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# Temporal Variability of Nutrient Budgets in a Tropical River Estuary : the Bangpakong River Estuary, Thailand

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## Abstract

Water, salt, dissolved inorganic nitrogen (DIN), and dissolved inorganic phosphorus (DIP) budgets in the Bangpakong Estuary were conducted by repeated observations and multiple box modeling. Water samples for inorganic nutrient analyses were collected monthly from June 2000 to May 2001. Flushing time at the estuary depicts high variations ranging from 1.4 (October 2000) to 80 days (February 2001) with an annual mean of 15.2 days. Seasonal variation in salinity gradients and estuarine Richardson numbers show the Bangpakong Estuary was partially stratified during the wet season and a well-mixed estuary in the dry season. Riverine nutrient inputs and distributions of nutrient concentrations within the river estuary varied in space and time. Temporal variations in fluxes were strong within inter-seasonal scales owing to water fluxes and system concentrations. The increase of DIN and DIP fluxes in the estuary may be the results of degradation of particulate organic matter. The Bangpakong Estuary appears to be a heterotrophic system where respiration exceeds photosynthesis ($p$-$r$ < 0) and a denitrifying system. Seasonal variations in biogeochemical rates were attributable to differences in magnitude of freshwater inputs.

***Keywords:*** nutrients budget; nutrient distribution; nonconservative flux; the Bangpakong River or Estuary, Thailand

## 1. Introduction

Estuaries are important regions in the transport and transformation of materials from terrestrial sources and anthropogenic activities. These regions also play an important role in processing nutrients exchanged between land and sea (Eyre and Twigg, 1997). The high nutrient and productivity of estuaries make them rich nurseries and feeding grounds for juvenile fish. Globally, estuarine nutrient loads have steadily increased over recent decades coincident with rises in the human population and industry. Such increases may boost primary production and provide either an additional sink and/or source for carbon, nitrogen and phosphorus (Gordon *et al.*, 1996) in coastal waters.

Nutrient budgets have been prepared for many estuaries and applied as management tools in several watersheds (Howarth *et al.*, 2000; Gazeau *et al.*, 2004; Cao *et al.*, 2005). Research on ecological impacts of altered biogeochemical fluxes in the coastal zone has advanced to the point where fluxes of biogeochemically important elements for environmental management applications can be estimated and predicted (Nixon *et al.*, 1995; Humborg *et al.*, 2000). In order to access efficient coastal zone management, we need to know the magnitude of changes and controlling feedback mechanisms, for example, the natural and anthropogenic nutrient sources and sinks. This involves a description of disturbed and undisturbed biogeochemical cycles on the relevant spatio-temporal scales (Humborg *et al.*, 2000) and an estimation of fluxes and budgets.

However, it is difficult to obtain carbon and nutrient budgets through direct measurement (Hung and Kuo, 2002). A model to estimate nutrient and carbon budgets was developed by Gordon *et al* (1996) and referred to as LOICZ (Land-Ocean Interactions in the Costal Zone). This model has been widely used for C-N-P budget calculations in estuarine and coastal ecosystems (Dupra *et al.*, 2000; Wattayakorn *et al.*, 2001; Hung and Kuo, 2002; Ngusaru and Mohammed, 2002; Wosten *et al.*, 2003; Camacho-Ibar *et al.*, 2003; Zhang *et al.*, 2004; Cao *et al.*, 2005). However, a number of the budgets for tropical estuaries derived from time-averaged concentrations of nutrients and salinity may have particularly large errors, when data from only two contrasting seasons (such as wet and dry seasons) are averaged (Hung and Kuo, 2002 and Webster *et al.*, 2000).

In the present study, non-conservative N and P