Marsh elevation and carbon accumulation in a Mediterranean restored marsh (Ebro Delta, Spain)

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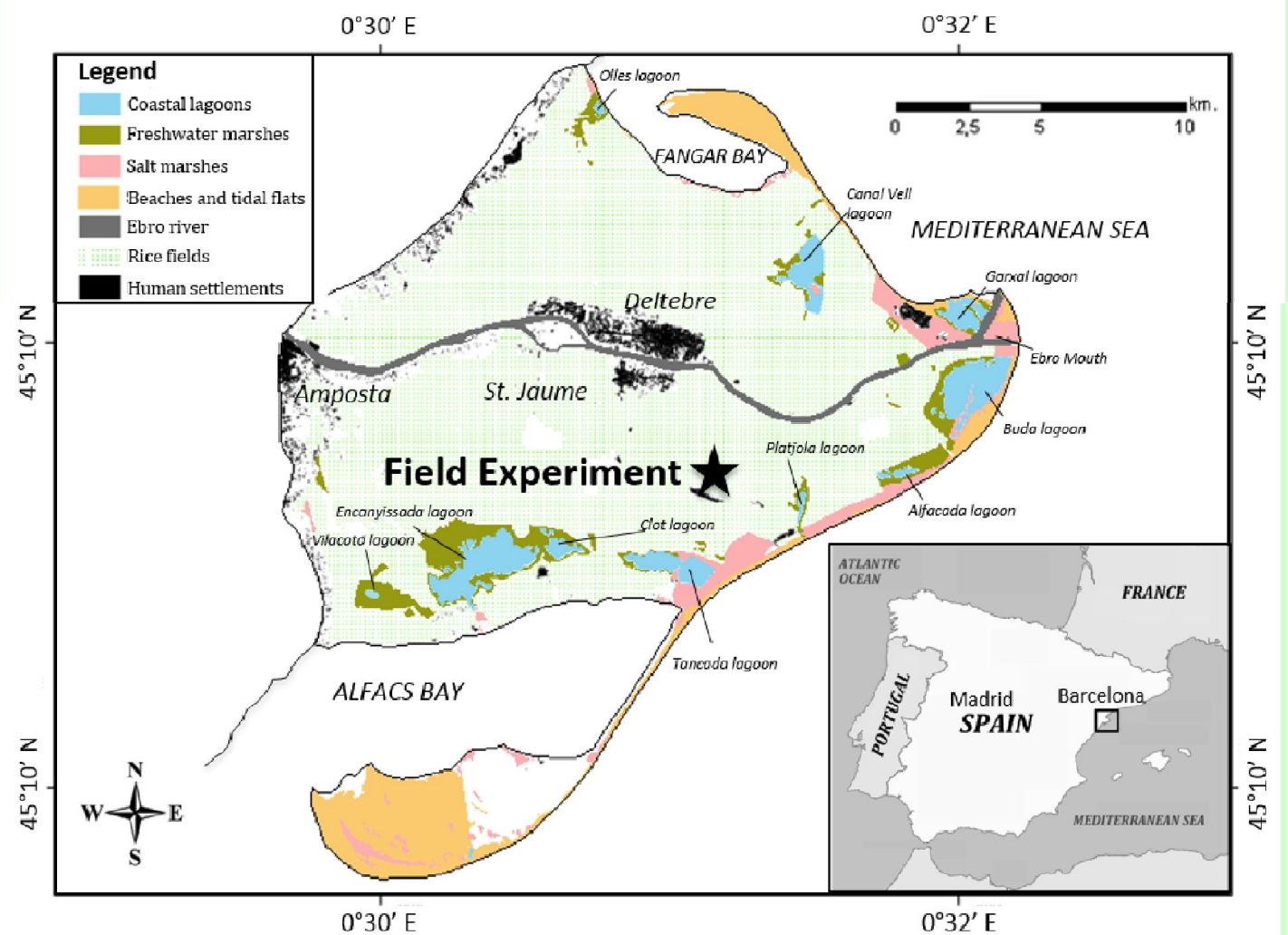
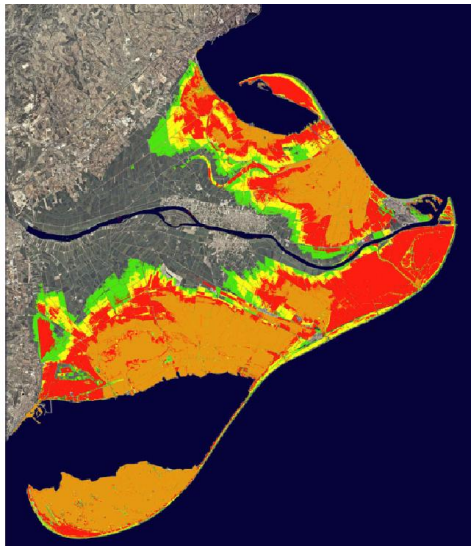
EBRO DELTA: ECOLOGICAL AND ECONOMIC VALUES

1. The Ebro delta is **the largest delta in Western Mediterranean** (330 Km2)
2. High **diversity of coastal ecosystems:** Coastal lagoons, bays, salt marshes, freshwater marshes…
3. **Rice fields** main economic activity (**60% delta plain**)



ECOLOGICAL IMPACTS: DELTAIC FLOODING RISK

EBRO DELTA FLOODING RISK MAP (year 2100)



Higher risk (RSLR = 5 mm/yr)
Medium risk (RSLR = 7 mm/yr)
Lower risk (RSLR = 8 mm/yr)

(From Alvarado-Aguilar et al. 2012)

Human infrastructures: Dams
Global warming

↓

Sediment input reduction
Accelerated Sea-Level Rise

↓

Deltaic subsidence = Flooding risk

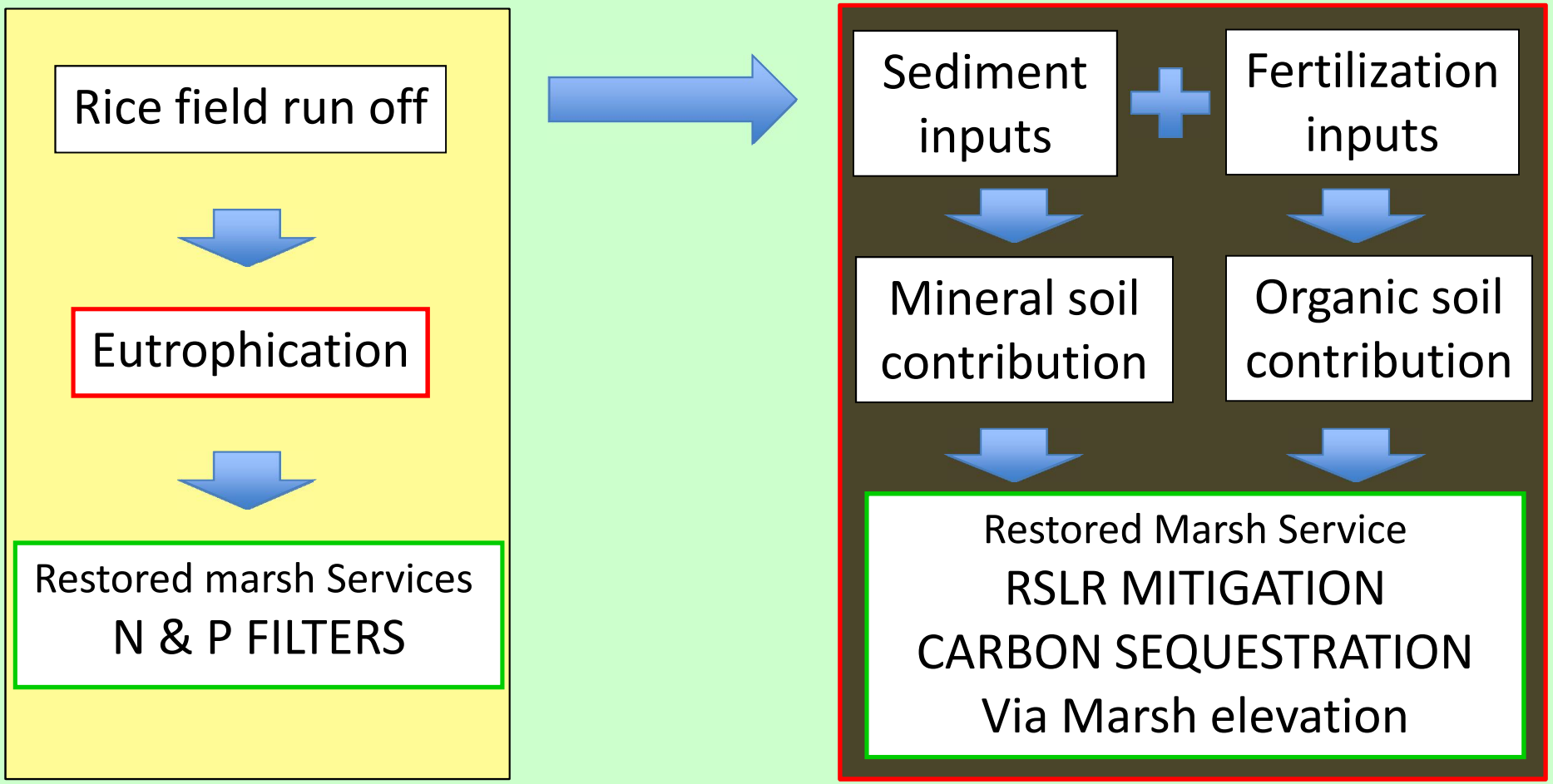
↓

Marsh surface Loss
Damage of rice fields: Loss and saline intrusion
Human population displacements

↓

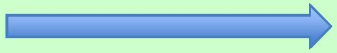
Restored marshes
SUBSIDENCE MITIGATION
via marsh elevation

ECOLOGICAL IMPACTS: AGRICULTURAL POLLUTION



OBJECTIVES

Assess marsh restoration initiatives regarding factors promoting marsh elevation and carbon sequestration



by conversion of rice fields back to restored marshes in the areas of lower elevation

MAIN RESEARCH QUESTIONS

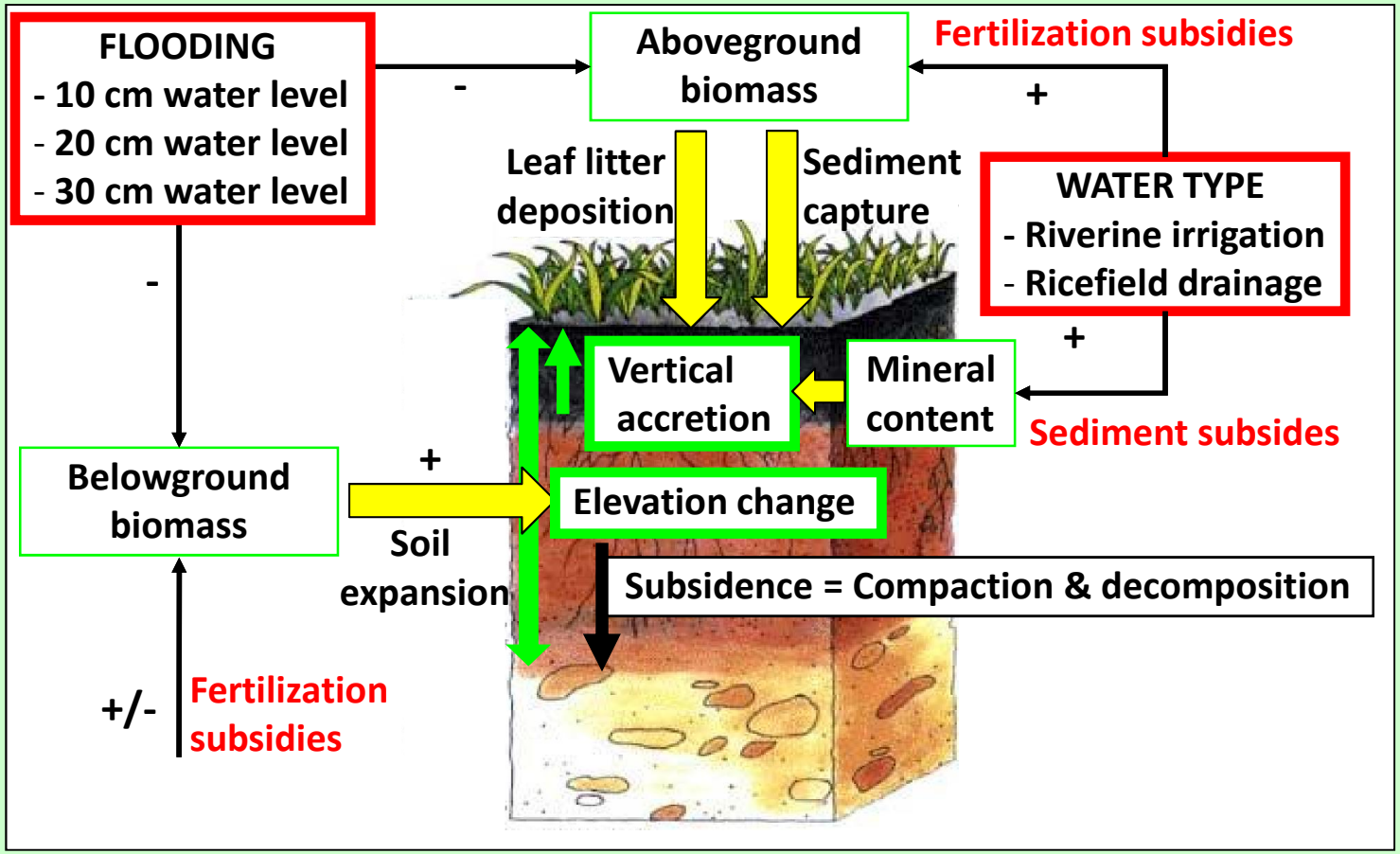
1. **Do fertilization and sediment inputs from rice field run off enhance vertical accretion and elevation change in an oligohaline restored marsh?**

2. **Both vertical accretion and elevation change should have higher rates compared with predicted RSLR in the Ebro Delta (5–8 mm yr^{-1}).**

3. **Do fertilization and sediment inputs from rice field run off enhance carbon accumulation in an oligohaline restored marsh?**

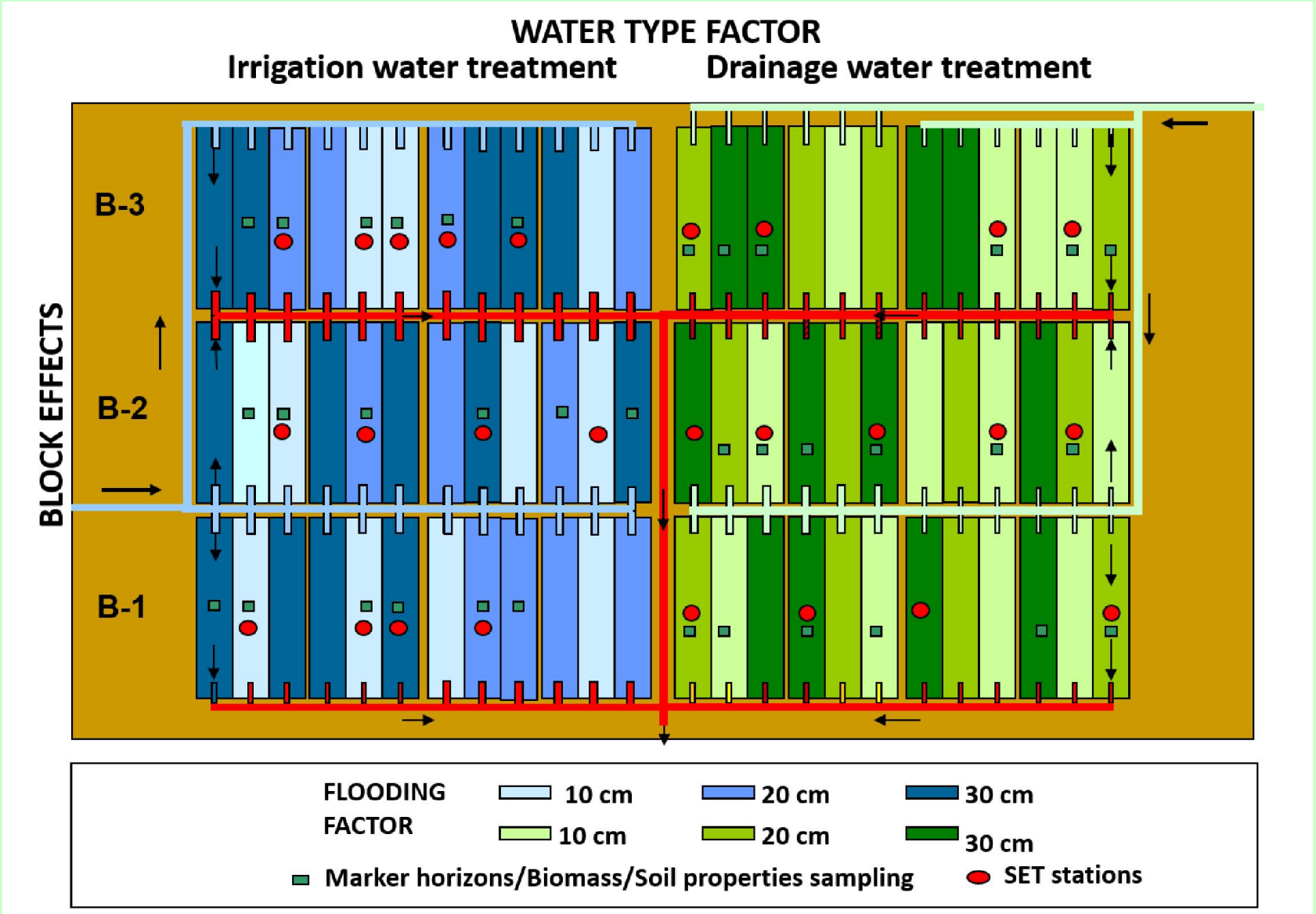
EXPERIMENTAL DESIGN

Treatments and response variables



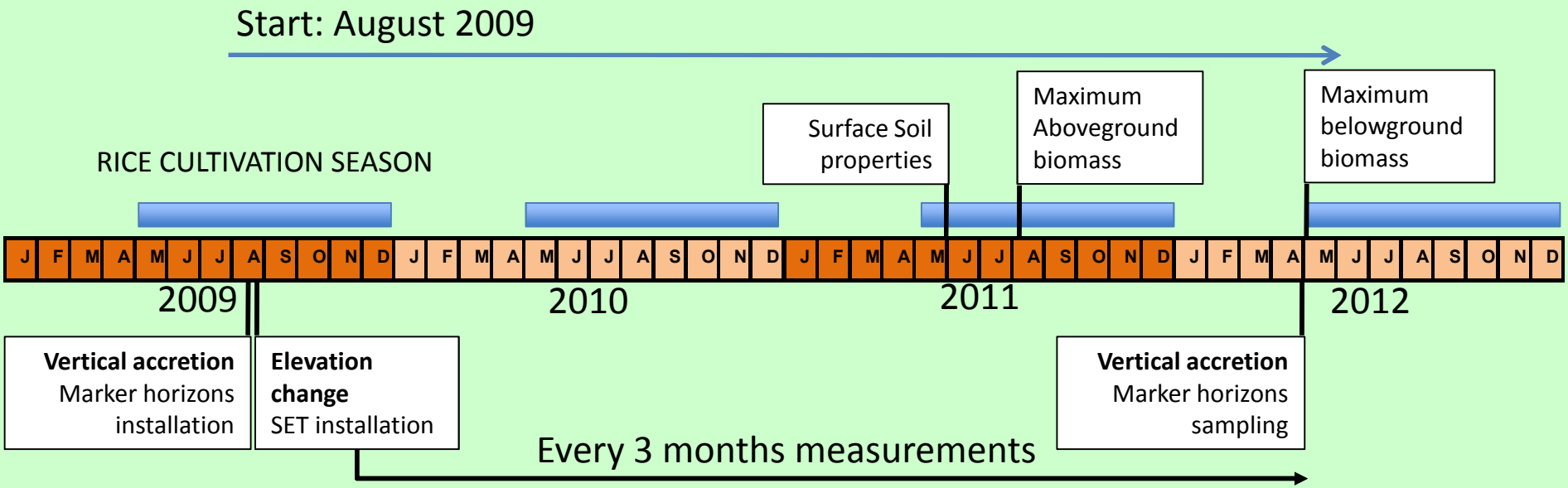
EXPERIMENTAL DESIGN Location

EXPERIMENTAL DESIGN



EXPERIMENTAL DESIGN Construction

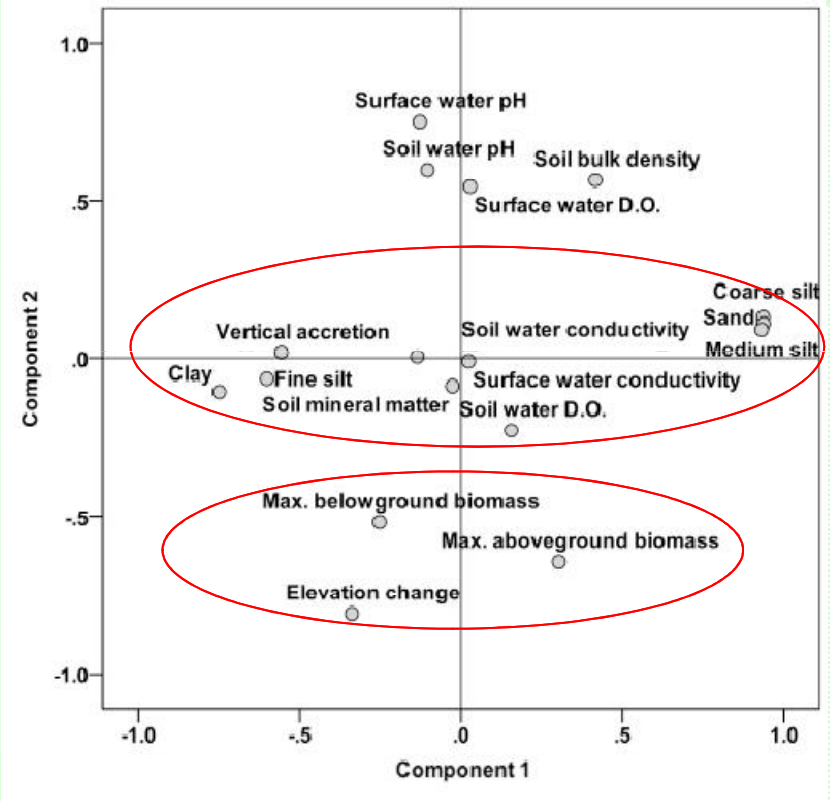
SAMPLING DESIGN



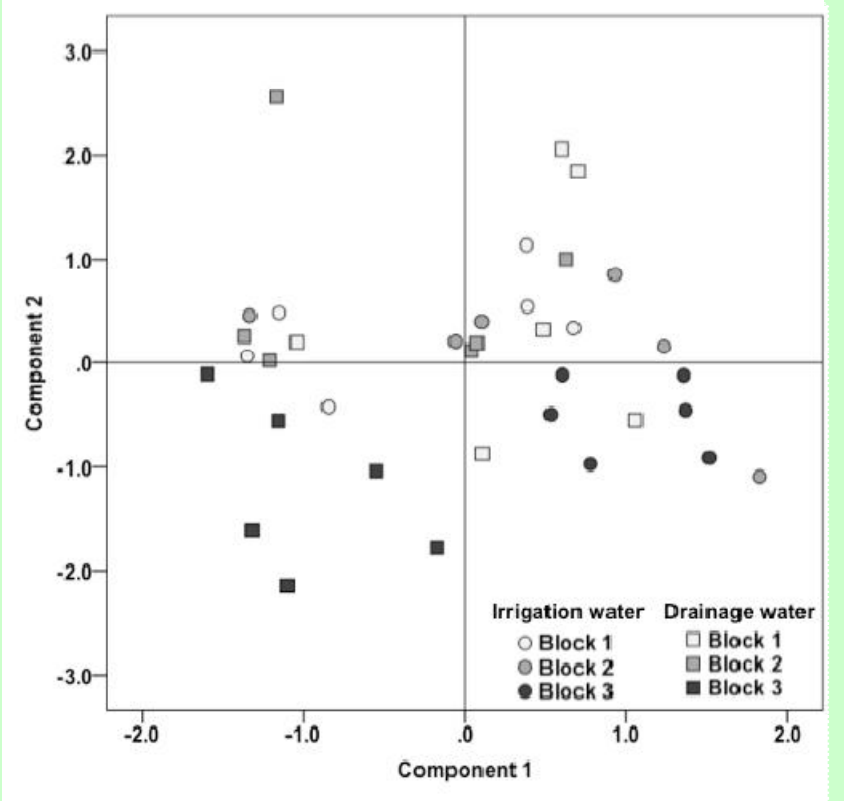
C soil accumulation (g/m²yr) = C content (g/Kg) x B. density (g/cm3) x V. accretion (mm/yr)

MARSH ELEVATION STUDY: PCA RESULTS

RESPONSE VARIABLES LOADINGS (CORRELATIONS)



EXPERIMENTAL UNITS SCORES



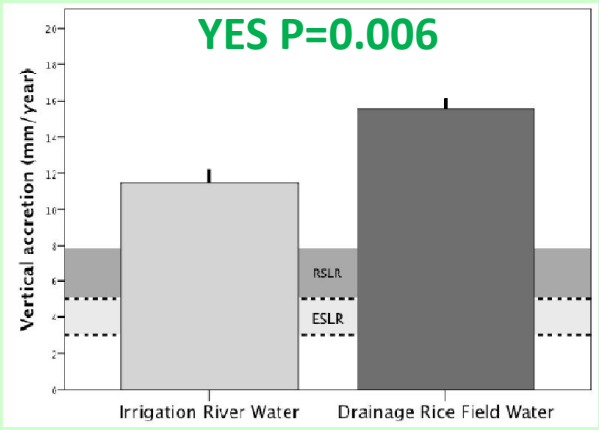
Component 1:
Vertical accretion-Soil properties relationships
Component 2:
Elevation change-Above/below biomass

Component 1 (26.89 % variation) explained by water type treatments
Component 2 (16.24 % variation) explained by block effects

MARSH ELEVATION STUDY: ANOVA RESULTS
Differences between water types

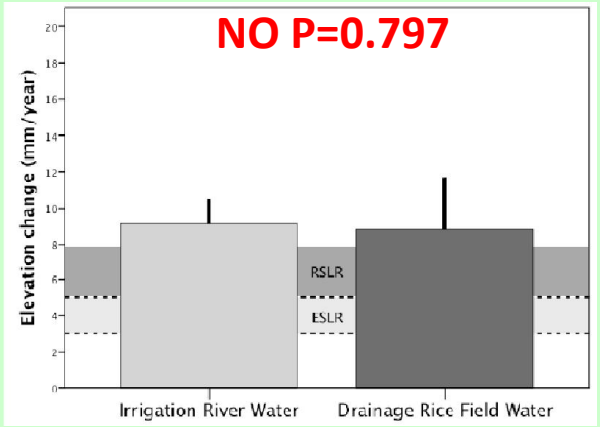
VERTICAL ACCRETION

YES P=0.006



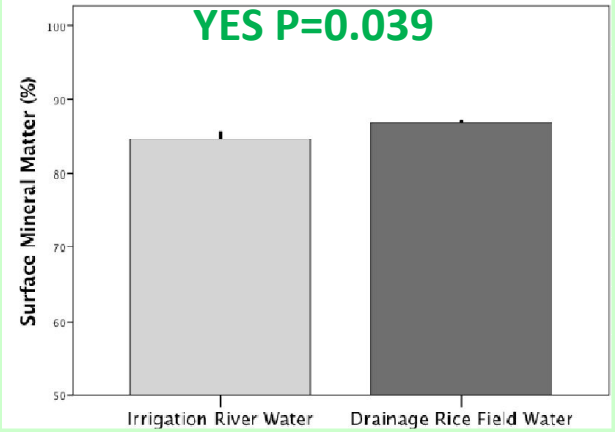
ELEVATION CHANGE

NO P=0.797



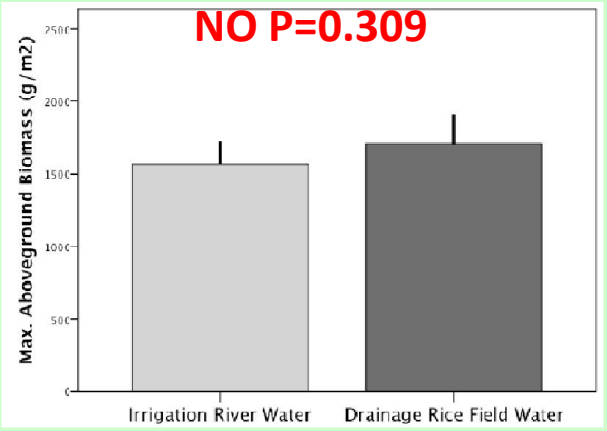
SURFACE MINERAL CONTENT

YES P=0.039



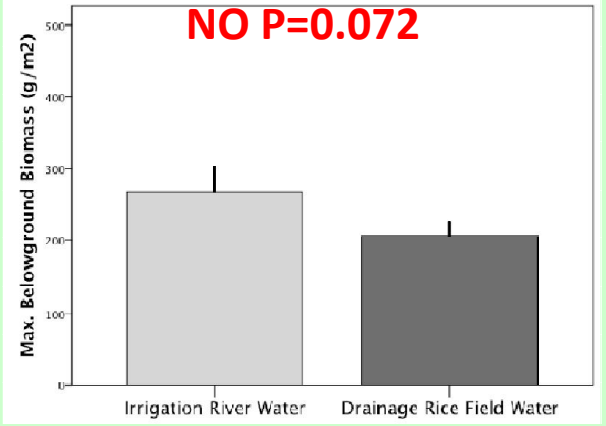
MAX. ABOVEGROUND BIOMASS

NO P=0.309



MAX. BELOWGROUND BIOMASS

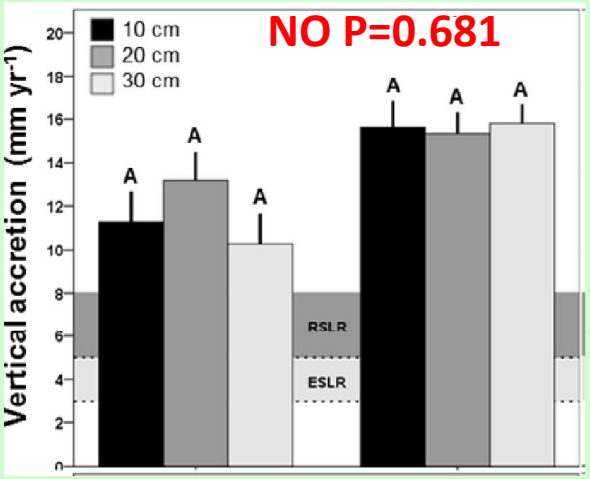
NO P=0.072



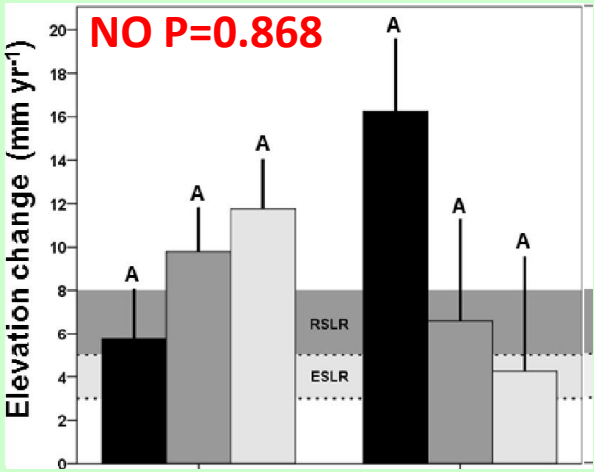
MARSH ELEVATION STUDY: ANOVA RESULTS

Differences between water levels

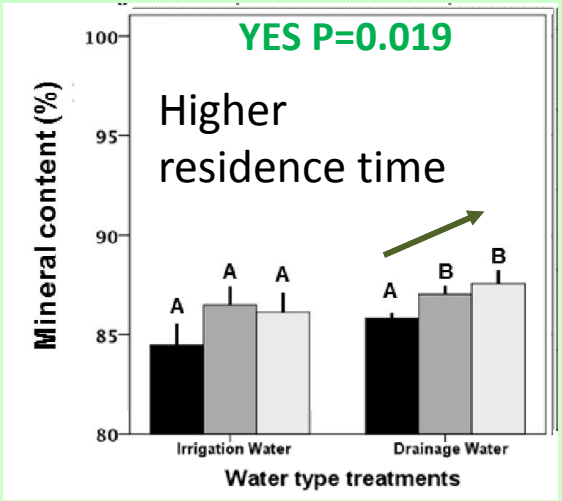
VERTICAL ACCRETION



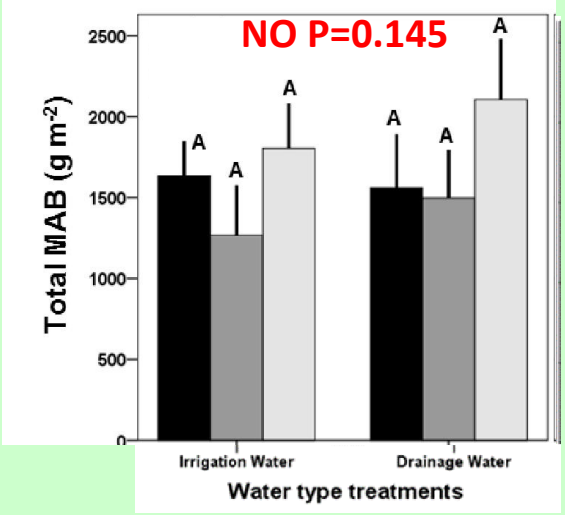
ELEVATION CHANGE



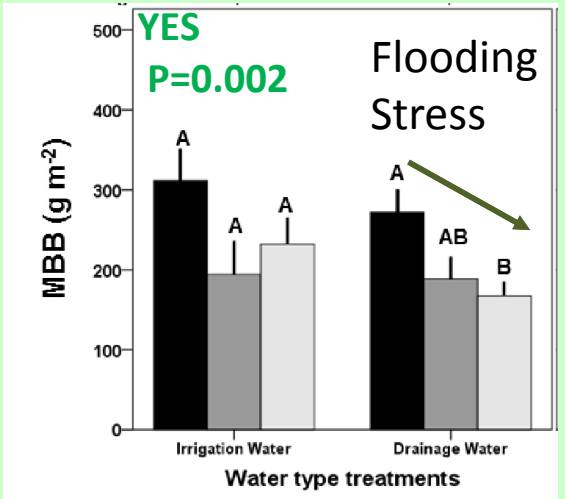
SURFACE MINERAL CONTENT



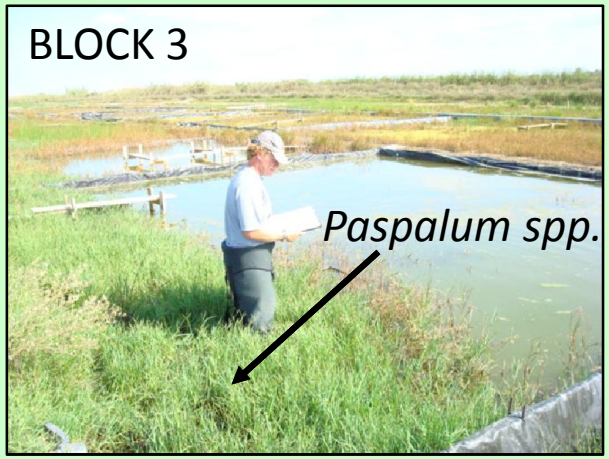
MAX. ABOVEGROUND BIOMASS



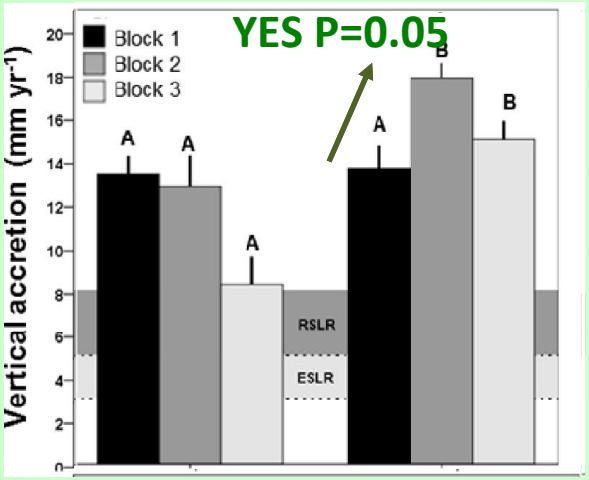
MAX. BELOWGROUND BIOMASS



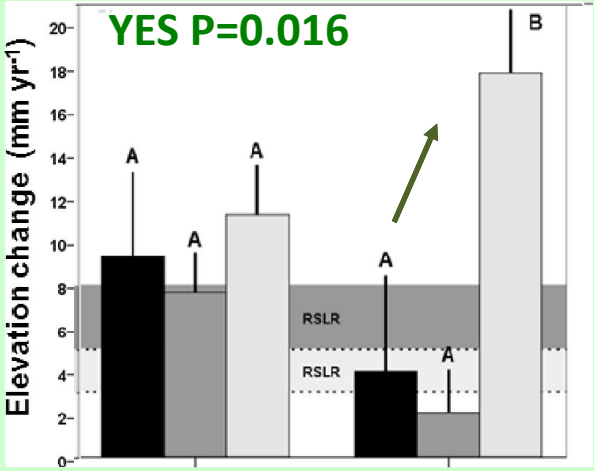
MARSH ELEVATION STUDY: ANOVA RESULTS
Differences between blocks



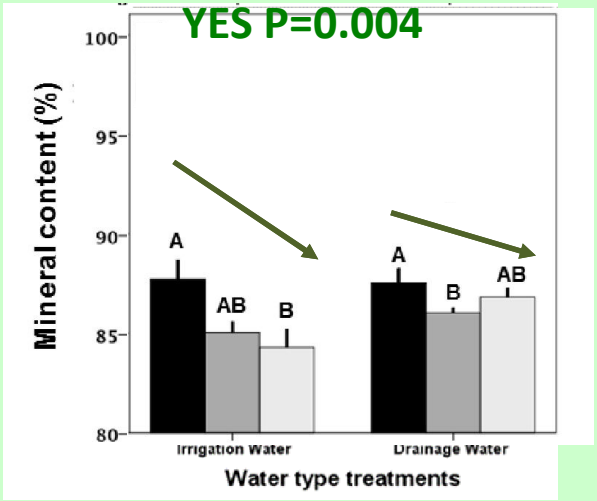
VERTICAL ACCRETION



ELEVATION CHANGE



SURFACE MINERAL CONTENT



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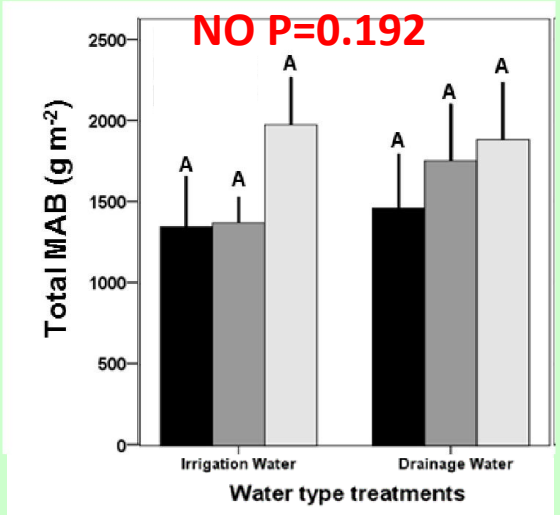
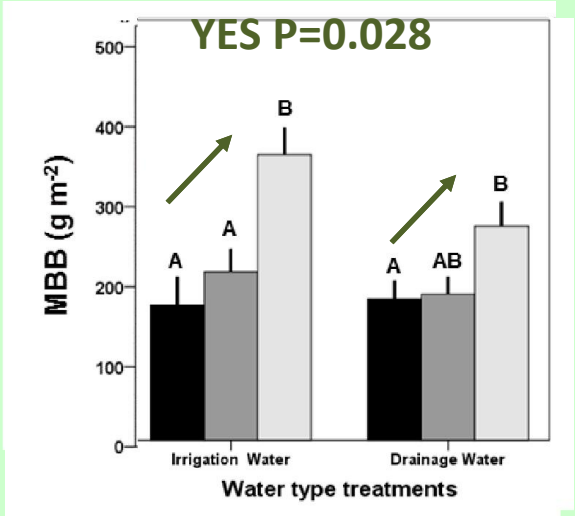
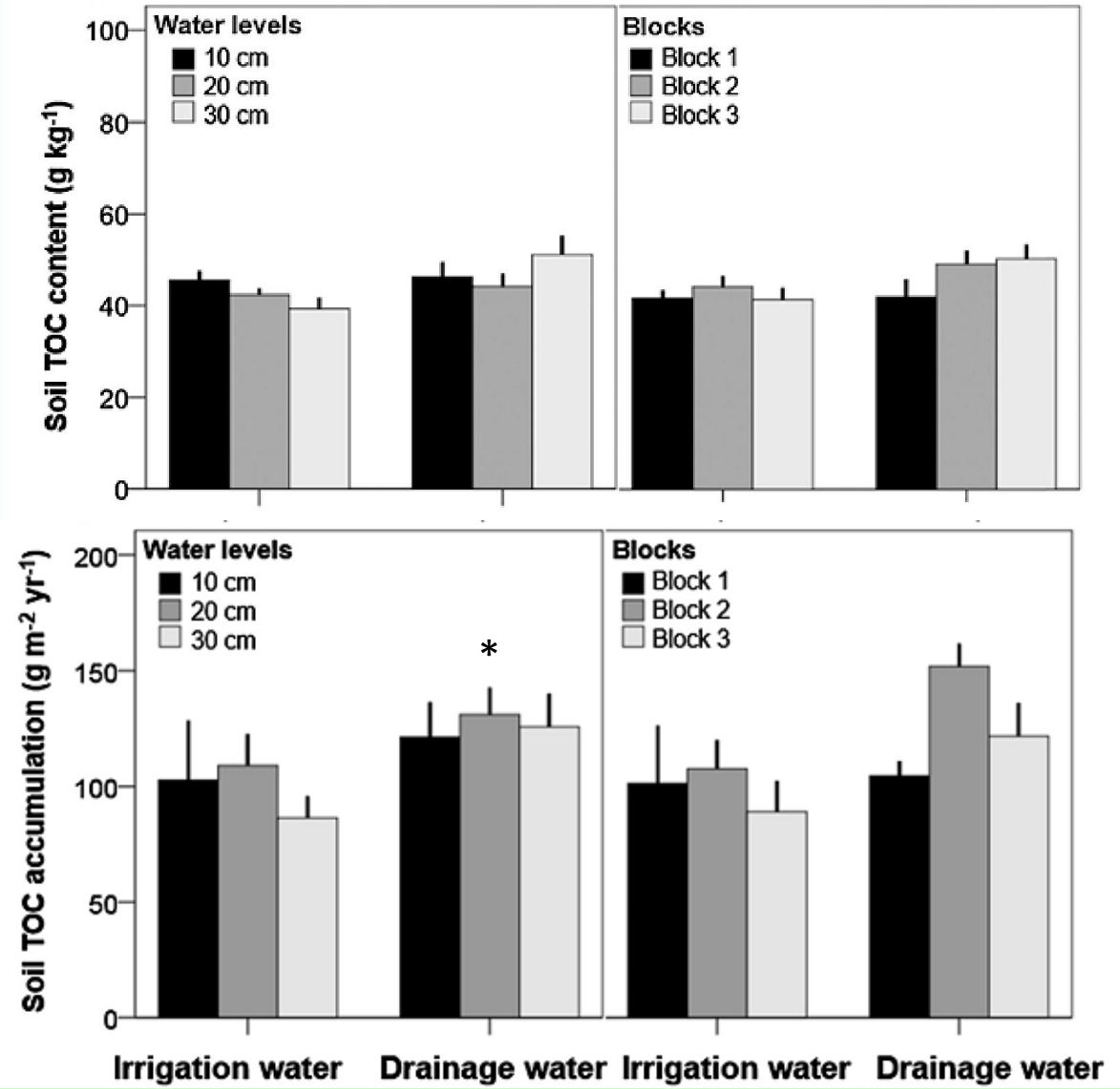


MAX. BELOWGROUND BIOMASS

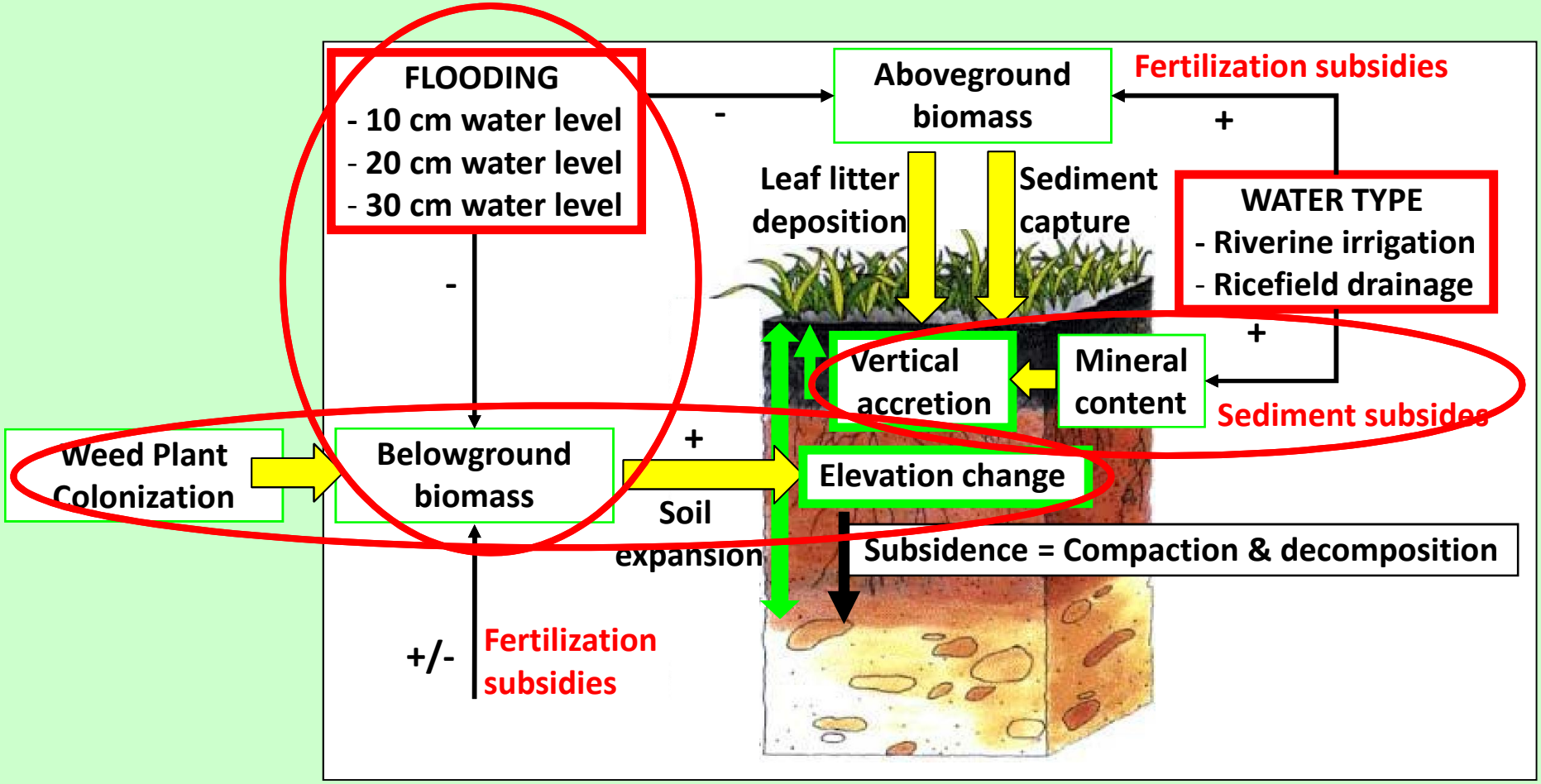


CARBON ACCUMULATION STUDY: ANOVA RESULTS

Differences between water types, water levels and blocks



MARSH ELEVATION STUDY DISCUSSION



CARBON ACCUMULATION STUDY DISCUSSION

HIGH ORGANIC AND MINERAL SEDIMENT DISCHARGE
Rice field drainage water

+

CARBON CONTENT AND ACCUMULATION

+

BELOWGROUND CONTRIBUTION

-

HIGH NUTRIENT DISCHARGE
Rice field drainage water

MANAGEMENT IMPLICATIONS

1. Marsh elevation and carbon accumulation were generally **controlled by sediment contributions.**

2. ***P. distichum* played a significant role** in marsh elevation via root growth.

3. Restored marshes using either water type promote marsh elevation gains **higher than predicted RSLR** at least during the initial marsh development (3 years).

The use of **agricultural runoff is beneficial** for marsh restoration projects focused primarily on mitigating RSLR and C accumulation.

The use of *P. distichum* to mitigate RSLR impacts is an **inexpensive and effective measure** to promote marsh elevation as the primary restoration goal.

AKNOWLEDGEMENTS

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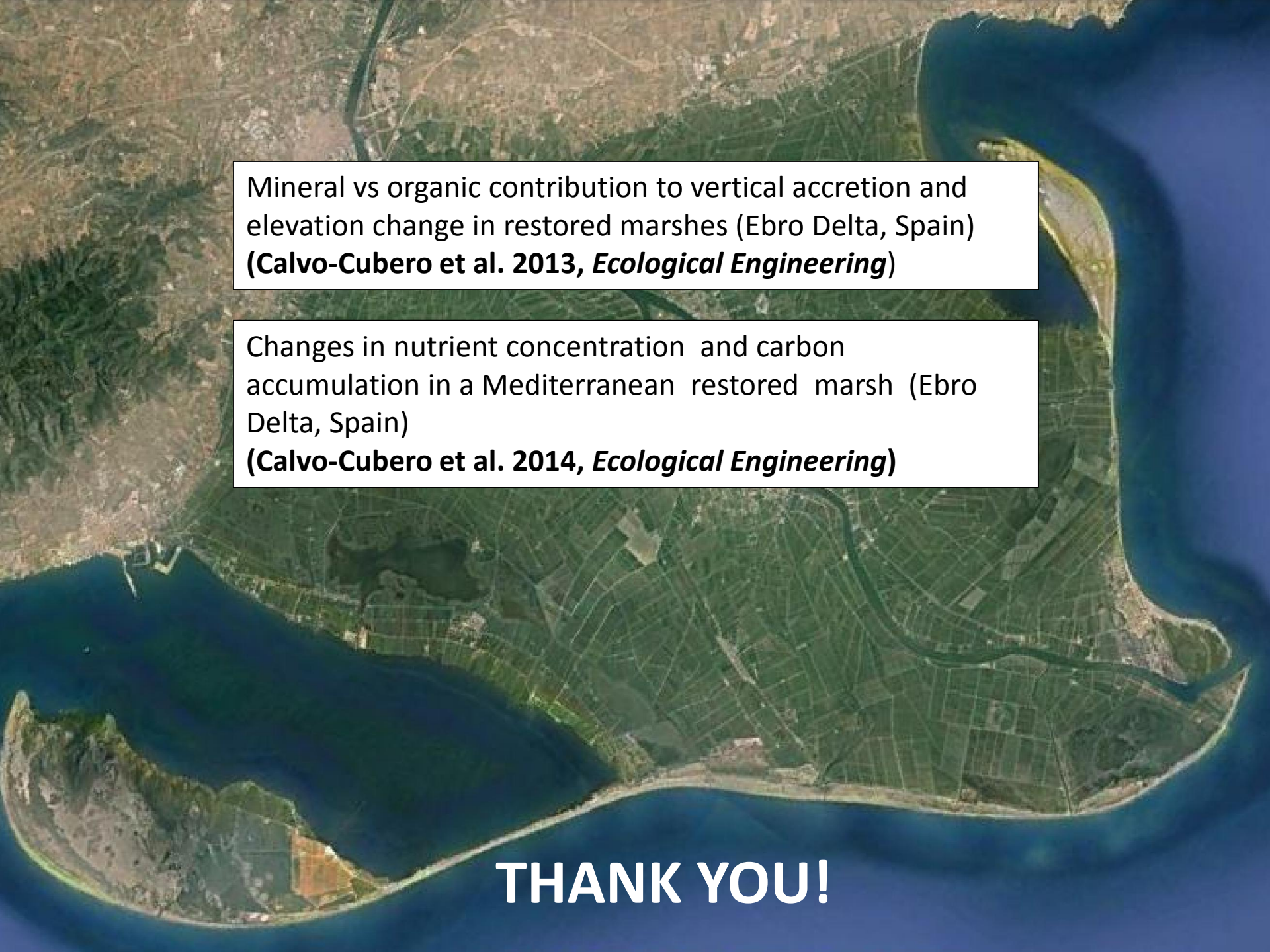
Research Project 056/RN08/04.3
Development of techniques to compensate subsidence and sea-level rise in coasts and wetlands of the Ebro Delta.



Mineral vs organic contribution to vertical accretion and elevation change in restored marshes (Ebro Delta, Spain) **(Calvo-Cubero et al. 2013, *Ecological Engineering*)**

Changes in nutrient concentration and carbon accumulation in a Mediterranean restored marsh (Ebro Delta, Spain) **(Calvo-Cubero et al. 2014, *Ecological Engineering*)**

THANK YOU!