



Article

# Influence of Riverbed Incision and Hydrological Evolution on Water Quality and Water Age Based on Numerical Simulation: A Case Study of the Minjiang Estuary

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**Abstract:** In recent years, problems such as water quality deterioration, saltwater invasion, and low oxygen have appeared in estuaries all over the world. The Minjiang River in Fujian, as a typical tidal estuary area, is facing these thorny problems. In this paper, the effects of topography and hydrologic evolution on the water age and water quality of the lower reaches of the Minjiang River were simulated by building a hydrodynamic and water quality model. The results show that: (1) It was found that the riverbed incision of the lower reaches of the Minjiang River led to the overall decline of river water level, the increase of river volume, and the increase of downstream water age, which eventually led to the decrease of dissolved oxygen (DO) and the deterioration of water quality in the downstream from Shuikou to Baiyantán. However, the decline of topography led to the increase of tidal volume in the estuary, the enhancement of the dilution effect of oxygen-rich water bodies in the open sea, and the increase of DO in the lower reaches of Baiyantán. (2) Under no tidal action, the concentration of pollutants in the water of the North Channel increased, the DO decreased, and the DO decreased from Baiyantán to the offshore water. After the enhancement of tidal action, the dilution of oxygen-enriched water from the offshore water increased, and the DO increased. (3) The hydrological and water quality characteristics of the upper part of the lower reaches of the Minjiang River were mainly controlled by topography, runoff, and pollutant discharge, which were more affected by the tidal current transport operation and pollutant discharge near the open sea. In recent decades, the deterioration of water quality and the aggravation of saltwater intrusion in the Minjiang River were closely related to the serious topographic downcutting. The results provide a scientific basis for revealing the deterioration of estuary water quality and long-term management of the estuary.

**Keywords:** Minjiang River Estuary; low dissolved oxygen; water age; water quality; riverbed incision

## 1. Introduction

In recent years, people are increasingly concerned about the estuary and coastal water environment. Estuaries, as heterotrophic ecosystems where large numbers of organic substance transported by rivers and inputted from the ocean are mineralized [1,2], have appeared low DO and deterioration of water quality around the world [3–5]. Estuarine discharge, topography (volume), tides, pollutant emissions etc., playing a role in controlling the estuarine environment [6,7]. Different from the water bodies of lakes or inland rivers, the migration and diffusion of estuary materials is a complex process, which is not only affected by runoff and tide, but also by gravity cycle, wind-driven and unique topography.