Remote sensing of cyanobacterial blooms in a hypertrophic lagoon using multitemporal Sentinel-2 images

Objectives of the study

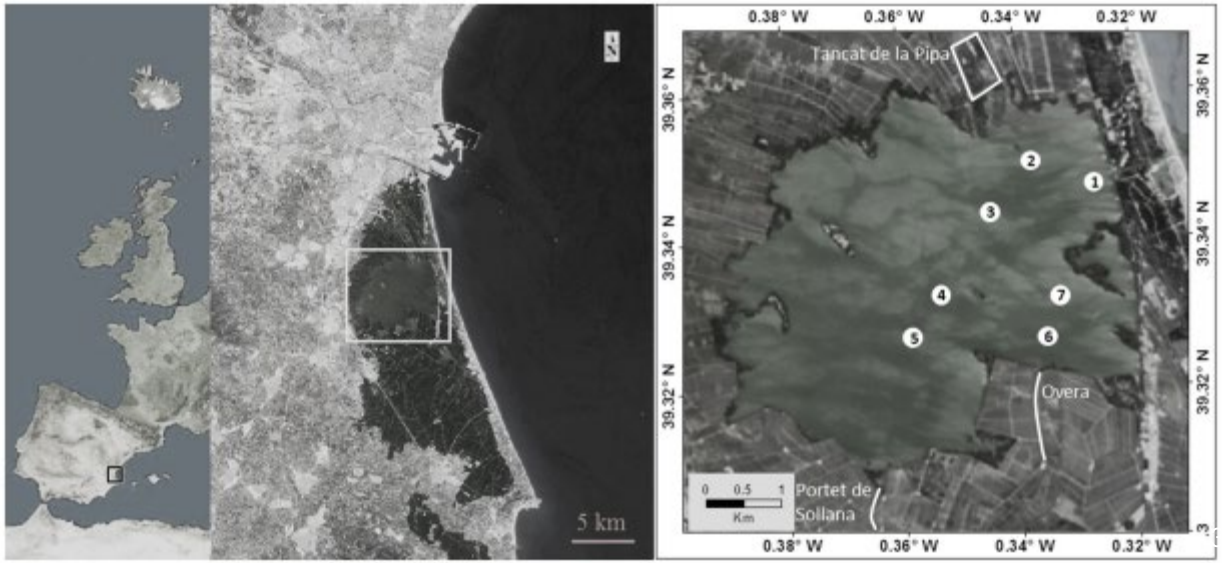
- Develop a method or an algorithm well calibrated to estimate cyanobacteria density variation and spatial.
- Evaluate the performance of the algorithm (accuracy) with observed data (validation).
- Verify the correspondence between cyanobacteria density and World Health Organisation policies.
- Establish a protocol for regular and frequent monitoring and understand the link between cyanobacteria (phycocyanin) growth and climate change, precipitation, human influence etc.

- Data collected from seven different places within the lagoon (picture below).
- Site on interest: Albufera lake in Valencia (Spain).

Retrieval algorithm: a satellite reflectance algorithm for estimating cyanobacterial total biovolume.

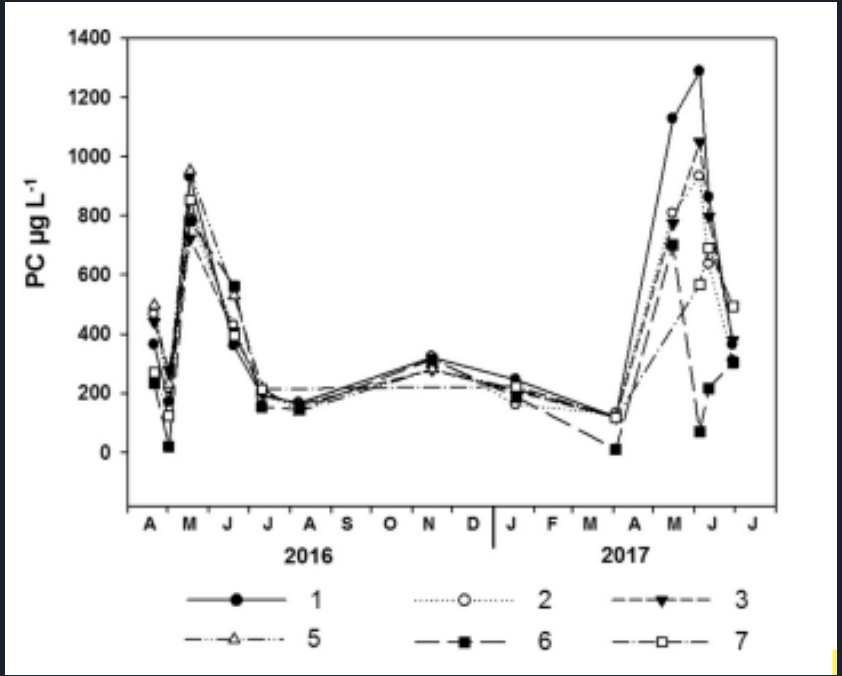
Datasets:
76 georeferenced samples were collected at 0.2 m depth.

Training or calibrating set : 21
Validating : 55



Observed data

retrace the evolution of the phycocyanin density in the period of 2 years for each region of the 7.



Temporal variations of the measured data in the campaigns for each sample point

PC: phycocyanin density

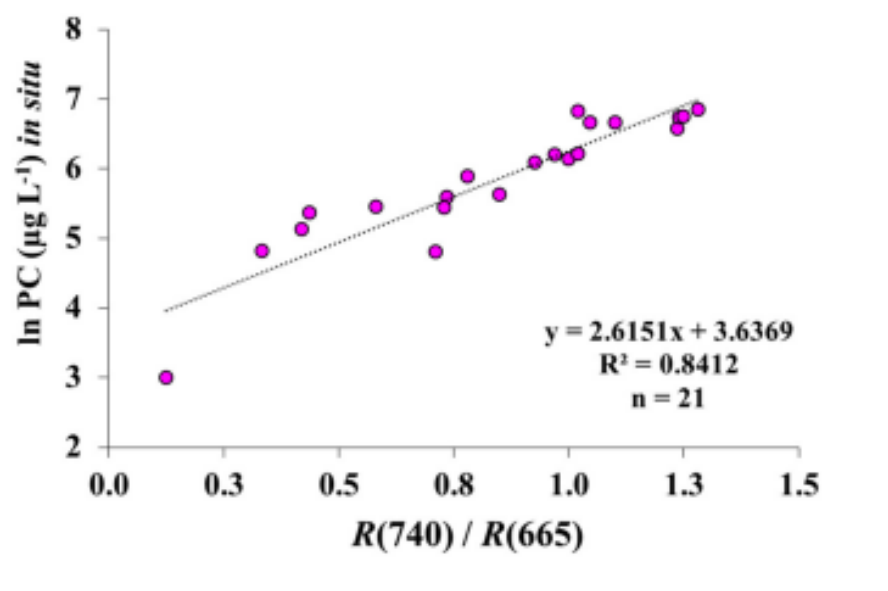
minimums and maximums due to flooding rate and precipitation

Fitting the model

Exponential regression

$$[PC]\left(\mu g\ L^{-1}\right) = e^{2.6151\ R740/R665-3.6369}$$

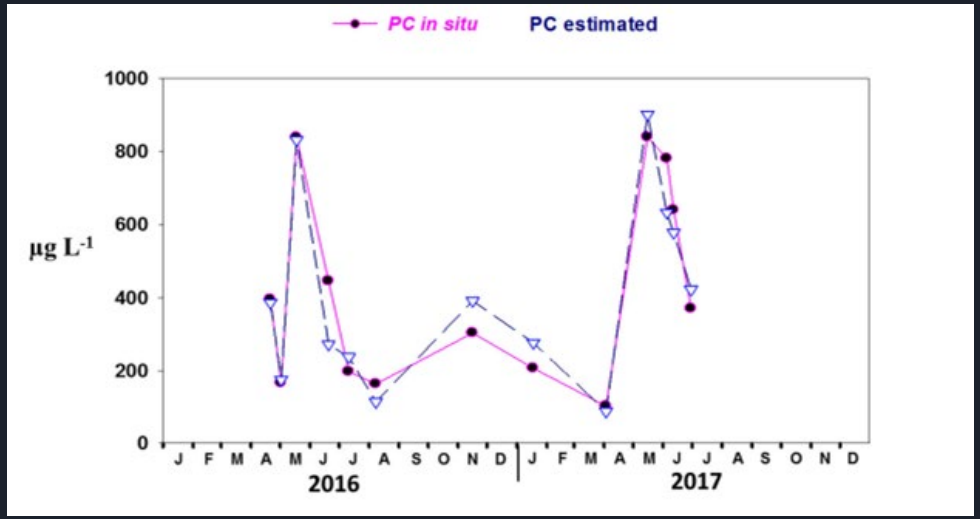
InPC : logarithm of phycocyanin density.
R740 (R665): Absorbance of the wave length 740 nm (respectively 665 nm).



RMSE=40%
R^2=0.775

Retrieval algorithm:deriving a regression model for operations with bands.
Absorption of phycocyanin is centred at 620 nm, while the absorption on the 709 and 779 nm bands is assumed to be dominated by water alone.

After calibrating and validating

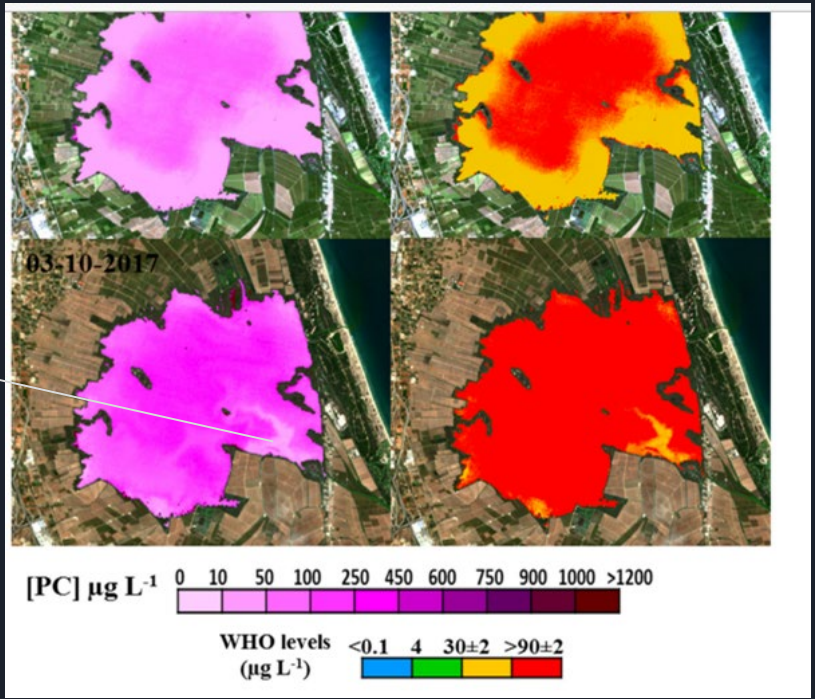


- For each day, for the observed data, we calculate the mean of algal concentration over all regions.
- PC in situ : observed data for algal density.
- PC estimated : predicted data after calibration.

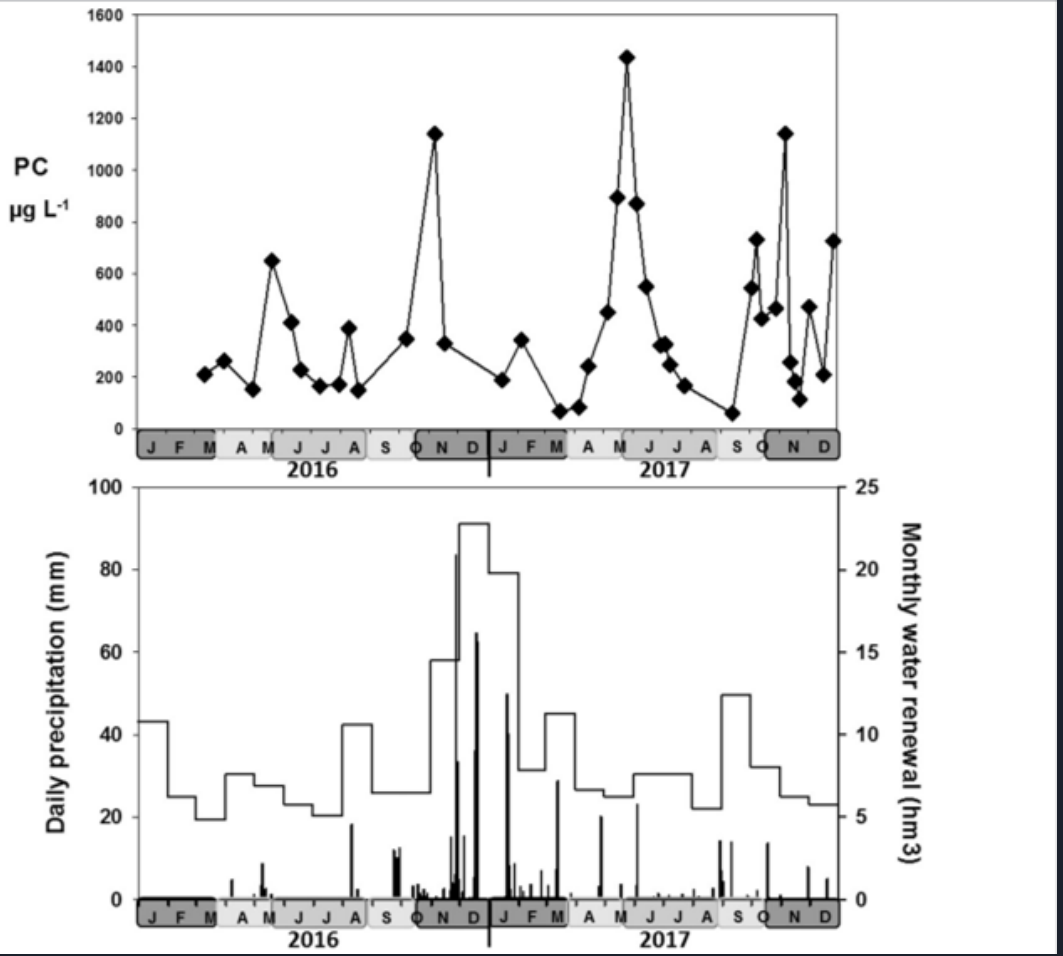
Applications of this study

Understand the correlation between Phycocyanin concentration and natural phenomenon: precipitation, climate change, human action

canal for water renewal



Follow in real time algal density variations and assess them under WHO policies.



Link between water floodings (rice paddies), precipitations, water renewal and Phycocyanin concentration variations.

WHO (World Health Organisation) surveillance limits

Drinking waters	Bathing waters	Density (cel. ml^{-1})	Biovolume ($mm^3\ L^{-1}$)	Chlorophyll *a* ($\mu g\ L^{-1}$)	Phycocyanin ($\mu g\ L^{-1}$)
Vigilance level		200	0.02	0,1	<0.1
Alert level I		2.000	0.2	1,0	4
	Guidance level 1	20.000	2	10	30 ± 2
Alert level II	Guidance level 2	100.000	10	50	90 ± 2

Guidance level 1: low probability of adverse health effects.
Guidance level 2: moderate probability of adverse health effects.

- High algal density (phycocyanin) may cause health problems and affect aquatic life.
- The developed algorithm permits a real-time monitoring in order to predict if phycocyanin concentration would reach alert levels.

Feedback for our case

- Follow the same methodology in our study : analyse observed data, establish a correlation between severity and other variables and test the correlation.
- Focus on absorbance wavelength as a key feature in severity classification (or wavelength bands).
- Not to ignore density : density variation rhythm between two dates may vary between two types of Algal blooms having different severity.

  => severity may be a function of the derivative of density. (Problem : severity is not a continuous function (only 5 different values ranging from 1 to 5).