Title of research project:

Physical-ecosystem numerical model for Jakarta Bay (Phase 2)

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Purposes

The purpose of this research project are:

1. To describe in detail 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

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 shown in the Figure.1.

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.

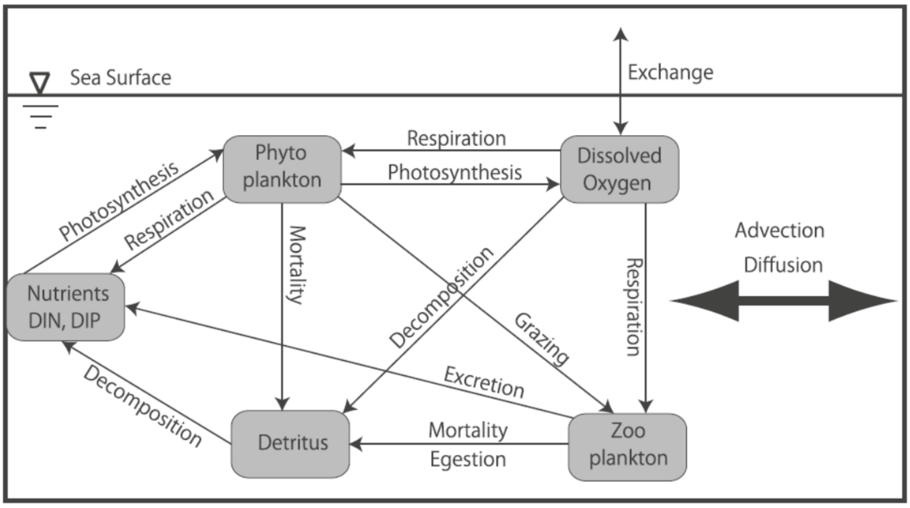

Figure.1. Configuration of ecosystem model (Morimoto, A., 2021)

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 efficiency 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 2023, we examine the important role of river water supplies for driving the ecosystem model results, because the comparison between the model results and observation data is still unreliable (Figure 2). This is a reason we still pay attention to find out the reliable input parameters that probably dominant in the model, i.e. river discharge.

To check how much the river discharge contribution to the model, we did a simulation without the ecosystem model as shown in Figure 4. For example, dissolved inorganic nitrogen (DIN), which is calculated using physical (hydrodynamic) models without ecosystem model parameters. The model results in Figure 4 show the horizontal distribution of daily DIN at several simulation times. The right-side panel shows the model results with daily river discharge input smoothed by a 6-day running-mean process. An example of the original and after 6-day running-mean river discharges can be seen in Figure 3.

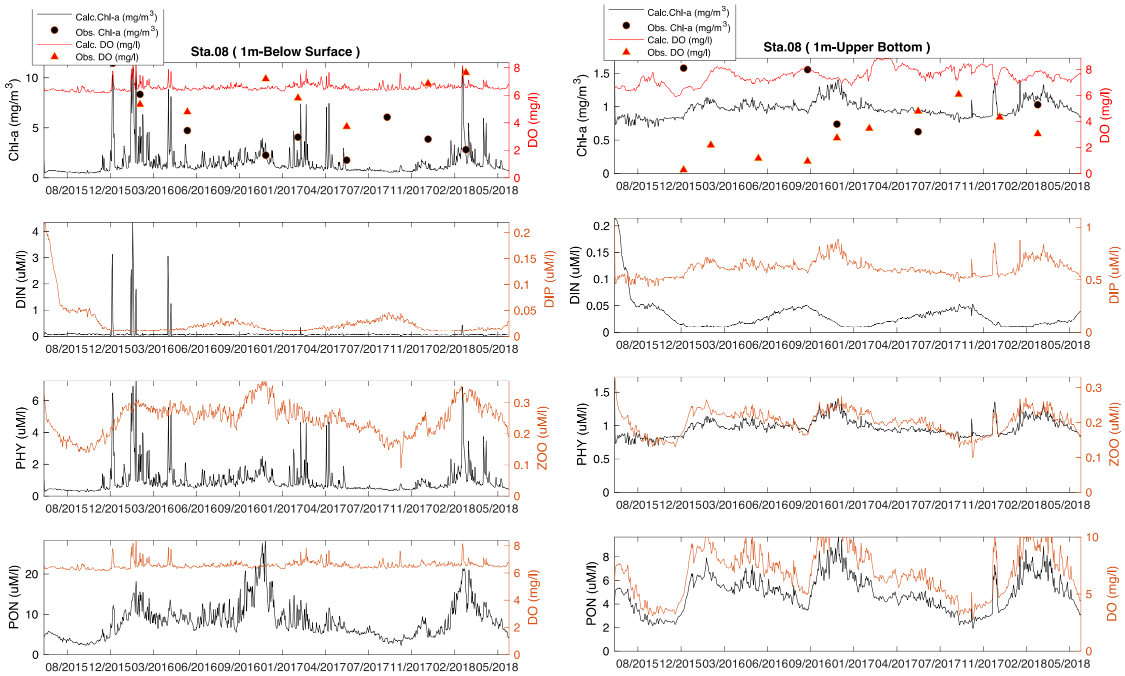

Figure.2. The model results observation for Sta-08 in Jakarta Bay

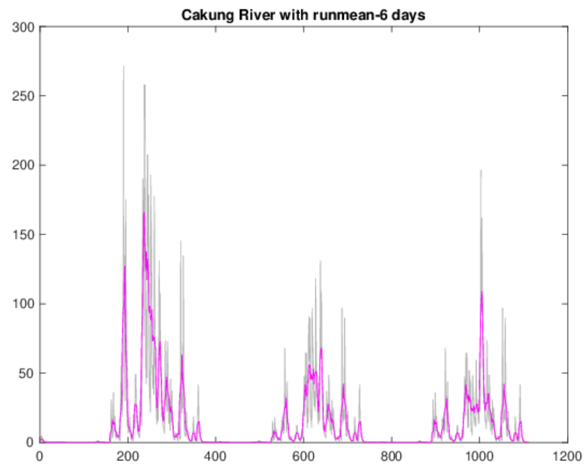

Figure.3. Cakung River Discharge. The purple graph is the result of the application's 6-day running-mean process.

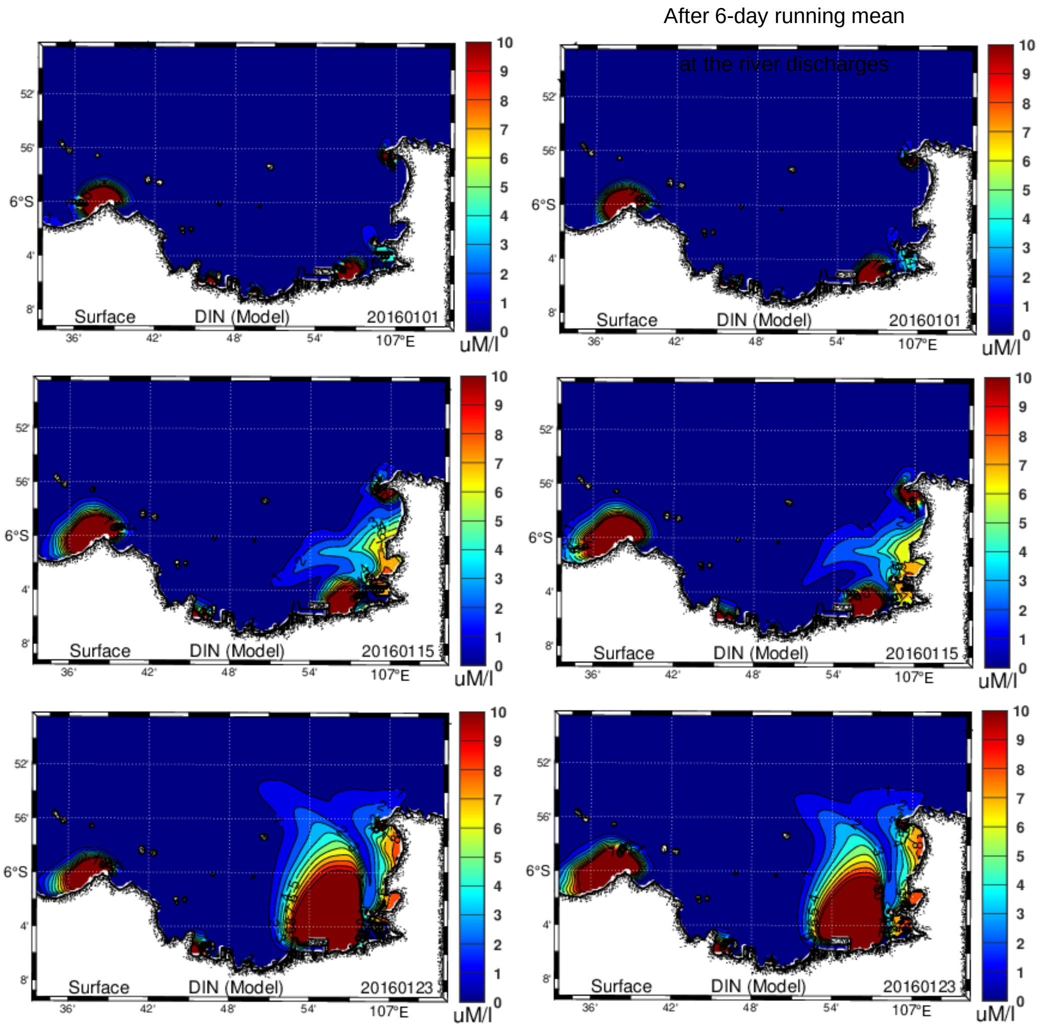

Figure.4. The horizontal distribution of DIN produced from only the hydrodynamic model in case original daily and after 6 day-running mean river discharges (left column panels)

The model results on Figure 4 show that the river discharges are important to reproduce observed parameters such as salinity and DIN distributions by the couple the hydrodynamic-ecosystem model.

Future challenges

To meet the need for realistic river discharge input, a river discharge estimation method is currently being carried out on rivers for which there is no discharge measurement data in Jakarta area. Some steps, namely:

1. collecting the precipitation data
2. examine the basin area of each river that flowing to Jakarta Bay waters
3. applying a run-off model to estimate the river discharge data

The above stages are currently being implemented gradually. The discharge data results from the run-off model will be used as input data for the hydrodynamics-ecosystem model. The parameters that are produced will then be compared to the field measurements.

References

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