- 5<sup>th</sup> NOWPAP Remote Sensing Training Course 2021

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

# Globally consistent assessment of coastal eutrophication

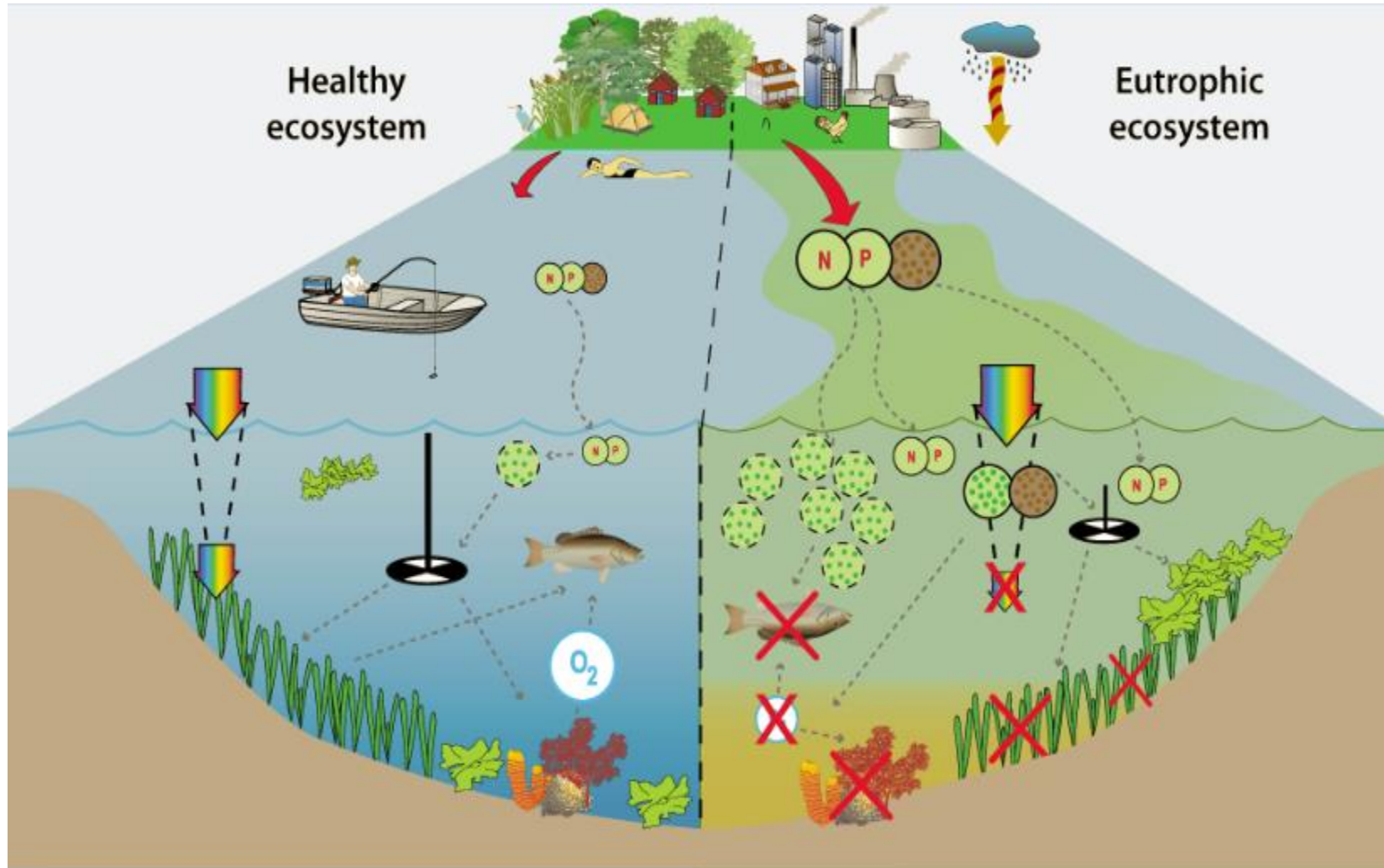Elígio de Raús Maúre ✉, Genki Terauchi, Joji Ishizaka, Nicholas Clinton & Michael DeWitt

Eligio Maure
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



(Maure et al. 2021, Nat. Commun.)
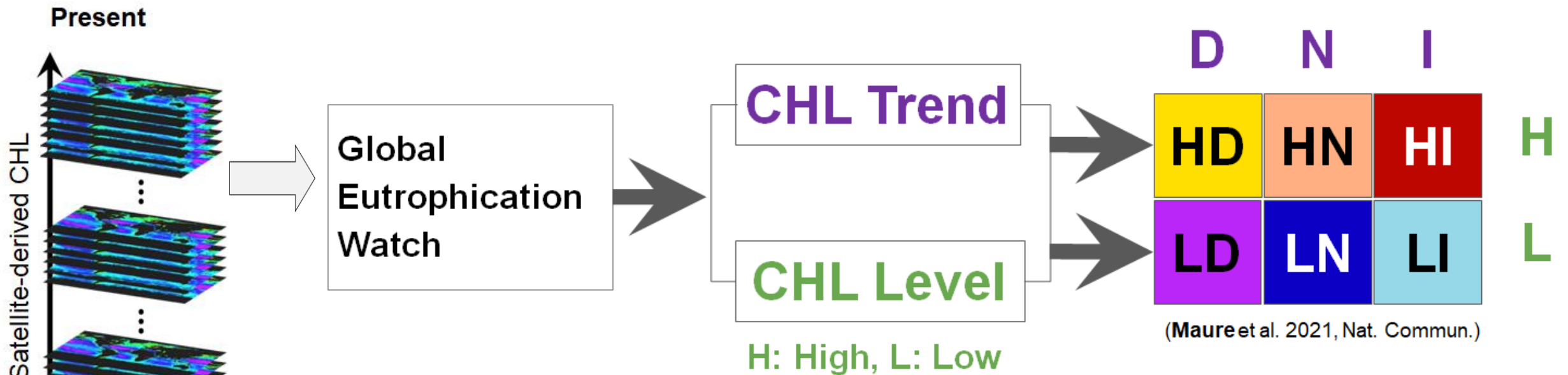
Eutrophic potential waters: HD, HN and HI
Eutrophication potential waters: HI and LI
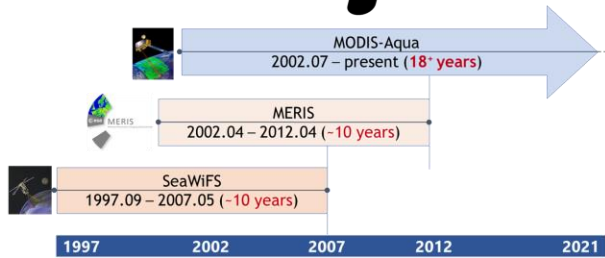
**NOWPAP**: Northwest Pacific Action Plan
**NEAT**: NOWPAP Eutrophication Assessment Tool (**Terauchi et al. 2014, 2018**)

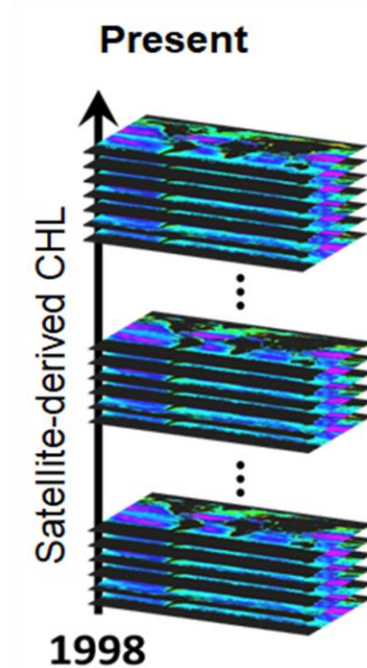# Global Eutrophication Watch: Trend in Annual CHL Max
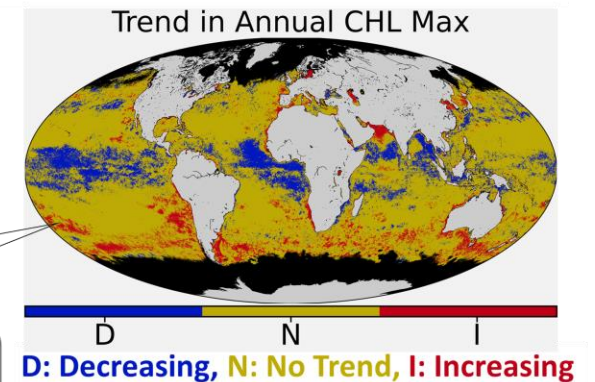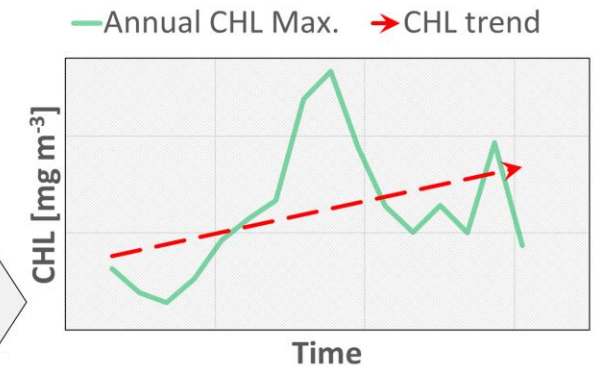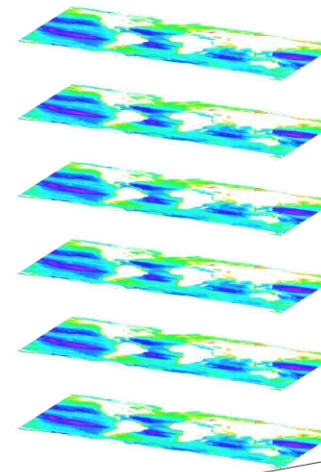


CHL time series (Monthly) → Annual CHL max → CHL trend

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

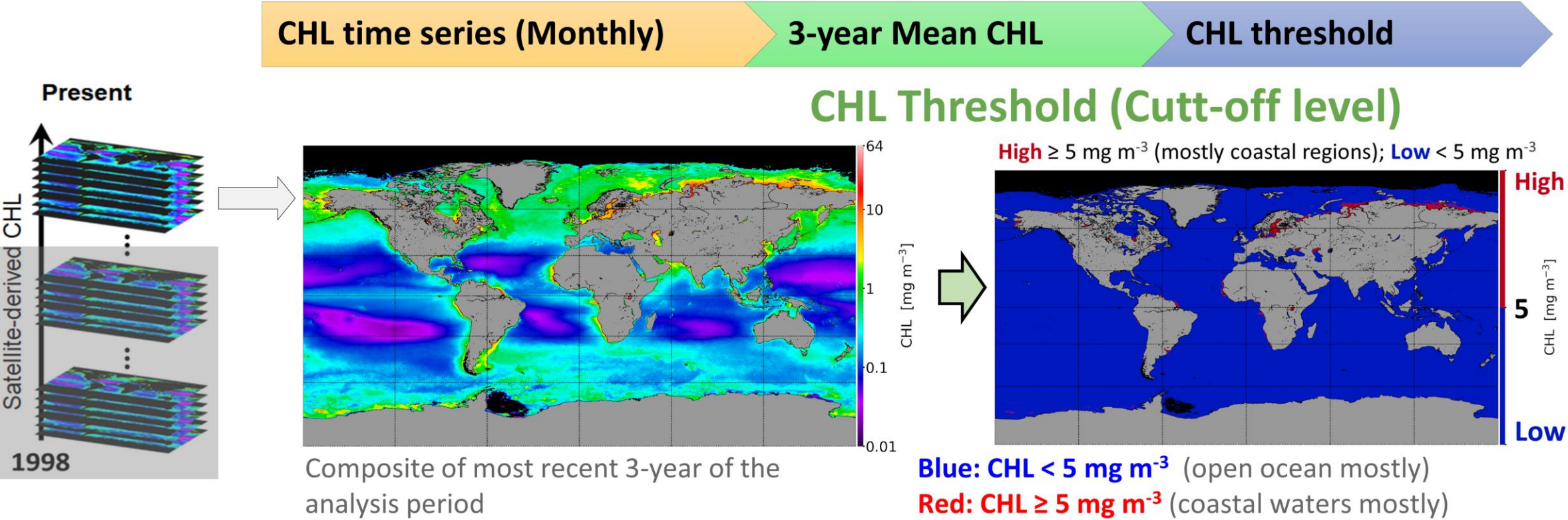- Long-term consistent CHL time series (1998-2018, **20+ years**)

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.
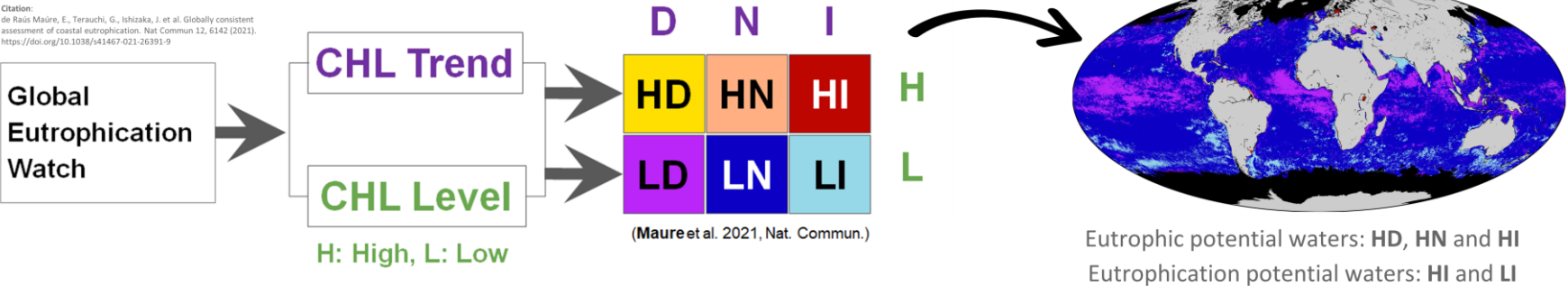
Trend in Annual CHL Max

D: Decreasing, N: No Trend, I: Increasing

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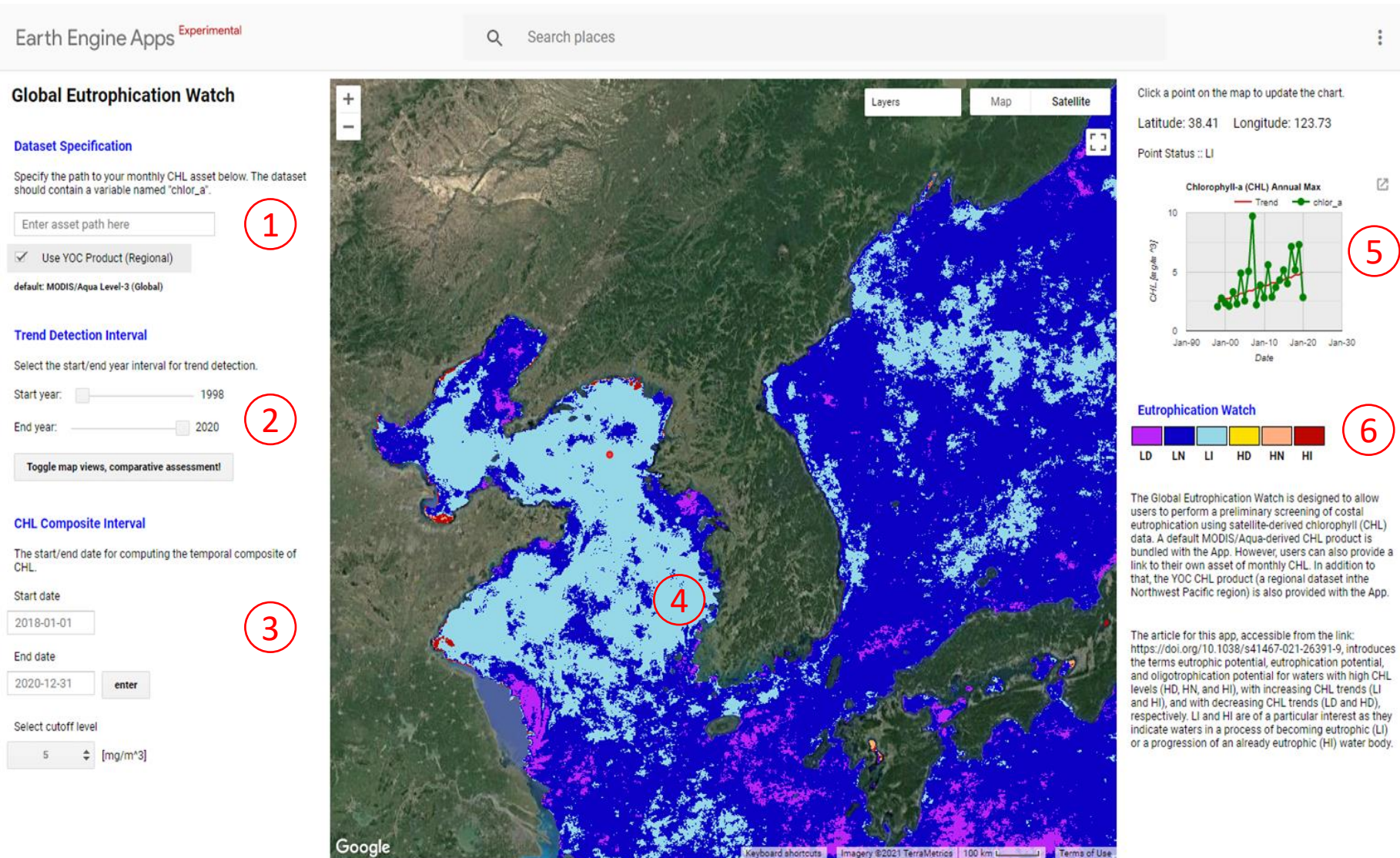**NOWPAP region**: combined above three sensors at 1 km spatial resolution

# Global Eutrophication Watch: 3-year Mean CHL



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

**Present**

Satellite-derived CHL

**1998**

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

CHL [mg m⁻³]

**High**

**5**

CHL [mg m⁻³]

**Low**

**Blue: CHL < 5 mg m⁻³** (open ocean mostly)
**Red: CHL ≥ 5 mg m⁻³** (coastal waters mostly)

Citation:
de Raüs 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

**D   N   I**

| HD | HN | HI | **H** |
| LD | LN | LI | **L** |

**H:** High, **L:** Low

(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
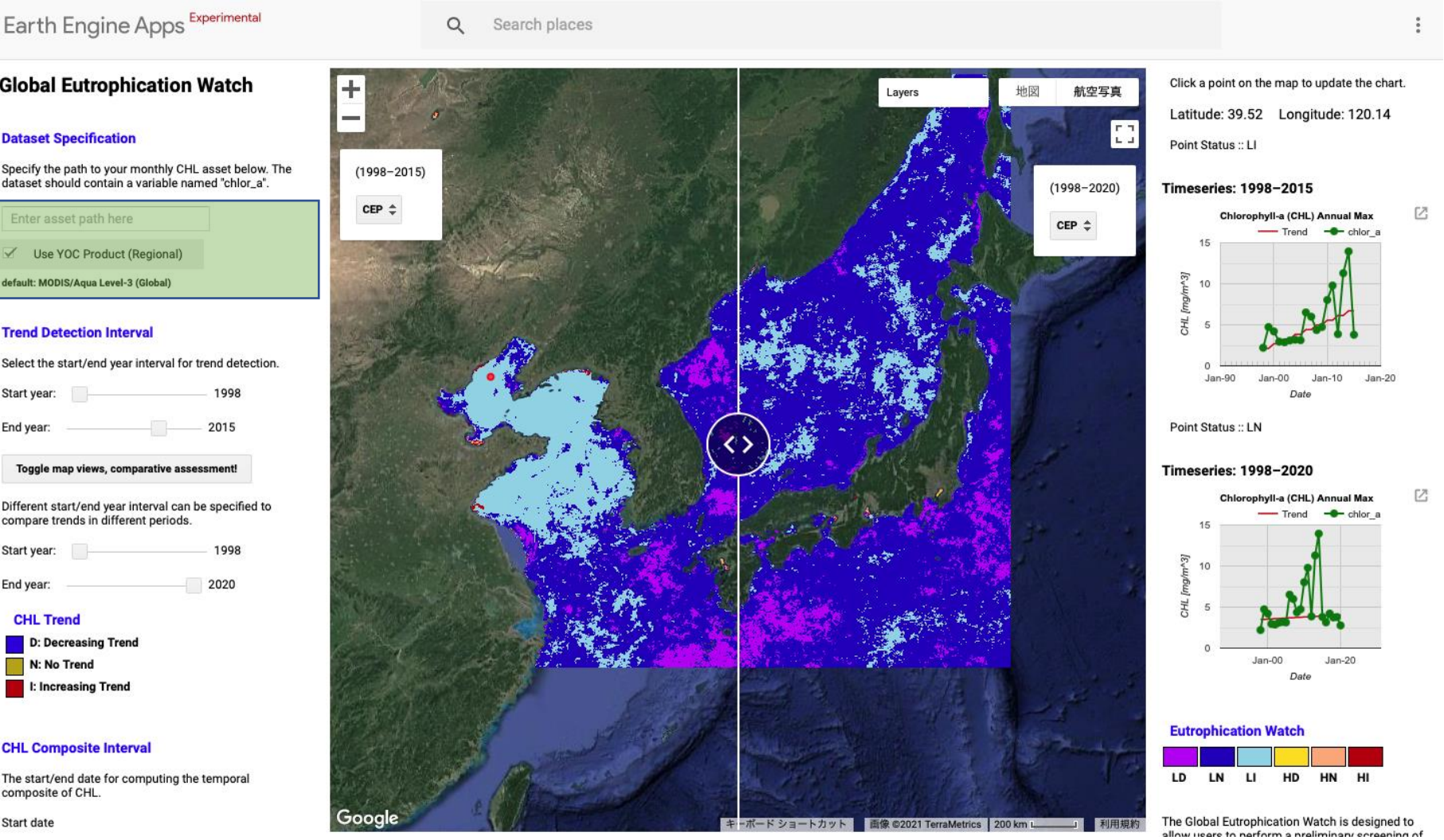


Eutrophication assessment in NOWPAP region using a regional dataset

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
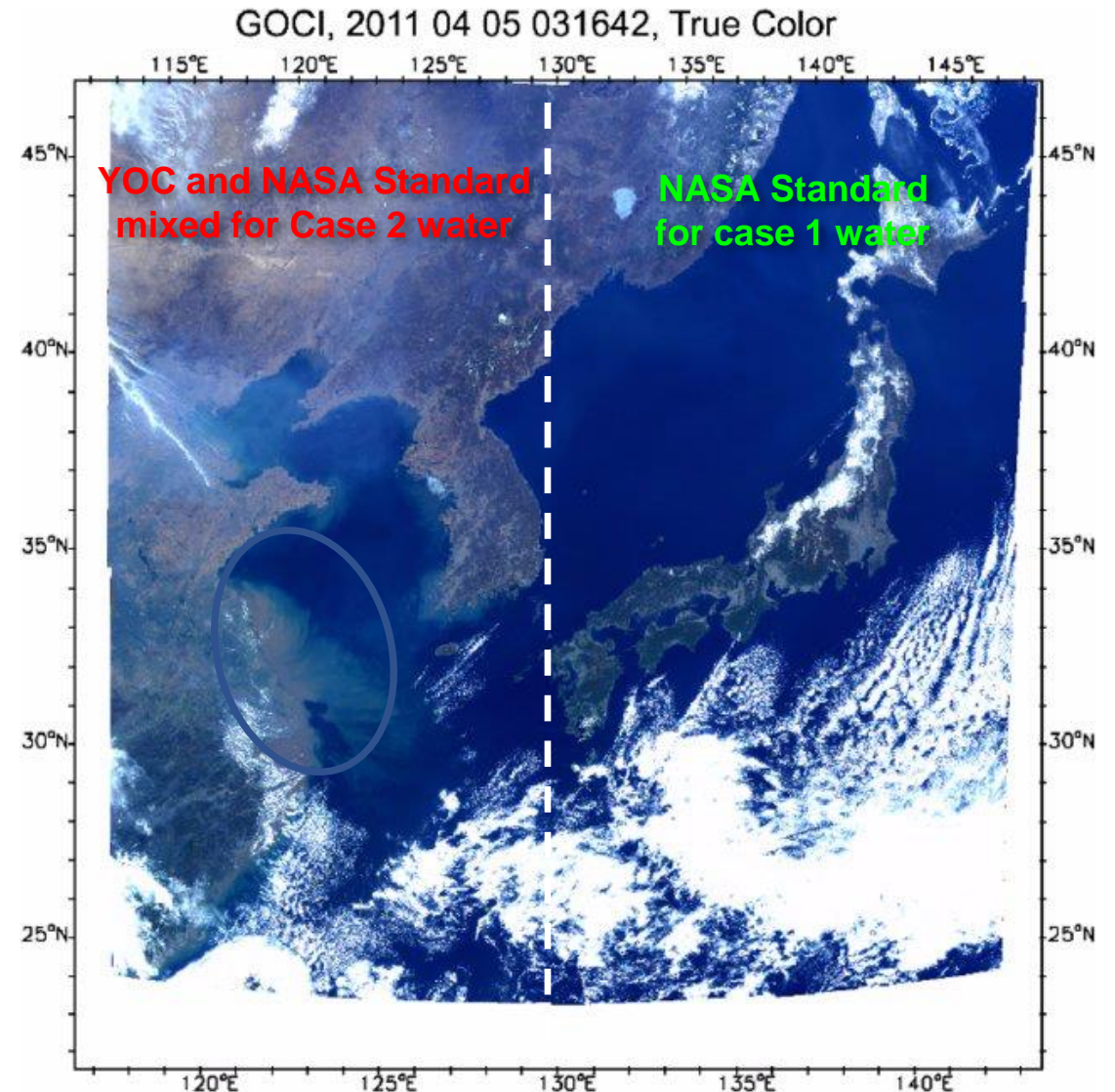
# Regional Satellite-derived CHL in the NOWPAP

**Satellite Sensors**

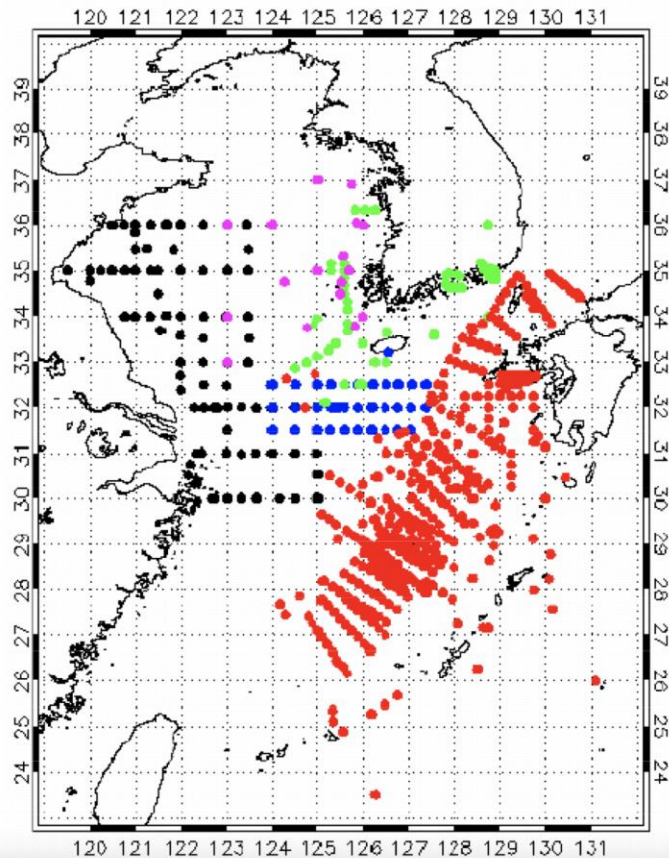- **SeaWiFS** (1998-2007)
- **MERIS** (2002-2012)
- **MODIS-Aqua** (2002-present)
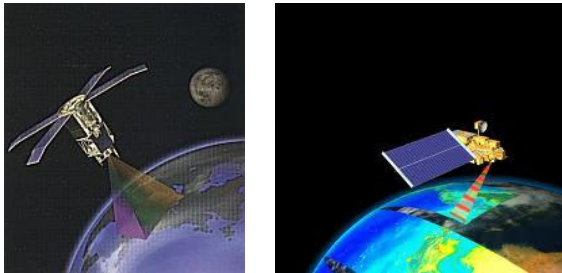


**Algorithm to estimate chlorophyll-a**

- NASA Standard
- Yellow Sea Large Marine Ecosystem Ocean Color Project Algorithm (YOC)



GOCI, 2011 04 05 031642, True Color

YOC and NASA Standard mixed for Case 2 water

NASA Standard for case 1 water

# Regional efforts to improve satellite derived CHL



YOC (2007-2009)

Leader: Kawamura

- 🟢 Ahn (KORDI)
- 🔴 Ishizaka (NU, SNFRI)
- ⚫ Tang (NSOAS)
- 🔵 Yoo (KORDI)
- 🔵 Kim (NFRDI)

Yellow Sea
Large Marine
Ecosystem
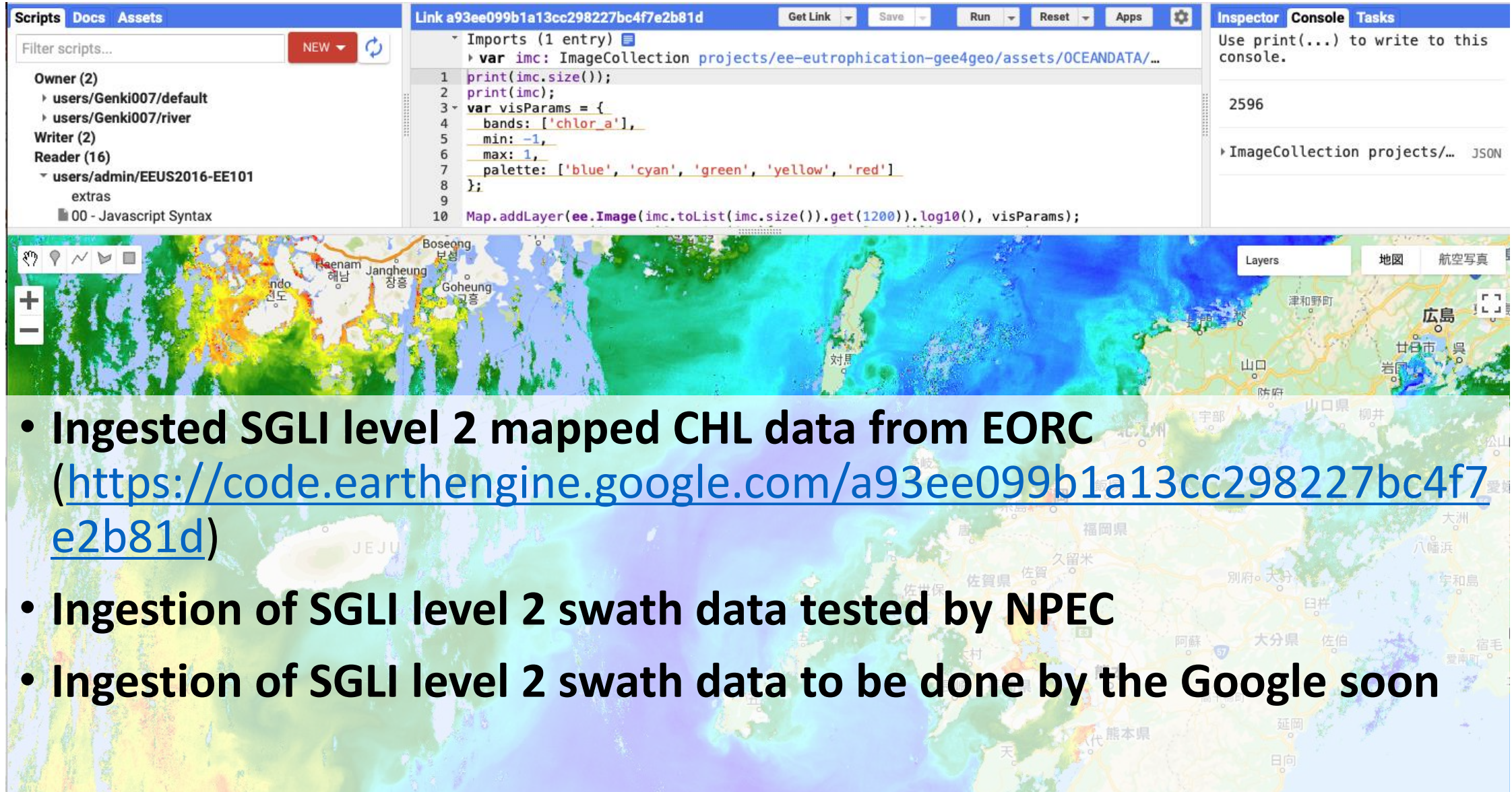Regional Ocean
Color Algorithm
Development

# Regional Satellite-derived CHL in the NOWPAP

Highlights improving water quality with decreasing CHL trends
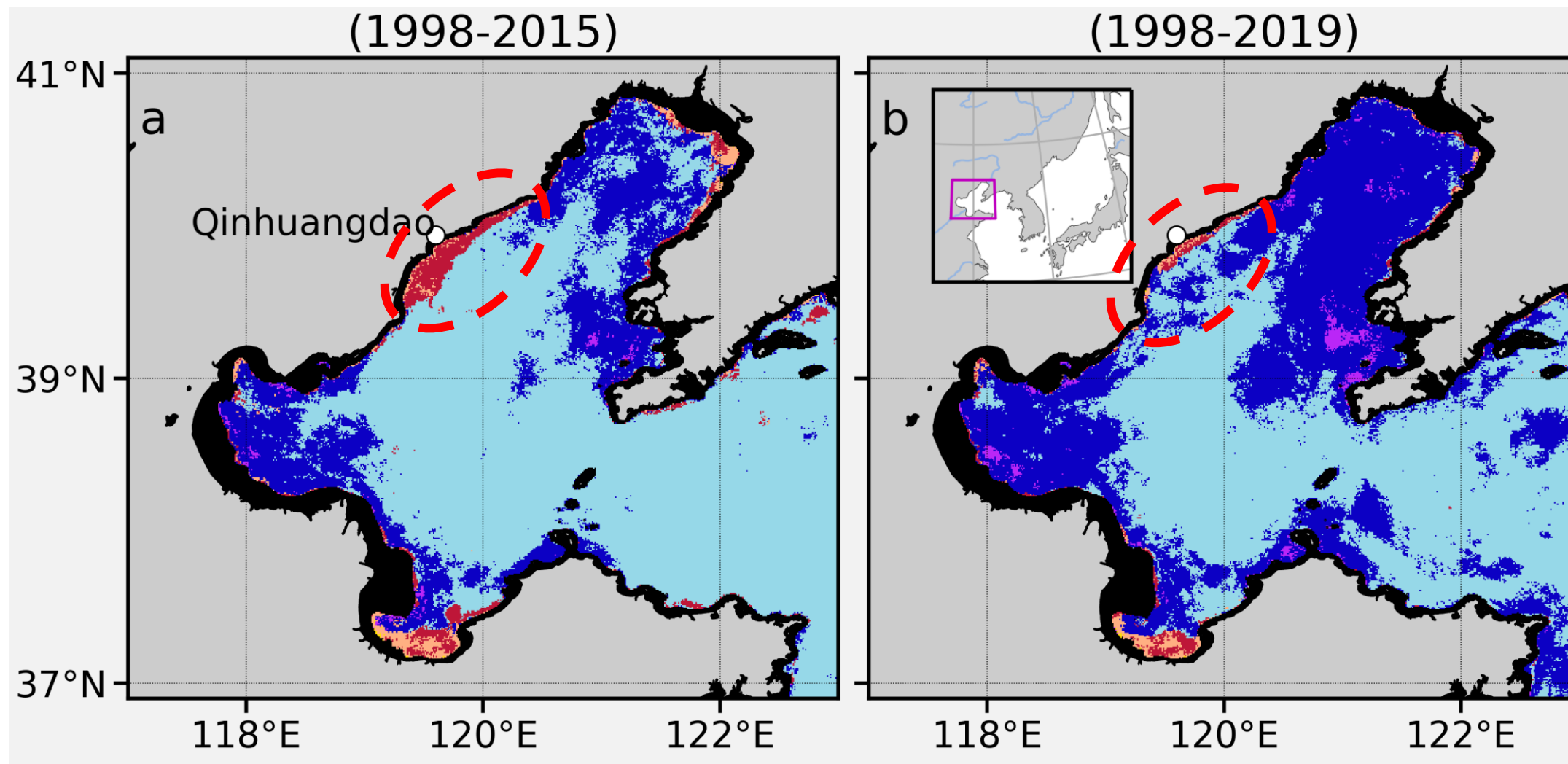
# SGLI data ingesting in Google Earth Engine



- **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**