

# ***On the use of satellite data to implement a pasimonious ecohydrological model in the upper Ewaso Ngiro river basin***

**G.Ruiz-Pérez<sup>1</sup>, F. Francés<sup>1</sup>, S.Manfreda<sup>2</sup> and K.Caylor<sup>3</sup>**

*(1): Research Institute of Water and Environmental Engineering. Universitat Politècnica de València. Spain.*

*(2): School of Engineering, University of Basilicata, Italy.*

*(3): Department of Civil and Environmental Engineering, Princeton University, USA.*



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- ❑ The vegetation plays a key role in a catchment's water balance particularly in semi-arid areas (Laio et al., 2001)

In some regions, the evapotranspiration may account for more than 90% of the precipitation → The proper knowledge of this process is vital (Andersen, 2008)

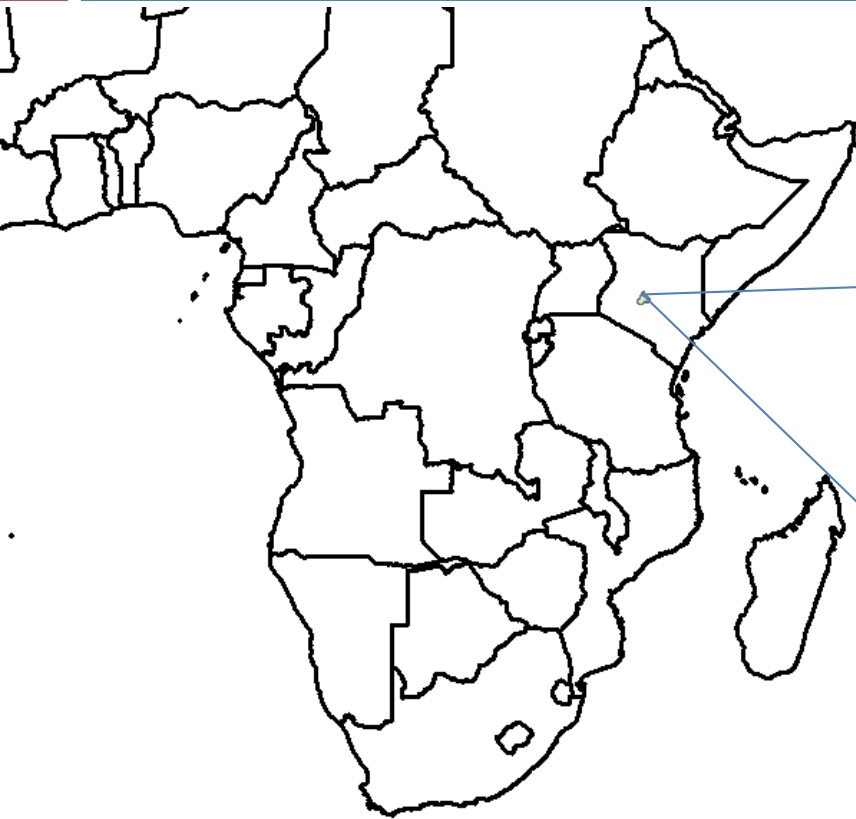
- ❑ Traditionally, very few hydrological models have incorporated the vegetation dynamics
- ❑ But, in the last decades, the number of hydrological models taking into account the vegetation development has increased substantially

Simple models + Remote Sensing data

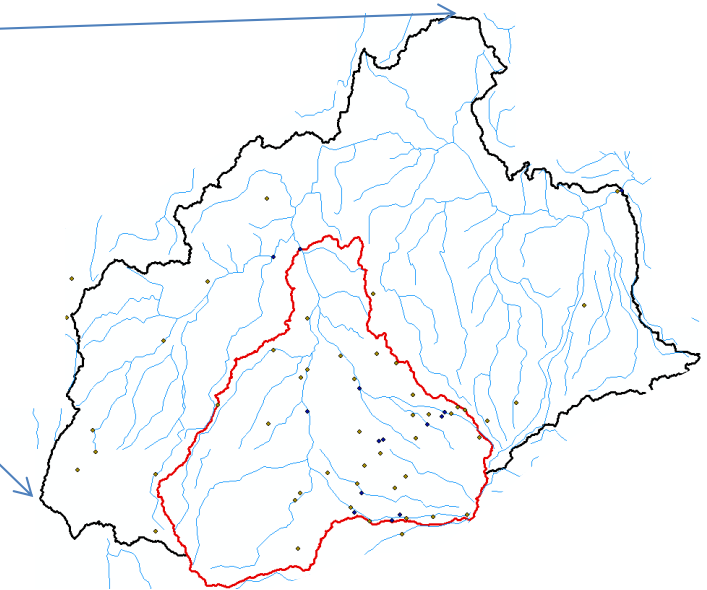
- Why satellite data?:
  - Available large historical data
  - Available even in inaccessible areas
  - A good alternative in ungauged basins

**SPATIO-TEMPORAL DATA**

# Study area and data



Area: 4605 km<sup>2</sup>  
Mostly water-controlled  
Sensitive to global change



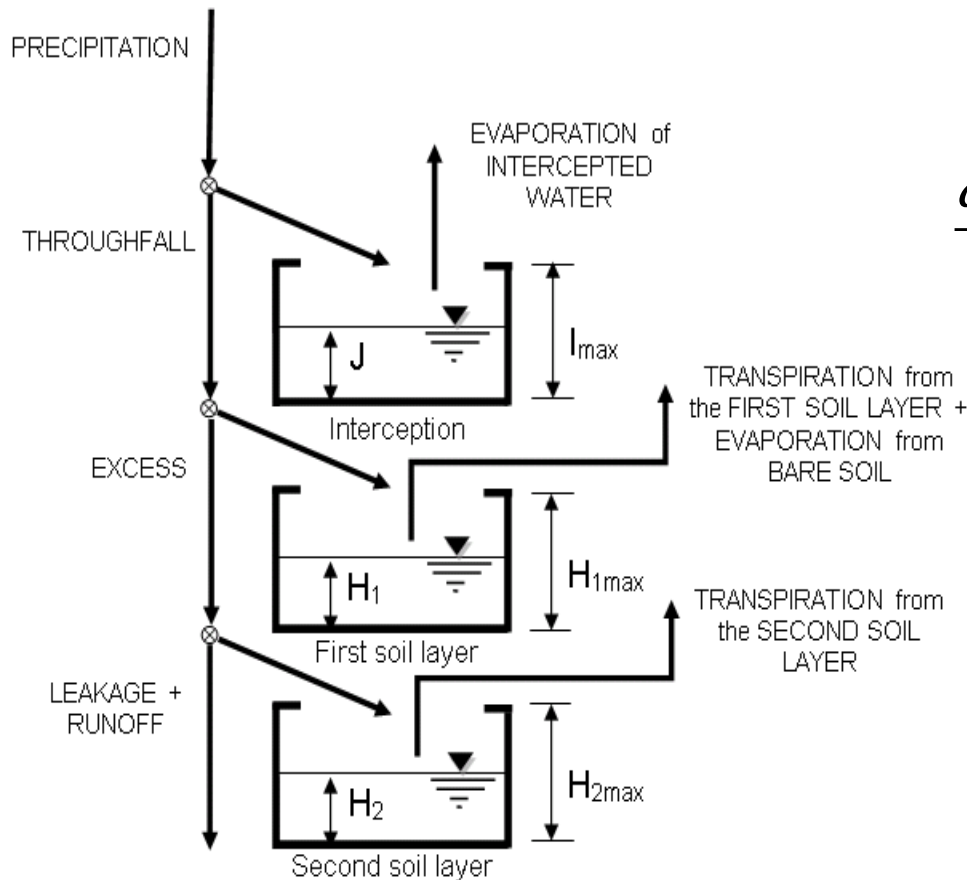
Rainfall: 1950-2003

Temperatures: 1950-Nowadays

Observed discharge: 1980-2002

NDVI: 2000-Nowadays (MODIS products)

# ECO-TETIS Model



$$T_1 = ET_o \cdot f_t \cdot \min(LAI, 1) \cdot \beta_t(H_1) \cdot r_1$$

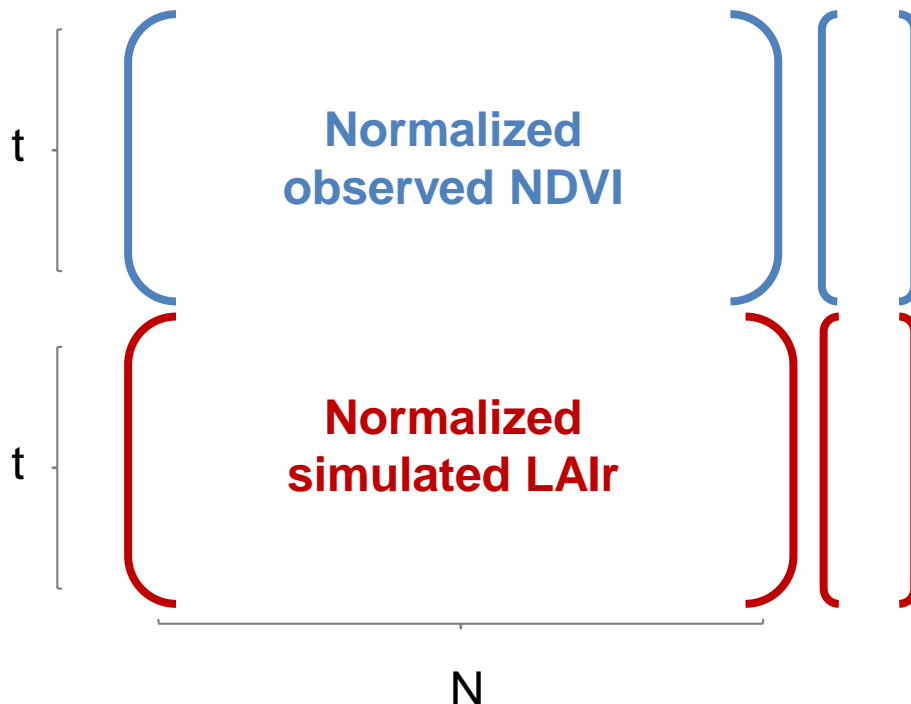
$$\frac{dB_l}{dt} = (LUE \cdot \varepsilon \cdot APAR - Re) \cdot \varphi_l - \kappa_l \cdot B_l$$

$$LAI = B \cdot SLA \cdot f_t$$

$\varepsilon$  depends on:

- Water Stress => connection with hydrological model
- Temperature

- ❑ Automatic calibration using SVD techniques
- ❑ Minimize the difference between the loadings of the observed maps and the simulated maps
- ❑ Always according to the explained variance



STEP 1: Concatenate observed and simulated matrices

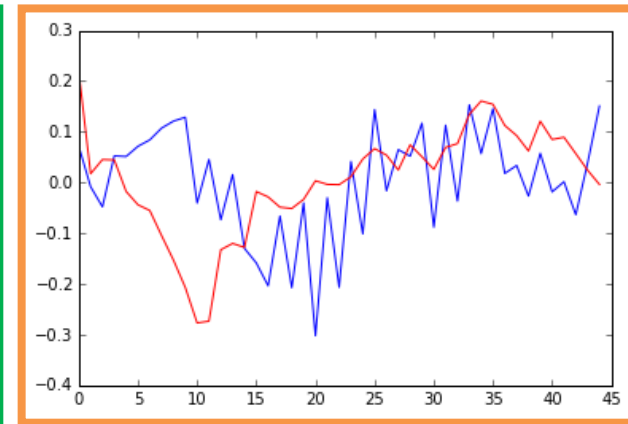
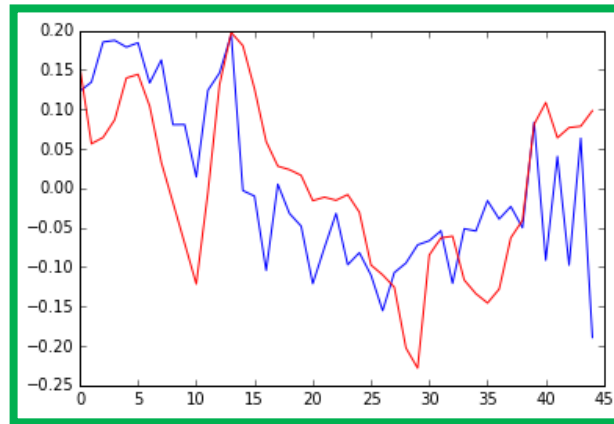
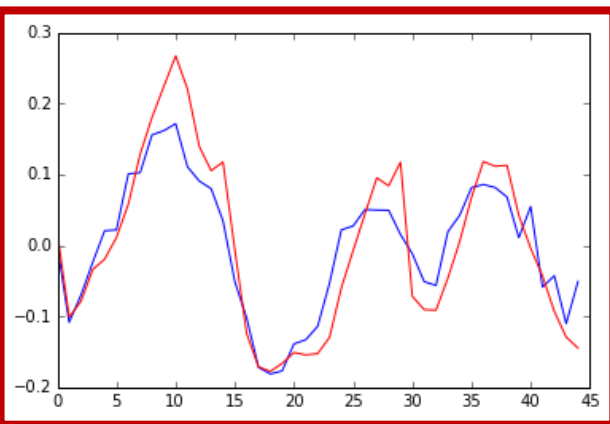
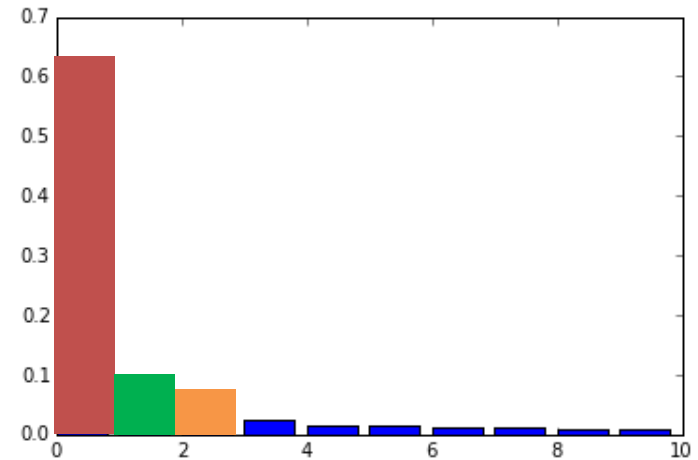
Addition of a column which takes into account the spatial gradient

STEP 2: Minimizing loadings differences according to the explained variance

## □ Results:

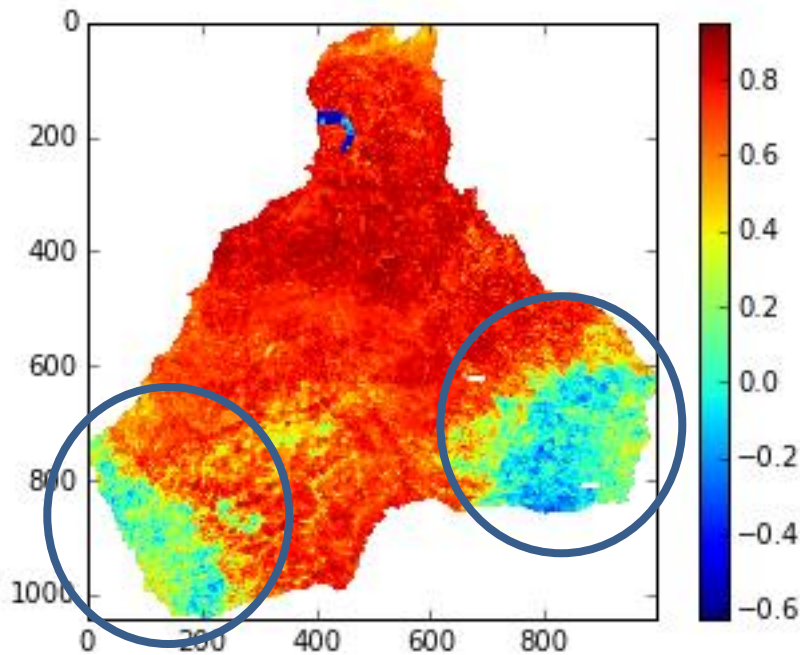
- Python package
- Objective function:

$$Error = \sum_{i=1}^n |w_i * (load_i^{SIM} - load_i^{OBS})|$$

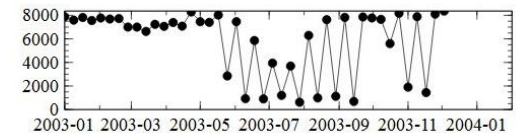
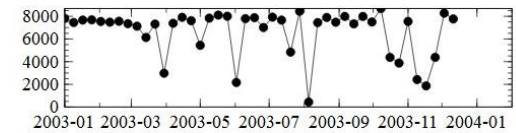
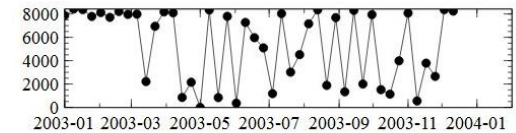


# ECO-TETIS calibration

- Results → Temporal correlation in each pixel



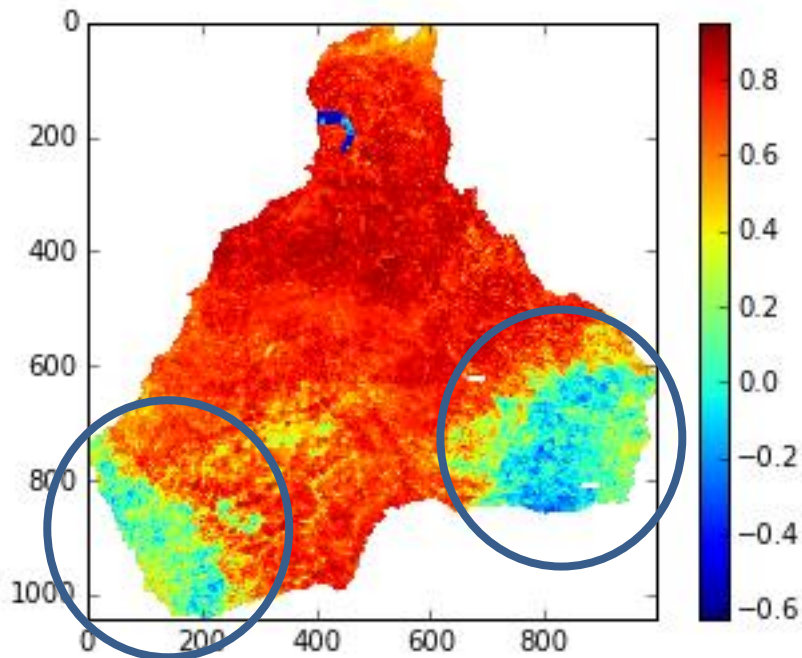
Realistic  
observed NDVI?  
Oscillations  
between 0.8 to  
0.2 (even 0.0) just  
in a week



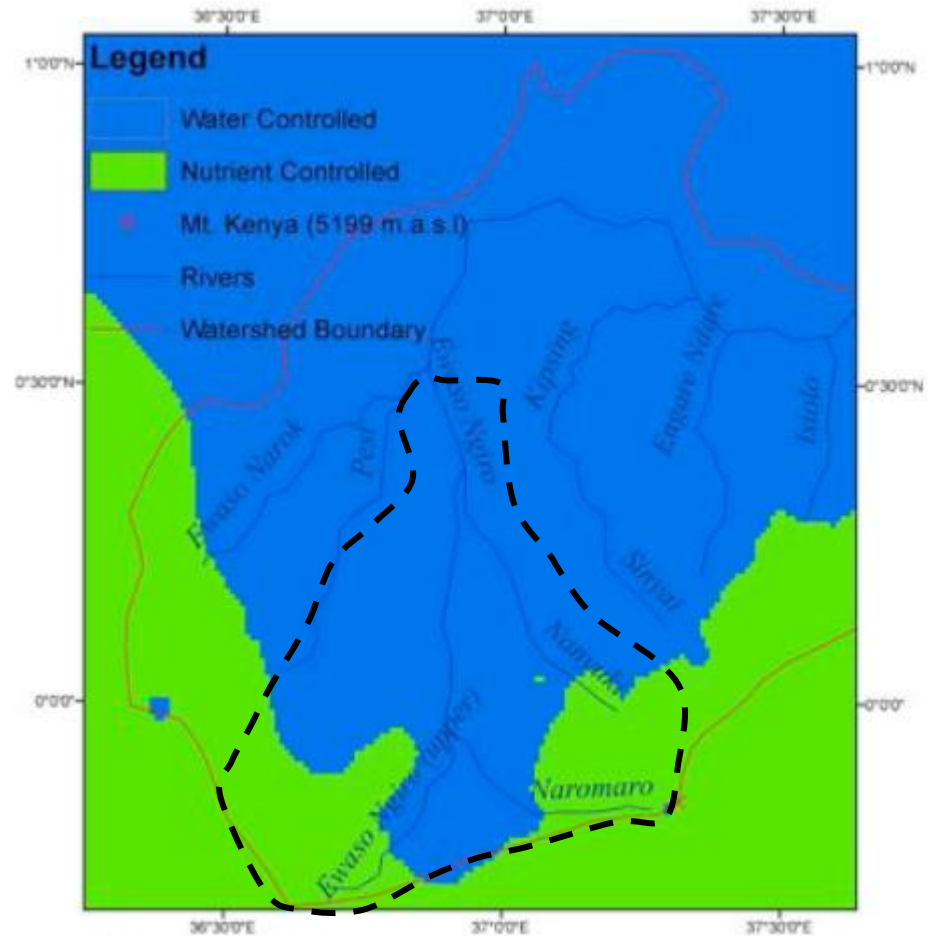


# ECO-TETIS calibration

## □ Why?

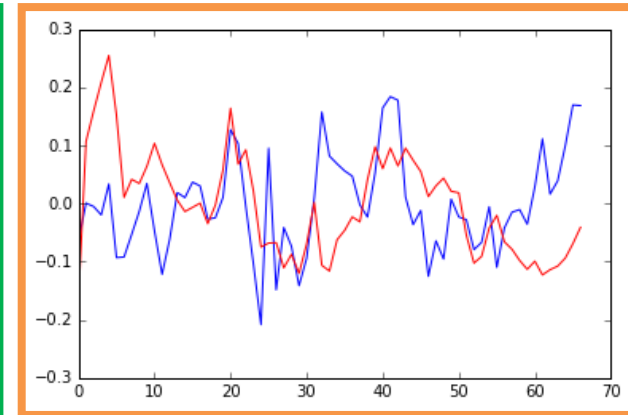
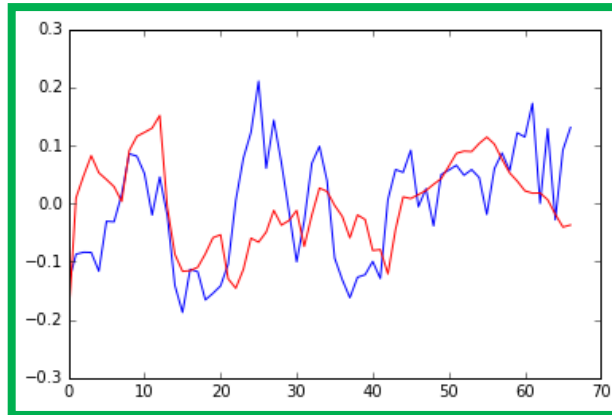
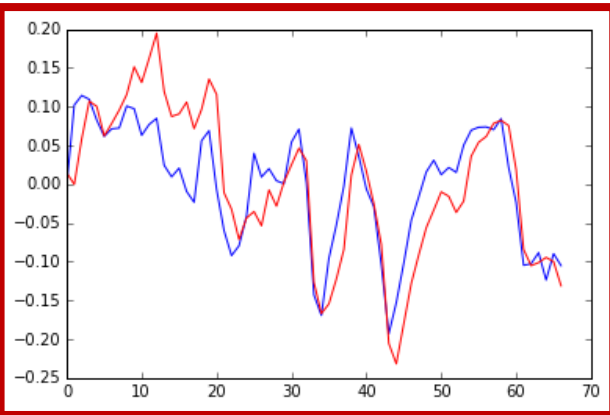
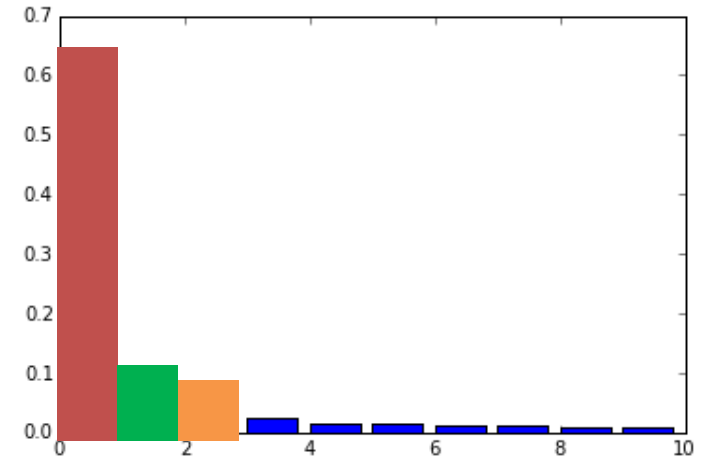


According to a previous work → No water-controlled areas



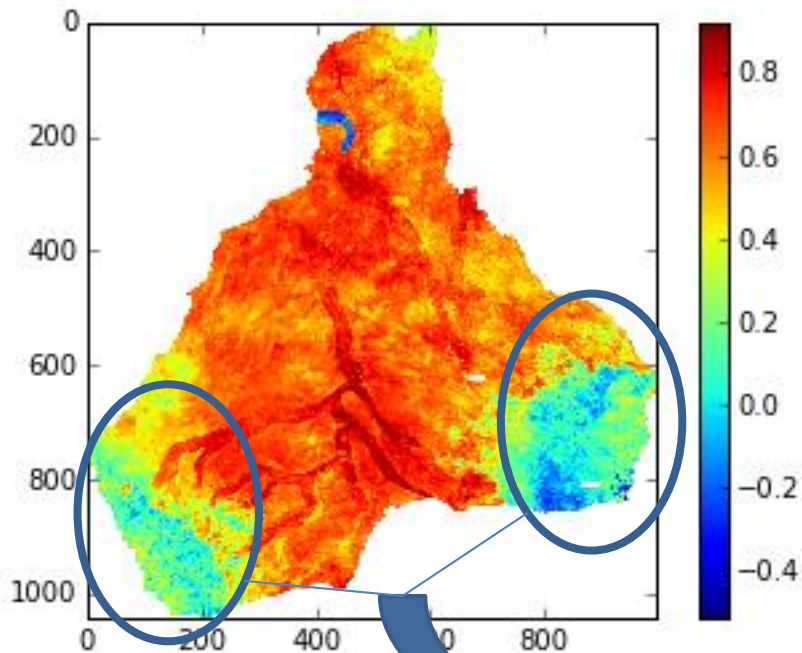
# ECO-TETIS validation

- Years 2000, 2001 and 2002
  - Vegetation
    - Loadings comparison
    - Temporal Pearson correlation maps in each year



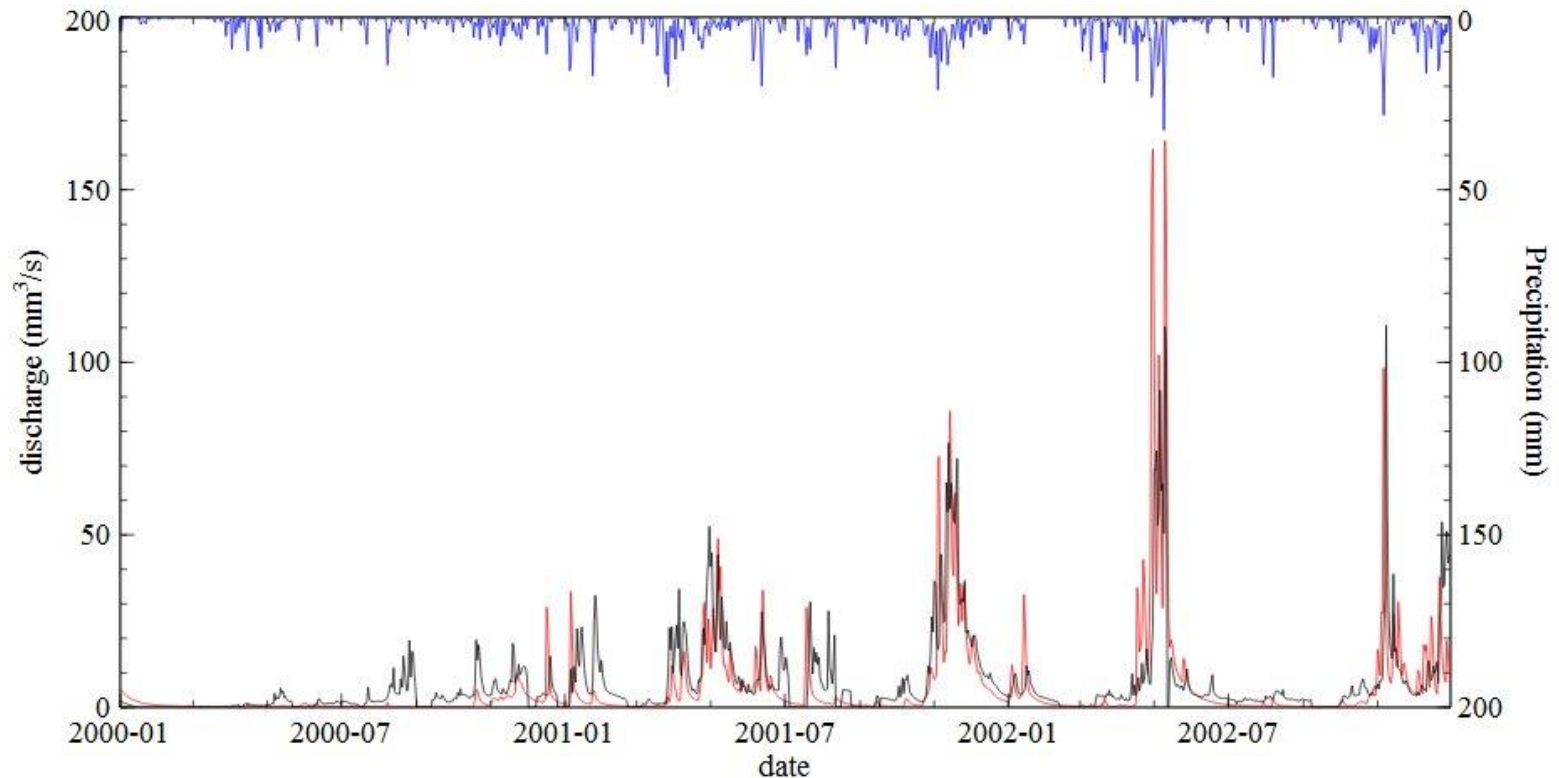
# ECO-TETIS validation

- Years 2000, 2001 and 2002
  - Vegetation
    - Loadings comparison
    - Temporal Pearson correlation maps



Expected  
bad results  
(even worse)

- Years 2000, 2001 and 2002
  - Water
    - Comparison between observed and simulated discharge



- ❑ Simple models together to remote sensing data could be a potential alternative in un-gauging basins
- ❑ Some limitations:
  - Related to the model (nutrient-limited areas)
  - Related to the satellite data (clouds and others)
- ❑ The proposed methodology is an innovative option in order to include spatio-temporal data
- ❑ More statistics and methodologies must be proposed and analyzed if we want to use spatio-temporal





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# Thanks for your attention

**Guiomar Ruiz-Pérez ([guruipr@cam.upv.es](mailto:guruipr@cam.upv.es))**

Research Group of Hydrological and Environmental Modelling

[luvia.dihma.upv.es](http://luvia.dihma.upv.es)

Research Institute of Water and Environmental Engineering

[iiama.upv.es](http://iiama.upv.es)

Universitat Politècnica de València

This work has been funded by the Spanish Ministry of Economy and Competitiveness through the research project INTEGRA (ref. CGL 2011-28776-C02). The MODIS data were obtained through USGS/Earth Resources Observation and Science (EROS) center ([https://lpdaac.usgs.gov/data\\_access](https://lpdaac.usgs.gov/data_access)). The meteorological data were provided by the Spanish National Weather Agency (AEMET).