



Global foundations for reducing nutrient enrichment and oxygen depletion from land based pollution, in support of the

Global Nutrient Cycle



Training of Trainers and Technology Validation on the Global Nutrient Management Toolbox

Prepared by: Marine Science Institute, University of the Philippines, Diliman, Quezon City, Philippines

Component B: Doc: B6-1

Partners:



March 2017

About the GEF-Global Nutrient Cycle Project

Project objective: to provide the foundations (including partnerships, information, tools and policy mechanisms) for governments and other stakeholders to initiate comprehensive, effective and sustained programmes addressing nutrient over-enrichment and oxygen depletion from land based pollution of coastal waters in Large Marine Ecosystems.

Core project outcomes and outputs:

- the development and application of quantitative modeling approaches: to estimate and map present day contributions of different watershed based nutrient sources to coastal nutrient loading and their effects; to indicate when nutrient over-enrichment problem areas are likely to occur; and to estimate the magnitude of expected effects of further nutrient loading on coastal systems under a range of scenarios
- the systematic analysis of available scientific, technological and policy options for managing nutrient over-enrichment impacts in the coastal zone from key nutrient source sectors such as agriculture, wastewater and aquaculture, and their bringing together an overall Policy Tool Box
- the application of the modeling analysis to assess the likely impact and overall cost effectiveness of the various policy options etc brought together in the Tool Box, so that resource managers have a means to determine which investments and decisions they can better make in addressing root causes of coastal over-enrichment through nutrient reduction strategies
- the application of this approach in the Manila Bay watershed with a view to helping deliver the key tangible outcome of the project – the development of stakeholder owned, cost-effective and policy relevant nutrient reduction strategies (containing relevant stress reduction and environmental quality indicators), which can be mainstreamed into broader planning
- a fully established global partnership on nutrient management to provide a necessary stimulus and framework for the effective development, replication, up-scaling and sharing of these key outcomes.

Project partners:

- Chilika Development Authority
- Energy Centre of the Netherlands
- Global Environment Technology Foundation
- Government of India - Lake Chilika Development Authority
- Government of the Netherlands
- Government of the Philippines
- Government of the United States
- Intergovernmental Oceanographic Commission of UNESCO
- International Nitrogen Initiative
- Laguna Lake Development Authority
- Partnerships in Environmental Management for the Seas of East Asia
- Scientific Committee on Problems of the Environment
- University of Maryland
- University of the Philippines
- University of Utrecht
- Washington State University
- World Resources Institute

Implementing Agency: United Nations Environment Programme

Executing Agency: UNEP- Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA)

Training of Trainers and Technology Validation on the Global Nutrient Management Toolbox

Marine Science Institute, University of the Philippines, Diliman, Quezon City, Philippines

20-24 March 2017

Funded by: The GEF- Global Nutrient Cycle Project.

Lead partners: IOC-UNESCO, Global Environment Facility, United Nations Environment Programme, Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, Global Partnership on Nutrient Management

Facilitated by:

University of the Philippines, Marine Science Institute
Utrecht University

Background

The GPNM Toolbox features detailed summaries of policy options, technology measures and their achievements, costs, socio-economic impacts and infrastructure required, along with a calculator tool that allows for users to estimate nutrient losses to the environment based on land management scenarios. The Toolbox has been undergoing validation over the past year, with familiarization and training activities to users at various levels. A final training series intends to draw on feedback from prior training sessions and engage technical and policy specialists using actual data (from their own countries) to cross-reference and validate the toolbox capabilities toward its finalization and eventual launch toward the end of 2016 or in the early part of 2017.

This “*Training of trainers and technology validation on the Global Nutrient Management Toolbox*” is intended to enhance uptake and replication in its application across the globe and is to be attended by participants from the major global regions to test the toolbox capabilities and its relevance under various management circumstances and geographic conditions.

Training objective: To enable trainees to effectively use the Global Nutrient Management Toolbox to evaluate nutrient loading/flux and impacts (hypoxia) based on global change scenarios (climate, land management, sewage and wastewater management) from broad continental to regional (LMEs) scales; and hands-on development and scenario analysis using nutrient flow models for a selection of megacities represented by the participants at the training workshop.

Expected learning achievements:

- Understanding the science behind the nutrient flux modelling modules of the Toolbox;
- Understanding of toolbox modelling requirements and scenario runs at continental scale to that of large marine ecosystems (LMEs);
- Demonstration of Manila Bay model evaluations;

- Use model for nutrient flows in the various megacities, scenario analysis and interpretation of results;
- Understanding the linkages between the various tools and how these will be applied in decision support processes at both technical and policy levels.

Target audience: Technical and policy professionals in relevant sectors of agriculture, urban planning, wastewater management who are charged with responsibilities for planning and management of investments in sustainable resource use and pollution control. The trainees should be in positions of leadership who could serve as contact points for onward promotion and subsequent delivery of training in-country on the toolbox. The trainees are to come from the major global regions; Africa, Southeast Asia, Europe, North America, Latin America and small island states. Trainees should be from countries that represent the 'typical' circumstance for the region being represented.

Trainees are expected to collect and prepare input data specific to the megacity they represent (in the prescribed format - specific guidance to be provided by the training team). Follow-up service to trainees will be provided through the partnership network under the GPNM toward further development, use and demonstration of the models.

Workshop Proceedings

Day 1 (3/20/2017): Introductions and background of the Global Nutrient Loading Challenge and the Global Nutrient Toolbox

1.1 Welcome Remarks

Fernando Siringan, Ph.D., Director, Marine Science Institute, University of the Philippines - Diliman

The first day of the workshop began with welcome remarks from the Director of the UP Marine Science Institute, Dr. Fernando Siringan, a geological oceanographer. He gave a background on the Marine Science Institute and its integral work in marine science research in the Philippines. After the welcome remarks, the participants and trainers introduced themselves, their region, and research interests.

1.2 Introductions and background of the Global Nutrient Toolbox

Lex Bouwman, Ph.D., Utrecht University, Netherlands

Dr. Lex Bouwman then introduced the GPNM Toolbox and its capability to demonstrate policy and technological options, which offer potential solutions for managing nutrients to decision makers and practitioners alike. A brief demo of the tool was done, showing its scenario building options, slider functionalities, and graph generation. Lex also explained the tool's assumptions and limitations in application especially with the way the tool deals with wastewater in some of the regions and watersheds.

1.3 Introduction to Wastewater Treatment and Nutrient Removal

Lex Bouwman, Ph.D., Utrecht University, Netherlands

The presentation introduced the basics of wastewater treatment and nutrient removal. This also paved the way for a discussion on the importance and need for wastewater treatment, disposal of sludge, and an explanation of septic tanks and their occurrence in the local setting of Manila, Philippines as well as other developing regions. A presentation on nutrient use efficiency was also given by Lex as added background on the Global Nutrient Cycle.

1.4 State of the science on nutrient management and need for integration in the sustainable development agenda

Christopher Cox, Ph.D., United Nations Environment Programme

Christopher Cox was then able to give the story and rationale behind the Global Program of Action (GPA) for the protection of the marine environment from land based activities as well as the Global Partnerships on Nutrient Management. He stressed the importance of integrating the science of nutrient management with the

UNESCO 2030 Sustainable Development Goals (SDGs). He also encouraged the participants, along with their organizations, to become partners and represent their respective regions in the GPNM.

1.5 Hands on Demonstration of the Global Nutrient Management Toolbox

Lex Bouwman, Ph.D., Utrecht University, Netherlands

After these presentations, the participants were able to download and work with the GPNM toolbox first hand with a demo from two different regions/watersheds: Pearl River and Pampanga River Basin in the Philippines. The exercise explored the tool's basic functions and also became an opportunity to check the results against local data from the region with the help of the participants from China and the Philippines.

Day 2 (3/21/2017): Other studies related to nutrient loading and checking of input data of the participants

2.1 Assessing Nutrient Inputs into Water Bodies and the Manila Bay Case Study

Gil Jacinto, Ph.D., Marine Science Institute, University of the Philippines - Diliman

The second day was opened with a presentation by Dr. Gil Jacinto to introduce the regional application of the Global Nutrient Cycle work: the Manila Bay Nutrient Load Model. Dr. Gil provided a background on hypoxia and eutrophication and an introduction to the study site, highlighting the nutrient loading related problems experienced by Manila Bay. He also shared one of the initiatives of the people living along the coast of the bay which was to sue the government prompting the Supreme Court to issue a Mandamus ordering the LGUs of the surrounding coastal provinces to conduct monitoring studies and rehabilitation efforts in the bay. However, he shared that despite the mandamus, progress in monitoring studies and rehabilitation efforts remain slow mostly due to coordination challenges.

2.2 Building a database and data gathering for the Manila Bay Nutrient Load Model

Lara Sotto, Marine Science Institute, University of the Philippines - Diliman

The next presentation was given by Ms. Lara Sotto on the details of the work behind the Manila Bay Nutrient Load Model, its challenges, modifications, baseline and scenario building results. Lara gave a walkthrough on the steps taken to build the nutrient load model from the data gathering, to the methodologies, and the modifications made to fit the local setting. The results were also shown, highlighting the scenario building experiments which has been useful in formulating the logical steps to take towards rehabilitation of the bay. The main source of nutrient loading in Manila Bay was determined to be domestic sources largely because of the high population density in the cities near the coast coupled with the inadequate sewage systems in place.

2.3 Participant Presentations I: Introduction to their Respective Regions and the Challenges and Issues Related to Nutrient Loading

Participants

The participants were given a chance to briefly present on their research area/region and the nutrient loading related problems in their area. Md. **Ziaur Rahman** from Bangladesh reported on the Buriganga River, which is considered one of the most polluted rivers in the world. The river receives discharge from tanneries and other industries as well as solid and domestic waste. There are proposals to move the tanning industries further up the watershed and set up new wastewater treatment plants. Some loading data from the tanneries are available.

Dr. **Luisa Diaz of Colombia** shared that they have good monitoring data from 2001 for inorganic dissolved nutrients and other parameters along the coast (16 years of data). The maps are uploaded onto a site easily accessible to the public. Their work in the area includes water quality assessment of coastal marine environments and the identification and characterization of land-based sources of pollution.

Stephanus Hamutenya then introduced us to Namibia at the SW of Africa, facing the Atlantic Ocean with 1572 km of coastline, 3 towns along the coast, and a population of 8 million people. The coastal area of Namibia has low population density and has no constant river runoff. Its potential threats include: harbour dredging, development of industries along the coast, land mining activities, and seabed mining. Their monitoring efforts include measurements on heavy metals, radionuclides, HABs, and nutrients.

2.4 The Laguna Lake Ecosystem Health Report Card: for Integrated Assessment and Decision aking

Engr. Jocelyn Sta. Ana, Laguna Lake Development Authority, Philippines

In between the participant presentations, Engr. Jocelyn Sta. Ana shared her work with the Laguna Lake Development Authority on the development of the Ecosystem Health Report Card for Laguna Lake. Their work went through 5 steps: conceptualization of key goals, values, and threats; identifying and choosing indicators; defining thresholds; calculating indicator scores; and visualizing and communicating results. Several workshops were also held to consult with experts, stakeholders, and LGUs, on how to build the report card. She shared the overall status of the bay as well as the status with respect to water quality (C-) and fisheries (F). A copy of the Laguna Lake Ecosystem Health Report card was also given out to the participants. Questions from the audience tackled total vs. fecal coliform, sampling frequency (monthly), threshold concentrations, and the cause of reduced depth in the lake (sedimentation).

2.5 Participant Presentations II: Introduction to their Respective Regions and the Challenges and Issues Related to Nutrient Loading

The next participant presentation was by **Ismaila Ndour** from Senegal. His study area, Hann Bay, is downstream of a densely populated area with lots of industries and domestic sewage sources. The most problematic nutrient source in Hann Bay is sewage from the coastal area that goes to the bay. The issues in the area include HABs and contaminations and they are concerned with ecosystem conservation and

human health. Oil discovery in Senegal also makes its impacts on the environment a concern. A wastewater treatment program is being developed for Hann Bay.

Ms. **Hiranthi Jansz** then gave a presentation on Sri Lanka located in the Southeast of India. Data availability in the region is good with available animal and industry inventory data. The training is timely because of an ongoing project funded by JICA whose main outputs are water body classification, establishing water quality standards, and strengthening capacities. There are also plans to set up an online water quality monitoring system. The most polluted river classified is the Keli River and an oil leak from Coca Cola has affected the area.

The Caroni River Basin in Trinidad and Tobago was introduced by Mr. **Hamish Asmath**. The Caroni River Basin is the largest watershed in Trinidad (887 km²). Efforts are being made to establish baseline and monitoring studies in the area as this has the highest amount of development and expansion of urban areas as well. The area has experienced lots of severe flooding, the effects of climate change, increase in rainfall. The river basin also receives effluents from wastewater treatment plants, industries, and the domestic sector. A unique factor in the Caroni River basin is that the discharges also pass through a protected swamp area which can absorb part of the nutrient input, a factor which is being studied using different modeling tools like Delft 3D.

Information about the Pearl River Basin was shared by Mr. **Wang Xutao** and Mr. **Wu Shiliang**. The Pearl River is affected by industrial, agricultural, and domestic waste. More than 65% of the watershed is used for agricultural activities and the major rivers flow to several huge cities. However, water quality seems to be getting better as people can swim across the 300m channel of the Pearl River in certain occasions.

The participants from the Philippines, Mr. **Brando Angeles** and Mr. **Erwin Mercado**, also work in the Laguna Lake Development Authority along with Engr. Sta. Ana so the introduction to their study site was already given in the earlier presentation about Laguna Lake.

2.6 Introduction to the Regional Nutrient Fluxes Model (RNFM)

Arthur Beusen, Ph.D., Utrecht University, Netherlands

The last session of the day was an introduction to the Regional Nutrient Fluxes Model (RNFM). The participants were immediately given a hands on exercise that began with downloading the required files and making sure that the program, Python, was installed in their computers. They each made sure that the installation was working by doing a quick test run in command prompt. An exercise on tweaking some settings such as changing the output directory and the input file was done in preparation for the participants to use their own data. The trainers made rounds to make sure each participant was able to do the exercises. Important reminders about using the model was given which was to make sure that everything was spelt correctly in the command line and .ini files to prevent errors.

The participants were then given some reminders to start thinking about their regions and the scenarios they would want to test using the RNFM. They were advised to go through the sample input file to check which parameters they have data on, which parameters they would like to add, and which parameters need to be explained. They were also reminded that at the end of the workshop, they were to give a presentation

on the results of their model runs.

Day 3 (3/22/2017): Hands On Work on the Regional Nutrient Fluxes Model and Scenario Building

3.1 Hands on Work with the Regional Nutrient Fluxes Model (RNFM), Quick Recap, and mid-week review of the course

Participants and Trainers

The third day began with some more hands on work so the participants could test and run the model followed by a quick evaluation by Dr. Arthur Beusen by asking the participants about their experience with the model. The feedback from the participants included adding more description about the model and questions about a graphical user interface (GUI) for the output which the current version does not have. A comparison between the RNFM and the Global Nutrient Toolbox was mentioned but it was reiterated by the trainers that this model is a scaled down version and does not have the GUI the Toolbox has. Ms. Lara Sotto also quickly went through the file structure of the model package and ran through the files and how the organization of the input and output files are done.

3.2 Presentation of Different Modelling Approaches for Nutrient Flows in Watersheds

Lex Bouwman, Ph.D., Utrecht University, Netherlands

After the hands on activity, Dr. Lex Bouwman gave a presentation on the different modelling approaches for nutrient flows in watersheds. He introduced the concept and importance of spatial scale when using modelling (local, sub basin, watershed, regional, global) which is important with models that have data in different scales. These factors have to be aggregated properly. The temporal scale was also mentioned. He introduced mechanistic and lumped regression models like the Global News Model. He also mentioned the hydrological and physical factors which are important in modelling nutrient sources. He gave an example of Black Box models with single regression equations wherein one does not know what is going on in the process. For example, the Global News Models lack processes and do not allow testing scenarios such as climate change. The coefficient model approach, based on coefficients, was also introduced. The disadvantages of this type of model is that it rarely accounts for nonlinear interactions and is seasonal scale at best. Dr. Bouwman mentioned that the RNFM tool the participants are working with uses this coefficient approach.

3.3 Hands on Work with the Regional Nutrient Fluxes Model

Most of the 3rd workshop day involved more work with the RNFM. The participants started to work with their own data, tweak some settings to create different output folders and input files, and plan their scenarios. Some modifications to the code were also done by Dr. Arthur Beusen based on the needs of the participants, improving

simple details in the model like the naming of the output file and the function to run multiple scenarios in one input file. Most of the participants already accomplished multiple runs at the end of the day and were able to run the models on their own. Some challenges encountered were incompatibilities with the default language set in some of the computers (esp. Chinese) and outdated software (e.g. Excel).

After the day's sessions, a welcome dinner was held at Via Mare, GT Toyota Center, University of the Philippines.

Day 4 (3/23/2017): Scenario Runs using the Regional Nutrient Fluxes Model and Analysis of Results

4.1 Participant Presentations III: Progress with the Model, Initial Results, and Plans for Scenario Runs

Participants

After a quick recap of the events in Days 2 and 3, plus a review of the model structure and exercises done, the participants gave their respective presentations on the progress they had made with the RNFM and the scenarios they wanted to test with the model. Brando Angeles and Erwin Mercado of the Philippines presented the results on Laguna Lake and worked with changing the population and %urban. Data is available in the area, especially for different regions of the Laguna Lake Watershed. Arthur suggested for them to test a scenario wherein the treatment of septic sludge is different and also helped them run multiple regions in one input file.

Mr. Hamish Asmath gave an update on the Caroni River Basin saying that most of the data needed by the model is available in the region. Three timelines were considered: 2030, 2040, and 2050 with change in the level of treatment (up to tertiary), population, and industrial pollution control as scenarios. Projections of wastewater treatment improvement in the area is reported to be 48% by 2025. However, the plans to improve wastewater treatment to tertiary will only apply to the newly built plants.

For Sri Lanka, Kelani River in Colombo has an upcoming project that will be able to provide data needed by the model. Ms. Hiranthi Jansz shared her scenario ideas for the Kelani River watershed which includes increase in population and improvements in sewage treatment. Eventually, other industries will also be added specific to the region like paper and textile industries.

Wang Xutao and Wu Shiliang of China shared their Guangzhou City run and planned to test population growth related scenarios as well as waste treatment improvement. With many small rivers in the city area, pollution in the rivers has been quite problematic.

4.2 Possible Applications of the Nutrient Load Model to Impacts Modeling: How do these Nutrients affect Hypoxia and Eutrophication in Manila Bay?

Lara Sotto, Marine Science Institute, University of the Philippines - Diliman

In between the participant's presentations, Ms. Lara Sotto talked about the possible applications of the Nutrient Load Model used in Manila Bay to impacts modeling. She

shared the work that was being done to integrate the results of the nutrient load model into a hydrodynamic and water quality model. The results of the different scenarios from the nutrient load model runs are to be incorporated as input to the water quality model.

4.3 Participant Presentations IV: Progress with the Model, Initial Results, and Plans for Scenario Runs

Participants

Md. Ziaur Rahman of Bangladesh shared information about the available data in the region that can be used in the model as well as the scenarios he is testing for Bangladesh which include improvements in sewage systems, wastewater management, and an increase in industries in the area. He also plans to utilize the model in other areas like Dhaka and Chittagong where the population density is higher.

Dr. Luisa Diaz then shared her initial runs using data for population with three scenarios at increasing population and increasing connection to sewage systems. However, she noted that she needs to update the parameters in the input files to data for Colombia. It was observed in her results that the ratio of N:P changed throughout the scenario years.

For Senegal, population and sewage treatment were used in the different scenarios, according to Ismaila Ndour. However, the data for the region considered is not yet readily accessible and data for the whole Senegal was used.

Stephanus Hamutenya then shared his planned scenarios for Namibia which was to improve wastewater treatment, increase population (simulate people moving to the coast), increase the number of industries in the coastal area, and increase dumping of waste in the water. A feature that he would like to add or test would be checking the contribution of ships docking in the harbours and the load it contributes.

Arthur then closed the session by showing some tips on how to tweak the models and giving suggestions on which scenarios to test.

Day 5 (3/24/2017): Participant's presentations, Summary of the Workshop, Feedback, and Closing

The morning of the last workshop day was dedicated to finalizing the RNFM runs of the participants and helping them wrap things up with their scenarios and results analysis. The trainers went around and interacted with the participants for troubleshooting or any questions. After lunch, the participants were ready with their results and presentations.

5.1 Participants Presentations V: Results of the Regional Nutrient Fluxes Model Runs for the Different Regions

Participants

Laguna Lake, Philippines

Brando Angeles and Erwin Mercado

The model run for the Laguna Lake region included all the municipalities (61) in the Laguna Lake watershed. They were able to include all these districts in one input file and the results in one output file. They presented the output logs wherein an error was noticed by Arthur. The error came about because the model automatically corrects for the percent of people connected to sewage systems in relation to the total percentage of primary, secondary, and tertiary treatment. The total of percentage treated cannot be higher than the percent of people connected. They shared their plan to run the model after all the data is obtained then have the trainers check the results.

Trinidad and Tobago

Hamish Asmath

There is a lot of nutrient work in the Caroni River basin so most of the data sets needed are available. In the region, there are a lot of agricultural land but fertilizers may not play a very significant role. The scenarios considered were 2010, 2030, and 2040. 2030 was included to be consistent with the UN Sustainable Development Goals. The parameters considered were: wastewater treatment and connections, population, no CAFOs, no change in animals, and no industry. In Trinidad and Tobago, the population pyramid is inverted so the population is expected to decrease just after 2025. There are planned construction of new treatment plants and a focus on moving to tertiary wastewater treatment.

Colombia

Dr. Luisa Diaz

There are a lot of nutrient concentrations available in the region for use in the model. In the area, especially along the coast, people are not connected to sewage systems and there is direct discharge to the water from small houses along the coast. This was not accurately depicted in the runs because of an error in the input files which was pointed out (in fraction of people in the coast). There are also extensive palm and banana crops in the area so in the future versions of the model, it will be useful to include fertilizers. A plan is to also include Magdalena River in the future runs of the model.

Pearl River, China

Wu Shiliang and Wang Xutao

The participants from China were able to do the model runs for the different scenario years in one batch file. They also tested improved sewage treatment. An interesting analysis of the results that they obtained was done by normalization of the years against a reference year which made it easier to visualize the trends.

Kelani River Basin, Sri Lanka

Hiranthi Jansz

As with most of the results of from the regions, an increase in the population in the Kelani River Basin led to an increase in emissions. For now, only population was changed in the scenarios but other parameters to be considered include: detergents, emissions related to textile washing industries, and agriculture related emissions.

Namibia

Stephanus Hamutenya

The model runs for Namibia will be focused on Luderitz and Walvis Bay because these are areas with mariculture activities. However, for Namibia, most of the data is only on population and N and P emissions so there is still a need to acquire additional data. In the meantime, data from global statistics were used to test for N and P emissions in the years: 1990 (independence year for Namibia), 2000, 2010, 2020, and 2030. It was a useful exercise to include a year in the past to check if the model runs for the baseline and future years make sense. Future plans include collaboration with the ministry of Agriculture to obtain the data needed for animal excretions, collect industry data, and integrate the local data available.

Senegal

Ismaila Ndour

The population related N and P emissions were tested for Senegal using World Bank data. It was seen that there was a positive correlation between the population and N and P emissions. However, the results shown were only the outputs to the ocean so Arthur had to clarify that in the output files, it is also important to look at the total emissions to surface water which also go to the ocean. It was suggested that a risk threshold or a benchmark for each scenario is included in the model.

Bangladesh

Md. Ziaur Rahman

The Khulna region was the focus of the model runs for Bangladesh. The main source of data was the FAO. The scenarios include improving wastewater management, increase in animals, and industries for the different years. Future plans include involving planners and ministries so that results can engage policy makers. The need for calibration and validation of the nutrient loading system was also recognized.

5.2 Closing Remarks

Dr. Lex Bouwman summarized the events of the week and highlighted important points in the model as well as where the model can still be improved with respect to the suggestions of the participants. He also invited the participants to work on a scientific article based on their experience in the workshop and the different results from the regions involved. Dr. Bouwman mentioned that for preparing the scientific article, scenario data for all countries involved will be circulated within a month after the course. This material will include a number of essential scenario data necessary to construct input files for the regions represented at the workshop. Dr. Beusen gave some final reminders about the proper use of the Regional Nutrient Fluxes Model. A brief awarding ceremony that highlighted peculiar events or characteristics of each of the participants followed as well as handing out of the workshop certificates.

Workshop Evaluation

Participant feedback

Evaluation forms were filled in by the participants and is summarized in Appendix IV. Generally, the feedback from the participants was positive in terms of satisfying the training objectives. They expressed appreciation for the amount of interaction between the trainers and participants during the training as they worked on the RNFM. In terms of meeting expectations, feedback was mixed, with one expecting to have learned more about the interpretation of the results and another expecting to have calibration, validation, and some coding included in the training. Otherwise, expectations were met. In general, the participants shared that they learned something new and useful during the training course, and that the tool is something they can use back in their respective regions/countries. Recommendations often included setting up a GUI with the model similar to the GNC Toolbox which includes the slider function to easily change scenario inputs and an option to automatically visualize the results.

Trainer reflections and evaluation of the workshop

The workshop was designed to introduce a scaled down version of the Global Nutrient Cycle models for application at the regional level. Based on the pilot study in Manila Bay, which had a similar objective, the goal was to be able apply a nutrient flux model that was broad enough to work on different regions. In planning for the workshop, Dr. Arthur Beusen and Dr. Lex Bouwman, modified the Manila Bay Nutrient Load model structure to work without the map inputs required. This simplified the work needed to gather the input data for the model and eliminated the need for GIS work in the training course.

The tool itself was well received by the participants, however there is a bit of a learning curve associated with the model especially for those without an inclination for working with computers. Specifically, in using the command prompt (even very basic use) and even the basics of Excel. These were especially relevant during the first part of the training course which required familiarization with the command prompt. This was observed with a couple of participants who struggled with setting up the model and

getting started because they did not have a good background with computers.

In opening the training course with an introduction to the Global Nutrient Management Toolbox, the participant's expectation for the Regional Nutrient Fluxes Model that they subsequently worked with became in line with the functions of the Global Nutrient Toolbox – specifically with the built in GUI and a more user-friendly interface. With an enhanced introduction and background on the RNFM tool itself, the limitations of the RNFM and expectations could have been clarified with the participants. For instance, more time could have been spent in setting the framework for developing the RNFM and demonstrating the default model run for Manila with more details on the inputs and output. Also, the dissemination of information to the participants beforehand on the required reading, background information, basic skills set needed for the training course, and the data input needed could have been better as most of the participants did not know about or failed to access the training materials available to them in Ocean Teacher or elsewhere. The current manual for the Regional Nutrient Fluxes Model can be improved with the addition of a short description of the functions, a walkthrough of the installation and use of the model, and a brief background on the concepts used in the tool. It may also help to be more explicit on the skills set required of participants to more effectively learn the tools during the training (e.g., familiarity with the command prompt and basic Excel functions).

Nevertheless, the hands on exercises of the participants in actually building the input and output files almost from scratch and running the model to run through the command prompt was a good way to train them to evaluate each step and question each function instead of just having a ready one step tool that will provide data and results. It was also useful for the participants to be able to see step by step how the changes in the input files affected the results of the model runs. This training method was better in allowing the participants to appreciate the processes in the model itself.

Appendix 1: Agenda

Training of trainers and technology validation on the Global Nutrient Management Toolbox

Venue: University of the Philippines Diliman, Quezon City, Philippines
20-24 March, 2017

Lead facilitators/trainers:

Lex Bouwman and Arthur Beusen - Utrecht University (UU)
Lara Sotto and Gil Jacinto- University of the Philippines, Marine Science Institute (MSI)
Jocelyn Sta. Ana, Laguna Lake Development Authority

Draft Agenda 20-24 March 2017

Session	Detail and Learning Objectives
Day 1: 20/3	
1.1 Opening remarks	Brief remarks and outline of the agenda and objectives of the course
1.2 Participant introduction	Participants provide their name, organization and priorities
1.3 State of the science on nutrient management and need for integration in the sustainable development agenda	Developing a baseline of the current water quality challenges due to increased nutrient loading and the most pressing hot spots – why is it important to act now, including a summary of implications on the GEF portfolio and in meeting the Sustainable Development Goals
1.4 Presentation of the Global Nutrient Management Toolbox	What it contains, functionalities, how to use it, scenario evaluation capabilities, assumptions and limitations in application.
1.5 Hands-on use of the Global Nutrient Management Toolbox at continental to LME scale	Participants apply the Toolbox to their own region, analyze scenarios and apply relevant management options for agriculture and wastewater.
Day 2: 21/3	
2.1 Nutrient source modeling and analysis in a local setting: The Manila Bay Case Study	Presentation of the Manila Bay nutrient flux model and results including scenario calculations
2.2 Introduction to the issues at stake in the regional nutrient fluxes represented by the participants	Open discussion of the challenges in the selection of regions, population growth, health issues, water availability and quality, flooding risks, sanitation and sewage connection
2.3 Ecosystem Report Card	Use of the Ecosystem Report Card for integrated assessment and decision-making: example Laguna de Bay
2.4 Introduction to the Regional Nutrient Fluxes Model	The trainers check the input data with each individual participant, and do the first calculation.
2.5 Recap	Discussion of results of day 2, and programme for day 3
Day 3: 22/3	
3.1 Continuation of region nutrient	Continuation of data preparation and model runs

Session	Detail and Learning Objectives
fluxes model runs	
3.2 Presentation on river nutrient modelling tools	Presentation of different modelling approaches for nutrient flows in watersheds
3.3 Discussion of scenarios to be analyzed	Each participant briefly (max. 5 minutes) presents the scenarios to be analyzed for his/her region, links with the scenarios analyzed at the LME level
3.4 First scenario calculations	Participants run scenarios and analyze results
3.5 Recap	Discussion of results of day 3, and programme for day 4
Day 4: 23/3	
4.1 Presentation on impacts modelling	Presentation of different modelling approaches for impacts (hypoxia, harmful algal blooms) in watersheds
4.2 Regional scenario calculations	Participants run scenarios with the regional nutrient fluxes model and analyze results
4.3 Recap	Discussion of results of day 4, and programme for day 5
Day 5: 24/3	
5.1 Presentation of the results for each Region	Each participant presents in max. 10 minutes the results of current situation and future outlooks analyzed with the regional nutrient fluxes model scenarios developed for each region
5.2 Summing-up	Summary of the results of the workshop, future plans and the expectations of the participants regarding follow-up service to trainees will be provided through the partnership network under the GPNM toward further development, use and demonstration of the models

Partners



Appendix 2: Participant List



#	Name	Department/Institute	Country	Email Address
1	Erik Okuku	Kenya Marine and Fisheries Research Institute	Kenya	eokuku@kmfri.co.ke, director@kmfri.co.ke, kmfridirector@gmail.com
2	Hiranthi Jansz	Authority	Sri Lanka	hjansz@cea.lk
3	Ismaila Ndour	Centre de Recherches Océanographiques Dakar-Thiaroye (CRODT)	Senegal	ndouiso@yahoo.fr, ndismaila@gmail.com, ismaila.ndour@isra.sn
4	Brando M. Angeles	Laguna Lake Development Authority	Philippines	kpmercado@gmail.com
5	Erwin Kim P. Mercado	Laguna Lake Development Authority	Philippines	brando.angeles@llda.gov.ph
6	Stephanus Hamutenya	Ministry of Fisheries and Marine Resources	Namibia	hamutenyasteven@gmail.com, Stephanus.Hamutenya@mfmr.gov.na
7	Hamish Asmath	Institute of Marine Affairs	Trinidad & Tobago	hasmath@ima.gov.tt
8	Luisa Fernando Espinosa Diaz	INVEMAR Coordinadora Programa Calidad Ambiental Marina (CAM)	Colombia	luisa.espinosa@invemar.org.co
9	Mohammad Ziaur Rahman	Institute of Water Modelling	Bangladesh	zia@iwmbd.org
10	Wang Xutao	Pearl River Valley Aquatic Environment	China	awuhu@126.com
11	Wu Shiliang	Pearl River Basin Water Resources Protection Bureau	China	349369006@qq.com
12	Lex Bouwman	Utrecht University	Netherlands	Lex.Bouwman@pbl.nl
13	Arthur Beusen	Utrecht University	Netherlands	Arthur.Beusen@pbl.nl

Summary of evaluation forms

Links to presentations (via dropbox link)