Deriving water quality from APEX imagery

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belspo NIOZ vito vision on technology REMOTE SENSING LABORATORIES RSL IVM Institute for Environmental Studies

Our test sites

Scheldt

Lake Constance

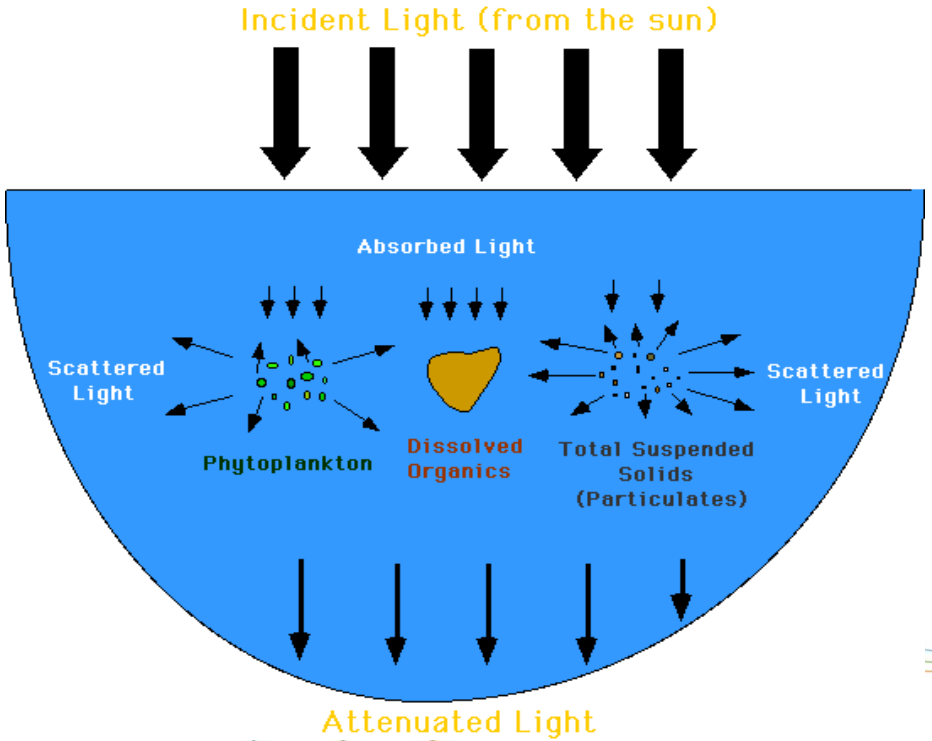
Wadden Sea

Gironde

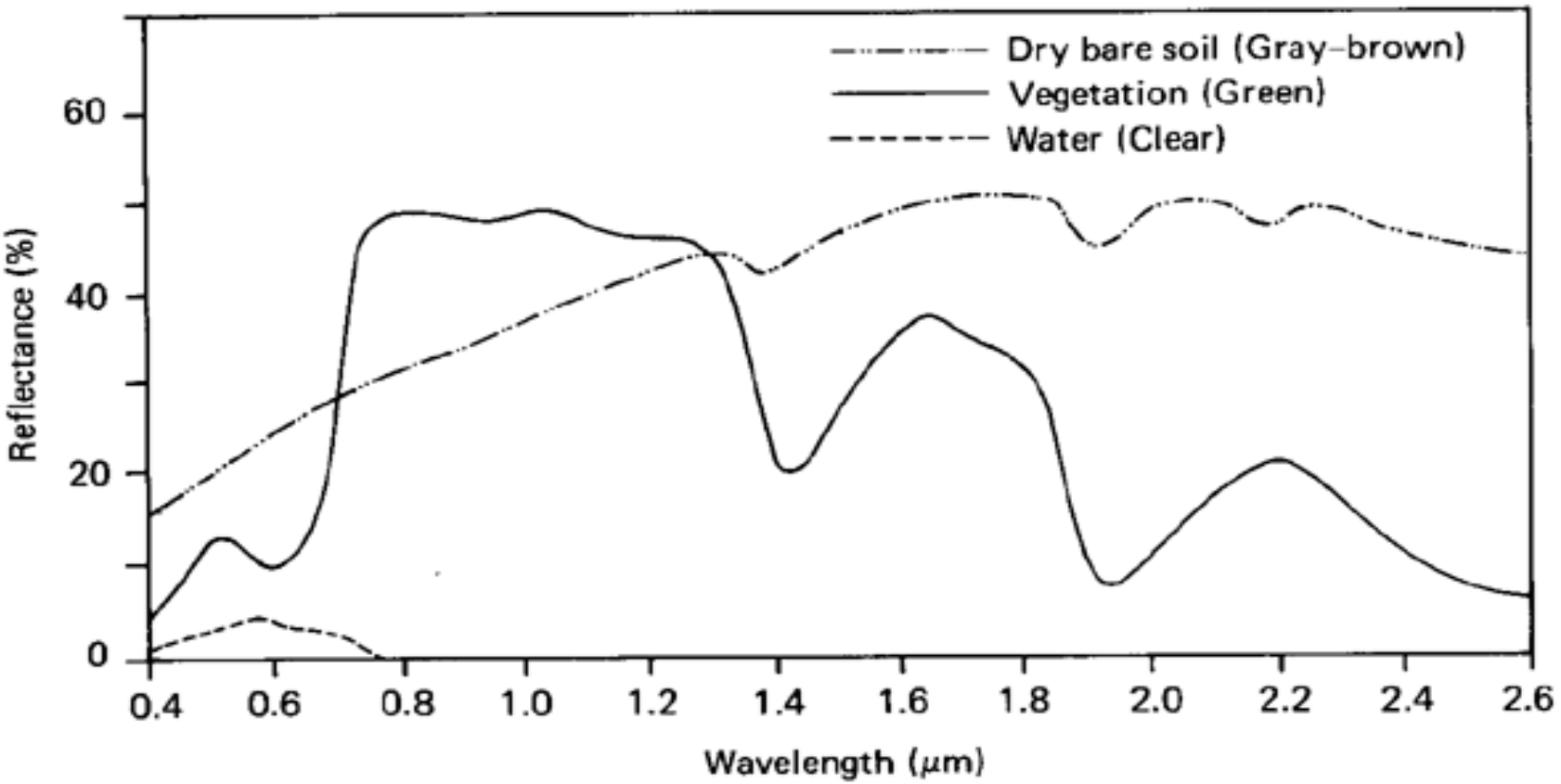
•macrotidal estuary suspended sediments delivered by the Garonne and Dordogne rivers and trapped within the maximum turbidity zone of the estuary.
•TSM from ten to four thousands mg L-1 (Doxaran et al. 2002a, 2002b, 2006, 2009)

Challenges - Complex waters

- Water Quality Estimations for CASE-II water systems
  - Algae [CHL]
  - Total Suspended Material [TSM]
  - Colored Dissolved Organinc material [CDOM]



Challenges - A low signal



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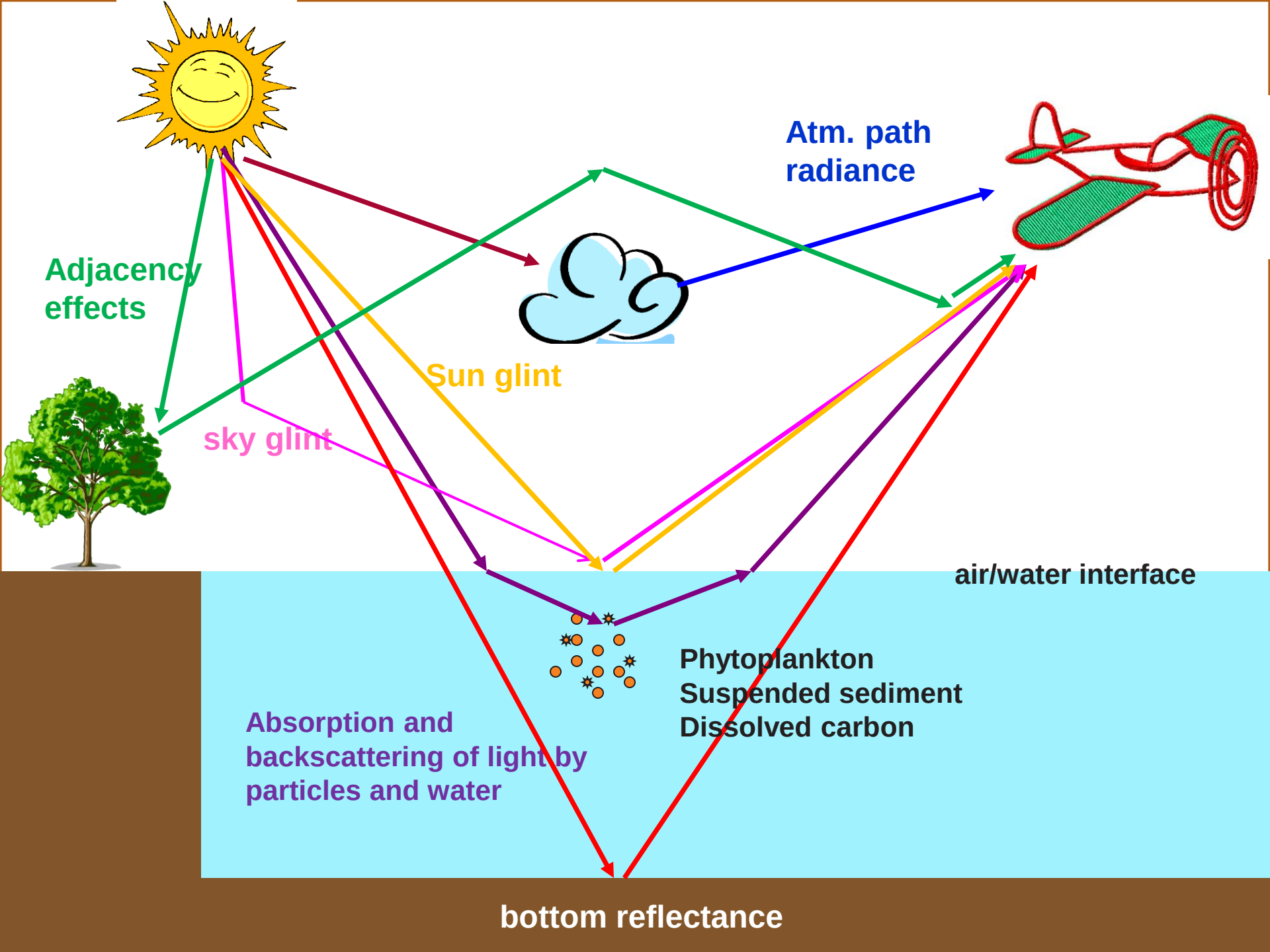
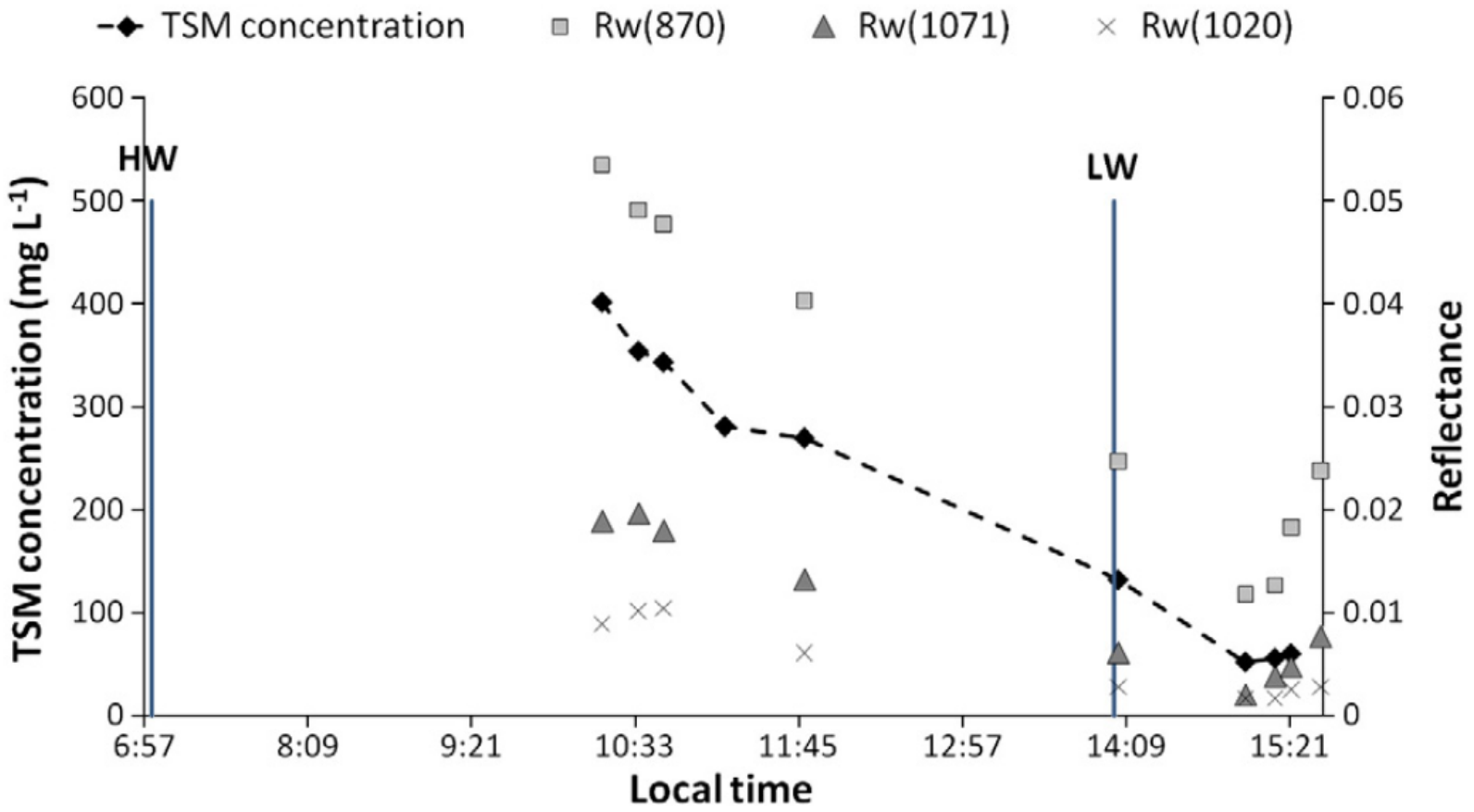

Atm. path
radiance
Adjacency
effects
Sun glint
sky glint
air/water interface
Phytoplankton
Suspended sediment
Dissolved carbon
Absorption and
backscattering of light by
particles and water
bottom reflectance

Challenges - Dynamic environment



→ **Match up difficulties**
Need for detailed campaign planning

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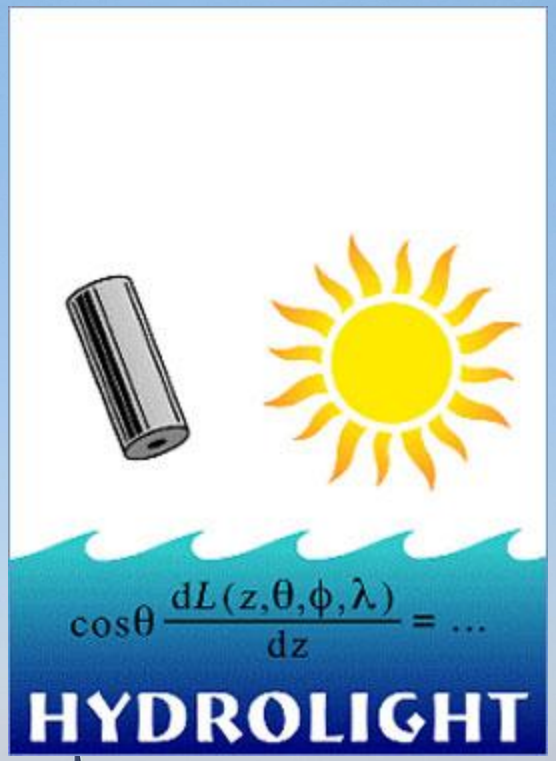
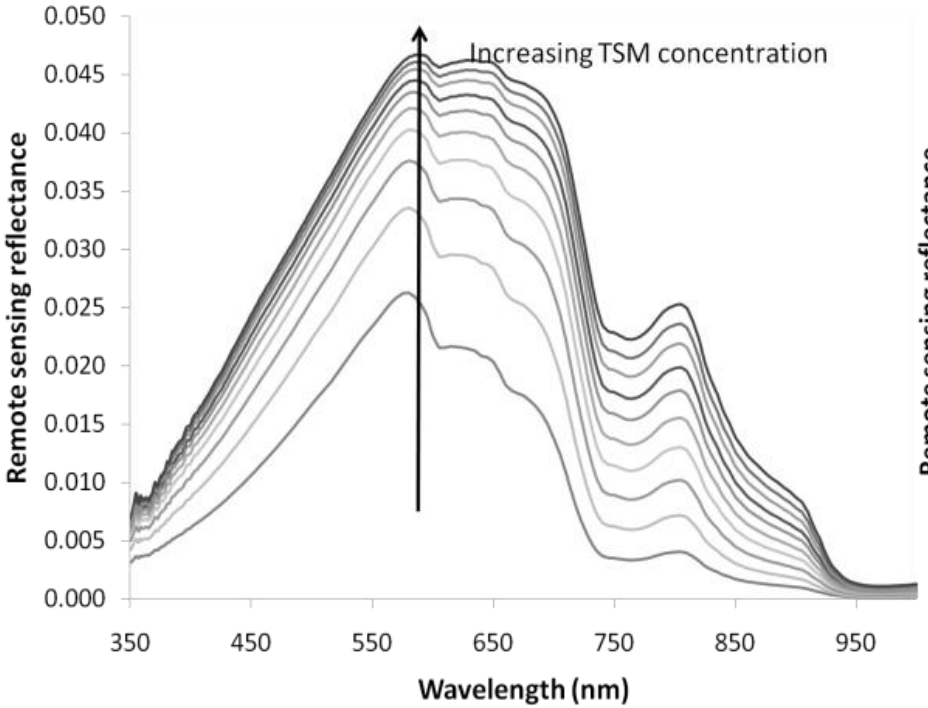
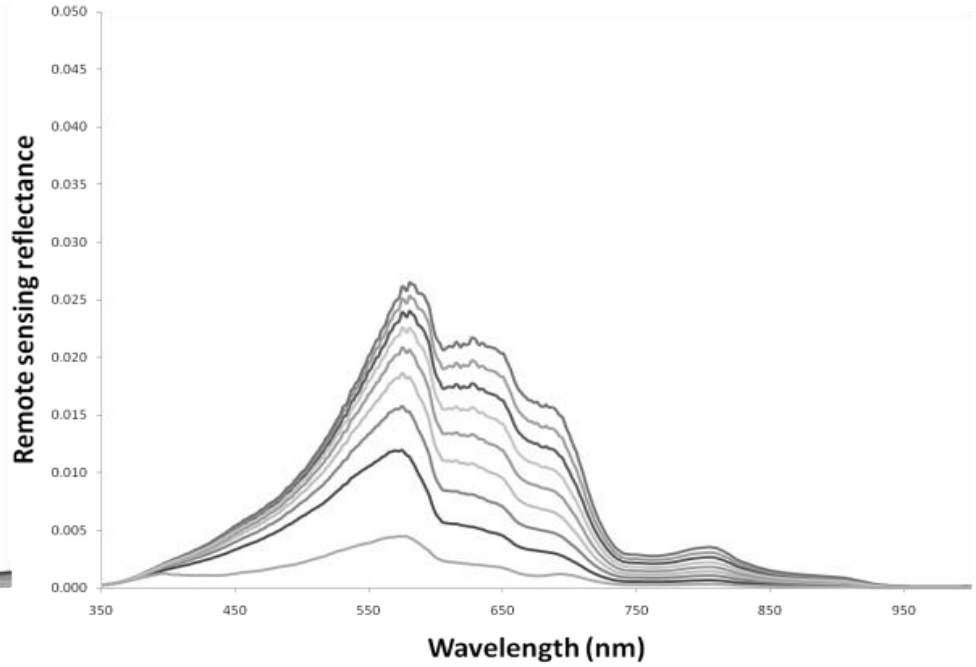
A typical water spectrum – simulation



Simulated Hydrolight spectra

Effect of concentration on the simulated spectra

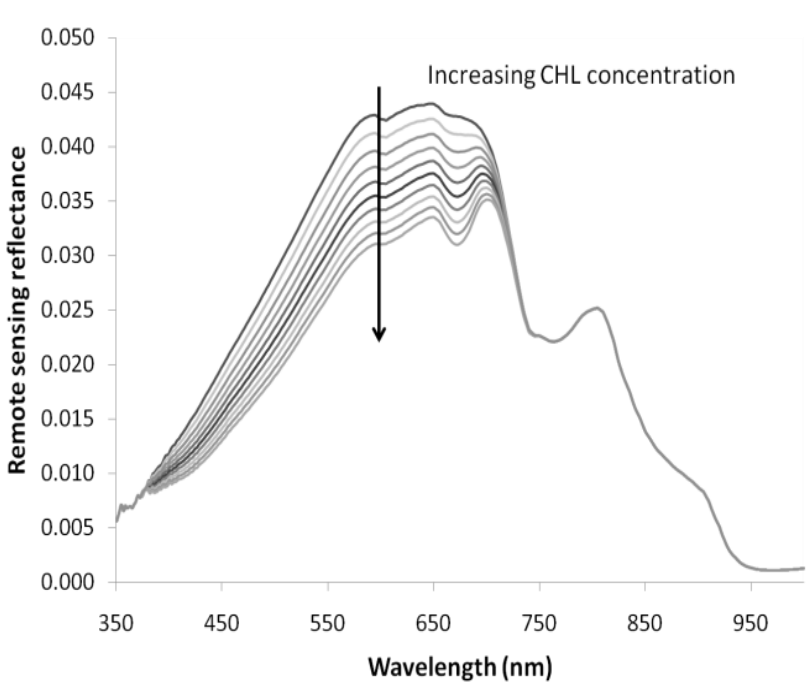


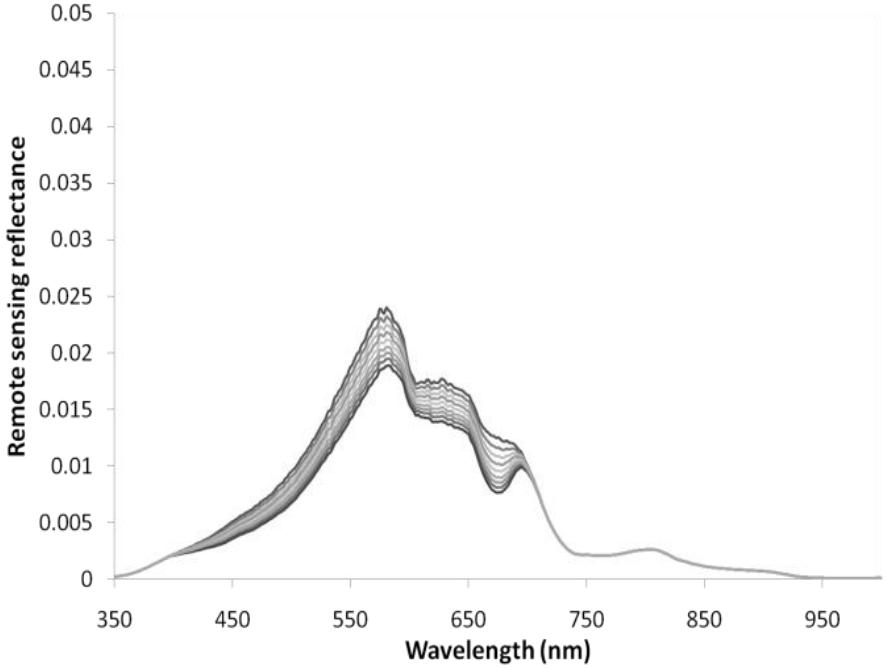


Variation in TSM concentration
Left: Scheldt
Right: Lake Constance

Simulated Hydrolight spectra

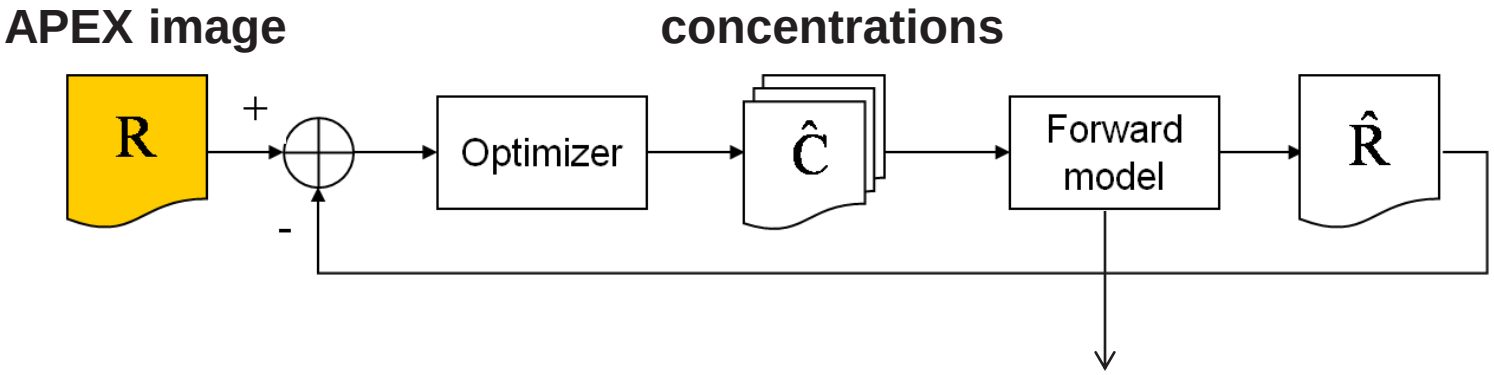
Effect of concentration on the simulated spectra





Variation in CHL concentration
Left: Scheldt
Right: Lake Constance

Water quality algorithm: Curve fitting



Bio-optical model of Albert and Mobley (2003)

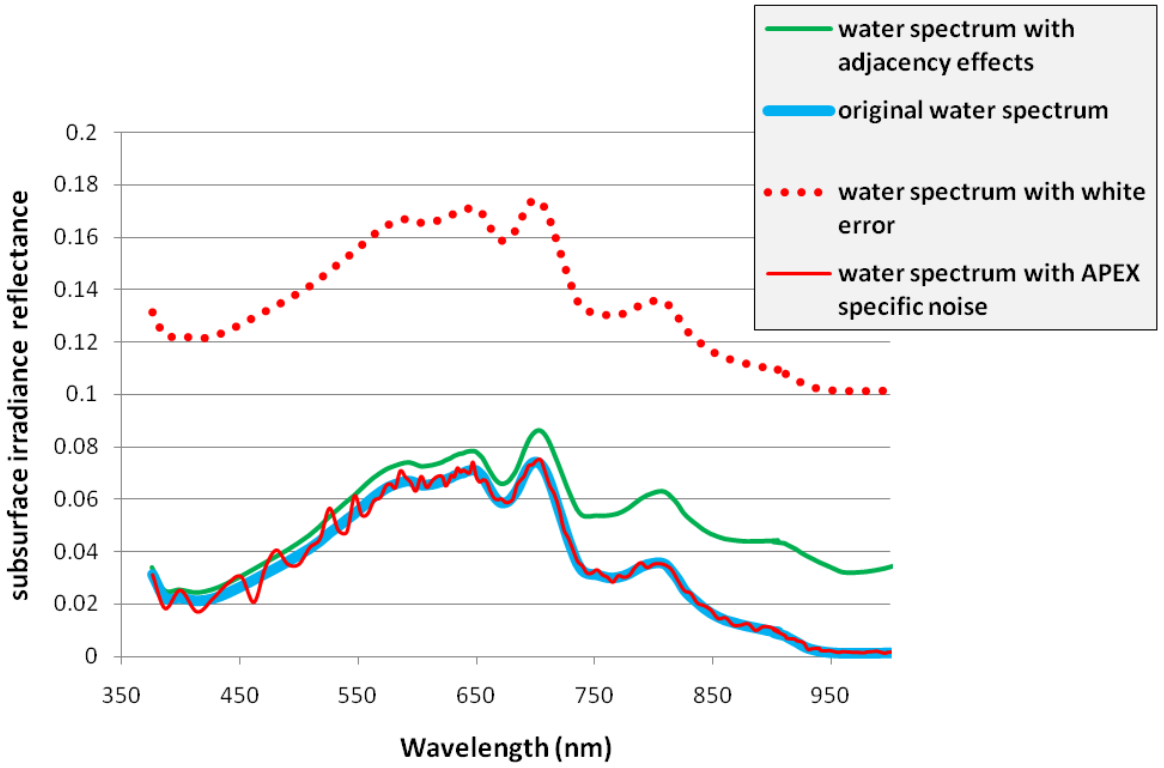
$$R(0-,\lambda) = p_1(1 + p_2 x + p_3 x^2 + p_4 x^3)(1 + p_5 \frac{1}{Cos\theta_s})(1 + p_6 u)x$$

$$x = \frac{b_b(\lambda)}{a(\lambda) + b_b(\lambda)}$$

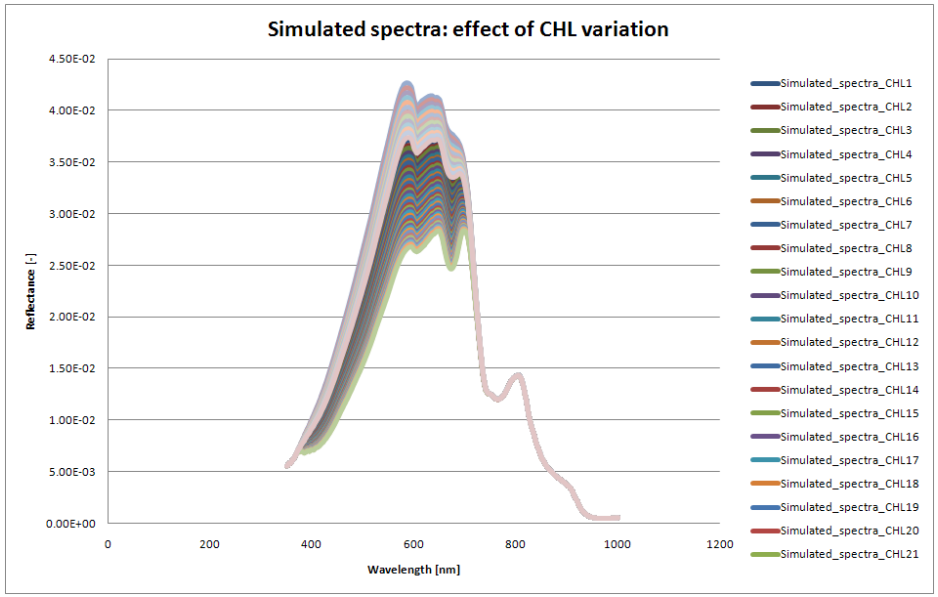
Objective: develop algorithm less sensitive to noise in atmospheric correction and sensor noise

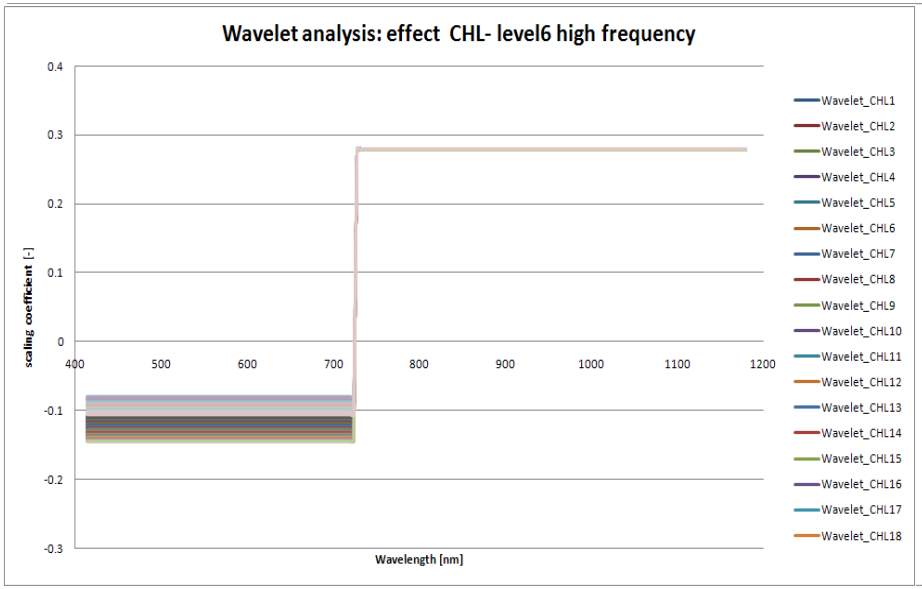
Simulated Hydrolight spectra

Effect of noise on the simulated spectra



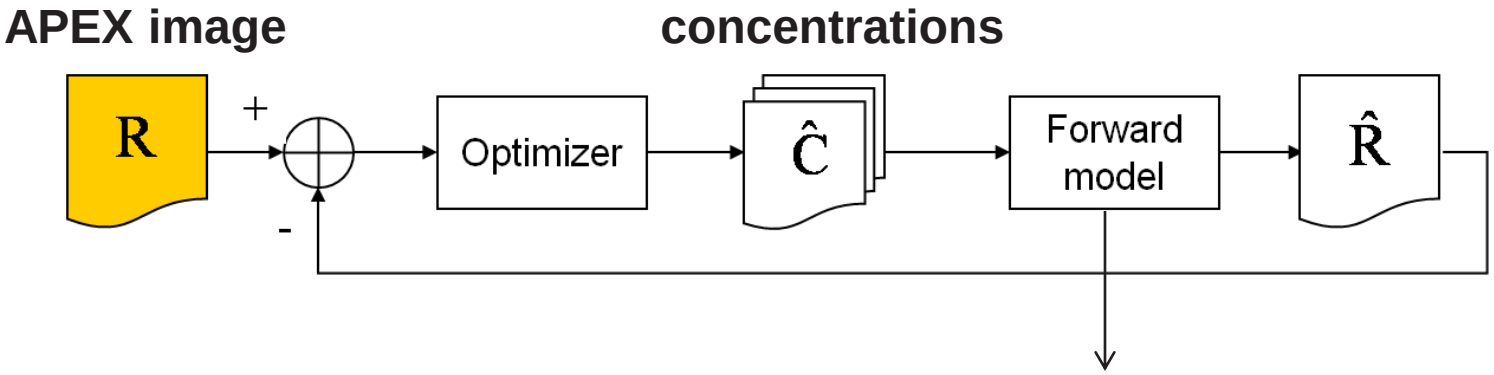
Wavelet based curve fitting algorithm





*Look at the shape of the spectra and those features which are **Sensitive** to change in the **WQP** and **Insensitive** to Noise*

Wavelet based curve fitting algorithm



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$$x = \frac{b_b(\lambda)}{a(\lambda) + b_b(\lambda)}$$

Objective: develop algorithm less sensitive to noise in atmospheric correction and sensor noise

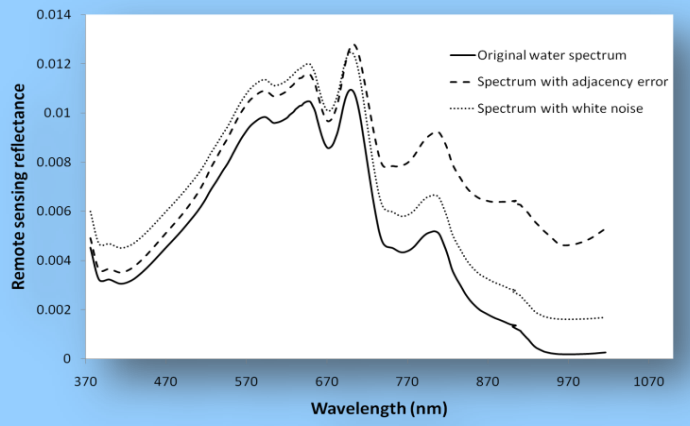
Study area: Scheldt

Reference = Hydrolight with known concentrations, resampled to APEX wavelengths

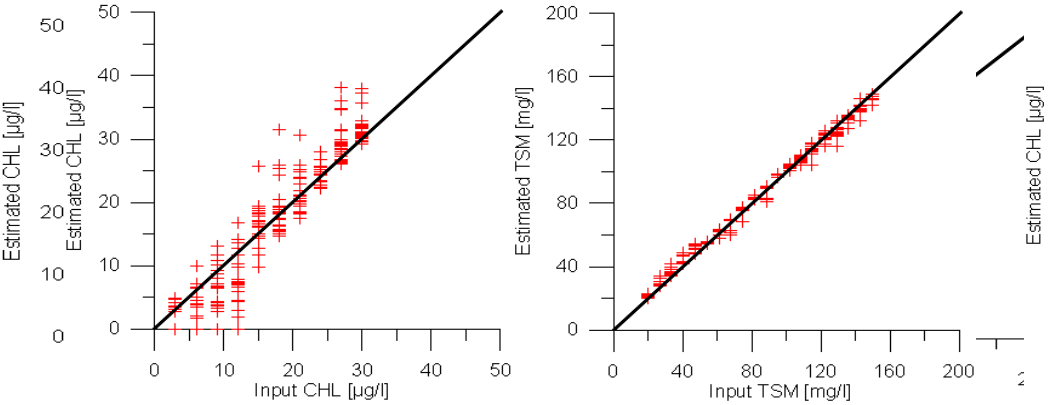
Noise: adjacency

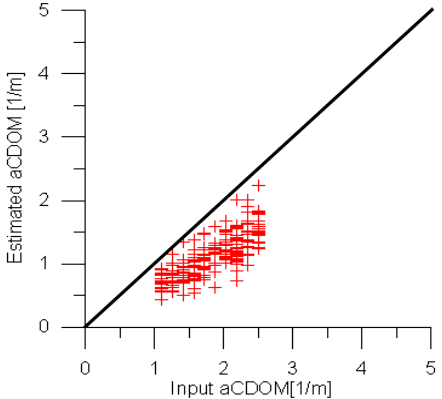
Noise: adjacency, with wavelets

Figure: Synthetic remote sensing reflectance spectra with white noise and adjacency error

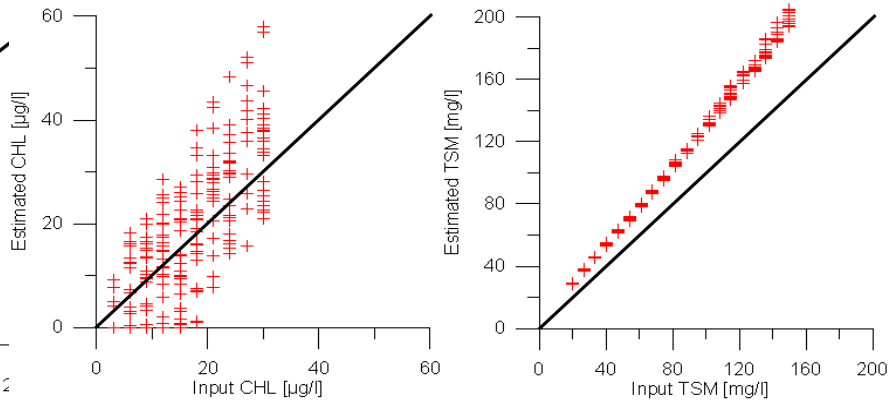


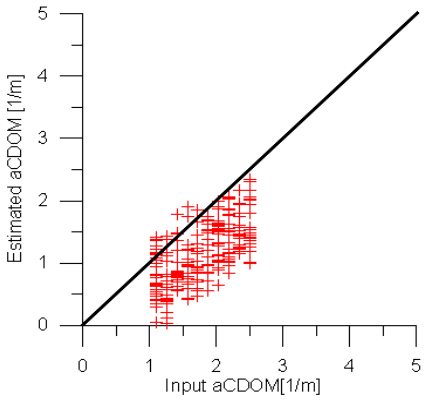
Water Quality Estimations: Scheldt
Noise: Adjacency effect
Optimalisation: Wavelet combination



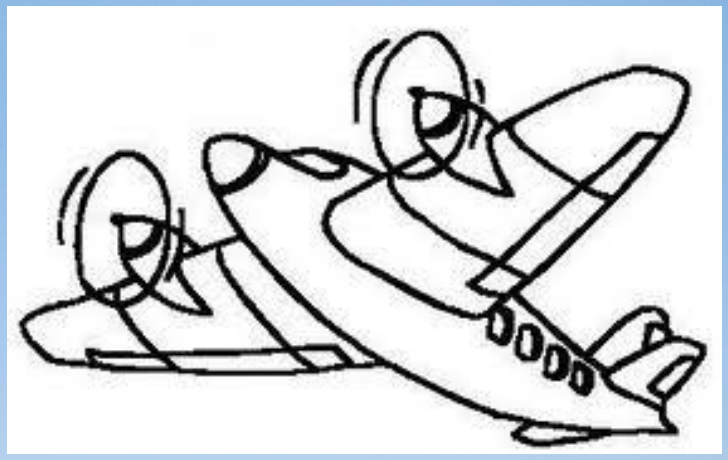


Water Quality Estimations: Scheldt
Noise: Adjacency effect
Optimalisation: RMSE



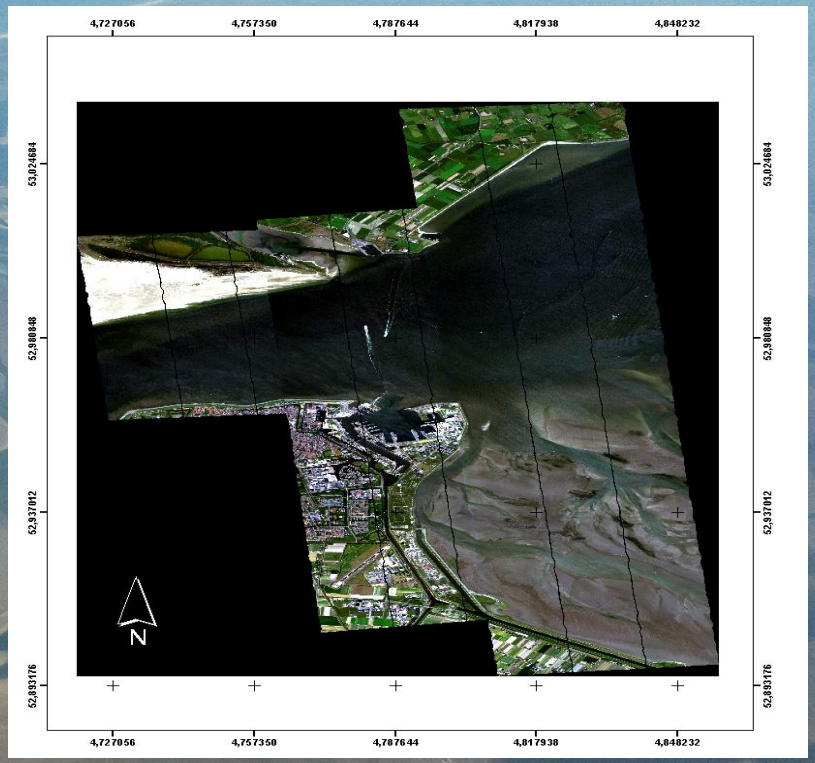


APEX



APEX campaign: 06/2011 - Wadden Sea

- Cooperation with INPLACE project
- Logistics (boat, lab, ..)



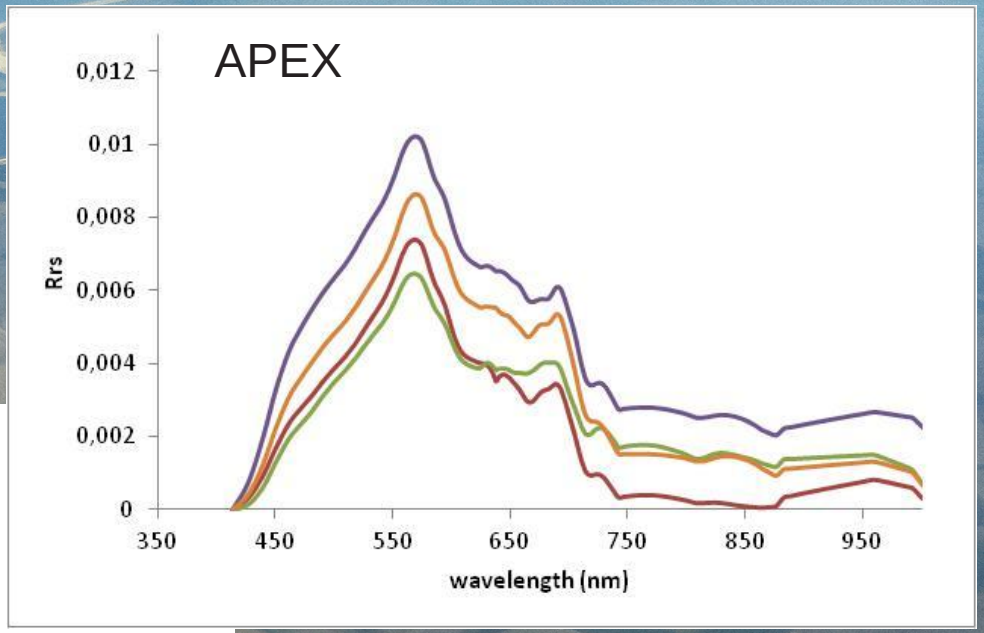
Zeevonk

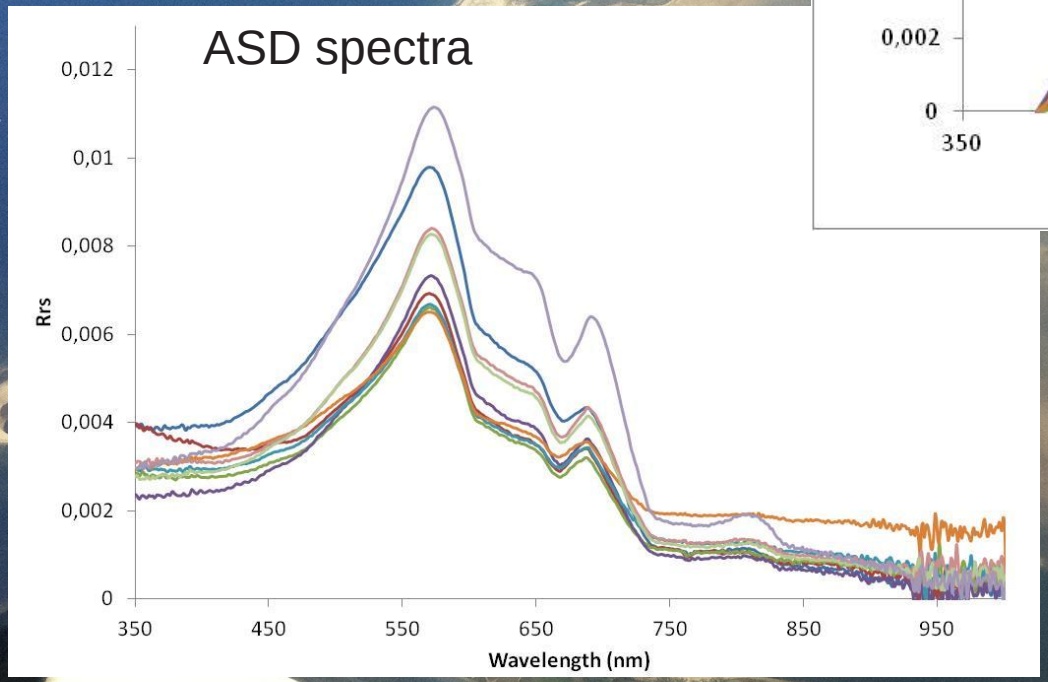
TESO (ferry)

NIOZ - pontoon

INPLACE pole

APEX campaign: 06/2011 - Wadden Sea





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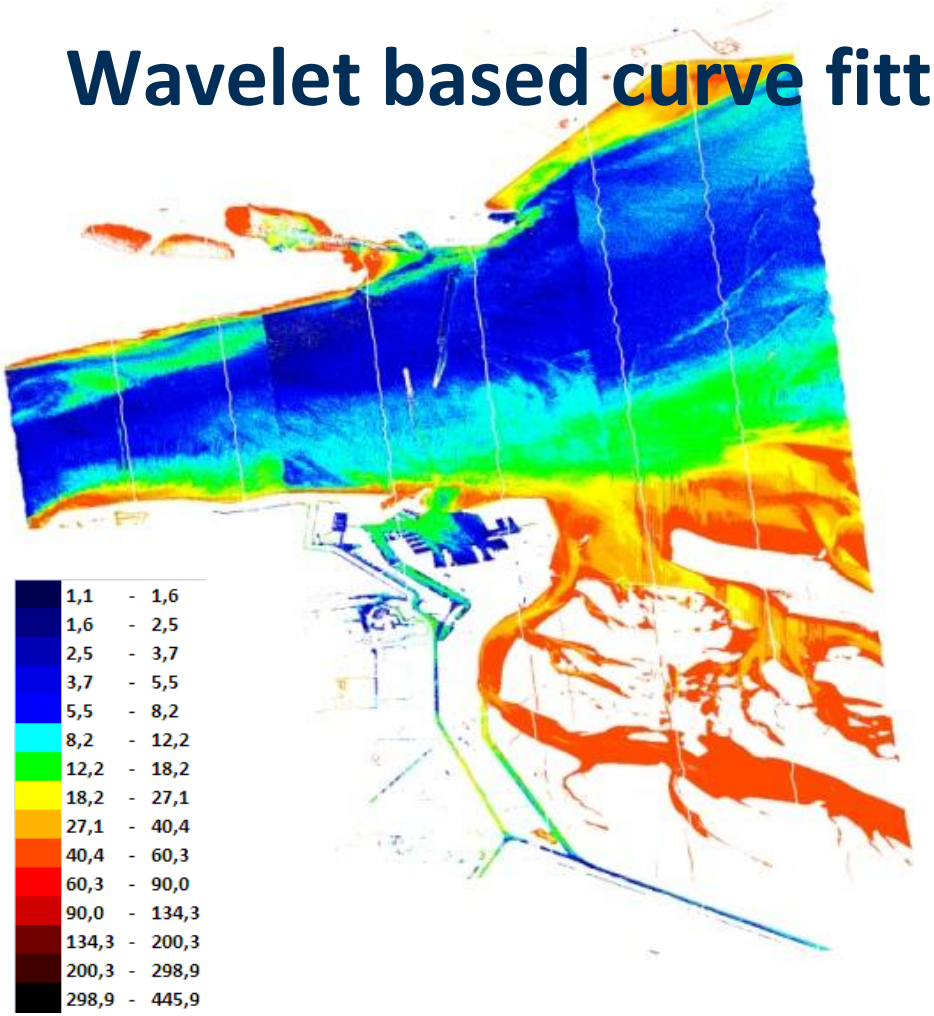
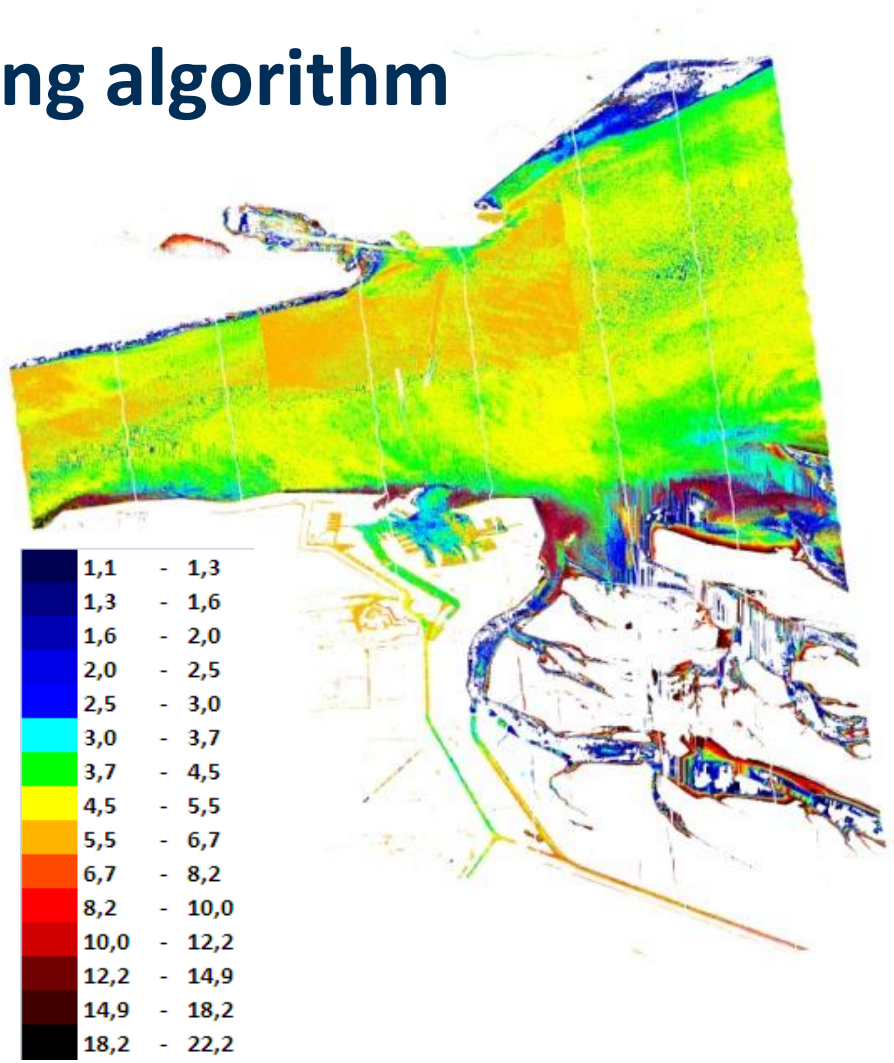


TSM concentrations in the Wadden Sea (in mg L^{-1}), mosaic of flight line 1, 2 and 3



CHL concentrations in the Wadden Sea (in µg L^{-1}), mosaic of flight line 1, 2 and 3

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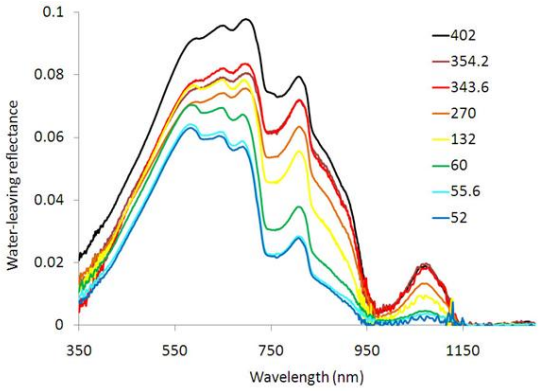
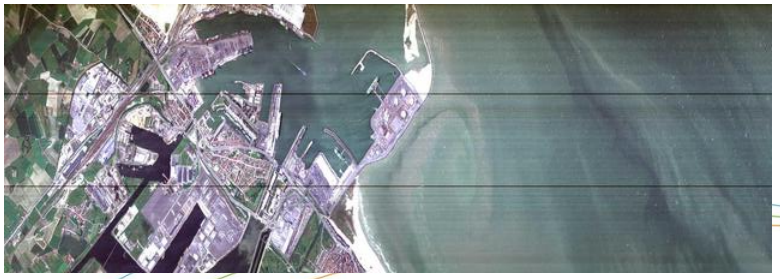
RMSE of 2.9 µg L^{-1} or 32% for the CHL concentration and 2.7 mg L^{-1} or 36% for the TSM concentration.

Life after MICAS?

- Looking at the SWIR part of the spectrum (SEASWIR - BELSPO)
- BELAIR Validation site in Zeebrugge (BELAIR – BELSPO)
- Water quality mapping from a UAV (Chameleon – IWT)
- WAVESIM – wavelet enhanced semi-analytical inversion model (PHD Eva Ampe)
- Remote sensing and in-situ data fusion for water applications (Phd Sivee Chawla)
- Processing of new satellite imagery –sentinel 2 (HIROC - FP7)
- Improvement of algorithm for new sensors (INFORM –FP7





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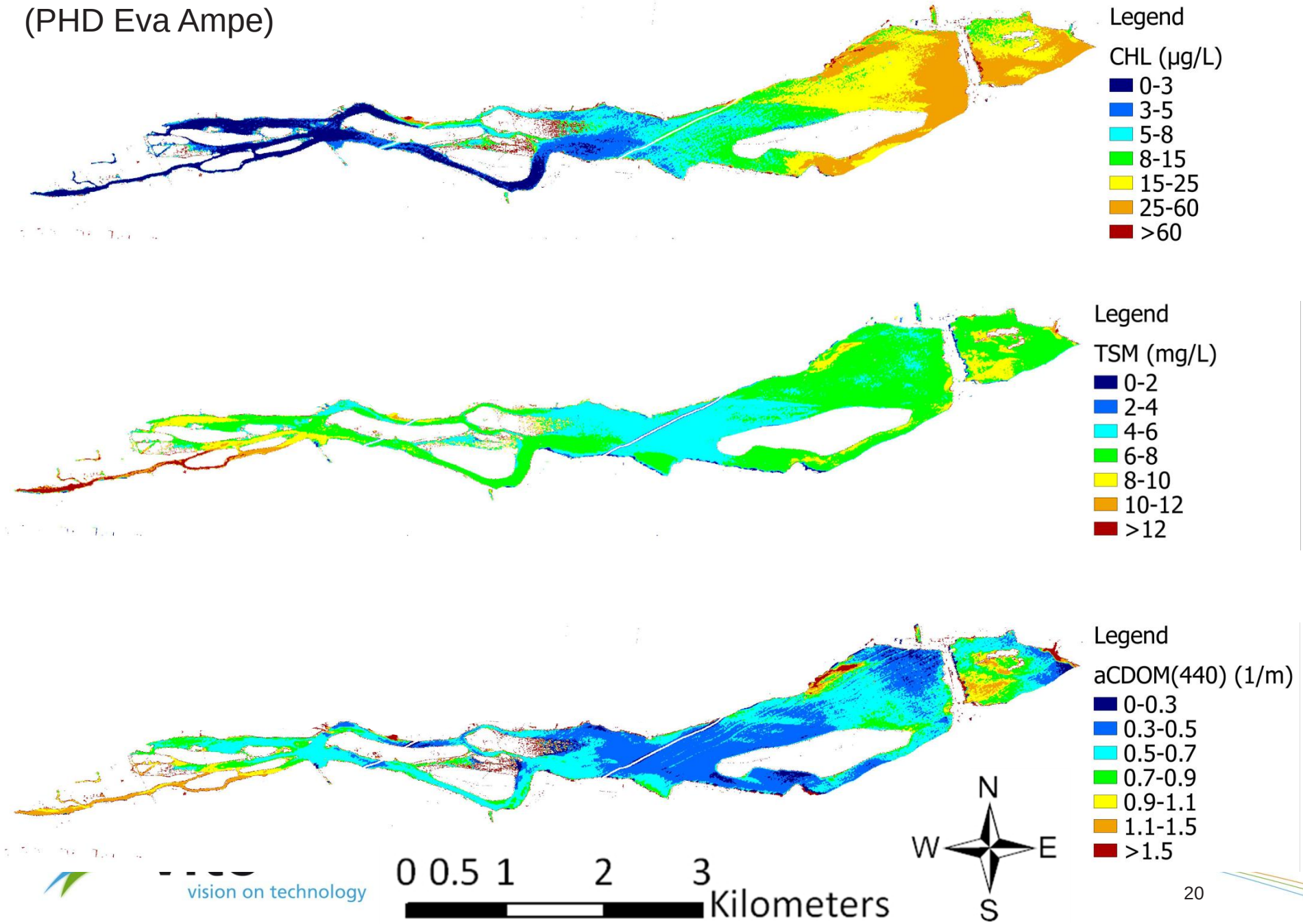
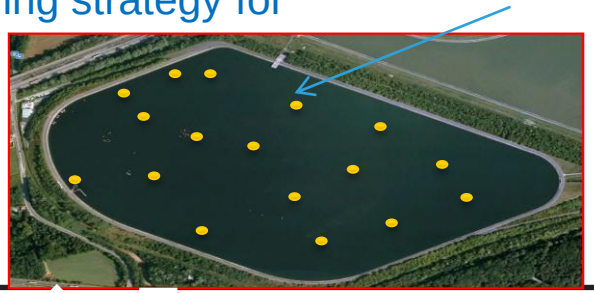


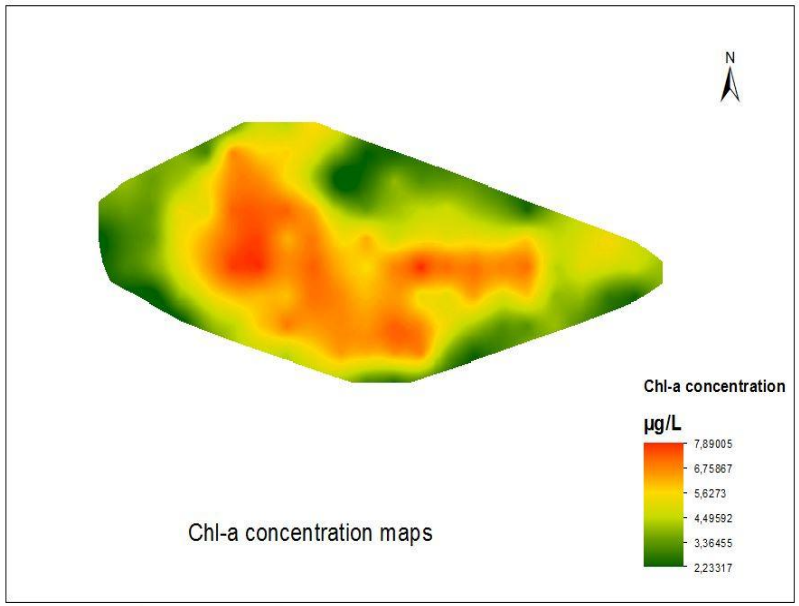
Remote sensing and in-situ data fusion for water applications (Phd Sivee Chawla)

Better calibration of RS data to develop Chl-a/ SPM concentration maps. Which needs in situ data having better spatial coverage (covering the entire range) .

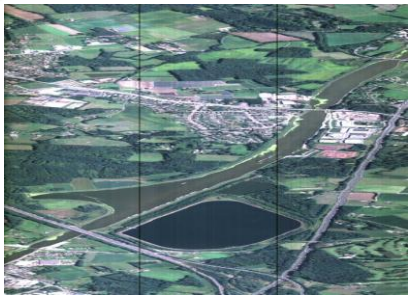
Define a sampling strategy for collecting in situ data.



Resultant Chl-a concentration map



Remote Sensing data as *priori information*



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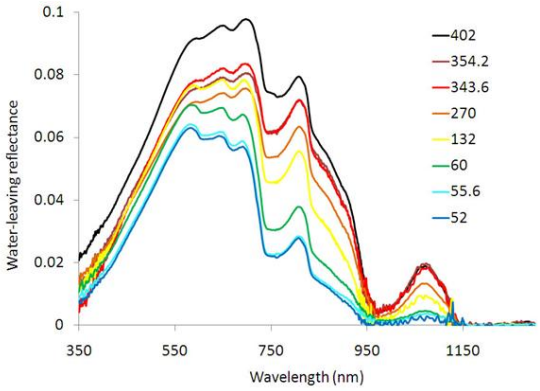


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