Title of research project:

Physical-ecosystem numerical model for Jakarta Bay

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Purposes

The purpose of this research project are:
1. To build a coupled physical-ecosystem numerical model for the Jakarta Bay waters;
2. To apply the above model for the prediction of physical-ecosystem parameters using the archives observation data in the Jakarta Bay waters
3. To analyze the model results and looking for the relationship between the dynamics of physical processes and ecosystem parameters in the Jakarta Bay waters.

Methods

Some field observations have done by the joint cooperation between CMES (Ehime Univ.) and Laboratory of Marine Survey Technology (BTSK), BPPT (the previous institution before BRIN exist) untill 2020. The archives observation data are include CTD, turbidity, DO, pH profiling, water sampling, etc. On the otherhand, collecting the dataset from the other institutions in Indonesia ,such as river discharges, weather, etc also should be done to support the input and initial condition fields of the model. The observations and collected dataset will fulfil the building of physical-ecosystem numerical ocean model.

In this project we build the physical-ecosystem ocean model for Jakarta Bay waters with coupling between the physical process (hydrodynamic) model and ecosystem model. The hydrodynamic model constructed by some input observation data as initial forcing such as tide, wind stress, river discharge, heat fluxes, water temperature and salinity water masses, etc. The hydrodynamic model used in this research was applied by Soeyanto, et.al (2023).   Meanwhile, the ecosystem model is a nutrient-phytoplankton zooplankton-detritus (NPZD) model (e.g., Morimoto et.al, 2021) as describe in the Figure.1.
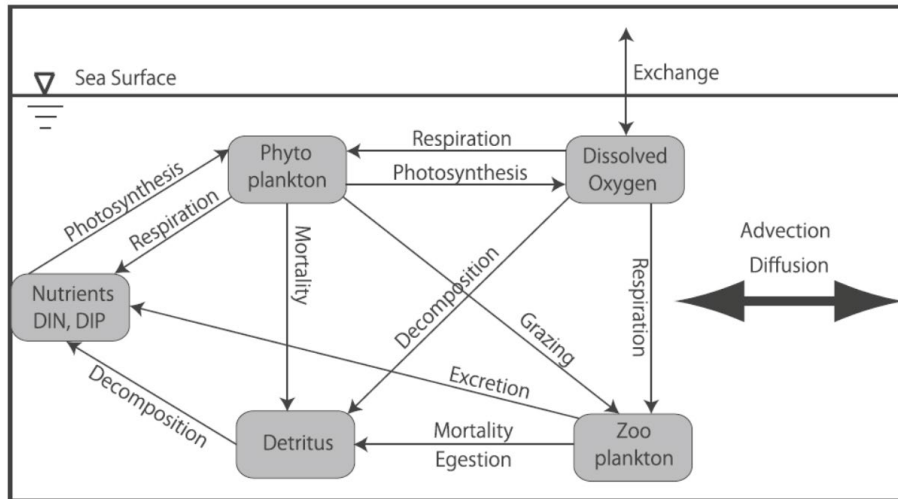
Figure.1. Configuration of ecosystem model (Morimoto, A., 2021)

The physical-ecosystem ocean model combined the physical processes such as ocean circulation, temperature and salinity distributions, etc can influence the dynamics in marine ecosystem, some ecosystem parameters such as nutrients, dissolved inorganic nitrogen (DIN), nutrients, dissolved inorganic phosphorus (DIP), phytoplankton (PHY), zooplankton (ZOO), particulate organic nitrogen / detritus (PON) and dissolved oxygen (DO) need to consider and merge in the previous physical model, and build a coupled physical-ecosystem numerical model for the Jakarta Bay.

Table.1 Parameters used on the ecosystem model

Parameter		*Values*
phytoplankton:		
resp	respiration rate of phytoplankton	0.03
vm	maximum photosynthetic rate	5
akdin	half saturation constant for DIN (0.5;11.4;3.0) (\mu M/l)	1.5
akdip	half saturation constant for DIP (\mu M/l)	0.1
alopt	optimum light intensity for phytoplankton (W/m^2)	70
deadphy	natural mortality rate of phytoplankton (mu molN/l)	0.03
zooplankton:		
Rmax	maximum grazing rate of zooplankton (1.0; 1.5; 0.3)	0.5
Deadzoo	natural mortality rate of zooplankton (mu molN/L)	0.06
ctzm	temperature coef. For zooplankton mortality	0.0693
Aruf	assimilation effeciency for zoo mortality	0.1
Bet	excretion of zooplankton	0.01
Detritus:		
sinkpon	Sinking velocity of detritus (m/s)	1.5
decopon	bacterial decomposition rate of detritus (s**(-1))	1.25

Progress Results

During year of 2022, we have been estimated some parameters such as DIN, DIP, PHY, ZOO, Chlorophyll-a (Chl-a), PON and DO by the model using input observation field data as describe in Figure 2 for Station 8 as an example observation point in Jakarta Bay. At this experiment we used some parameters as noted in Table.1.

In upper panel of Figure 2 that representing of surface layer, the estimated Chl-a present overestimate than the observation data. The modeled Chl-a ranged between ~3.0-66.0 mg/m^3. Meanwhile the observation values between ~1.7 – 15.9 mg/m^3. In this surface layer, the modeled DO also have discrepancy to the observation data. Range values of modeled DO is between ~6 – 13 mg/l. But, the observation values have ~3.7 – 12.9 mg/l.

In lower panel of Figure 2 for represent of bottom layer, the modeled Chl-a have close to their observation values. Overestimate of the model for this parameter only occurs on March 2016 and November 2017. In case of DO parameter at this layer, we also have close model results to the observation. Exception for the December 2015 and September 2016, respectively.

Future challenges

To develop a physical-ecosystem ocean model that accurately represents the ecosystem of Jakarta Bay waters, in the next research project some additional experiments by adjusting the ecosystem model parameters to match the observation data should be done.

References

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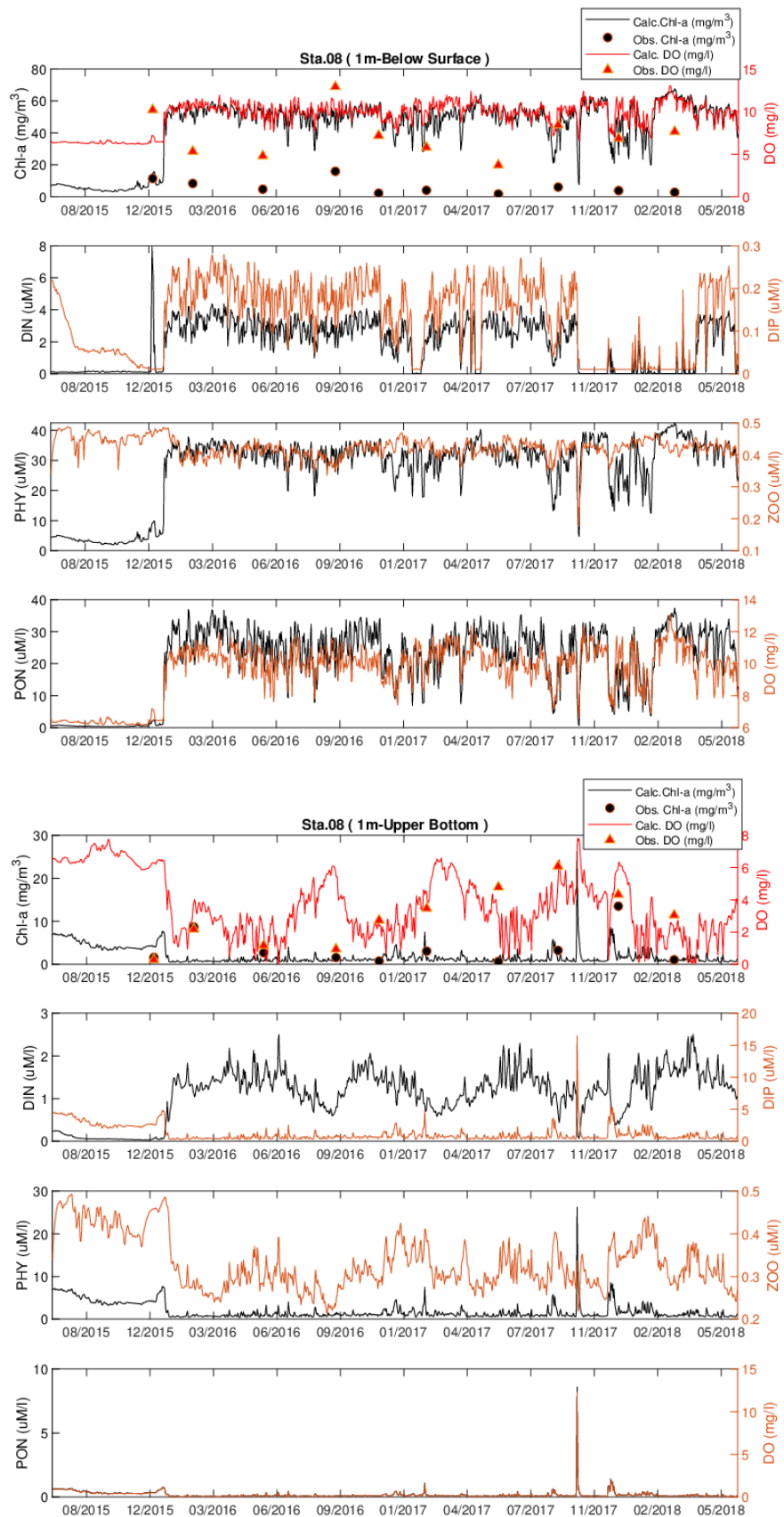
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Figure.2. Modeled parameters results from ecosystem model (Station 8; Longitude: 06º 3.697' S, Latitude: 106º 53.740' E) in Jakarta Bay