International Workshop SEVAMOD2:
Results of three years of joint Armenian-German research on Lake Sevan

Oct 5, 2023, Yerevan, Armenia

Remote sensing for monitoring the water quality of Lake Sevan: FEASIBILITY AND LIMITATIONS

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- ❑ Encountered problems and limitations
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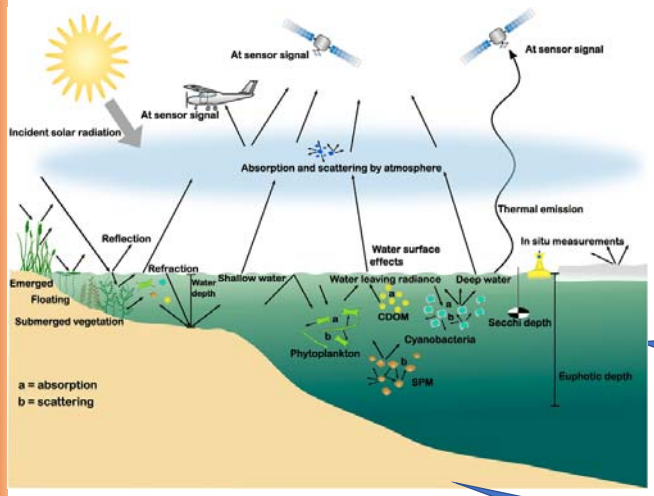
Overview: remote sensing techniques to assess Lake water quality



Source: K. Dörnhöfer, N. Oppelt / Ecological Indicators 64 (2016)
http://dx.doi.org/10.1016/j.ecolind.2015.12.009

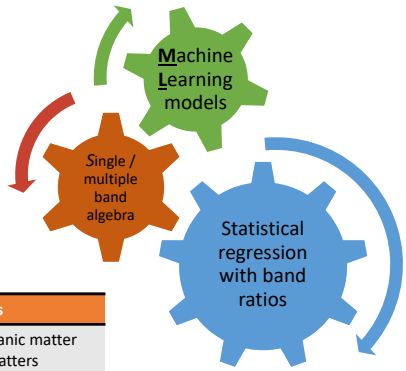
- Lake water quality is a key factor for human wellbeing and health.
- *In situ* measurements are traditionally conducted and widely accepted as instruments for water quality monitoring.
- In many regions, ***classical monitoring*** capacities are limited and in case of large water bodies they lack monitoring at the required spatial and temporal scales

Remote sensing data and products provide synoptic, spatio-temporal views and their integration can lead to a better understanding of lake ecology and water quality.

Remote sensing has great potential for assessing spatio-temporal dynamics of water quality in a cost- effective and informative manner

Satellite remote sensing data relevant for Lake Sevan and its water quality monitoring

1. **Landsat (ETM, OLI, TIRS)**
2. **Sentinel (2; 3)**
3. ...



Lake properties	Response variables	Remote sensing indicators
Transparency	• Turbidity • Dissolved organic carbon • Secchi Disk Depth • ...	• Colored dissolved organic matter • Suspended particle matters • Total suspended solids • Turbidity (NTU) • Secchi Disk Depth • ...
Biota	• Algae blooms • Phenology	• Chlorophyll-a (phytoplankton) • Phytocyanin (cyanobacteria) • Time series analysis of Chl-a
Hydrology	Water level	Bathymetry
Temperature	Epilimnic temperature	Surface temperature
Ice phenology	• Ice-out • Ice-duration	• Ice-out; time series analysis • Ice-duration; time series analysis

Lake Sevan water quality to be assessed and monitored by remote sensing

eoLytics Water Quality: a web application

allows users to control state-of-the-art satellite data processing within the EOMAP cloud.

eoAPP: free visualizer of EOMAP's water quality products covering selected areas around the Globe

Application for Lake Sevan:

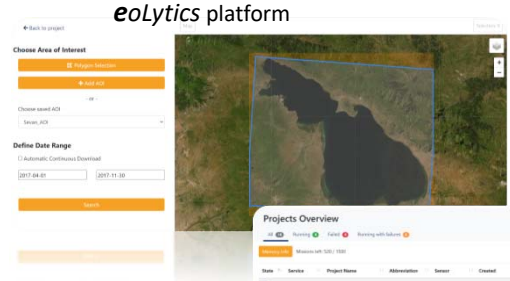
>1000 scenes of Sentinel3 OLCI were downloaded and geoprocessed for Lake Sevan

Covering period: 2017-2021

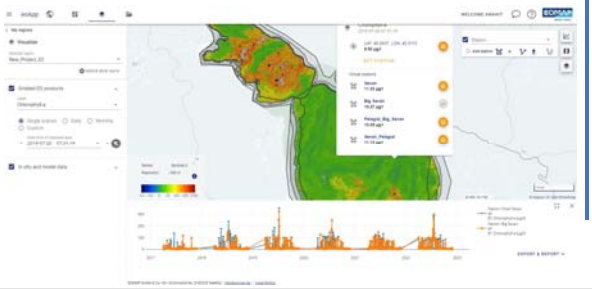
Remote sensing indicators:

- Chlorophyll – a
- Harmful Algae Bloom (HAB)

***e**oLytics* platform



***e**oAPP* platform



*V*alidation of the algorithms of Chl-a quantification

Validation of results (Chl-a) derived from Sentinel 3 via eoLytics tools

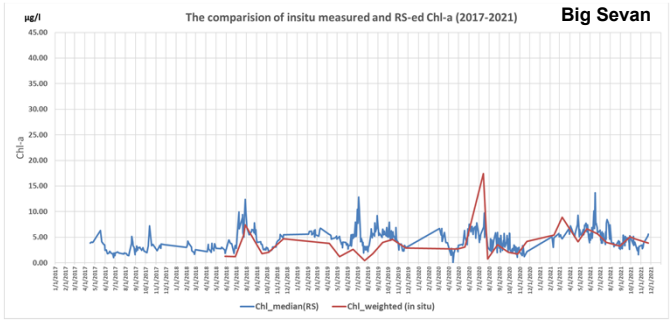
In situ measured Chl-a and its correlation with Sentinel 3 derived Chl-a ***by Python***

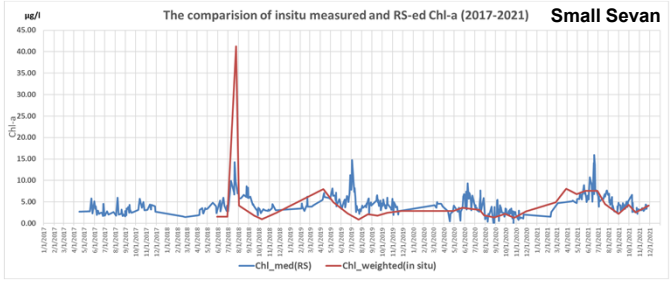
Number of in situ measurements – 76
Period – per-month 2018-2021 (April –November)

Number of Sentinel 3 scenes - >700
Period – 2017-2021 (April –November)

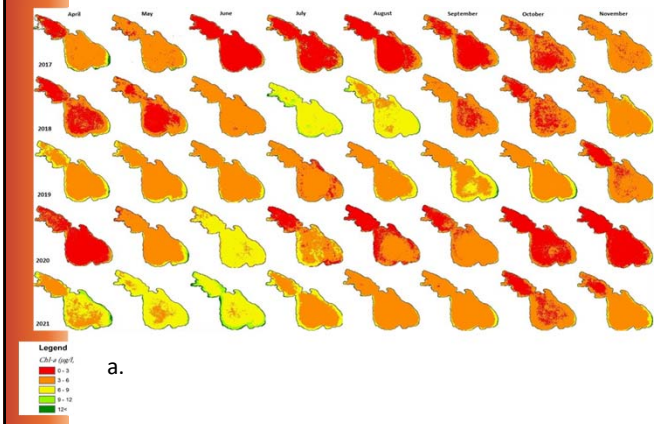
	r	p-value
Big Sevan (BS)	0.576	0.000450 (>0.001)

	r	p-value
Small Sevan (SS)	0.607	0.000180 (>0.001)





Validation of the algorithms of Chl-a quantification



a.

The seasonal and spatial water quality dynamics in Lake Sevan over 5 years (2017-2021) based on Sentinel 3 OLCI:

a. **Chl-a;**
b. **Harmful algae bloom (HAB)**

b.

Encountered problems and limitations

The algorithm of the quantification of Chl-a in water ***does not catch the high values!!!***

HAB indicator works well and still reliable for qualitative assessment***!!!***

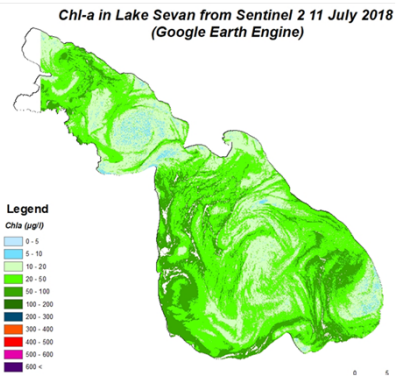
<u>The problem stems</u> from atmospheric correction, which cannot be fully performed for ***Sentinel-3*** but can be done for ***Sentinel-2***

Open source algorithm developed for ***Sentinel-2*** in Google Earth Engine (GEE) platform

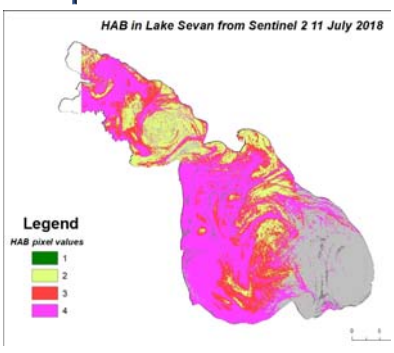
FAILED Validation

Sentinel-2 11 July 2018 (RGB)

Chl-a in Lake Sevan from Sentinel 2 11 July 2018 (Google Earth Engine)



HAB in Lake Sevan from Sentinel 2 11 July 2018



Currently

Play with data - Making experimental visual assessment based on RGB imagery, SDD and HAB indicator, which enables to catch the bloom period…

… statistically must **be confirmed** and **published!!!**

Conclusions

- There are methodological ***limitations***, in particular ***the spatial and temporal scarcity of the in-situ monitoring*** needed to enhance the validation results of remote sensing algorithms developed for quantification of Chl-a and other qualitative parameters.
- However, the outcomes of **HAB algorithm are reliable** and in conjunction with Chl-a, SDD and the RGB remote sensing data shows the water bloom.

Hence, at this stage
we confirm that Sentinel-3 OLCI daily scenes and the EOAPP processing platform are feasible to detect the algae bloom period (based on HAB indicator) and so,
envisaged these technologies to be included in the further monitoring system of Lake Sevan.

Thank you

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