SDG Indicators 14.1.1a 14.1.1b and 14.2.1

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Indicator 14.1.1a

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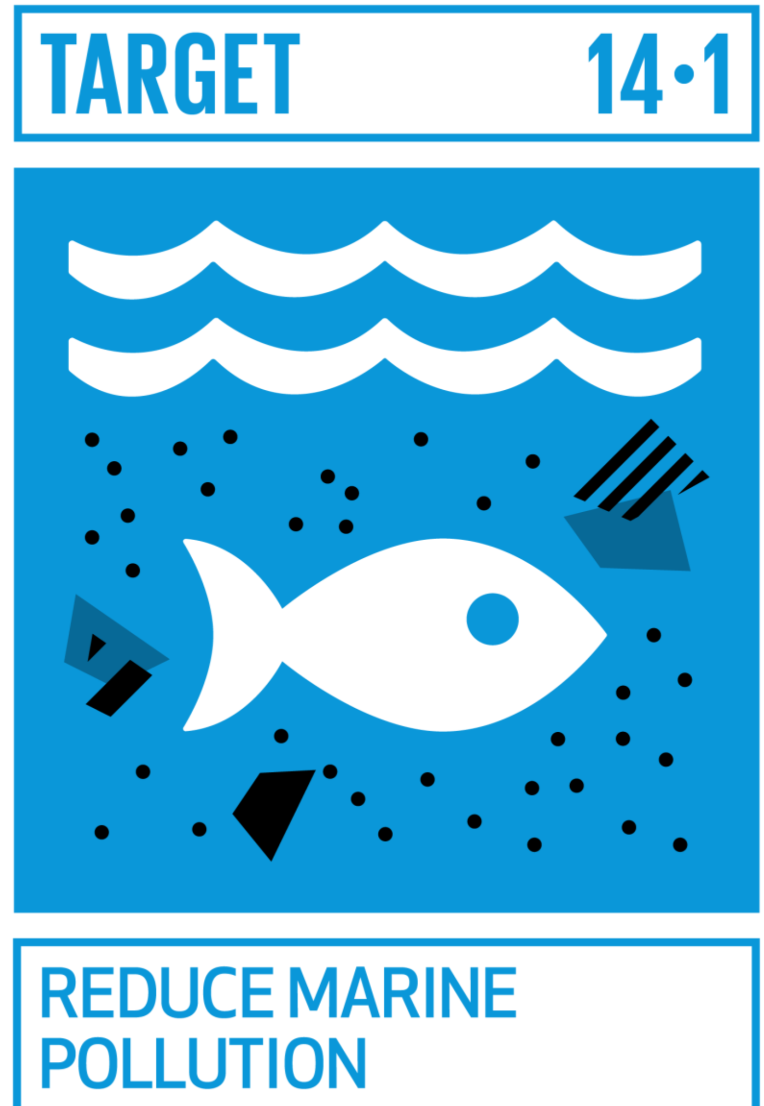


SDG Target 14.1 and Indicator 14.1.1

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Target 14.1:

"By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution"

Indicator 14.1.1:

"Index of coastal eutrophication and floating plastic debris density"

Indicator 14.1.1a:

"Index of coastal eutrophication"

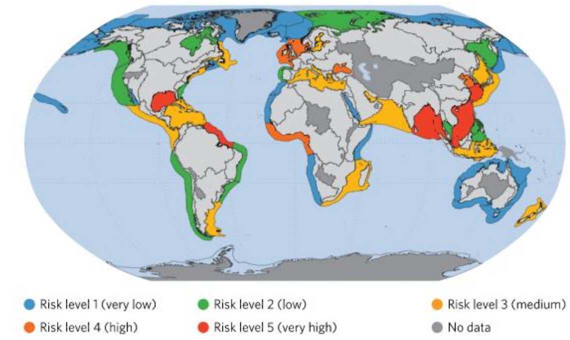
UNEP is the custodian agency for this indicator

Introduction

- **Eutrophication** and its detrimental effects on coastal ecosystems is one of the biggest issues in many regions of the world. Human activities and climatic change are the most important drivers of eutrophication, leading to harmful **algal blooms** and the proliferation of **hypoxic conditions** in many coastal ecosystems.
- Rivers are among the most important drivers of eutrophication, as they influence coastal ecosystem dynamics through freshwater flow and the transport of nutrients and organic matter.

Introduction

Nutrient risk indicator categories of large marine ecosystems

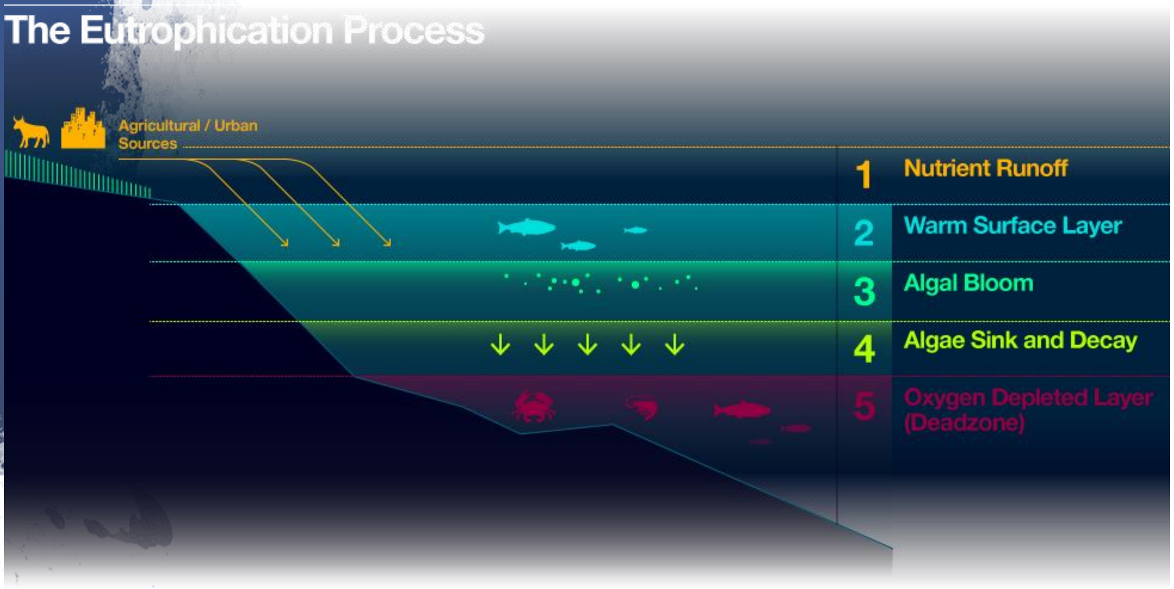


Note: Global map is for illustrative purposes only and does not imply the expression of any opinion whatsoever concerning the legal status of any country or territory, or concerning the delimitation of its frontiers or boundaries.

- **Eutrophication** — occurs when the environment becomes enriched with nutrients, increasing the amount of plant and algae growth to estuaries and coastal waters.
- According to the Transboundary Waters Assessment Programme global comparative assessment in 2016, the five large marine ecosystems most at risk from coastal eutrophication are the *Bay of Bengal, East China Sea, Gulf of Mexico, North Brazil Shelf and South China Sea*, areas which provided ecosystem services for coastal populations of 781 million in 2010.

Introduction

- Eutrophication sets off a chain reaction in the ecosystem, starting with an overabundance of algae and plants.
- The excess algae and plant matter eventually decompose, producing large amounts of carbon dioxide.
- This lowers the pH of seawater, a process known as ocean acidification. Acidification slows the growth of fish and shellfish and can prevent shell formation in bivalve mollusks. This leads to a reduced catch for commercial and recreational fisheries, meaning smaller harvests and more expensive seafood.

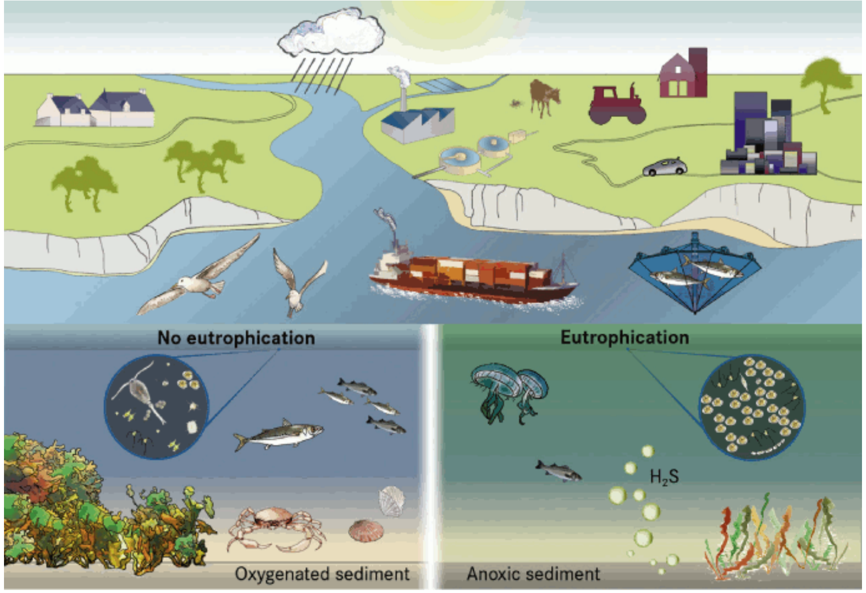


Introduction

According to research there are four main types of indicators for coastal eutrophication exist:

- Indicators for the cause of eutrophication (nutrient input and concentrations),
- Indicators for the direct effects of eutrophication (e.g. ***Chlorophyll-a*** concentrations, biomass growth, water clarity/turbidity),
- Indicators for the indirect effects of eutrophication (e.g. *dissolved oxygen levels*),
- Modelled indicators of the potential for coastal eutrophication (the ***Index of Coastal Eutrophication Potential*** (ICEP), based on analyzing nutrient load ratios and expected influence on eutrophication due to land based activities).

In 2008, massive green macroalgae blooms caused by eutrophication spread over 2,400 km2 in the Yellow Sea and East China Sea and 1 million tons had to be removed and treated at a cost of more than US$100 million.



Why is this SDG Important?

- It is fundamentally important to understand how the freshwater-marine link works in order to establish appropriate measures to maintain (or recover) the good environmental status (GES).

Definition

- Eutrophication – excess nutrient loading into coastal environments from anthropogenic sources, resulting in excessive growth of plants, algae and phytoplankton.
- Coastal Zone – national Exclusive Economic Zone (EEZ) (200 nautical miles from the coast) as outlined by the United Nations Convention on the Law of the Sea.
- Marine litter - any persistent, manufactured or processed solid material which is lost or discarded and ends up in the marine and coastal environment.

Limitations

It is assumed that countries would use the data to actively make decisions, but as oceans are transboundary, it makes this decision-making complex.

Methodology – Approach

Level 1: Globally available data from earth observations and modelling

Level 2: National data which will be collected from countries (through the relevant Regional Seas Programme, where applicable (i.e. for countries that are a member of a Regional Seas Programme)

Monitoring parameters for eutrophication to track progress against SDG indicator 14.1.1a

Monitoring parameters	Level 1	Level 2	Level 3	Reporting Frequency
Indicator for Coastal Eutrophication Potential (N and P loading)	X			Five years
Chlorophyll-a deviations (remote sensing)	X			Annual
Chlorophyll-a concentration (*remote sensing and in situ*)		X		
National modelling of indicator for Coastal Eutrophication Potential (ICEP)		X		4 years (aligned with Regional Seas)
Total Nitrogen of DIN (dissolved inorganic nitrogen)		X		
Total Phosphorus or DIP (dissolved inorganic phosphorus)		X		
Total silica		X		
Dissolved oxygen			X	NA
Biological/chemical oxygen demand (BOD/COD)			X	NA
Total organic carbon (TOC)			X	NA
Turbidity (remote sensing)			X	NA
River parameters from SDG 6.3.2			X	NA
Other water parameters (O_2 % saturation, Secchi depth, river discharge, salinity, temperature, pH, alkalinity, organic carbon, toxic metals, persistent organic pollutants)			X	NA
Microalgal growth, harmful algal blooms, submerged aquatic vegetation coverage, biodiversity and hypoxia			X	NA

Level 3 is about supplementary data

Methodology – Level 1

Indicator for coastal eutrophication potential

- This indicator assumes that excess **nitrogen or phosphorus relative to silica** will result in increased growth of potentially harmful algae (ICEP>0).
- This indicator is based on loads and ratios of nitrogen, phosphorous and silica delivered by rivers to coastal waters (Garnier et al. 2010) which contribute to the ICEP.
- The indicator can be further developed by incorporating in situ monitoring to evaluate the dispersion of concentrations of nitrogen, phosphorous and silica to ground-truth the index.
- ICEP is expressed in kilograms of carbon (from algae biomass) per square kilometre of river basin area per day (kg C km-2 day-1).

Methodology – Level 1

- The ICEP model is calculated using one of two equations depending on whether nitrogen or phosphorus is limiting. The equations (Billen and Garnier 2007) are

*ICEP (N limiting) = [NFlx/(14*16)-SiFlx/(28*20)]*106*12*

*ICEP (P limiting) = [PFlx/31 – SiFlx/(28*20)]*106*12*

Where PFlx, NFlx and SiFlx are respectively **the mean specific values of total nitrogen, total phosphorus and dissolved silica** delivered at the mouth of the river basin, expressed in kg P km-2 day-1, in kg N km-2 day-1 and in kg Si km-2 day-1.

Methodology – Level 1

Chlorophyll-A deviation modelling

- Satellite-based assessments of ocean colour began in 1978 with the launch of the Coastal Zone Color Scanner (CZCS) aboard the NASA Nimbus 7 satellite

Magnitude of *Chlorophyll-a* Deviation = $(\gamma - \beta / \beta) \times 100$

Where β = the average monthly pixel chlorophyll-a 2000-2004

Where γ = the average monthly pixel chlorophyll-a for the reporting year

- Deviation will be calculated by pixel and deemed a high deviation if the magnitude is in the 90th percentile.
- The percent of pixels with a high value will be calculated per month.
- The average monthly anomalies will be calculated as the average percent over 12 months (Jan-Dec).

Methodology – Level 2

Northwest Pacific Action Plan Eutrophication Assessment Tool (NEAT), which is a satellite imagery technique for detection of potential dead zones in the sea.

In situ monitoring of nutrients

- National level measurements of **Chlorophyll-a** and other parameters (including nitrogen, phosphate and silica) (*in situ* or from remote sensing), should be used to complement and ground truth global remote sensing and modelled data and enable a more detailed assessment of eutrophication.

National ICEP modelling

- Existing ICEP modelling at the national level is limited, but could be further developed.
- A study of basin level data of Chinese rivers utilizes Global NEWS – 2. The Global NEWS-2 model is basin-scale and quantifies river export of various nutrients (nitrogen, phorsphorus, carbon and silca) in multiple forms (dissolved inorganic, dissolved organic and particulate) as functions of human activities on land and basin characteristics (Strokal et al 2016)

Data

- Data sources – Satellite data, Global models, national government.
- Data Collection – through Regional Seas Programme, NOAA, GEOBluePlanet, Global Nutrient Management System (GNMS)
- Data will be available for all member states
- The number of parties considered to have submitted post-2010 NBSAPs that take the Strategic Plan for Biodiversity (2011-2020) into account is regularly updated as well.
- Chlorophyll-a deviation and anomalies Earth Observation Data were reported in February 2021.
- In situ data will be collected directly from countries later this year through the Regional Seas programme.
- Data processing will be handled by UN Environment Programme and partners.

Example – Case Studies

Indicator for Coastal Eutrophication Potential (N and P loading)

- Modelling of basin level N, P and Silca inputs to river mouths is a well-established practice in terms of understanding coastal eutrophication.

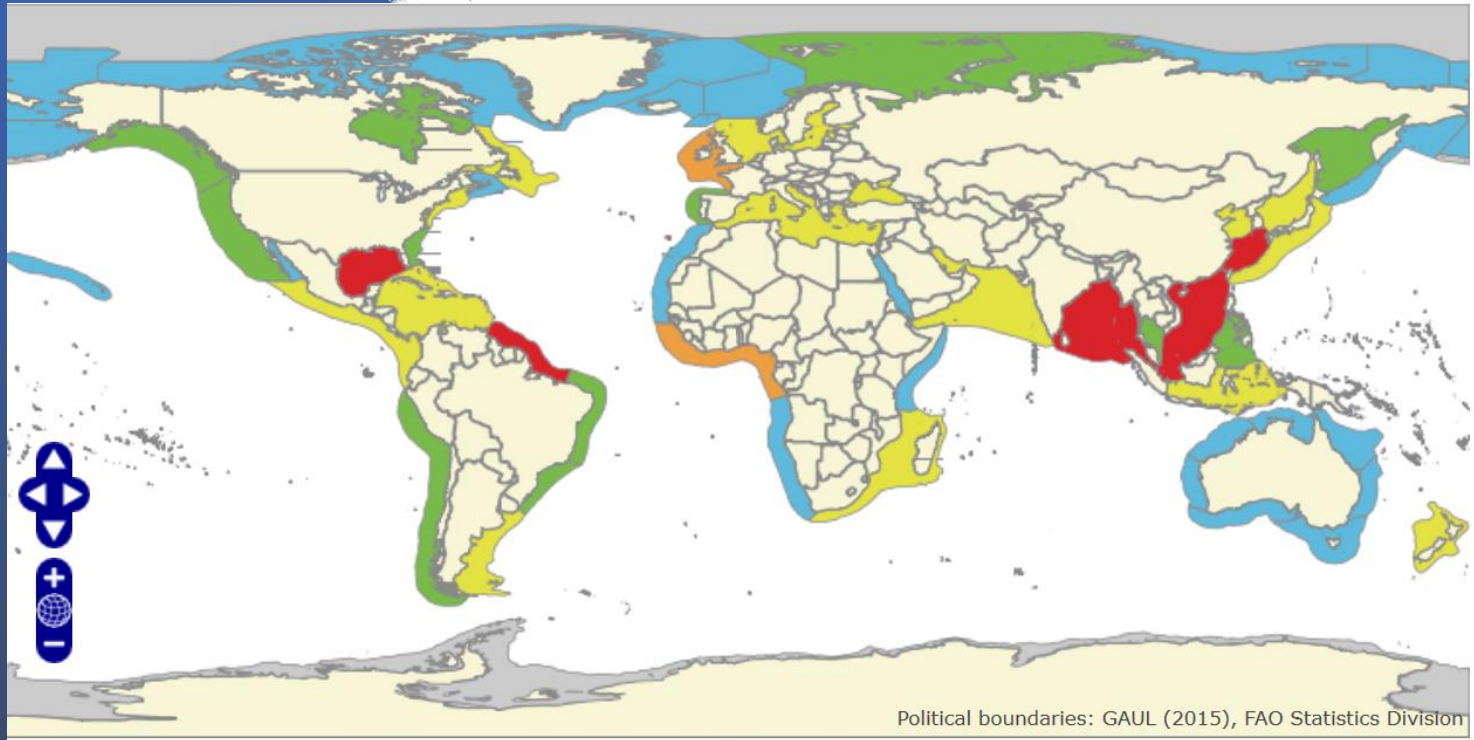
- This have been done at the basin level, which is not particularly useful for national level decision making.

- A sub-basin level product is expected to be finished by end of this year. For transboundary sub-basins, the N and P loading will be on a percentage basis using the socio-economic, land use and nutrient management data for each country.

- It is recommended that countries refine the ICEP model based on their own figures (such as land use, fertilizer use, livestock, wastewater treatment, etc.)

Example – Case Studies

Indicator for Coastal Eutrophication Potential (N and P loading)



Nitrogen load, base year 2000, categorized from the lowest (1) to the highest (5) values

Risk level:

1: Lowest
2: Low
3: Medium
4: High
5: Highest
No data

Summary

- **Coastal eutrophication** can lead to serious damage to marine ecosystems, vital sea habitats, and can cause the spread of harmful algal blooms.
- Using NEAT*—as a satellite-based technique to keep an eye on growing eutrophication threat to oceans.
- The Special Monitoring Centre has also developed an online portal on harmful algal blooms, countermeasures against harmful algal blooms and eutrophication monitoring guidelines for local government officials in coastal regions.

*Northwest Pacific Action Plan Eutrophication Assessment Tool

Thank you !

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