Life DELTA-LAGOON & Life EBRO-ADMICLIM: restoration of coastal lagoons and the survival of deltas

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The case of deltas: vulnerability versus resilience

Deltas represent 1% of the Earth surface but more than 500 million live in !!!

The are highly valuable systems in socio-economic and ecological terms.

But…what's the best strategy to protect their people and natural capital?

Two approaches: restoring protected areas (coastal lagoons) versus restoring natural processes to protect the whole system (delta).

LIFE+ DELTA-LAGOON: restoration of two coastal lagoons in a Mediterranean delta (Ebro)

ALFACADA

TANCADA

Main goal of Delta-Lagoon:

To improve the ecological status of two coastal lagoons (Alfacada and Tancada) of the Ebro Delta, through habitat restoration and specific management measures

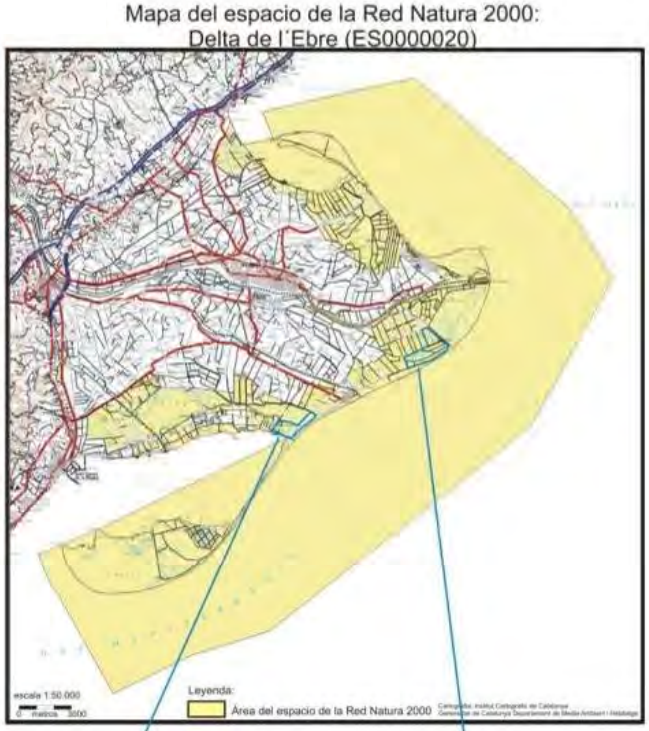
Actions:

Conservation (15)

Communication / education (13)

Monitoring / management (12)

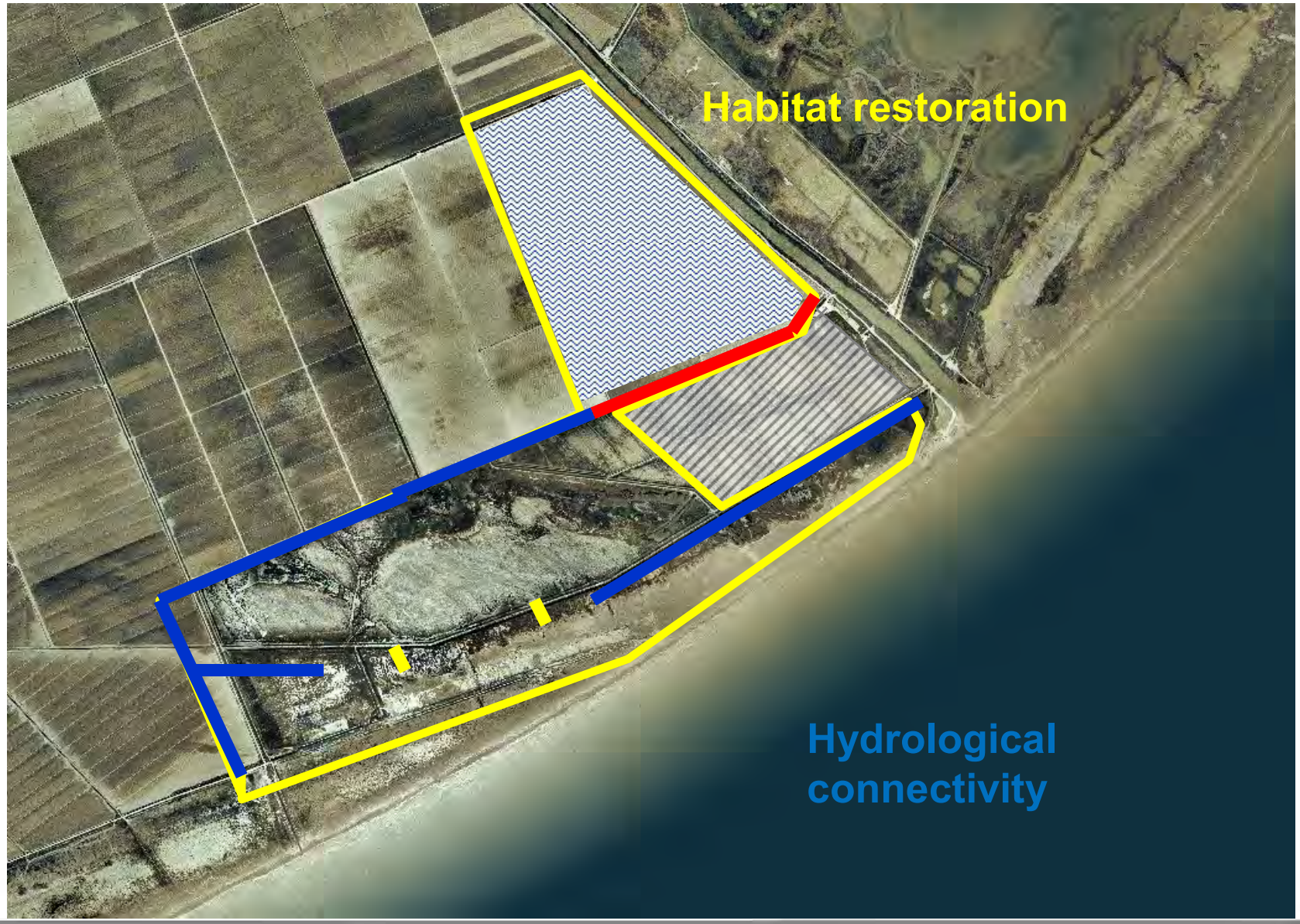
Conservation actions



Mapa de Sant Antoni-Tancada

Mapa de l´Alfacada

Conservation actions ALFACADA

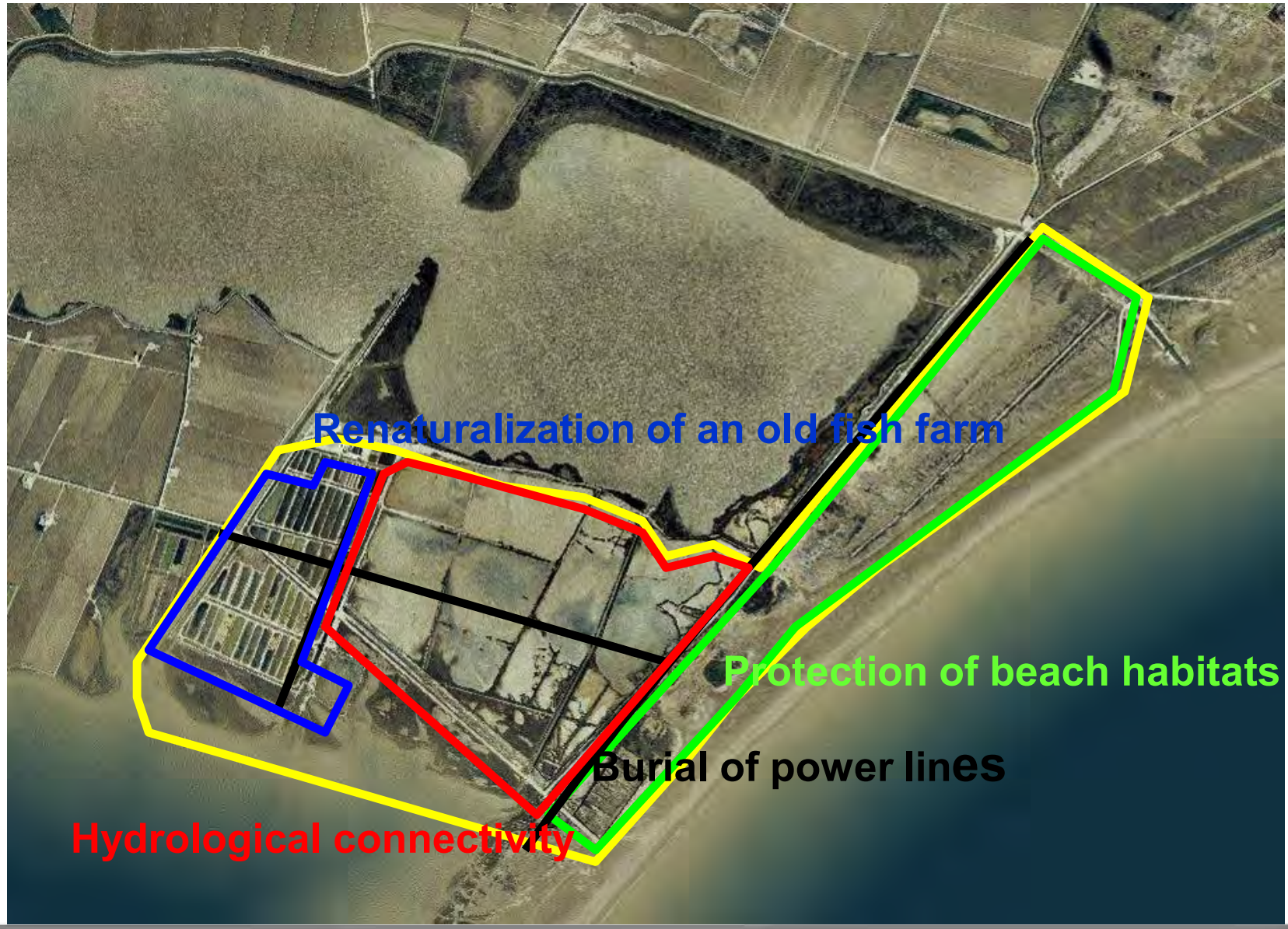


Conservation actions ALFACADA

Reintroduction European pond turtle

Conservation actions ALFACADA

Conservation actions TANCADA



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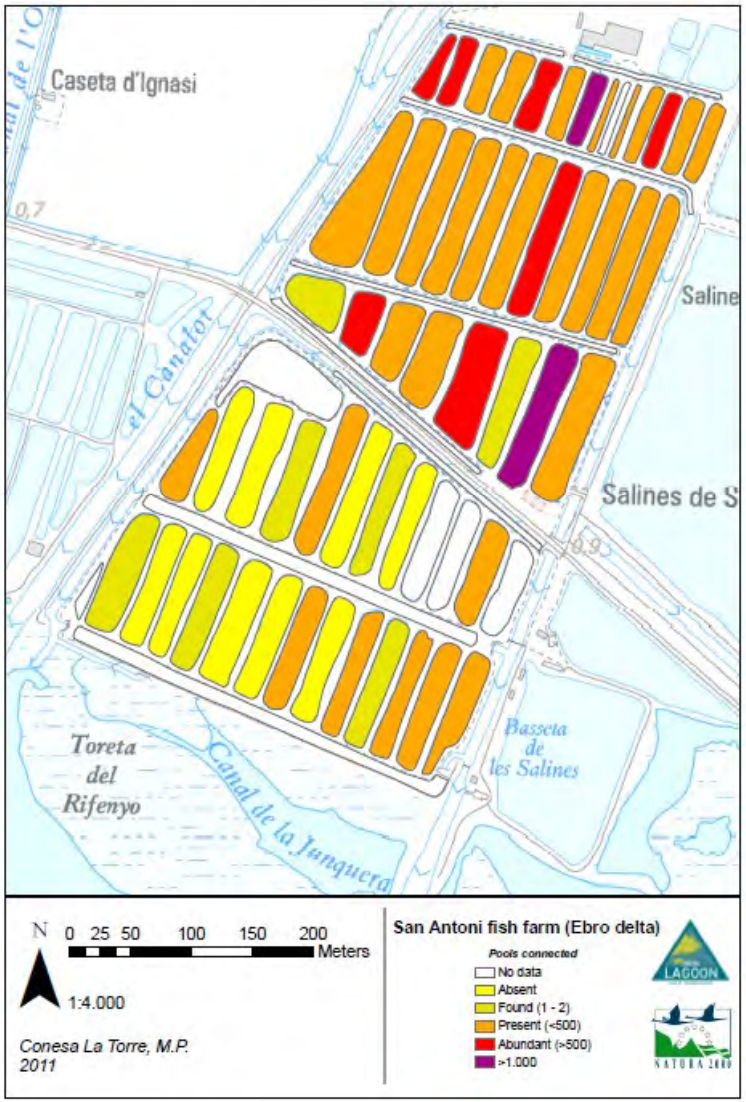
Conservation actions TANCADA

Monitoring of Spanish toothcarp



Conservation actions TANCADA

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Conservation actions TANCADA

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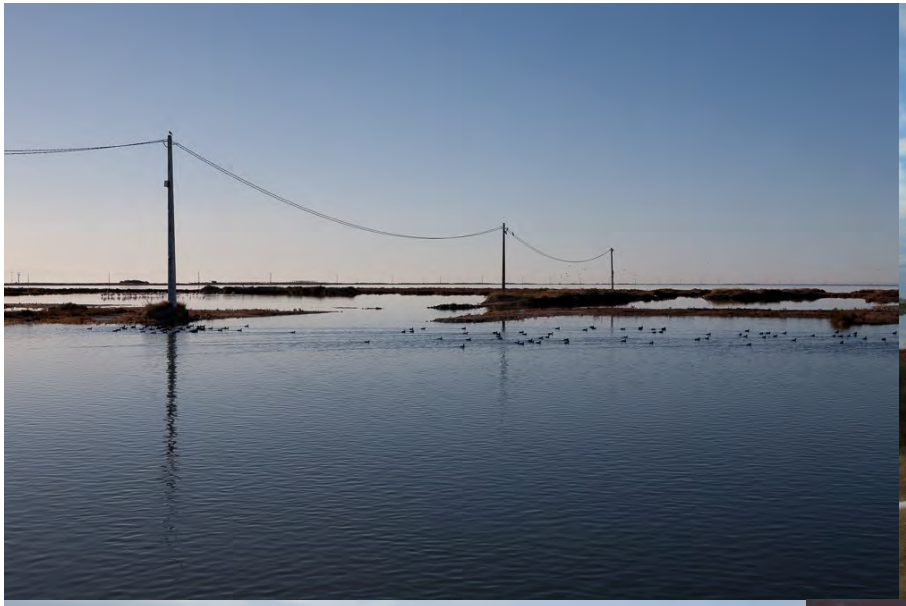

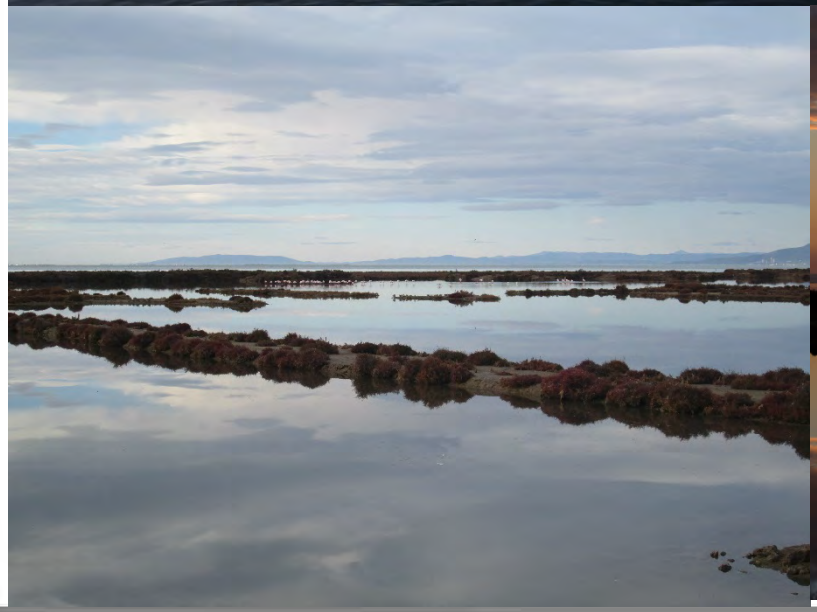

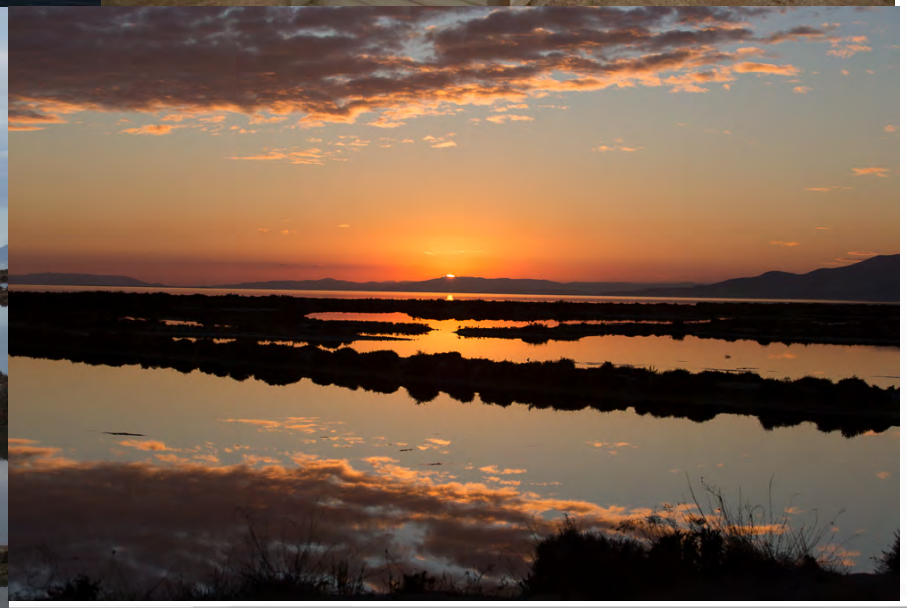

Monitoring of ecological quality

Monitoring of Purple swamphen

Life EBRO-ADMICLIM: mitigation and adaptation to climate change

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The problem: sediment deficit in the context of climate change

Sediment inputs to deltas are decreasing due to dams and water abstraction

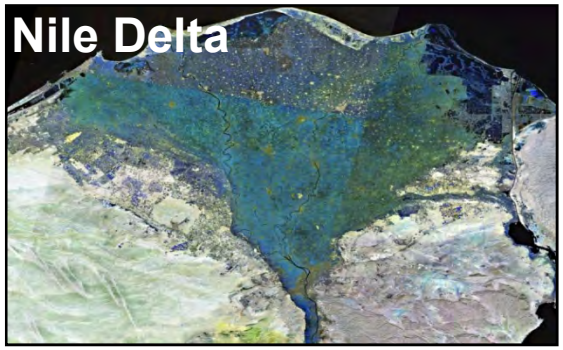
Sediment needs in deltas are increasing due to accelerating SLR and subsidence

This is causing elevation loss, coastal erosion, flooding, salt intrusion, etc.

What adaptation options can be considered?

What role can play sediment recovery and management?

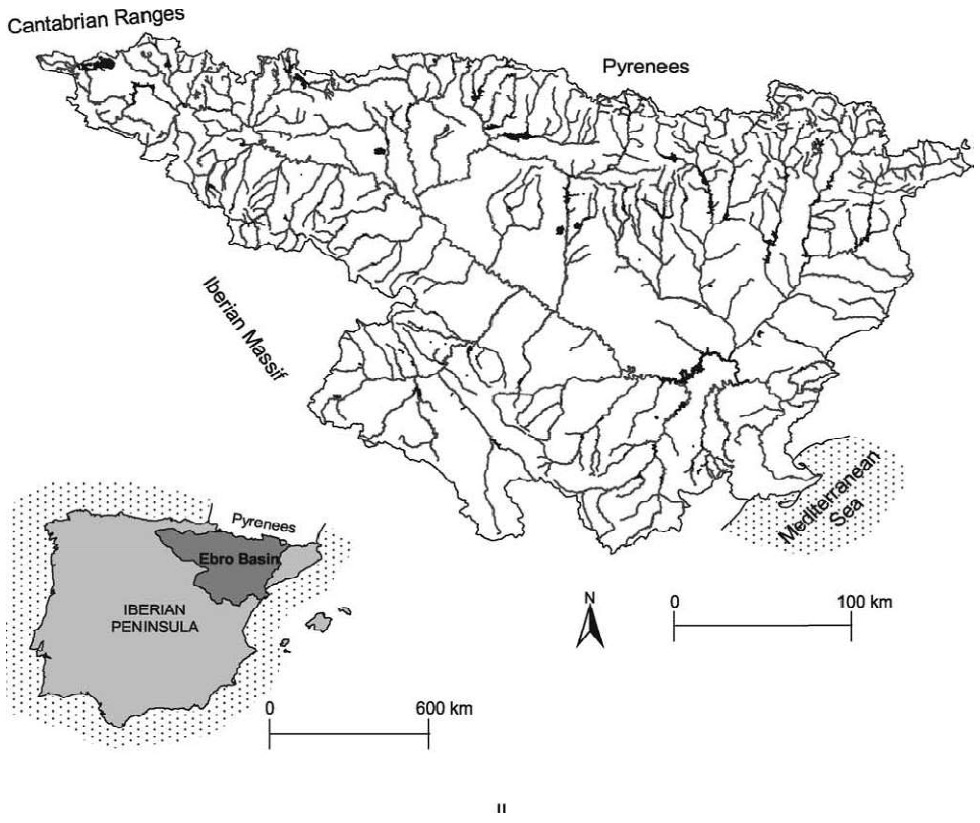
RISING GROUNDS (elevation capital) ⟹ IRBM + ICZM



The sediment deficit: the case of the Ebro Delta

•The **Ebro Delta** has a watershed with a Mediterranean climate in which large river floods with a **high suspended sediment load** were usual before and after human intervention. Values **from 0.1 to 10 g/l** were usual in the Ebro River before dam construction (Ibañez et al. 1996).

• Only recently, after 1960's the Ebro River has undergone a **dramatic reduction of sediment fluxes (up to 99%) due to dam construction for hydropower**. Suspended sediment load is presently <0.01 g/l (Rovira et al. 2012).



Ibáñez, C., Prat, N. and Canicio, A. (1996). Changes in the hidrology and sediment transport produced by large dams on the lower Ebro river and its estuary. *Regulated Rivers* 12(1):51-62.

Rovira, A., Alcaraz, C. & Ibañez, C. (2012). Spatial and temporal dynamics of suspended load at-a-cross-section: The lowermost Ebro River (Catalonia, Spain). *Water Research* 46: 3671-3681.

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Coastal retreat in the Ebro Delta

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Expected coastal retreat in the Ebro Delta

Expected sea level rise in the present century and beyond

Source: Jevrejeva et al. (2012): Sea level projections to AD2500 with a new generation of climate change scenarios. *Global & Planetary Change* 80-81: 14-20.

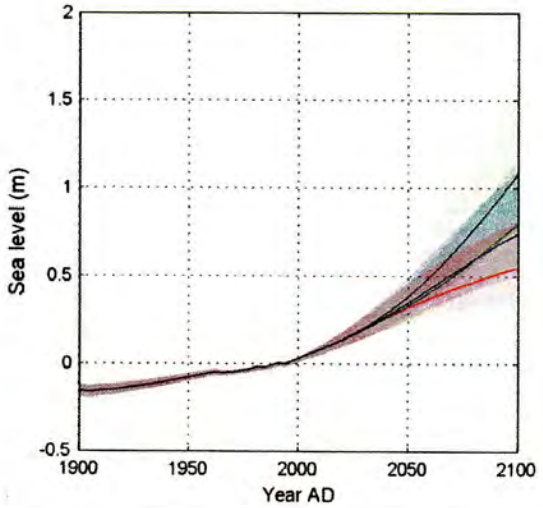

Fig. 3. Sea level projections by 2100 with RCP scenarios; red– RCP3PD, blue– RCP4.5, green– RCP6 and black – RCP8.5. Shadows with similar colour around sea level projections are upper (95%) and low (5%) confidence levels.

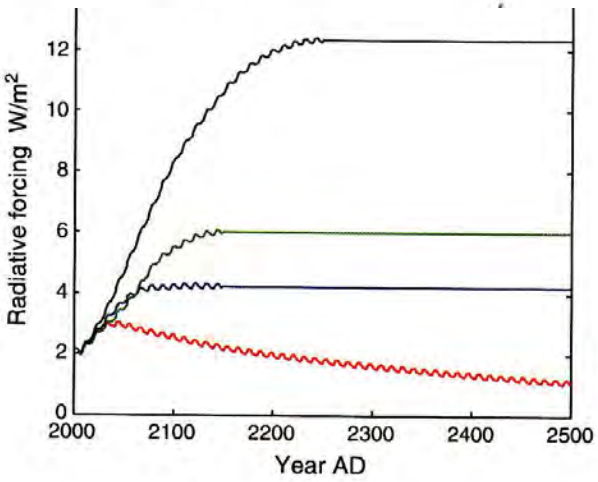

Fig. 1. Radiative forcings for the RCP scenarios; red– RCP3PD, blue– RCP4.5, green– RCP6 and black – RCP8.5.

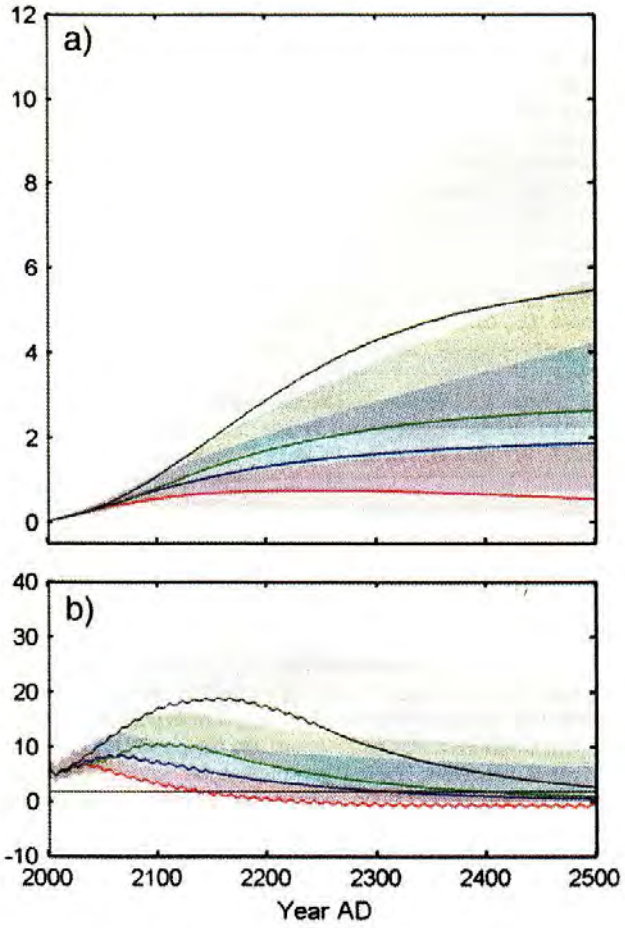

Fig. 4. (a) Sea level projections by 2500 with RCP scenarios; red– RCP3PD, blue– RCP4.5, green– RCP6 and black – RCP8.5. Shadows with similar colour around projections are upper (95%) and low (5%) confidence level. (b) Rates of sea level rise (colour scheme the same as panel a). The black horizontal line corresponds to the rate of sea level rise during the 20th century (1.8 mm/yr).

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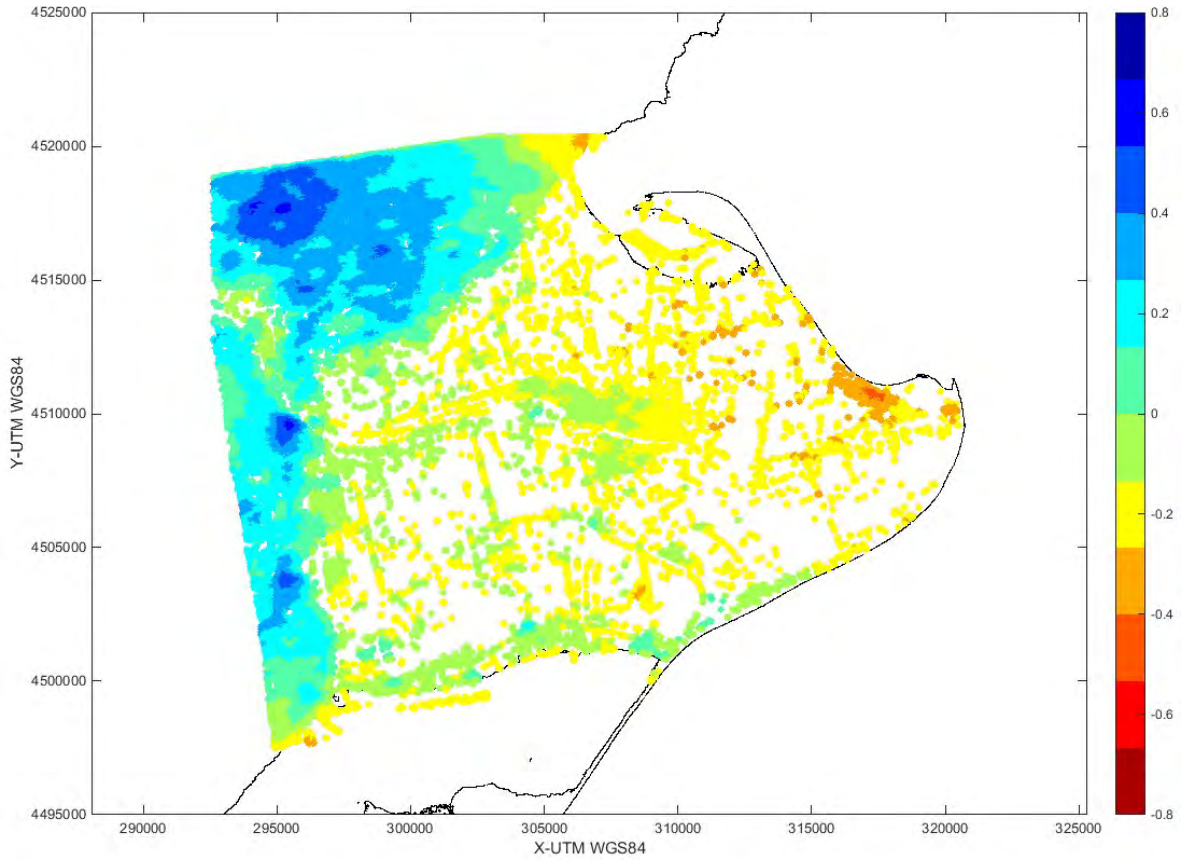
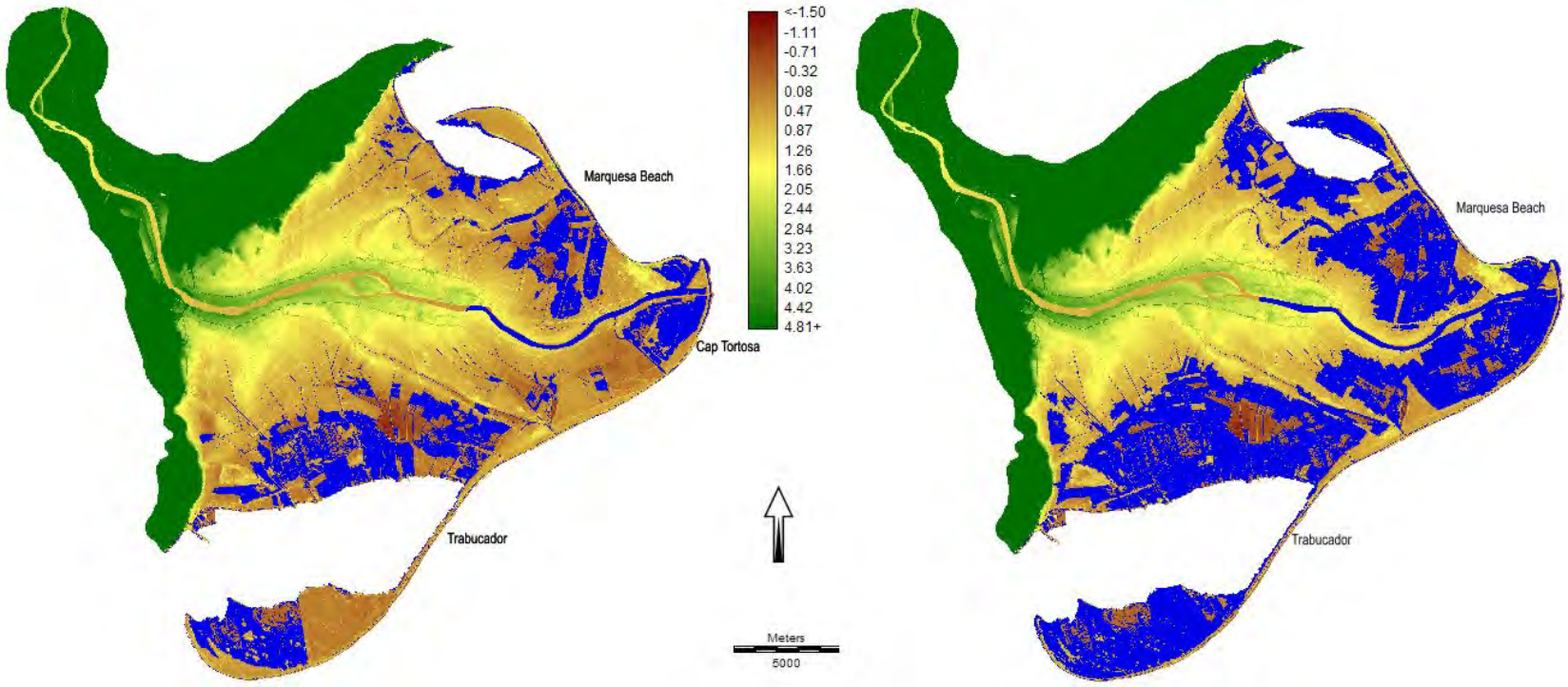
Subsidence and relative sea level rise (RSLR)



- **Subsidence, 1-5 mm/yr**.
- **Seal level rise (SLR), 3-4 mm/yr**.
- **Relative sea level rise (RSLR), 4-9 mm/yr**.

Flooding risks



Flood hazard areas (in blue) to RSLR of 0.25 m (left) and 0.5 m (right) at the Ebro delta. Source: Alvarado-Aguilar and Jiménez

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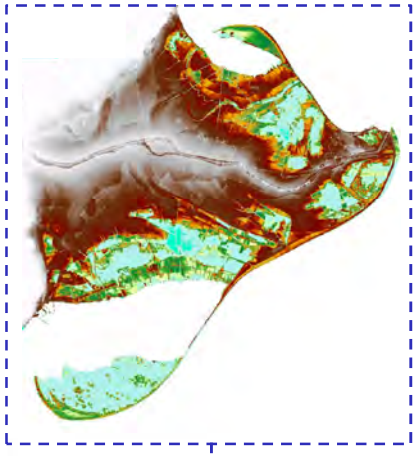
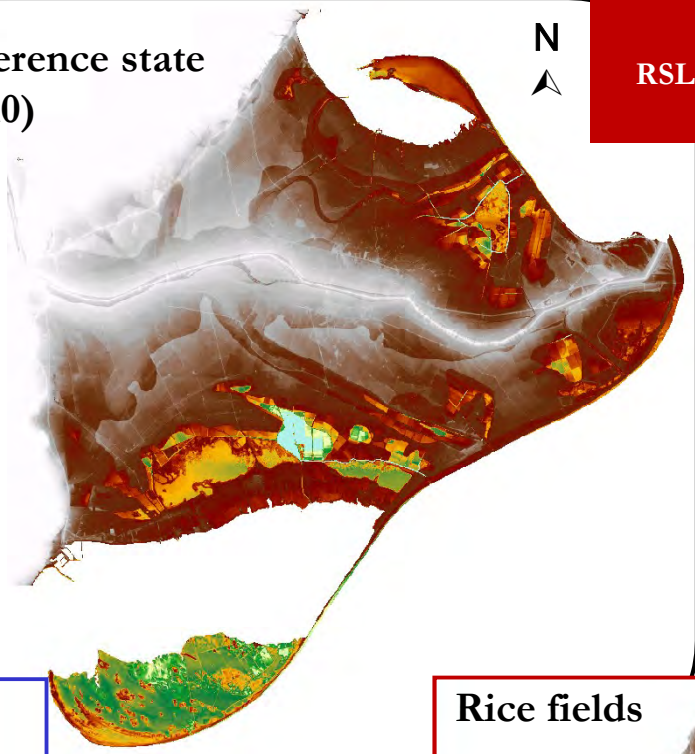
RCP 4.5

RSLR = 0.47 m + (3 mm x 90 yr)

RSLR = 0.74 m



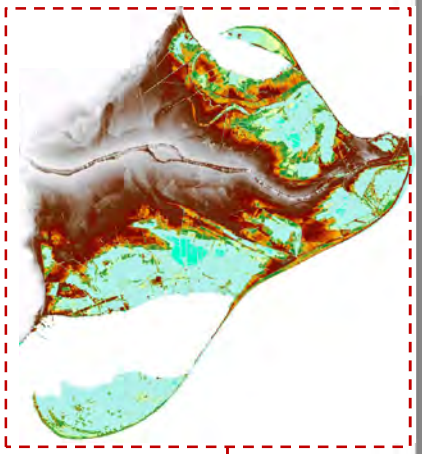
Reference state (2010)



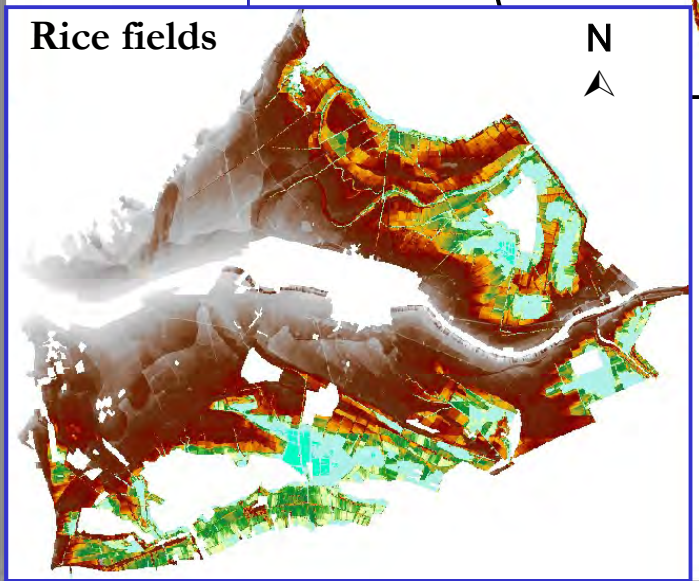
RCP 8.5

RSLR = 0.63 m + (3 mm x 90 yr)

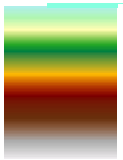
RSLR = 0.90 m



Rice fields



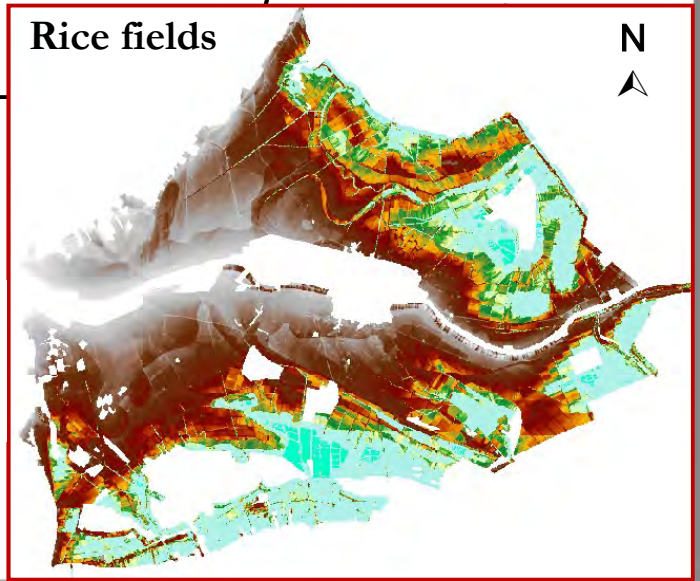
Soil salinity (dS m^{-1})



Maximum: >20

Minimum: 0

Rice fields



Adaptation options for high-end scenarios of SLR

- The current approach (structural): **rising dikes** (The Netherlands).

- The alternative approach (functional): **rising grounds** (Ebro Delta).

- The combined approach (structural & functional): **rising dikes & rising grounds** (Mississippi Delta).

• The **current view** is that protection is the best (or the only) strategy for future SLR up to 2 to 5 meters. Beyond 5 meters the retreat would be the best (or the only) strategy (Tol et al. 2006).

• The **alternative view** suggest that "rising dikes" will be only feasible if "rising grounds" is also implemented; if not, retreat will be the only solution in the long-run. Rising grounds could be the main strategy in most deltas.

• **We propose that "rising grounds" is the best adaptation strategy in most deltas** for high-end scenarios of SLR, though in some cases the option of retreating may be necessary in combination with structural and functional measures.

• The **different options should be applied as a function of the natural and human features of deltas** (population and urbanisation level, availability of sediment sources, local rates of relative sea-level rise, etc.).

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The goal of Life EBRO-ADMICLIM

We propose an **integrated approach for managing water, sediment and habitats** (rice fields and wetlands), with the **multiple aim** of **increasing ground elevation** (through inputs of inorganic sediment and organic matter), **reducing coastal erosion**, increasing **carbon sequestration** in the soil, **reducing emissions of greenhouse gases** (GHG), and **improving water quality**.

Put it in another way, the idea is to **jointly manage the inputs of inorganic and organic matter** (i.e. sediment and plant residues respectively) of the ground, in order to optimize vertical accretion processes (soil formation) and organic matter decomposition (GHG emissions) in **rice fields** and in **constructed wetlands**.

The Project Life EBRO-ADMICLIM: actions

B1. Pilot test of injection of sediment from a water treatment plant into the Ebro Delta irrigation network.
Assessing the feasibility of reinjecting sediments from the water treatment plant into the Ebro Delta, so that the sludge becomes a resource contributing to climate change adaptation.

B2. Pilot test of injecting sediment into the final stretch of the river Ebro.
Evaluation of the potential for sediment transport in the current hydrologic conditions of the River Ebro, to determine the feasibility of transferring sediments from the reservoirs.

B3. Operational optimization of two constructed wetlands to maximize carbon sequestration, the soil elevation, and the assimilation of nutrients and pollutants.
Optimization of these variables by testing different water management schemes.

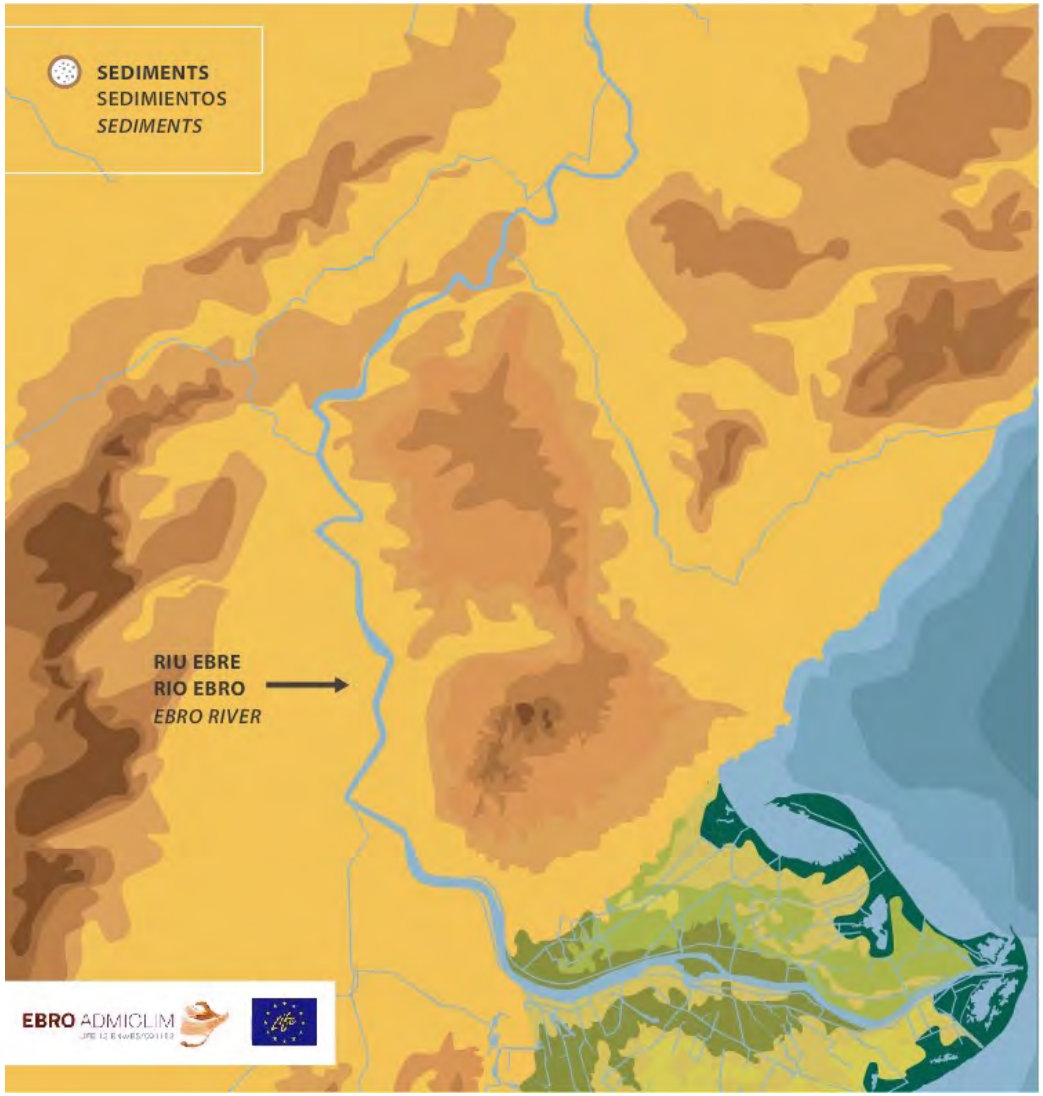
B4. Optimization of GHG emissions and carbon sequestration in the rice fields of the Ebro Delta.
Evaluation of emissions and sequestration as a function of agricultural practices and the characterization of terrains. Establishment of the basis for a plan for GHG emissions management.

B5. Evaluation of the effects of sediment from a water treatment plant on rice production and GHG emissions.
To assess the possible effects of sediment supply from the water treatment plant CAT on rice production.

B6. Assessment of areas vulnerable to subsidence and sea-level rise.
Determination of the most vulnerable areas of the delta with high spatial resolution.

B7. Developing a Climate Action Plan of the Ebro Delta.
Integration of adaptation measures and mitigation to develop a coherent scheme of measures that will combine those in the Catalan Strategy for Climate Change Adaptation with those resulting from the pilot actions.

Restoring the river sediment flow from the Reservoirs: the Ebro case



1. Transfer the sediment stored into the reservoirs
2. Sediment transport by the river
3. Sediment transport by the irrigation network
4. Sediment deposition in the river mouth and the rice fields

Execution of sediment injection tests and monitoring

Execution of sediment injection pilot tests in the irrigation canals

The Project Life EBRO-ADMICLIM

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Highlights:

- **Successful integration of research and innovation goals** under a sound scientific paradigm.
- **Effective integration of a complex team of diverse institutions**: IRTA, Comunitat de Regants, Consorci d'Aigües de Tarragona, Oficina Catalana de Canvi Climàtic, Institut Cartogràfic i Geològic de Catalunya, Agència Catalana de l'Aigua, Universidad de Córdoba.
- **Strong interaction with the rice sector and irrigation communities**, as well as NGO's (Campanya pels Sediments).
- **Relevant outcomes in terms of innovation**: system of sediment recycling (CAT), agronomic practices to reduce GHG emissions (rice sector), sediment transport guidelines (irrigation communities), sediment transport model (Universidad de Córdoba).
- **Interest of private companies**: Aquatech (Suez), Flowtite and Proyecar.
- **Great potential for future R+D projects** with the private sector and leading research groups (H2020, Life, etc.).
- **Hugh impact on mass media and the society**: large number of news in top newspapers, TV and radio: TV program Volando Voy (Cuatro), TV3, El Periódico, etc. More than 155.000 visits to the web site! www.lifeebroadmiclim.eu
- **Potential impact on Catalan, Spanish and EU policies**: Technical Commission on Sediments (Generalitat), Comissió d'Agricultura i Medi Ambient (Parlament and Congreso de los Diputados), Water Framework Directive, Sediment Management (European Union).

Thanks for your attention !

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delta LAGOON
LIFE 09 NAT/ES/000520

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