluate the utility of the four models described above for investigating the impacts of a river diversion in a wetland system, and (2) to use the four models to evaluate the effects of a Mississippi River diversion in terms of both hydraulics and nitrogen loading, with the former being the key focus area.

To accomplish these objectives, the following tasks were undertaken:

- A. Construct the 1-D geometry for HEC RAS 3.0 utilizing surveyed Hope Canal cross-sections.
- B. Run HEC RAS 3.0 to determine a maximum flow through the canal based on scour and overbank flow.
- C. Construct the 1-D geometry for QUAL2E interpolated from the Hope Canal cross sections.

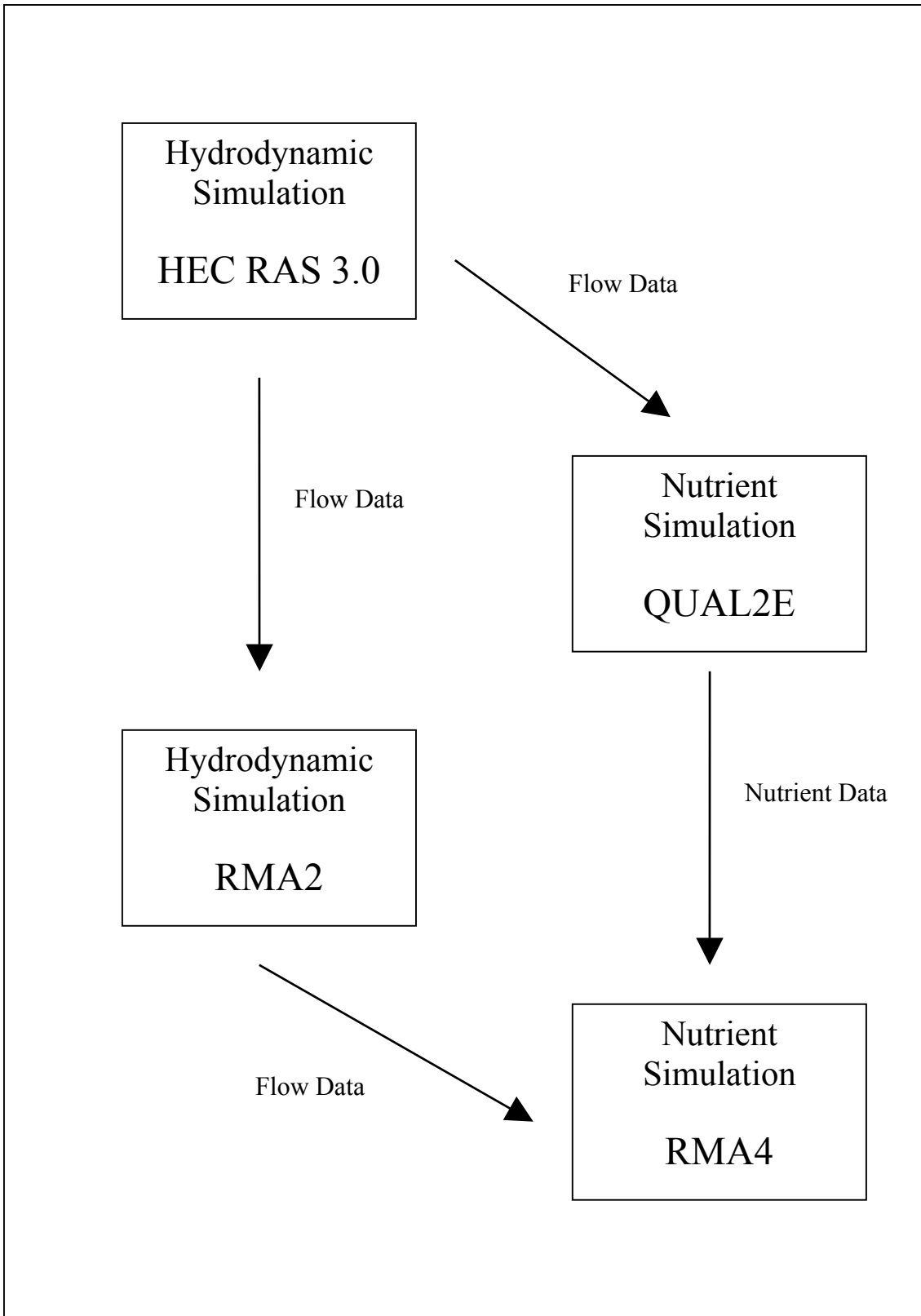


Figure 1: Modeling sequence

- D. Run QUAL2E with typical nitrogen loading of Mississippi River water as a boundary condition to estimate the total organic nitrogen concentration that will enter the modeled Maurepas Swamp area.
- E. Construct the 2-D geometry for RMA2 and RMA4 with the Surface Water Modeling System (SMS) utilizing USGS digital elevation models, scanned topographic maps, and digitized orthophotos.
- F. Run the RMA2 program to evaluate the 2-D flow field through Maurepas Swamp with USGS stage data and a flow rate determined with the HEC RAS 3.0 model as boundary conditions.
- G. Run the RMA4 program to evaluate nutrient transport within Maurepas Swamp utilizing the flow field determined by RMA2.
- H. Conduct a sensitivity analysis on parameters for all four models.
- I. Evaluate the utility of and appropriateness of each model in this type of modeling environment.