3RD
YSLME
SCIENCE
CONFERENCE
15-19 July 2019
Qingdao, PR China

NUTRIENTS USE EFFICIENCY

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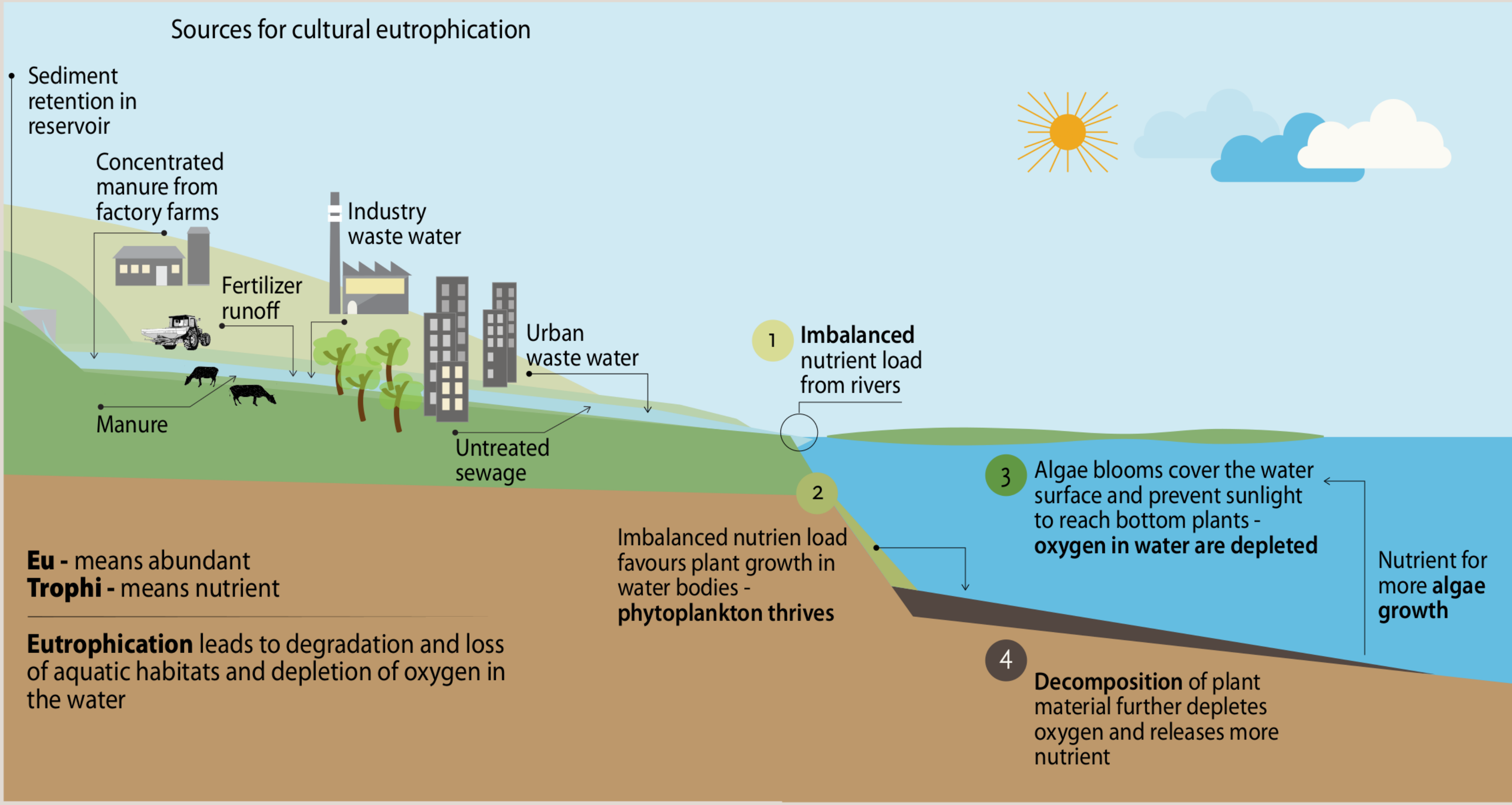
The Eutrophication Process



Introduction

The accelerated use of nitrogen and phosphorus is at the centre of a complex web of development benefits and environmental problems.

United Nations Environment Programme (UNEP) host the Global Partnership on Nutrient Management (GPNM) under the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA); which is a response to this 'nutrient challenge' – how to reduce the amount of excess nutrients in the global environment consistent with global development.

The Global Partnership on Nutrient Management (GPNM) was established in 2009 to promote effective nutrient management, to achieve the twin goals of food security through increased productivity and conservation of natural resources and the environment.

Activities on Nutrients management

Two projects:

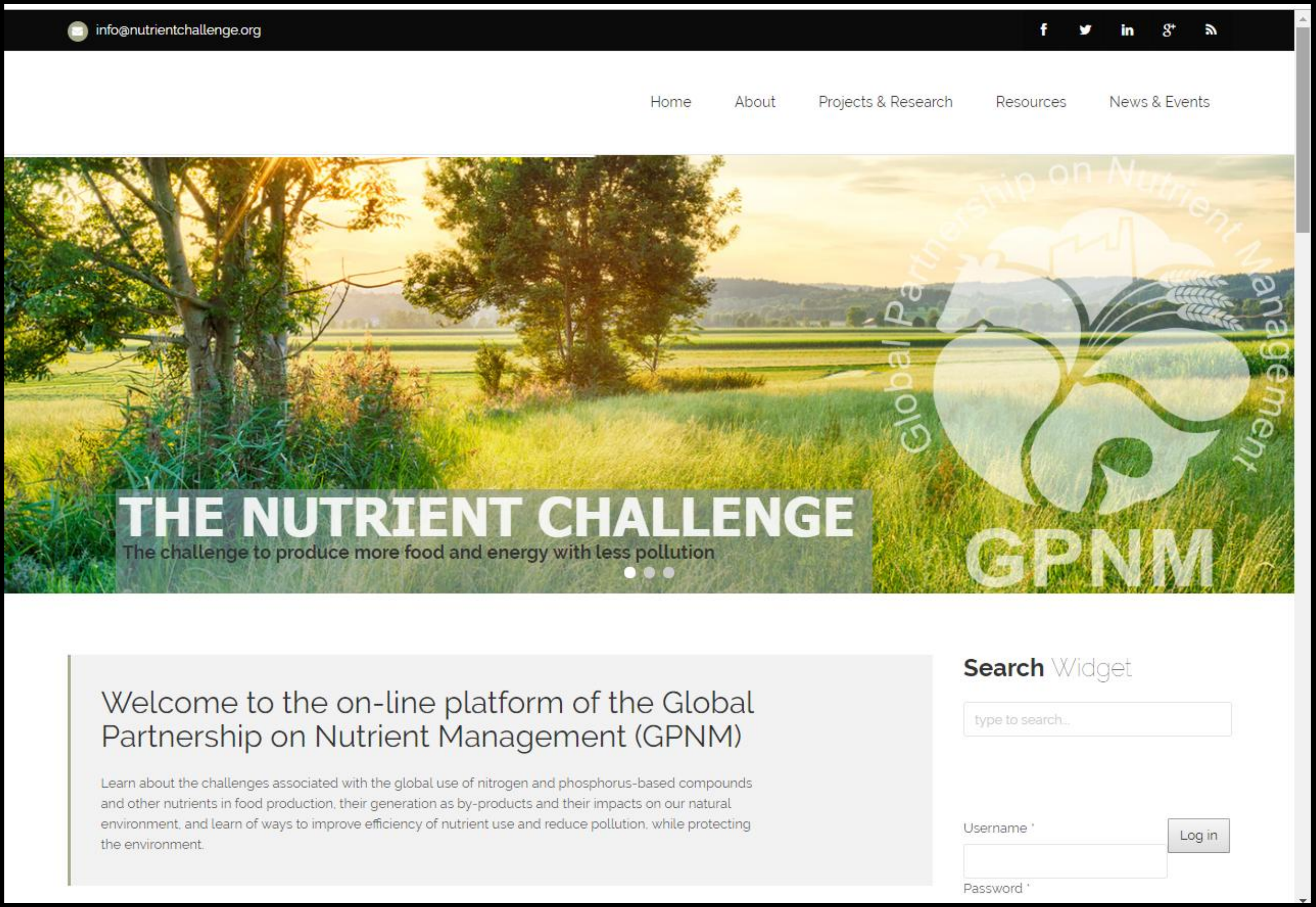
A. Global foundations for reducing nutrient enrichment and oxygen depletion from land based pollution, in support of Global Nutrient Cycle (GNC Project). **Period: 2012 – April 2019**

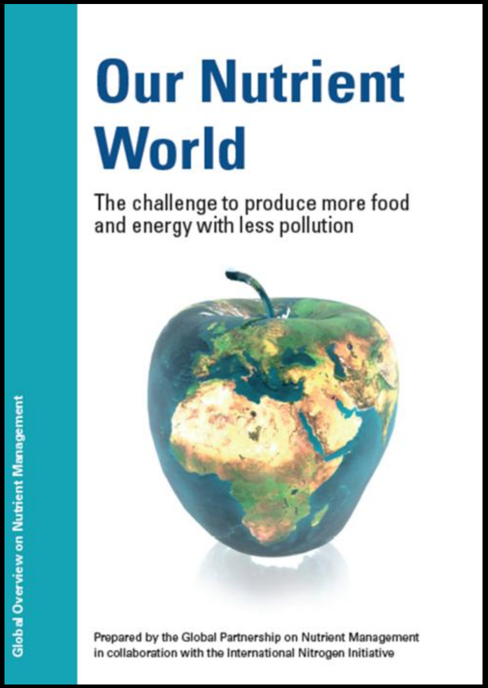
B. International Nitrogen Management System (INMS) project. **Ongoing**

Component A: Global Partnership on Nutrient Management addressing causes and impacts of coastal nutrient over-enrichment and hypoxia

Outputs:

- GPNM established at global and regional levels
- GPNM web platform
- GPNM communication strategy
- Global overview - nutrient over-enrichment /eutrophication/ hypoxia
- Community of Practice





Link: https://wedocs.unep.org/bitstream/handle/20.500.11822/10747/ONW-full%20report.pdf?sequence=1&amp%3BisAllowed=

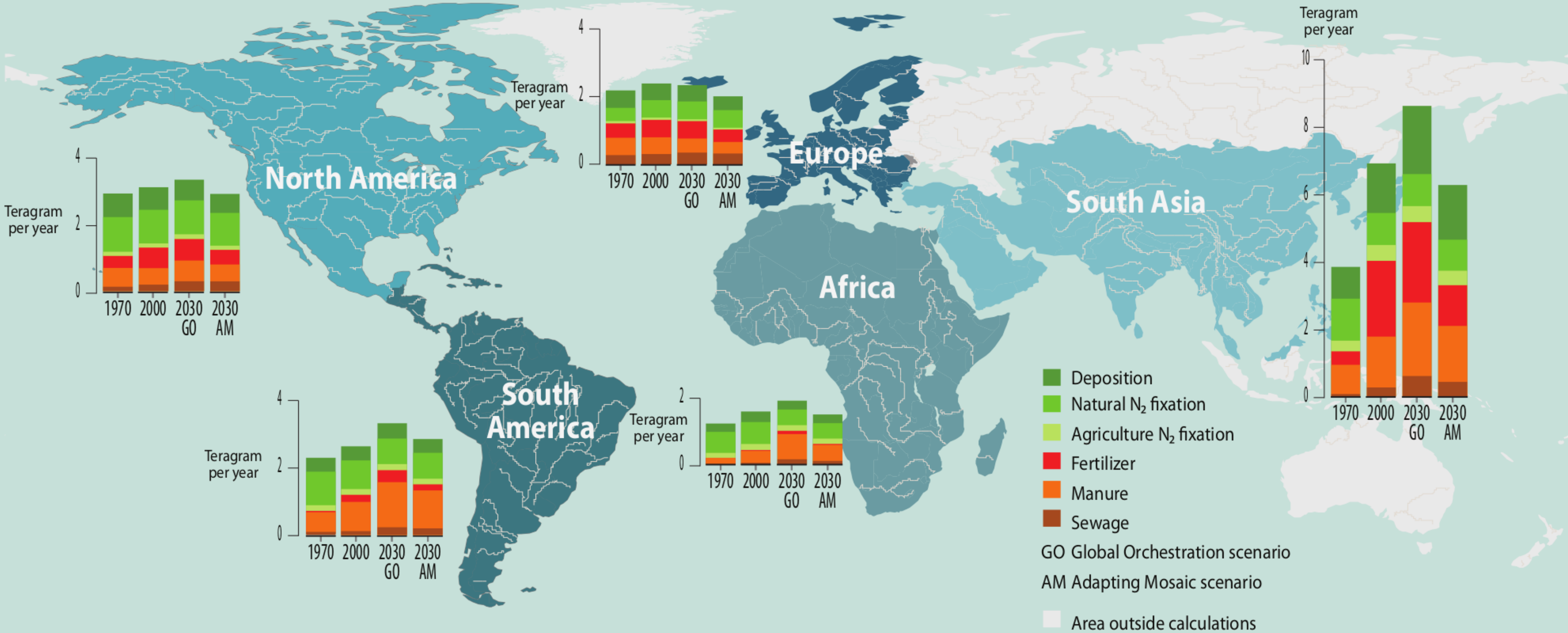
Component B: quantitative analysis of relationship between nutrient sources and impacts to guide decision making on policy and technological options

Outputs:

- Overview of existing tools for source-impact analysis of nutrients
- Global data base on nutrient loading and occurrence of HABs, hypoxia, and effects on fish landings, abundance and populations
- Nutrient impact modeling for global and local to regional nutrient source impact analysis
- Regional models of nutrient source-impact modeling for Manila Bay watershed demonstration area
- Regional and national scientists and policy experts trained in nutrients source-impact modeling
- Nutrient source-impact guidelines and user manuals

Estimated annual volume of Dissolved Inorganic Nitrogen contributed to rivers by Source

Values calculated using the Global Nutrient Export from WatershedS (NEWS) Model for years 1970 and 2000 and projected to year 2030 based on Millennium Assessment scenarios.



Source: Modifed from Seitzinger et al. (2010)

SDG 14 indicator on Marine pollution

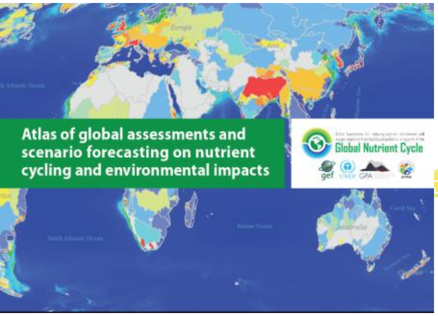
- **Target 14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities**
  - **Indicator 14.1.1: Index of coastal eutrophication (ICEP) and floating plastic debris density**

- **UN Environment Programme is Custodian Agency; supported by IOC-UNESCO**

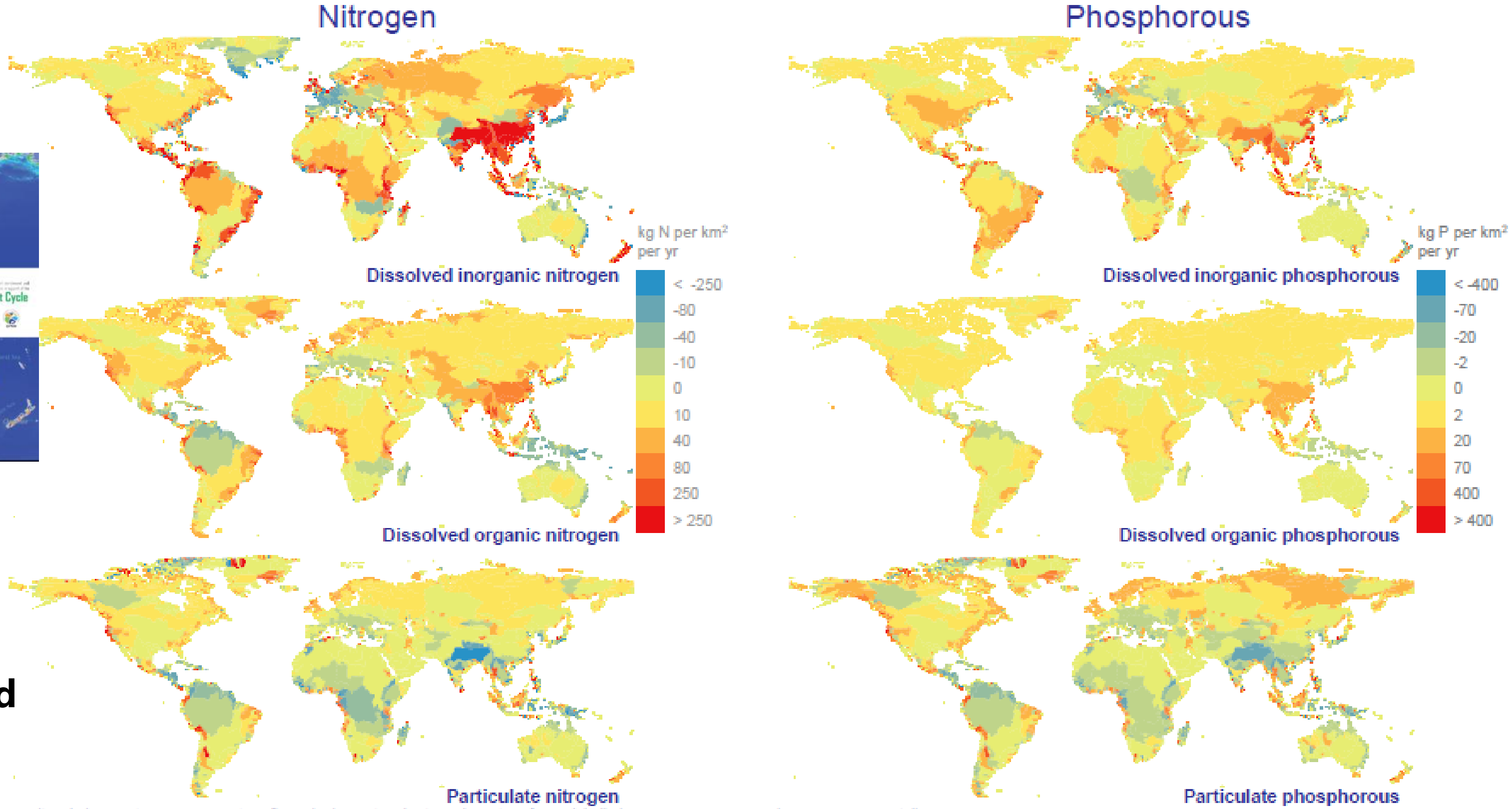
- **ICEP is calculated based on relative concentrations of nutrients - riverine nitrogen (N), phosphorus (P) versus silicon (Si) deliveries to coastal environments**
  - **When Si is in excess over N and P - favours development of diatoms;**
  - **When N and P are discharged in excess over Si (with respect to requirements of diatoms, these will be limited) - nondiatoms, often non-siliceous algal species will develop instead**

Ref: ***N:P:Si nutrient export ratios and ecological consequences in coastal seas evaluated by the ICEP approach*** in J of Biogeochemical Cycles. J. Garnier, A. Beusen, V.Thieu, G. Billen L. Bouwman
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2009GB003583

Predicted changes in per-area nutrient fluxes and nutrient form (2000 - 2050)



Atlas of global assessments and scenario forecasting on nutrient cycling and environmental impacts



Map produced by GRID ARENDAL

Predicted changes in per-area nutrient fluxes by large river basin and nutrient form globally between years 2000 and 2050. Note especially large anticipated changes in DIN and DIP loading in South Asia and parts of Central and South America.
There are substantial differences in the relative contributions of various nutrient sources and human drivers causing the scenario trends between developing countries and industrialized countries.
Global NEWS scenarios for 2030 and 2050 indicate that substantial changes in coastal nutrient loading may occur due to changing nutrient management in agriculture

DIN: Dissolved Inorganic Nutrients
DON: Dissolved Organic Nutrients
PN: Particulate Nitrogen

DIP: Dissolved Inorganic Phosphorus
PP: Particulate Phosphorus
DOP: Dissolved Organic Phosphorus

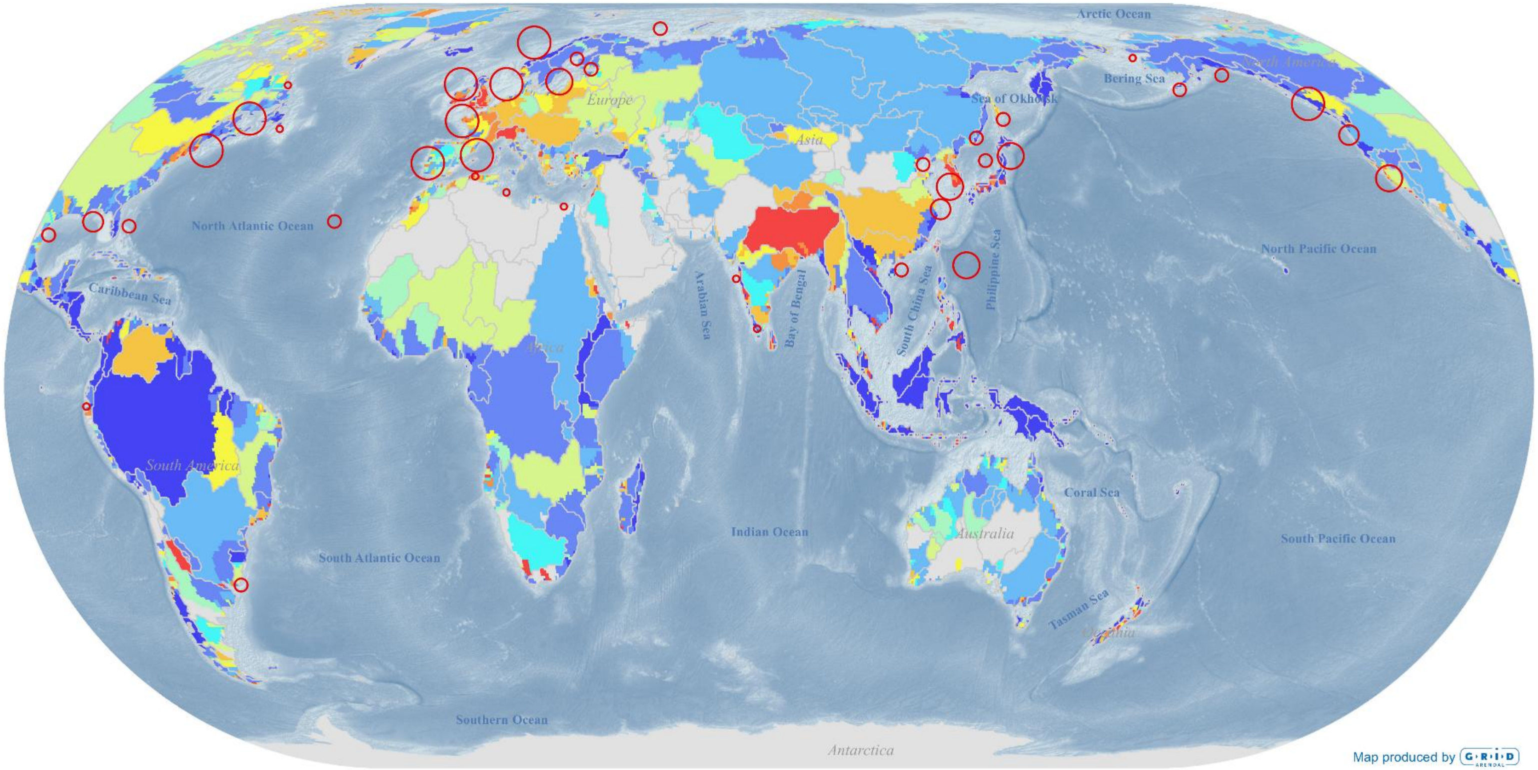
Map produced by GRID

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

UN environment gef GPA

Atlas of global assessments and scenario forecasting on nutrient cycling and environmental impacts

Index for coastal eutrophication of river basins, and number of harmful algal blooms



Map produced by GRID-Arendal

The Index for Coastal Eutrophication Potential (ICEP) is an indicator for the potential of riverine nutrient export to sustain new production of non-diatoms phytoplankton biomass. ICEP is calculated by comparing the nitrogen, phosphorus and silicon loading to the Redfield ratios expressing the requirements of marine diatoms growth.

Low ICEP values indicate that silicon is present in excess over the other nutrients and would thus indicate a low likelihood of harmful algal bloom development. High ICEP values indicate an excess of nitrogen or phosphate over silicon, which may lead to blooms of non-diatoms, possibly harmful algae species. The ICEP represents the potential impact of the riverine delivery to the coastal zone.

ICEP of water draining into coastal seas is presented on the scale of river basins. The observed algal blooms data is collated from harmful algae event database (HAEDAT, http://haedat.iode.org).

Large river basins

Index for coastal eutrophication

Low — High

Number of reported harmful algal blooms

1 - 10, 10 - 50, 50 - 100, 100 - 200, 200 - 691

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

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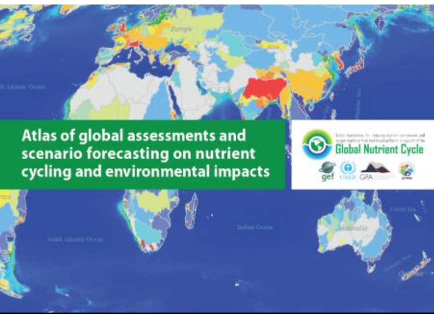
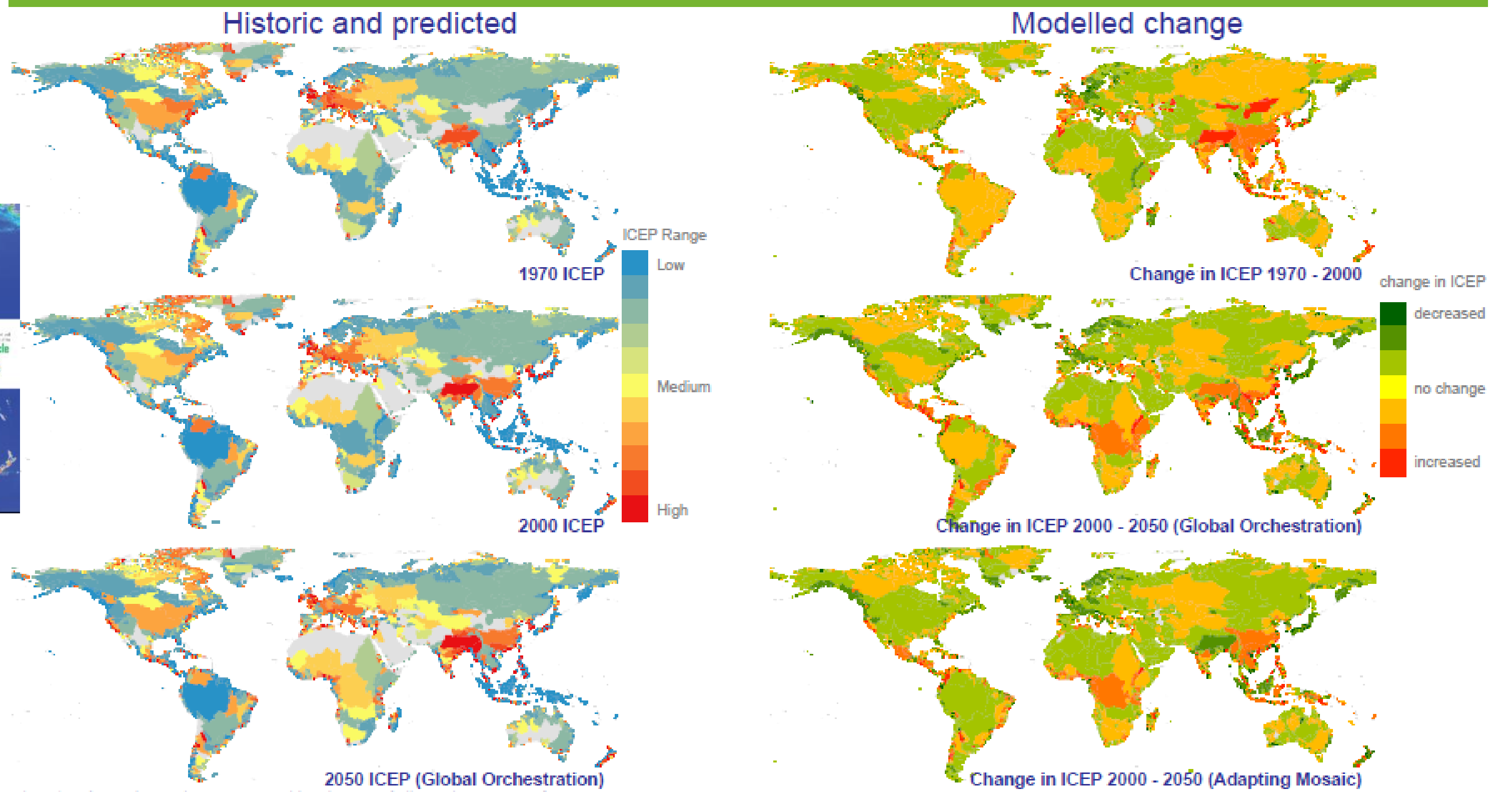
Historic and predicted index of coastal eutrophication (ICEP) at basin level



Atlas of global assessments and scenario forecasting on nutrient cycling and environmental

Map produced by G·R·I·D ARENDAL



The index of coastal eutrophication potential (ICEP) concept [Billen and Garnier, 2007], we can now use the scenarios for river nutrient export to assess the potential risk that non-diatom algal growth may lead to harmful algal blooms in coastal marine ecosystems. ICEP is an indicator for the potential of riverine nutrients to sustain new production of non-diatom phytoplankton biomass; it is calculated by comparing the N, P and Si loading to the Redfield ratios expressing the requirements of marine diatom growth. Positive values of ICEP indicate an excess of N or P over Si, which may lead to blooms of non-diatom, possibly harmful species

Map produced by G·R·I·D

The historical data suggest that harmful algal blooms risk increased considerably between 1970 and 2000. Scenario results for 2050 indicate that this risk will further spread (South America, Africa) and increase in areas with current high risk (Eastern Asia) (Figure 7.10). There are also large parts of the world where HAB risk is expected to decrease as a result of higher efficiency of nutrient use in agriculture and improved wastewater treatment. This is particularly so in the Adapting Mosaic scenario, which is a scenario with an orientation towards environmental issues and local simple

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

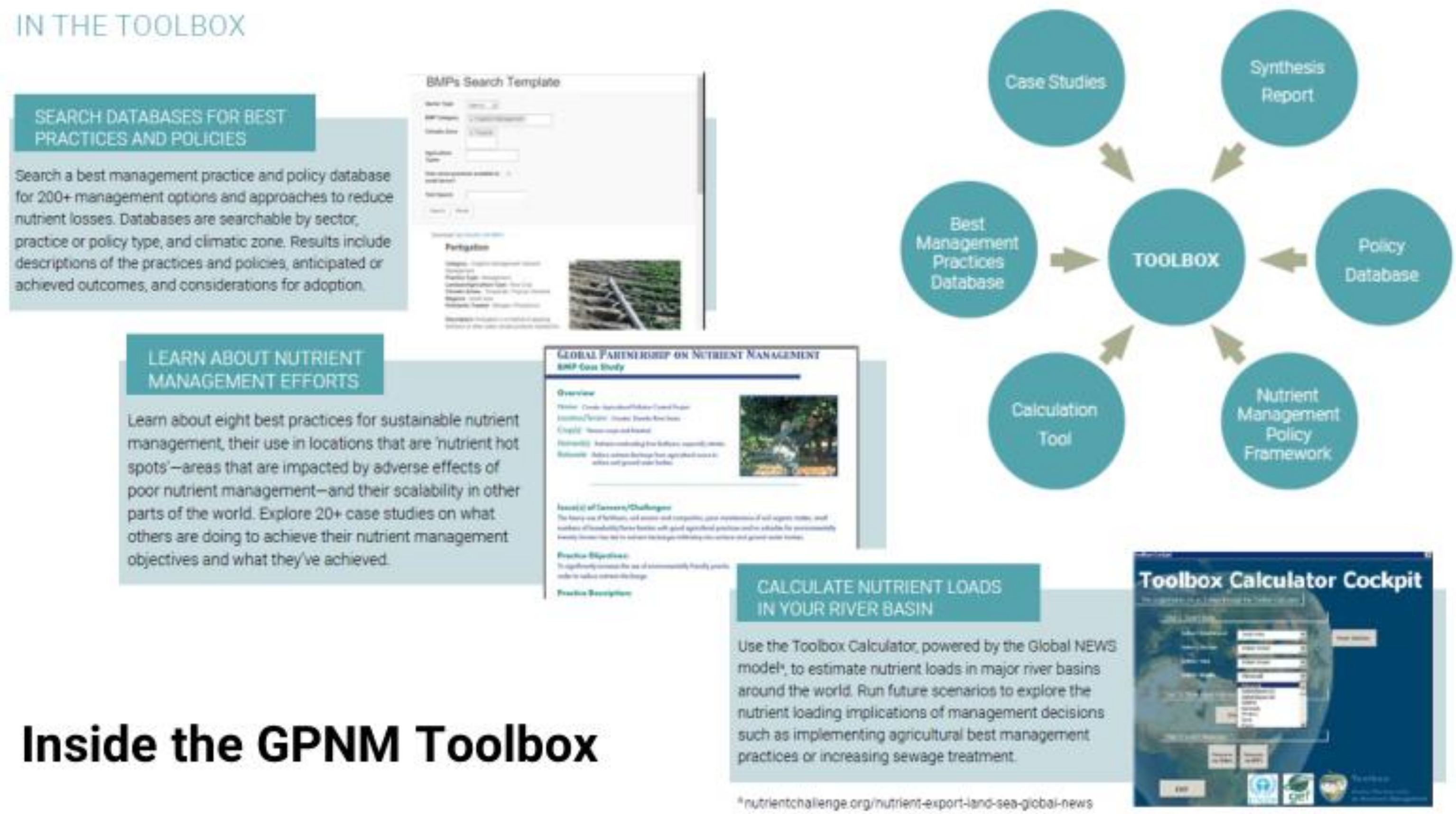
Component C: Establishment of scientific, technological and policy options to improve coastal water quality policies in LMEs and national strategy development

Outputs:

- Global overview & inventory of nutrient reduction best practices
- Case studies - technology and policy options
- Overview and synthesis of policy, technological options, measures and regulations
- Replication and up-scaling of best practice
- GPNM Policy Tool Box
- Including integration Component B source-impact modeling/analysis
- Training experts on application of Tool Box

GPNM Policy toolbox

Link: http://nutrientchallenge.org/gpnm-toolbox



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Training (IWC9): GPNM Policy toolbox

Training-of-trainers workshop on nutrient flux modelling, Technology Validation on the Global Nutrient Management Toolbox. March 2017, Manila, Philippines

Training of farmers and extension agents on GPNM toolkit, Wetland Training Centre, Chilika Lake (India), 20-21 July 2015

GEF Western Indian Ocean from Land-based Sources and Activities (WIOSAP) Project: **Training on the GPNM toolbox at a regional technical workshop on land-based pollution**, Maputo Mozambique, 10-11 December 2018

Component D: Development of nutrient reduction strategies through application of quantitative source-impact modeling and best practices in Manila Bay watershed

- Strengthened information / reporting on nutrient issues in Manila Bay watershed
- Establishing foundations for nutrient reduction strategies in Manila Bay watershed based on source-impact modeling / best practices
- Development / application of final source-impact models for Manila Bay in developing nutrient reduction strategies
- Development and adoption of integrated nutrient reduction strategies
- Application in Lake Chilika and Laguna de Bay of ecosystem health report cards
- Replication and upscaling strategy

Development and application of the final source-impact models for Manila Bay in developing nutrient reduction strategies

Emissions and loads

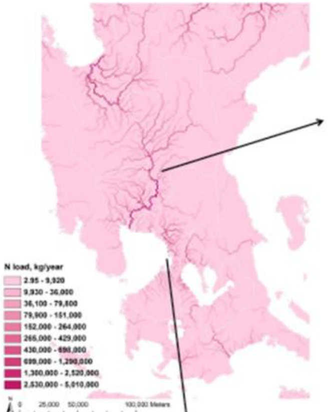


Figure 6. Total N load from domestic and agricultural sources in the Manila Bay watershed (2010)

One of the major rivers in the Manila Bay Watershed, the Pampanga River, drains a majority of the agricultural areas in the watershed bringing in as much as **1.47 million kg of N** and **395 thousand kg of P load to the bay per year**

Pasig river passes through most of the densely populated urban areas in Metro Manila bringing in as much as **3.61 million kg N** and **340 thousand kg P load into the bay per year.**

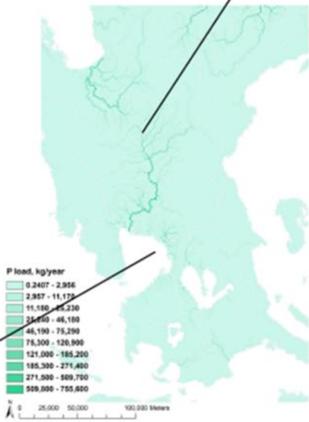
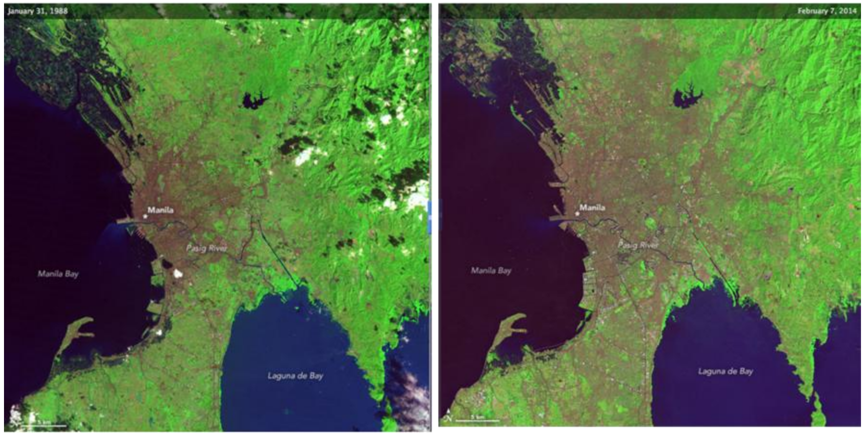


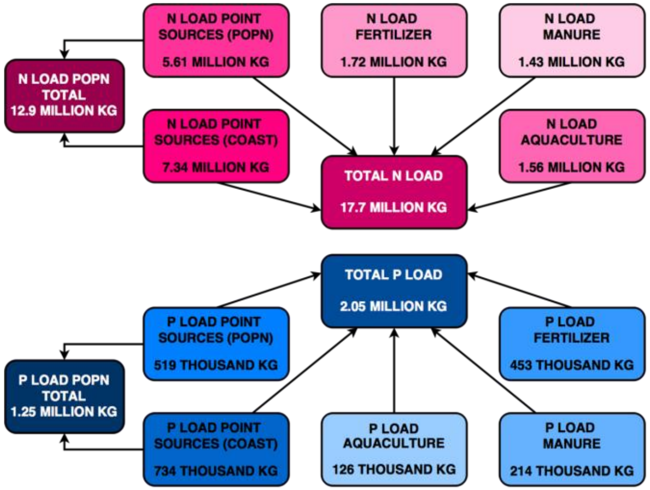
Figure 7. Total P load from domestic and agricultural sources in the Manila Bay watershed (2010)

Metro Manila

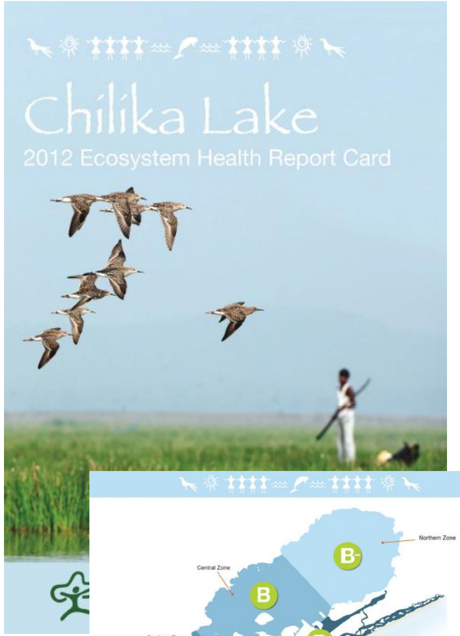
1988 2014

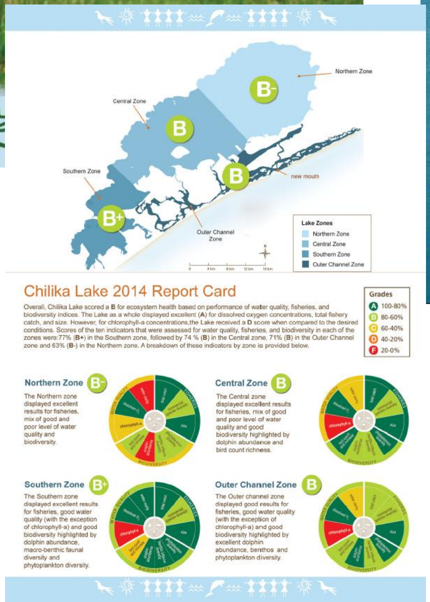


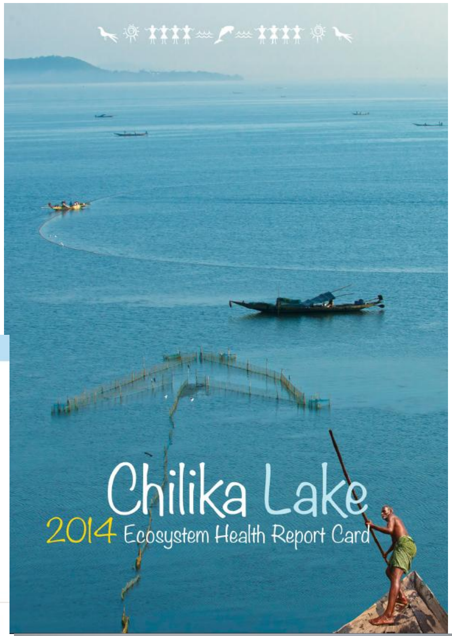
Rural areas (mainly farmland and forest) appear light green. Urban areas are gray.
Source: http://earthobservatory.nasa.gov/IOTD/view.php?id=86780&src=fb

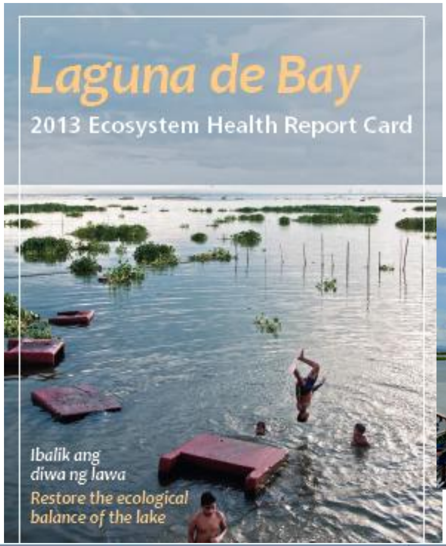


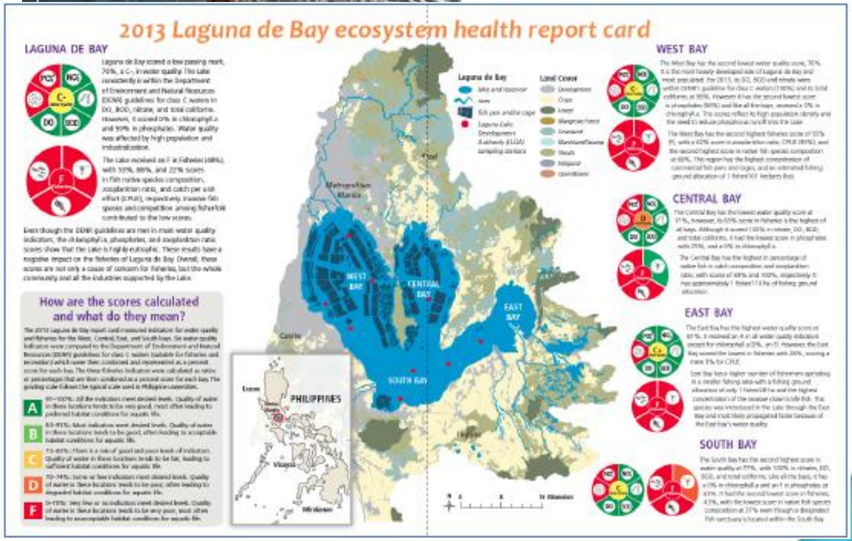
Ecosystem Health Report Card











UNEA-4 Resolution: Sustainable Nitrogen Management

UNEP MANDATED TO:

i. Facilitating better coordination of policies on the nitrogen cycle;
ii. Explore sustainable options for nitrogen management;
iii. Coordinate existing relevant platforms for assessment of improved nitrogen management;
iv. Conduct capacity-building activities for policy-makers and practitioners;
v. Support member states on informed decision-making on nutrients (nitrogen and phosphorus) management.

Thank you!

Visit the project site on the GPNM Nutrient Challenge website at

http://www.nutrientchallenge.org/gef-global-nutrient-cycling-gnc-project