Form 3

Annual Report

LaMer, Ehime University

Date (d 21, m 02, 2018)

To Director of LaMer

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Include the report on the result of the project/meeting in a separate sheet.

1. Project ~~/ Meeting~~ title

The analysis of mooring current data for the investigation of water hypoxia in coastal aquaculture area of Chonburi Province, Thailand

2. Members of project ~~/ meeting~~

Name	Affiliation	Position	Contribution part
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LaMer Faculty member in charge Dr. Akihiko Morimoto	Center for Marine Environmental Studies (CMES), Ehime University	Professor	Co-researcher, host scientist

3. Contents (please write in separate sheet, A4-size, within 5 pages including figures and tables. Itemize “Title, members’ names and affiliations, aim, procedure, result, publication/conference presentation, perspectives in future”).

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The analysis of mooring current data for the investigation of water hypoxia in the coastal aquaculture area of Chonburi Province, Thailand

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Introduction

The upper Gulf of Thailand (UGoT) is eutrophic and red tides frequently occur in the northern part of the area where major river mouths located. Our focus area is in the eastern part of UGoT (Figure 1), the coastal aquaculture area of Chonburi Province (Chonburi Bay), where massive mortality of cultured shellfish usually occurs in late southwest monsoon (late rainy season) to early northeast monsoon. We have conducted field observations covering the focus area and deployed a mooring system during the problem period in 2011 and 2012. Hypoxic water mass was observed and it was expected to be the cause of the mortality of marine organisms as mentioned above. Time series data is very crucial for investigating the movement of water mass which is related to the mechanism of hypoxic water development in this area. Anyways, knowledge and skill in time series data analysis of the Thai colleague is still limited. During the visiting at Ehime University hosted by Professor Akihiko Morimoto and supported by LaMer, I took this chance to work on harmonic analysis and apply Tide Killer Filter program (TKF) on the measured current data during year 2011. All the results are presented as follows.

Procedure

Current data at 1 meter above sea bottom of the mooring system installed in the area from 5 September to 23 October 2011 are used for the analysis. Harmonic analysis based on leased-square method written in FORTRAN code is applied to extract amplitudes and phases of 8 tidal constituents. TKF also written in FORTRAN code is applied to extract residual current from raw current data from the mooring system.

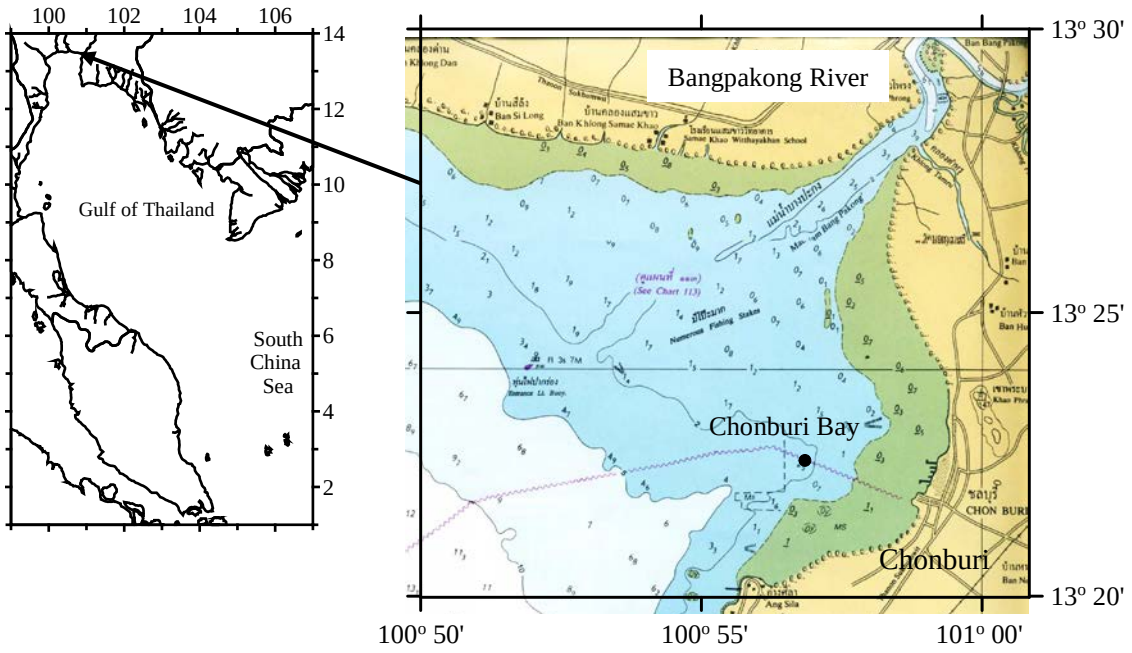

Figure 1 The coastal aquaculture area of Chonburi Province (Chonburi Bay), dot represented the position of mooring point

Results

The extracted 8 tidal constituents from raw current data are shown in Table 1. The resulted amplitudes suggest that current in east-west direction (u) and semi-diurnal tidal current are more dominant than that in north-south direction (v) and diurnal tidal current, respectively. The most influential tidal constituent in the area is M_2 followed by K_1, S_2, P_1 and S_2, respectively. Figure 2 shows the comparison between measured and predicted velocities based on 8 tidal constituents extracted from the harmonic analysis. The predicted current data fit well in both amplitudes and phases confirming the significant of semi-diurnal and east-west current dominance. Discrepancy between both data are supposedly occurred from residual currents influenced by wind, river discharge and turbulence. The results also suggest that maximum tidal current amplitude in east-west direction is around 40 cm/s and in north-south direction around 10 cm/s. This information is useful for considering the influence of turbulence induced by tidal current on hypoxic water development. Among factors influencing water column conditions

including river discharge, surface heat flux, wind and tidal stirring, weak tidal amplitudes provide more opportunity for water stratification and bottom-water hypoxia.

Table 1 Amplitudes and phases, based on harmonic analysis, of 8 tidal constituents of current data measured near the Bangpakong River mouth

Tidal Constituents	u - Current		v - Current	
	Amp (cm)	Phase (deg)	Amp (cm)	Phase (deg)
K_1	7.54	248.73	1.14	100.02
O_1	3.12	169.46	0.61	50.64
M_2	10.78	11.32	2.40	290.32
S_2	5.62	276.41	1.31	171.27
P_1	3.37	18.30	1.22	196.39
Q_1	0.54	197.73	0.29	123.15
N_2	1.95	34.98	0.37	308.57
K_2	1.18	241.22	0.17	6.00

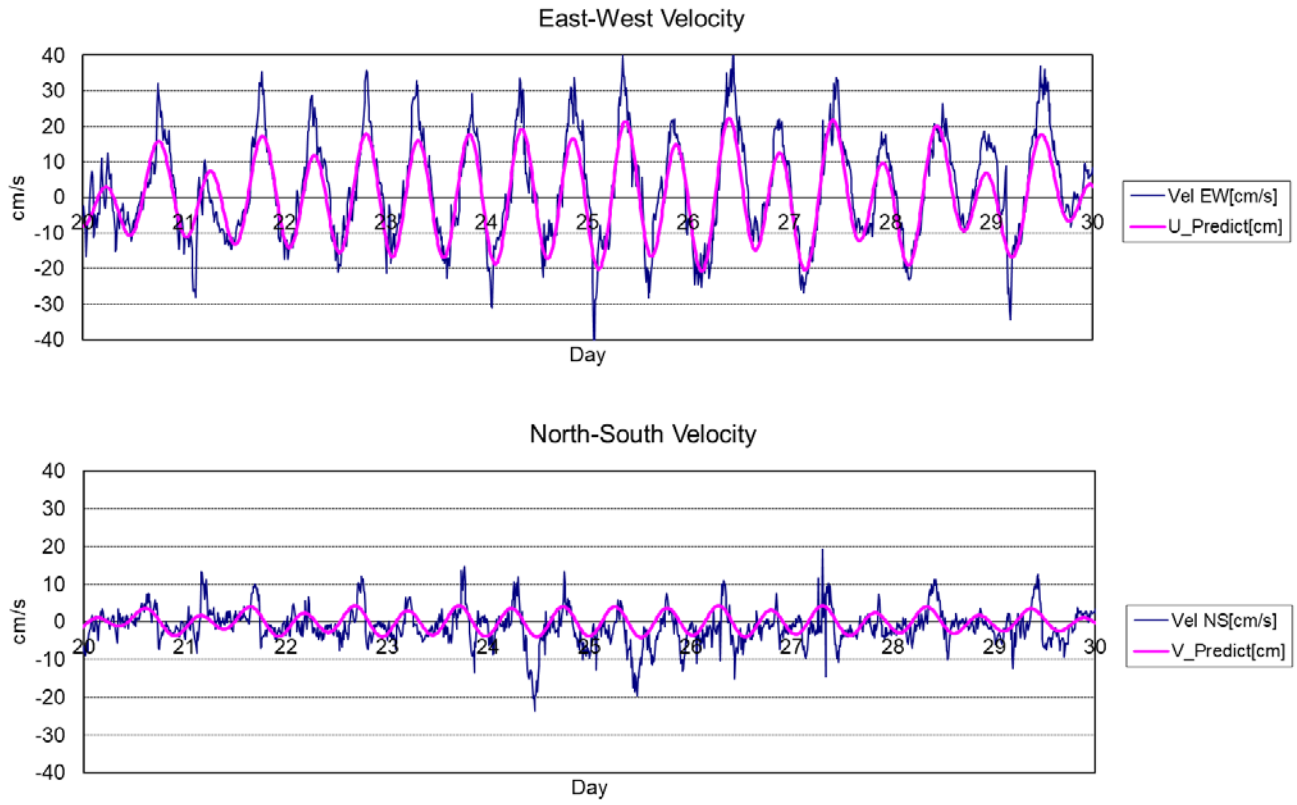

Figure 2 Measured and predicted tidal current, based on harmonic analysis, in east-west (upper) and north-south (lower) components

In order to track the movement of hypoxic water mass, the information on residual current is required. The residual current can be extracted from in situ current data when tidal current is known. In our case, for this purpose, measured current is subtracted by simulated tidal current from harmonic analysis. Unfortunately, the resulting currents are random and the trend of residual flow cannot be observed. To achieve this goal, TKF process is applied to extract residual current from in situ current data. The result is shown in Figure 3.

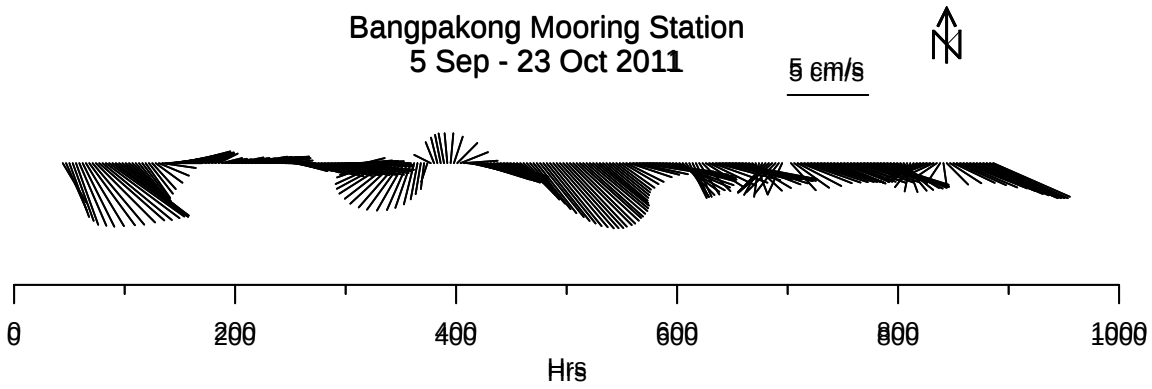

Figure 3 Time series of current velocity, after TKF application, at the mooring station from 5 September to 23 October 2011

The measured current after TKF application (Figure 3) suggests that residual currents mostly direct to southeast direction. This results reflect the net forcing both from seasonal wind and river discharge. This time of the year is the transition periods from the southwest to the northeast monsoon. Wind direction during this time is uncertain but normally ranges from the southeast to the northeast direction in a clockwise direction. This is maybe a major factor forcing the residual current to move eastward. However, a great flood in central Thailand in 2011 providing abnormally large discharge into UGoT may contribute to the evidence. Hypoxic water mass may develop in the west of the area where the Chaopraya River mouth locates and come into the aquaculture area following the residual current. Further investigation is required to confirm this evidence and year-to-year variation in both spatial and temporal aspects.

Publication/conference presentation

It was planned to do in the near future.

Perspectives in the future

Time series analysis will be applied on surface current data measured by using coastal radar installed around UGoT. It is expected that tidal information and residual circulation extracted from the analysis will help us understand the dynamics of eutrophication and hypoxic water mass in the entire UGoT.