Methane emissions and carbon balance in Mediterranean wetlands and rice fields: Ebro Delta case study

M. Martínez-Eixarch[1], S. Fenessy[2], M. Viñas[1], X. Aranda[1], C. Alcaraz[1], C. Ibáñez[1]

[1]IRTA- Catalonia

[2]Kenyon College, Ohio (EUA)

EBRO ADMICLIM

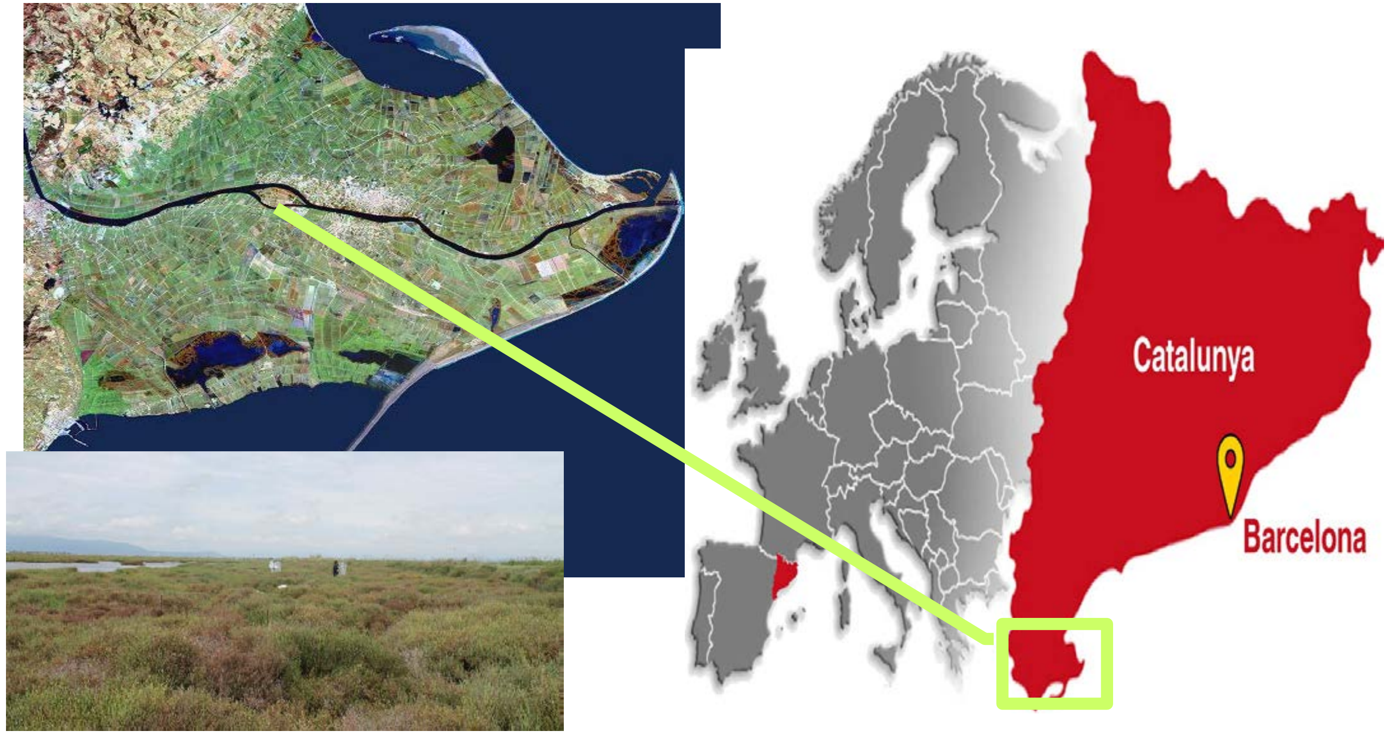
LIFE 13 ENV/ES/001182

Life

12th International Symposium on Biogesochemistry of Wetlands,

April, 23-26 April, Coral Springs, Florida

Study site:The Ebro Delta (S Catalonia)



The Ebro Delta is one of the most important wetland complexes in the Mediterranean with 65% of its area covered by rice fields

Rice fields are crucial for preserving biodiversity of the surrounding natural wetlands and the local economy.

Paddy rice fields, considered as semi-natural wetlands, also play crucial role in C budget:

- ➔ Paddy rice cultivation represents 47 % of anthropogenic CH_4 emissions
- ➔ After harvest, straw is incorporated into the soil: soil accretion, carbon sequestration
- ➔ Rice fields as sources or sink of C? Agronomic practices to modulate C budget.

Two studies on CH4 and C accretion in natural wetlands and rice fields in the Ebro Delta

Study 1 (2013-2014)- The Effect of Landscape Position on Methane Emissions in Wetlands in the Ebro Delta

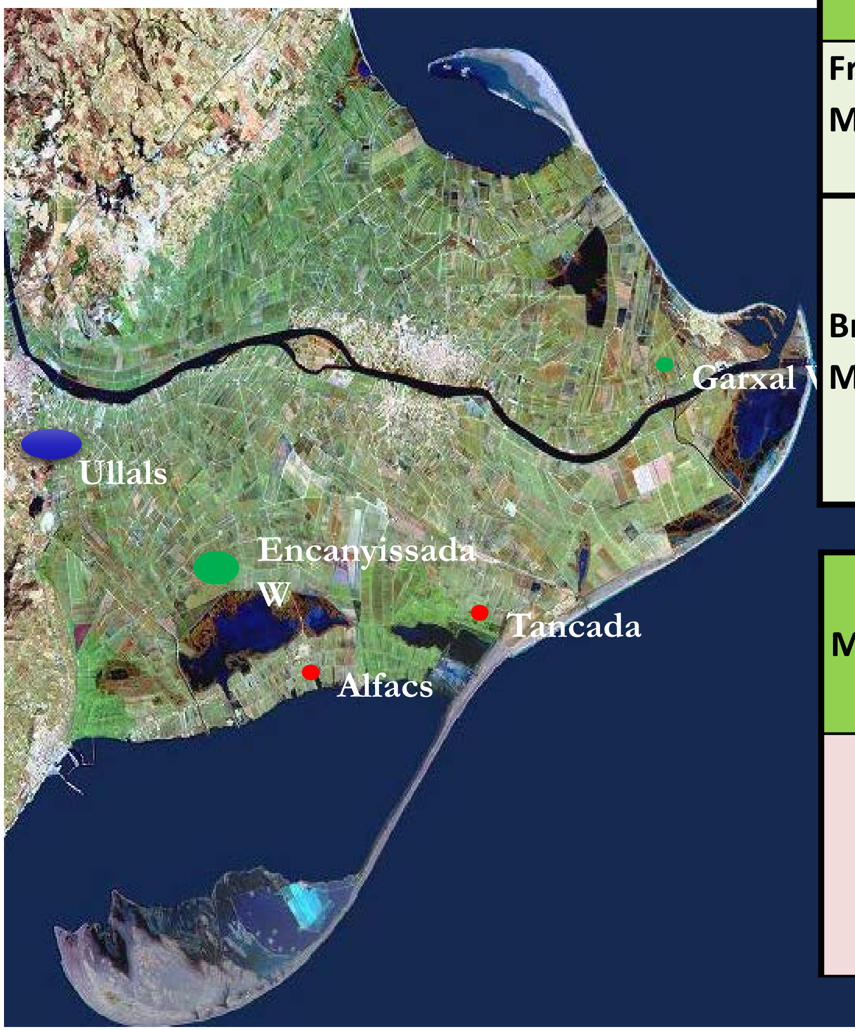
- Quantify carbon accretion and CH_4 emission rates from coastal wetlands in the Ebro Delta → the balance between C sequestration and CH_4 emissions
- Determine how salinity affects CH_4 emission rates

Study 2 Life Ebro-Admiclim project (2015-2018)- Methane emissions and C sequestration in Mediterranean rice fields.

- Estimation of CH_4 emission and seasonal pattern
- Determination of the major drivers of CH_4 emissions
- Guidelines for mitigation practices in rice fields
- Soil accretion and C sequestration in rice fields

STUDY 1.- The Effect of Landscape Position on CH4 Emissions in Wetlands in the Ebro Delta

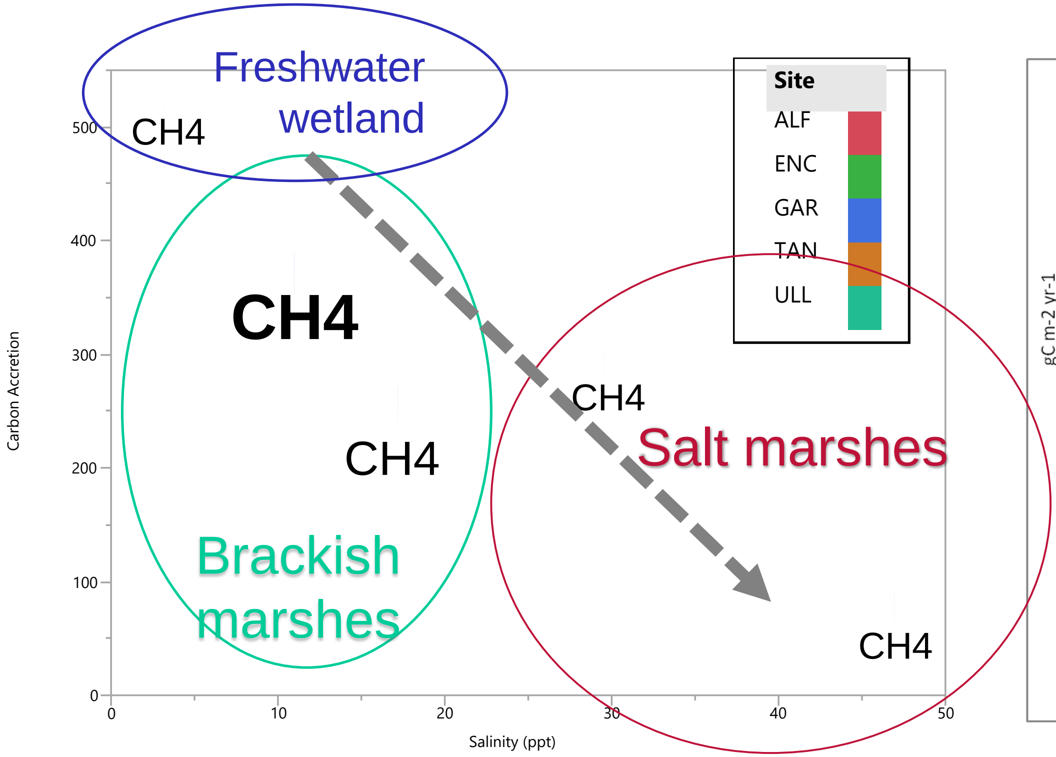
Type of wetlands



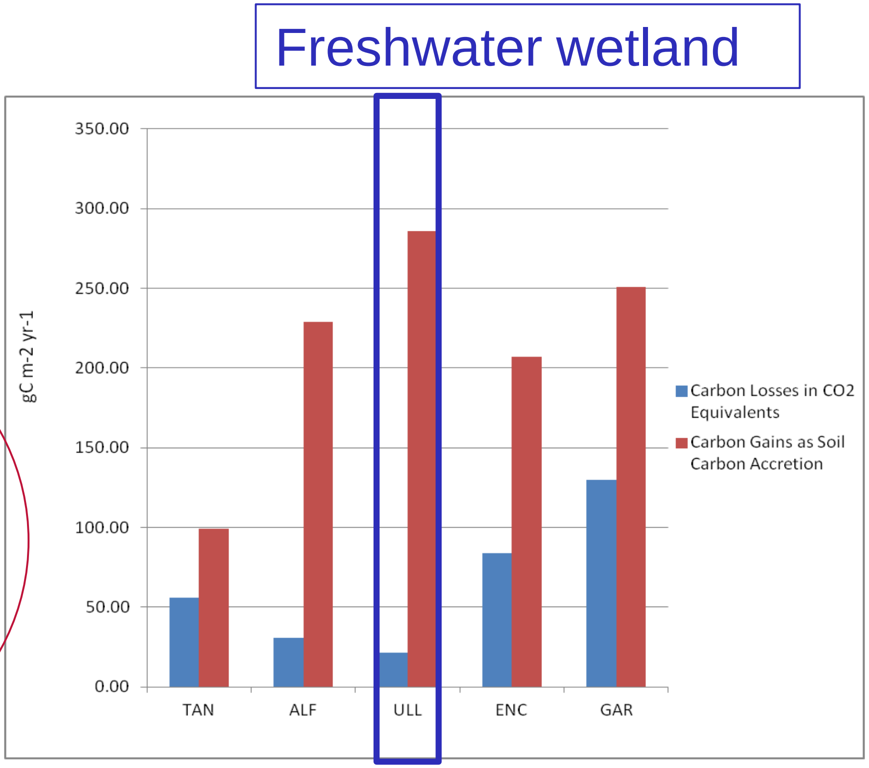
Marsh Type	Sedimentary Enviroment	Study Sites	Dominant Vegetation
Fresh water Marshes	Impounded	Ullals	*Phragmites australis*
Brackish Marshes	Coastal Lagoon	Encanyissada W	*Phragmites australis*
	Riverine Mouth	Garxal W	Spartina versicolor, Paspalum spp.

Marsh Type	Sedimentary Enviroment	Study Sites	Dominant Vegetation
Salt Marshes	Coastal Lagoon	Tancada	*Sarcocornia fructicosa*
	Bay	Alfacs	*Sarcocornia fructicosa*

The effect of salinity on carbon accretion and CH_4 emission rates

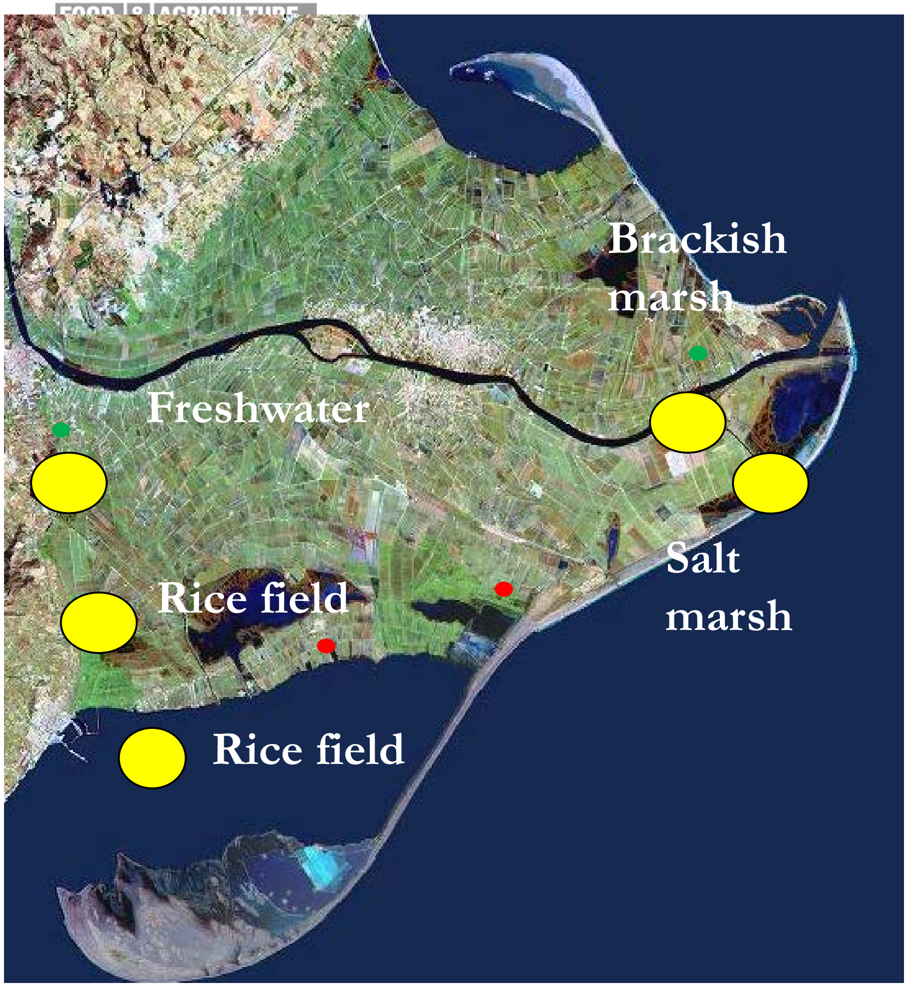


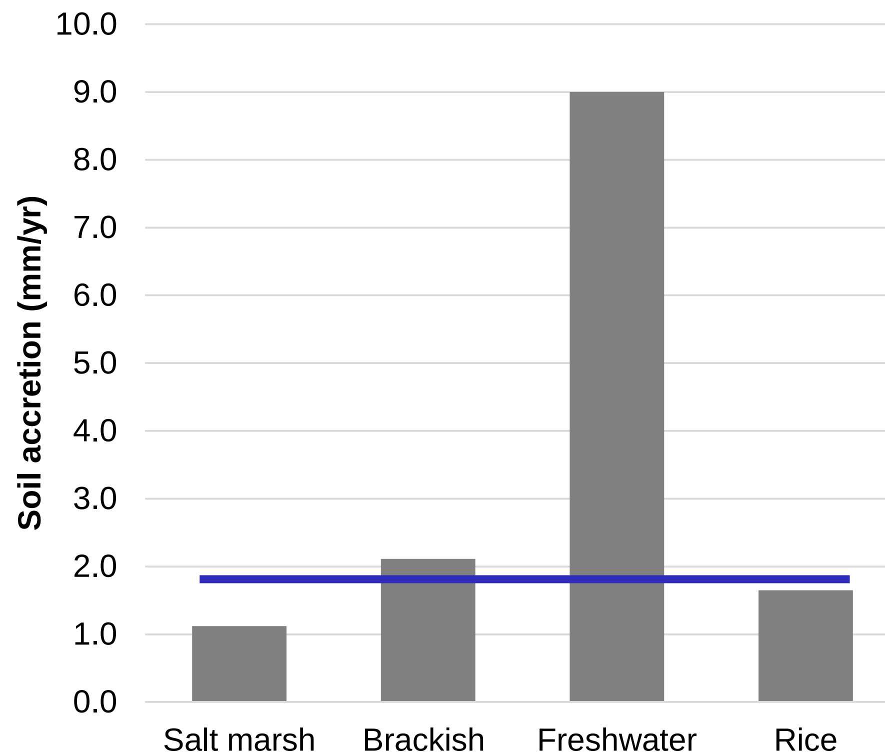
Carbon accretion and CH4 emissions were negatively related to salinity



Balance between C accretion and CH_4 emission rates across wetland types. Freshwater wetland showed highest sink capacity

Soil accretion in natural wetlands and rice fields in Ebro Delta





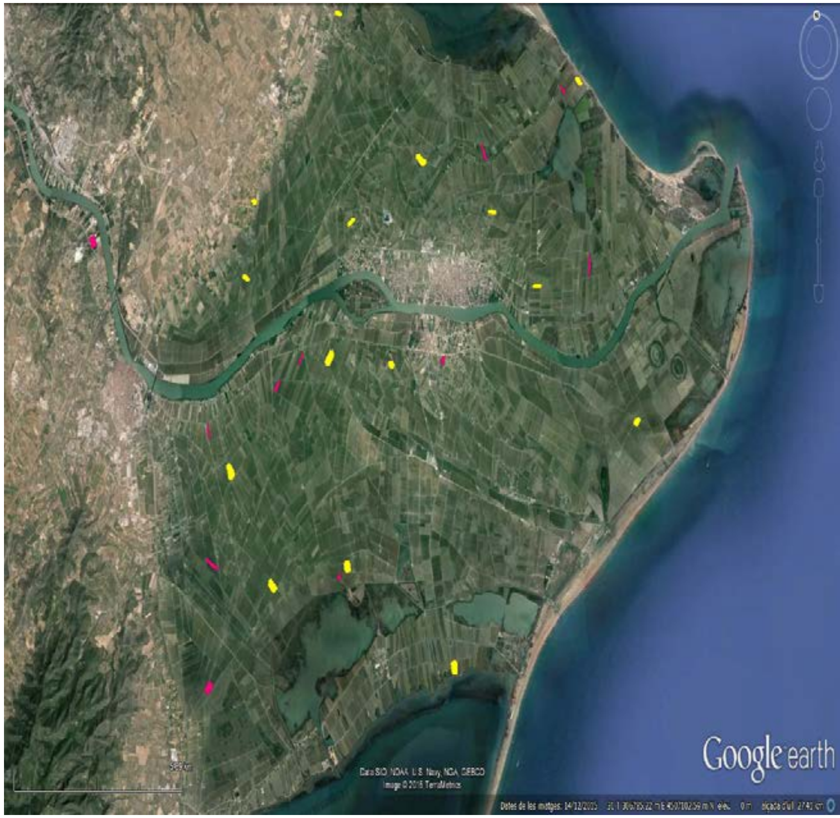
Data from: Ibáñez et al 2010; Callaway et al., 2013

Rice accretion rates comparable to salt and brackish marshes

STUDY 2.- CH4 emissions: seasonal pattern and major drivers

Material and Methods (2015-2016)

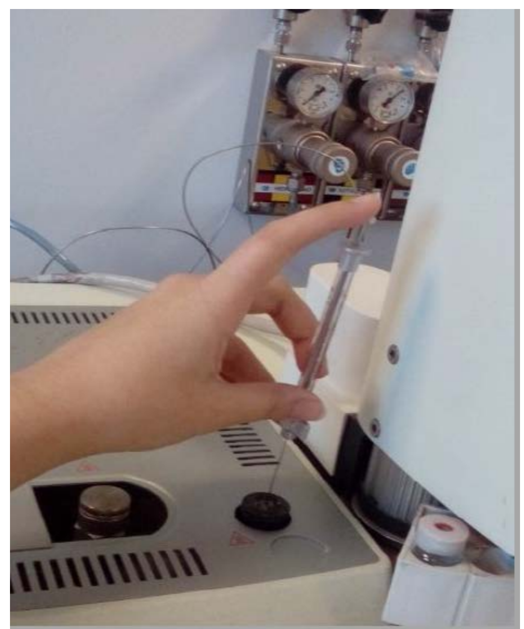
- **Monthly sampling in 22 commercial fields in Ebre Delta**
  - ➔ Rice fields are flooded from May to September (harvest) and left to progressively dry out over post-harvest period
  - ➔ After harvest, straw is incorporated
- **Data collection:**
  - o CH_4: non-steady closed chambers
  - o Physicochemical: Soil temperature Eh, pH, conductivity
  - o Agronomic traits



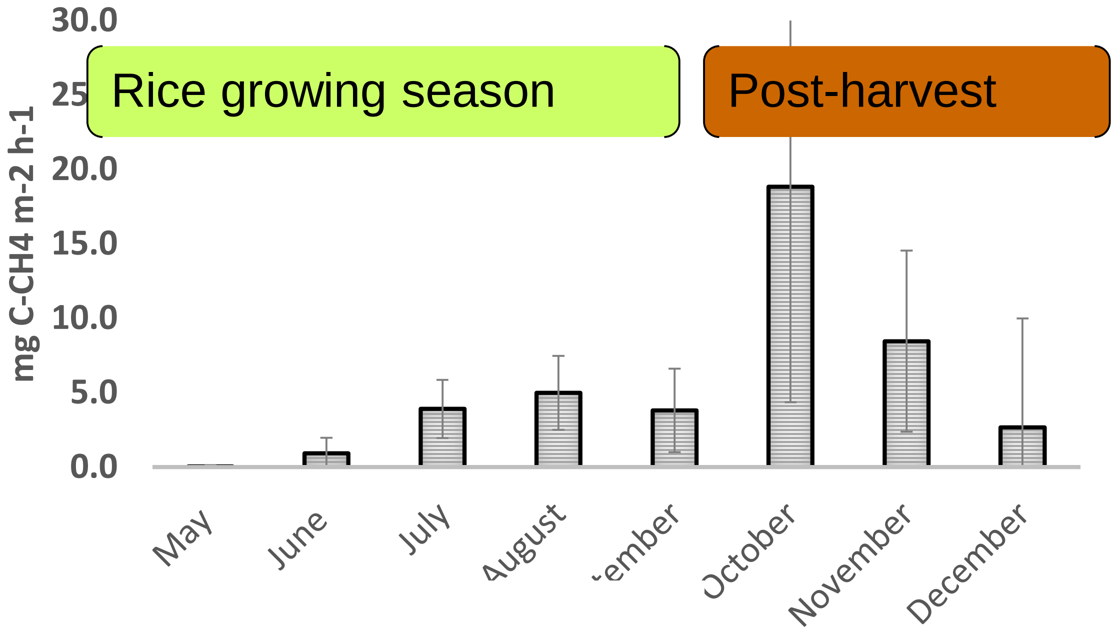
Generalitat de Catalunya
Government of Catalonia

EBRO ADMICLIM
LIFE 13 ENV/ES/001182

Gas sampling and analyses methodology



Temporal pattern of CH_4 emissions

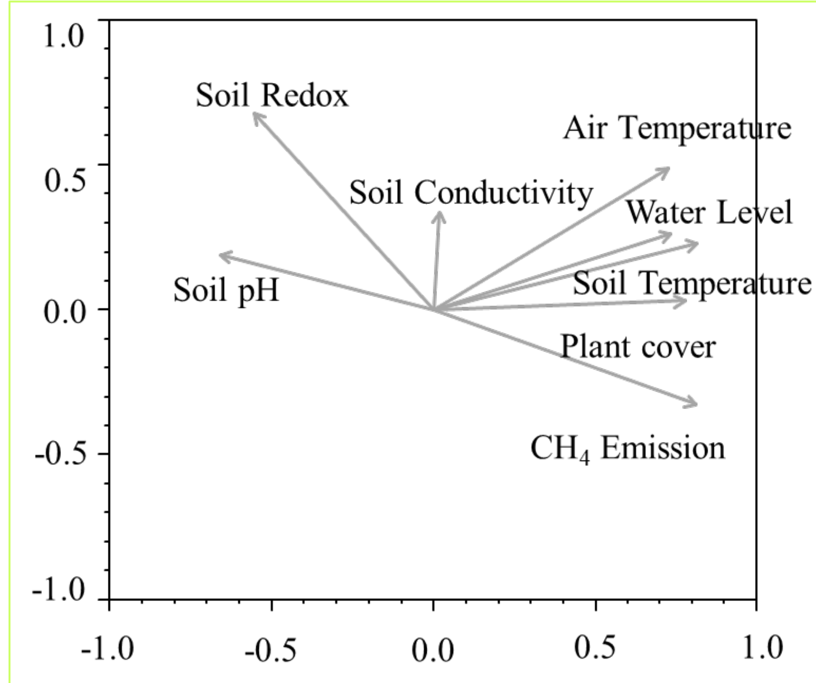


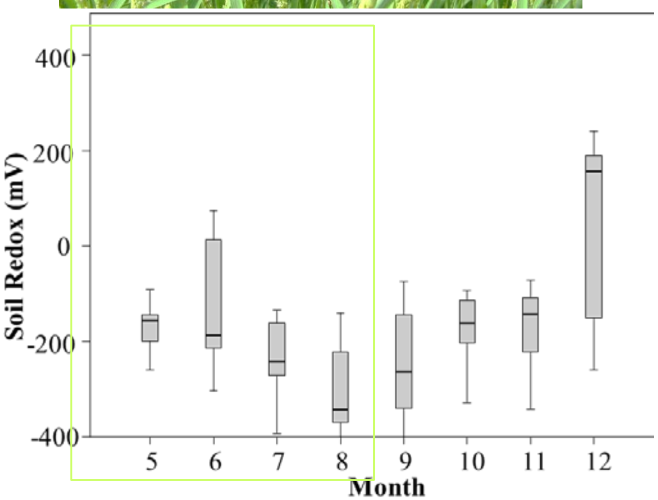
Season	2015 (mg C-CH_4 m^{-2} ha^{-1})	2016 (mg C-CH_4 m^{-2} ha^{-1})
Growing season	2.71 ± 0.25	3.15 ± 0.61
Post-harvest	9.71 ± 1.60	10.1 ± 2.14
Annual	5.20 ± 0.62	6.12 ± 1.01

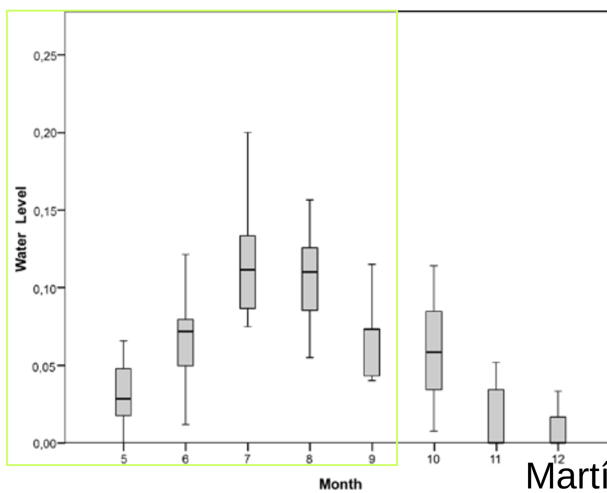
70 % of CH4 emitted during post-harvest

Correlation among all the variables

Rice growing season



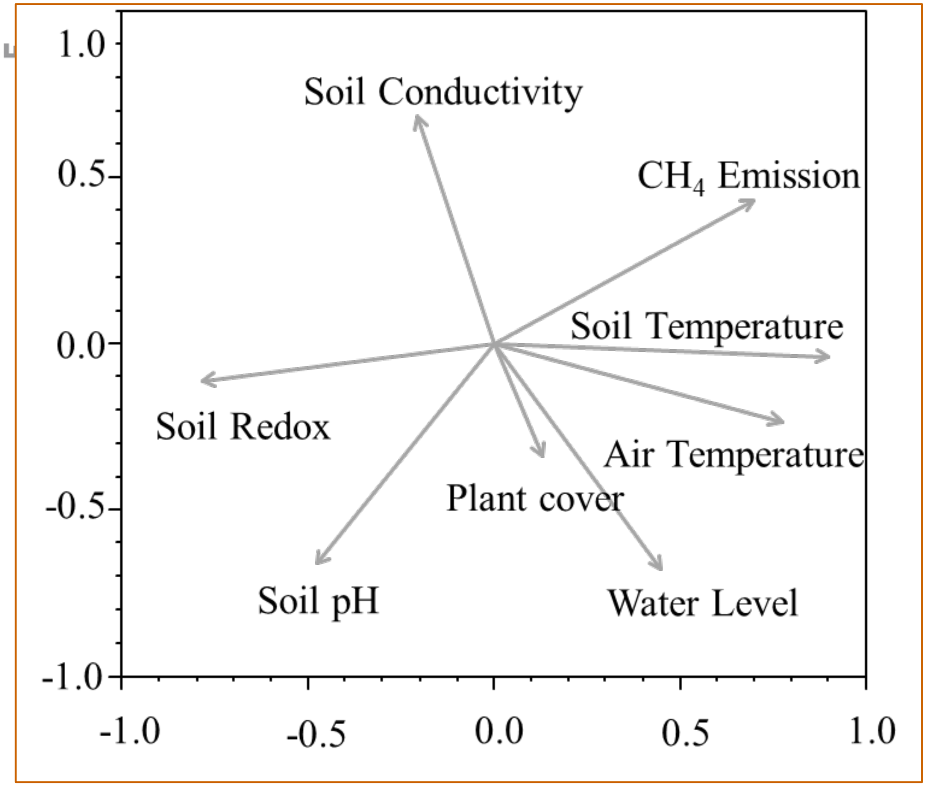


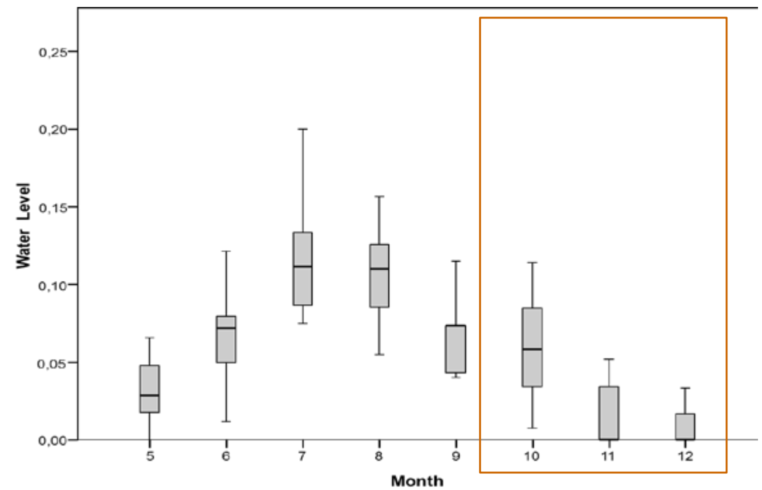


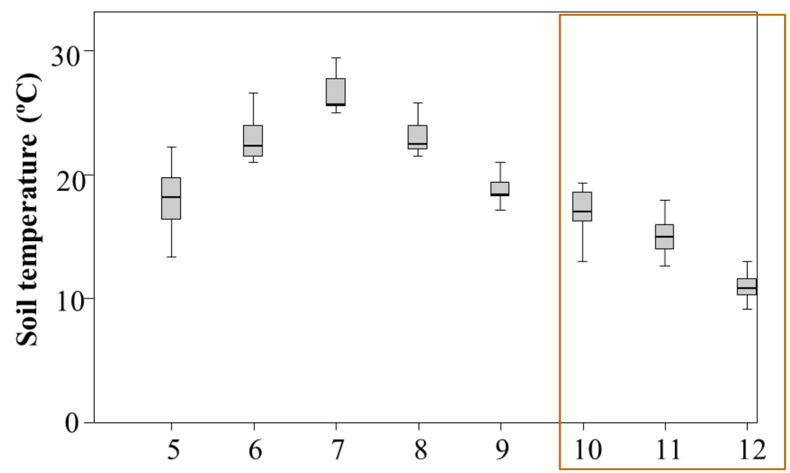
Martínez-Eixarch et al., in review

Correlation among all the variables

Post-harvest







Martínez-Eixarch et al., in review

Straw incorporation

Generalized Linear Model (GLMz)

model parameter	RICE GROWING SEASON N=20			POST-HARVEST N=26		
	SP	ß	Bias	SP	ß	Bias
(Intercept)	1.000	3.670	-0.191	1.000	-6.918	-0.115
Soil Redox	1.000	-3.798	0.026	0.453	-1.551	-1.142
Soil Temperature	0.288	0.208	-2.977	1.000	4.771	-0.263
Soil pH	0.335	-0.766	-1.776	0.135	0.009	-218.89
Soil conductivity	0.379	-0.214	-1.400	0.230	0.221	-2.331
Plant cover	0.956	0.050	0.021	0.240	0.021	-3.820
Water level	1.000	3.884	0.103	0.985	-5.240	0.044
Air temperature	0.225	0.000	1721.8	0.203	-0.360	-3.823
Straw incorporated… … 1 month prior to CH4 sampling				0.993	0.788	-0.156
…2 months prior to CH4 sampling				0.993	-0.001	2.457
… 3 months prior to CH4 sampling				0.993	-0.556	0.703

SUMMARY

- Wetlands in Ebro delta are a sink of carbon
- Soil salinity is negatively related to CH4 emissions and to soil accretion
- Rice fields emit more CH_4 than natural wetlands
- Rice fields in Ebro Delta emitted more than 70% of the total annual emisions during post-harvest, after straw incorporation >> need of more studies on straw management strategies.
- Main drivers of CH4 emissions in rice fields differ in the growing and post-harvest seasons:
  - Growing season: water level, soil redox, plant cover and temperature
  - Post-harvest season: straw incorporation, water level and soil temperature
- Soil accretion in rice fields in Ebro Delta is comparable to salt and brackish wetlands


Thank you!