

Hypoxic water mass in Jakarta Bay, Indonesia

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[Introduction]

Jakarta Bay is an open bay located at the northern coast of West Java (Fig. 1). Its width is about 30 km and length is about 16 km. It is located in the equatorial area at the latitude of 6° S. Its mean depth is 15 m and there are 13 rivers flowing into Jakarta Bay (Wouthuyzen et al., 2011). Active commercial fishing is conducted in Jakarta Bay. However, recently massive fish kill often happened. It is supposed that the upwelling of oxygen depleted water (hypoxic water mass) would induced the massive fish kill (Sachoemar and Wahjono, 2007). However, it was not confirmed because of the lack of dissolved oxygen data. Not only Jakarta Bay, there are few information of hypoxic water mass in the coastal sea in the tropical zone especially equatorial area. The hypoxic water mass happened in many semi-enclosed bays in summer and became a big environmental problem in the temperate zone; e.g. in Chesapeake Bay, Tokyo Bay and Ise Bay. In these temperate bays, the surface heating and the increase of river discharge from spring to summer enhance the stratification and trigger the generation of hypoxic water mass. But the climate in the tropical zone is largely different from the temperate zone (e.g. the seasonal temperature variation is very small). Therefore, if the hypoxic water mass was formed in Jakarta Bay, its formation mechanism would be different from the temperate zone. So, in order to clarify the seasonal variation in dissolved oxygen (DO) in Jakarta Bay, field surveys were conducted in this study.

[Methods]

We made water quality survey in Jakarta Bay 6 times between December 2015 and February 2017 about every 3 months. In each survey, the casts of multi-parameter water quality profiler were conducted at 26 to 29 stations in Jakarta Bay. The dates of the survey were shown in Table 1. The survey was carried out during 5 to 6 hours beside in December 2015 when it took 2 days to make the survey. At each station, the vertical profiles of temperature, salinity, DO, chlorophyll fluorescence and turbidity were measured with a RINKO Profiler (JFE Advantech Co.) and the transparency was measured with a Secchi disk. Only in the survey in December 2015, an AAQ1183 Profiler (JFE Advantech Co.) was used instead of the RINKO Profiler.

[Results and discussions]

Hypoxic water mass was observed in all the 6 surveys in Jakarta Bay (Fig.2), the minimum DO was less than 2 mg/L in all the surveys. It suggests that the hypoxic water mass was formed throughout the year in Jakarta Bay. Seasonally, the hypoxic water mass was diminished in February when it was in the mid-rainy season (North West Monsoon). On the other hand, the hypoxic water mass most developed in November to December when it was the transition from the dry season to the rainy season. The hypoxic water mass often formed in the area with the bottom depth of 5 to 15 m especially in the eastern part of the bay head. In May 2016, the DO was less than 3 mg/L even in the surface layer in the eastern coastal area. It indicates that the upwelling of the hypoxic water mass really happened. The thermal stratification was not formed or weak throughout the year, the temperature difference between surface and bottom layers was less than 2 °C. The haline stratification was observed throughout the year. The stratification weakened in February when the hypoxia was reduced. In November to December, the stratification was relatively strong.

Since Jakarta bay is located in the equatorial area, surface heating tends to overwhelm the surface cooling. Therefore, the vertical convection reaching at the bottom unlikely happens. However, during the

mid-rainy season, the vertical mixing would be enhanced caused by the strong wind and high wave due to the North West Monsoon. As it would reduce the stratification and increase the oxygen transport to the bottom layer, the hypoxia would be reduced. In the deep tropical lakes and reservoirs which are not located at high altitude, the permanent thermocline was formed (oligomictic) (Hutchinson and Löffler, 1956). The water tends to become hypoxic below the thermocline in these lakes and reservoirs (e.g. Lehmusluoto and Machbub, 1995). However, in the case of Jakarta Bay, though the depth was shallow and the stable thermocline was not formed, the hypoxic water mass was formed throughout the year. It would be due to the 3 reasons. 1) This bay tends to be stratified because of the weak tidal mixing (tidal range is less than 1 m) and enough river discharge. 2) As it is difficult to occur the continuous vertical convection due to the surface cooling, the water column tends to keep stratification. 3) The oxygen consumption rate in this water may be high.

Keywords: hypoxic water mass, Jakarta Bay, Indonesia, tropical zone, dissolved oxygen

Table 1 Observation dates

8,9 Dec. 2015
9 Feb. 2016
29 May 2016
20 Sep. 2016
27 Nov. 2016
10 Feb. 2017

Fig.1 Map of Jakarta Bay and location of the observation stations

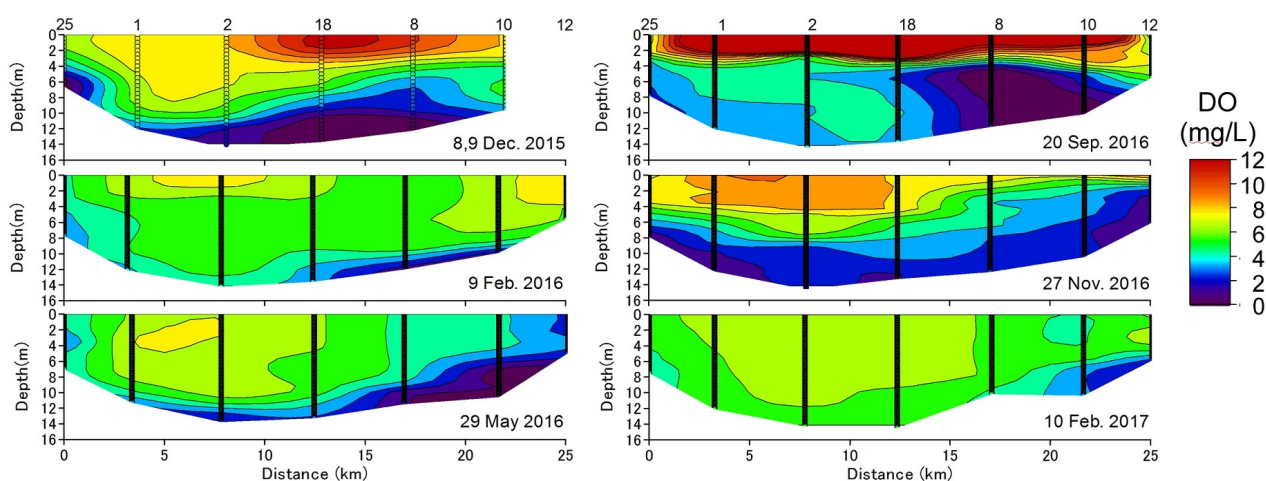
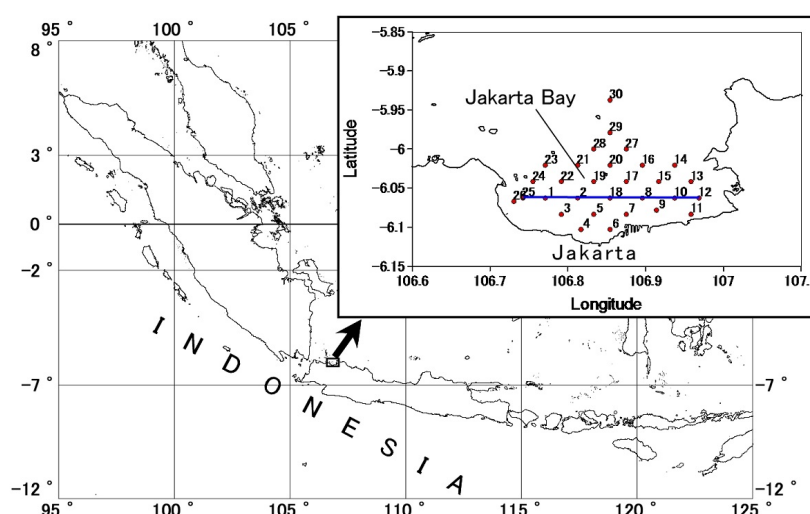


Fig.2 Distribution of Dissolved Oxygen along the longitudinal line in Jakarta Bay