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# Assessment on Chl-*a* concentrations & eutrophication dynamics

## 2nd SET OF TRAINING SESSIONS ON EARTH OBSERVATION & ENVIRONMENTAL MONITORING FOR YOUNG SCIENTISTS & PRACTITIONERS

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AUA ACOPIAN CENTER for the ENVIRONMENT

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

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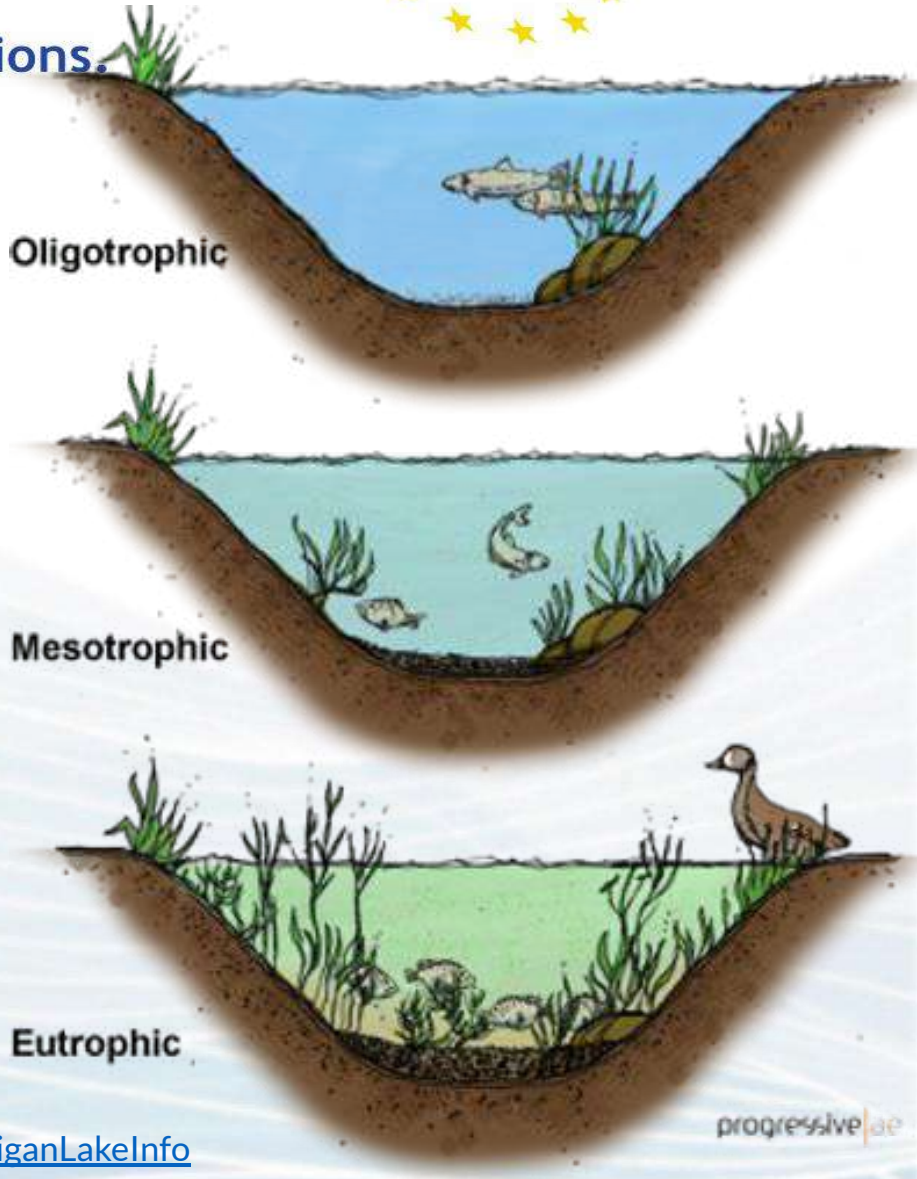
GREEN ALTERNATIVE

1865

# Trophic levels

Anthropogenic impacts driving many aquatic systems to eutrophic states:

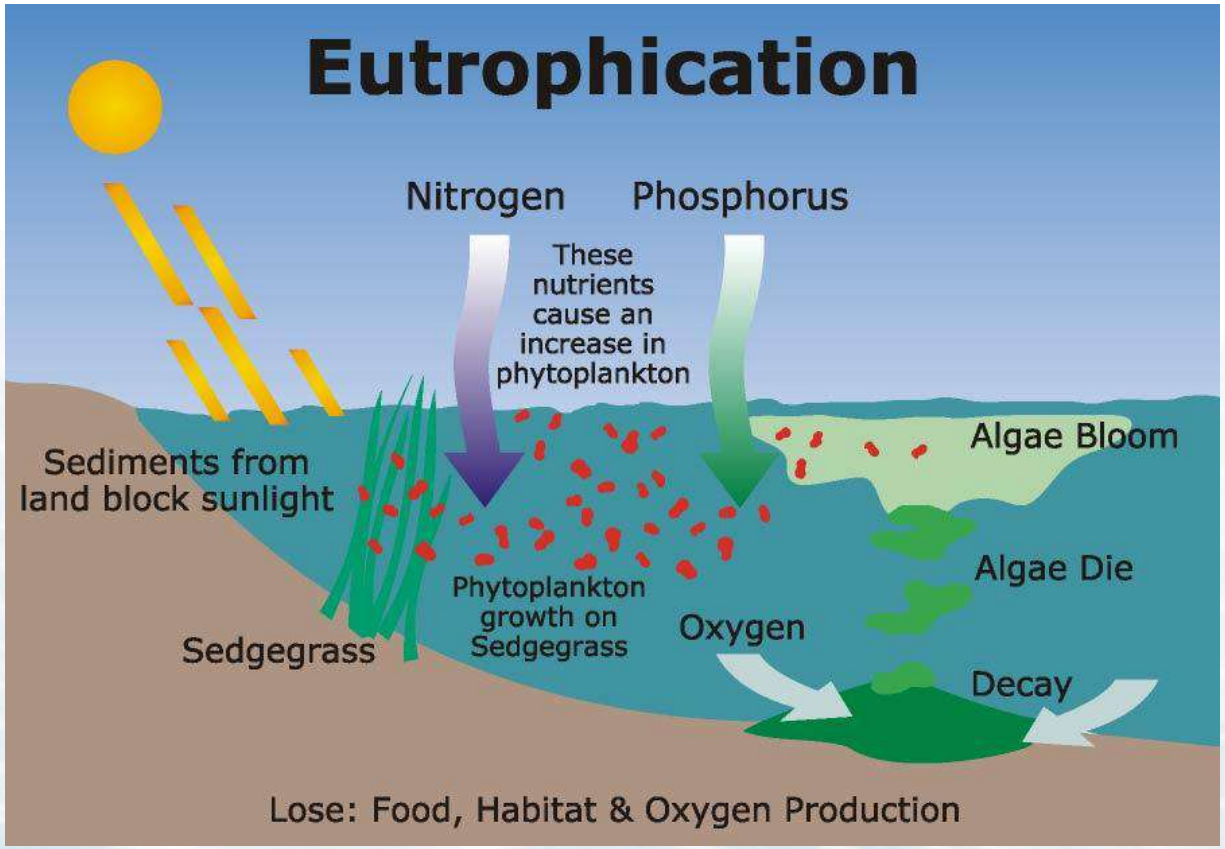
- Agriculture & husbandry
- Urbanization
  - Habitat destruction/land change
  - Untreated sewage
  - Land erosion
- Floods




Source: MichiganLakeInfo

# Impacts of eutrophication

- Increased BOD
- Potential anoxia
- Reduced biodiversity
- Toxic cyanobacterial blooms
- Increased undesirable emissions ($CH_4$, $H_2S$)
- Loss of ecosystem services



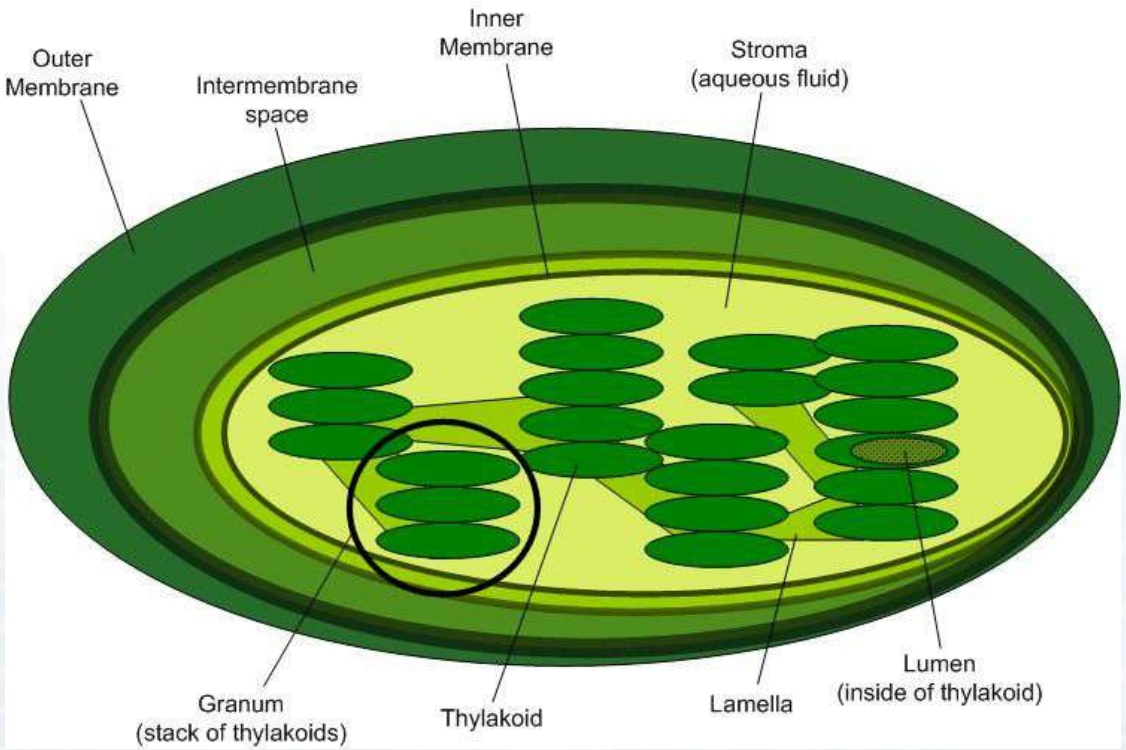

- Indicator / outcome of anthropogenic impacts and water quality deterioration.
- Reporting of chl-a concentrations required measurements of the EU WFD.

Source: Online Science Notes

# Harmful algal blooms have become common in Lake Sevan

# Chlorophyll-*a* as proxy

- Pigment found in plants and algae (Vital for photosynthesis)
- Generally a good correlation between chl-*a* concentrations of algal biomass
- Could be used as proxy to detect occurrence and quantity of algal blooms
- Used as an indicator to monitor water quality

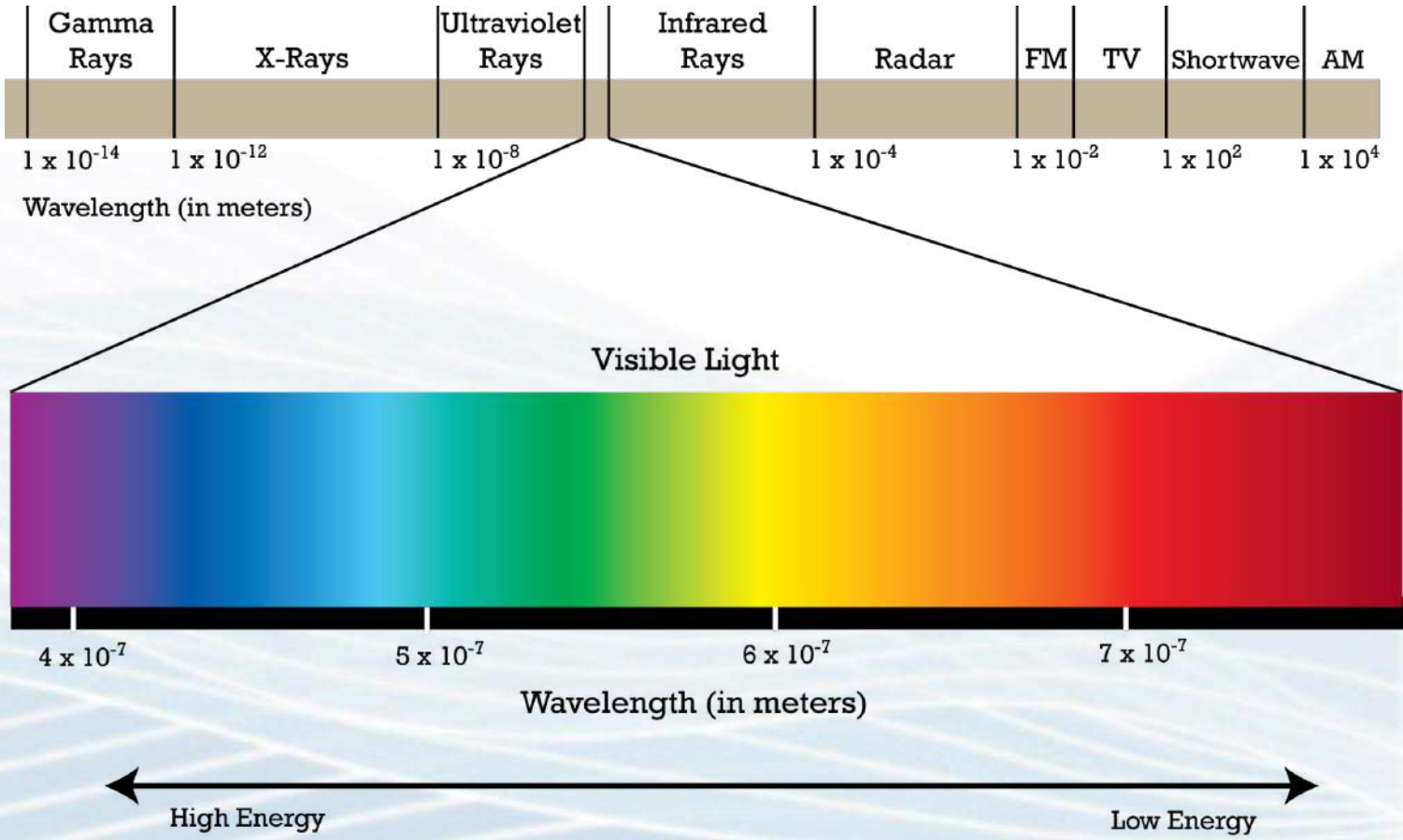



Source: Wikimedia Commons

# Chl-*a* remote sensing

Higher reflectance in lower wavelengths (blue + green regions) at lower [chl-*a*]

=> Challenges in inland waters with higher chl-*a* + humic substances



# Satellites used in remote sensing

**Landsat 4-5**

**2009-2011**

**Landsat 7 ETM+**

**2012**

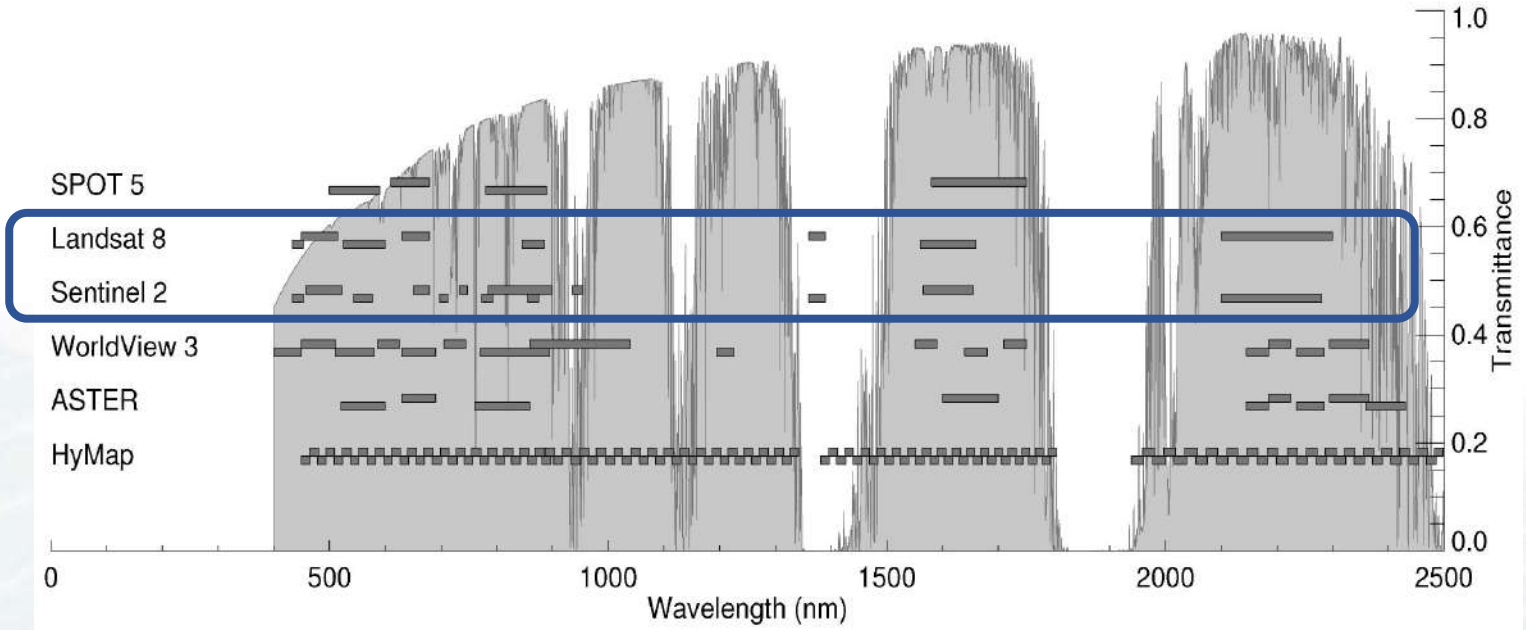
**Landsat 8**

**2013-2015**

**Sentinel 2**

**2015-2019**

# Wavelengths and bands of used satellites




| | Waveband | Central λ (nm) | Bandwidth (nm) | Spatial resolution (m) |
|---|---|---|---|---|
| 1 | Coastal aerosol | 442.7 | 21 | 60 |
| 2 | Blue | 492.4 | 66 | 10 |
| 3 | Green | 559.8 | 36 | 10 |
| 4 | Red | 664.6 | 31 | 10 |
| 5 | Vegetation red edge | 704.1 | 15 | 20 |
| 6 | Vegetation red edge | 740.5 | 15 | 20 |
| 7 | Vegetation red edge | 782.8 | 20 | 20 |
| 8 | Near infrared | 832.8 | 106 | 10 |
| 8A | Narrow near infrared | 864.7 | 21 | 20 |
| 9 | Water vapour | 945.1 | 20 | 60 |
| 10 | Shortwave infrared – Cirrus | 1373.5 | 31 | 60 |
| 11 | Shortwave infrared | 1613.7 | 91 | 20 |
| 12 | Shortwave infrared | 2202.4 | 175 | 20 |

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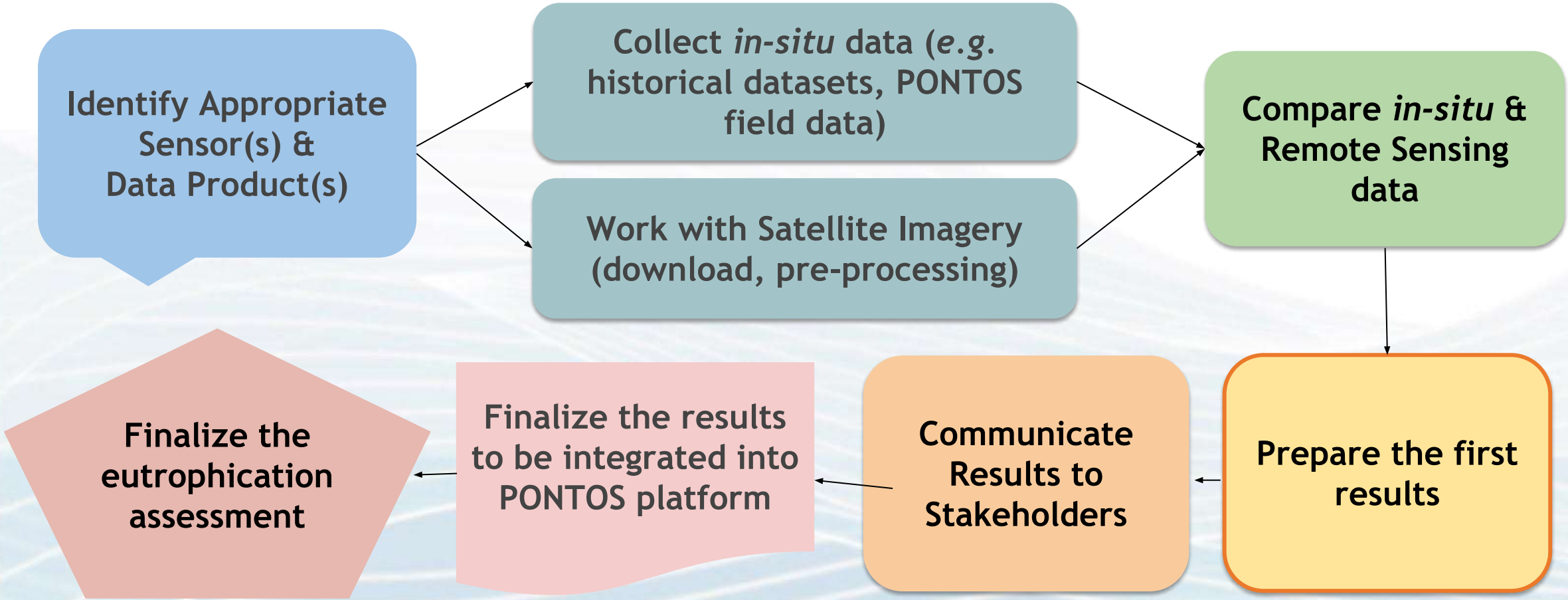


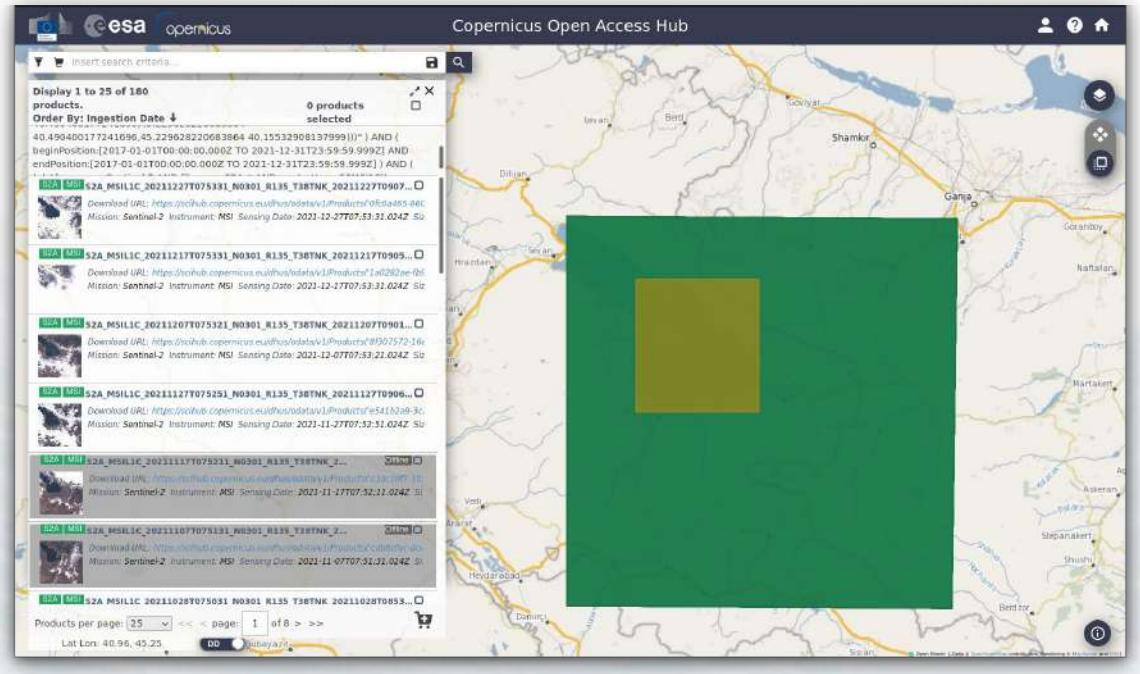
# Method used

- Images downloaded from Copernicus Open Access Hub & USGS Earth Explorer
- Images then processed in SNAP with C2RCC

Image nomenclature:

S2A_MSIL1C_20200729T090601_N0209_R050_T35TKF_20200729T112307

- S2A: mission ID
- MSIL1C: Product Level
- 20200729T090601: sensing start time
- N0209: PDGS Processing Baseline number
- R050: Relative Orbit number
- T35TKF: Tile Number field
- 20200729T112307: Product Discriminator




https://scihub.copernicus.eu

# Estimate chl-*a* concentrations via C2RCC

- Started as The CoastColour Project
- Amended by additional neural networks and eventually renamed Case 2 Regional CoastColour (C2RCC)
- Is applicable to all past and current ocean colour sensors as well as Sentinel 2
- Is available as a package in ESA's SNAP Toolbox

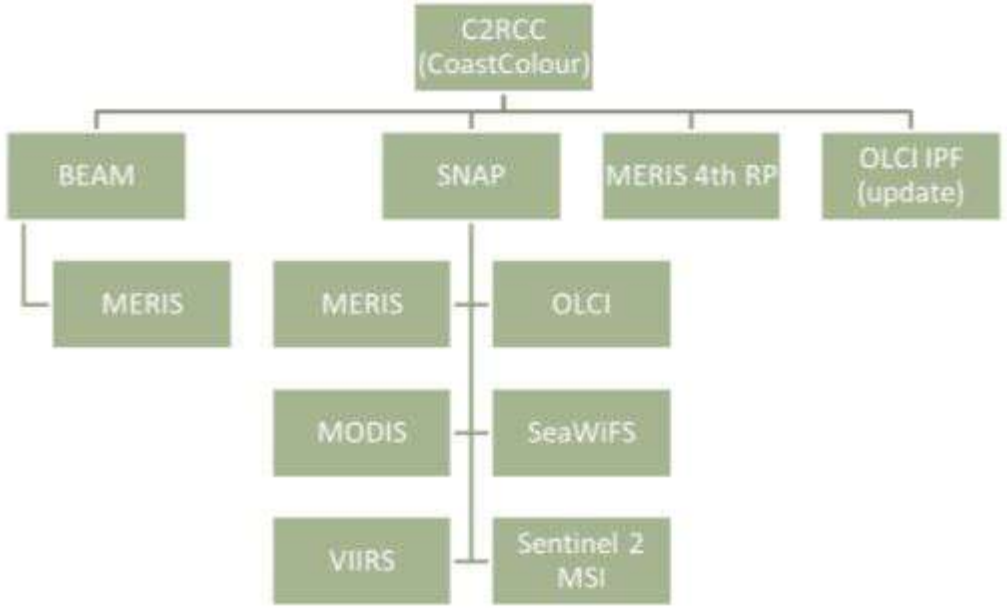


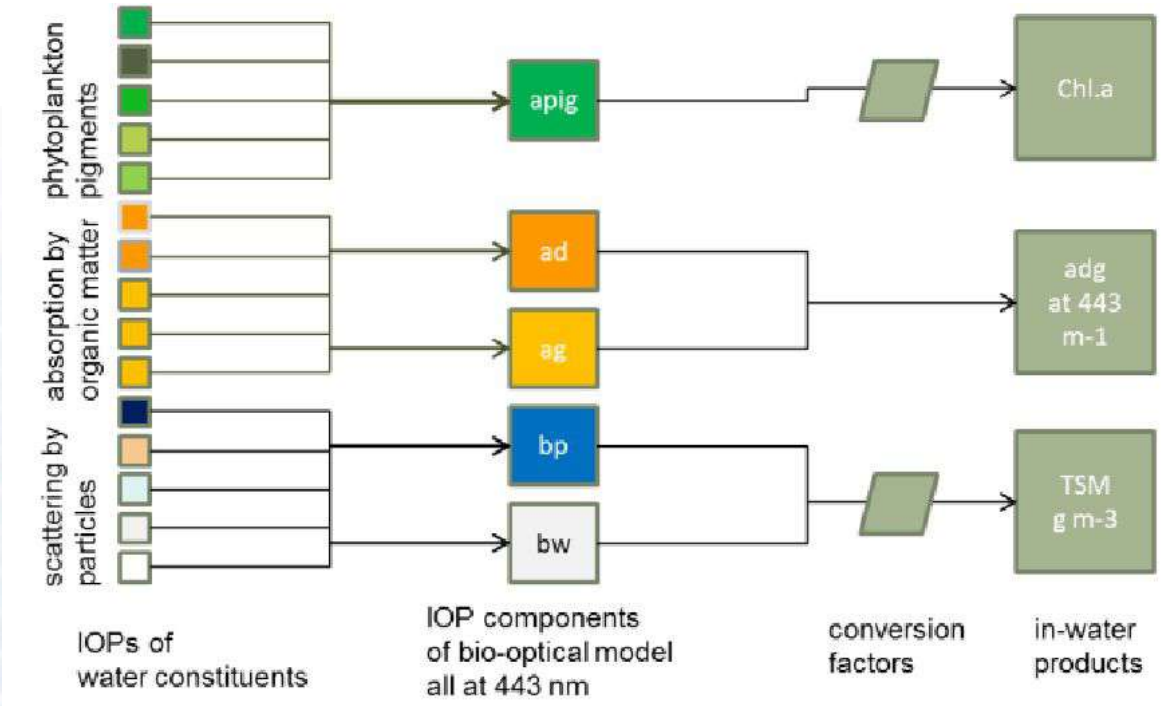

*Figure 4: C2RCC processor family tree*

Source: Brockmann et al., 2016

# Estimate chl-*a* concentrations via C2RCC

The model uses 5 components for scattering and absorption:

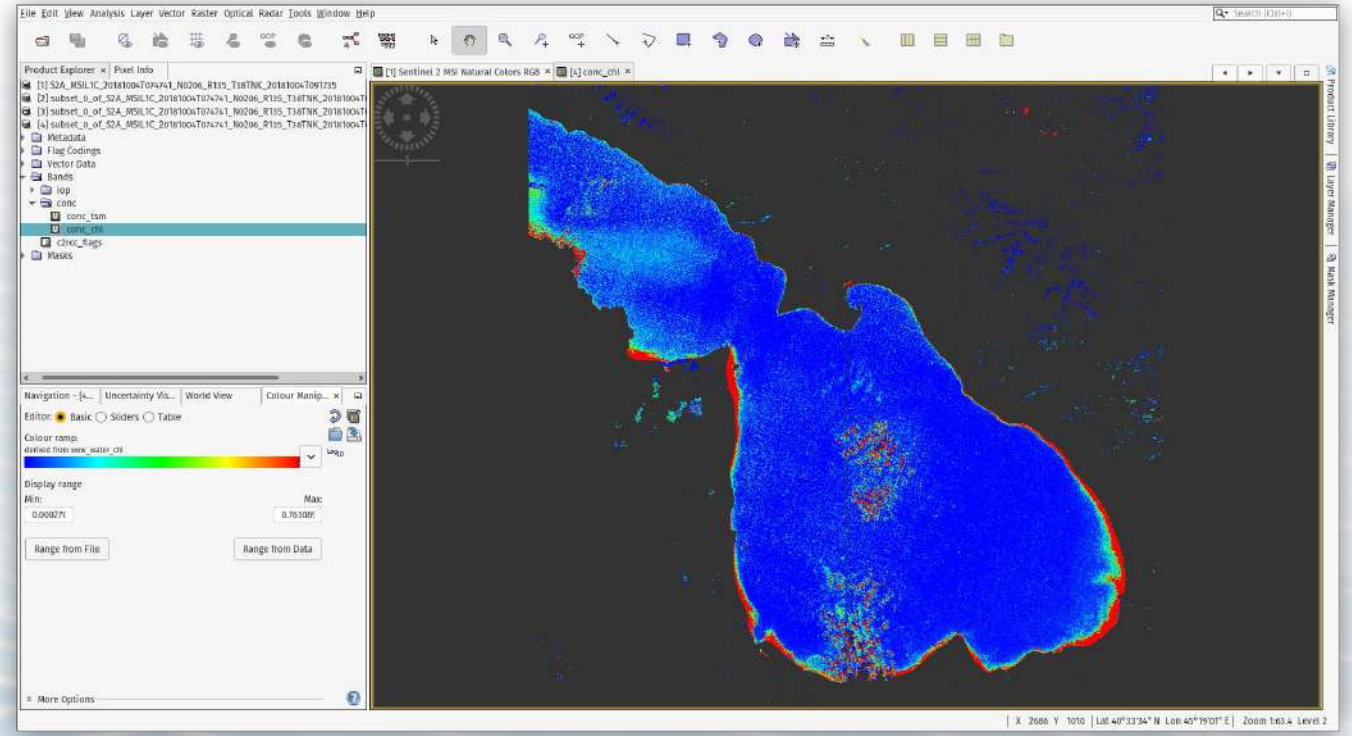
1. pigment absorption (apig)
2. detritus (adet)
3. gelbstoff (agelb)
4. white scatterer (bwhit) - calcareous material
5. typical sediment scatterer (btsm)



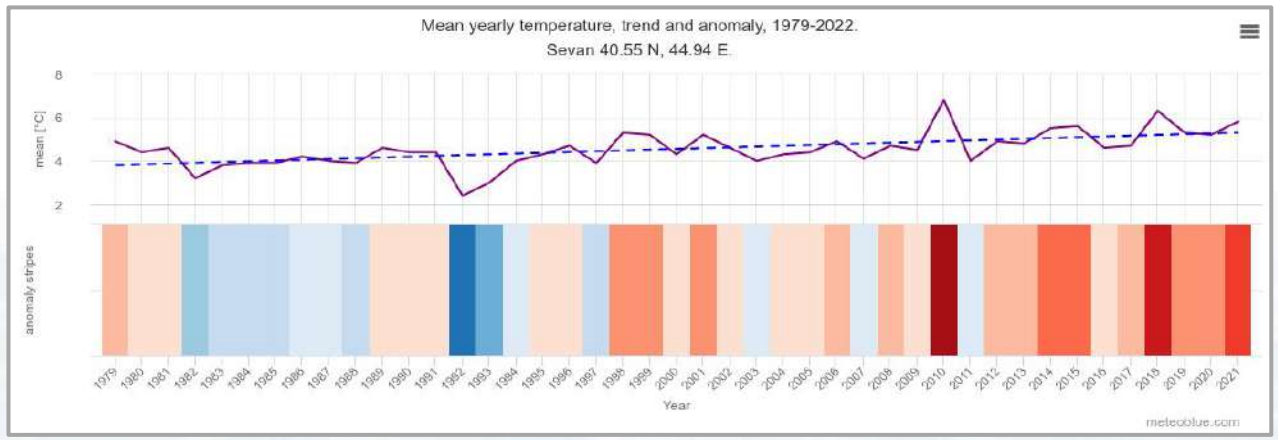

Source: Brockmann et al., 2016

# Hands on work

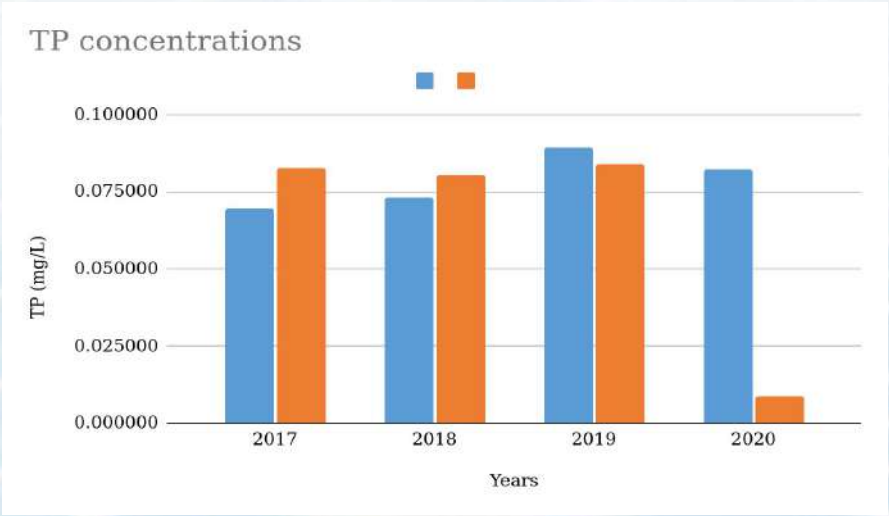
1. Open ESA SNAP Tool
2. Open map file
3. Subset
4. Resample based on 10m resolution
5. Using C2RCC tool, calculate chl-*a* & TSM
6. Export maps
7. Statistics
8. Compare the 2 maps



# A peak into bloom drivers







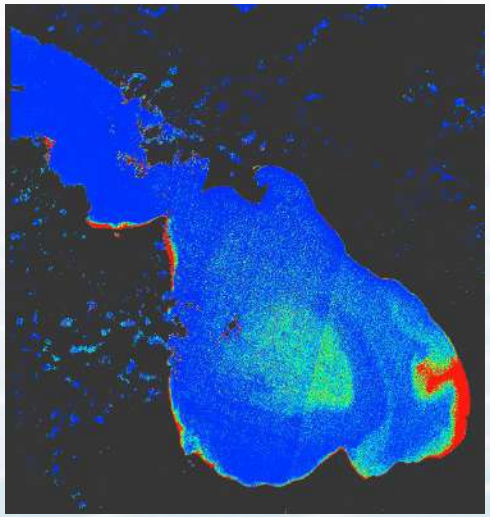

Average water temperature in Lake Sevan in July over a decade

| 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|
| 19°C | 19.1°C | 19.2°C | 18.6°C | 19°C | 20.7°C | 19.4°C | 18.7°C | 19°C | 17.3°C |

Source: seatemperature.info

# Challenges and limitations

1. Higher inaccuracies from shallow areas due to bottom reflections
2. High levels of chl-a measured in southern littoral areas. Phytoplankton or filamentous algae?



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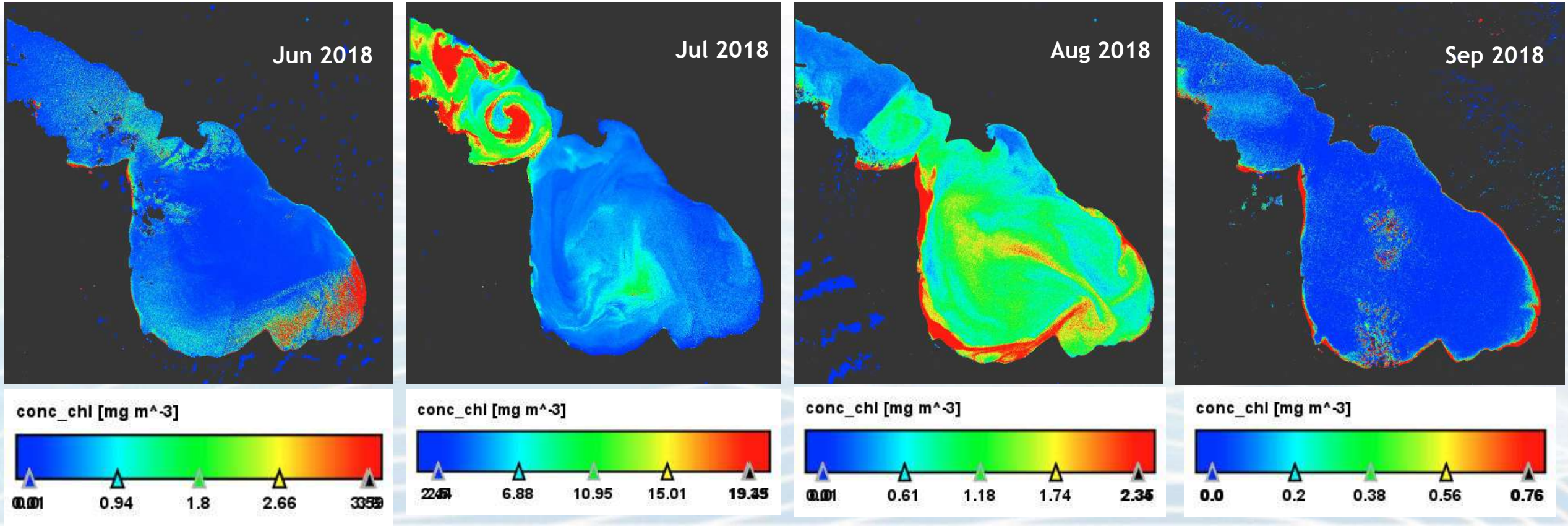
# Eutrophication dynamics (Lake Sevan, Armenia)

Distinct dynamics within years (algal blooms generally appearing in July)



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