Progress Report

Project Title

Understanding the Dynamics of Hypoxia and Eutrophication in Manila Bay through Hydrodynamic and Watershed Modeling - in Support of Component B of the Global Foundations for Reducing Nutrient Enrichment and Oxygen Depletion from Land-based Pollution in Support of the Global Nutrient Cycle

Submitted by

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Period covered by this report

1 – 30 September 2012

Summary of Activities

- Laboratory work for August 2012 field samples
    - Nutrient analysis (partial)
    - Dissolved Organic Carbon analysis (completed)
- Research work
    - Preliminary matrix of data requirements and available data
    - Grid building

Report

Analysis Results

Nutrient Analysis

Surface inorganic nitrogen (nitrate + nitrite) was found to be high near the coast of Cavite and Bataan with values ranging from 4 – 8 µM (Figure 1A). At the bottom, inorganic nitrogen was highest off Bataan with values ranging from 12.5 – 15 µM but values for the southern part of the bay were mostly high as well, ranging from 6 – 10 µM, which is beyond the ASEAN criterion for nitrate+nitrite of 8 µM (Figure 1B).

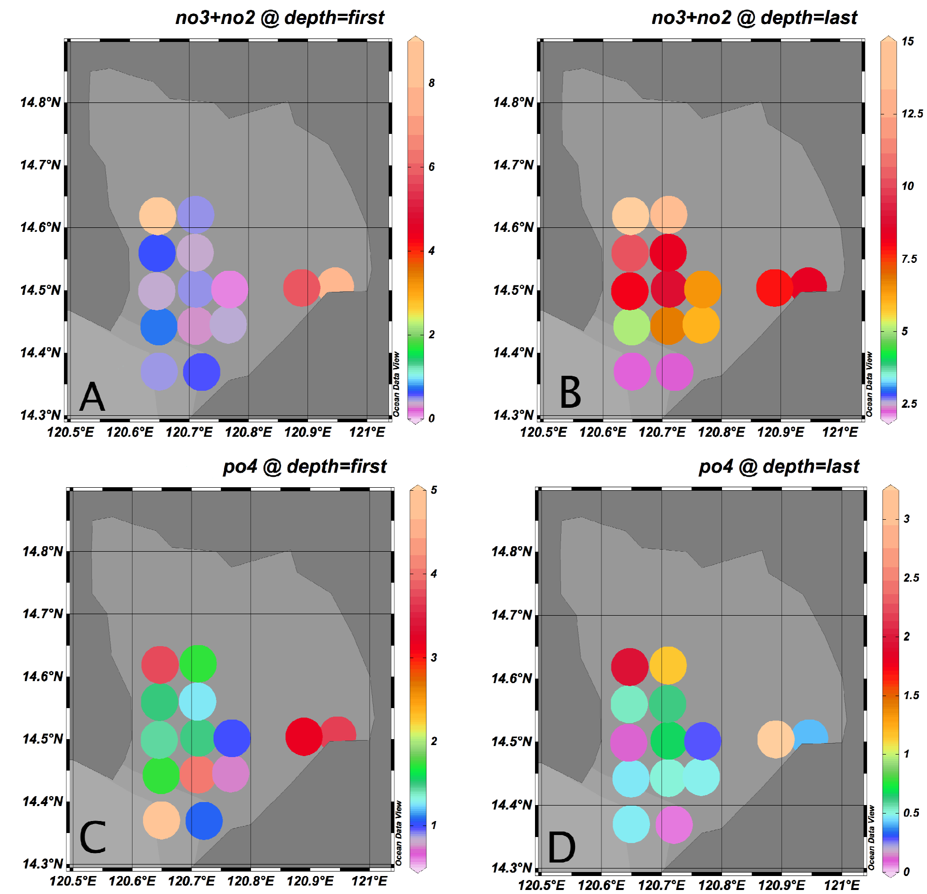

Figure 1. Surface (A) and bottom (B) distribution of nitrate+nitrite and surface (C) and bottom (D) distribution of phosphate in µM in Manila Bay during August 2012 (14 stations only)

Surface phosphate was also highest off Bataan and Cavite ranging from 3 – 4 µM exceeding the threshold of 1.45 µM (Figure 1C). Most of the surface phosphate values ranged from 1.5 – 2 µM. At the bottom, phosphate values were again highest off Bataan and Cavite at 2.5 – 3 µM (Figure 1D). Algal blooms are often recorded off Bataan which could be preceded by elevated nutrient concentrations. Cavite is a known shellfish mariculture area where excess waste can lead to the increase in the nutrient concentration.

Dissolved Organic Carbon

The surface dissolved organic carbon (DOC) in Manila Bay for August 2012 ranged from 116.7 – 204.4 µM with an average of 150.5 µM (Figure 2A). At the bottom, the DOC concentrations ranged from 59.5 – 227.3 µM with an average of avg. 97.3 µM (Figure 2B). A slight decrease in the surface average was seen from last year's survey (August 2011) while the bottom average remained relatively the same. However, an increase in the maximum DOC concentrations was found for both the surface and bottom.

At the surface, the highest DOC concentrations were found off the coasts of Bulacan, Manila, and Cavite where elevated primary productivity (from increased chlorophyll-a levels) has been seen before during the August 2011 survey. These results were also similar to DOC concentrations in August 2011, which were also elevated off the coasts of Bulacan and Manila. At the bottom, concentrations were highest off Pampanga, Bulacan, and Manila, again similar to the 2011 results where bottom concentrations were highest near the northern coast of the bay.

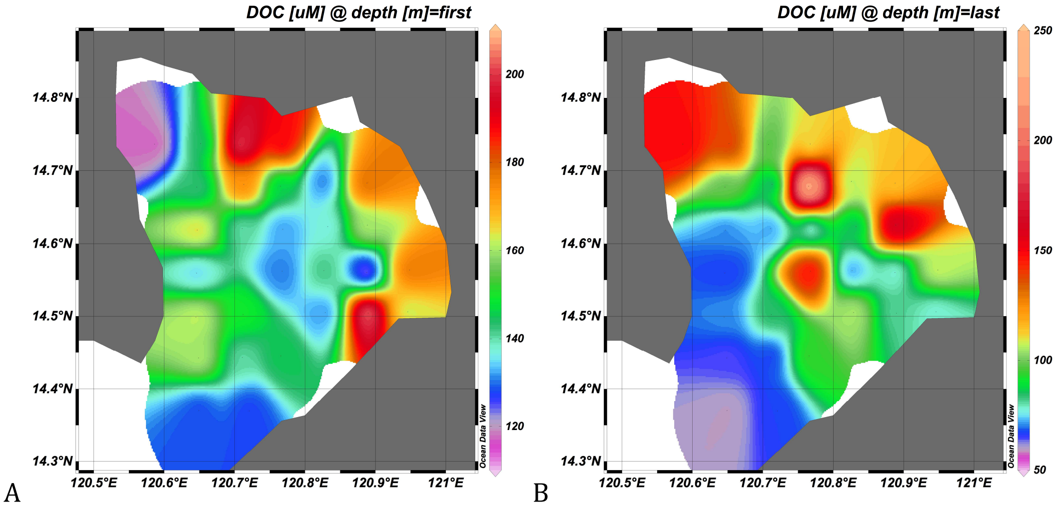

Figure 2. Surface (A) and bottom (B) dissolved organic carbon (DOC) concentrations for Manila Bay in August 2011 (wet season).

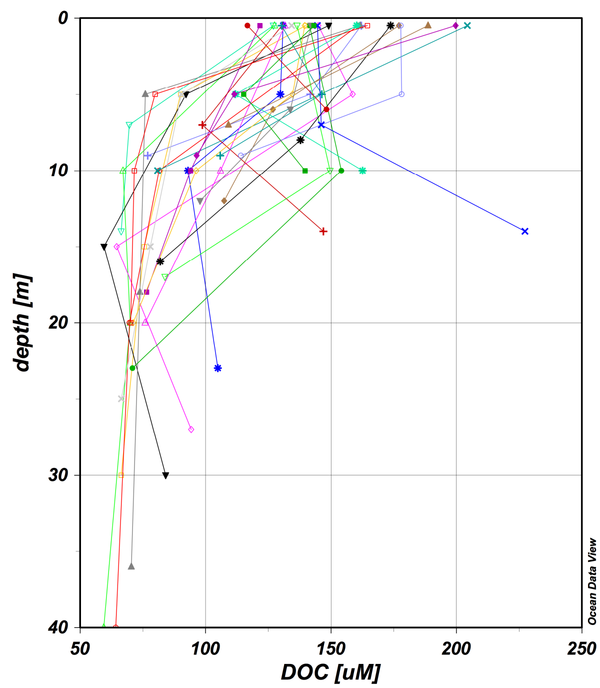

Figure 3. Dissolved organic carbon (DOC) profiles for Manila Bay during August 2012.

The DOC profiles for Manila Bay during August 2012 show a reverse-nutrient like profile with elevated values at the surface and depletion with depth. High DOC at the surface could be attributed to high primary productivity.

Research work

Data matrices

Table 1. List of data inputs to the waste load model (c/o Mr. Robert Jara of PEMSEA)

Parameter	Data source/ Exact data needs	Processing needed to input data	Present limitations and constraints
1. Crop area	GIS (1) Arable land area (2) Plantation land area (3) Grassland/ brushland area (4) Forest land area	Land cover is computed from NAMRIA and/ or satellite images	Decision to use NAMRIA or satellite image.
2. Leaching from agricultural soils	(1) Literature (2) BSWM data –physicochemical characterization of soil collected from select stations around the watershed (% organic matter, N, P, K, heavy metals)	Research Geo-referencing data	

Kg/ha/yr	BOD	NH_4	NO_3	P
Arable Land	75	25	10	9
Plantation	25	1	2	2
Forest	50	0	3	0.5
Grass land	25	1	2	2

Parameter	Data source/ Exact data needs	Processing needed to input data	Present limitations and constraints
3. Forest area	Forest land area Land use area, land use maps	Digitizing data maps Compilation of data into tabular format	
4. Leaching from forests	Literature		
5. Wastewater discharge coming from each type of industry	(1) Wastewater quality from every type of industry	Geo-referencing data available from reports (BSWM, PEMSEA, DENR) Quality check	Data from selected stations only Additional surveys should be conducted

6. Concentration in industrial wastewater (g/m3)	(1) Emission factor per type of industry	(1) Based on actual monitoring of industrial waste water discharge	

Concentrations in Industrial Wastewater (g/m3)

	NH_4	NO_3	TP	BOD_5
Food Manufacturing	50	0	12	1003
Pulp and Paper Manufacturing	6	0	1	57
Dye/Textile/Garments	5	50	6	47
Piggeries/Poultry/Livestock	138	0	10	750
Slaughterhouse/Hatchery	198	0	20	667
Beverages	22	0	10	40
Semicon	0	0	0	19
Metal	0	15	1	8
Agricultural	214	0	29	5
Chemicals/Pharmaceuticals	30	2	2	22
Minerals/Non-metals	15	0	23	5
Laundry	19	0	11	30
Wood	23	0	62	74
Rubber/Leather	123	0	7	728
Plastic/Film/Foam	24	0	1	142
Gasoline Station	0	0	0	109
Industrial Estate/Dumpsite	0	38	1	49
Housing/Recreation	0	0	0	137
Powerplant	0	30	1	3

7. Number of inhabitants with septic tanks	(1) Total population distribution per sub-basin (2) Survey from NSO of population with and without septic	(1) Compute from Total Inhabitants % with septic and % without septic	
8. Population equivalent for toilet and grey water - under inhab itants with septic tanks	(1) Literature (2) Study of emission factor from gray and toilet wastewater		

9. Decay rate for septic tank	(1) Literature (2) Study of decay rate of septic tanks in the Philippines		
10. Number of inhabitants with toilets discharging to drain or toilets without septic	(1) NSO survey (2) Assumed % of inhab with toilets without septic		
11. Decay rate/ Loss rates in local drain system			

Table 2.MIKE ZERO model requirements

Parameter	Data source/ Exact data needs	Processing needed to input data	Present limitations and constraints
MIKE SHE Model requirements			
1. Model extent – polygon, grid area	Maps, shape files, Google earth and satellite images.	Digitization of maps, creation of grid or mesh for the model, georectification of maps Boundaries from shape files have been completed	Identification of minimum grid/cell/mesh size for the model
2. Topography – as point or gridded data	Topography maps from NAMRIA	Digitization of maps	Access to topography maps
3. Precipitation – as station (rain gauge) data, can be specified as a rate or amount	Rain gauge data from PAGASA	Encoding	Access to PAGASA data
4. Reference evapotranspiration – as station data or from meteorological and vegetative data Vegetation: Leaf area index Root depth	Land use maps BSWM data reports	Data checks Digitization Data summary	

5. Sub-catchment delineation – for runoff distribution	Maps, delineation assigned by BSWM		
6. River morphology – geometry and cross-sections, for river flow and water level calculations	DPWH, PAGASA, maps	Digitization of maps	Lack of available data
7. Land use distribution – for vegetation and paved runoff calculations	BSWM report, satellite images, land use maps	Digitization of maps, encoding of data, checking data quality	
8. Soil distribution – for distributing infiltration and calculating runoff	BSWM data – soil maps for the different watershed	Encoding of data, checking of data quality	Data may be sparse or lacking, access to raw data for input into the model
9. Subsurface geology – for calculating groundwater flow			Data may be sparse, lacking, or unavailable
10. Water quality – source, sorption and degradation, rate constants	Literature, inferred from data		Limited data available
MIKE 21 and 3 Hydrodynamic model requirements			
1. Grid/Mesh	Maps, satellite images	Update boundary	
2. Bathymetry	Bathymetric surveys and maps	Additional bathymetric data from rivers and near the coast	
3. River discharge rates	DPWH, PAGASA, UP MSI	Data compilation	Update data, data may be lacking, access to data from PAGASA
4. Wind data	PAGASA		
5. Boundary conditions – tide levels	Tide gauge data	Update if necessary	
MIKE ECOLAB requirements – Eutrophication model 2			
1. Phytoplankton C, N, P	Field collection for CHNS analysis, published literature, estimate from field	Field collection for phytoplankton biomass,	Phytoplankton P will have to be estimated or taken from

	data	analysis of monocultures for C,N ratios	literature, Budget for a field survey
2. Chlorophyll-a	Previous field data	Comparison with CTD data	
3. Zooplankton	Literature		
4. Detritus C, N,P	Field collection for sediments Literature review	CHNS analysis of sediments	Budget for a repeat field survey
5. Ammonium	Field data	Data analysis and clean-up	Time series data will also be useful
6. Nitrate	Field data	Data analysis and clean-up	Time series data will also be useful
7. Inorganic phosphorus	Field data	Data analysis and clean-up	Time series data will also be useful
8. Dissolved oxygen	Field data	Data analysis and clean-up	Time series data will also be useful
9. Benthic vegetation carbon	Literature	Estimate from available data	

Table 3. Datasummary from previous field surveys in Manila Bay

Date	Data available	Status	Remarks
February 2010, dry season	Nutrients Dissolved oxygen profile (from YSI multimeter) Salinity profile (YSI multimeter) Temperature profile (YSI multimeter) Chlorophyll-a profile (YSI multimeter) Total suspended solids	Ok	YSI Data to be bin averaged
July 2010, wet season	Nutrients DO, salinity, temperature, and chlorophyll-a profiles (YSI multimeter) DO, salinity, temperature profiles (Seabird CTD) Total suspended solids	Ok	YSI data to be bin averaged and compared with Seabird CTD data
February 2011, dry season	Nutrients DO, salinity, temperature, and chlorophyll-a profiles (YSI multimeter) DO, salinity, temperature profiles (Seabird CTD)	Ok	YSI data to be bin averaged and compared with Seabird CTD data

	Total suspended solids		
August 2011, wet season	Nutrients DO, salinity, temperature, and chlorophyll-a profiles (YSI multimeter) DO, salinity, temperature profiles (Seabird CTD) Total suspended solids Total alkalinity (TA) Dissolved organic carbon	TA samples to be analyzed	YSI data to be bin averaged and compared with Seabird CTD data
August 2012, wet season	Nutrients DO, salinity, temperature profiles (Seabird CTD) Total suspended solids Total alkalinity (TA) Dissolved organic carbon Particulate organic nitrogen and carbon Surface current data (drogue)	Laboratory analysis ongoing Nutrient samples partially finished DOC samples completed	Re-processing of CTD data (bin averaging, evaluation, etc.)

Table 4. Summary of available data from the Bureau of Soils and Water Management (Assessment of Non-Point Source Pollution from Croplands of Manila Bay System Report, DENR/BSWM 2012)

Parameter	**Scope/Stations**	**Available Data**	**Remarks**
Land use maps	By sub-watershed: Pampanga, Bataan, Pasig, and Cavite	General land use Specific crop use Land use maps Specific land use (area)	Survey done on reconnaissance level and should be updated/complemented with satellite imagery/data
Water quality assessment	18 sites along main tributaries of the sub-watersheds Pampanga (6 stations) Bataan (2 stations) Pasig (5 stations) Cavite (5 stations)	Nutrients Total and Fecal coliform Heavy metals Pesticide residues Nutrient load	
Soil characterization	18 stations from the 4 sub-watersheds	Soil taxonomy maps Organic matter N, P, K content Heavy metal content	

Grid building using MIKE ZERO

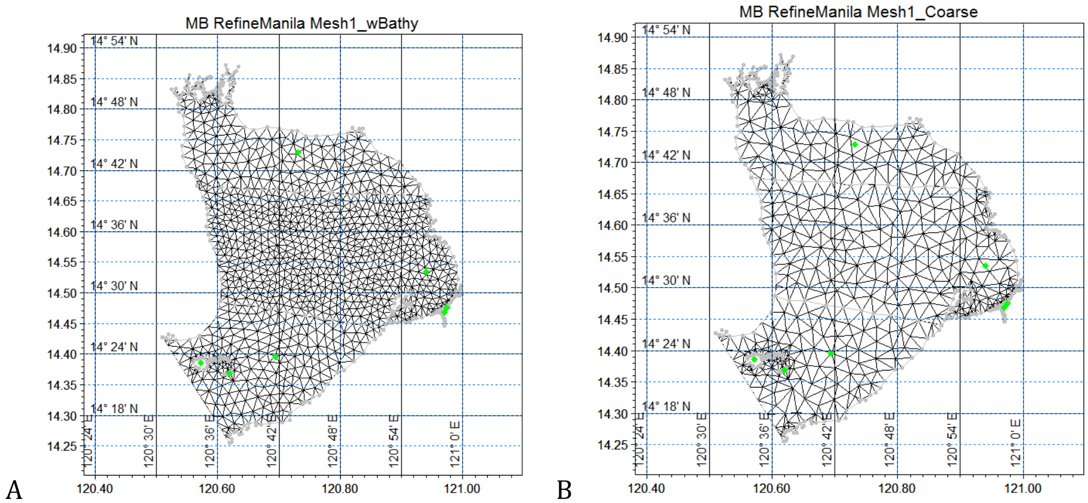

Figure 4.(A) Nested refined grid for Manila Bay with a minimum area of about 12 m^2 and a maximum area of 123 m^2 and (B) coarser grid for Manila Bay with a minimum area of 500 m^2.

Two grids were generated for use in the Manila Bay model. One has a refined middle area to better capture the circulation at the midsection where aggregation of debris and organic matter is suspected due to the two circulation gyres previously modeled for the bay. The coarse grid will be used to check if the main circulation features are still present even if the grid size is coarse.