Multi-method approach combining isotopic tracers, anthropogenic contaminants and mapping to retrace socio-environmental trajectories of groundwater-dependent coastal hydrosystems

EGU General Assembly 2020

M. Erostate[1]*, F. Huneau[1], E. Garel[1], V. Pasqualini[1] - **melanie.erostate@gmail.com** / erostate_m@univ-corse.fr

[1] Université de Corse - CNRS UMR 6134 Sciences pour l'environnement (SPE), Campus Grimaldi BP 52, 20250 Corte, France

CC BY NC ND

Coastal groundwater-dependent hydrosystems (coastal GDE)

Coastal areas water & nutrient balances often depend on groundwater. **Groundwater controls the evolution, durability & resilience of these sensitive coastal GDEs**. Understanding the groundwater dependency is thus essential to establish sustainable resource & ecosystem management *(Fig.1)*.

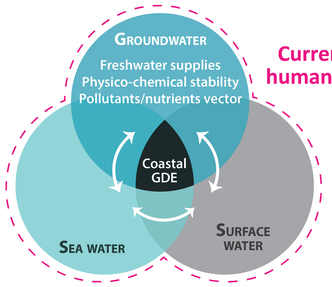


Fig. 1: Understanding the importance of water bodies interactions.

As groundwater can be an important vector of current and past contaminations, it is essential to consider the full range of pressures on coastal GDEs or, in other words, to trace the **socio-environmental trajectories of coastal GDEs.**

Study area: the Biguglia lagoon hydrosystem (Corsica, France)

The Biguglia lagoon is *(Fig. 2)* :

- **a groundwater dependent ecosystem**
- the **largest wetland of Corsica Island** (14.5 km²)
- recognized as a **RAMSAR site & Nature Reserve**



Fig. 2: Aerial view & location of the Biguglia lagoon watershed.

The watershed (182 km²) is :

- composed by an **alluvial Quaternary plain**, corresponding to the **main aquifer** ;
- delimited by schistous hills
- drained by a major stream, the Bevincu River & 3 temporary rivers
- **increasingly anthropized** : growing population *(Fig.3)*, urbanization, agriculture

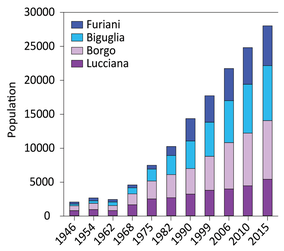


Fig. 3: Demographic evolution for the 4 municipalities of the Biguglia lagoon watershed.

Multi-method approach

Tracers/Methods

Current quality

The groundwater qualitative assessment through :

- the **nitrate concentrations [NO_3-]** *(Fig.4A)*
- the analysis of **pharmaceutical and domestic-used organic micro-pollutants (µ-pol)** *(Fig.4B)* ...

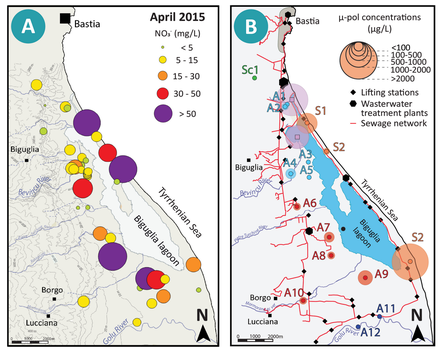


Fig. 4: Maps of A. [NO_3-] and B. total concentrations in µ-pol measured into the aquifer (●) & the lagoon (■).

Results

... shows :

- the **vulnerability of groundwater**
- the **diffuse anthropogenic impact**
- the infiltration of **untreated wastewater**

? Pollution origin
Past or present ?

Pollutants origins

The tracing of pollutant sources using :

- **nitrate isotopes ($\delta^{15}N$-NO_3- & $\delta^{18}O$-NO_3-)** *(Fig.5A/5B)*
- **groundwater residence time tracer (^3H)** *(Fig.5A)* **...**

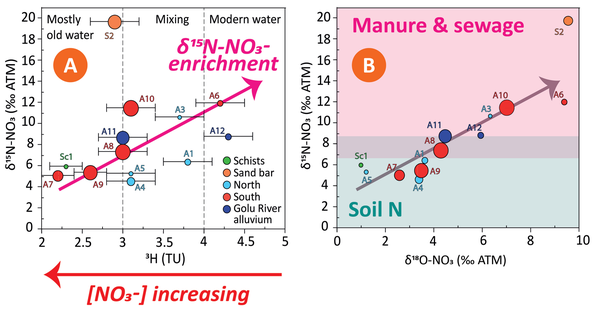


Fig. 5: A. $\delta^{15}N$-NO_3- vs ^3H; the symbol size is proportional to [NO_3-] and B. $\delta^{15}N$ vs $\delta^{18}O$ with compositional ranges from different NO_3- sources.

... shows:

- the **progressive NO3- accumulation** in goundwater for decades *(Fig.5A)*
- the **evolution of NO_3- isotopic signatures over time** *(Fig.5A)* : from **soil** to **sewage** *(Fig.5B)*
- **NO_3- mainly come from the soil !!**

? Natural contamination
or indirect anthropogenic impact ?

Current/Past & Direct/Indirect anthropogenic impacts

Sewage : present direct impact *(Fig. 6)*

- Rather low concentrations show an **ongoing impact**
- µ-pol allow for :
  - tracing of **recharge areas & fast infiltration**
  - distinction between **sewage leakages/runoff** contamination

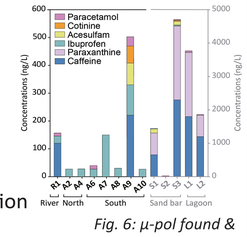


Fig. 6: µ-pol found & concentrations in waters.

Soil : past indirect impact

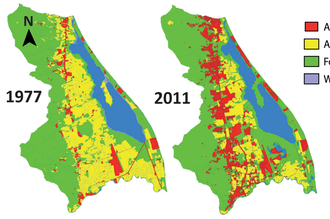


Fig. 7: Evolution of land-use between1977 and 2011.

The **study of land-use** shows *(Fig. 7)* :

- **important modifications since the 60's** : land clearing, agricultural changes from vineyards/orchards to cattle breeding/vegetables production, **disturb the soil & favour NO_3- leaching**
- **growing urbanization since the 90's**

FOR FURTHER READING

M. EROSTATE, et al. 2020 in Water Reasearch 172
M. EROSTATE, et al. 2019 in J. of Hydrology 578
J. JAUNAT, et al. 2019 in Sc. Of Total Env. 658, 1390-1403
M. EROSTATE, et al. 2018 in Sc. of The Total Env. 644, 928–940

Socio-environmental trajectories & take home message

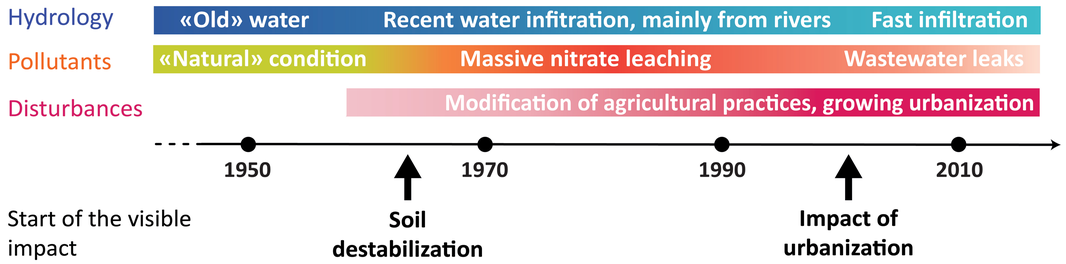


Fig. 8: Socio-environmental trajectories over the past decades for the Biguglia lagoon hydrosystem.

- The multi-method approach makes it possible to trace the causal **links between anthropogenic development & current state of water resources.**
- The **current deterioration is mainly due to a legacy pollution** resulting from planning policies implemented in the 1960s.
- **Groundwater could be seen as an archive,** it is thus possible to trace back in time the degradation processes & their chronology.
- Water resource management strategies must imperatively **take into account inherited pollution to ensure the sustainability of coastal GDEs**.