**LOICZ II Inaugural Open Science Meeting,
Egmond aan Zee, 27-29 June 2005**

On the Study of Simulated Nutrient Budget in Lampung Bay, Indonesia Using a Coupled Hydrodynamic-Ecosystem Model

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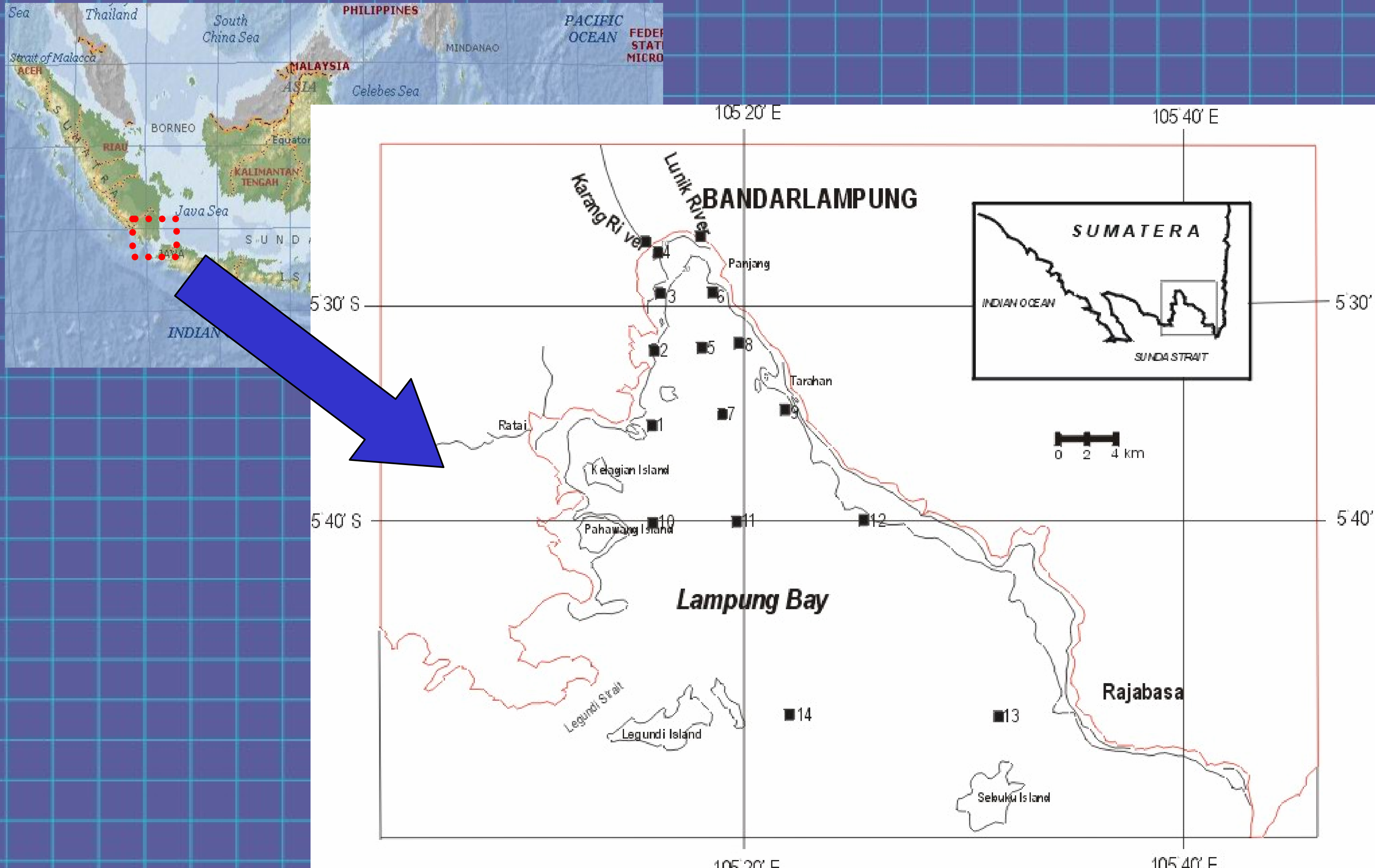

MAP OF LAMPUNG BAY, LOCATION OF STATION AND THE MODEL AREA

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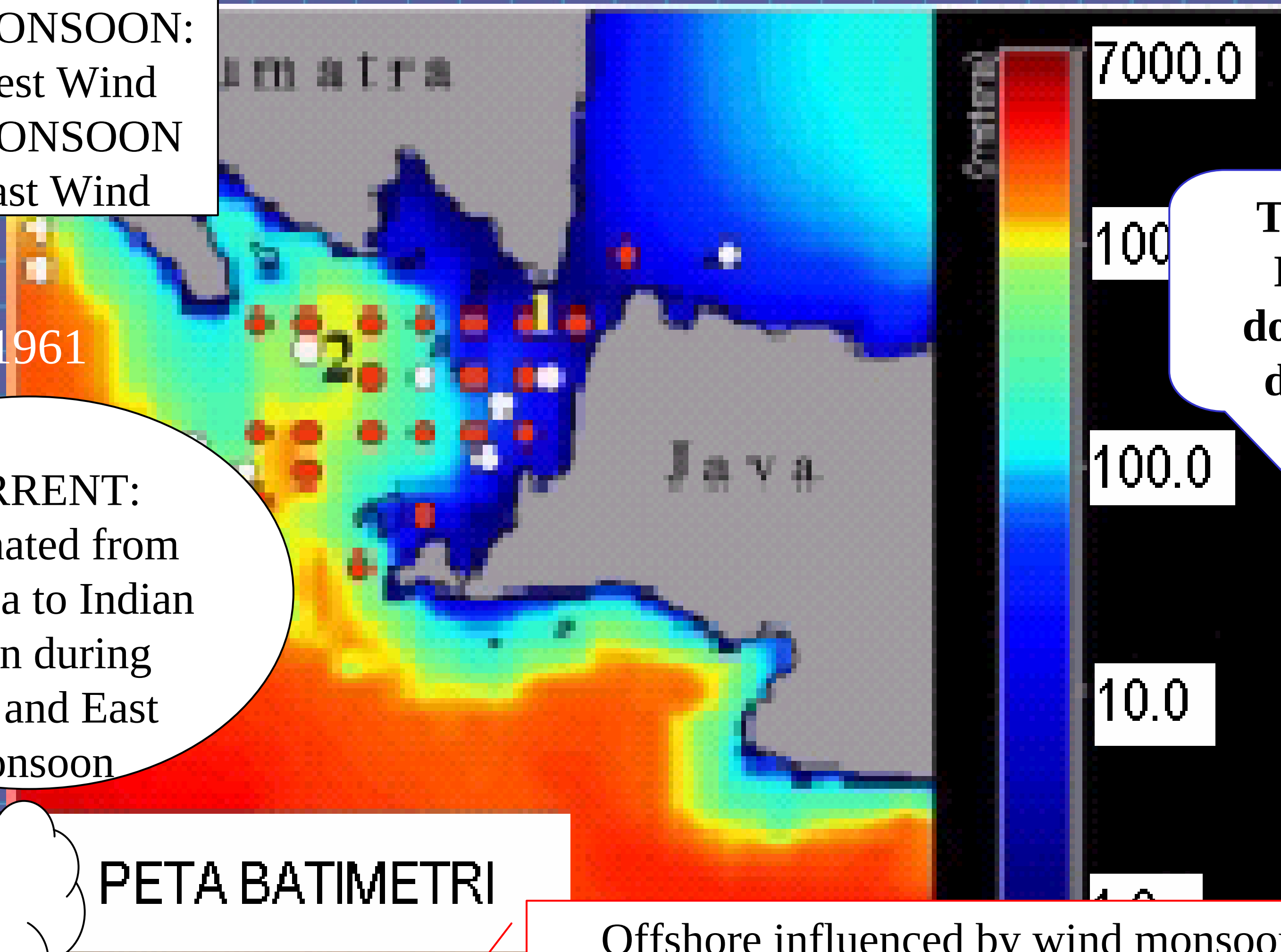
GENERAL CONDITION OF RESEARCH LOCATION

WEST MONSOON:
Northwest Wind
EAST MONSOON
Southeast Wind

Wyrtki, 1961

CURRENT:
Dominated from Java Sea to Indian Ocean during West and East Monsoon



**TIDAL:
Mixed dominant diurnal**

Pariwono, 1985

Offshore influenced by wind monsoon, coastal water monsoon by tidal current

Birowo and Uktolseja, 1981

BATHYMETRY MAP

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OBJECTIVE OF RESEARCH

To study the nutrient budget and the dynamic of an aquatic ecosystem in semi-enclosed Lampung Bay, Sumatera, Indonesia by using a numerical coupled hydrodynamic-ecosystem model.

METHOD

MATHEMATICAL MODEL:

COUPLED OF

2D DEPTH AVERAGED HYDRODYNAMICS MODEL → POM

ECOSYSTEM MODEL → QUICK METHOD

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Hydrodynamics Model and Ecosystem Model

2D Depth-Averaged Hydrodynamic Model using POM

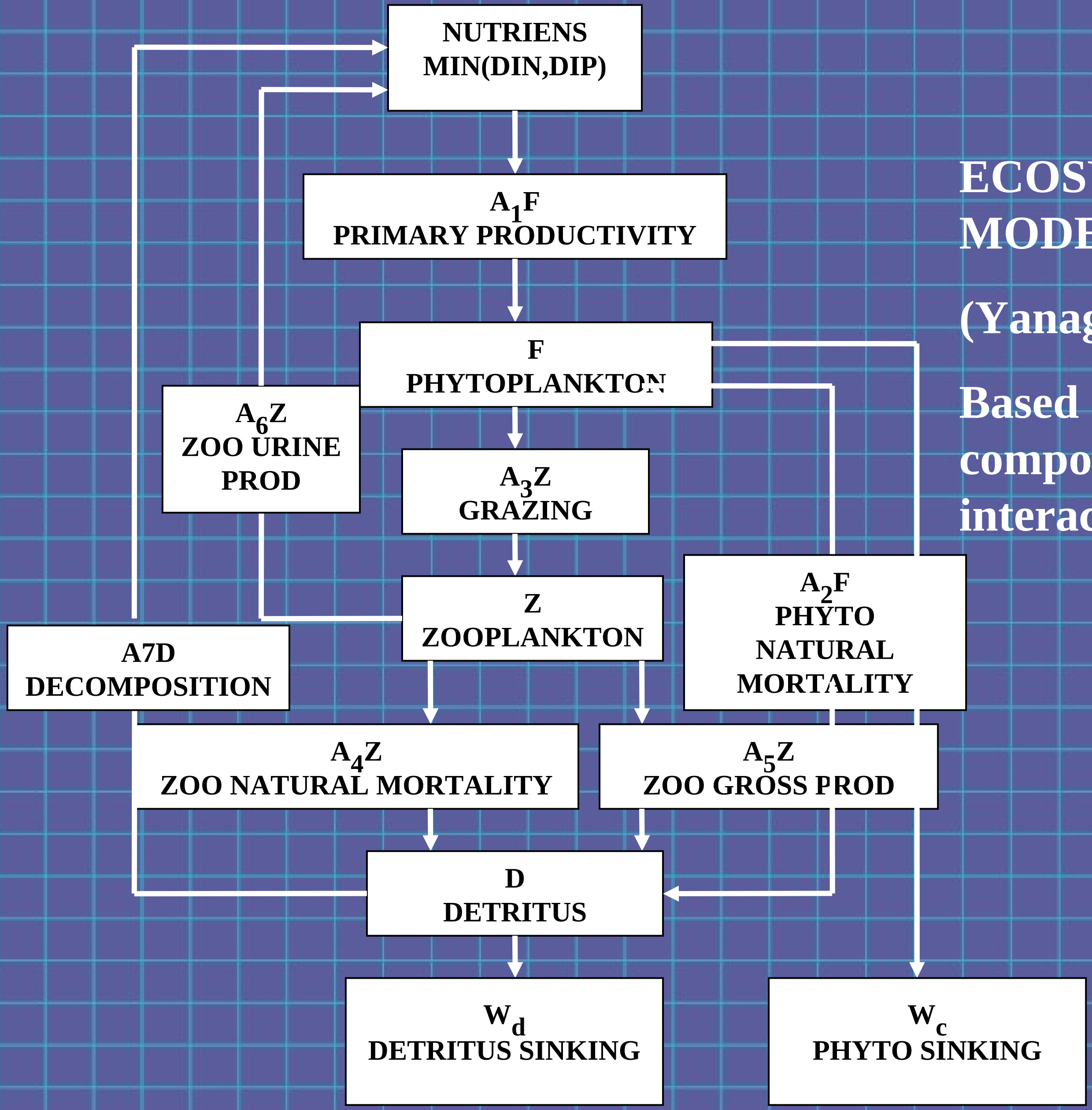
Closed Boundary Condition

$$\left(\overline{U},\overline{V},\eta\right)=0$$

Open Boundary Condition :

- Radiation condition for current

-Interpolated hourly tidal elevation data from ORITIDE (Matsumoto)



ECOSYSTEM MODEL

(Yanagi, 1999)

Based on ecosystem components interactions

A1 = Vm Min {V1(N), V1(P)} V2(I) V3(T) V4(S)

$$V1(N) = \frac{N}{K_N + N} \qquad V1(P) = \frac{P}{K_P + P} \qquad V2(I) = \frac{I}{I_{opt}} \exp\left(1 - \frac{I}{I_{opt}}\right)$$

$$V3(T) = \frac{T}{T_{opt}} \exp\left(1 - \frac{T}{T_{opt}}\right) \qquad V4(S) = \frac{S}{S_{opt}} \exp\left(1 - \frac{S}{S_{opt}}\right)$$

$A3 = R_{max} \{1- \exp \lambda(- F + F^*)\}$

R_{max} – grazing maximum speed

λ - Ivlev constant

F* - potensial phytoplankton concentration grazed by zooplankon. If $F^* < F$, then $A3 = 0$

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$$\frac{\partial F}{\partial t} + u\frac{\partial F}{\partial x} + v\frac{\partial F}{\partial y} = \frac{\partial}{\partial x}(K_h \frac{\partial F}{\partial x}) + \frac{\partial}{\partial y}(K_h \frac{\partial F}{\partial y}) + A1F - A2F - A3F - \frac{W_C F}{H}$$

$$\frac{\partial Z}{\partial t} + u\frac{\partial Z}{\partial x} + v\frac{\partial Z}{\partial y} = \frac{\partial}{\partial x}(K_h \frac{\partial Z}{\partial x}) + \frac{\partial}{\partial y}(K_h \frac{\partial Z}{\partial y}) + A3Z - A4Z - A5Z - A6Z$$

$$\frac{\partial N}{\partial t} + u\frac{\partial N}{\partial x} + v\frac{\partial N}{\partial y} = \frac{\partial}{\partial x}(K_h \frac{\partial N}{\partial x}) + \frac{\partial}{\partial y}(K_h \frac{\partial N}{\partial y}) - A1F + A6Z + A7D$$

$$\frac{\partial P}{\partial t} + u\frac{\partial P}{\partial x} + v\frac{\partial P}{\partial y} = \frac{\partial}{\partial x}(K_h \frac{\partial P}{\partial x}) + \frac{\partial}{\partial y}(K_h \frac{\partial P}{\partial y}) - A1F + A6Z + A7D$$

$$\frac{\partial D}{\partial t} + u\frac{\partial D}{\partial x} + v\frac{\partial D}{\partial y} = \frac{\partial}{\partial x}(K_h \frac{\partial D}{\partial x}) + \frac{\partial}{\partial y}(K_h \frac{\partial D}{\partial y}) + A2F + A4Z + A5Z - A7D - \frac{W_C D}{H}$$

Numerical solution using QUICK method

Iteration time for steady state condition :

Stage I = 30 days   Stage II = 40 days

NUMERICAL RESULTS VERIFIED WITH OBSERVATION DATA ON JANUARY 9, 2001

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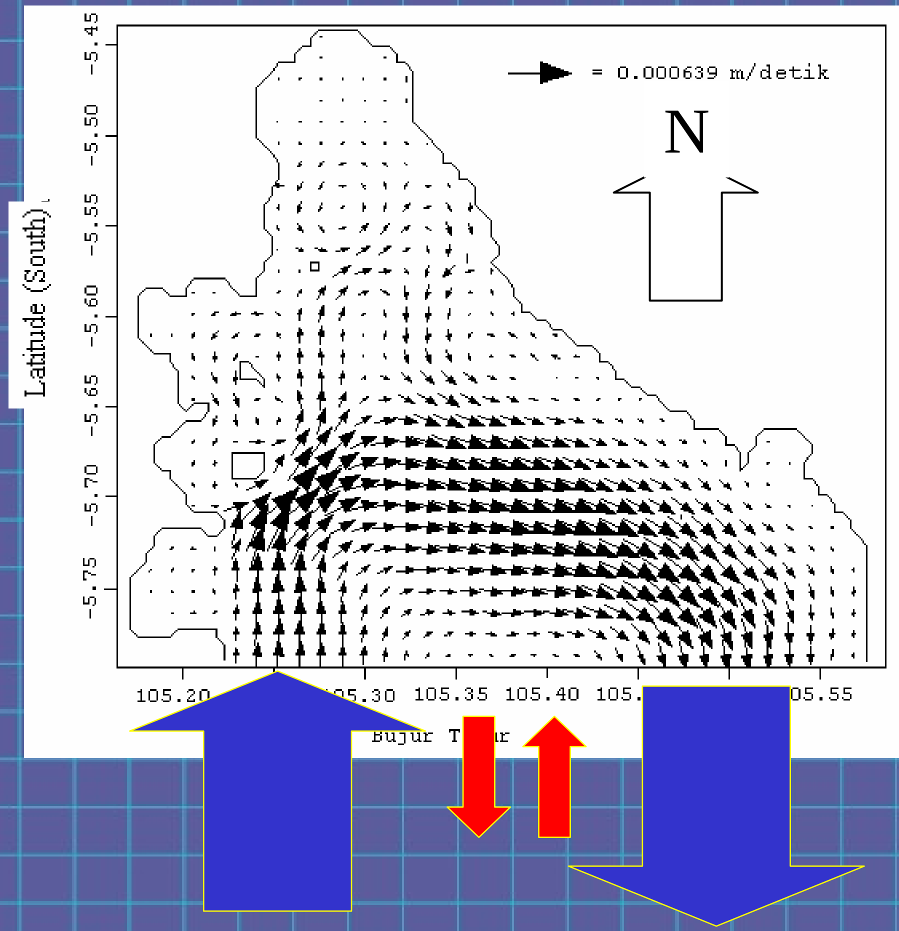
NUMERICAL M2 RESIDUAL CURRENT



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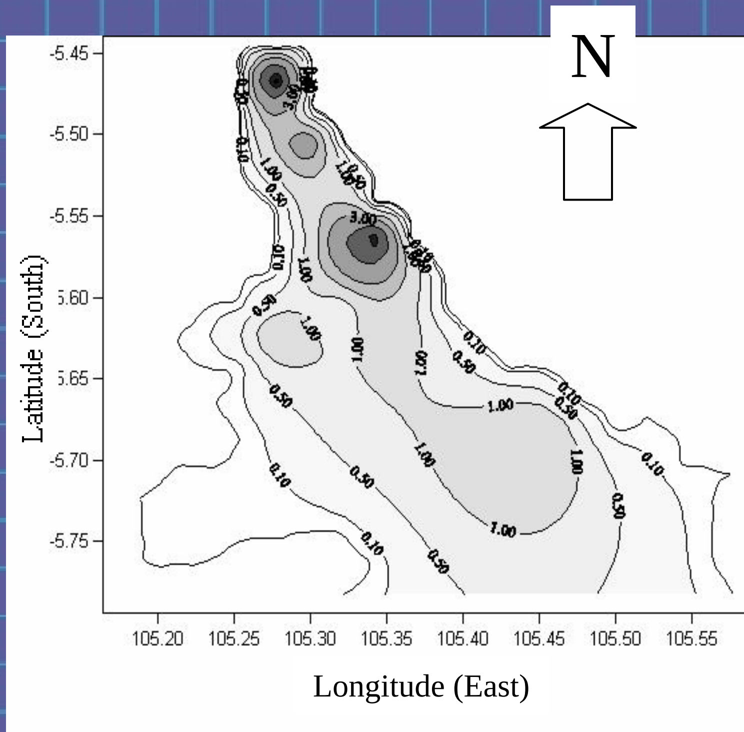

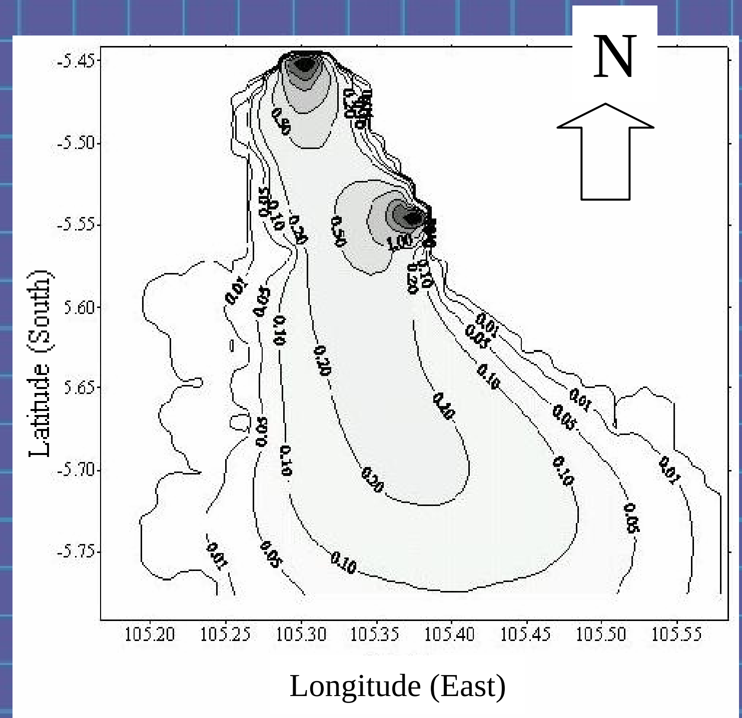

OBSERVATION

MODEL

SURFACE DISTRIBUTION OF NITRAT (uM)

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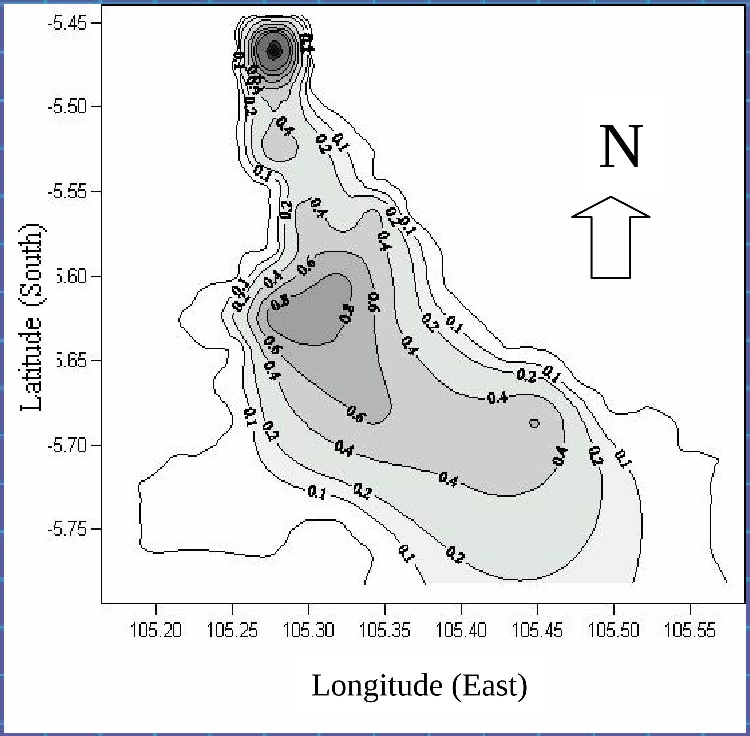
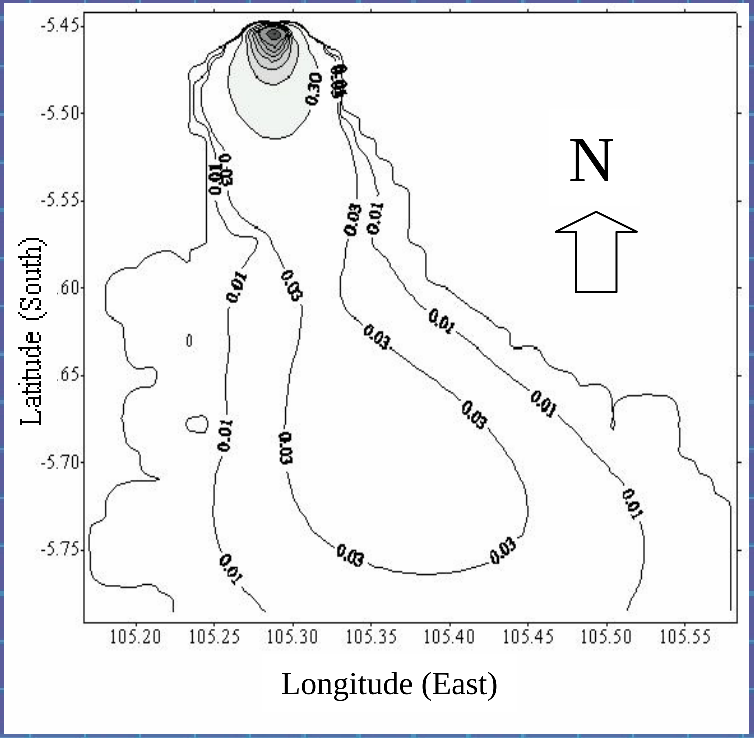
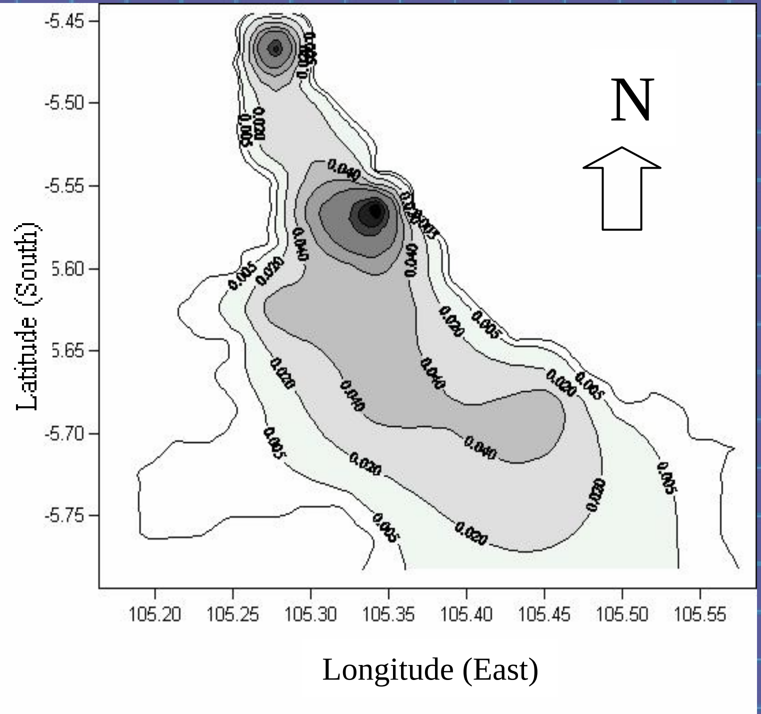


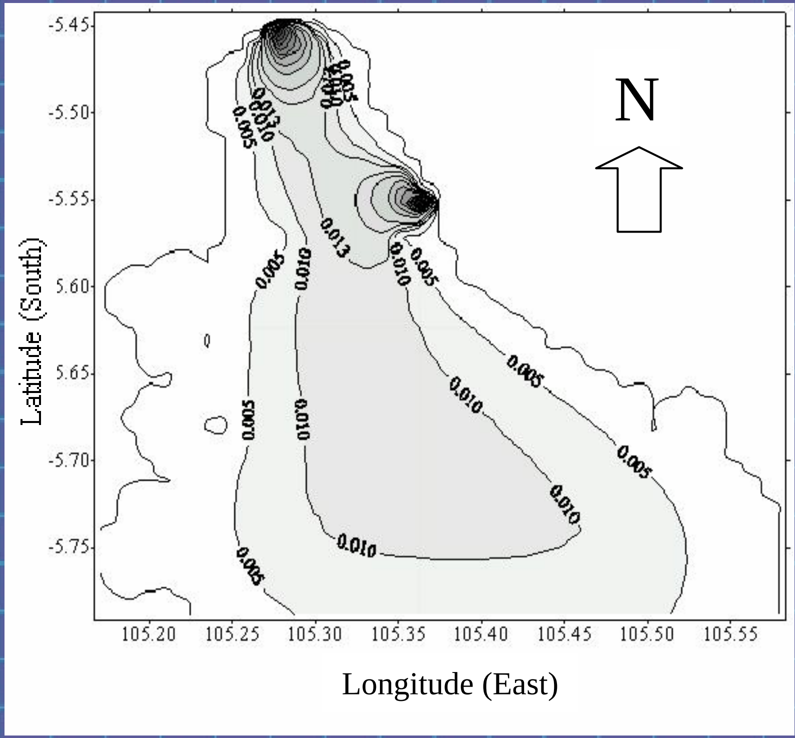


OBSERVATION

MODEL

SURFACE DISTRIBUTION OF PHOSPHAT (uM)

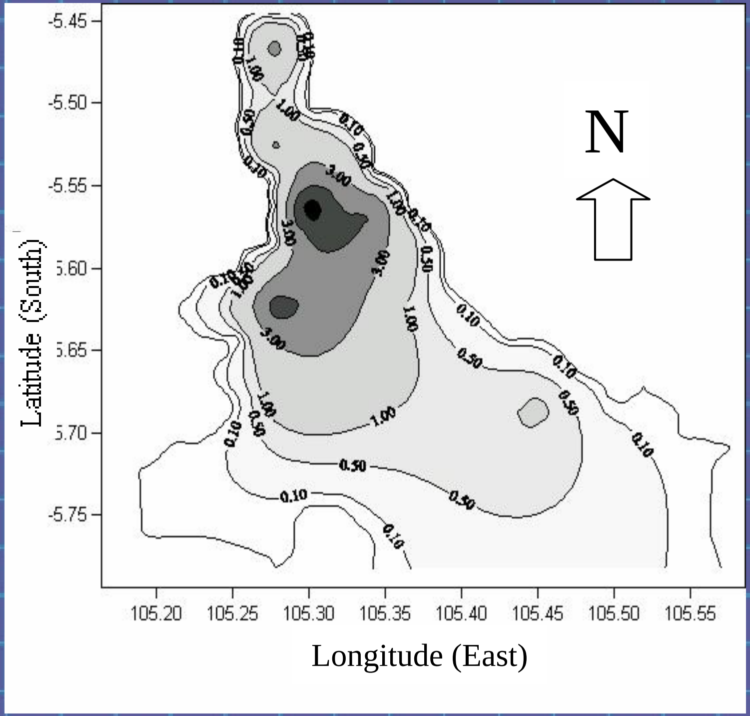


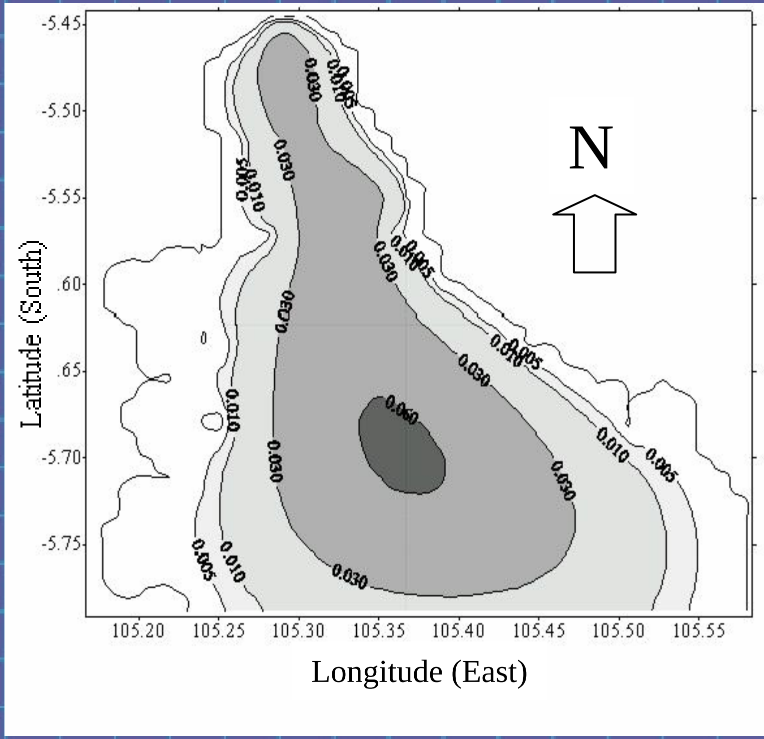


OBSERVATION

MODEL

SURFACE DISTRIBUTION OF CHLOROPHYL (ugC /lt)





OBSERVATION

MODEL

SURFACE DISTRIBUTION OF ZOOPLANKTON (ugC /lt)

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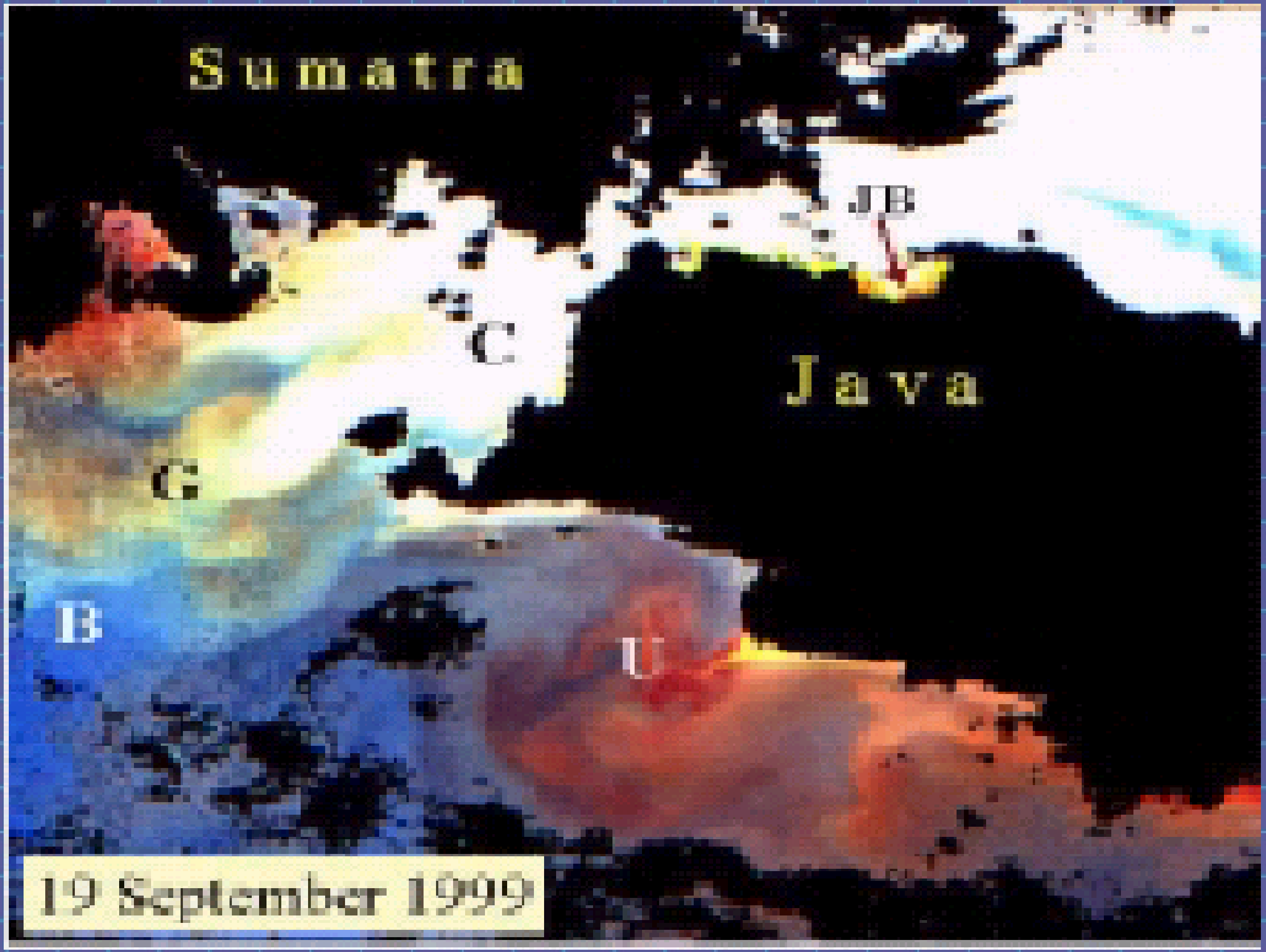
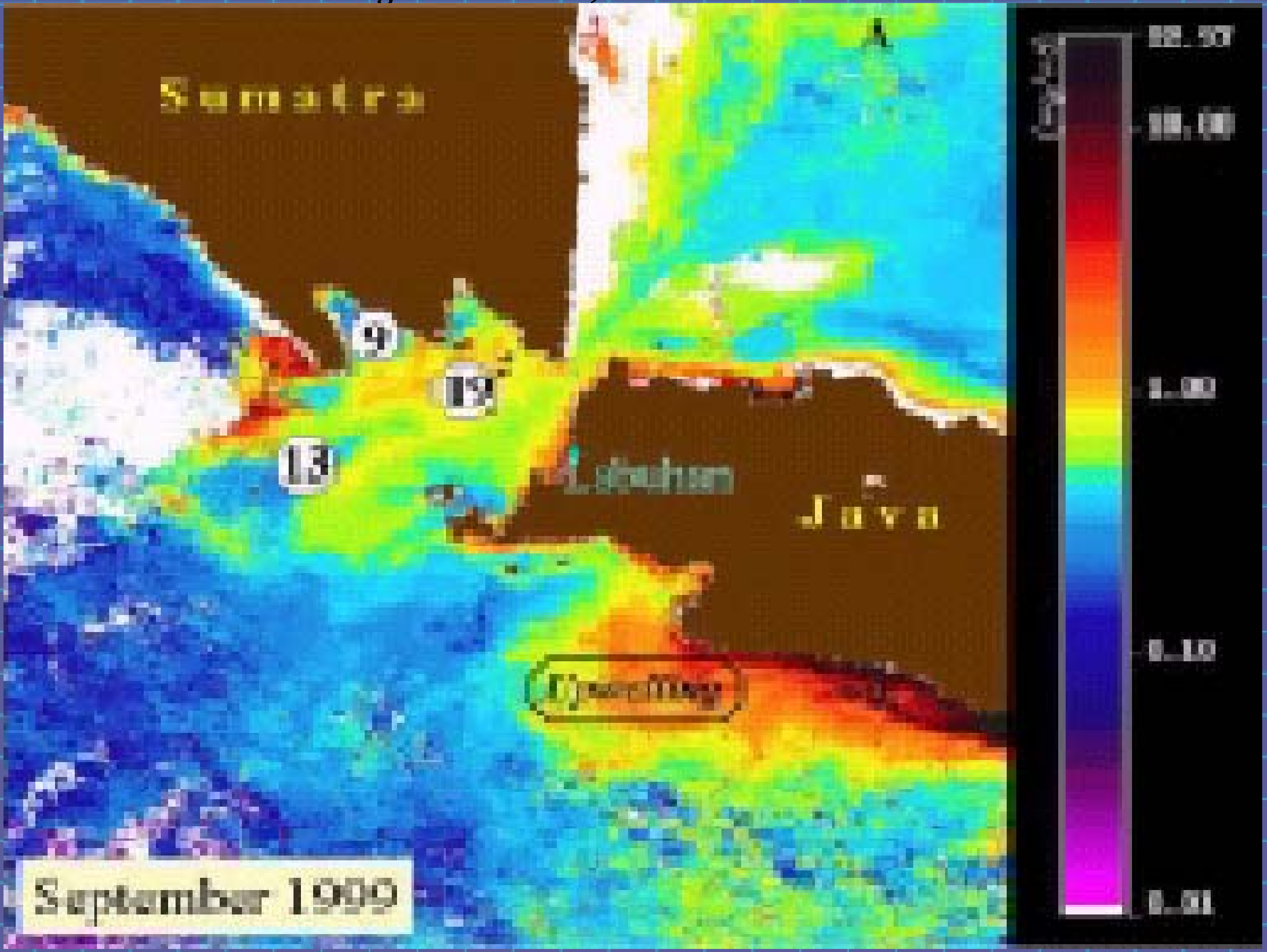
Table1. Simulation result of budget compartment affected by M2 residual current

Compartment	Source			Output	Nett
	River	Sea	Tarahan and Panjang coast		
Nitrat (kg mol)	0,79	13154 .4	0,79	6048, 0	7107,19
Fosfat (kg mol)	0,76	79531 ,2	-	34636 ,04	44895,92
Klorofil-a (Kg C)	-	7101, 63	-	1013,92	6087,71
Zooplankton (Kg C)	-	65087 ,28	-	12605 ,37	52481,91



C = Java Sea Water Mass; G = Mixed Water Mass (Hendiarti et. al., 2002)



Monthly averaged Chlorophyil-a in Septermber 1999 (Hendiarti, et. al,, 2002)

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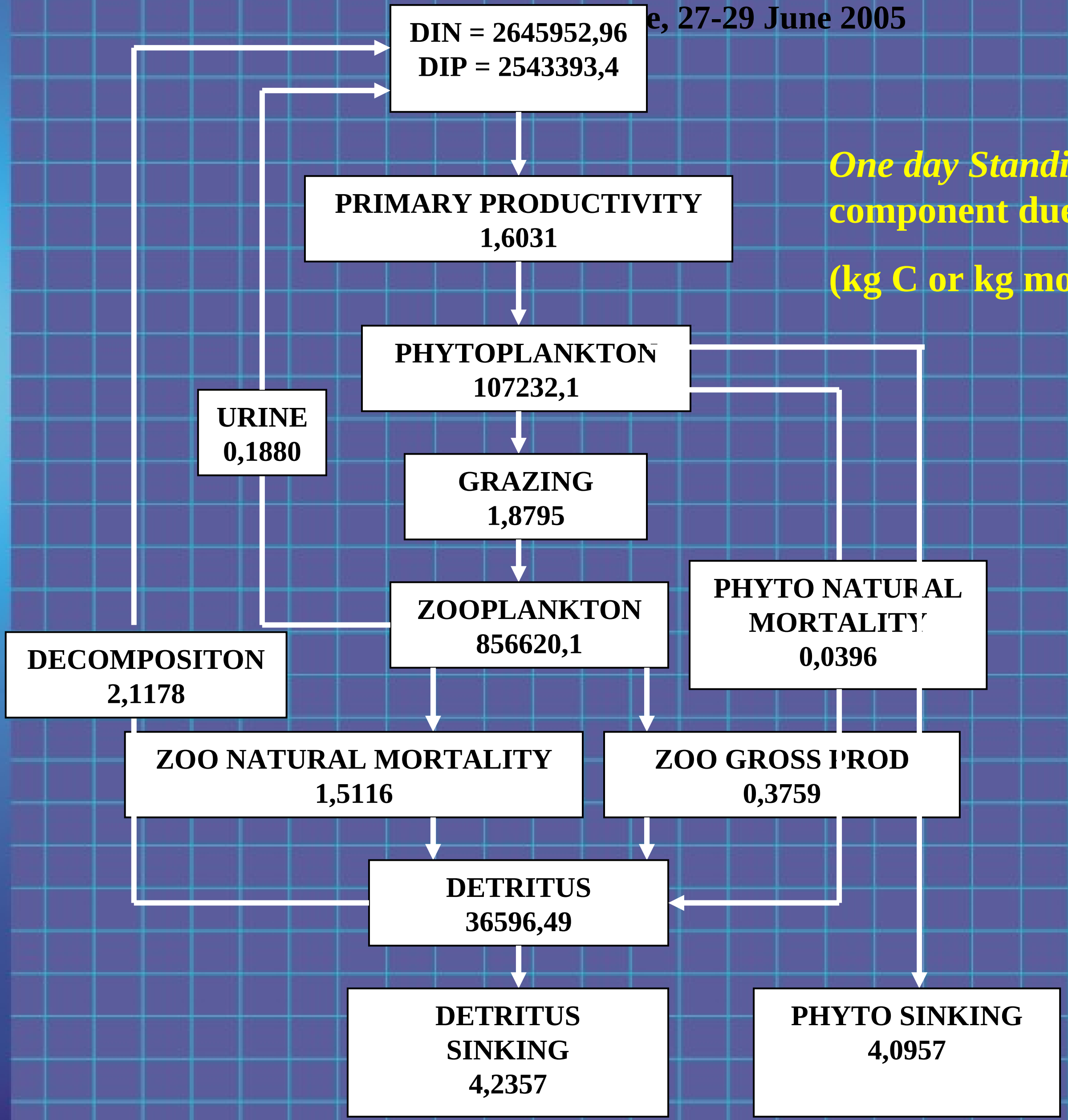
One day Standing stock **of ecosystem component due to M2 residual current**

(kg C or kg mol)



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CONCLUSIONS

- ✓ **The simulated flow pattern of M2 residual current, the dominant tidal constituent in this bay, tends to flow into the western mouth of the bay from which part of them flow toward the head of the bay while the other parts flow out through the eastern mouth of the bay.**

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CONCLUSIONS

- ✓ The primary production, secondary production (grazing), natural mortality of plankton and also decomposition by bacteria are less important to the budget and standing stock calculation in Lampung Bay ecosystem. The influence of rivers run off and ocean water from supply from Sunda Strait are more important than biochemical processes in the bay.

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CONCLUSIONS

- ✓ **The simulated rate of efficiency of heat flow from both the decomposition process and urine production by zooplankton to the primary production has missed of 30.48 %, while from the primary production to the secondary production (grazing) has added of 17.24 %.**

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@THANK YOU!

@TERIMA KASIH!

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