LIVING LAB OF CATALONIA (SPAIN)

Restoration for the future WETLANDS
www.alfawetlands.eu

Universitat de Barcelona

Monitoring greenhouse gas emissions in Mediterranean wetlands for climate change resilience and mitigation



Mediterranean wetlands are among the most vulnerable ecosystems in Europe, highlighting the need for proactive conservation and restoration actions to protect them from the impacts of climate change.

1 OUR LIVING LAB

WHERE?





THE CHALLENGE

Wetlands are increasingly **threatened by the combined effects of human activities pressure and climate change**, resulting in habitat degradation, biodiversity loss, soil deterioration, and reduced water availability. These changes weaken their capacity to regulate water quality and quantity, store carbon, and provide essential ecosystem services.



WETLAND TYPES

a) **Mountain peatlands** within National and Natural Park affected by grazing pressure from cattle, horses, sheep and goats.

b) **Coastal wetlands** co-created and restored between 2015 and 2017 to enhance environmental quality and suport biodiversity.

c) **Riparian forest** receiving treated wastewater through an intermittent subsurface flow to improve water quality and enhance ecosystem services.

d) **Forested floodplain** seasonally flooded by precipitation facing severe droughts driven by climate change.

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2 WHAT WE DID

ACTIONS

a) Grazing exclusion in mountain peatlands

b) Coastal wetland restoration

c) Riparian zone recharged with treated wastewater

d) Natural floodplain impacted by climate change



WHAT WAS MEASURED?

Greenhouse gas emissions from soils, flooded soils, and vegetation • Soil and water physicochemical properties • Wetlands ecosystem services • Stakeholder perspectives

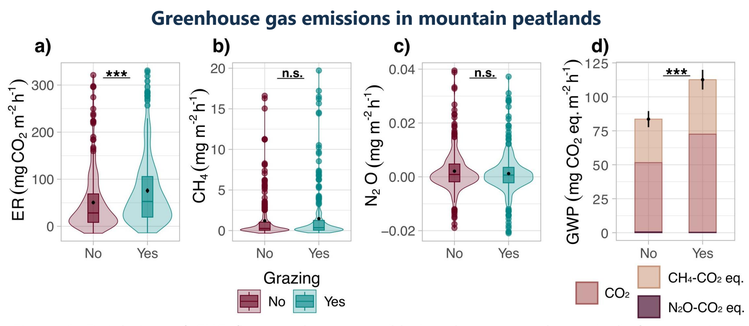


Figure 1. Distribution of GHG fluxes under grazing (blue) and grazing exclusion (red), for ecosystem respiration (a; n= 540), CH_4 (b; n= 552), and N_2O (c; n= 541). Violins show the distribution of observations, and embedded boxplots represent the median and interquartile range (25^{th} – 75^{th}). Global warming potential (GWP; d; n= 518) is shown as the mean value for grazing exclusion and presence, with the contribution of each gas (CO_2, and CH_4 and N_2O expressed in CO_2 equivalents). Black dots indicate mean values with standard error. Asterisks indicate significant effects (*p<0.05, ** p < 0.01; *** p < 0.001).

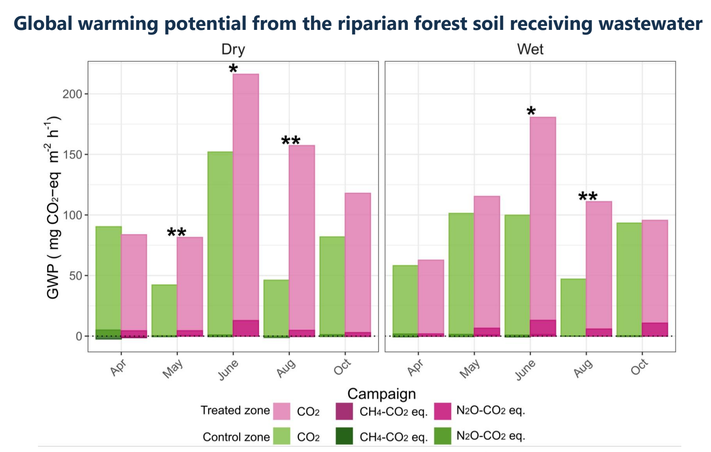


Figure 2. Bar plot showing the mean global warming potential (GWP) for the control (green) and treated (pink) zones across each month, under dry (left panel) and wet (right panel) conditions. Emissions are expressed in CO_2, and CH_4-CO_2 and N_2O-CO_2 equivalent, to visualize the contribution of each gas to the GWP in CO_2-equivalent units. Asterisks indicate significant effects (*p<0.05, ** p < 0.01; *** p < 0.001).

3 RESULTS & LEGACY

KEY FINDINGS

✓**Grazing exclusion** decreased ecosystem respiration in mountain peatlands (a).

✓**Higher marine connectivity** reduced GHG emissions from coastal wetlands (b).

✓**Intermittent application of treated wastewater** to a riparian zone improved water with low impact on GHG emissions (c).

✓**Climate change** is modifying floodplain hydrological regime, altering the **frequency and duration** of flooding events, and challenging their GHGs emissions prediction (d).

BENEFITS & TRADE-OFFS

Climate mitigation	+
Biodiversity	++
Water quality	++
Production	+/-
Management costs	+/-
Stakeholder acceptance	+

++ strong positive
+ positive
+/− mixed
− negative / trade-off

LESSONS

WHAT WORKED:

Restoring natural hydrological connectivity and reducing ecosystem disturbance can significantly enhance wetland climate regulation functions.

WHAT WAS DIFFICULT:

Balancing conservation goals with land-use demands and adapting management to ongoing climate variability remains challenging.

WHAT OTHERS CAN APPLY:

Prioritize nature-based management that restores water dynamics, maintains ecological connectivity, and reduces disturbances to improve wetland resilience and ecosystem services.

LEGACY AND NEXT STEPS

We generated **evidence** on how wetland management influence greenhouse gas emissions and ecosystem services. **Next steps need to assess the long-term effectiveness** of management interventions under increasing climate variability, while enhancing implication and support from citizens and stakeholders.

ONE KNOWLEDGE GAP

What are the long-term effectiveness of these restoration actions and their impacts on ecosystem functioning?

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