ØKOSAT

Satellite water quality monitoring in Norway

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Brockmann Geomatics Sweden AB



Background / Motivation

- The Norwegian coastline , excluding Svalbard, is ca 103 000 km long with 2300 WB
- Norway has 450 000-1 milj lakes and 18 of those are larger than 50 km², 6000 that needs to be classified
- This is one of the motivations for developing the use of remote sensing data for water quality in relation to the WFD
- Data from Sentinel 2 and Sentinel 3 provides better surface coverage and temporal resolution -> that can contribute with additional data to the in situ monitoring programme or with data for un monitored WBs



Goal 2023-2024 (2025-?)

1. To develop and improve the methods for using satellite data to calculate the concentration of chlorophyll-a and other water quality parameters, such as turbidity, Secchi Disc Depth



2. Develop a system for operational and quality assured data processing, operated on an ITplatform that can be hosted on a private or public cloud, and that can be used for ecological status classification with the goal of implementation during the assessment period 2025-2027



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How is this to be achieved?

• Close contact between Norwegian Environment Agency (NEA) and the contractors

Different work packages with 3 core focuses;

- Final products, algorithms, validation etc.
- Implementation of a new data type into the National and regional/local water quality assessment system and practices through regular workshops each quarter





Validation, algorithms, and final products

- In situ WQ data from 76 coastal stations 2016-2023
 - Chl a, SD, turbidity, TSM
- In situ WQ data from 27 lake stations been 2016-2023
 - Chl a, SD, turbidity, colour
- Sentinel-3 processing chain
- Atmospheric correction and in-water retrieval algorithms applied:
 - Five Chl a alternatives included
 - Four SDD alternatives included
- Sentinel-2 processing chain

C2X-complex, C2RCC, C2X atmospheric correction and inwater retrieval algorithms applied

• One Chl and one SDD alternative included



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Validation selection

- 10 coastal water bodies and 10 lake water bodies was selected as a first round
- Selection based on;
 - Available in situ data
 - Range in Chl-a, Secchi depth, Colour (CDOM)
 - Relationship between Chl-a and Secchi depth + in lakes
 - Water body/Lake size and depth
 - Inclusion of different water types





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Products to use in the upcoming classifications

Hemnessjøen, 50 m









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Secchi depth, sheltered coast

Coastal/mixed type - Sentinel 2





0.0

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Lakes categorized based on Colour (CDOM)

For the more humic lakes (Farge (mg Pt/l) = 40+) the results are inconclusive: Vansjø Storefjorden and **Vanemfjorden**, slight less humic, higher chl and turb

Sentinel 2







Lakes categorized based on Colour (CDOM)

For the least humic lakes (Farge (mg Pt/l) = 0-20) the results are better and more consistent:

Steinsfjorden – intermediate chl, low turb

Sentinel 2







Next steps 2024 and 2025

- Automatic algorithm selection based on water types per pixel
- Example products for water quality assessments
- Scale-up and roll-out plans for the system
- Cost estimates
- Prioritizing of satellite-based monitoring intensity for different water bodies
- Training for regional and local water managers at County and Municipality level (Stadsforvaltaren)
- Implementation of the system
- Continuous product improvements and evaluation etc.

	Chl-a average stations				Status average	
	S3		ln-situ		stations	
	µg l-1	StDev	µg -1	StDev	S3	In-situ
Mjøsa, Skreia	3.03	0.98	2.44	0.51	Good	Good
Gjende	1.19	0.41	1.17	0.34	High	High
Selbusjøen	3.07	1.72	0.96	0.19	Good	High
Røssvatnet	1.54	0.34	0.34	0.03	High	High
Snåsavatnet	5.70	0.91	0.94	0.20	Mod.	High
Femunden	6.49	2.01	0.70	0.18	Mod.	High
Mjøsa other monitoring stations						
Brøttum	3.21	1.11			Good	
Furnesfjorden	3.49	1.79			Good	
Kise	2.39	0.92			Good	

