

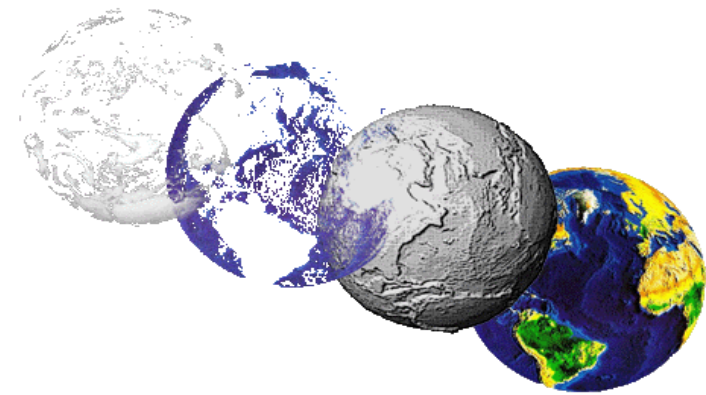
# METODOLOGIE E APPROCCI PER OSSERVAZIONI IPERSPETTRALI IN ACQUE COSTIERE E INTERNE

Federica Braga

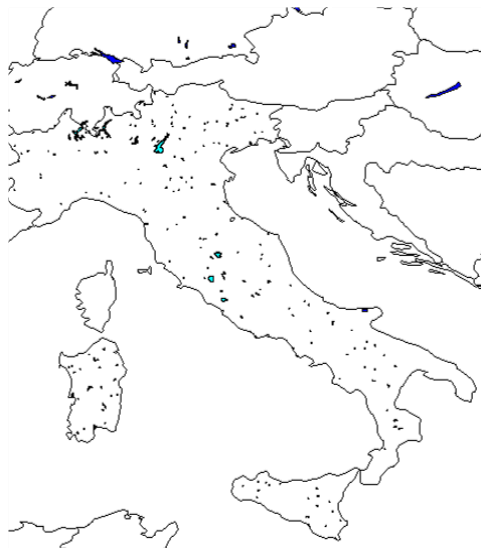
In collaboration with Claudia Giardino, Mariano Bresciani (IREA-CNR)  
and Vittorio E. Brando (ISAC-CNR)



# Coastal and inland waters: physical and ecological complex systems



- *Water Framework Directive*
- *Integrated Coastal Zone Management*
- *Bathing Water Directive*
- *Marine Strategy Framework Directive*
- *Maritime Spatial Planning*



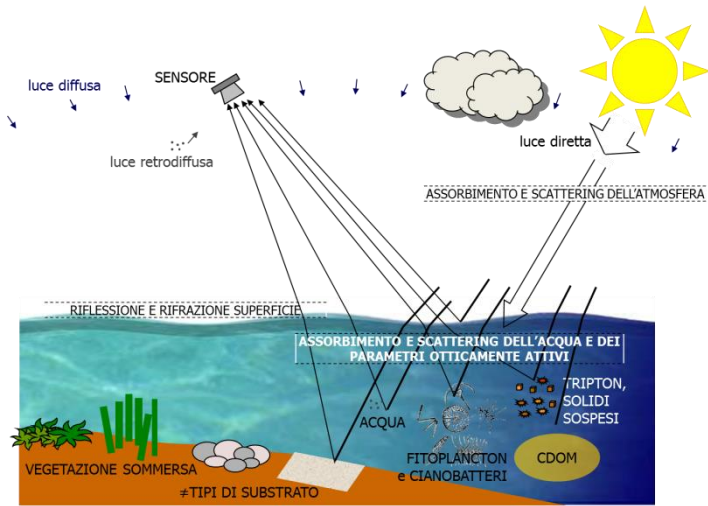
~ 457 lakes



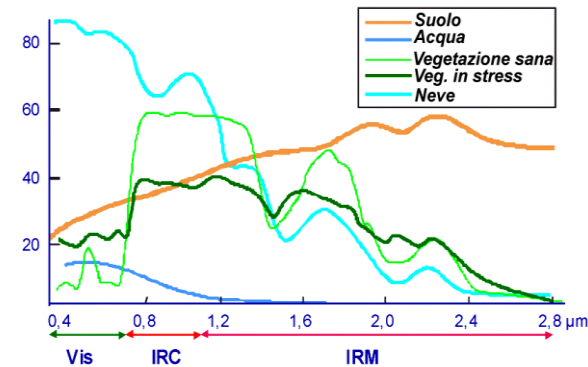
7.750 km of  
coastline



# Coastal and inland waters: optical complexity



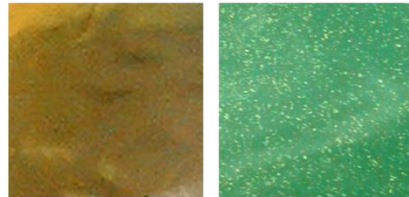
Pure water reflects a max of 5% of incident light, i.e. the radiant flux in water is subject to transmission, absorption and scattering processes, which strongly reduce the upwelling energy.



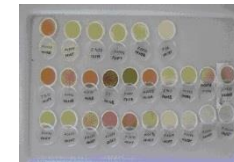
**Sun-target-sensor viewing geometry**



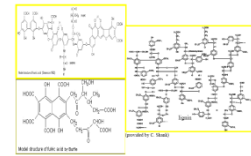
**Suspended and dissolved matter**



Phytoplankton

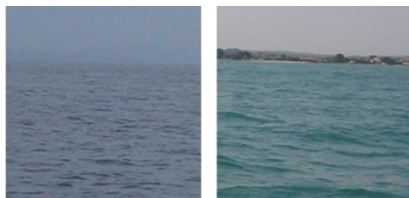


TSM

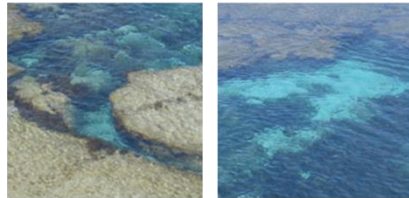


CDOM

**Atmospheric conditions**



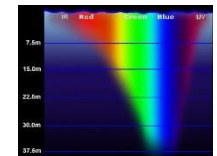
**Seafloor characteristics**



Bare soil



Submerged vegetation



Water depth

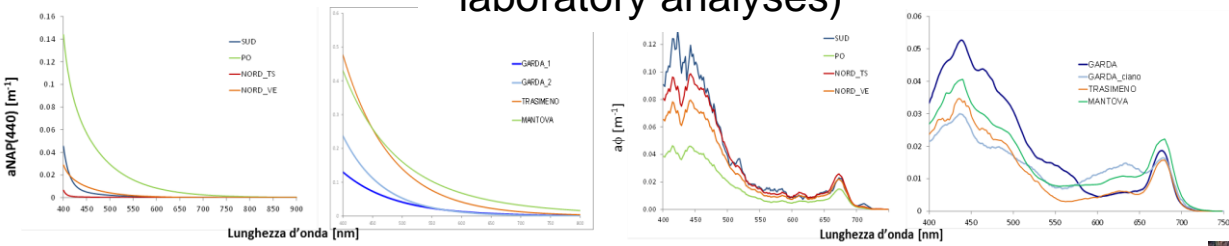


# Coastal and inland waters: Hyperspectral data

APEX

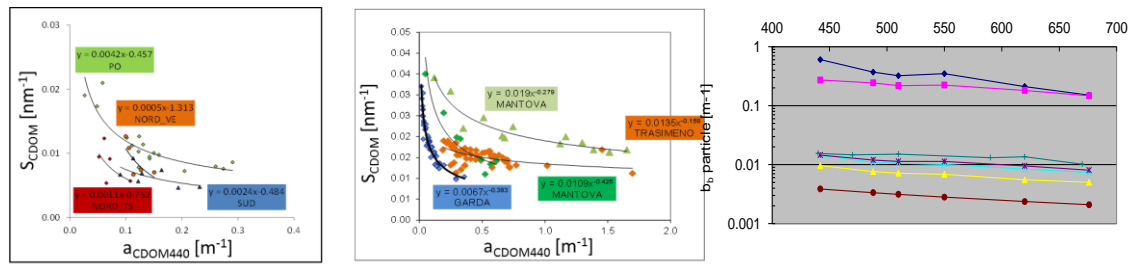
Airborne and satellite Images

IOP (in situ and laboratory analyses)

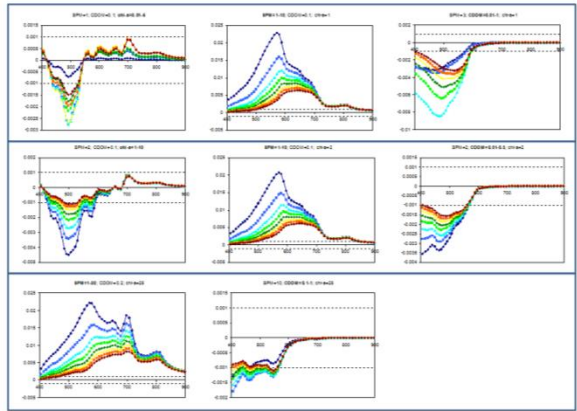
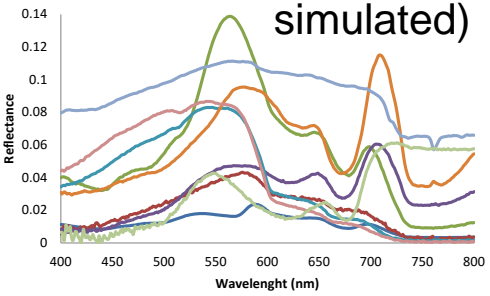


MIVIS

PROBA



AOP (in situ and simulated)



HICO

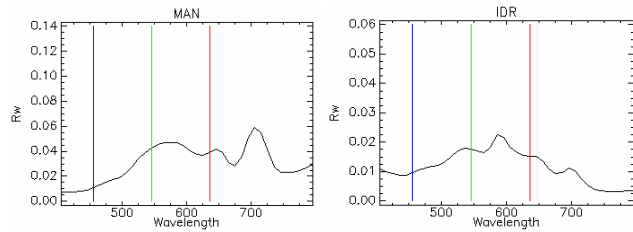
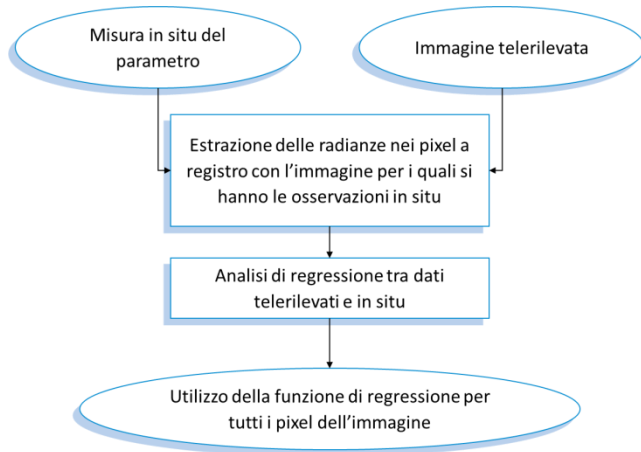


HYPERION

# Coastal and inland waters: approaches and methodologies

## Semi-empirical algorithms

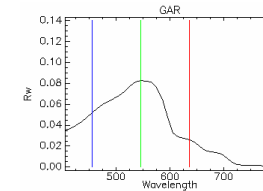
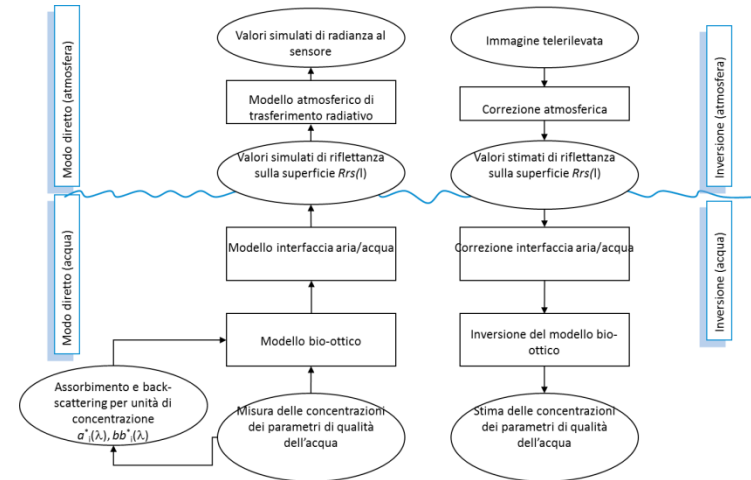
Based on statistical correlation between spectral bands and biogeophysical parameters (radiometric index)



*High contribution of the main optically active substance, which causes specific features*

## Physical based models

Spectral inversion procedures of bio-optical model which relate optical properties and Reflectance

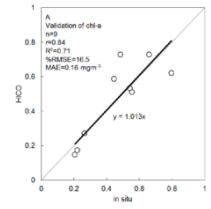
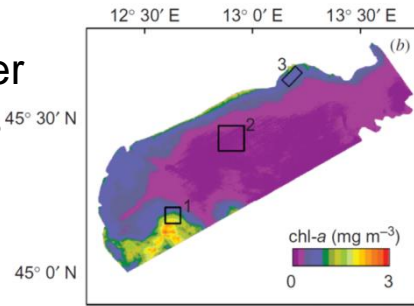
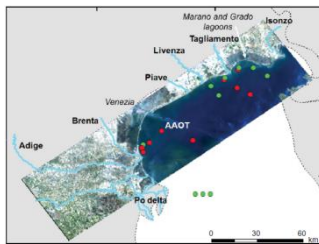


*When optically active substances are mixed, the reflectance signal should be deconvolved, through bio-optical models, to simultaneously estimate concentrations of water constituents*

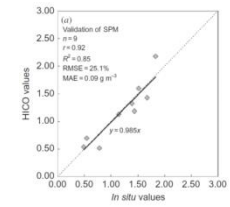
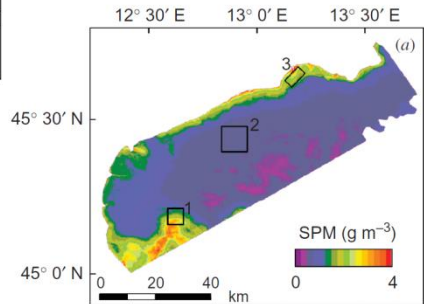
# Coastal and inland waters: products and applications

## Hydrology, Coastal dynamics and processes Northern Adriatic Sea - HICO

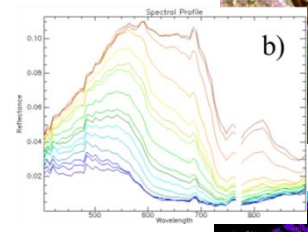
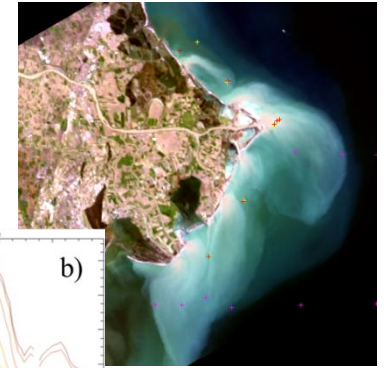
### Assessment of water quality parameters



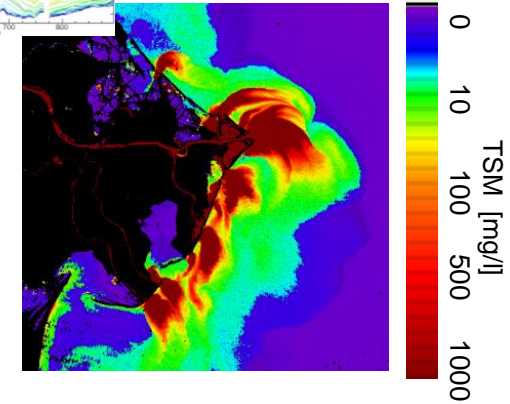
### Analysis of lagoon-sea exchange



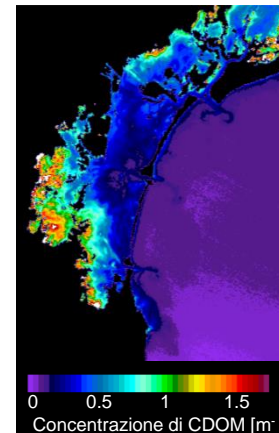
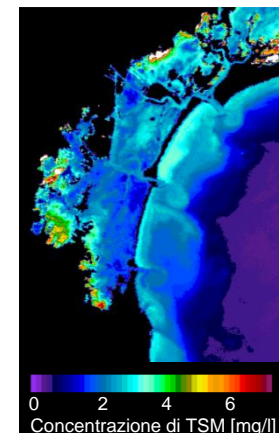
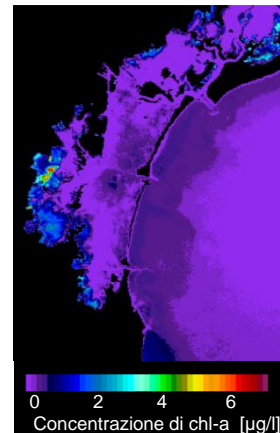
### Monitoring of river plumes



### Bio-optical model



### Semi-empirical Algorithm

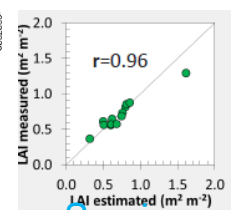
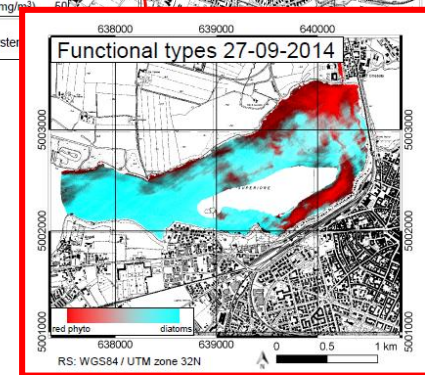
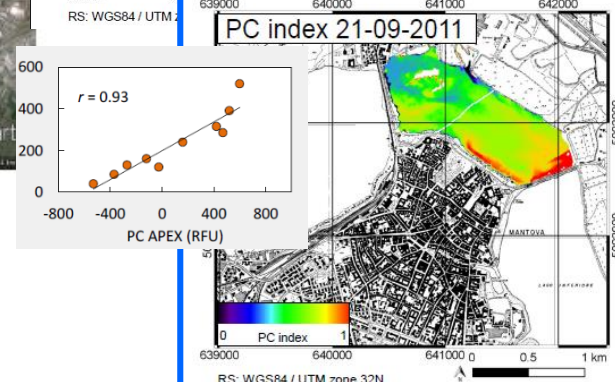
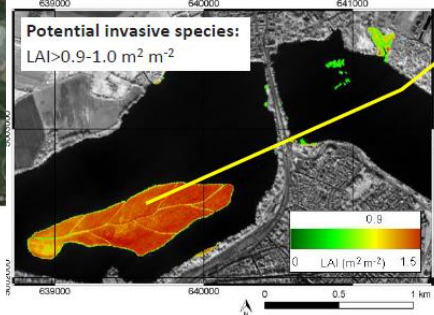
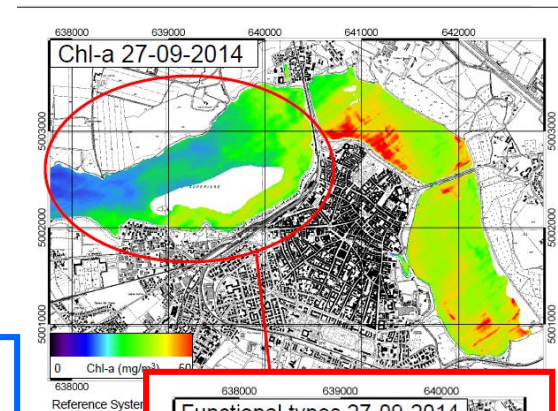
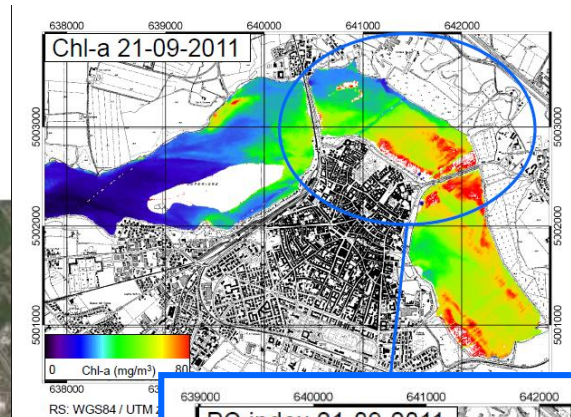
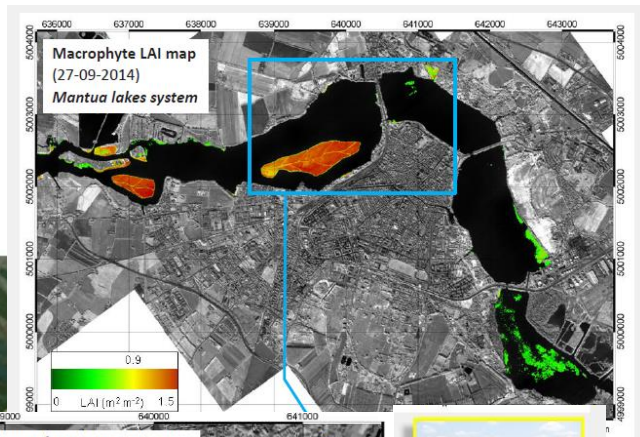
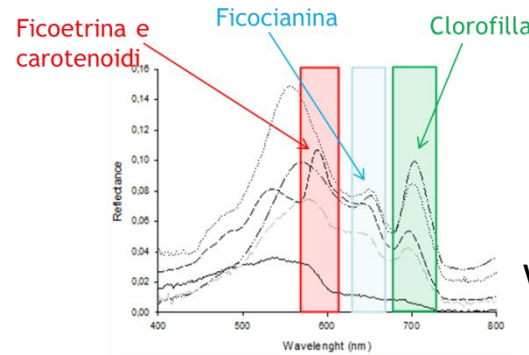




# Coastal and inland waters: products and applications

## Management of aquatic ecosystems Mantua Lakes - APEX

To differentiate phytoplankton functional types, algal pigments are detected based on radiometric indexes involving those wavelengths sensitive to pigments variations.



Biophysical parameters of emerging vegetation  
LAI

Semi-empirical Algorithm + Bio-optical model

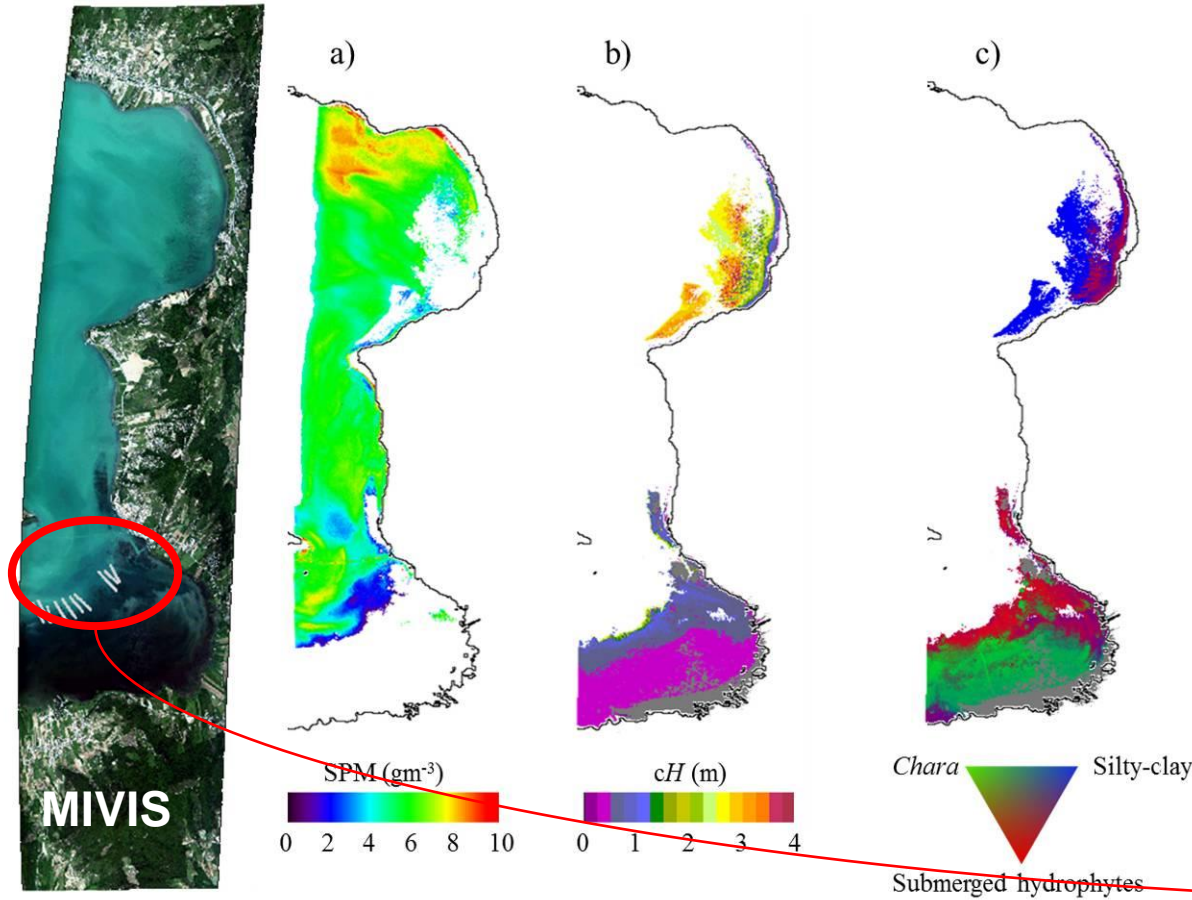
PC Index

Phytoplankton functional types

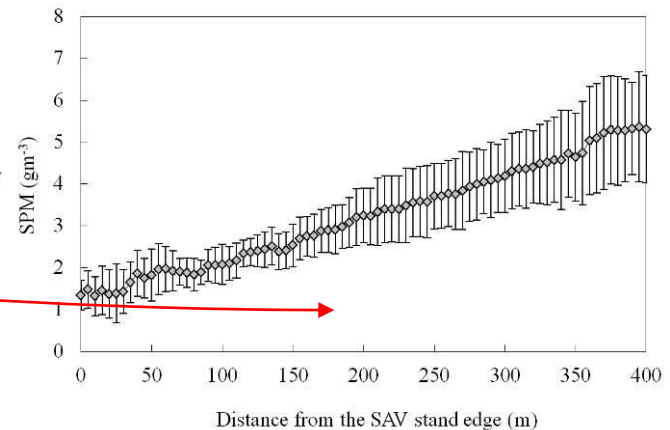
# Coastal and inland waters: products and applications

## Management of aquatic ecosystems Trasimeno Lake - MIVIS

Bio-optical model



The colonisation patterns of submerged vegetation reflect the spatial distribution of SPM concentrations, in particular, SPM conc is lower near submerged vegetation.



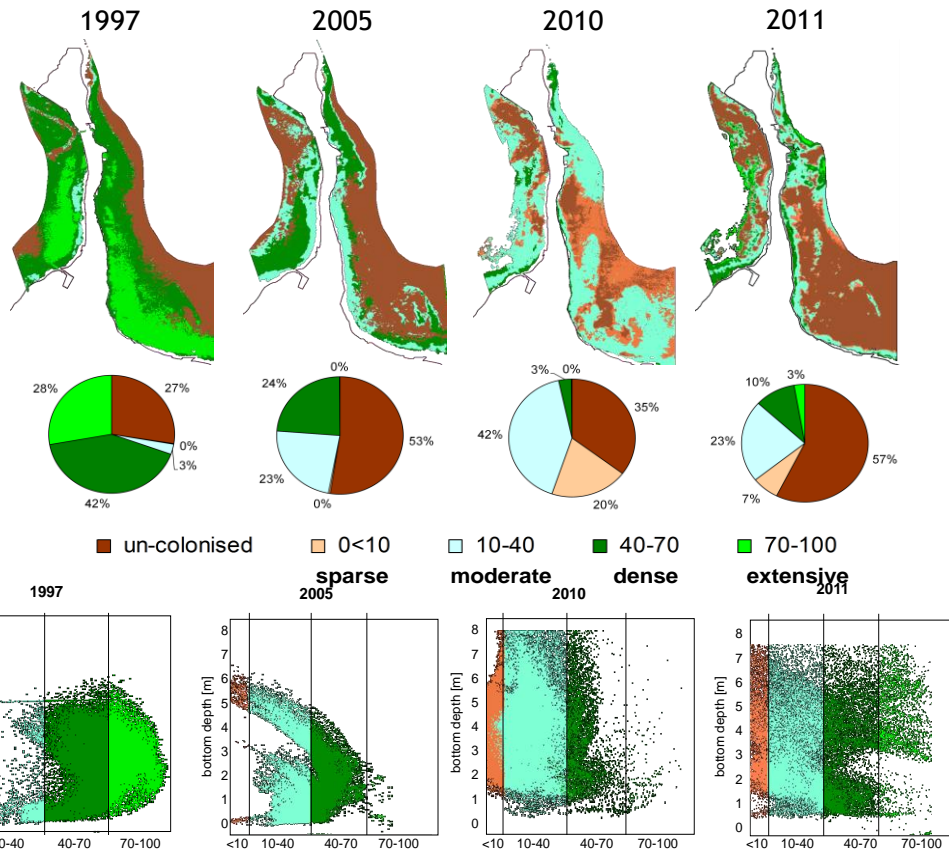
**Interaction between total suspended sediments and macrophytes**



# Coastal and inland waters: products and applications

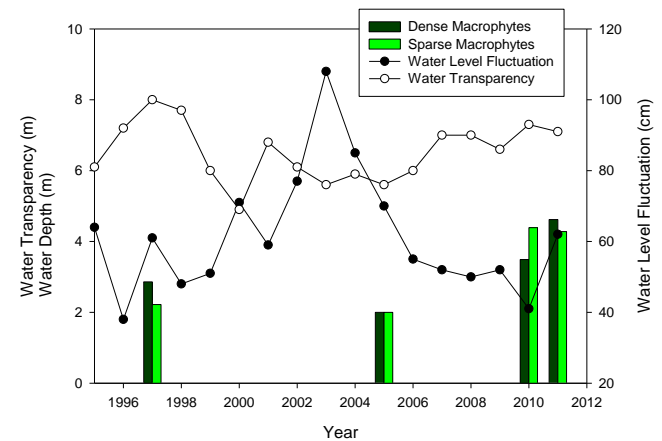
## Management of aquatic ecosystems Garda Lake - MIVIS

### Macrophytes coverage and water depth



Macrophyte distribution depends on water depth.

Correlation with water level and water clarity

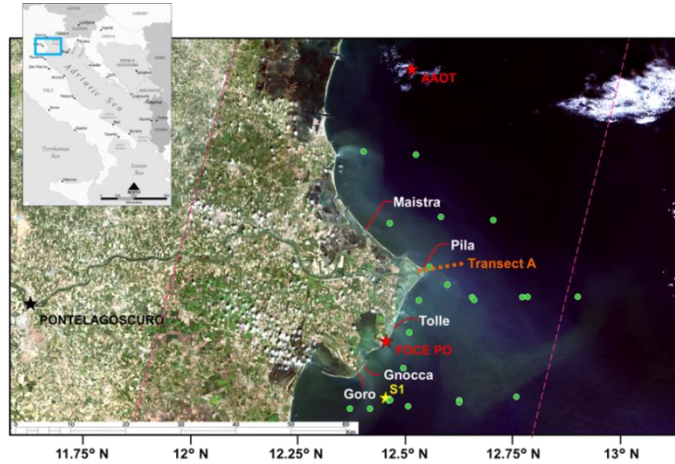


Bio-optical model

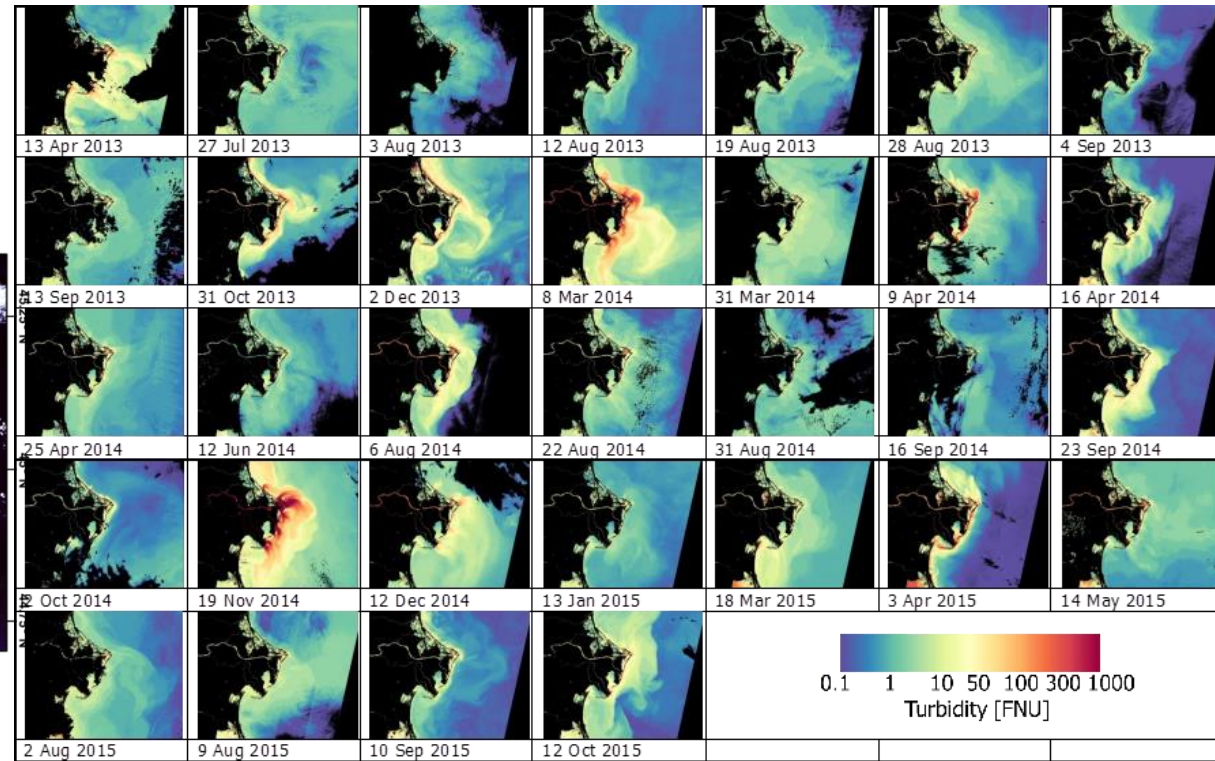
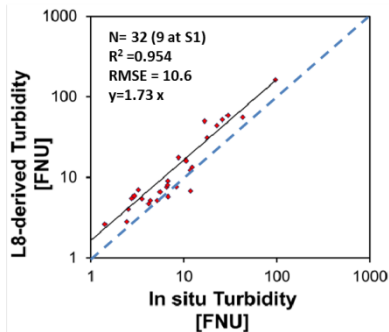
# Coastal and inland waters: products and applications

## Coastal processes and dynamics

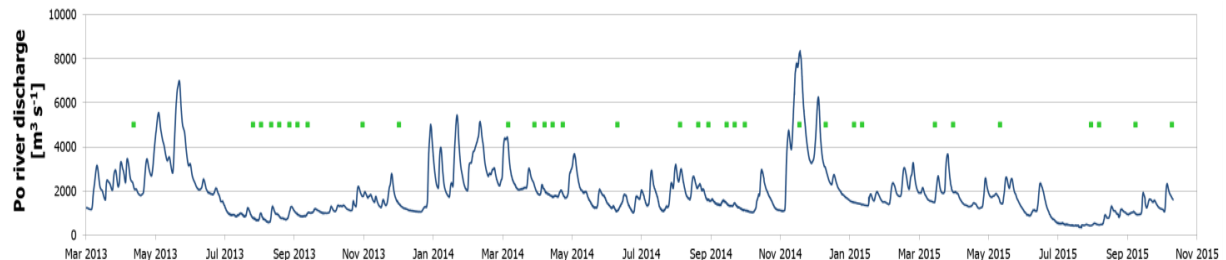
### River Po Delta – Landsat 8



### Semi-empirical Algorithm

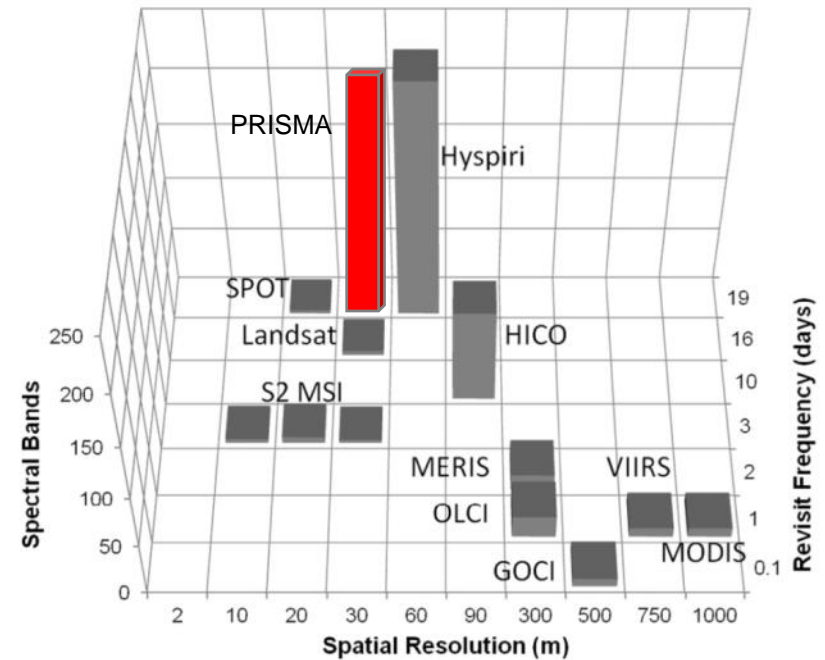
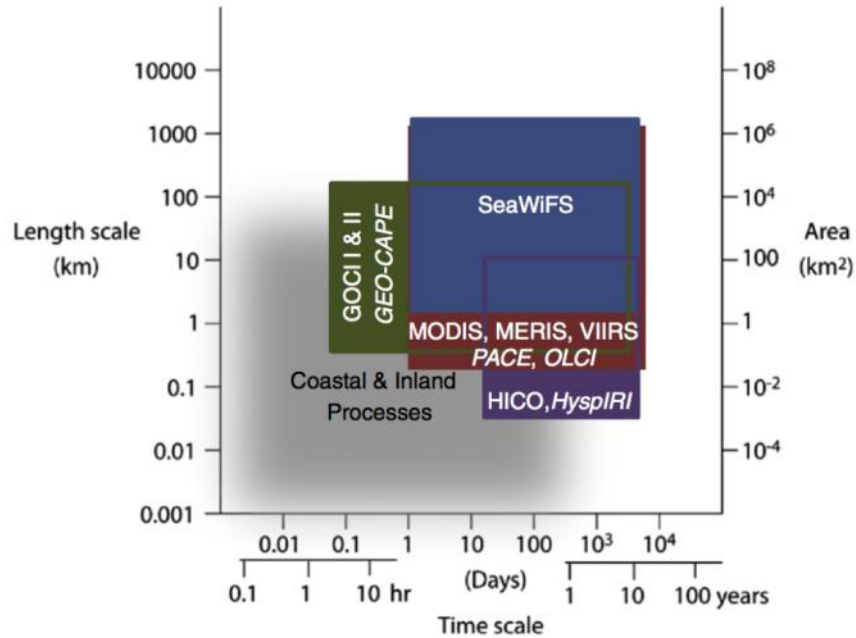


### Mapping turbidity patterns



Po River discharge. Green dots indicate Landsat 8 acquisitions.

# Conclusions



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**Remote Sensing of Environment**

journal homepage: [www.elsevier.com/locate/rse](http://www.elsevier.com/locate/rse)

Review

Aquatic color radiometry remote sensing of coastal and inland waters: Challenges and recommendations for future satellite missions



Colleen B. Mouw<sup>a,\*</sup>, Steven Greb<sup>b</sup>, Dirk Aurin<sup>c</sup>, Paul M. DiGiacomo<sup>d</sup>, Zhongping Lee<sup>e</sup>, Michael Twardowski<sup>f</sup>, Caren Binding<sup>g</sup>, Chuanmin Hu<sup>h</sup>, Ronghua Ma<sup>i</sup>, Timothy Moore<sup>j</sup>, Wesley Moses<sup>k</sup>, Susanne E. Craig<sup>l</sup>

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journal homepage: [www.elsevier.com/locate/rse](http://www.elsevier.com/locate/rse)

Measuring freshwater aquatic ecosystems: The need for a hyperspectral global mapping satellite mission

Erin Lee Hestir<sup>a,b,\*</sup>, Vittorio E. Brando<sup>a,c</sup>, Mariano Bresciani<sup>c</sup>, Claudia Giardino<sup>c</sup>, Erica Matta<sup>c</sup>, Paolo Villa<sup>c</sup>, Arnold G. Dekker<sup>a</sup>



**THANK YOU!**