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Review

A feasibility analysis of discharge of non-contact, once-through industrial cooling water to forested wetlands for coastal restoration in Louisiana

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ABSTRACT

Louisiana has had a high rate of coastal wetland loss due mainly to the isolation of the Mississippi River from the deltaic plain. We conducted a feasibility analysis of using once-through, non-contact industrial cooling water for restoring subsiding forested wetlands in coastal Louisiana. We considered the impacts of heated water and high nutrient and sediment concentrations. River diversions introduce sediments and nutrients to stimulate the productivity and accretion of coastal wetlands. Since increases in sediments and nutrients can cause water quality problems, we analyzed the assimilative capacity of the swamp. Based on a loading rates analysis, we estimated that the following nutrient reductions would occur: 75% for NO_3, 50% for TN, 60–75% for TP, and 100% for suspended sediments. Because of the concern of impacts from heated water, it is likely that the temperature of the cooling water will have to be decreased before discharge. Altering the duration and location of the discharge are ways to minimize the impact of temperature. We recommend that a pilot study be carried out to determine the effects of heated water on the functioning of the system, the retention of sediments and nutrients, and the impacts of different discharge scenarios.

1. Introduction

Wetland loss is a global problem worldwide. There are approximately 8.6 million km^2 of wetlands that cover about 6% of the land surface (Mitsch and Gosselink, 2000). Wetland loss is most severe in highly populated or developed regions. Over the past two centuries, the United States has lost more than 53% of the original 900,000 km^2 of wetlands (Dahl, 1990). Coastal wetland loss is an especially critical problem in the Mississippi delta. The state of Louisiana has about 40% of the total U.S. area of coastal wetlands but has suffered greater than 80% loss of its coastal wetland (loss of 4920 km^2 since 1930s; Field et al., 1991; Dunbar et al., 1992; Barras et al., 1994; Dahl, 2006). The main causes of wetland loss in the Mississippi delta region are isolation of the river from the deltaic plain by levees, pervasive alteration of hydrology, enhanced subsidence due to removal

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of oil and gas, and loss of barrier islands (Boesch et al., 1994; Day et al., 2000; Morton et al., 2002).

In order to restore the Mississippi delta, the state of Louisiana and the Federal Government have begun a massive restoration program that includes reintroduction of river water to the deltaic plain, hydrologic restoration, creation and nourishment of marshes with dredged sediments, and barrier island restoration (Penland et al., 1990; Mendelssohn and Kuhn, 2003; USACE, 2004). Reconnection of the river to the delta by reintroduction of river water via diversions (gated structures in levees or siphons over levees) is perhaps the major management tool for delta restoration (Boesch et al., 1994; Day et al., 2000; USACE and LADNR, 2003). In general, diversions are gated structures in levees or siphons over levees (e.g., Boesch et al., 1994; Lane et al., 1999, 2004; DeLaune et al., 2003).

A novel, and potentially important, approach to diverting river water into coastal wetlands is through the use of industrial cooling water. Many industries along the Mississippi River south of Baton Rouge pump river water for once-through, non-contact cooling (Schonberg et al., 2003). After passing through heat exchangers, the heated water is pumped back to the Mississippi River. An estimated 8.1 million m^3 (2300 million gal/day (MGD)) of water is used by various types of industrial plants in Louisiana (petrochemical 68%, refining 22%, paper products 5%, food products 2%, and other 2%) (Schonberg et al., 2003). Approximately, 93% of the water usage is from surface water and about 72% of all surface water withdrawn is from the Mississippi River. In 2002, a survey was conducted to determine the major uses of water by the petrochemical industry (Fig. 1). Cooling water accounted for 4.2 million m^3 (1100 MGD) or 67% of the 6.3 million m^3 (1657 MGD) of water withdrawn from the Mississippi River for industrial use.

In this paper, we report on a preliminary feasibility analysis of diverting once-through, non-contact industrial cooling water from the IMC Phosphates Company for the purpose of restoring subsiding forested wetlands in coastal Louisiana (Fig. 2). Currently, IMC Phosphates uses up to 5.2 m^3/s (82,000 gal/min, GPM) of water from the Mississippi River. This non-contact cooling water is used once and returned directly to the river. It has been suggested that this cooling water might serve as a source of river water for diversion into coastal wetlands. In a properly designed diversion project, the nutrients and sediments in river water can enhance wetland sustainability (DeLaune et al., 1990, 2003; Lane et al., 1999; DeLaune and Pezeshki, 2003). However, pumping heated water into a wetland can have serious detrimental impacts. In particular, we analyzed the potential impacts of diverting heated water with high nutrients and sediments on the adjacent forested wetland and developed a general design for a distribution system for delivering cooling water to the swamp. Because of the uncertainty of the impact of heated water on the forested wetland, a detailed assessment of this impact was carried out. Although recent research has demonstrated beneficial effects of river diversions (Lane et al., 1999, 2001, 2003; DeLaune et al., 2003, 2005; Wheelock, 2003), none of these diversions included heated water.

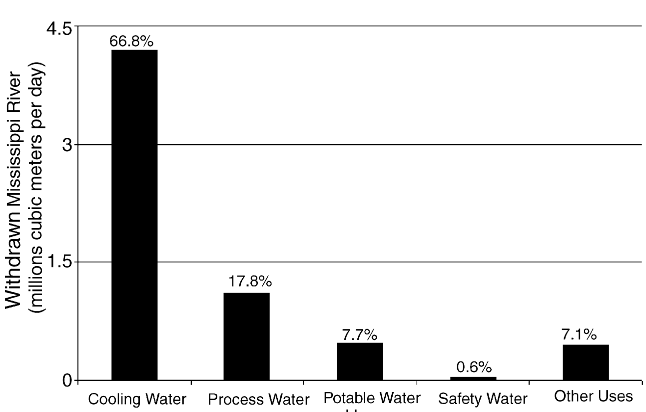

Fig. 1 – Categories and the relative importance of water usage withdrawn from the Mississippi River for industrial use (modified from Schonberg et al., 2003).

2. Area description

The IMC Phosphates plant is located on the east bank of the Mississippi River near Uncle Sam, Louisiana in St. James Parish (Fig. 2). The plant produces ammonia, diammonium phosphate, monoammonium phosphate, phosphoric acid, sulfuric acid, and urea fertilizer. The plant pumps up to 5.2 m^3/s

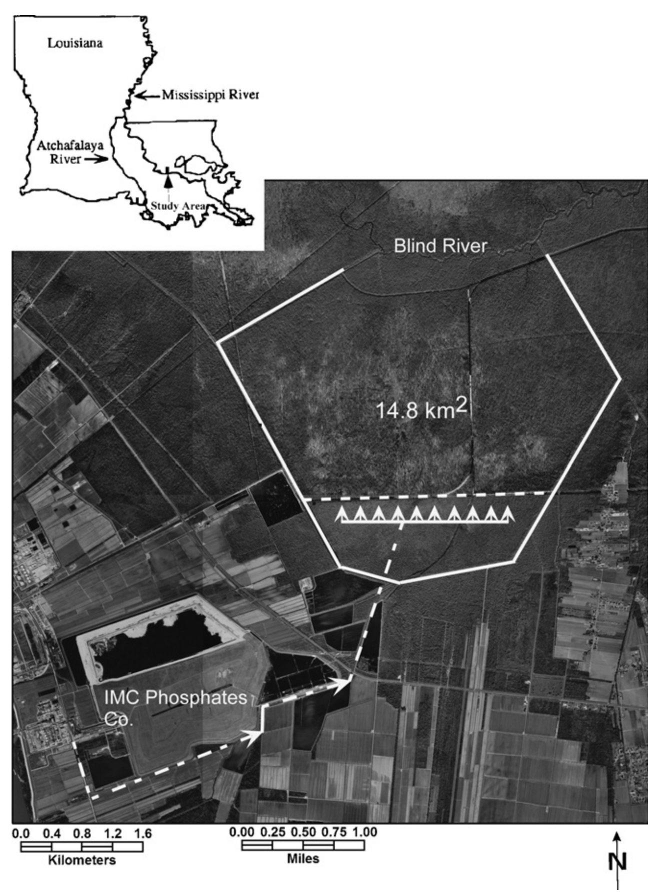

Fig. 2 – Map of the location of the IMC Phosphates Company. White arrows indicate the proposed dispersal path of cooling water. Solid white lines indicate projected forested swamp area to be influenced.