Title of research project:

Semi-annual monitoring of hypoxic water masses and their impact on the Jakarta Bay ecosystem (Wet and Dry Seasons in 2024)

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Purposes

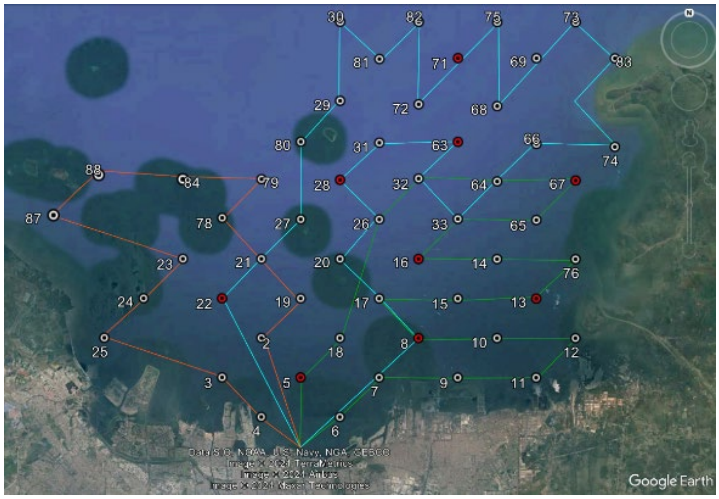
The purpose of this research project are:

1. To study the mechanisms for the formation and distribution of hypoxic water masses and their relationship to the dynamics of coastal ecosystems around the waters of Jakarta Bay;
2. To see how much influence hypoxic water masses have on the ecosystem, especially on traces of sediment and benthos at the bottom of the bay waters.

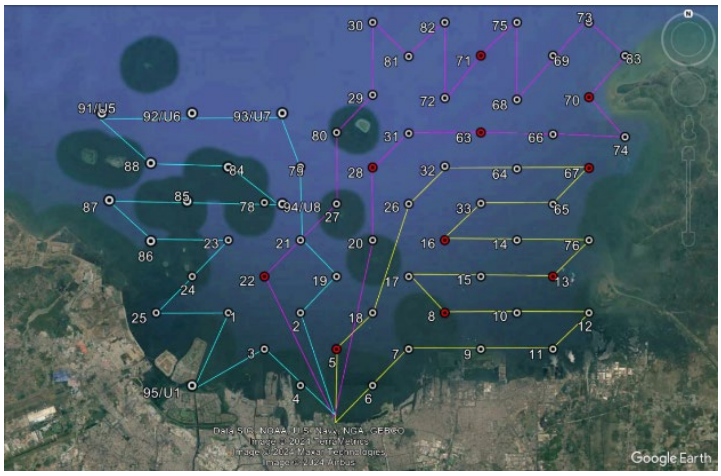
Methods

To obtain the status of water quality and bottom sediment and benthos in the waters of Jakarta Bay on the central and eastern sides of the bay specifically relates to the existence of a periodic distribution of hypoxic water masses and clarifying its existence with each 6-month observation (2-time observations per year) to observe their inter-annual patterns. There are two observations in Jakarta Bay during the period year of 2024, i.e. *Dry Season Survey in 15-17 July 2024* and *Wet Season Survey in 9-11 November 2024*. **Figure 1.a** shows the trip of field observations and its activities. Meanwhile, to collect the sediment and benthos samples in Jakarta Bay that represented the dry season in 2024, we have done a *Sediment and Benthos Sampling Survey in 29 July to 02 August 2024*. These distribution sampling stations applied based on the distribution of low dissolved oxygen (< 2mg/L) at the dry season period. The distribution of sediment and benthos sampling can be seen on **Figure 1.b**. Marine survey instruments used in this study also can be seen on **Figure 2**.

(a) **15-17 JULY 2024 (Dry Season)**



9-11 NOVEMBER 2024 (Wet Season)



(b) **29 JULY – 02 AUGUST 2024 (Dry Season)**

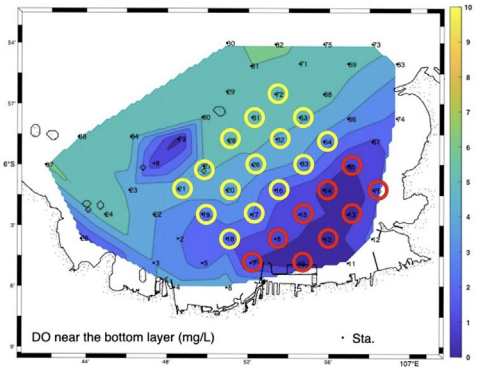


Figure.1. (a) Distribution stations for the water quality observations in Jakarta Bay for the period of 2024; three days of field observations marked by different color lines, each station profiling CTD-Dissolved Oxygen (DO) and water quality parameters. Additional water sampling activities were done in the red colors of the stations. (b) Distribution stations of the Sediment and Benthos Sampling on 2024; The priority of benthos sampling is above the existing area of hypoxic water masses on the bottom layer on the dry season in 2024.

Figure.2. Survey Instruments i.e. Rinko CTD profiler, Smith-Mctyre grab sampler, Van Dorn water sampler, GPS Handheld and Water Quality Checker-Horiba

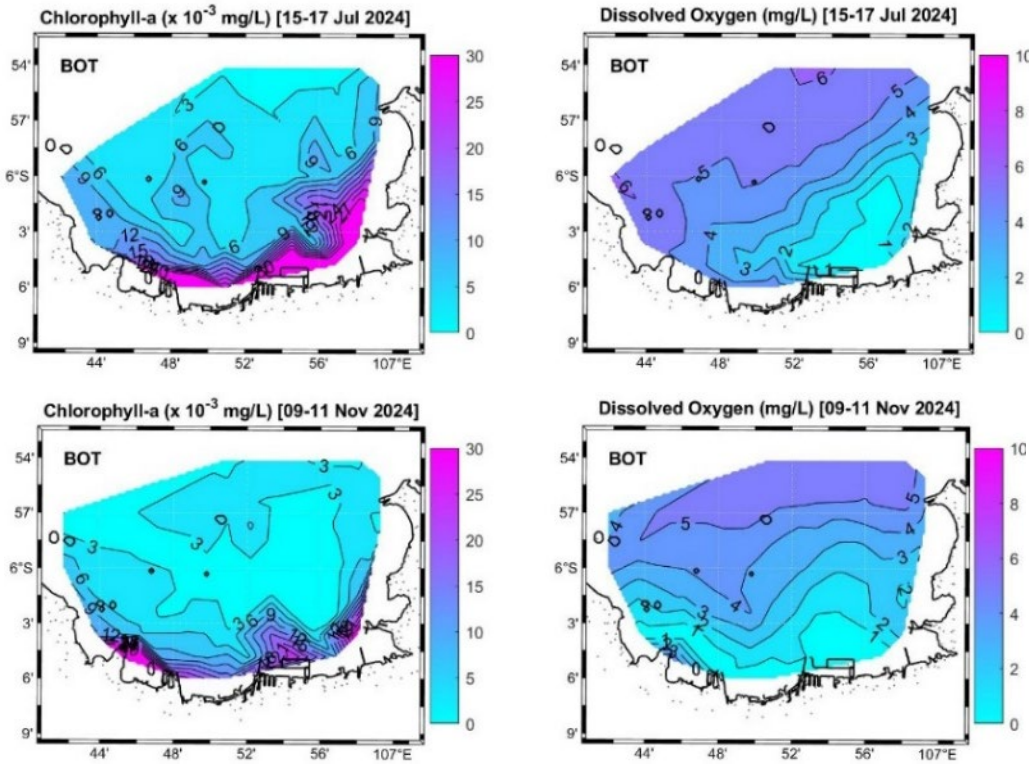
Progress Results

The main point from the results of observations in both seasons is that striking differences were obtained, mainly in the spatial distribution of hypoxic water mass (DO < 2 mg/L) and chlorophyll-a, especially in the layer near the seabed. The difference can be seen more clearly from **Figure 3.a**. During the dry season (15-17 July 2024), the core of the hypoxic water mass appears to be concentrated on the inner side between the East and Southeast of Jakarta Bay. This horizontal distribution coincides with the finding of the maximum concentration of chlorophyll-*a* in the same area. Meanwhile, in the wet season (9-11 November 2024), minimum DO concentrations of less than 2 mg/L appear to be more widely distributed on the inner side of the bay, especially in areas near the coastline in the Southeast, South, and Southwest directions.

Figure 3.b shows the vertical sections A-A' and C-C' that can describe the thickness of chlorophyll-*a* and Dissolved Oxygen on subsurface layers in Jakarta Bay. Generally, the thickness of DO layer on Wet Season (Nov 2024) looks bigger than Dry Season (Jul 2024).

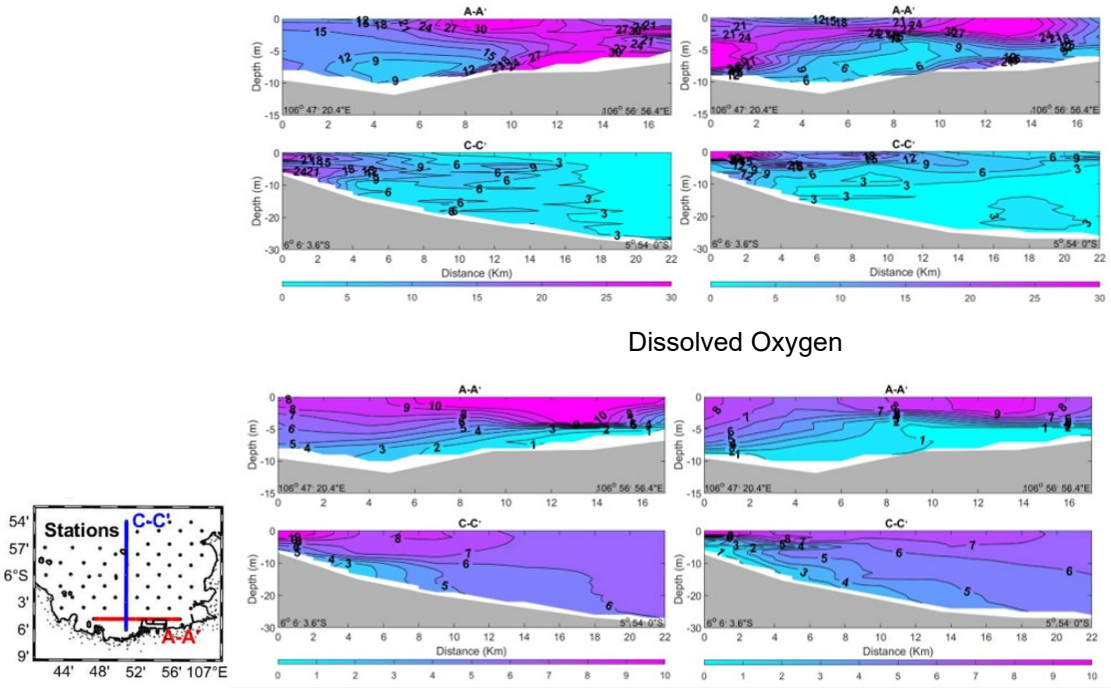
Those above conditions presumably coincide with the discovery of maximum chlorophyll-*a* values on almost the same sides of the coastline. In the conditions of these two seasons, we see a strong relationship between the presence of maximum chlorophyll-a concentrations and the presence of hypoxic water masses. This relationship is very similar to that reported by Li et al. (2023), who reported the association of chlorophyll-a with water masses with low oxygen content (< 2 mg/L) in the Pearl River Estuary, China.

(a)



(b) (15-17 Jul 2024) (9-11 Nov 2024)

Chlorophyll-*a*



Dissolved Oxygen

Figure.3. (a) Horizontal distribution of observation results for Chlorophyll and Dissolved Oxygen (DO) on bottom layer for two survey periods i.e. Dry Season on 15-17 July (upper panels) and Wet Season on 9-11 November 2024 (lower panels); (b) Same as Fig.3a for vertical sections on A-A' and C-C' lines for two period surveys on left and right panels, respectively.

Meanwhile, benthos and sediment samples resulting from sampling survey on 29 July- 02 August 2024 are currently in the process of analysis to identify the presence and type of specimens at the Invertebrate Laboratory, RCO-BRIN

Future challenges

To get more clarity for the mechanism of formation of hypoxic water masses, we need to consider both biochemical and physical processes that occurring in Jakarta Bay. Untreated wastewater that flows on rivers around Jakarta Bay, of course, will make the water quality parameters worse, but this process also be controlled by physical processes such as fluctuation of water level (ocean tide), ocean currents, stability of water masses, etc.

Therefore, the next stages in this study i.e.:
1. To extend the field observation activities in 2025 with the same observation survey design on 2024, with the addition of stationary ocean current measurements at certain location (mooring current meter).
2. To develop realistic numerical simulations for the dynamics of the bay's waters by considering integrated physical and biochemical processes.

References

Soeyanto E., Morimoto A., Hayami Y. and Sudaryanto A. (2023) Seasonal spreading and age of Citarum River water in the Jakarta Bay, *IOP Conf. Series: Earth and Environmental Science 1137 (2023) 012009*, doi:10.1088/1755-1315/1137/1/012009

Hayami Y, Morimoto A, Sudaryanto A, Sachoemar S I, Soeyanto E, Rusdiansyah A and Saleh M (2020) A quasi-persistent hypoxic water mass in an equatorial coastal sea, Jakarta Bay, Indonesia. *Estuarine, Coastal and Shelf Science 246 107030*

Li D., Gan J., Lu Z., Cheng W., Kung H., and Li J., (2023) Hypoxia formation triggered by the organic matter from subsurface chlorophyll maximum in a large estuary-shelf system. Water Research 240 120063