

Satellite based monitoring of Chlorophyll-a in lakes

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The Problem

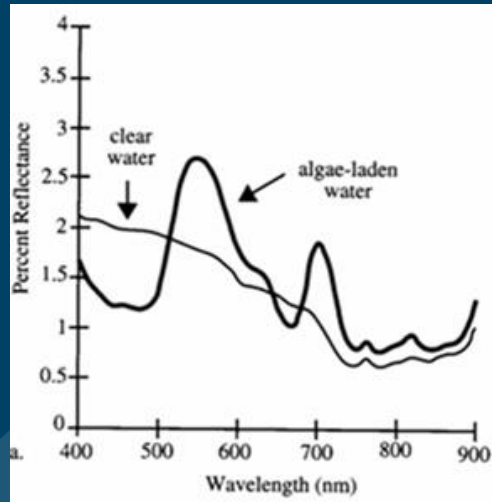
- Danish Ministry of Environment needs information about current state and development of lakes
- More than 600 lakes > 5 ha
- Annually, ca. 15% of the lakes can be covered with current in-situ sampling approach

- Danish Ministry of Environment seeks new solutions for cost-effective monitoring
- Initiative under the EcoInnovation Fund, Ministry of Environment, Denmark (**AMOS project**)

Objectives of AMOS

- Demonstrate the possibility of supplementing the traditional water bottle measurements with chl-a from Earth Observations (EO)
- Demonstrate value of EO data as part of the national monitoring programme NOVANA
- Development of a beta-version water management tool

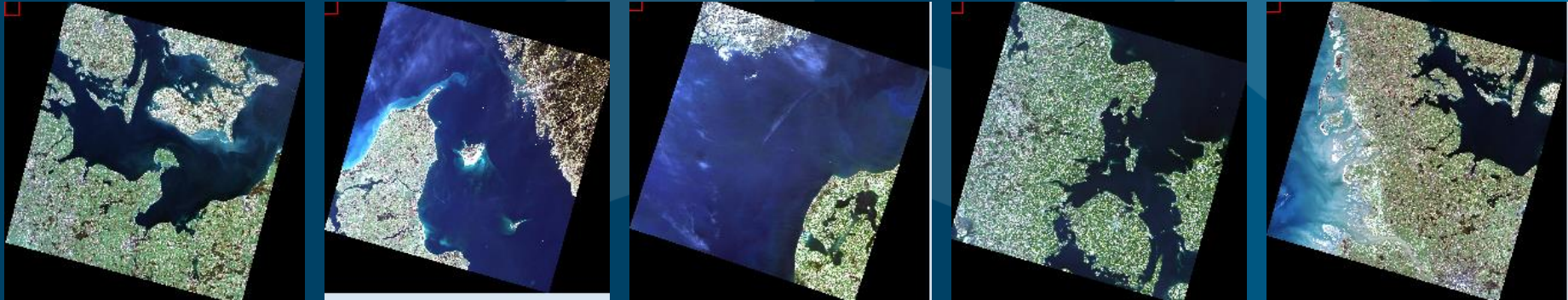
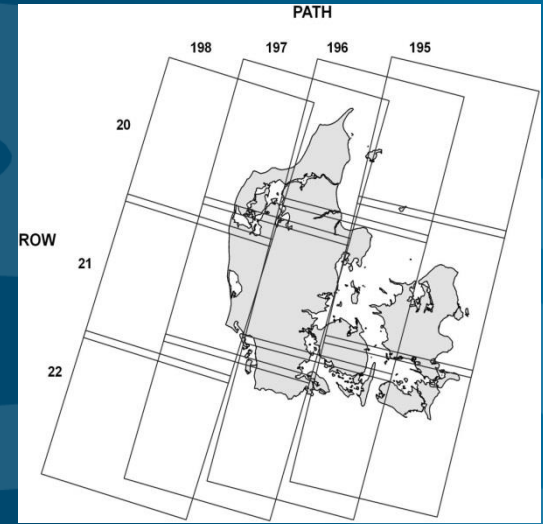
How can we see chlorophyll from space?



Jensen, 2007

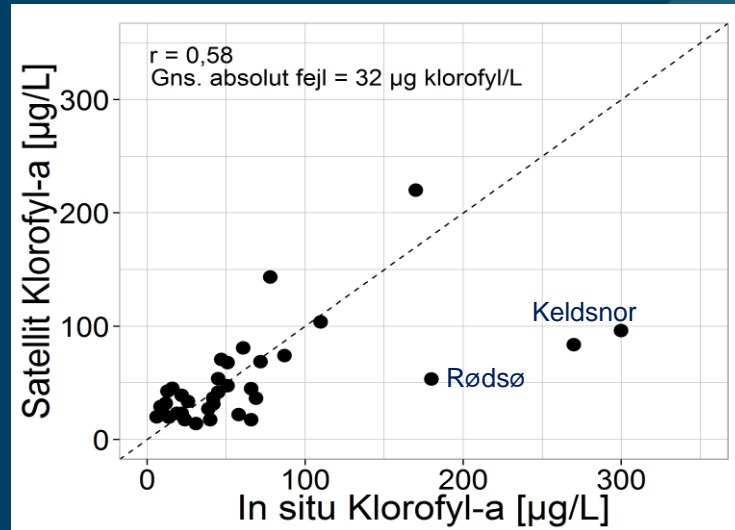
Landsat 8 satellite images

- 2013: 32 images; 2014: 35 images
- Spring to autumn
- data from approx. 16 days
- 30x30m pixels





Evaluation

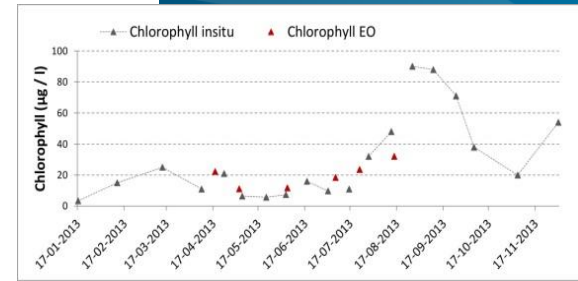
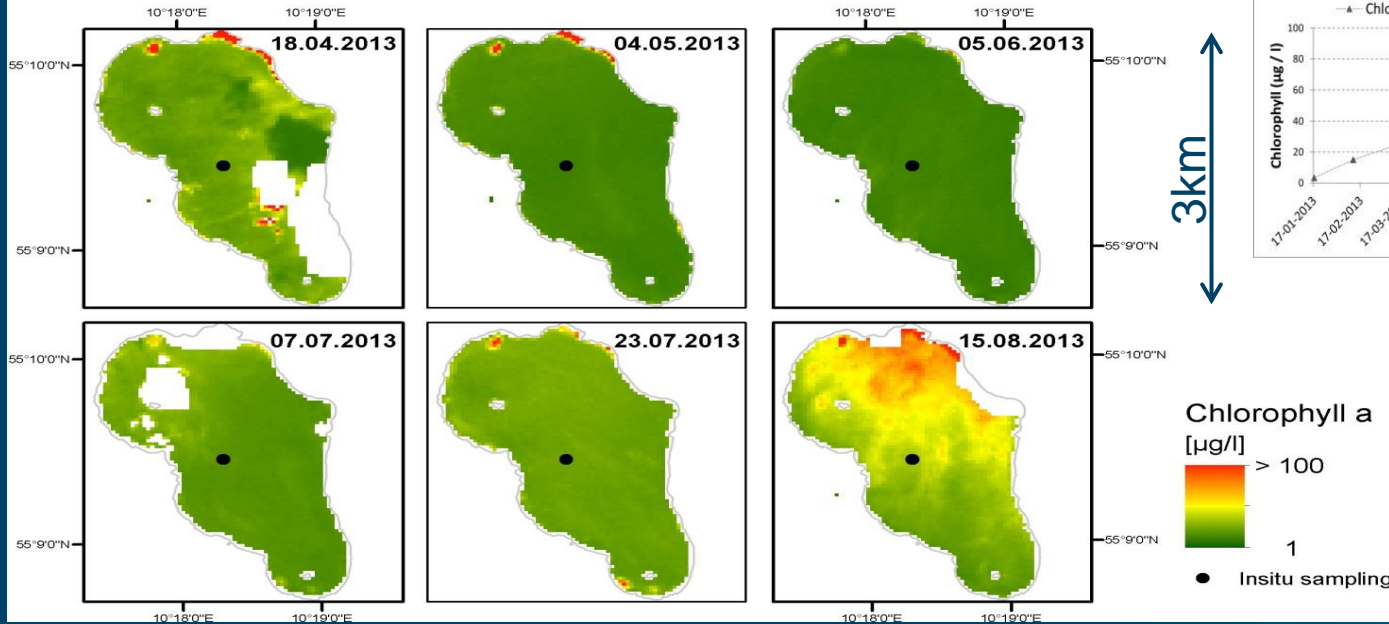


35 points, 22 for 2013 og 13 for 2014, from 25 different lakes

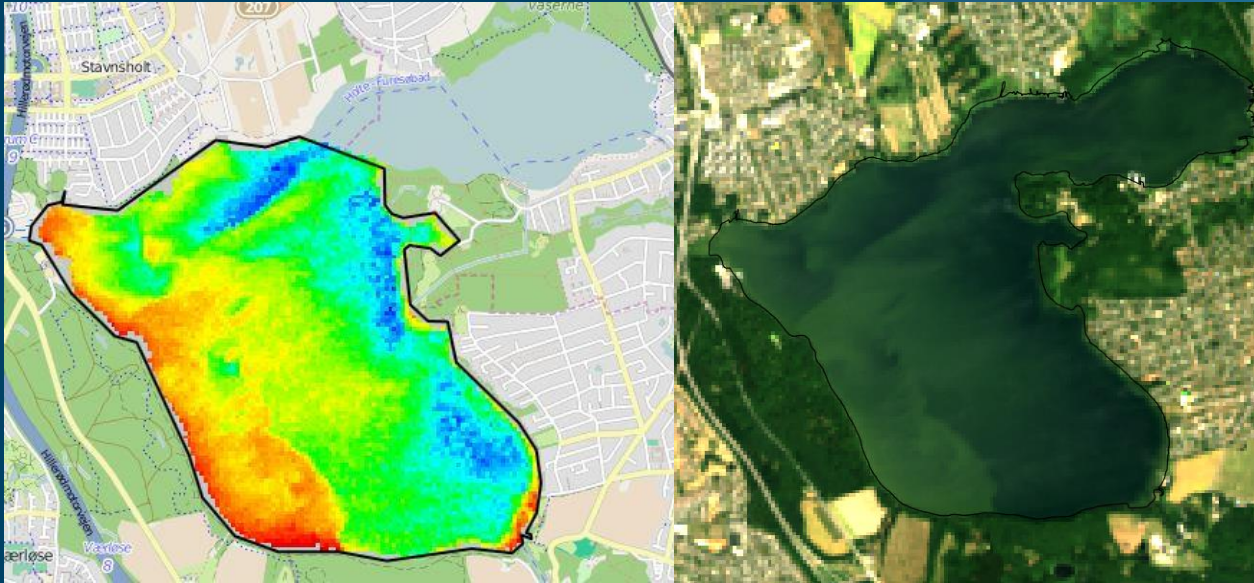
- 30 m resolution – late summer bloom



Arreskov lake (Denmark)

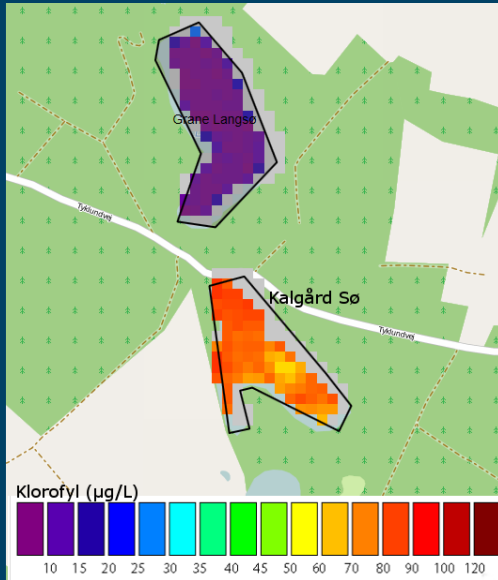
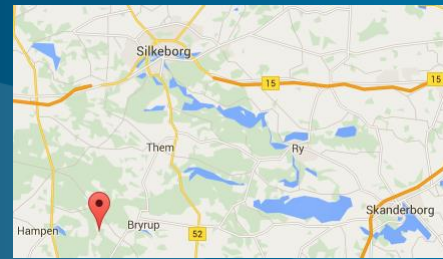


Example: Effect of wind on spatial chl. distribution



← 60 mg/m³ gradient →

Kalgård Sø: one of the purest lakes in DK?



Sat. image summer 2014



Ortho photo summer 2014

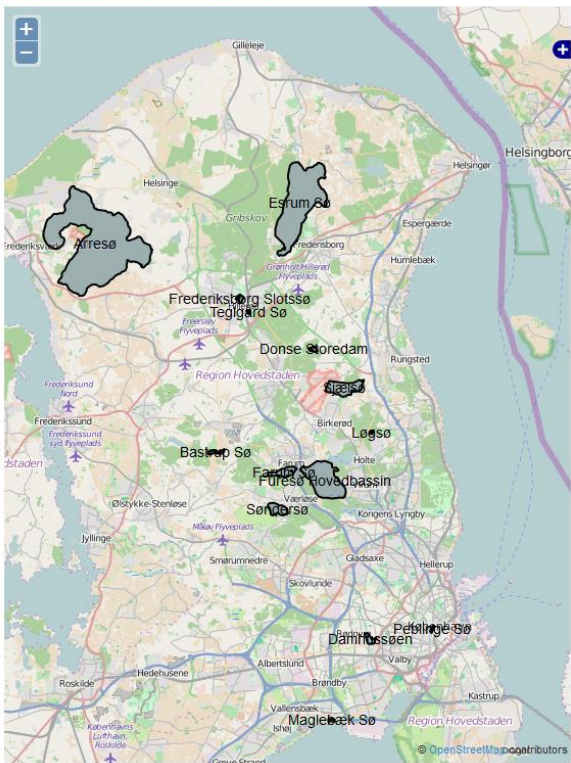
Beta-version water management tool

No online demo...

Vælg en sø...

Vis kun kvalitetssikrede søer

[Åbn websiden "Tryser" tryk F5 ev. Ctrl + F5.](#)



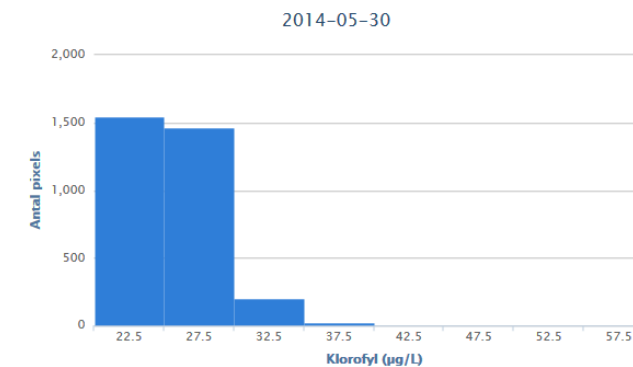
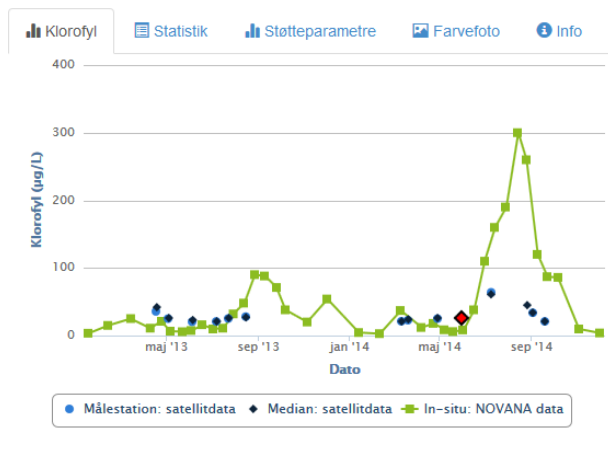
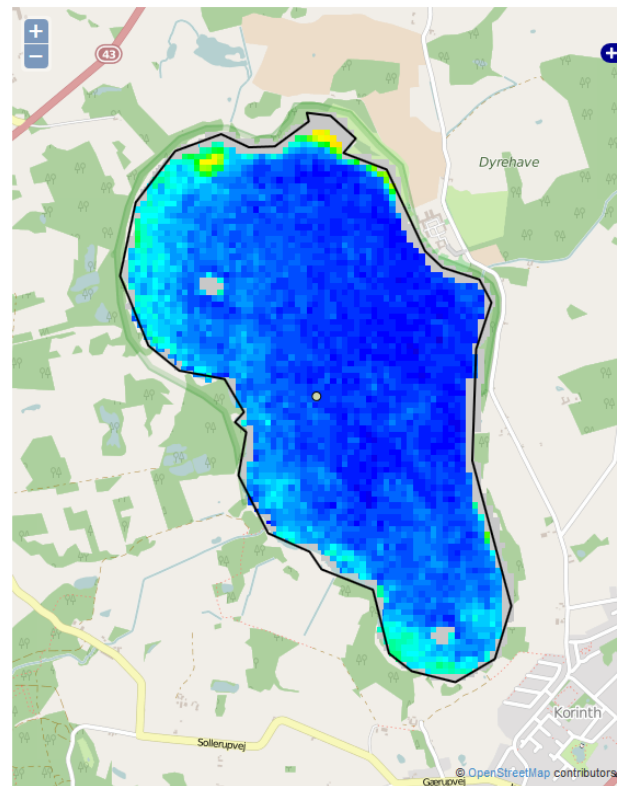
Info Søpolygoner fra Kortstyrelsen (Geodatastyrelsen, Vandområdeplaner, Basisanalyse 2015–2021, vp2b2013soer.shp, februar 2015)

Klorofyl Statistik Støtteparametre Farvefoto Info

187. Arreskov Sø 2014-05-30

Vis kun kvalitetssikrede søer

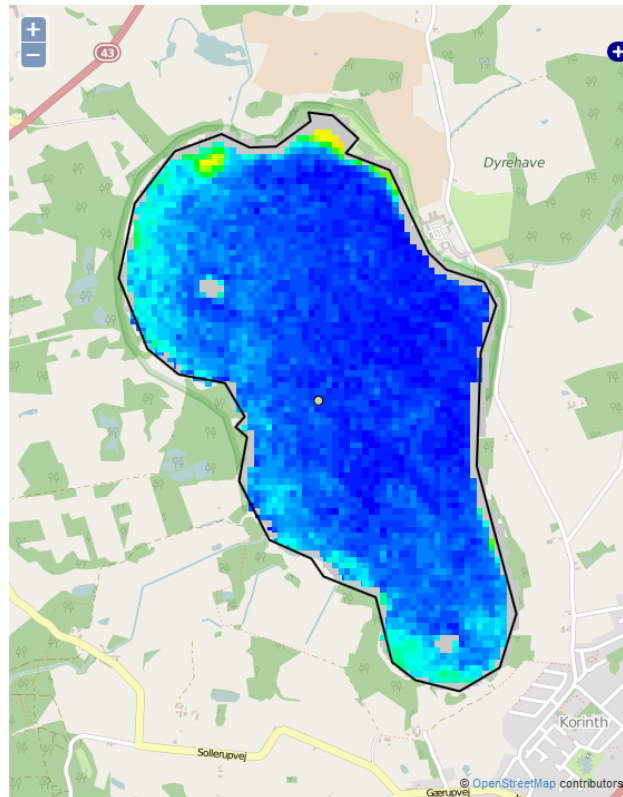
Hvis websiden "fryser" tryk F5 ev. Ctrl + F5.



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Hvis websiden "fryser" tryk F5 ev. Ctrl + F5.



Klorofyl ($\mu\text{g/L}$)

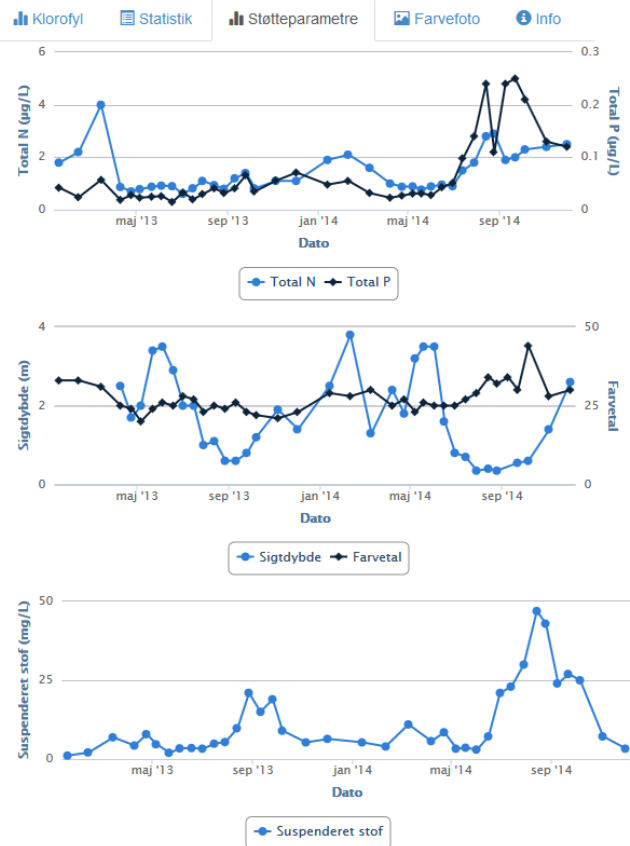
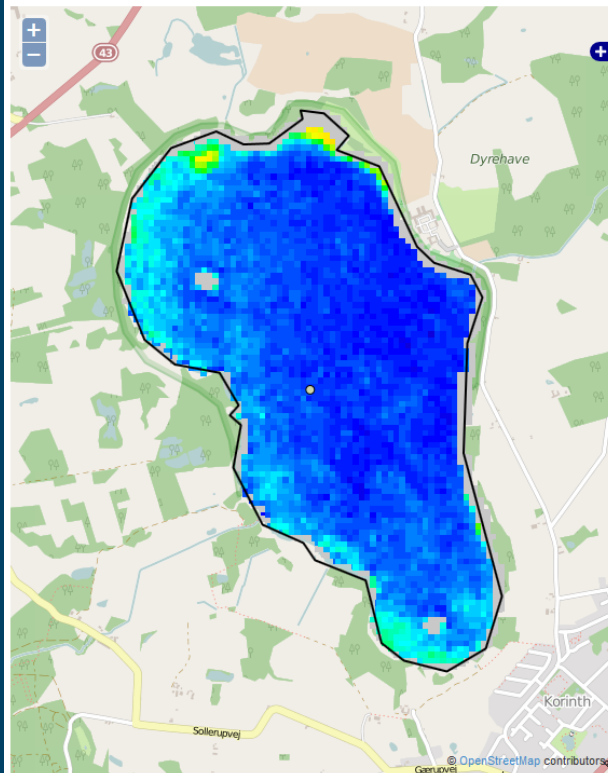
[Klorofyl](#) [Statistik](#) [Støtteparametre](#) [Farvefoto](#) [Info](#)

Dato	p25 ($\mu\text{g/L}$)	Median ($\mu\text{g/L}$)	p75 ($\mu\text{g/L}$)	Dækning (%)
2013-04-18	38	42	47	65
2013-05-04	25	26	28	95
2013-06-05	22	23	24	93
2013-07-07	20	21	22	71
2013-07-23	25	26	27	92
2013-08-15	25	27	29	85
2014-03-11	20	21	22	96
2014-03-20	23	24	25	90
2014-04-28	25	26	27	94
2014-05-30	24	26	27	93
2014-07-10	59	61	63	91
2014-08-27	44	45	47	49
2014-09-03	33	34	36	75
2014-09-19	21	21	21	92

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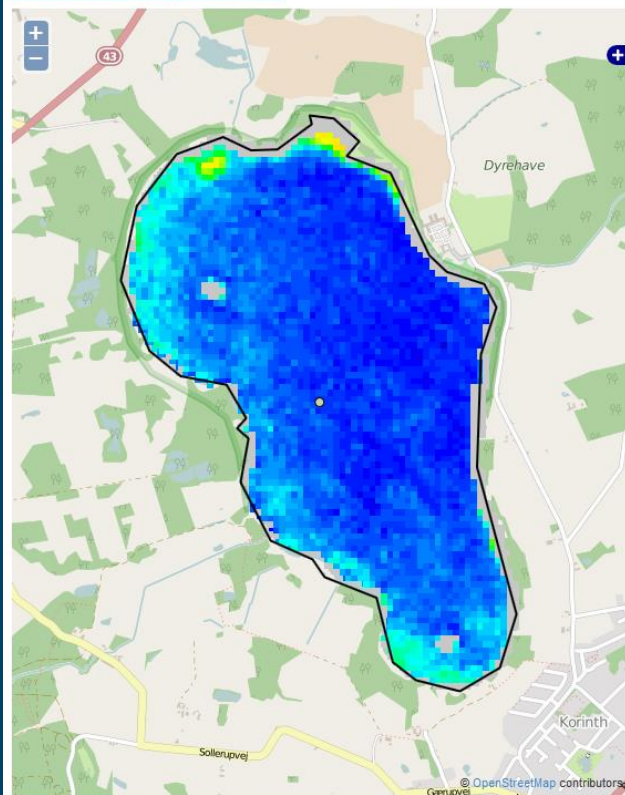
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Klorofyl ($\mu\text{g/L}$)

Klorofyl

Statistik

Støtteparametre

Farvefoto

Info

Dato

2013-04-18

2013-05-04

2013-06-05

2013-07-07

2013-07-23

2013-08-15

2014-03-11

2014-03-20

2014-04-28

2014-05-30

2014-07-10

2014-08-27

2014-09-03

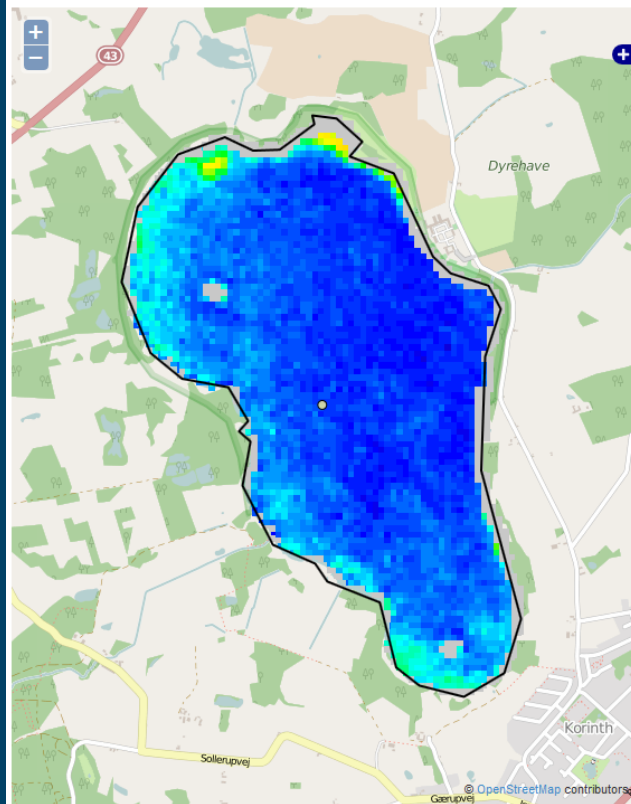
2014-09-19



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Klorofyl ($\mu\text{g/L}$)

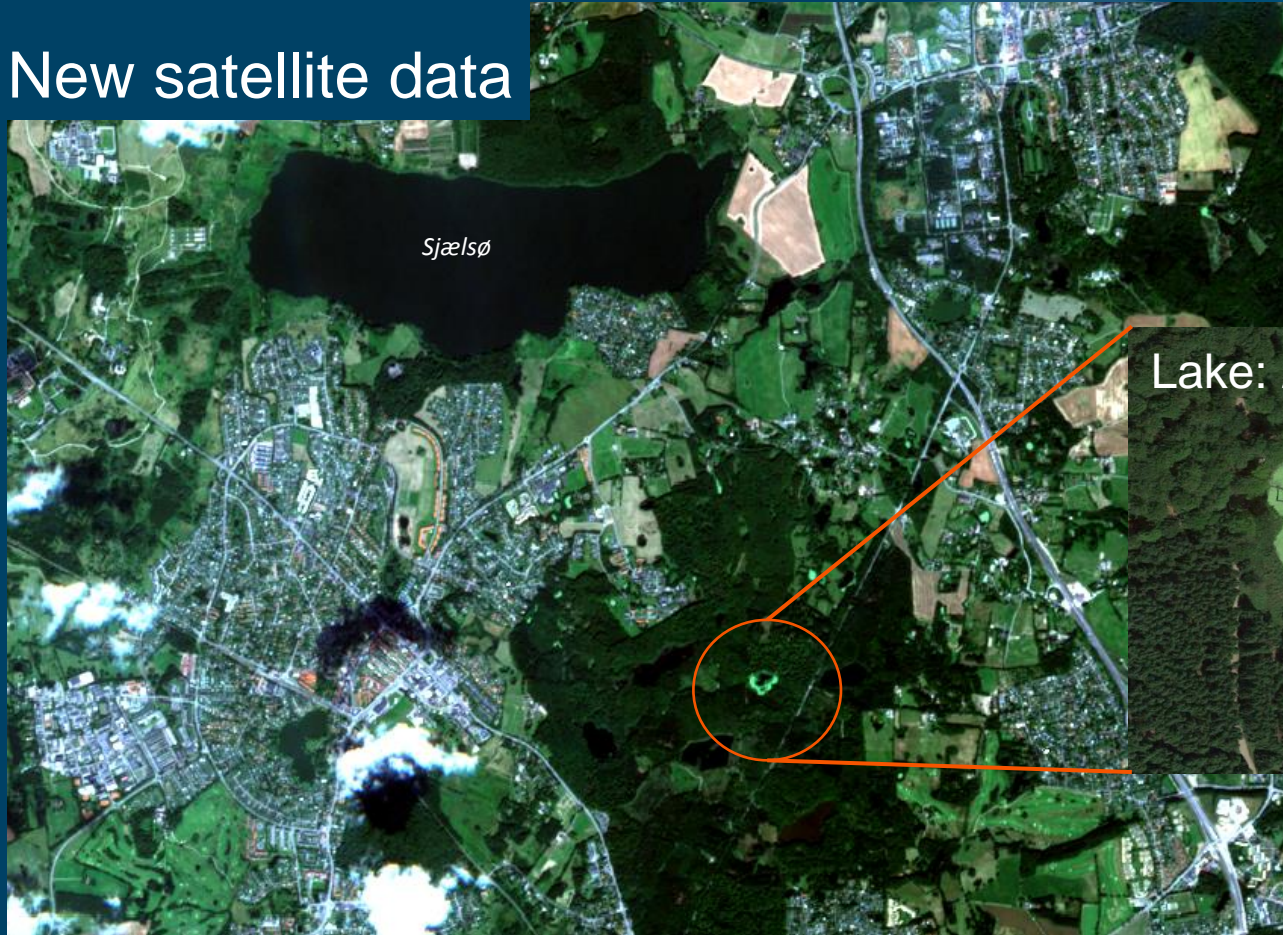
[Klorofyl](#) [Statistik](#) [Støtteparametre](#) [Farvefoto](#) [Info](#)

187. Arreskov Sø

Areal	317,43 ha
Middeldybde	1,9 m
Maksdybde	3,3 m
Fersk / Brak	Fersk
Makrofytter	39% (2011) dækningsgrad

Outlook & Conclusion

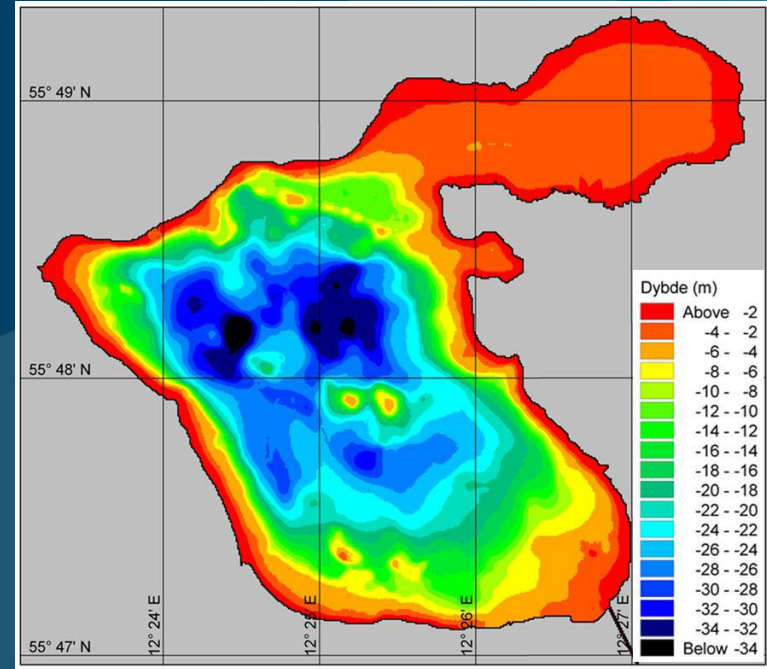
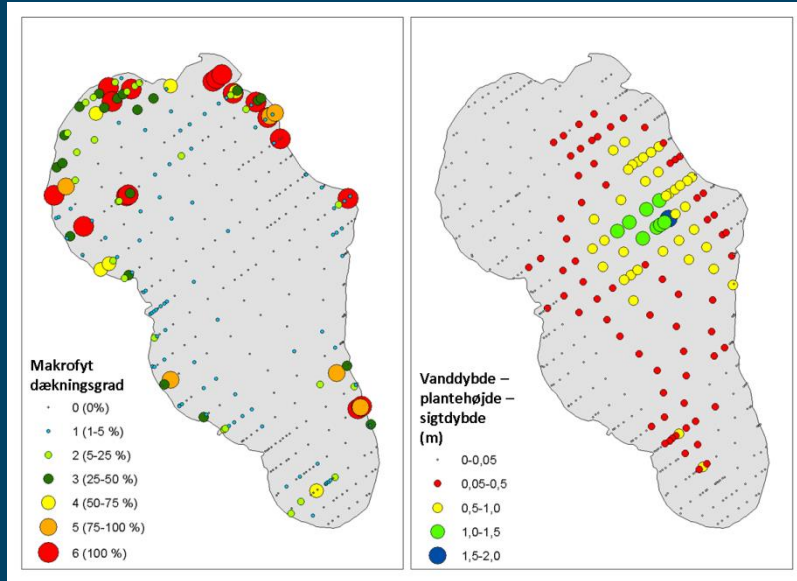
New satellite data



Lake: 2 ha



Additional data



Conclusion

- More work is needed on methods for retrieval of constituents
 - EO is a supplement to traditional monitoring, no replacement
 - Limitations because of clouds, shallow lakes, plants etc.
 - Satellite based information can help optimize use of monitoring resources
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- Project details incl. technical: shu@dhi-gras.com