# Satellite observations for monitoring and status assessment of coastal and lakes waters

Nordic WFD conference
Working group 4 meeting 26.9.2024

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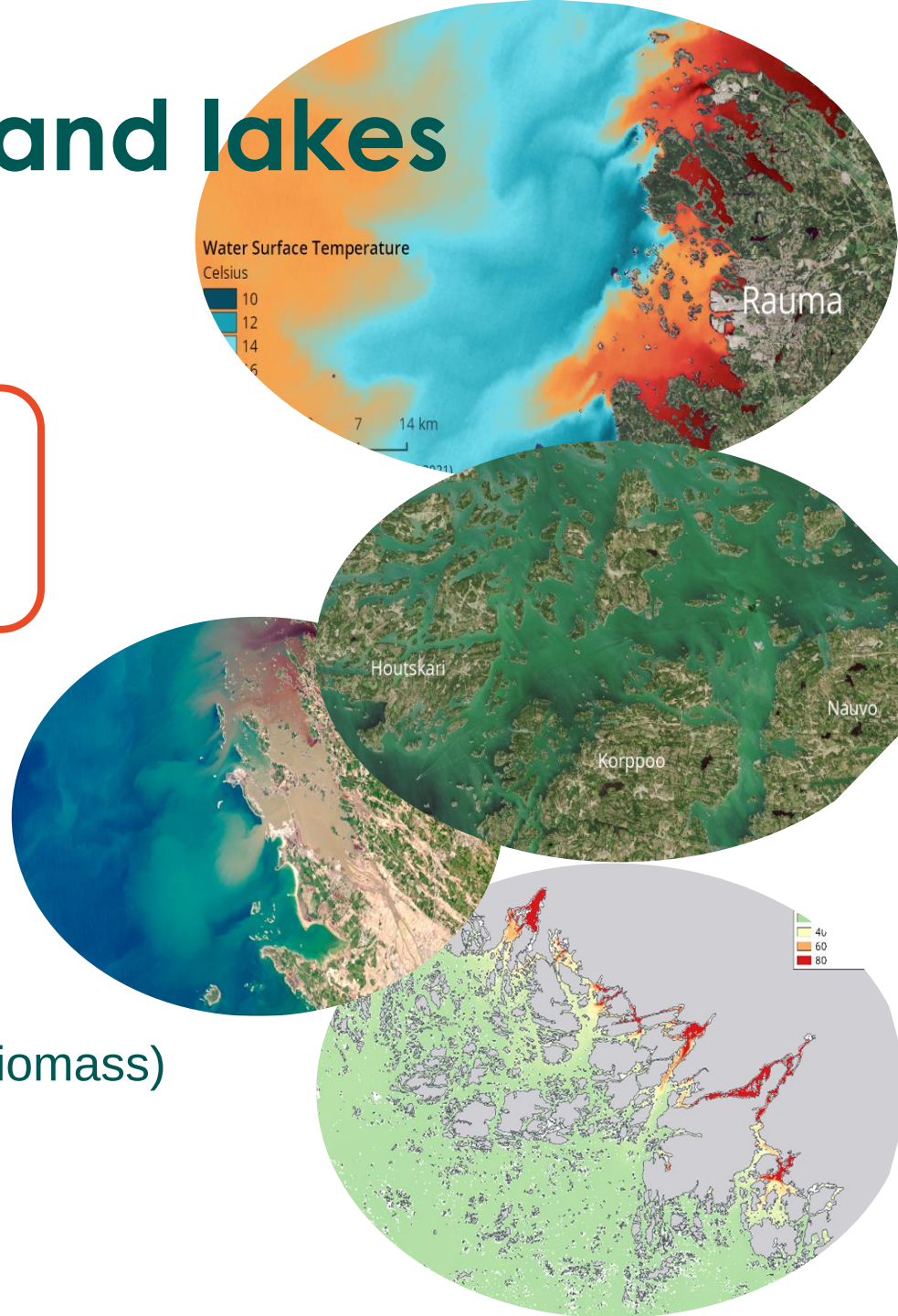
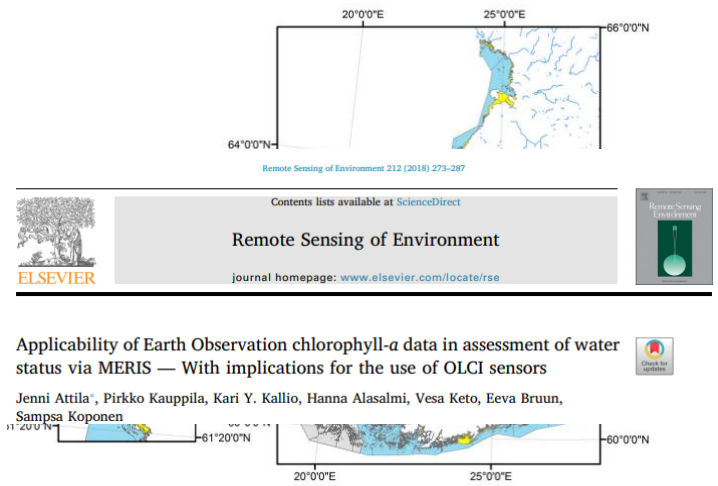
# Status assessment of marine and lakes water quality in Finland

- **EU Water Framework Directive (WFD)**
  - Summer chl-a (coastal and lakes)
  - Secchi depth, total phosphorus coming up
- **Coastal MSFD***
  - Spring bloom indicator (coastal water bodies)
  - Summer chl-a coming up
- **Open sea assessment**: HELCOM HOLAS III & MSFD*
  - Chl-a indicator
  - Cyanobacteria bloom indicator
  - Map of productive areas (high spring chl-a, annual biomass)



# EO for Water Framework Directive

**1. WFD 2000-2007** | **2. WFD 2006-2012** | **3. WFD 2012-2017** | **4. WFD 2017-2023**



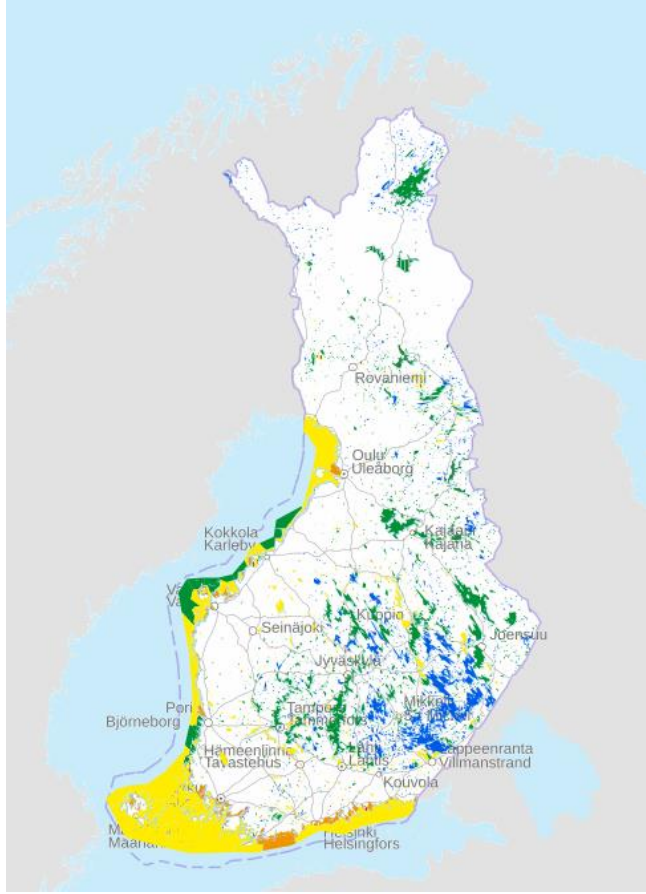


## Preparations for coastal WB

- chl-a,
- total phosphorus
- Secchi depth

## lakes WB

- Reround for chl-a
- Increase N of lakes
- Phosphorus relevant lakes



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- Water quality products over Finnish lakes and the Baltic Sea
- Authorities, media and citizens

# Open EO interface: Tarkka.syke.fi

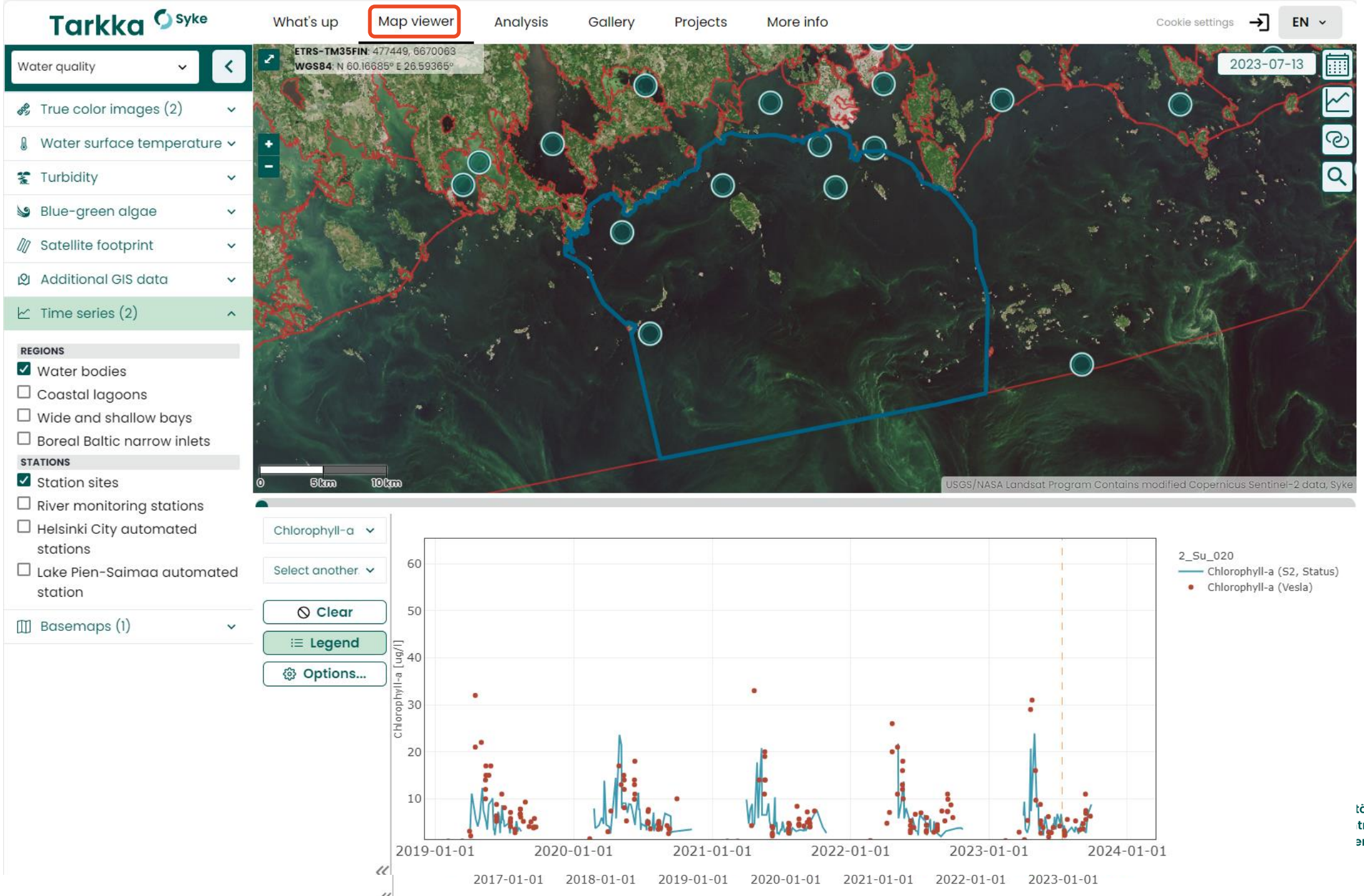
Tarkka Syke | What's up | Map viewer | Analysis | Gallery | More info | Cookies | EN

## Highlights

| | |
|---|---|
| 6.9.2024 | Blue-green algae on Säkylä's Pyhäjärvi |
| 6.9.2024 | Blue-green algae on Lake Pyhäjärvi, Tampere |
| 5.9.2024 | Blue-green algae swirls on Lake Lohja |
| 5.9.2024 | September blue-green algae on Lake Hiidenvesi |
| 5.9.2024 | Blue-green algae at lake Vanajavesi |
| 4.9.2024 | Humic water off the coast of the Kokemäki River |
| 3.9.2024 | Reddish river estuaries of the west coast |
| 29.8.2024 | Blue-green algae summary of summer 2024 |
| 26.8.2024 | Resuspension on the west coast |
| 14.8.2024 | Algae in the bays of lake Pyhäjärvi (Tampere) |
| 14.8.2024 | Algae in lake Ylisjärvi (Salo) |
| 14.8.2024 | Lakes of Vihti in various shades of green from blue-green algae |

Blue-green algae on Lake Sääksjärvi. 19 Sep 2024.


Previously published carousell images



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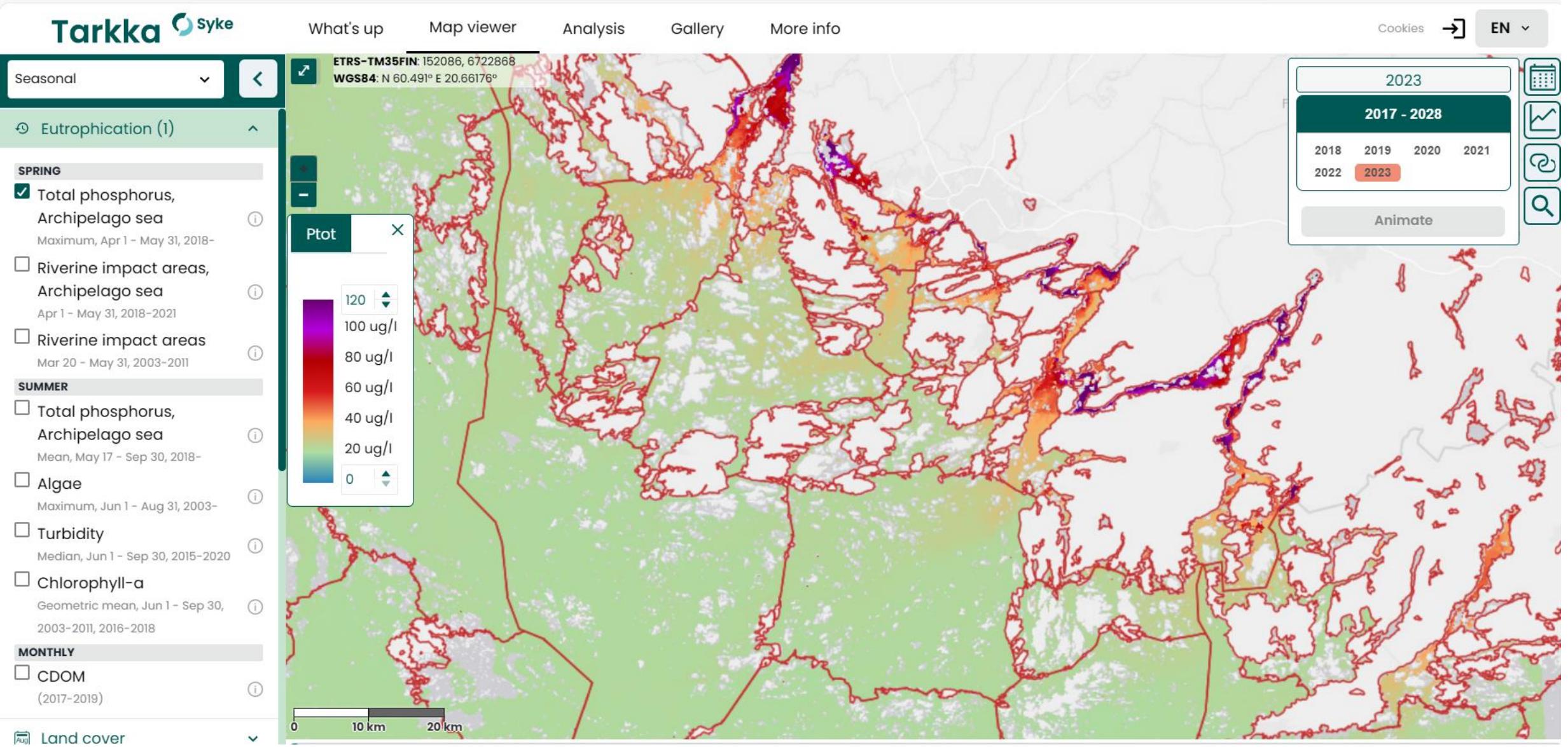




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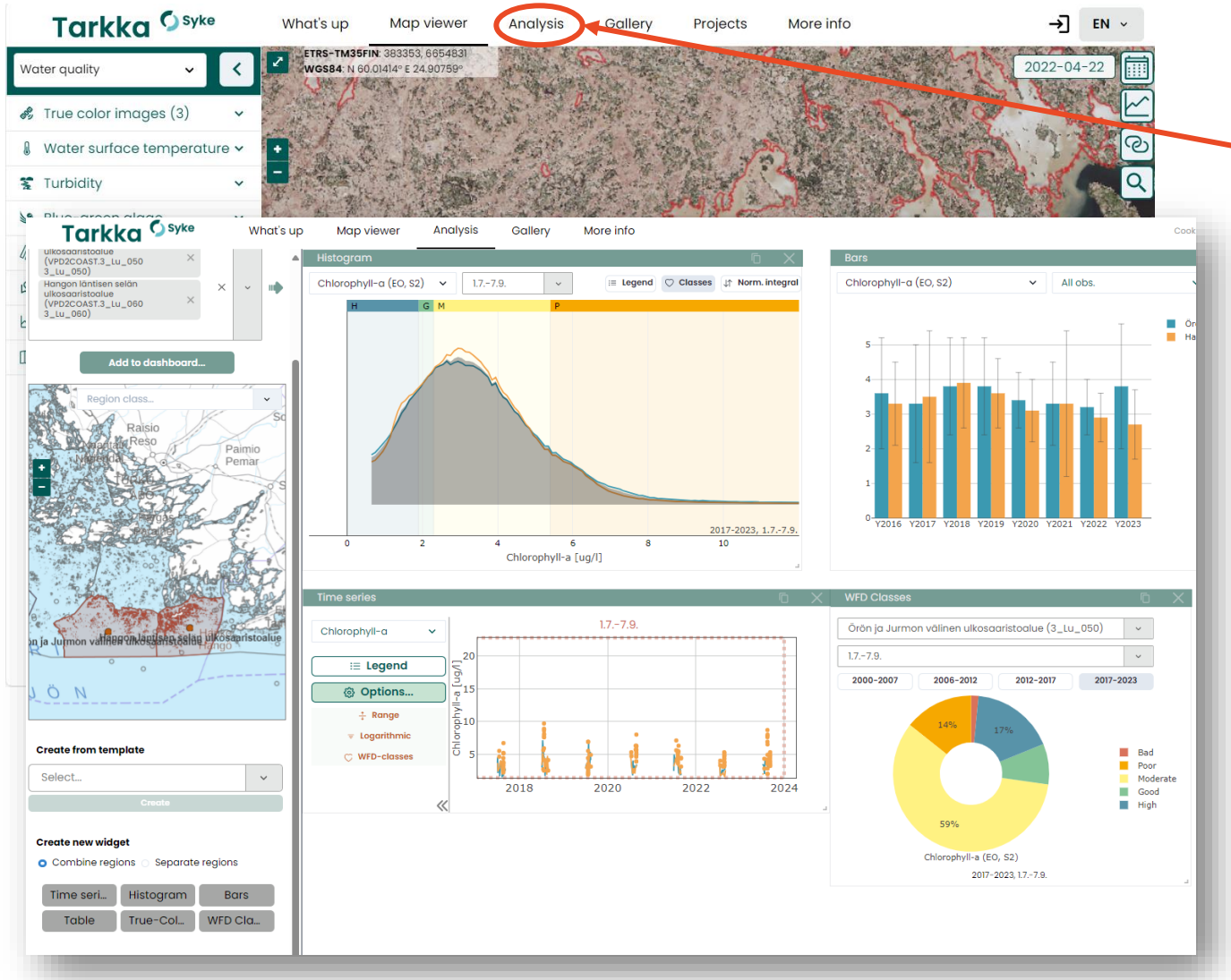
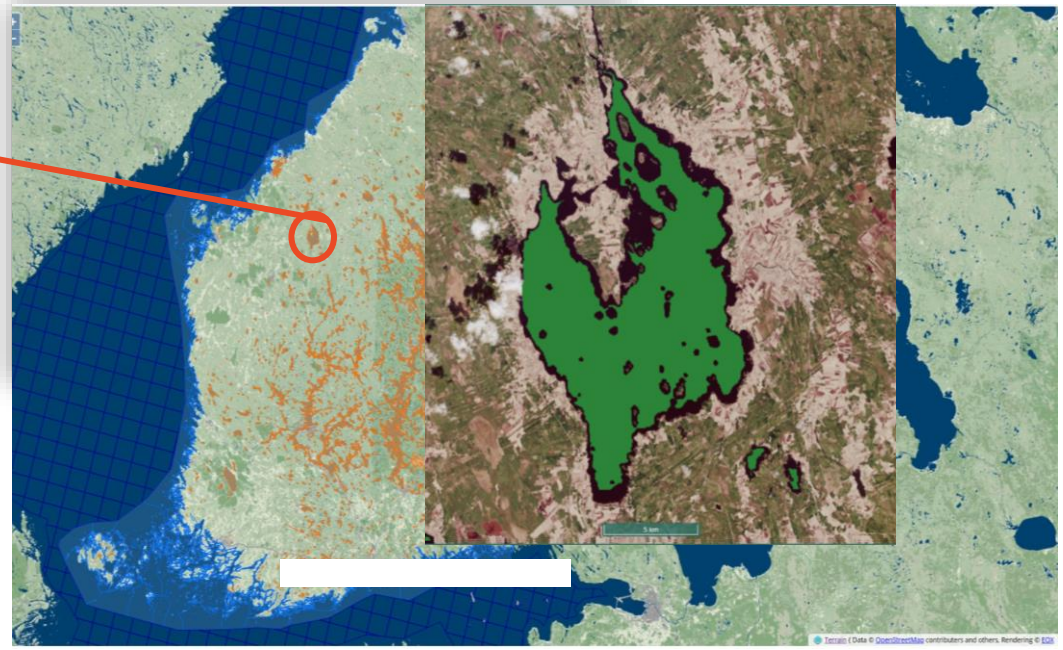
# Open interface and EO database Status



## STATUS Database

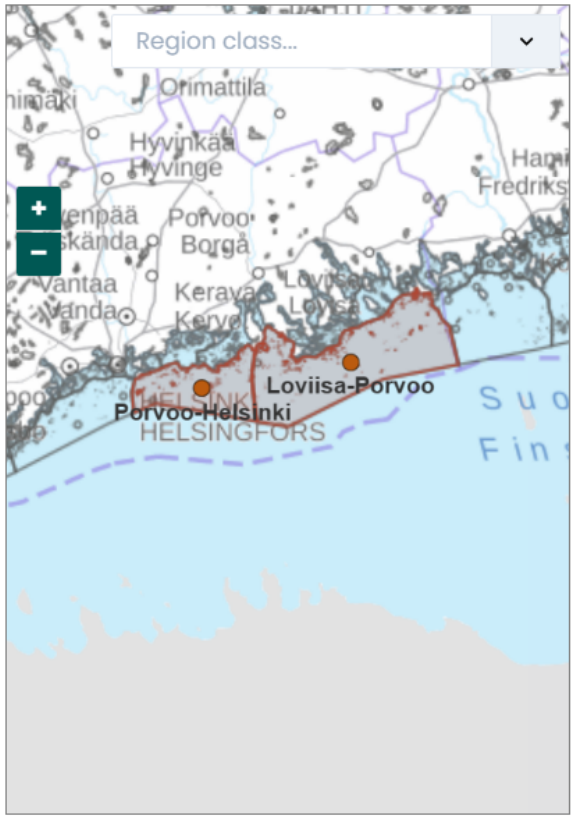
- Numerical and aggregated EO water quality data & database for water bodies

Tarkka Syke

What's up | Map viewer | Analysis | Gallery | Images | More info

Cookies SYKE DEV TEAM | EN

Add to dashboard...

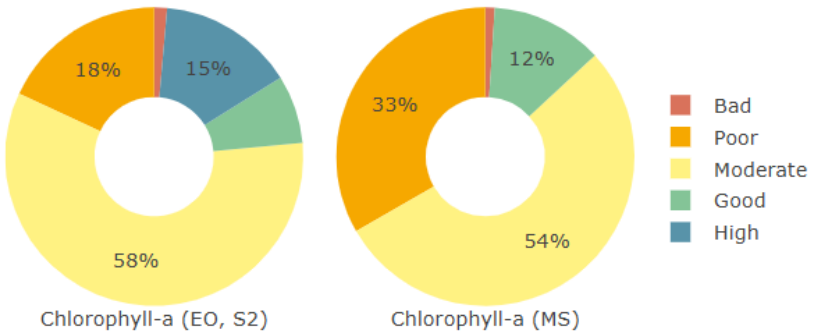



**WFD Classes**

Porvoo-Helsinki (2_Su_040)

1.7.-7.9.

2000-2007 | 2006-2012 | 2012-2017 | 2017-2023



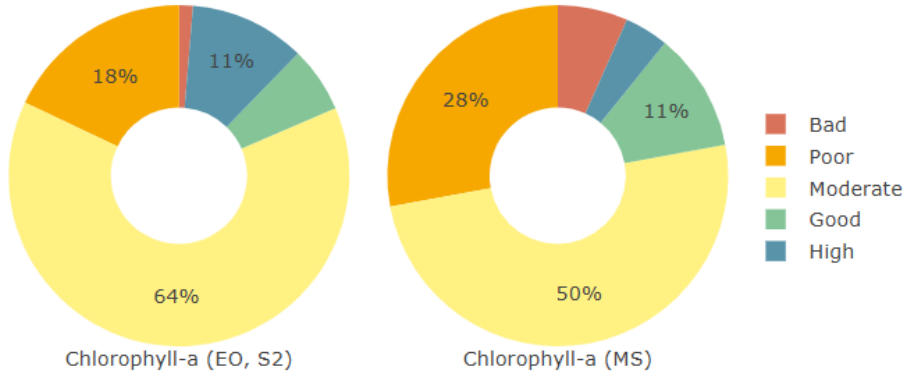

1998-2026, 1.7.-7.9.

**WFD Classes**

Loviisa-Porvoo (2_Su_030)

1.7.-7.9.

2000-2007 | 2006-2012 | 2012-2017 | 2017-2023




1998-2026, 1.7.-7.9.



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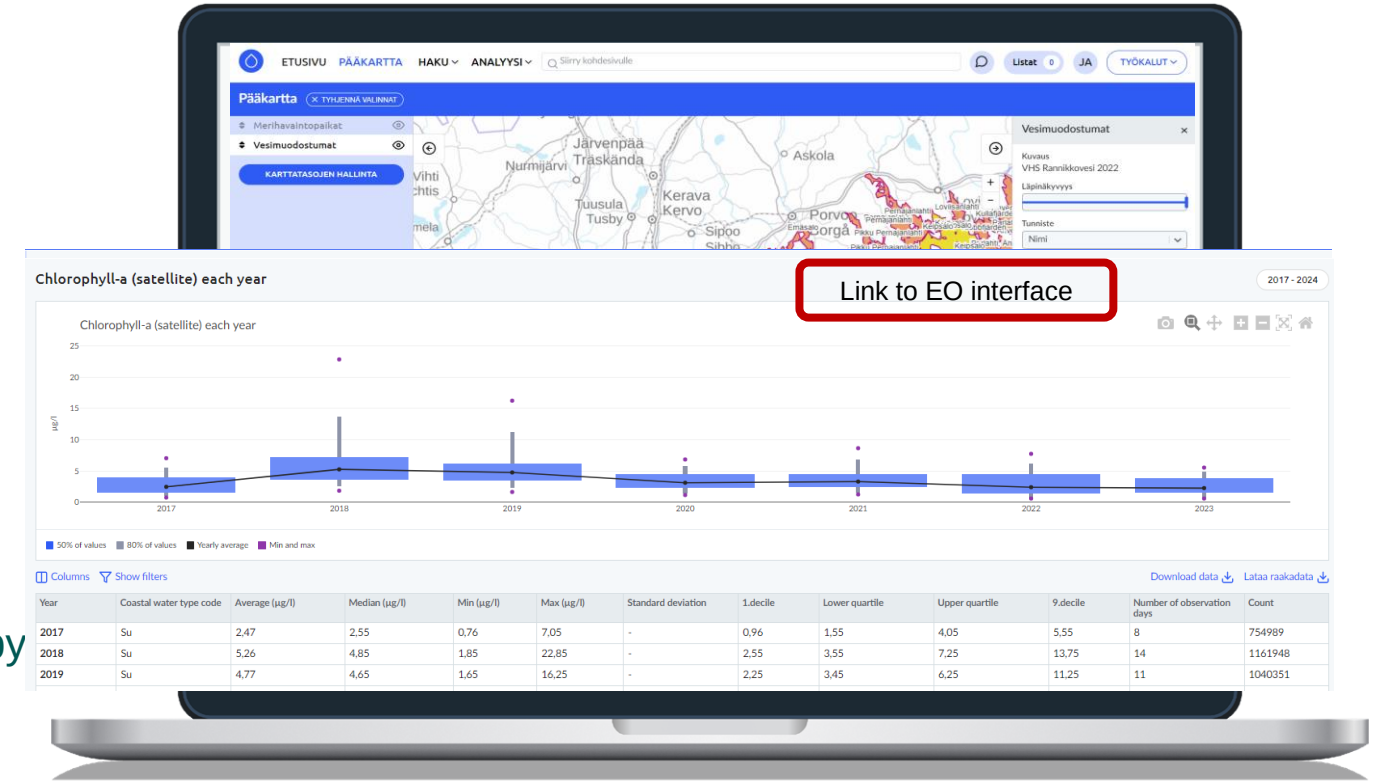
# Pisara (Drop) – information system for marine and water management

**Presentation by Sari Mitikka later today**

- Supports the planning process of water and marine management, e.g
  - status assessments
  - monitoring
  - planning the measures
  - impact assessment
- EO summary data integrated in the water management system
- Also link to EO interface Tarkka's analysis part by each water body




| Year | Coastal water type code | Average (µg/l) | Median (µg/l) | Min (µg/l) | Max (µg/l) | Standard deviation | 1.decile | Lower quartile | Upper quartile | 9.decile | Number of observation days | Count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | Su | 2,47 | 2,55 | 0,76 | 7,05 | - | 0,96 | 1,55 | 4,05 | 5,55 | 8 | 754989 |
| 2018 | Su | 5,26 | 4,85 | 1,85 | 22,85 | - | 2,55 | 3,55 | 7,25 | 13,75 | 14 | 1161948 |
| 2019 | Su | 4,77 | 4,65 | 1,65 | 16,25 | - | 2,25 | 3,45 | 6,25 | 11,25 | 11 | 1040351 |

# Preparations for the 4th WFD

- Interfaces for assessment:
  - PISARA for water management and Tarkka EO interface
  - EO material provided for authorities responsible for status assessment via PISARA and Tarkka
- Expert judgement rule
- Underway:
  - update of the lake and coastal water bodies EO material (chl-a).
  - Shallow lakes, lakes in Lappland
  - Secchi depth material (one of the classification criteria for coastal water bodies).
  - Experimental: Total phosphorus estimates using EO
    - Focus on areas that are highly affected by agriculture:
      - Archipelago sea (one of HELCOM hot spot areas for agricultural loading in the Baltic Sea)
      - Selected lake water bodies

# Thank you!

**Tarkka.syke.fi**

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# EU-wide Survey on the use of Earth observations on WFD

Jenni Attila, Finnish Environment Institute (Syke)
Ioanna Varkitzi, JRC
Krista Alikas, Tartu observatory

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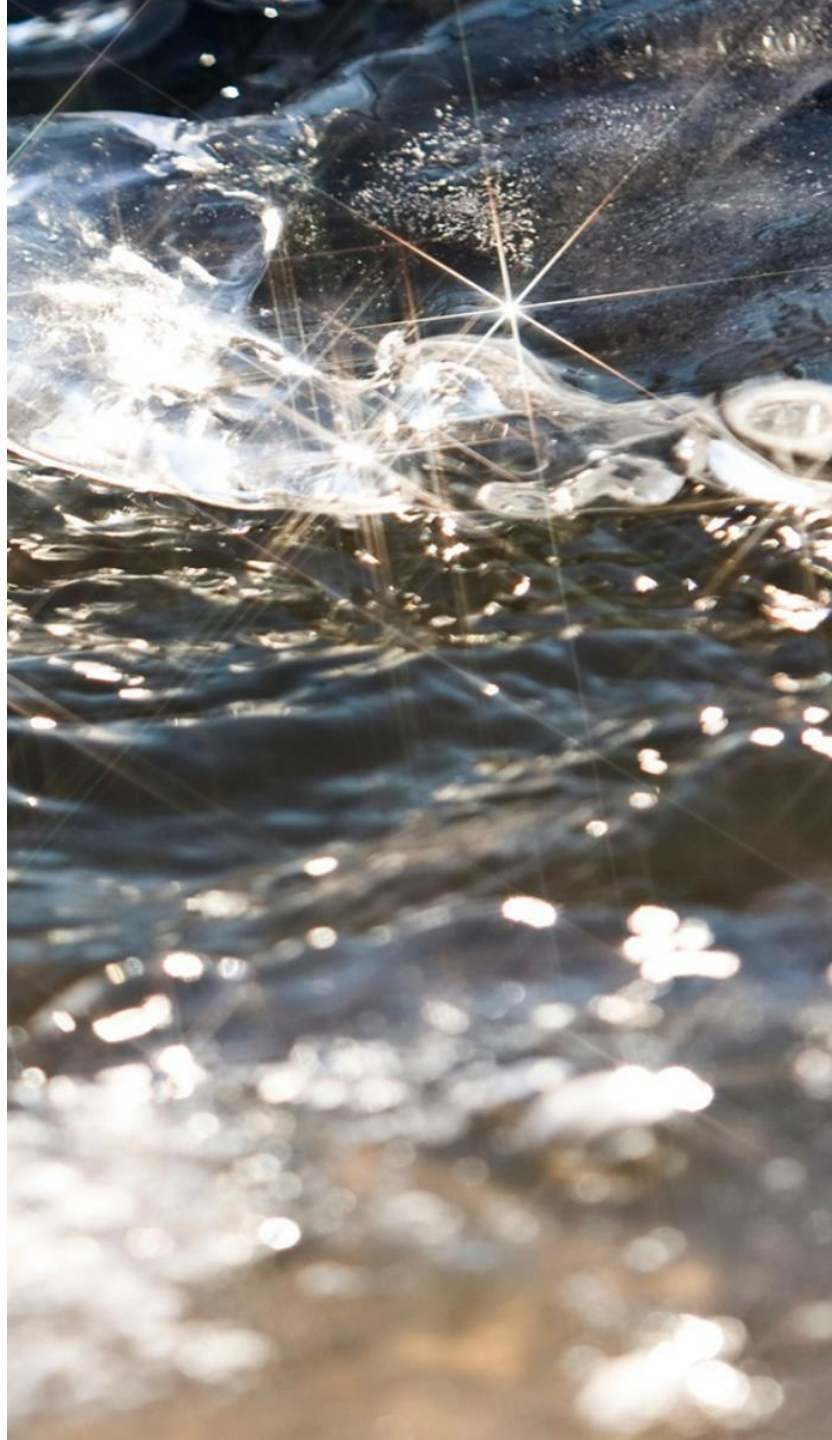
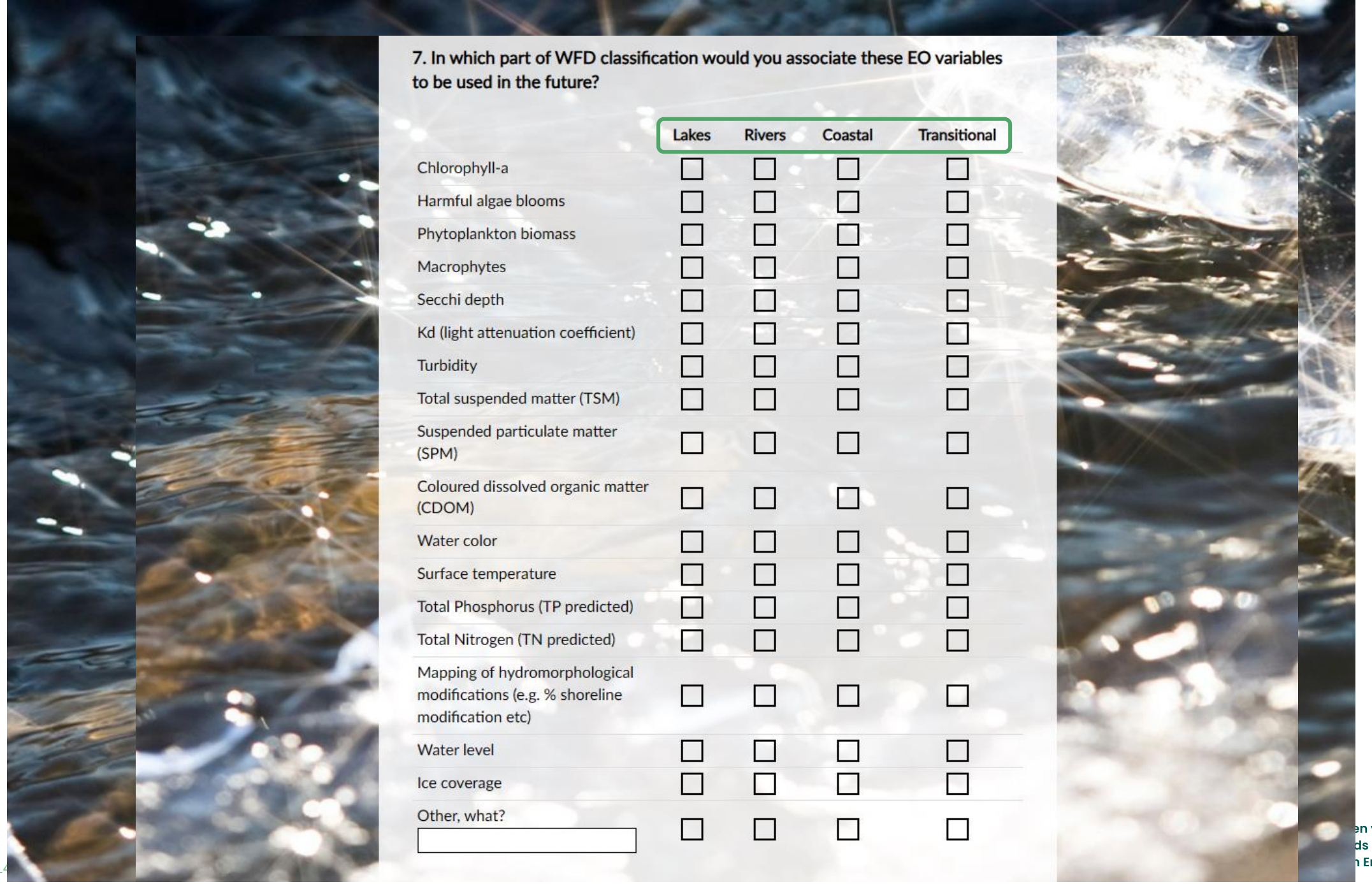
# Background information

- During summer 2024, a survey on the use of Satellite observations, i.e. Earth Observations as a work initiated by JRC, Finland and Estonia.
- The survey was sent to
    - EO experts in EU Member States (MS)
    - Also to countries not EU MS, such as Switzerland, U.K.
    - National delegates of the EU Copernicus programme User Forum



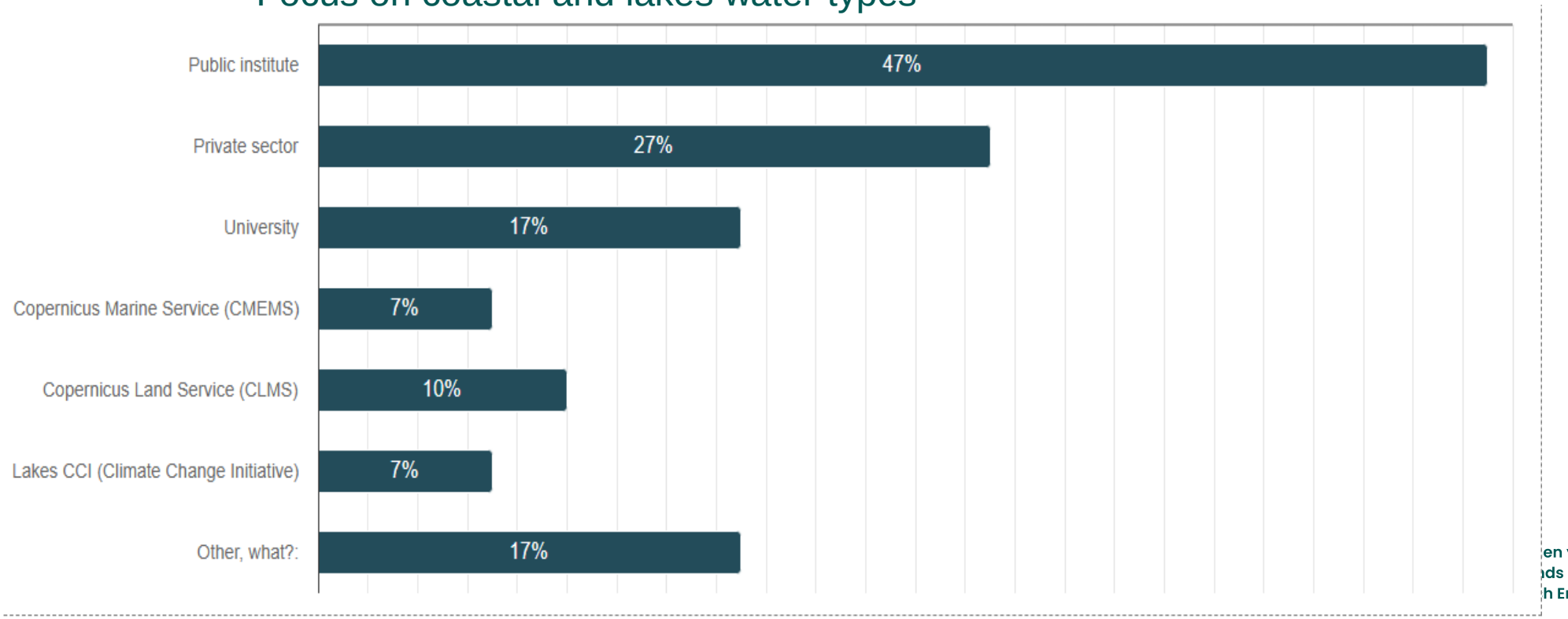


**7. In which part of WFD classification would you associate these EO variables to be used in the future?**

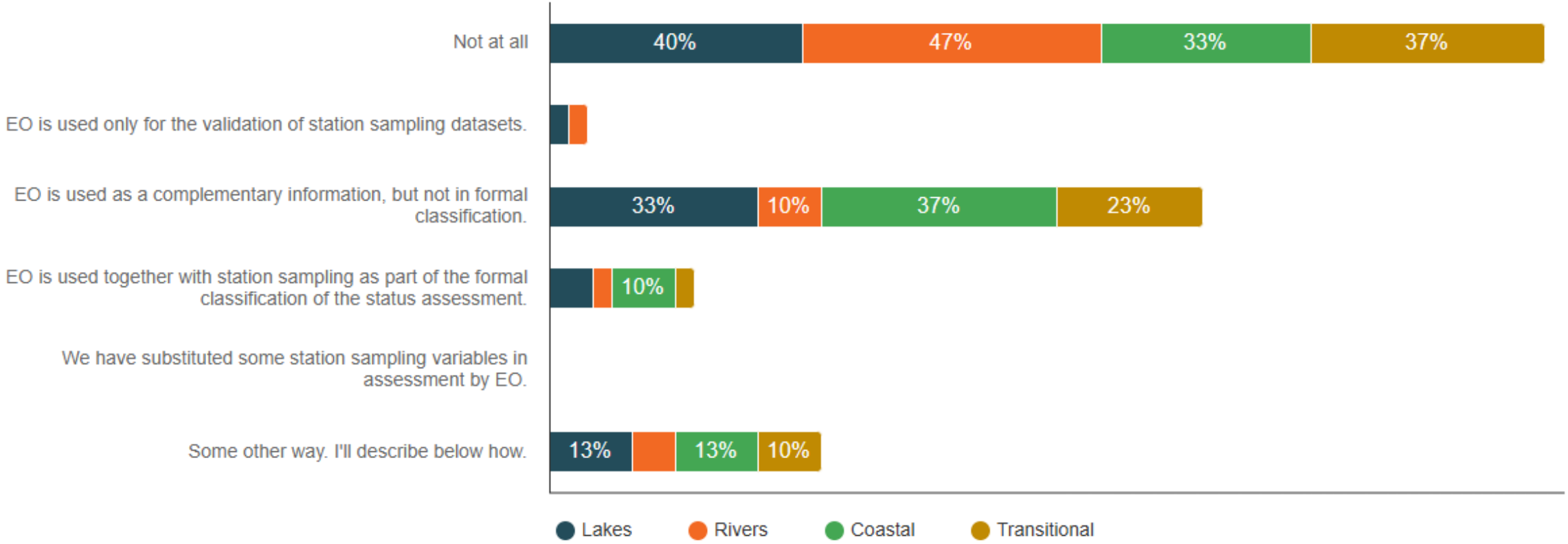
| | Lakes | Rivers | Coastal | Transitional |
|---|---|---|---|---|
| Chlorophyll-a | ☐ | ☐ | ☐ | ☐ |
| Harmful algae blooms | ☐ | ☐ | ☐ | ☐ |
| Phytoplankton biomass | ☐ | ☐ | ☐ | ☐ |
| Macrophytes | ☐ | ☐ | ☐ | ☐ |
| Secchi depth | ☐ | ☐ | ☐ | ☐ |
| Kd (light attenuation coefficient) | ☐ | ☐ | ☐ | ☐ |
| Turbidity | ☐ | ☐ | ☐ | ☐ |
| Total suspended matter (TSM) | ☐ | ☐ | ☐ | ☐ |
| Suspended particulate matter (SPM) | ☐ | ☐ | ☐ | ☐ |
| Coloured dissolved organic matter (CDOM) | ☐ | ☐ | ☐ | ☐ |
| Water color | ☐ | ☐ | ☐ | ☐ |
| Surface temperature | ☐ | ☐ | ☐ | ☐ |
| Total Phosphorus (TP predicted) | ☐ | ☐ | ☐ | ☐ |
| Total Nitrogen (TN predicted) | ☐ | ☐ | ☐ | ☐ |
| Mapping of hydromorphological modifications (e.g. % shoreline modification etc) | ☐ | ☐ | ☐ | ☐ |
| Water level | ☐ | ☐ | ☐ | ☐ |
| Ice coverage | ☐ | ☐ | ☐ | ☐ |
| Other, what? _____ | ☐ | ☐ | ☐ | ☐ |

# Overview of the respondents

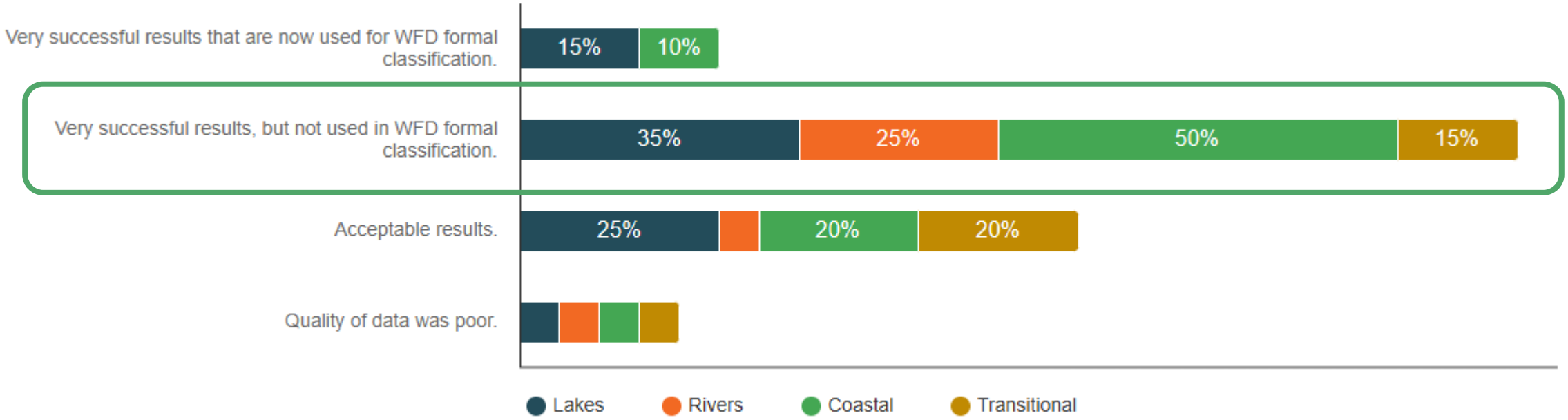
- 22 countries replied, altogether 40 answers
- **74% EO experts**
- Public institutes: 47%
- Focus on coastal and lakes water types



# How EO data is presently used in WFD status assessment for various water types in your country?



# If you have funded research in EO for WFD purposes, how successful was it?



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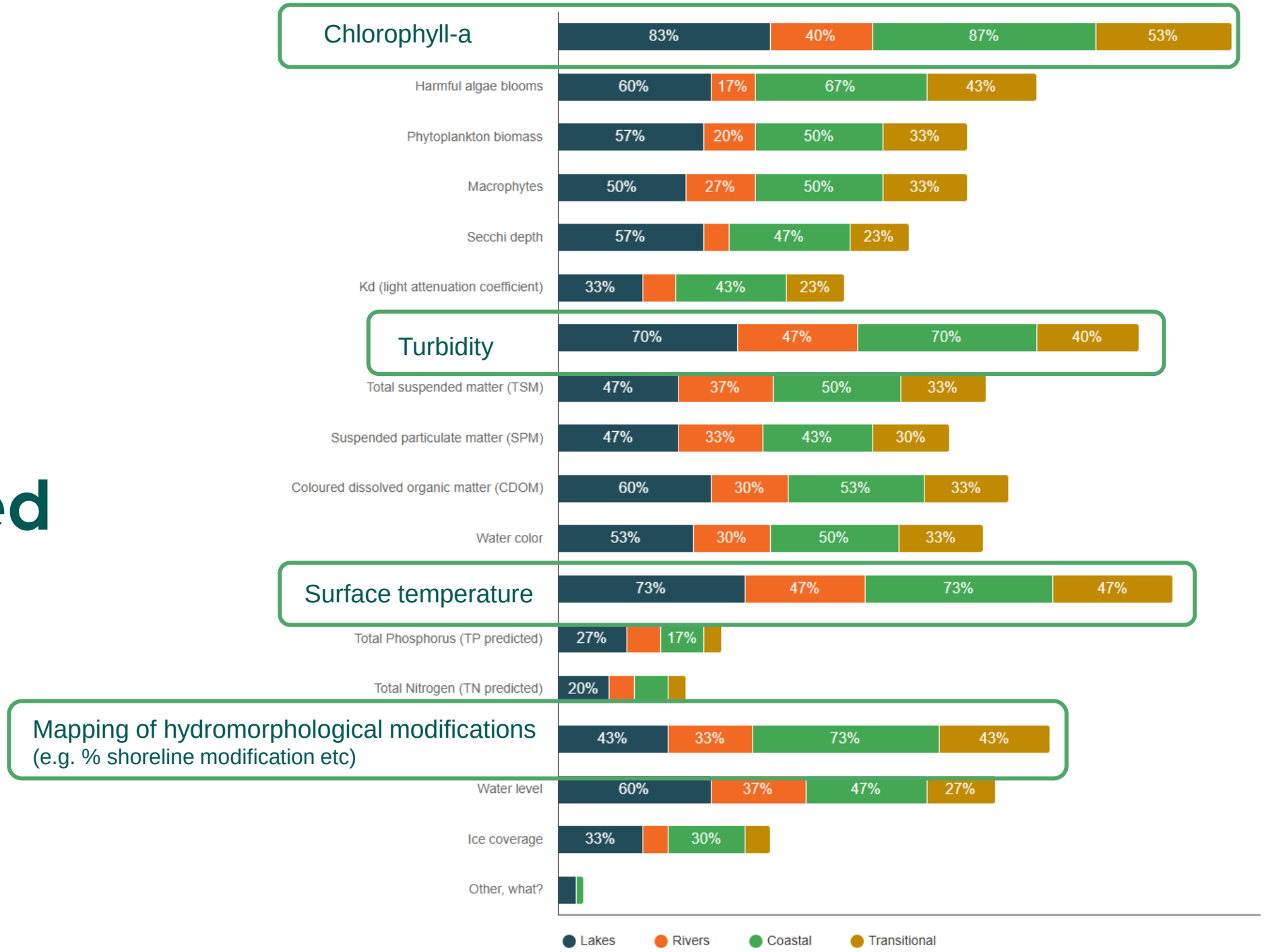
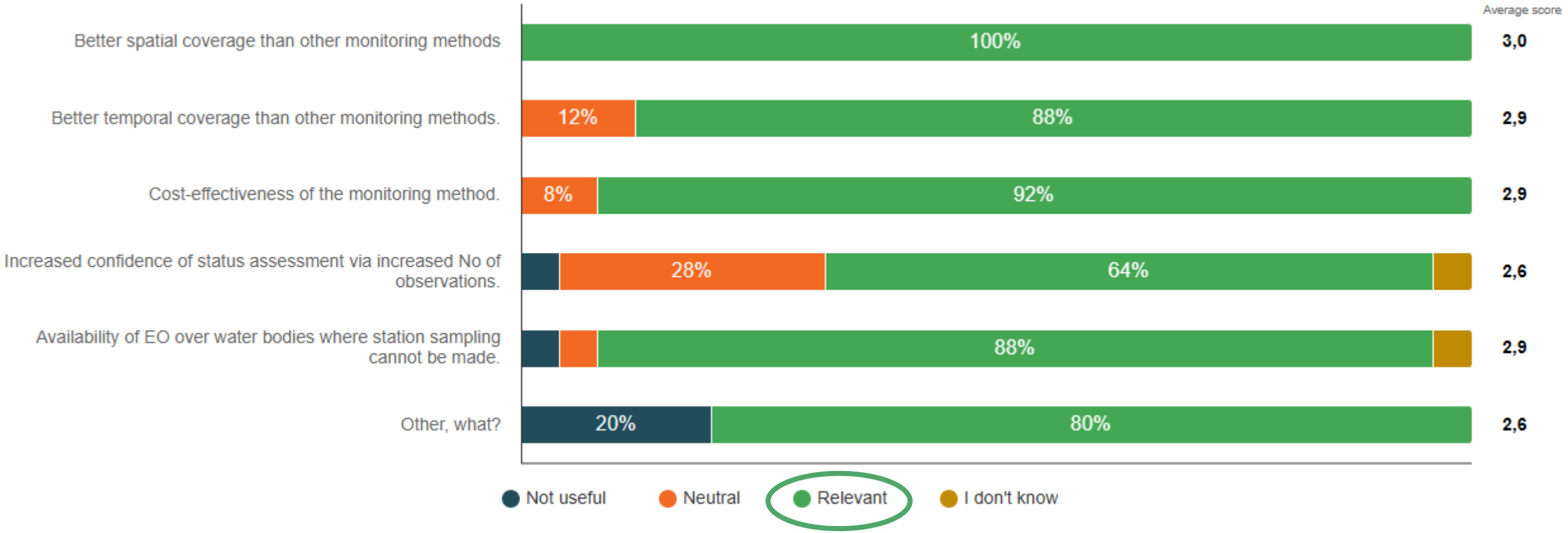
# In the future, what are the current WFD monitoring gaps that could be filled by using EO more?



# What are the main benefits of using EO data in WFD monitoring?

**Better spatial and temporal coverage**
**Cost-efficiency and availability of observations over areas with no other sampling:**
**Increased confidence in status assessment : 64%**



# What are the major obstacles for taking EO as one monitoring method to account in WFD?

13 alternatives for obstacles, most of which were considered either as 'Major obstacle' or at least

**No1:** We don't have **common guidelines** on how to utilize EO
**Major obstacle score: 48%**

**No2: Legal issues in WFD**
(e.g. it is against current monitoring guidelines).
**Major obstacle score: 44%**

**No3: Authorities are not well informed about EO datasets and tools.**
**Major obstacle score: 38%**



Major obstacle  Obstacle to some extent  Not an obstacle  I don't know

# What could be done to advance the use of EO in WFD status assessment ?

**No1:** Adjustment of national water management systems: **EO datasets integrated in national status assessment tool**
**Score : 90%**

**No2:** Training courses at national level
**Score : 70%**

**No3:** User-friendly guidance
**Score 63%**

**No4:** Collaboration and discussion among MS
**Score: 60%**

# Thank you!

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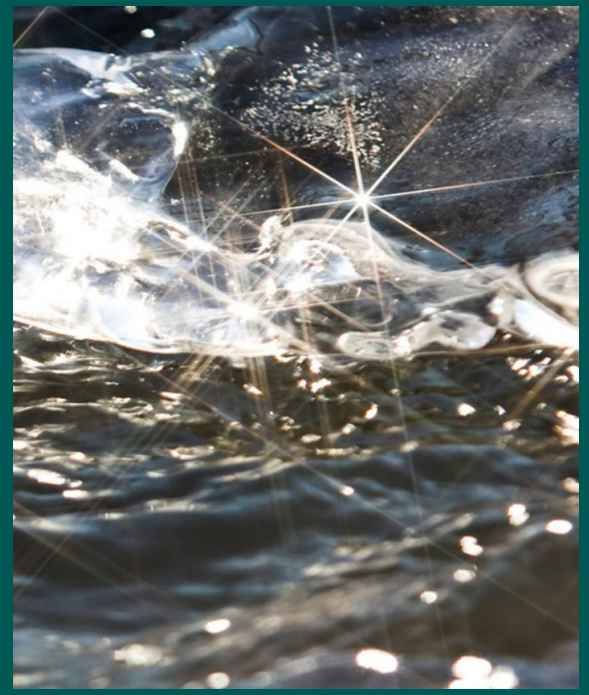

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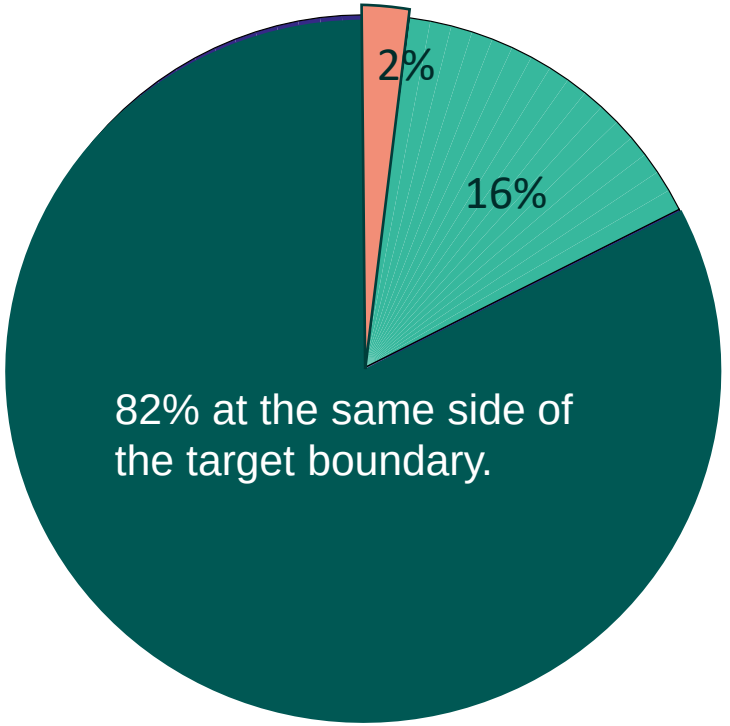
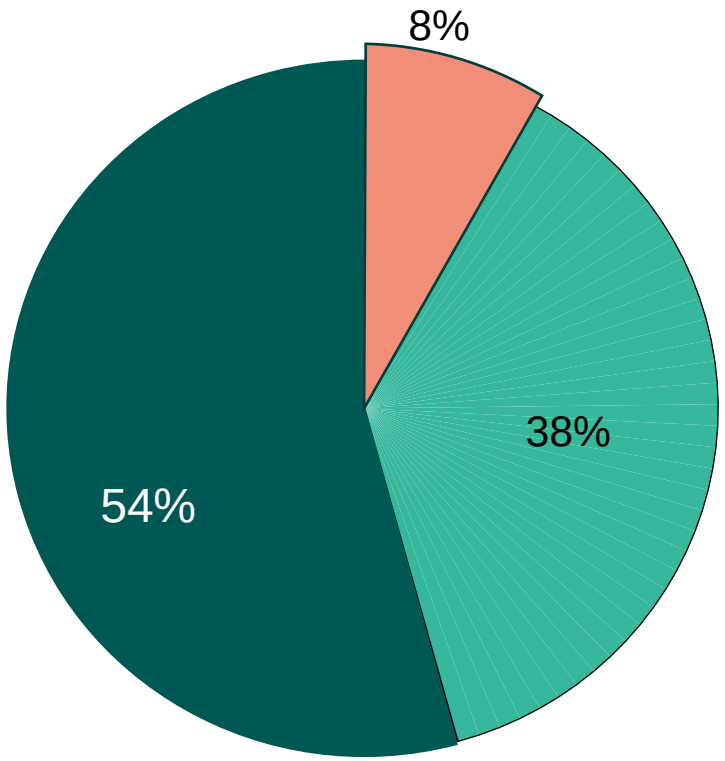
# EO and station sampling at the threshold between chl-a status ‘good’ and ‘moderate’ status?

The relevant boundary with regard to the target of the WFD: if a water body does not meet this target -> WFD requires that the Member State initiates water-protection measures to improve its condition.



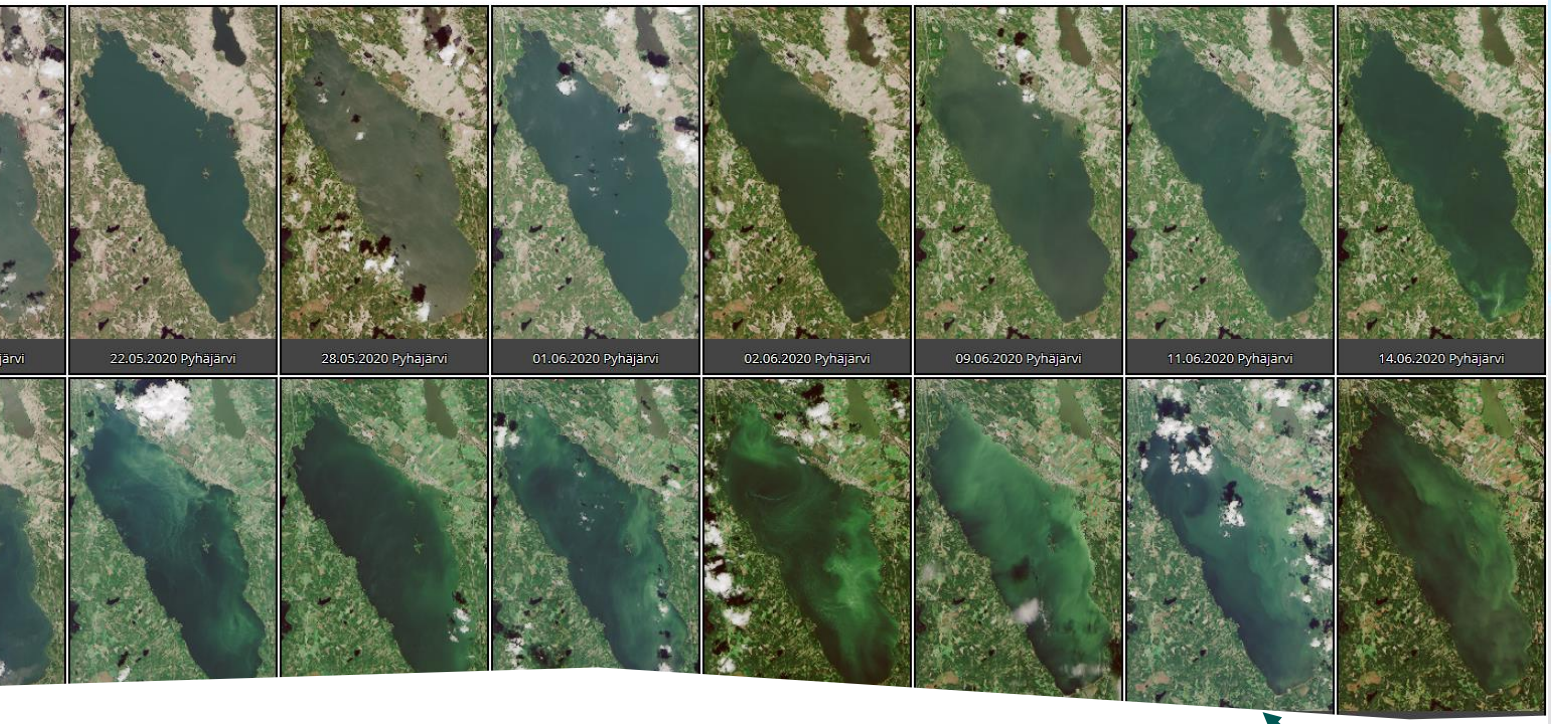

3rd WFD 2019
1513 lakes

# EO & station sampling-based status assessment in Finnish lakes

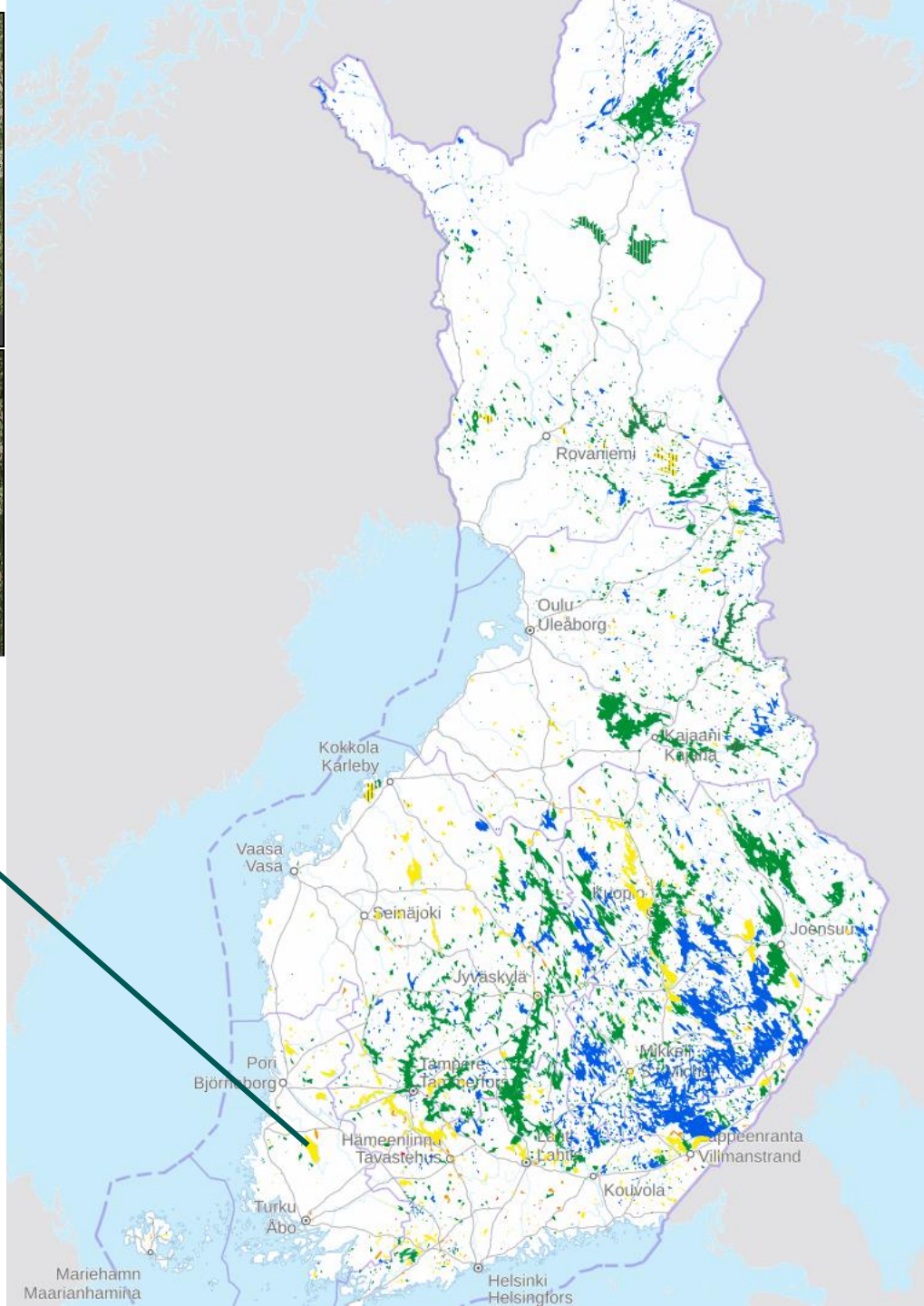



3rd WFD 2019
1513 lakes

- WFD chl-a status by EO and station sampling is the same on 54% of the analysed 1513 lakes water bodies
- WFD status defined by EO ends up in better status than by station sampling on 38% of the analysed 1513 lakes water bodies




- **EO interface has same functionalities as coastal water bodies**
- **4639** lake water bodies under reporting oblications
- More than 87% of the surface area of  Finnish lakes is in **good or excellent ecological** condition.
- EO and Status DB covers information from ~ 2200 WFD* water bodies in Finland (87% of the total area under WFD obligations)



Sentinel benefits for the society- earsc.org/sebs

https://earsc.org/sebs/water-quality-in-finland/

WATER QUALITY IN FINLAND

What it is about

Sentinel-2 and Sentinel-3 data are being used to monitor water bodies in Finland. These measurements allow the environmental institute of Finland and regional environmental agencies, known as ELY Centres, to monitor the quality of water in lakes throughout their region to a degree that is not possible using traditional in-situ water sampling and testing.

Using satellite data is especially helpful in a country like Finland where the large amount of water bodies would imply enormous associated costs for authorities should they have to use traditional monitoring methods across the whole country. Sentinel data therefore helps authorities to improve water quality at a lower cost, which in turn improves the quality of life for citizens, aids in the protection of biodiversity and helps to ensure environmental sustainability.

What we found

- Sentinel data helps regional authorities and the Finnish environmental institute to monitor the lakes more effectively, more frequently and more comprehensively.
- Thanks to the use of Sentinel data offered through a publicly available platform, economic and leisure activities are better informed and lake ecosystems are better protected. The associated benefits are important and will grow significantly in the next five to ten years.
- This exemplary use of Sentinel satellite data in Finland not only generates positive impact in the country but also illuminates the associated value for regulatory aspects of water monitoring across Europe.

Copernicus Sentinels Benefits Study: A Show Case — Funded by the EU and ESA

# White paper

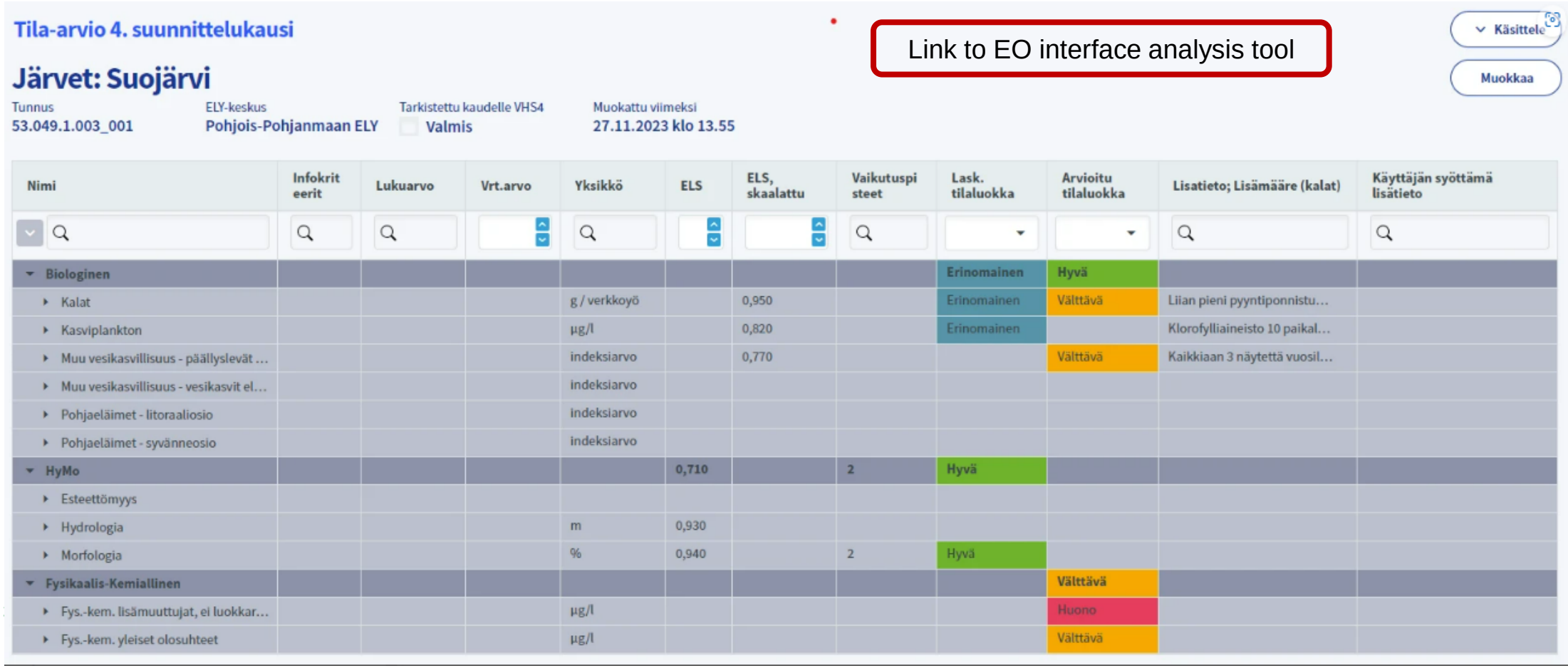
**Recommends:** actions should be taken to utilise the EO derived metrics in the WFD.


doi: 10.5281/zenodo.3463051

This project has received funding from the European Union's Horizon 2020 research and innovation programme (grant agreements 730066 and 776384).

# Pisara interface for lake and river WBs
## (underway during spring and summer)

**EO will be added as annual statistics – and the link to EO interface analysis tool**



Tila-arvio 4. suunnittelukausi

Link to EO interface analysis tool

Käsittele

Muokkaa

### Järvet: Suojärvi

| Tunnus | ELY-keskus | Tarkistettu kaudelle VHS4 | Muokattu viimeksi |
|---|---|---|---|
| 53.049.1.003_001 | Pohjois-Pohjanmaan ELY | Valmis | 27.11.2023 klo 13.55 |

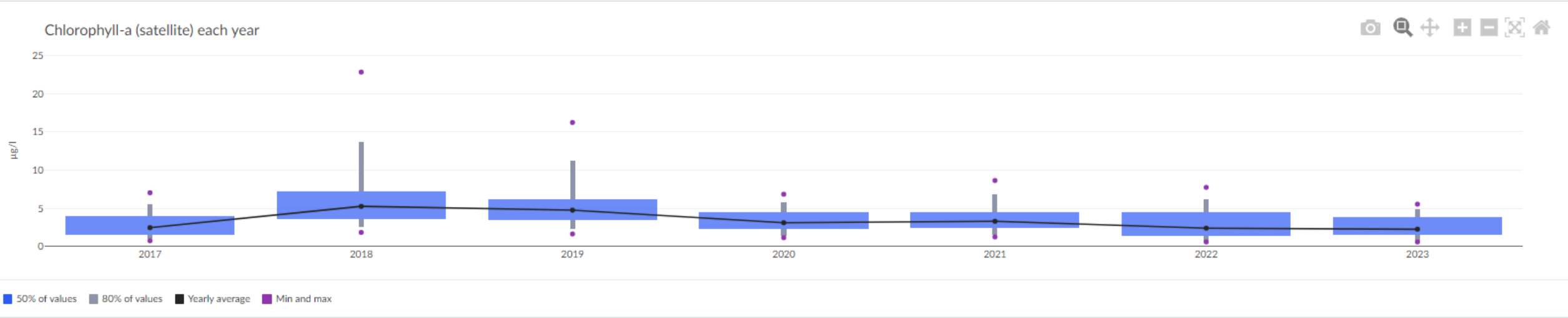
| Nimi | Infokriteerit | Lukuarvo | Vrt.arvo | Yksikkö | ELS | ELS, skaalattu | Vaikutuspisteet | Lask. tilaluokka | Arvioitu tilaluokka | Lisatieto; Lisämääre (kalat) | Käyttäjän syöttämä lisätieto |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Biologinen | | | | | | | | Erinomainen | Hyvä | | |
| Kalat | | | | g / verkkoyö | | 0,950 | | Erinomainen | Välttävä | Liian pieni pyyntiponnistu… | |
| Kasviplankton | | | | µg/l | | 0,820 | | Erinomainen | | Klorofylliaineisto 10 paikal… | |
| Muu vesikasvillisuus - päällyslevät … | | | | indeksiarvo | | 0,770 | | | Välttävä | Kaikkiaan 3 näytettä vuosil… | |
| Muu vesikasvillisuus - vesikasvit el… | | | | indeksiarvo | | | | | | | |
| Pohjaeläimet - litoraaliosio | | | | indeksiarvo | | | | | | | |
| Pohjaeläimet - syvänneosio | | | | indeksiarvo | | | | | | | |
| HyMo | | | | | 0,710 | | 2 | Hyvä | | | |
| Esteettömyys | | | | | | | | | | | |
| Hydrologia | | | | m | 0,930 | | | | | | |
| Morfologia | | | | % | 0,940 | | 2 | Hyvä | | | |
| Fysikaalis-Kemiallinen | | | | | | | | | Välttävä | | |
| Fys.-kem. lisämuuttujat, ei luokkar… | | | | µg/l | | | | | Huono | | |
| Fys.-kem. yleiset olosuhteet | | | | µg/l | | | | | Välttävä | | |

# Pisara interface for assessment: station sampling chl-a …and EO chl-a

Chlorophyll-a (satellite) each year

Link to EO interface analysis tool

2017 - 2024




Columns Show filters Download data Lataa raakadata

| Year | Coastal water type code | Average (µg/l) | Median (µg/l) | Min (µg/l) | Max (µg/l) | Standard deviation | 1.decile | Lower quartile | Upper quartile | 9.decile | Number of observation days | Count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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