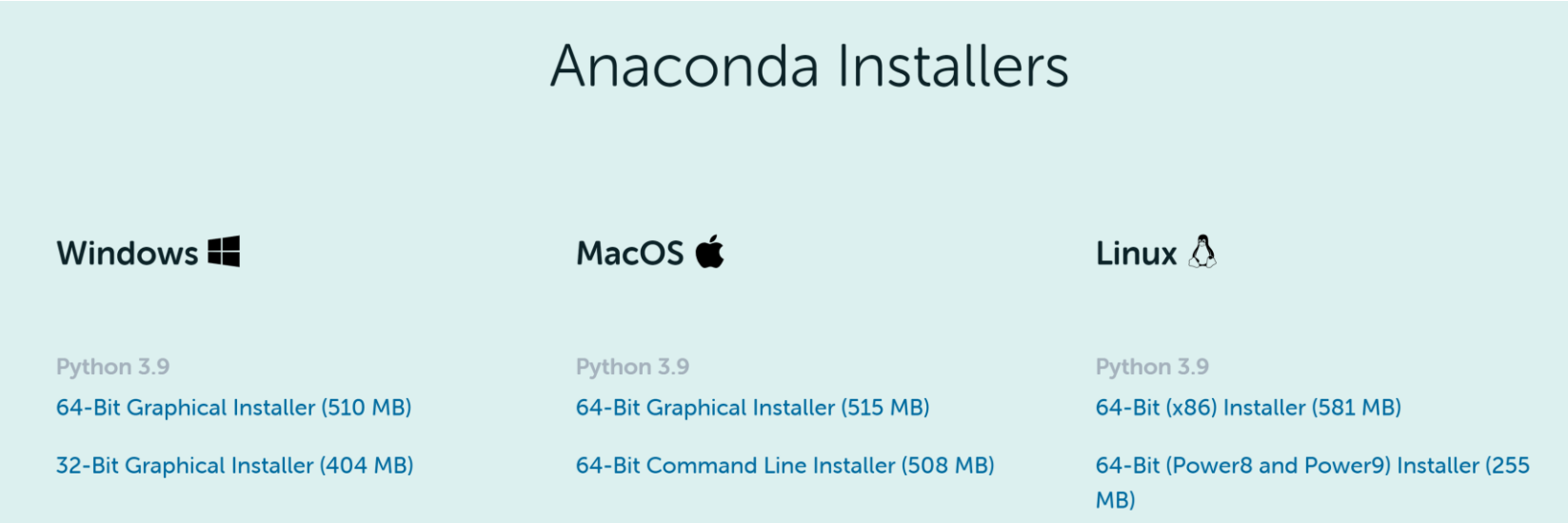
- 5th NOWPAP Remote Sensing Training Course 2021

- **Webinar 2**: Monitoring and Assessment of Water Quality by Ocean Color Remote Sensing

# Prerequisites

- Install Jupyter Notebook:
  - https://jupyter.org/install

- Best and simple option is to use **ANACONDA**
  - https://www.anaconda.com/products/individual




- **Optionally, have access to Google Earth Engine**
  - https://code.earthengine.google.com/

# Training Outline

- Day 1 (~2 h):
  - Application of ocean color products (global eutrophication watch)
  - Working with satellite swath imagery
    - Introduction to OC data products and online match-up tool

- Day 2–3 (~2 h):
  - **Time-series analysis**
    - Browse and download NOWPAP-Marine Env. Watch data
    - Generate monthly composites from daily images
    - Create animations from monthly images
    - Extract annual max from monthly images
    - Extract point/region of interest
    - Perform trend detection

# Certificate

- **A certificate of completion will be awarded to those who**:
  - Attend most of the lectures and hands-on sessions
  - Complete the feedback form by the deadline

- The certificate of completion will be sent approximately two weeks after the completion
- Any questions direct to: cearac@npec.or.jp
  - In the subject put: **5th NOWPAP Training Course: Webinar 2**

# Outline for Day 1

- Application of ocean color products (H) 50 mins
  - Introduction to the global eutrophication watch

- Working with satellite swath imagery (H) 60 mins
  - Introduction to the online match-up tool

- **Resource page**
  - https://github.com/npec/5th-NOWPAP-Training-Course-on-Remote-Sensing-Data-Analysis

  - **Download training materials** 👉 https://github.com/npec/5th-NOWPAP-Training-Course-on-Remote-Sensing-Data-Analysis/archive/refs/heads/main.zip

# Introduction to the global eutrophication watch

Article | Open Access | Published: 22 October 2021

## Globally consistent assessment of coastal eutrophication

Elígio de Raús Maúre ✉, Genki Terauchi, Joji Ishizaka, Nicholas Clinton & Michael DeWitt

*Nature Communications* **12**, Article number: 6142 (2021) | Cite this article



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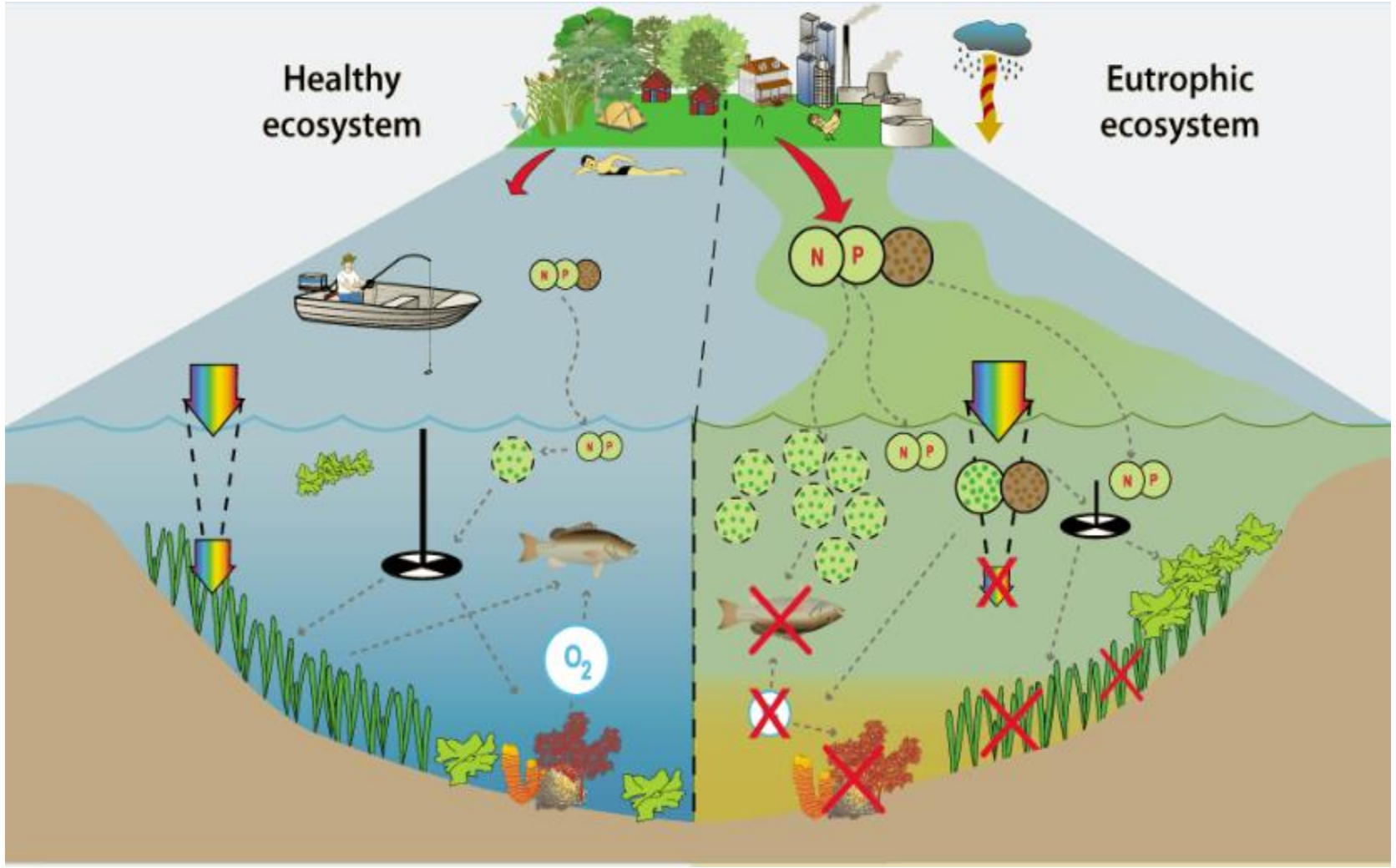
Northwest Pacific Region Environmental Cooperation Center

# Coastal Eutrophication

Also known as cultural eutrophication: accelerated degradation of coastal ecosystems associated with increasing anthropogenic nutrient loading.

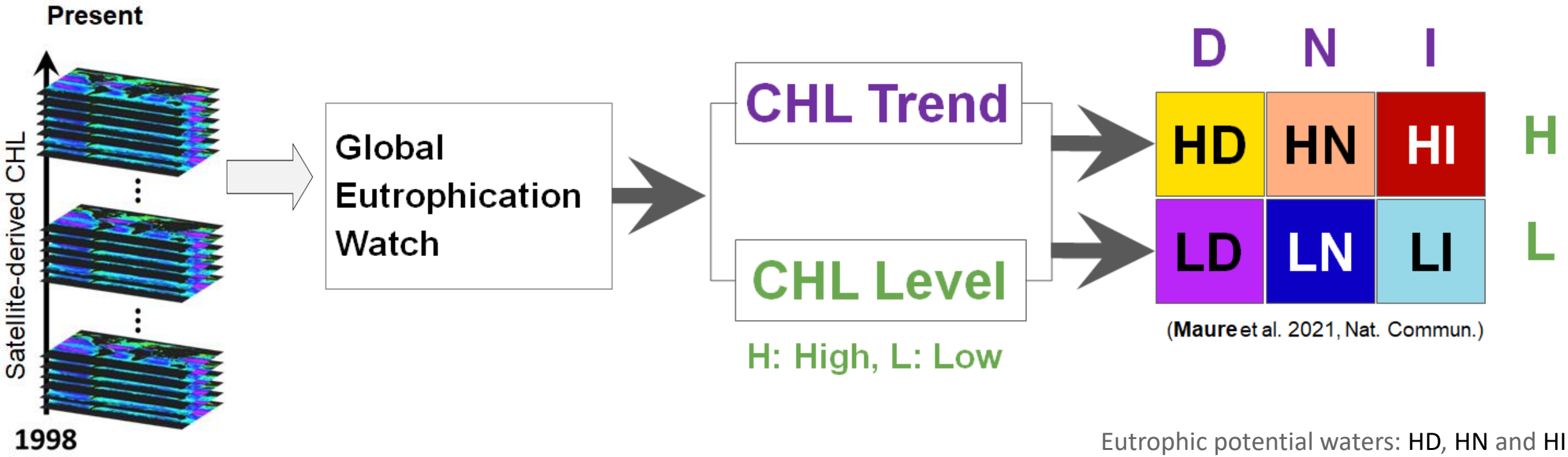



- High Nutrients loads (**industrial & household**)
- Red Tide (**Harmful Algal Blooms**)
- Low Bottom Oxygen (**Hypoxia and anoxia**)
- Low Transparency (**Less submerged vegetation**)
- Global Coastal Problem
- SDG 14.1.1a: (**Index of coastal eutrophication**)

# Global Eutrophication Watch

A planetary scale tool for eutrophication assessment

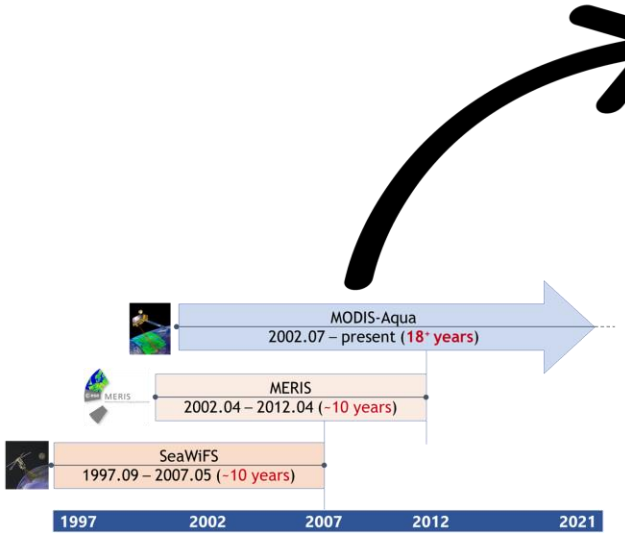
**Global Eutrophication Watch**: a Google Earth Engine tool for coastal eutrophication assessment using the **NEAT** methodology
It detect symptoms of coastal eutrophication using only satellite-derived chlorophyll-a (CHL) concentration




Eutrophic potential waters: HD, HN and HI
Eutrophication potential waters: HI and LI

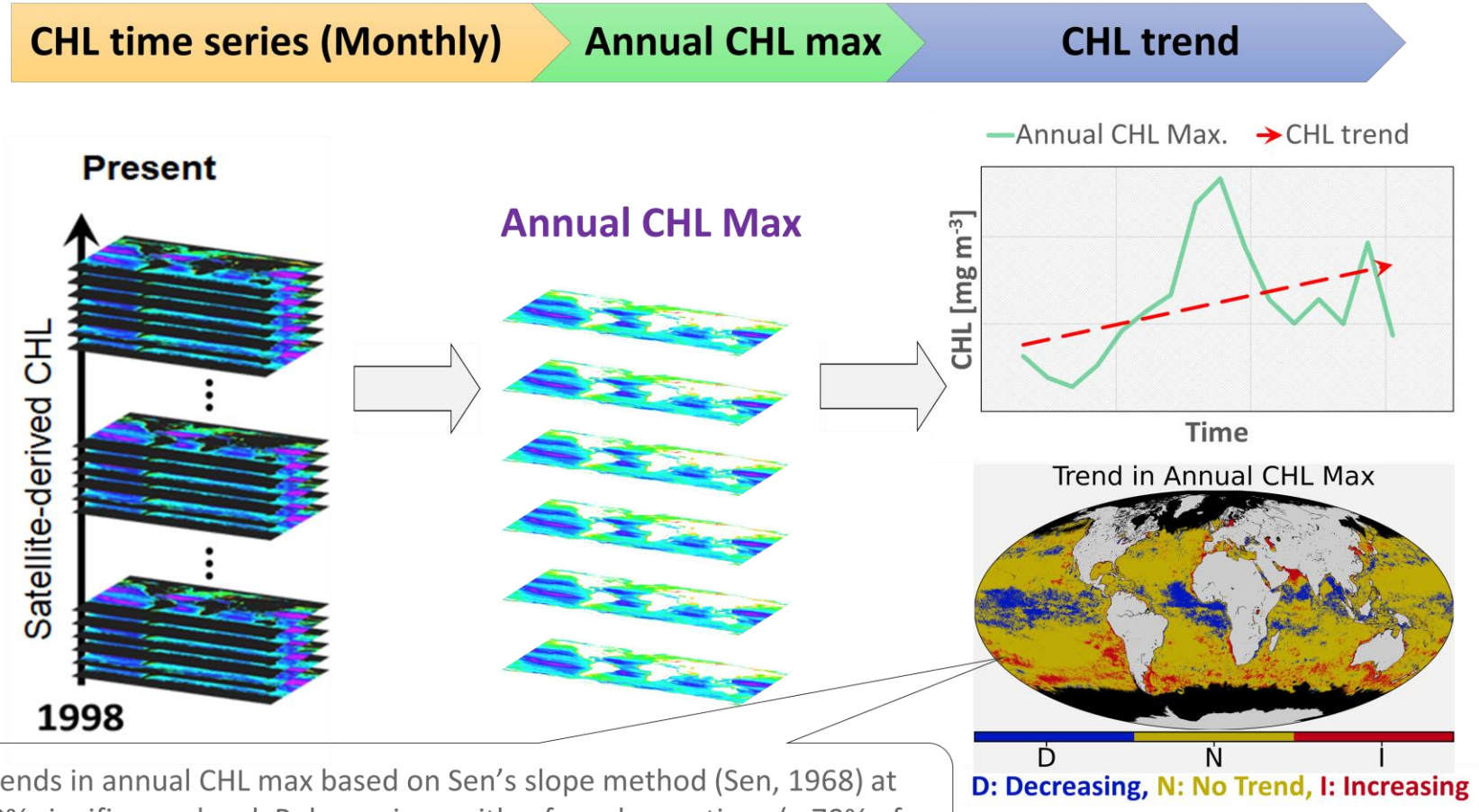
**NOWPAP**: Northwest Pacific Action Plan
**NEAT**: NOWPAP Eutrophication Assessment Tool (**Terauchi et al. 2014, 2018**)

# Global Eutrophication Watch: Trend in Annual CHL Max




Global assessment based on combined **SeaWiFS, MERIS** and **MODIS-Aqua** derived CHL at 1 km spatial resolution

- Long-term consistent CHL time series (1998-2018, **20+ years**)

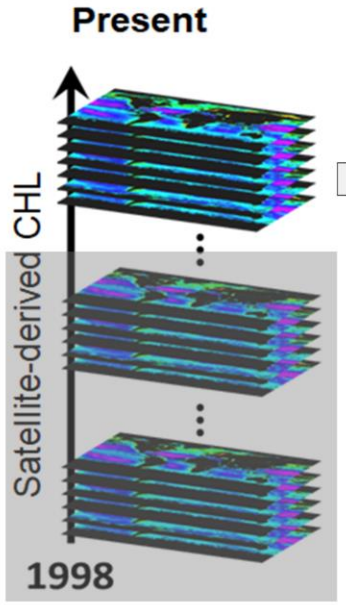


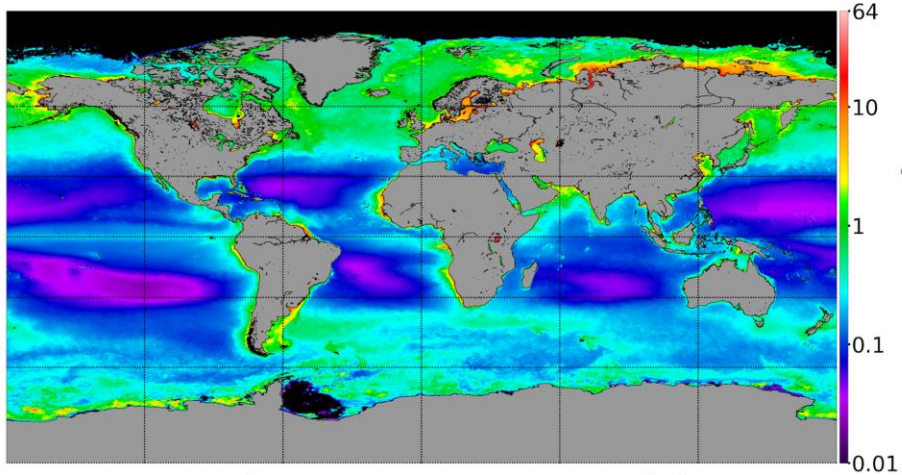

Trends in annual CHL max based on Sen's slope method (Sen, 1968) at 90% significance level. Polar regions with a few observations (< 70% of the study period) were masked.

**Global assessment**: MODIS-Aqua CHL data with 4 km spatial resolution
**NOWPAP region**: combined above three sensors at 1 km spatial resolution

# Global Eutrophication Watch: 3-year Mean CHL

**CHL time series (Monthly)** → **3-year Mean CHL** → **CHL threshold**

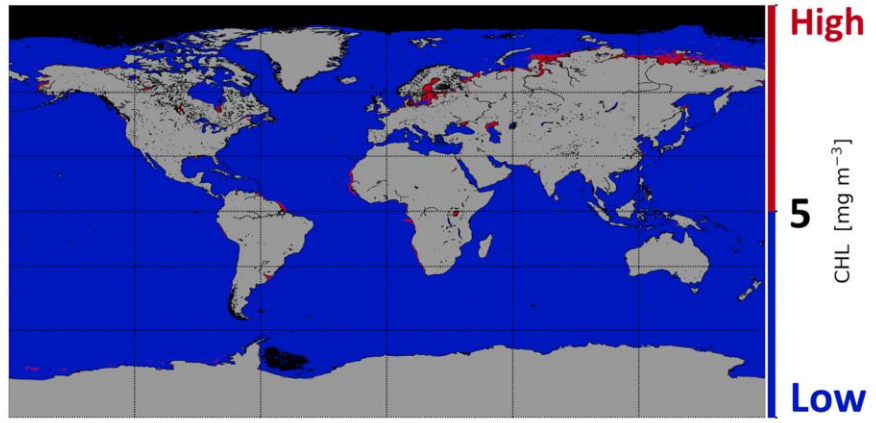



Composite of most recent 3-year of the analysis period

## CHL Threshold (Cutt-off level)

**High** ≥ 5 mg m$^{-3}$ (mostly coastal regions); **Low** < 5 mg m$^{-3}$




**Blue: CHL < 5 mg m$^{-3}$** (open ocean mostly)

**Red: CHL ≥ 5 mg m$^{-3}$** (coastal waters mostly)

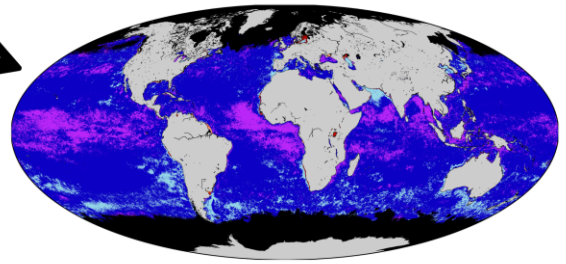
Citation:
de Raús Maüre, E., Terauchi, G., Ishizaka, J. et al. Globally consistent assessment of coastal eutrophication. Nat Commun 12, 6142 (2021). https://doi.org/10.1038/s41467-021-26391-9

Global Eutrophication Watch → **CHL Trend** + **CHL Level**

H: High, L: Low

| | D | N | I |
|---|---|---|---|
| H | HD | HN | HI |
| L | LD | LN | LI |

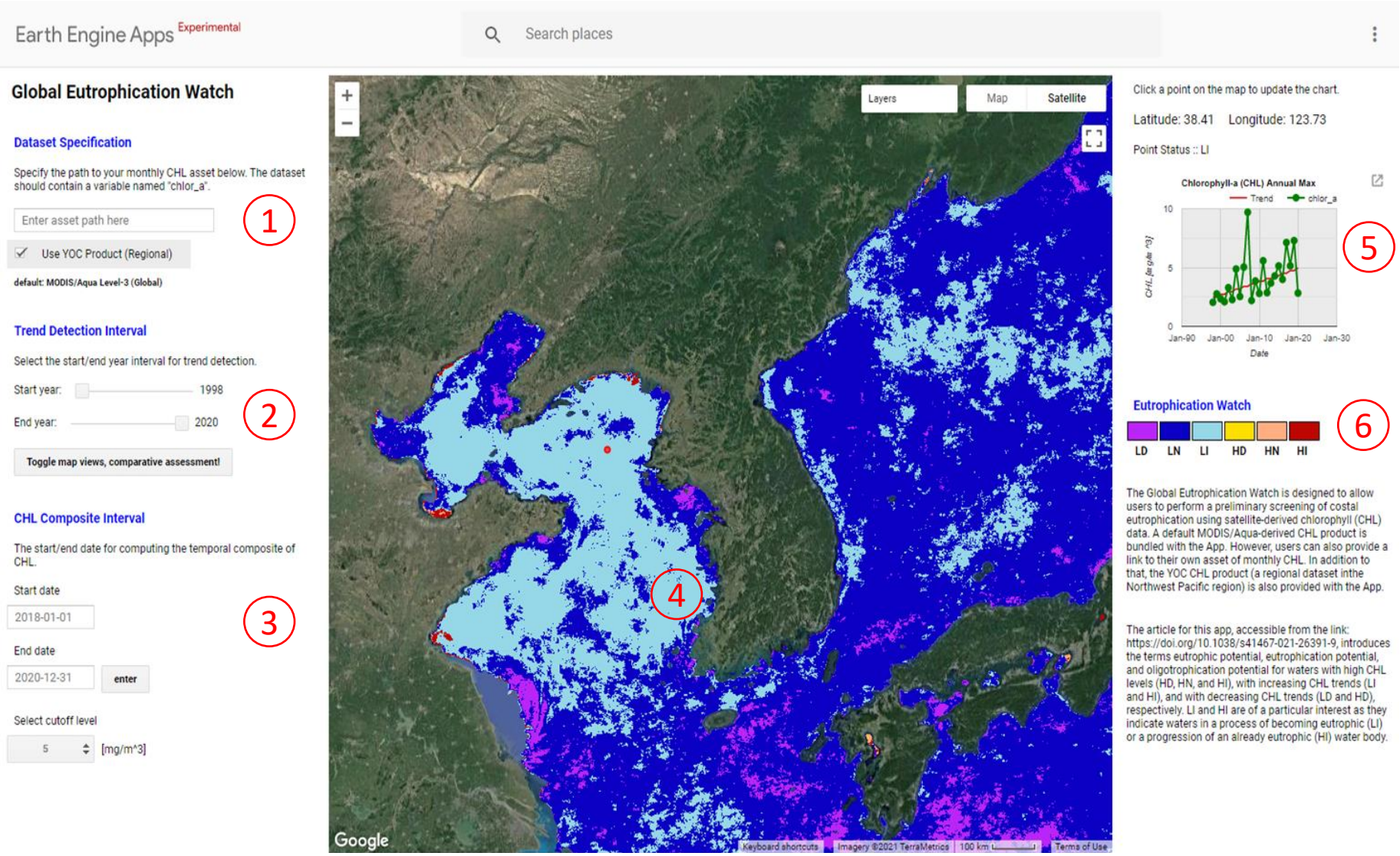
(Maure et al. 2021, Nat. Commun.)



Eutrophic potential waters: **HD**, **HN** and **HI**

Eutrophication potential waters: **HI** and **LI**

# The Global Eutrophication Watch App: Global Assessment

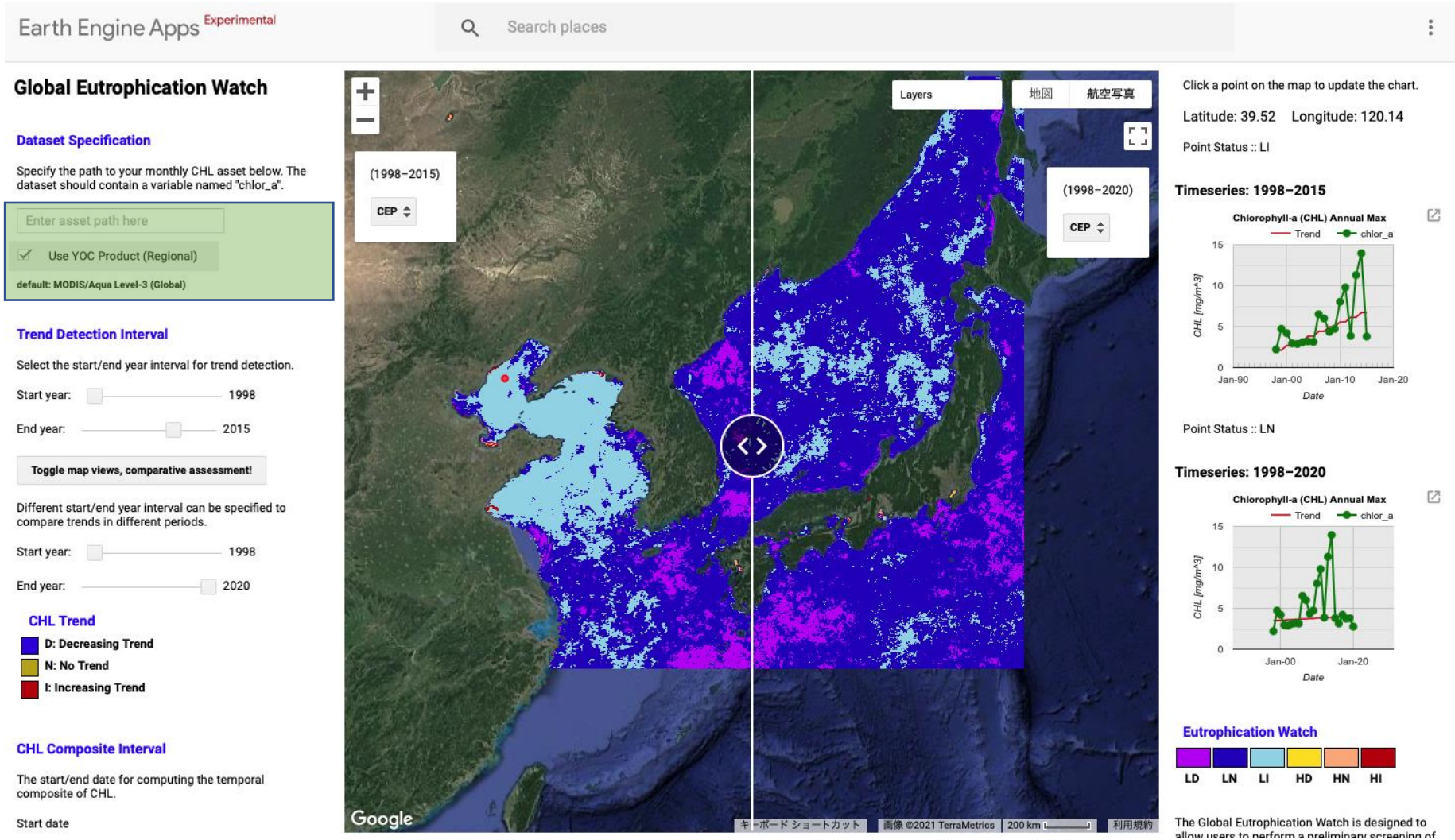



Fields in the App

1. Specification of dataset for eutrophication assessment
2. Definition of assessment interval for trend detection
3. Definition of chlorophyll (CHL) level parameters (CHL threshold)
4. Eutrophication assessment map
5. Time series of a select point on the map
6. Assessment colour codes

EE App: https://eutrophicationwatch.users.earthengine.app/view/global-eutrophication-watch

# The Global Eutrophication Watch App: Regional Assessment




Eutrophication assessment in NOWPAP region using a regional dataset

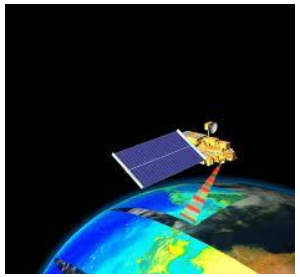
The dataset is based on a local algorithm developed to improve CHL retrievals in coastal regions highly influenced by coloured dissolved organic matter and suspended sediments (Siswanto et al. 2011)

https://eutrophicationwatch.users.earthengine.app/view/global-eutrophication-watch

# Regional Satellite-derived CHL in the NOWPAP

**Satellite Sensors**

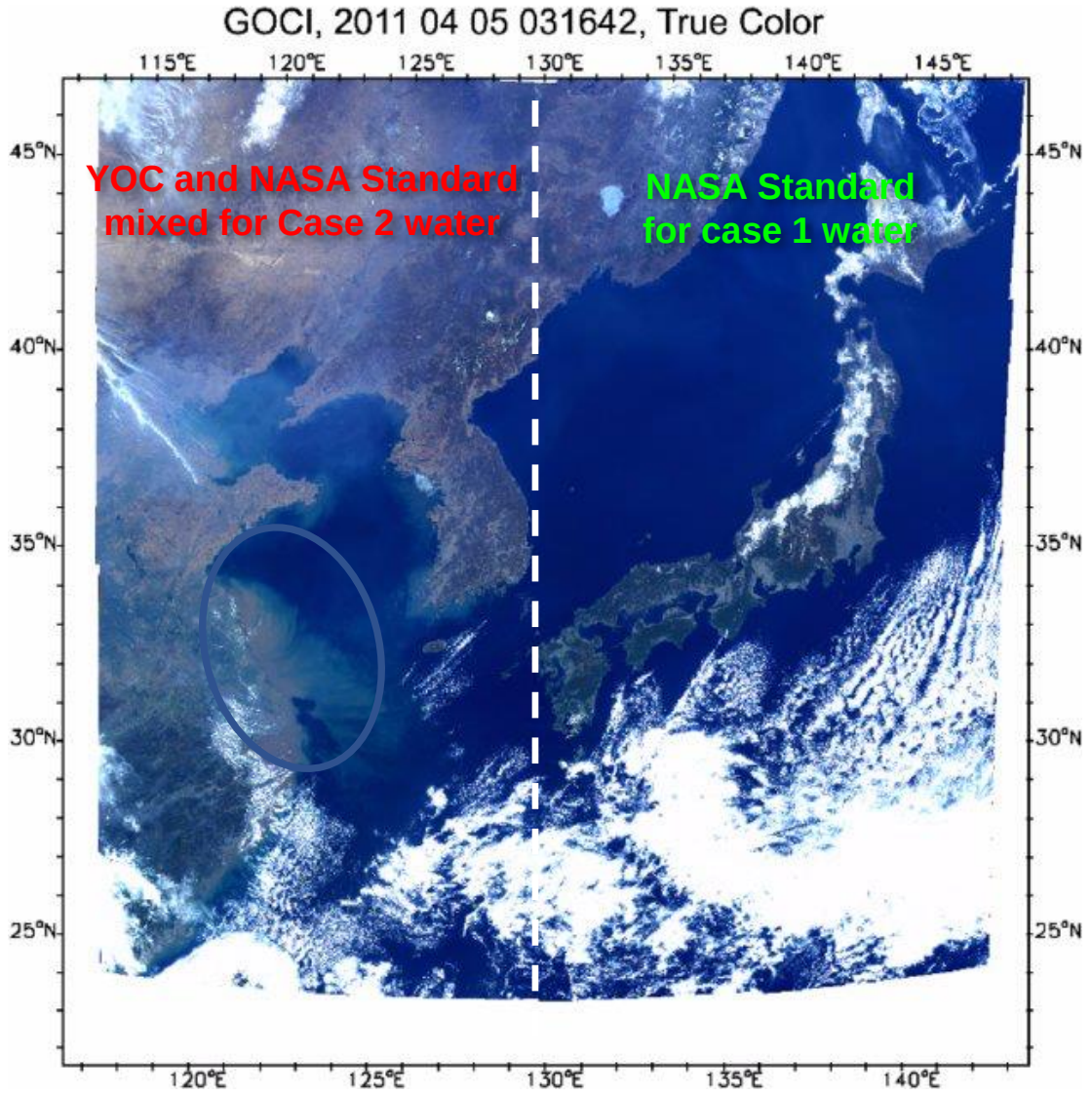
- **SeaWiFS** (1998-2007)
- **MERIS** (2002-2012)
- **MODIS-Aqua** (2002-present)



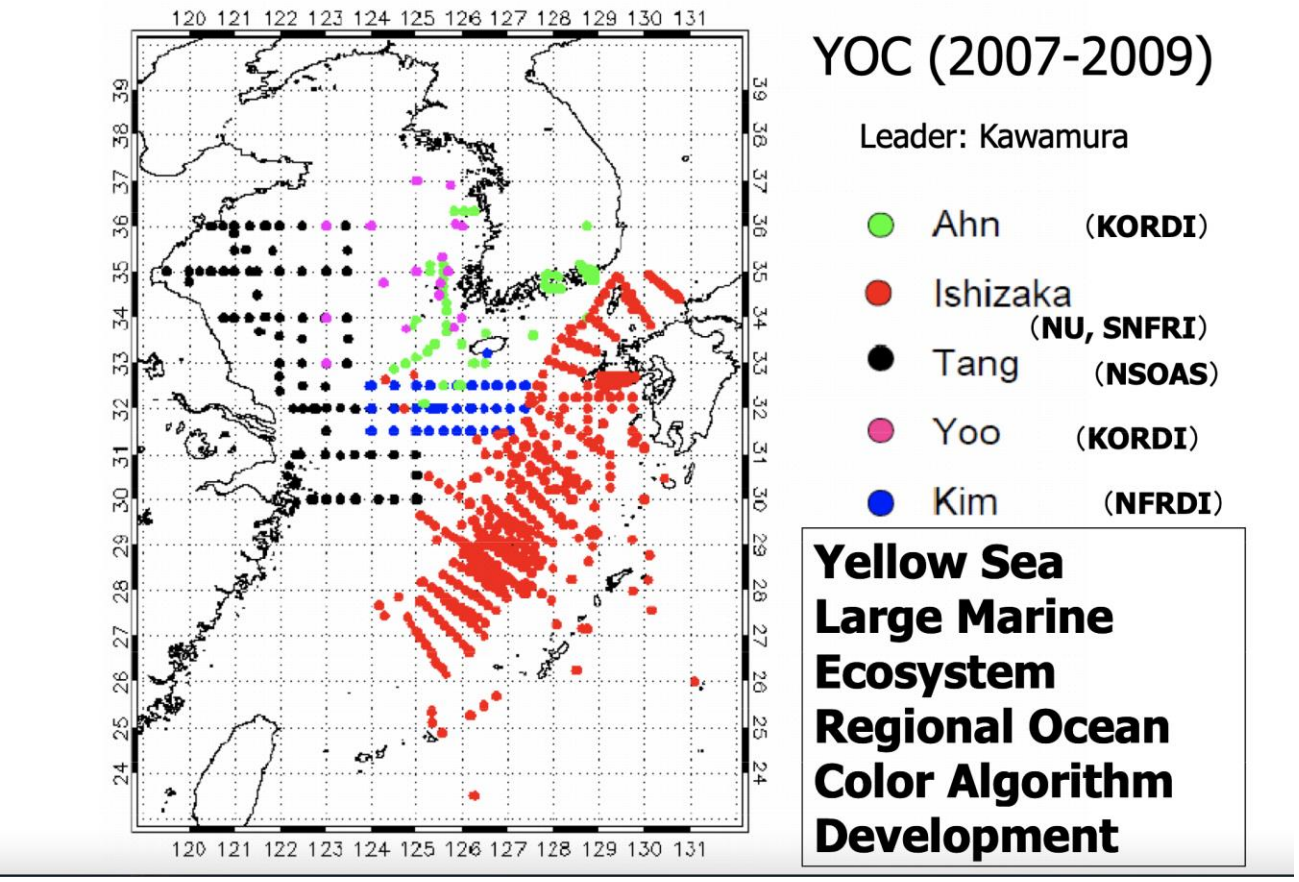
**Algorithm to estimate chlorophyll-a**

- NASA Standard
- Yellow Sea Large Marine Ecosystem

Ocean Color Project Algorithm (YOC)

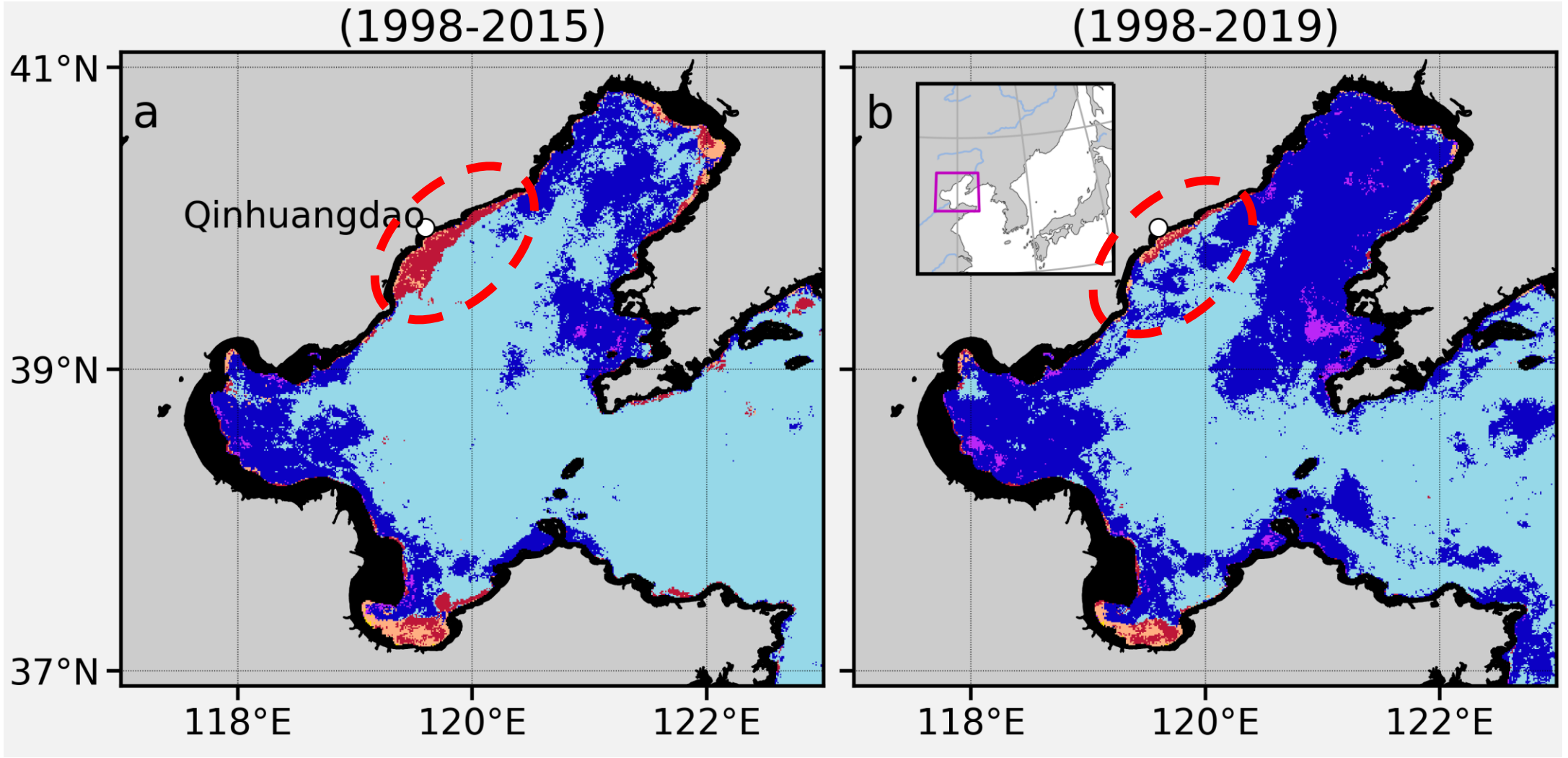


# Regional efforts to improve satellite derived CHL




# Regional Satellite-derived CHL in the NOWPAP

Highlights improving water quality with decreasing CHL trends



# SGLI data ingesting in Google Earth Engine


- **Ingested SGLI level 2 mapped CHL data from EORC (https://code.earthengine.google.com/a93ee099b1a13cc298227bc4f7e2b81d)**
- **Ingestion of SGLI level 2 swath data tested by NPEC**
- **Ingestion of SGLI level 2 swath data to be done by the Google soon**

# Summary

- **We introduced the global eutrophication watch**
  - It can be used for rapid and cost-effective screening of eutrophication
  - Can help identify areas in need of eutrophication management or with improving water quality
  - Ideal for awareness raising and education

- **For assessment in coastal waters**
  - High resolution data with suitable data quality are needed
  - The global eutrophication watch user to specify region-specific dataset
  - Existing and future ocean colour missions (e.g. SGLI/GCOM-C (250m) and OLCI/Sentinel-3 (300m)) are enabling coastal water monitoring and global eutrophication watch will play a key role

# Acknowledgments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- We also acknowledge the help received from the Nagoya University and Pusan University in preparing the lectures.

- Organizer:
  - NOWPAP CEARAC

- Supporter:
  - IOC/Sub-Commission for the Western Pacific (WESTPAC)
  - North Pacific Marine Science Organization (PICES)