PHOSPHORUS AND NITROGEN FUTURE IN EUTROPHISED MEDITERRANEAN LAGOONS

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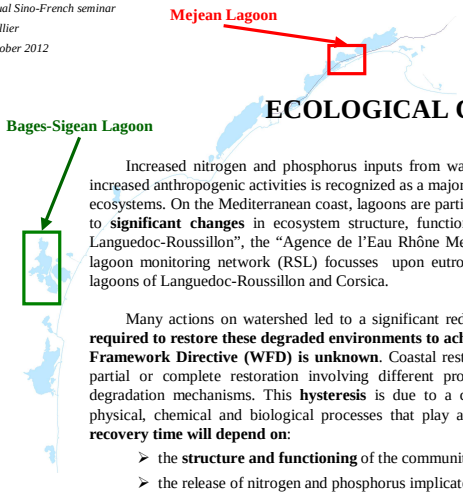
ECOLOGICAL CONTEXT



Increased nitrogen and phosphorus inputs from watersheds, especially since the 1960s with the increased anthropogenic activities is recognized as a major cause of environmental degradation of coastal ecosystems. On the Mediterranean coast, lagoons are particularly affected by the **eutrophication** leading to **significant changes** in ecosystem structure, functioning and services. Since 2000, the "Région Languedoc-Roussillon", the "Agence de l'Eau Rhône Mediterranée & Corse" and Ifremer developed a lagoon monitoring network (RSL) focusses upon eutrophication to assess and monitor status of 24 lagoons of Languedoc-Roussillon and Corsica.

Many actions on watershed led to a significant reduction of nutrient inputs. However, **the time required to restore these degraded environments to achieve good ecological status under the Water Framework Directive (WFD) is unknown**. Coastal restoration is characterized by a *hysteresis*, i.e. a partial or complete restoration involving different processes and generally longer than the rapid degradation mechanisms. This **hysteresis** is due to a complex ecosystem functioning involving all physical, chemical and biological processes that play a role in the matter cycles. In a lagoon, **the recovery time will depend on**:

- the **structure and functioning** of the communities
- the release of nitrogen and phosphorus implicated as the **internal load**
- the **ability to export** the excess nitrogen and phosphorus to the open areas.

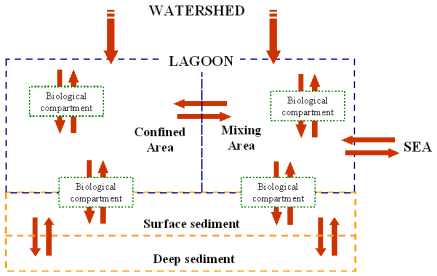


Figure 1: *Conceptual view of lagoon functionning. Arows indicate fluxes between compartment*

HISTORICAL DATA

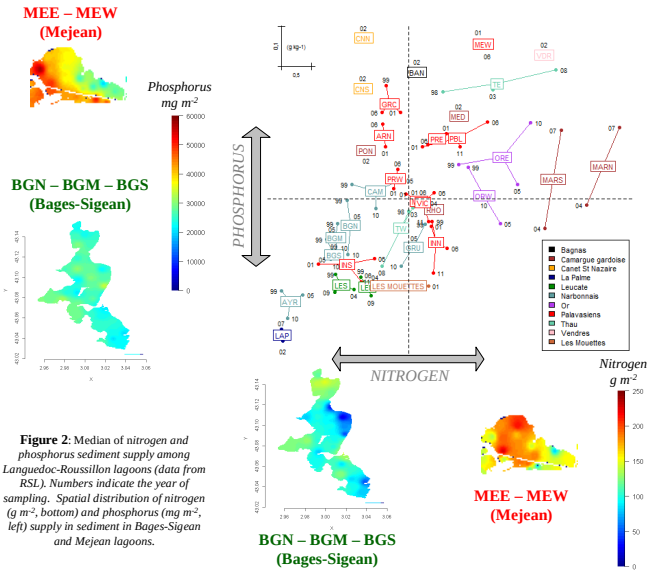


Figure 2: Median of *nitrogen and phosphorus sediment supply among Languedoc-Roussillon lagoons (data from RSL). Numbers indicate the year of sampling. Spatial distribution of nitrogen (g m-2, bottom) and phosphorus (mg m-2, left) supply in sediment in Bages-Sigean and Mejean lagoons.*

AIMS OF THE STUDY

✓ to **characterize and quantify the main nutrient flows** participating in the reduction of internal nitrogen and phosphorus content in Mediterranean lagoons

✓ to **improve the parametrization** of mathematical models

✓ to **define dynamic restoration scenarios** of eutrophised Mediterranean lagoons

PRELIMINARY RESULTS

HYDRODYNAMICS

- Hydrodynamic model (*MARS-3D*)
- Simulations under meteorological forcing (dec. 2005 – march 2007)

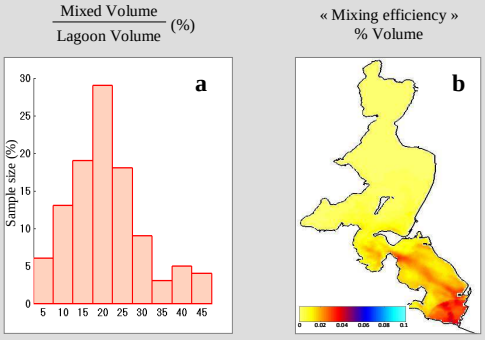


Figure 3: *(a) Volume exchange during theoritical total exchange and (b) Mixing area in Bages-Sigean lagoon*

- Low variation of volume exchange among simulations
- Mixed vs. Confined area
  - ✓ **mixed area restricted to the South** of Bages-Sigean lagoon

⬇ **Lower nutrient availabilty** for primary production in mixed areas (South) than confined area (North)

⬇ **Restoration Time** North ≠ South

➡ **Improve description of physical process** in model using results of the 3D hydrodynamics model (description of mixed vs. confined areas)

BENTHIC FLUXES

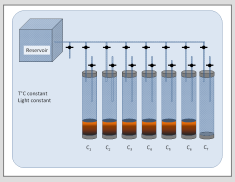


Figure 4: *Experimental design to measure nutrient fluxes. Temperature, light are controlled during all the experiment*

- Spring experiment
- 2 sampling sites (Bages-Sigean and Mejean lagoons)

Lagoon	Eutrophised level	Macrophyte
Bages-Sigean	Weakly eutrophised	Seagrass, red algae
Mejean	Highly eutrophised	-

- Incubation of 6 cores in closed experimental system
- 10h under Dark condition / 10h under Light condition

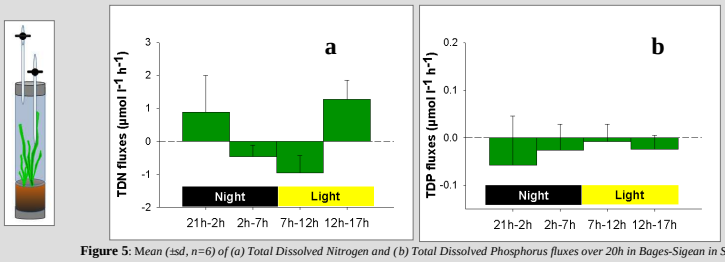


Figure 5: *Mean (±sd, n=6) of (a) Total Dissolved Nitrogen and (b) Total Dissolved Phosphorus fluxes over 20h in Bages-Sigean in Spring*

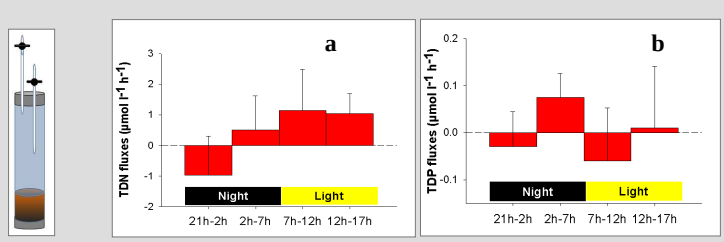


Figure 6: *Mean (±sd, n=6) of (a) Total Dissolved Nitrogen and (b) Total Dissolved Phosphorus fluxes over 20h in Mejean in Spring*

- nitrogen and phosphorus fluxes **vary over the day** ➡ **Uptake** (macrophytes) or **Release** (sediment)?
- nitrogen fluxes **higher than** phosphorus fluxes
- **Effect of seagrasses** on benthic fluxes

Enhance remineralisation processes ⬆ ➡ Increase oxygen in the sediment

REMAINING ISSUES

✓ What are the **effects of segrasses** on benthic fluxes ?

✓ What are the effects of nitrogen and phosphorus **sediment content** on benthic fluxes?

✓ Which nitrogen and phosphorus **forms** (Dissolved or Particular) are mainly **exported** from the lagoon?

✓ Improve parametrization of nitrogen and phosphorus fluxes at sediment – water interface in budget model (*LOICZ*)