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Common borders. Common solutions.

Integrated assessment on chlorophyll-*a* concentration and eutrophication dynamics -

Theoretical background

March 10, 2022

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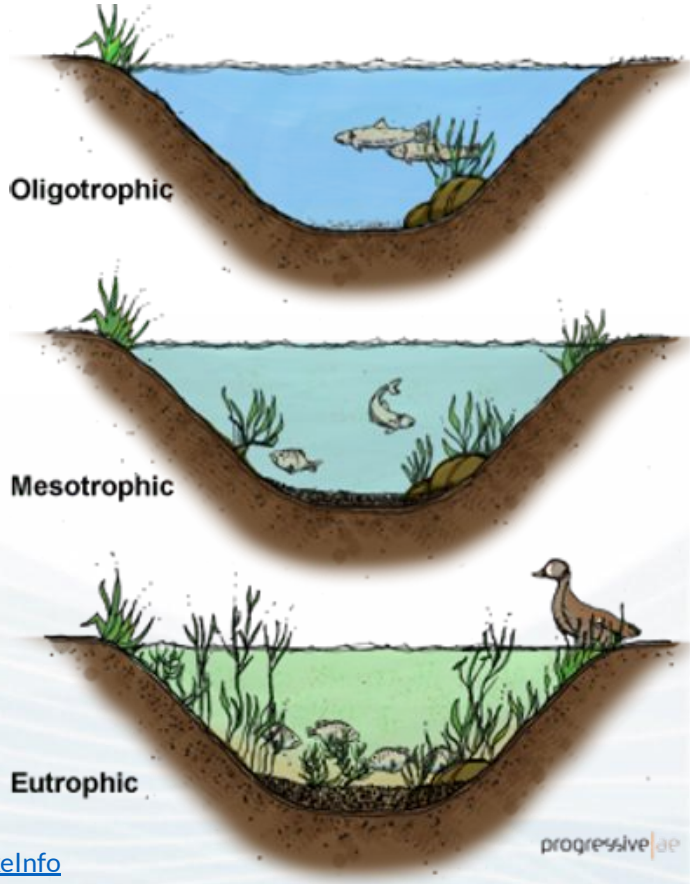
Trophic levels

Anthropogenic impacts driving many aquatic systems to eutrophic states:

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



Source: MichiganLakeInfo

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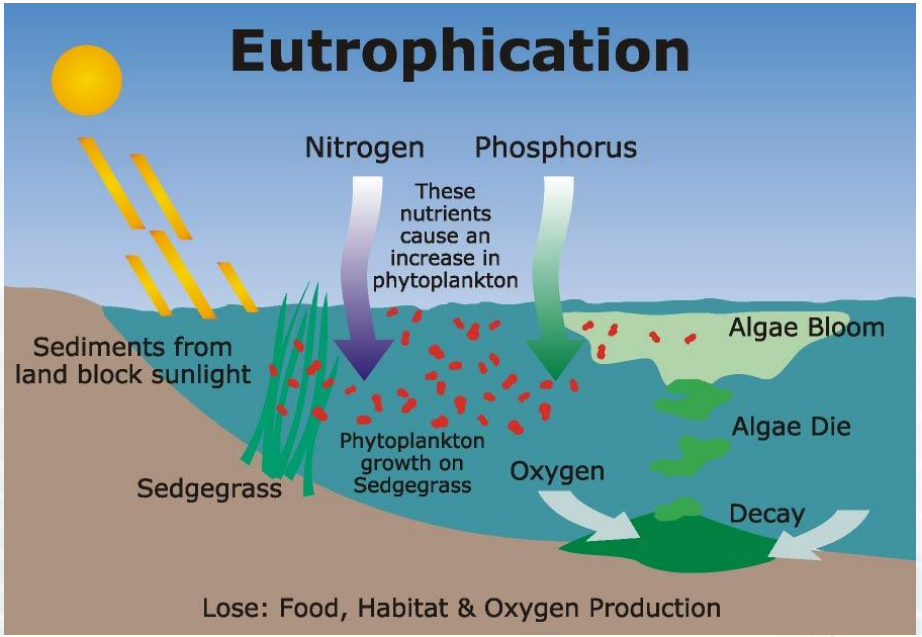
Impacts of eutrophication

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

Source: Online Science Notes



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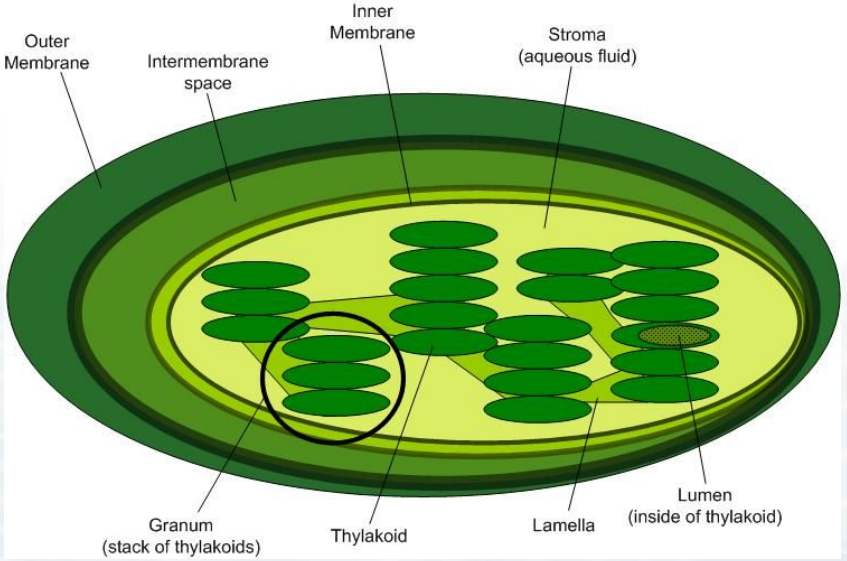
Chlorophyll-*a* as proxy

- 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

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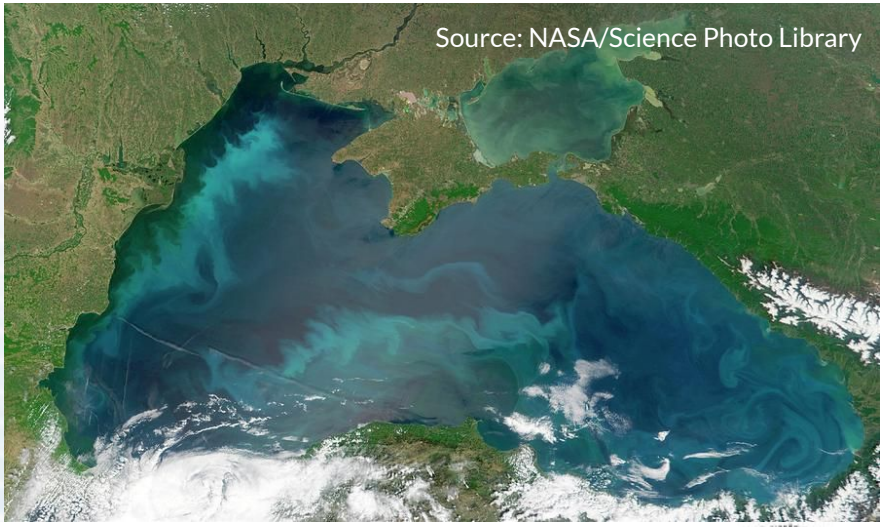
Remote sensing to estimate chl-*a* concentrations

- Compliment the *in-situ* measurements of chl-*a* and algal biomass / productivity
- Other water quality parameters can also be measured: Turbidity, TSM, DOM, *etc* …
- Challenges:
  - Isolate the Chl-*a* signal from other optically active compounds
  - The diel (vertical) movements of plankton in the water column
  - Atmospheric correction



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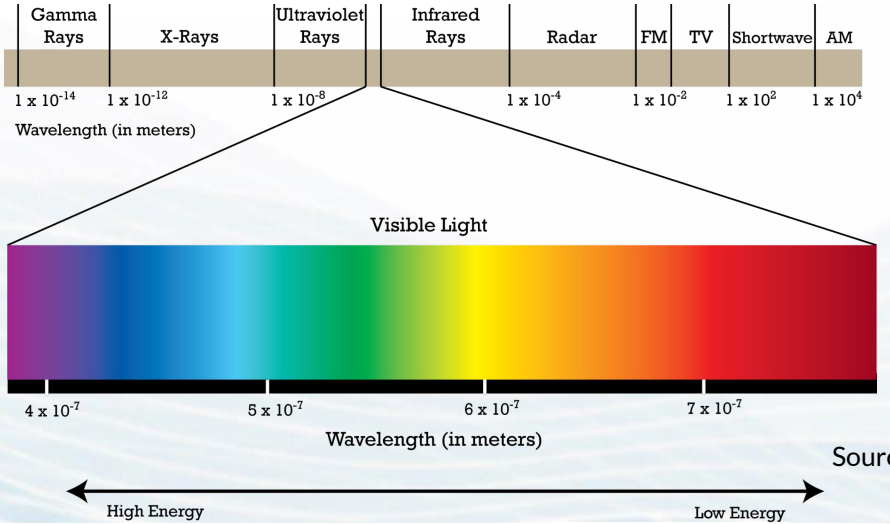
Remote sensing to estimate chl-*a* concentrations

- Earliest chl-*a* estimation via remote sensing in the late 1970s in marine waters [Nimbus 7, Coastal Zone Color Scanner (CZCS), based on 2 bands]
- Higher reflectance in lower wavelengths (blue + green regions) at lower [chl-*a*]

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



Source: ubc.ca

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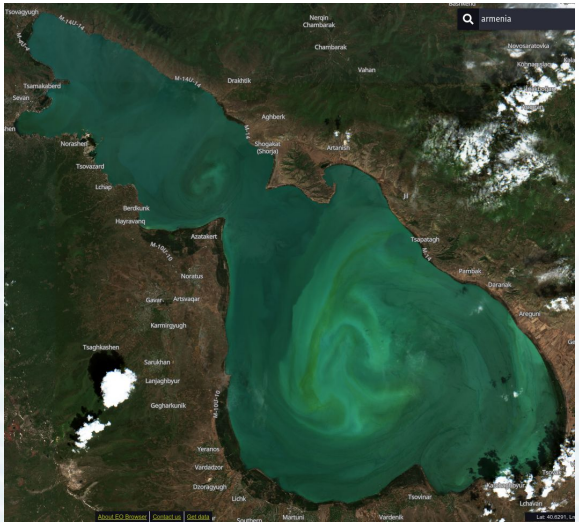
Remote sensing to estimate chl-*a* concentrations

- SeaWIFS, MODIS, MERIS, Landsat 7,8,9, Sentinel 2, 3 (OLCI) have all since been launched that can estimate chl-*a*.
- Satellites with multispectral images -> possibility of more complex algorithms to estimate chl-a in inland waters
- Neural networks



Source: Sentinel 2

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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

Source: Brockmann et al., 2016

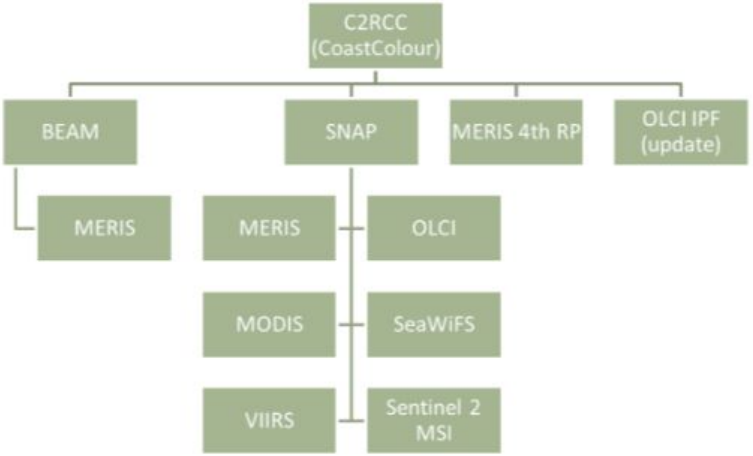

Figure 4: C2RCC processor family tree

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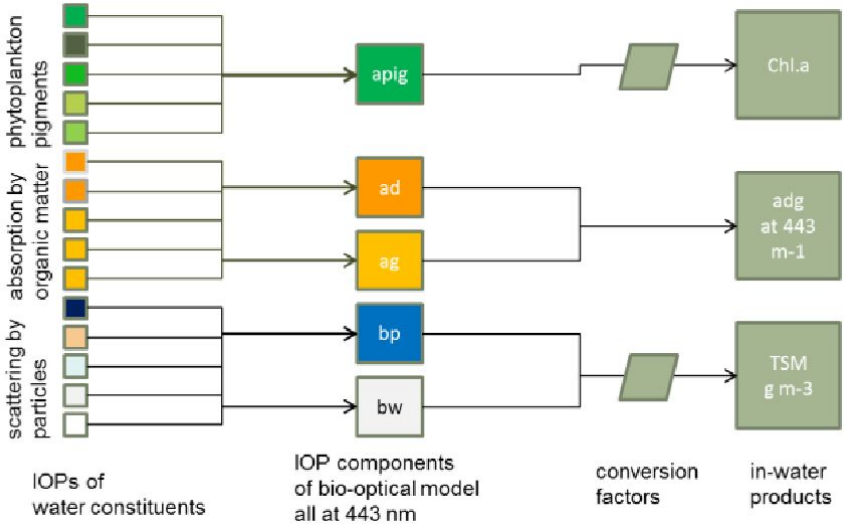
Estimate chl-*a* concentrations via C2RCC

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

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