



Sustainable Nutrient Management

Global Perspectives and Context

Mahesh PRADHAN

UNEP GPA GPNM, Marine and Freshwater Branch, Ecosystems Division

3 March 2021

Context

Global Overview on Nutrient Management

Our Nutrient World

The challenge to produce more food and energy with less pollution



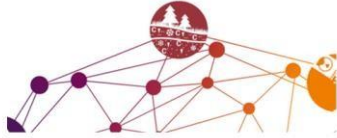
Prepared by the Global Partnership on Nutrient Management in collaboration with the International Nitrogen Initiative

Foreword



FRONTIERS 2018/19

Emerging Issues of Environmental Concern



“Every year, an estimated US\$200 billion worth of reactive nitrogen is now lost into the environment, where it degrades our soils, pollutes our air and triggers the spread of “dead zones” in our waterways.”

Joyce Msuya
Acting Executive Director
United Nations Environment Programme



The Nitrogen Fix: From nitrogen cycle pollution to nitrogen circular economy

The global nitrogen challenge

The UNEP 2014 Year Book highlighted the importance of excess reactive nitrogen in the environment.¹ Its conclusions are alarming. This is not just because of the magnitude and complexity of nitrogen pollution, but also because so little progress has been made in reducing it. Few of the solutions identified have been scaled up, while the world continues to pump out nitrogen pollution that contributes significantly to declines in air quality, deterioration of terrestrial and aquatic environments, exacerbation of climate change, and depletion of the ozone layer.²⁻¹⁰ These impacts hinder progress toward the Sustainable Development Goals as they affect human health, resource management, livelihoods and economies.¹¹⁻¹⁵ Yet there are signs of hope. The past four years have seen a transformation in approaches to managing nitrogen

pollution. These include new thinking for both consumption and production in order to seriously address the nitrogen problem.¹⁶⁻²⁴

Nitrogen is an extremely abundant element in the Earth's atmosphere. In the form of the N_2 molecule, nitrogen is harmless, making up 78 per cent of every breath we take. The two nitrogen atoms are held together by a strong triple bond ($N\equiv N$), making it extremely stable and chemically unreactive. The planet benefits because N_2 allows a safe atmosphere in which life can flourish, while avoiding the flammable consequences of too much oxygen. The environmental interest in nitrogen focuses on the conversion of N_2 into other chemically reactive forms. For simplicity, scientists refer to all other nitrogen forms as “fixed” or “reactive nitrogen” (N_r).^{11,25} There are many types of N_r with many different effects –



Modified from the European Nitrogen Assessment (2011)



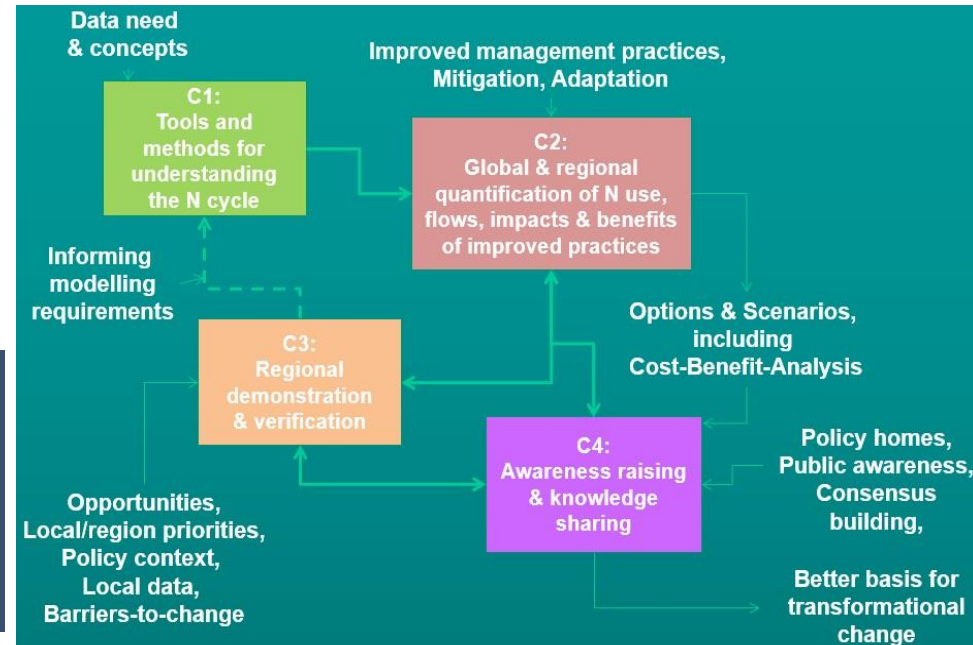
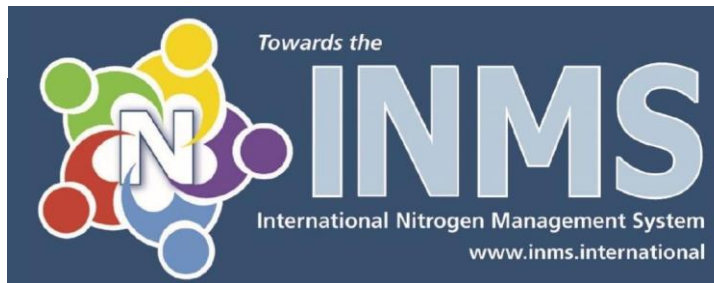
SACEP



सत्यमेव जयते
Government Of India

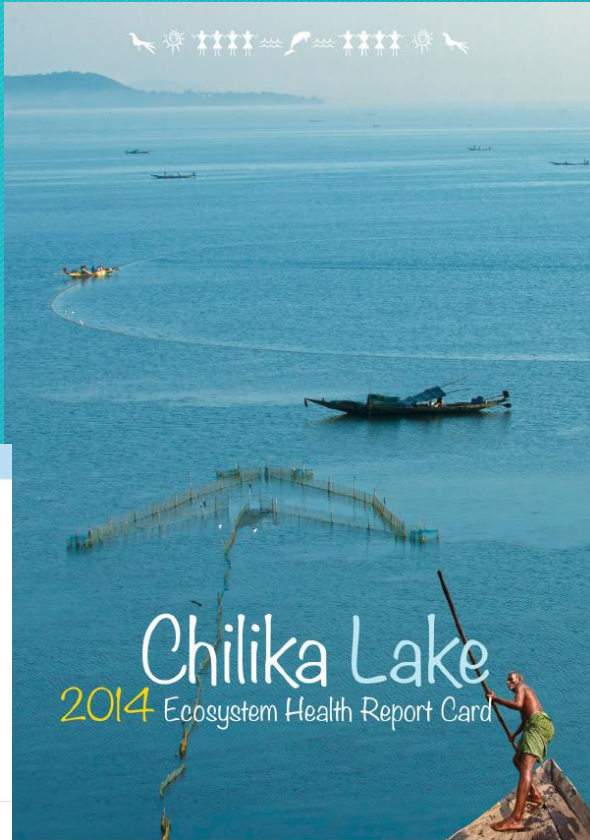


International Nitrogen Initiative



Chilika Lake

2012 Ecosystem Health Report Card



Chilika Lake

2014 Ecosystem Health Report Card



Chilika Lake 2014 Report Card

Overall, Chilika Lake scored a **B** for ecosystem health based on performance of water quality, fisheries, and biodiversity indices. The Lake as a whole displayed excellent (A) for dissolved oxygen concentrations, total fishery catch, and size. However, for chlorophyll-a concentrations the Lake received a **D** score when compared to the desired conditions. Scores of the ten indicators that were assessed for water quality, fisheries, and biodiversity in each of the zones were: 77% (B+) in the Southern zone, followed by 74% (B) in the Central zone, 71% (B) in the Outer Channel zone and 63% (B-) in the Northern zone. A breakdown of these indicators by zone is provided below.



Northern Zone **B-**

The Northern zone displayed excellent results for fisheries, mix of good and poor level of water quality and biodiversity.



Central Zone **B**

The Central zone displayed excellent results for fisheries, mix of good and poor level of water quality and good biodiversity highlighted by dolphin abundance and bird count richness.



Southern Zone **B+**

The Southern zone displayed excellent results for fisheries, good water quality (with the exception of chlorophyll-a) and good biodiversity highlighted by dolphin abundance, macro-benthic faunal diversity and phytoplankton diversity.



Outer Channel Zone **B**

The Outer channel zone displayed good results for fisheries, good water quality (with the exception of chlorophyll-a) and good biodiversity highlighted by dolphin abundance, benthos and phytoplankton diversity.



Laguna de Bay

2013 Ecosystem Health Report Card



Ibalik ang diwa ng lawa

Restore the ecological balance of the lake



2013 Laguna de Bay ecosystem health report card

LAGUNA DE BAY

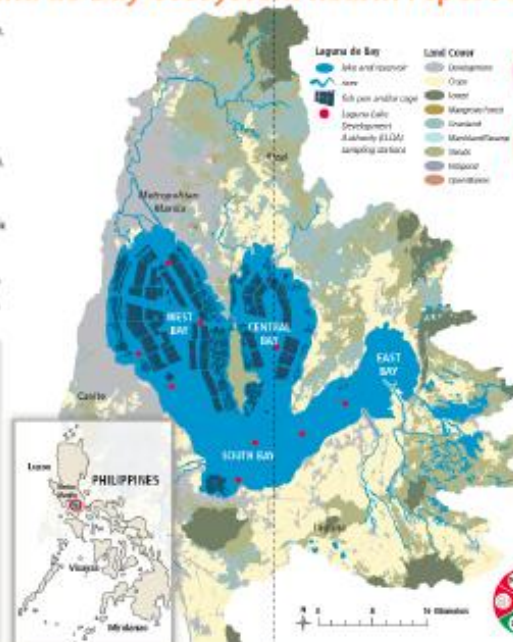
Laguna de Bay scored a low passing mark, 30%, a C-, in water quality. The Lake consistently falls within the Department of Environment and Natural Resources (DENR) guidelines for class C waters in DO, BOD, nitrate, and total coliforms. However, it scored 0% in chlorophyll-a and 30% in phytoplankton. Water quality was affected by high population and industrialization.

The Lake received an F in fisheries (fish), with 33%, 0%, and 22% scores in fish native species composition, total fish catch, and catch per unit effort (CPUE), respectively. Invasive fish species and carpenter bees among fish and birds contributed to the low scores.

Even though the DENR guidelines are not in most water quality indicators, the chlorophyll-a, phytoplankton, and zooplankton rate scores show that the Lake is highly eutrophic. These results have a negative impact on the fisheries of Laguna de Bay. Overall, these scores are not only a cause of concern for fisheries, but the whole community and all the industries supported by the Lake.

How are the scores calculated and what do they mean?

- A** 100-80%: All water indicators were deemed levels. Quality of water in these locations leads to the good, often leading to acceptable habitat conditions for aquatic life.
- B** 80-60%: Most water indicators were deemed levels. Quality of water in these locations leads to the good, often leading to acceptable habitat conditions for aquatic life.
- C** 60-40%: There is a mix of good and poor level of indicators. Quality of water in these locations leads to the fair, leading to sufficient habitat conditions for aquatic life.
- D** 40-20%: Some of the indicators are deemed levels. Quality of water in these locations leads to the poor, often leading to marginal habitat conditions for aquatic life.
- E** 20-0%: Most of the indicators are deemed levels. Quality of water in these locations leads to the very poor, often leading to unsupportable habitat conditions for aquatic life.



WEST BAY

The West Bay has the second lowest water quality score, 34%, it is the most heavily developed side of Laguna de Bay and most populated. For 2013, its DO, BOD and nitrate were within DENR guidelines for class C waters (30%), and its total coliforms at 30%. However, it has the second lowest score in phytoplankton (0%) and low all fisheries, receiving a 0% in chlorophyll-a. The scores reflect its high population density and the need to reduce phosphorus and nitrogen in the Lake.

CENTRAL BAY

The Central Bay has the lowest water quality score at 11%, however, its DO score in fisheries is the highest of all bays. Although it scored 100% in nitrate, DO, BOD, and total coliforms, it had the lowest score in phytoplankton with 0%, and a 0% in chlorophyll-a.

EAST BAY

The East Bay has the highest water quality score at 81%, it received an A in all water quality indicators, except for chlorophyll-a (3%), and DO. However, the East Bay consistently scores in fisheries with 20%, receiving a B in the DENR.

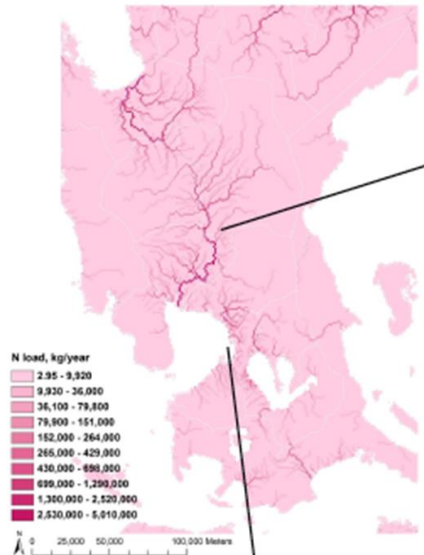
SOUTH BAY

The South Bay has the second highest score in water quality at 77%, with 100% in nitrate, DO, BOD, and total coliforms. Like all the bays, it has a 0% in chlorophyll-a and an F in phytoplankton at 0%. In fisheries, it scored lowest score in fisheries, 43%, with the lowest score in native fish species composition at 13%. Even though a degraded fish sector's based within the South Bay.

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.

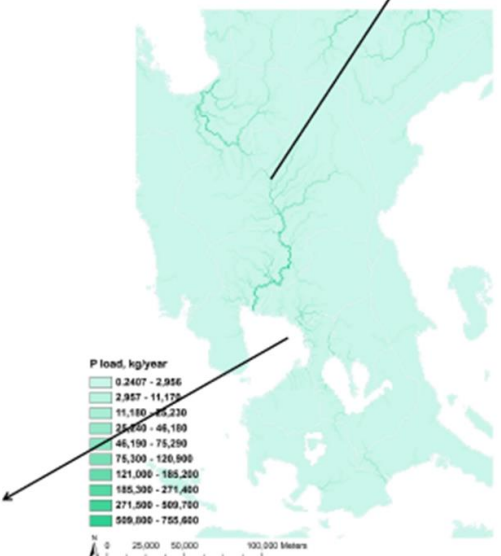
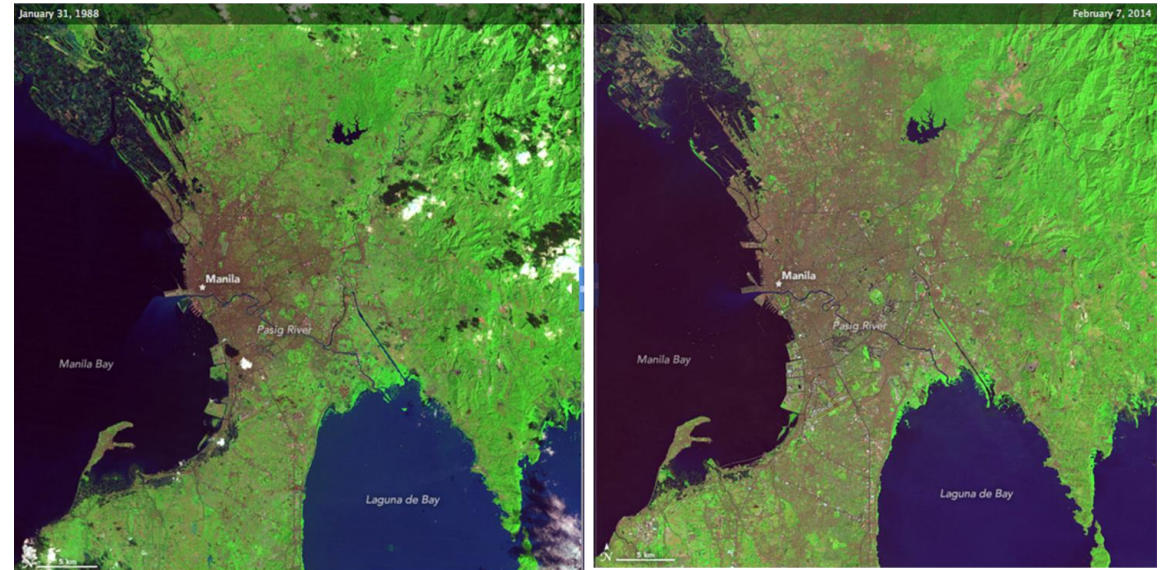
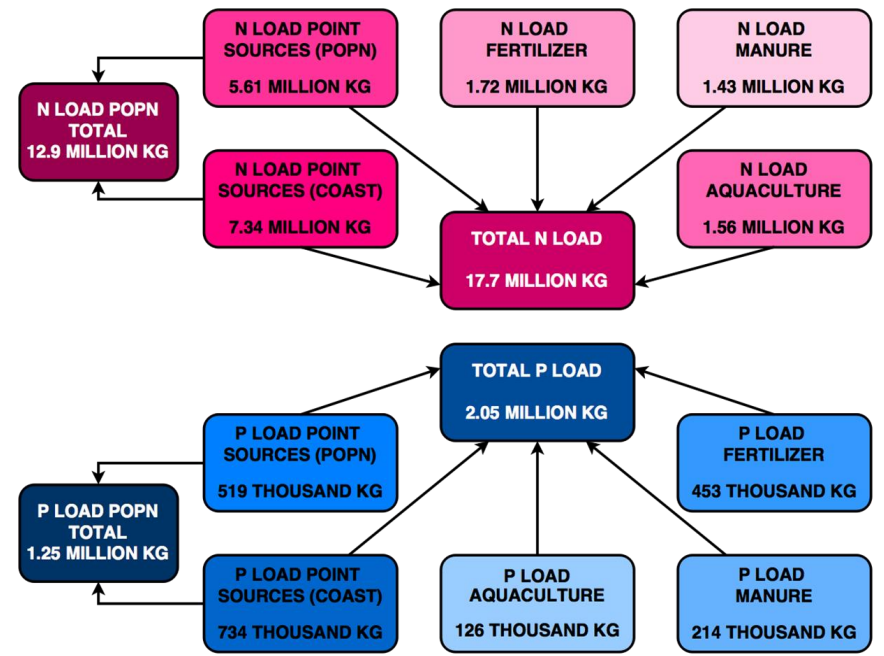


Figure 7. Total P load from domestic and agricultural sources in the Manila Bay watershed (2010)

1988 Metro Manila 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>



CARTAGENA CONVENTION

Where is the most Nitrogen coming from?



Sub-region:



Sub-regions are displayed with a color scale of red (highest DIN input values) to orange to yellow to light green to dark green (lowest DIN input values).

Drainage area to sub-region:



Dissolved inorganic nitrogen input from watersheds to coastal areas in five sub-regions (in 2000). Data sources: Sub-regions and DIN values (UNEP-CEP - 2000), Drainage area (HydroBASINS - 2018), Rivers (Natural Earth - 2019), Land (GSHHG - 2013).

I
1.08 Tg/yr

V
0.06 Tg/yr

0.0006 Tg/yr
IV

II
0.12 Tg/yr

III 0.69 Tg/yr

III
0.69 Tg/yr



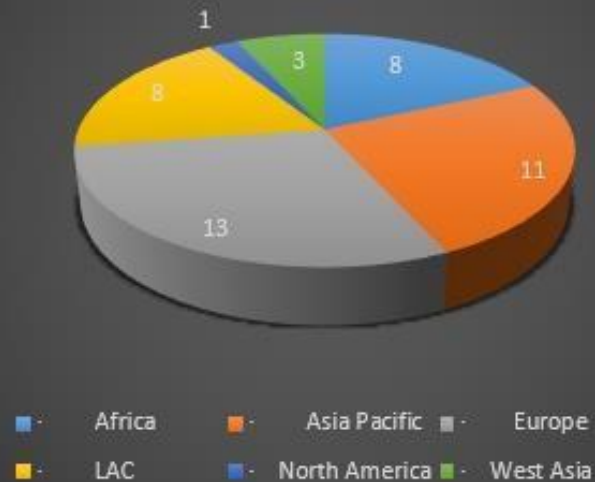
Global Nitrogen Campaign Launch Colombo, Sri Lanka 23-24 October 2019

“Nitrogen for Life - Everywhere and Invisible”
Halve Nitrogen Waste by 2030

- Colombo Declaration on Sustainable Nitrogen Management adopted
- Multi-Actor Dialogue: Science-Policy-Political (250 participants, 30 countries)
- Nitro Concert (over 1,400 participants for inaugural session)
- Campaign Communication Strategy and Marketing Strategy (**under development**)

Intergovernmental Working Group on Nitrogen Management

Working Group Nominations



AFRICA (7)

- Benin
- Eswatini
- Seychelles
- Sudan
- Uganda (2)
- Madagascar
- South Africa

LATIN AMERICA & CARIBBEAN (6)

- Brazil
- Chile
- Paraguay
- Haiti
- Guatemala
- Mexico (3)

ASIA PACIFIC (11)

- Bhutan
- Fiji
- Kyrgyz Republic
- Lao PDR
- Myanmar
- Pakistan
- Sri Lanka
- New Zealand
- Iran Republic
- India
- China

WEST ASIA (3)

- Oman
- Turkey
- Cyprus

EUROPE (9)

- Croatia
- Romania (3)
- Albania
- Belgium
- Germany
- Sweden (2)
- Spain
- Hungary
- Poland (2)

N. AMERICA (1)

- United States

Ten Key Action Areas to Address the Nutrient Challenge

- 10** Optimization of:
- a. nutrient pollution sources placing them farther away from sensitive receptors (spatial planning, buffer zones, etc.);
 - b. integration of different nutrient flows to foster more effective use;
 - c. nutrient production to being closer to consumers

- 1** Implement a 'five-element strategy'
- a. nutrient management;
 - b. selecting appropriate crop cultivars;
 - c. precision irrigation whenever needed;
 - d. integrated weed, pest and disease management;
 - e. site-specific mitigation measures.

- 2** Improve:
- a. animal breeding;
 - b. animal housing;
 - c. animal health;
 - d. dietary management to avoid over-feeding of nutrients;
 - e. nutrient management planning.

- 3** Improving fertilizer value by:
- a. manure processing
 - Reducing losses from
 - b. animal housing;
 - c. manure storage and handling;
 - d. manure treatment;
 - e. land application of manure.

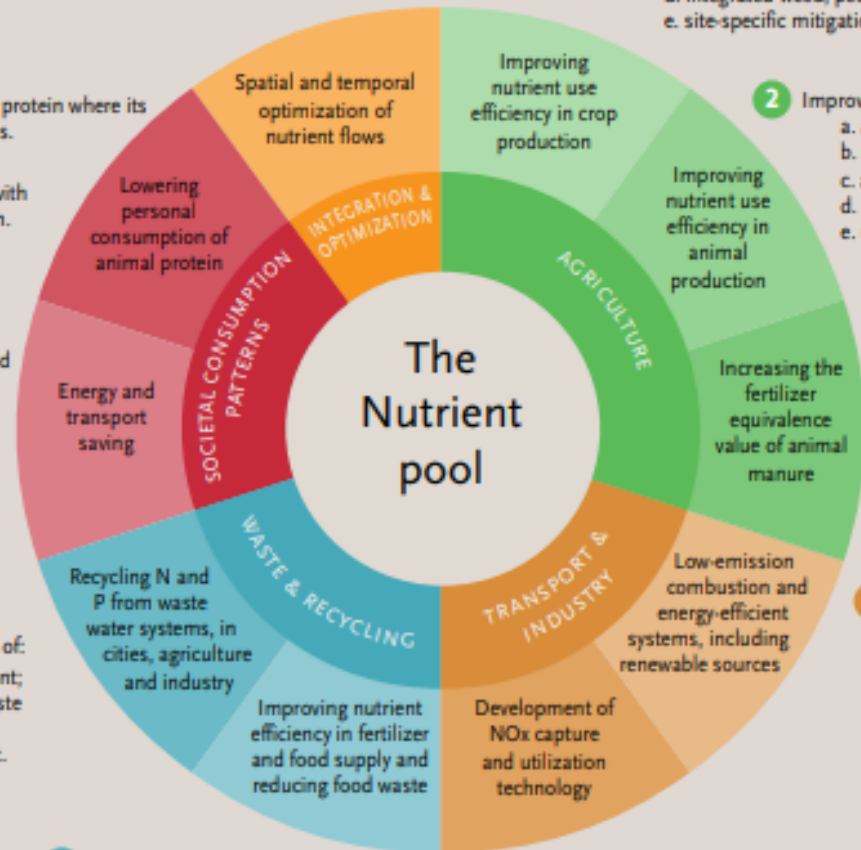
- 4** Improve techniques to
- a. reduce NOx and other Nr emissions in combustion
 - b. improve fuel efficiency in combustion process
 - c. reduce energy requirement for fuel use (e.g., improved insulation)
 - d. greater use of renewable energy sources (wind, solar, wave, tidal, geothermal)

- 5** Innovation capture with utilization:
- a. technology for extracting N from waste streams.

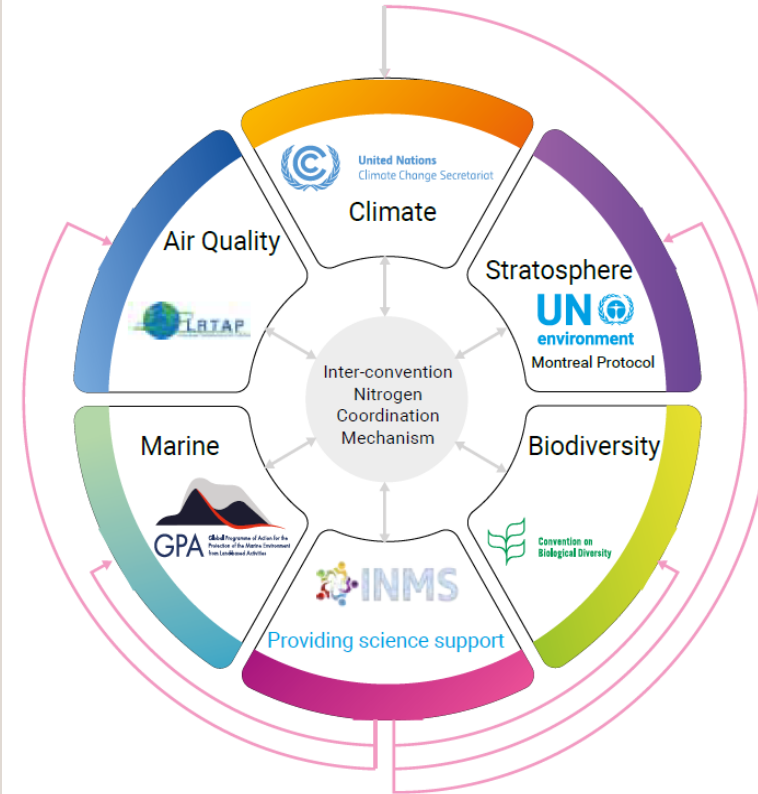
- 6** Reduce and improve:
- a. reducing waste from phosphorous mining and processing;
 - b. improving food supply efficiency and reducing food waste.

- 8** Improve:
- a. transport activities by advanced telematics;
 - b. transport planning;
 - c. mass public transportation;
 - d. development of highly fuel-efficient cars.

- 9** Reduce:
- a. intake of animal protein where its above dietary needs.
- Replace:
- b. animal protein with plant-based protein.



Inter-convention Nitrogen Coordination Mechanism



Sutton et al. (2019) The Nitrogen Fix. UNEP Frontiers

Opportunities



**UNITED NATIONS
FOOD SYSTEMS
SUMMIT 2021**



**UN Ocean Conference
Lisbon, Portugal**



**UNITED NATIONS DECADE ON
ECOSYSTEM
RESTORATION
2021-2030**



**2021
2030** United Nations Decade
of Ocean Science
for Sustainable Development



2020 UN BIODIVERSITY CONFERENCE
COP 15 - CP/MOP10 - NP/MOP4
Ecological Civilization - Building a Shared Future for All Life on Earth
KUNMING - CHINA



**UN CLIMATE
CHANGE
CONFERENCE
UK 2021**

IN PARTNERSHIP WITH ITALY



Nitrogen is everywhere, yet invisible, across the UN Sustainable Development Goals (SDGs).

Thank you for your attention!

Email: Mahesh.Pradhan@un.org
