Eutrophication in the Upper Gulf of Thailand

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Introduction

The situation of eutrophication brings about hypoxic condition in water column or "dead water" related to exceeded decomposition process resulted from the accumulation of organic material in a coastal ecosystem through phytoplankton bloom (autochthonous) or direct inputs (allochthonous). The problem becomes more complex in coastal environment where land-sea interaction is high. Marine organisms living in such an area have to adapt to this threat situation, otherwise severe mortality among them may happen. Eutrophication and hypoxia in coastal water are now happening in many regions in Asia. They are included Jakarta Bay, Indonesia; Manila Bay, Philippines; Pear River estuary and Chang Jiang River mouth, China; Ariake Bay, Isahaya Bay, Ise Bay and Tokyo Bay, Japan. The upper Gulf of Thailand is also a coastal sea now facing with eutrophication-related problems. It is really important to understand the mechanism of the phenomena in order to find the ways how to mitigate the problems that become more severe in this area.

The objective of this research is to investigate the contribution of material from rivers to the eutrophic areas in the upper Gulf of Thailand based on passive tracer simulation using a hydrodynamic model.

Procedure

The Princeton Ocean Model (POM) is used for current simulation in the upper Gulf of Thailand (Figure 1). It is also coupled passive tracer subroutine to simulate the distribution of a conservative dissolved material released from 4 river mouths including the Thachin River, The Maeklong River, The Chaopraya Ricer and the Bangpakong River. POM is forced by monthly winds (QuickScat), water elevation (Harmonic Analysis) and monthly river discharge (Royal Irrigation Department). It is operated in diagnostic mode with climatology temperature and salinity data from World Ocean Atlas 2001. The tracers are continuously released at the sea surface at 4 river mouths with initial concentration of 100 units and operation time of 50 days.

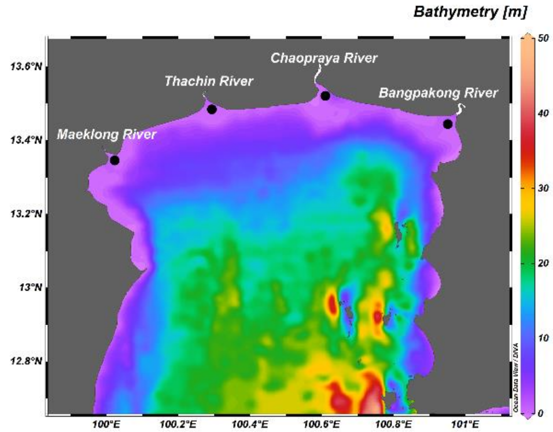

Figure 1 The upper Gulf of Thailand showing water depth in meter and dots represent the releasing points of the tracer.

Results

Water circulation between the southwest and the northeast monsoon are simulated and presented as monthly depth-averaged current in July and December, respectively (Figure 2). Clockwise circulation develops during the southwest monsoon, and strong current is observed along the western and the northern coasts. Circulation pattern is changed to counter-clockwise when the northeast monsoon prevails. Current along the western and the northern costs are also strong but flow southward and westward, respectively.

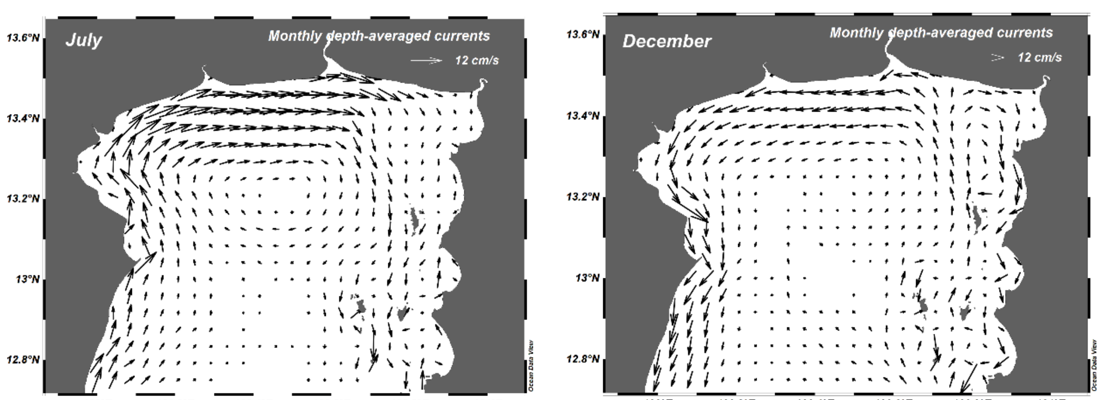

Figure 2 Monthly depth-averaged residual current simulated using POM during the southwest monsoon (left) and the northeast monsoon (right).

The distribution of passive tracer after continually released from the river mouths for 50 days during the southwest and the northeast monsoons are shown in Figure 3. The tracer is transported along the coastline from the western to eastern coasts during the southwest monsoon (July) following the circulation developed in this time (Figure 2). Highest concentration around 70 units is found in the northeastern area or in the south of the Bangpakong River mouth. This evidence agrees well with phytoplankton bloom that usually occurs in this area during the southwest monsoon. The movement of the tracer change to opposite direction during the northeast monsoon when the counter-clockwise circulation develops. Most tracer is transported along the coastline from the river mouths to the west, except at the Bangpakong River mouth that the tracer is still moved southward along the western coast. Compared to the southwest monsoon, the accumulation of the tracer during the northeast monsoon is not so high due to its widely distribution along the coastline. The results accord with the evidence of sub-surface hypoxic water that is usually observed along the western coastline during the onset of the northeast monsoon season.

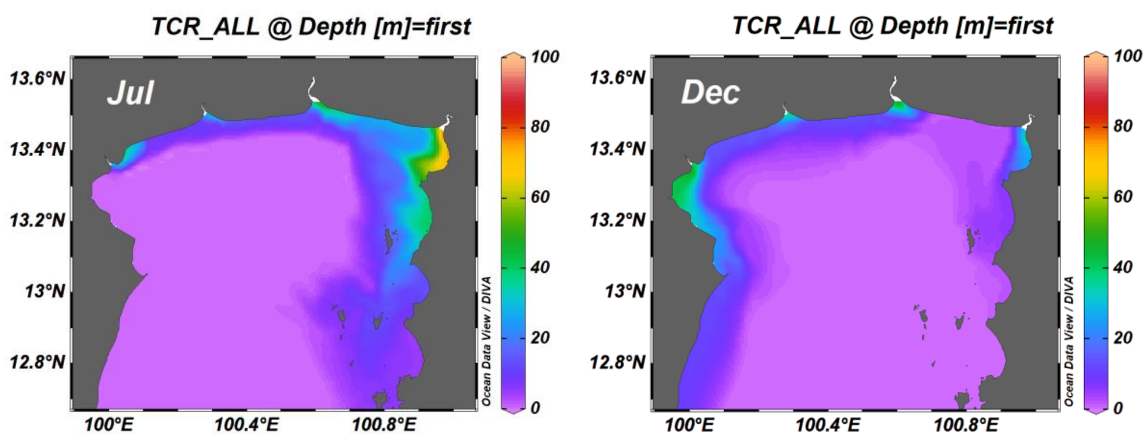

Figure 3 The distributions of simulated passive tracer continually released from the river mouths for 50 days in the upper Gulf of Thailand.

The contribution of tracer from each river to selected areas where eutrophic-related problems frequently occur is investigated. A selected area in the east of the upper gulf (Figure 4) faces severe phytoplankton bloom during the southwest monsoon almost every year. The water turns dark green due to the blooming of *Noctiluca scintilland* disturbing aquaculture and tourist attractive areas. It is believed that discharged water and nutrients from the Bangpakong River, the closet river located in the north of the area, is a major cause of the blooming. The investigation of our study however shows that this area is under the influences of all four rivers. The major contribution comes from the Chaopraya River for 35%, the Bangpakong River for 29%, the Maeklong River and the Thachin River for 28% and 8%, respectively. The selected area in the west of the upper Gulf of Thailand is chosen for the investigation due to its importance as a large shellfish aquaculture area affected by hypoxia during the onset of the northeast monsoon. The results of our study in December suggest that the problem may come mainly from the Chaopraya River material. The contribution of the Chaopraya River is in an amount of 50% followed by those from the Maeklong River, the Thachin River and the Bangpakong River for 25%, 17% and 8%, respectively (Figure 5).

Our results suggest that material transport form the Chaopraya River play a major role to eutrophication in the upper Gulf of Thailand. In order to improve the quality of water in this coastal area, water management in the Chao Phraya River is therefore essential.

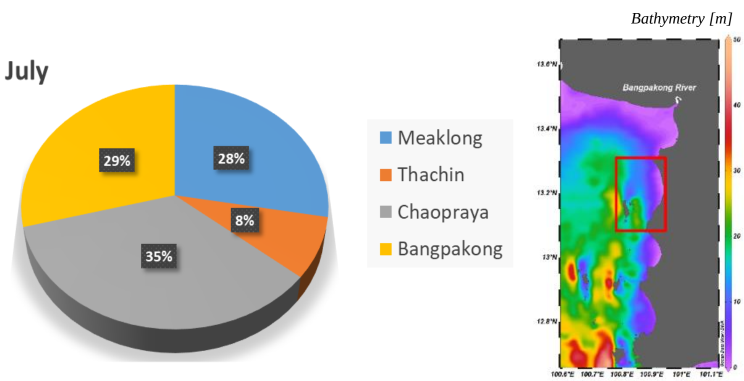

Figure 4 The contributions of the tracers form each river to the eastern coast in July.

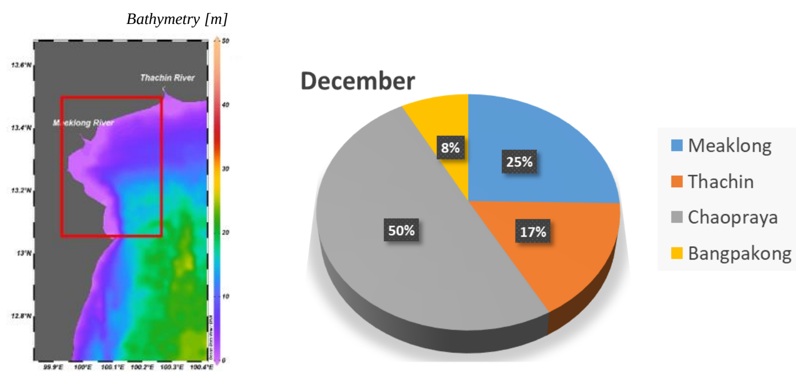

Figure 5 The contributions of the tracers form each river to the western coast in December.

Publication/conference presentation

Publication: It was planned to do in the near future on the title of "Seasonal variations in material transport from the river mouths to the upper Gulf of Thailand revealed by numerical simulations"

Presentation:

1. Title: "Material transport from the river mouths to the upper Gulf of Thailand" in International symposium on coastal ecosystem change in Asia: hypoxia, eutrophication, and nutrient conditions, 14–15 November 2019, Ehime University, Matsuyama, Japan
2. Title: "The influences of material transport from the river mouths into the upper Gulf of Thailand" in The 7th Asian/16th Korea-Japan Workshop on Ocean Color, 11 – 14 December 2019, Burapha University, Chonburi, Thailand

Perspectives in the future

We will apply an ecosystem model to investigate the role of material transport from the rivers as a major source of nutrient supply to eutrophication in the upper Gulf of Thailand.