EGU General Assembly 2022

Spatial and vertical patterns of Soil Organic Matter and Carbon content in the salt marshes of the Venice Lagoon (Italy)

Puppin, A., Tognin, D., Ghinassi, M., Franceschinis, E., Realdon, N., Marani, M., D'Alpaos, A.

Alice Puppin –
EGU General Assembly - Vienna, Austria, 27 May 2022

Università degli Studi di Padova

Venezia2021

This presentation participates in OSPP

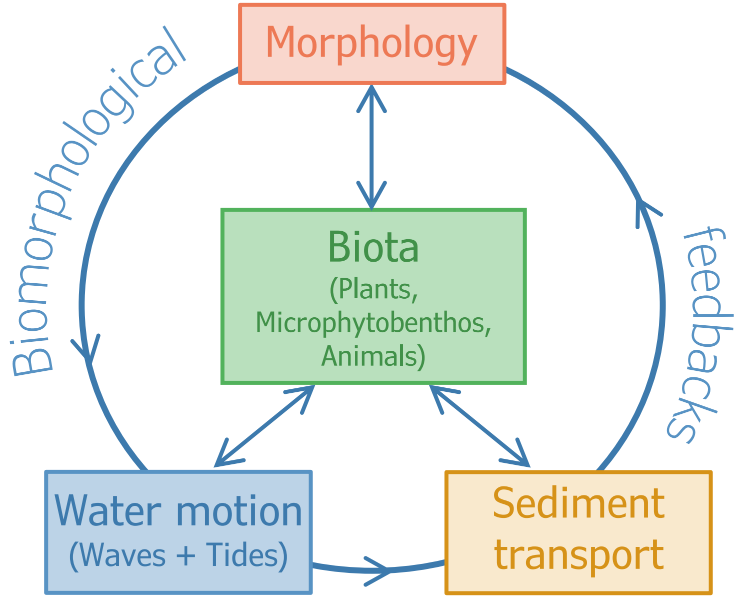
Outstanding Student & PhD candidate Presentation contest

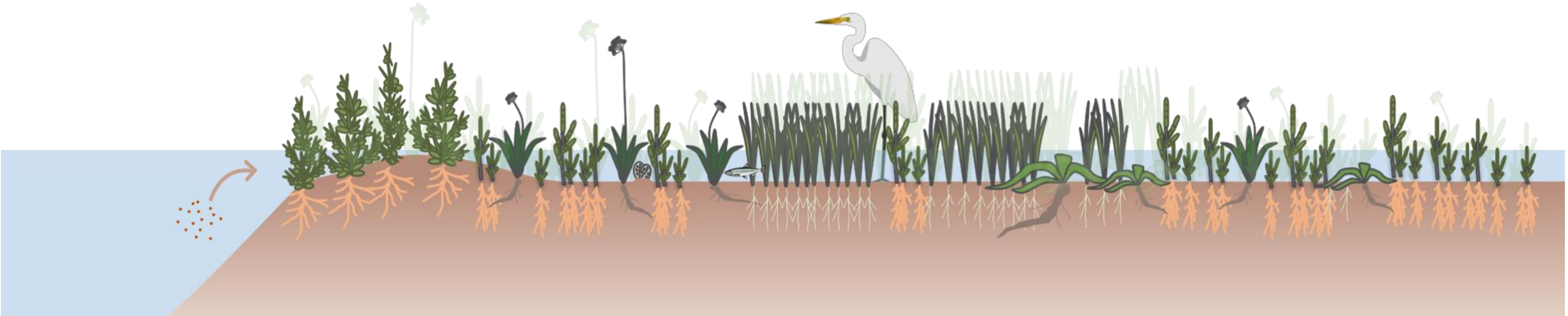
Salt marshes: tidal ecosystems

↘ regularly flooded by the tide

↘ herbaceous salt-tolerant vegetation

↘ dynamic evolution regulated by biomorphological feedbacks

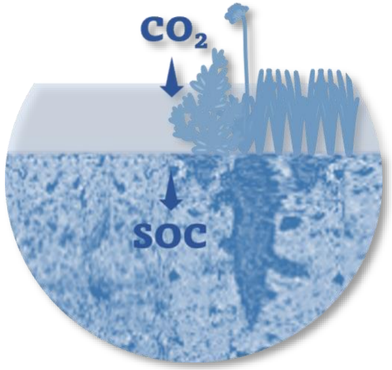




Salt marshes: valuable ecosystems

Diverse range of ecosystem services

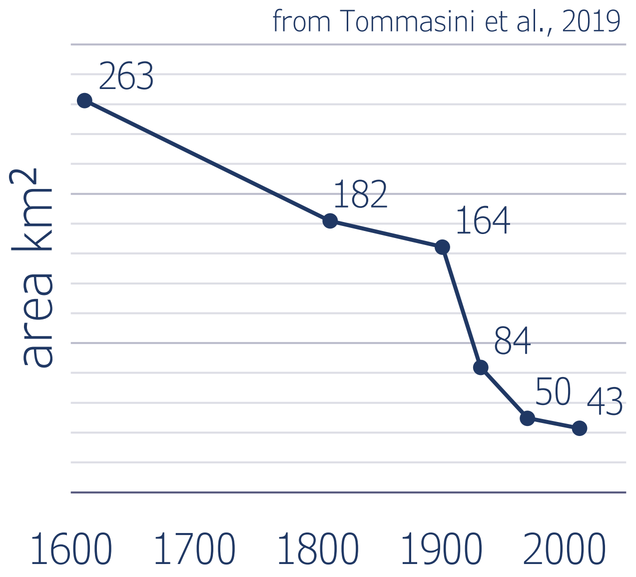
- ↘ coastal protection
- ↘ sediment trapping
- ↘ nutrient/pollutant filtration
- ↘ biodiversity support
- ↘ fishery support
- ↘ blue carbon



Salt marshes: fragile ecosystems

- ↘ accelerating relative sea-level rise
- ↘ declining sediment supply
- ↘ coastal land reclamation

Salt-marsh loss
in the Venice lagoon



Project aim

Better understading of **ORGANIC MATTER DYNAMICS**

improve & inform

BIOGEOMORPHOLOGICAL MODELS

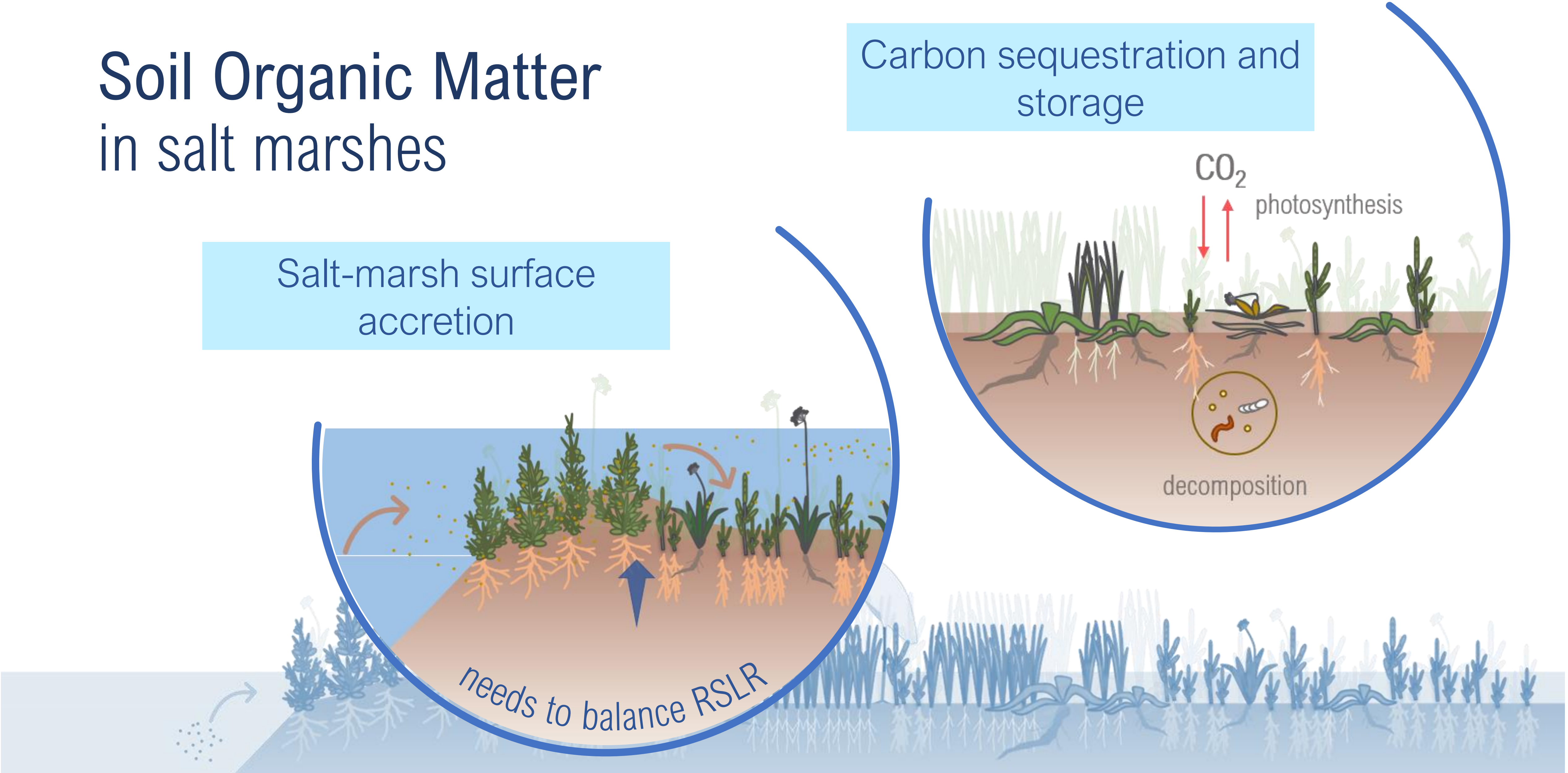
MANAGEMENT & CONSERVATION

Surface accretion and marsh survival

Carbon storage function

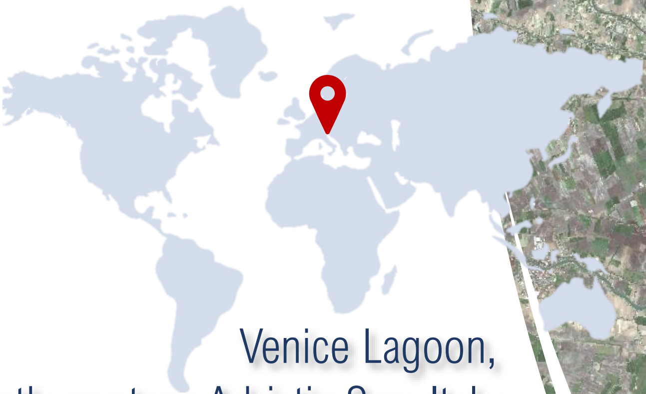
in the face of climate change

Soil Organic Matter
in salt marshes

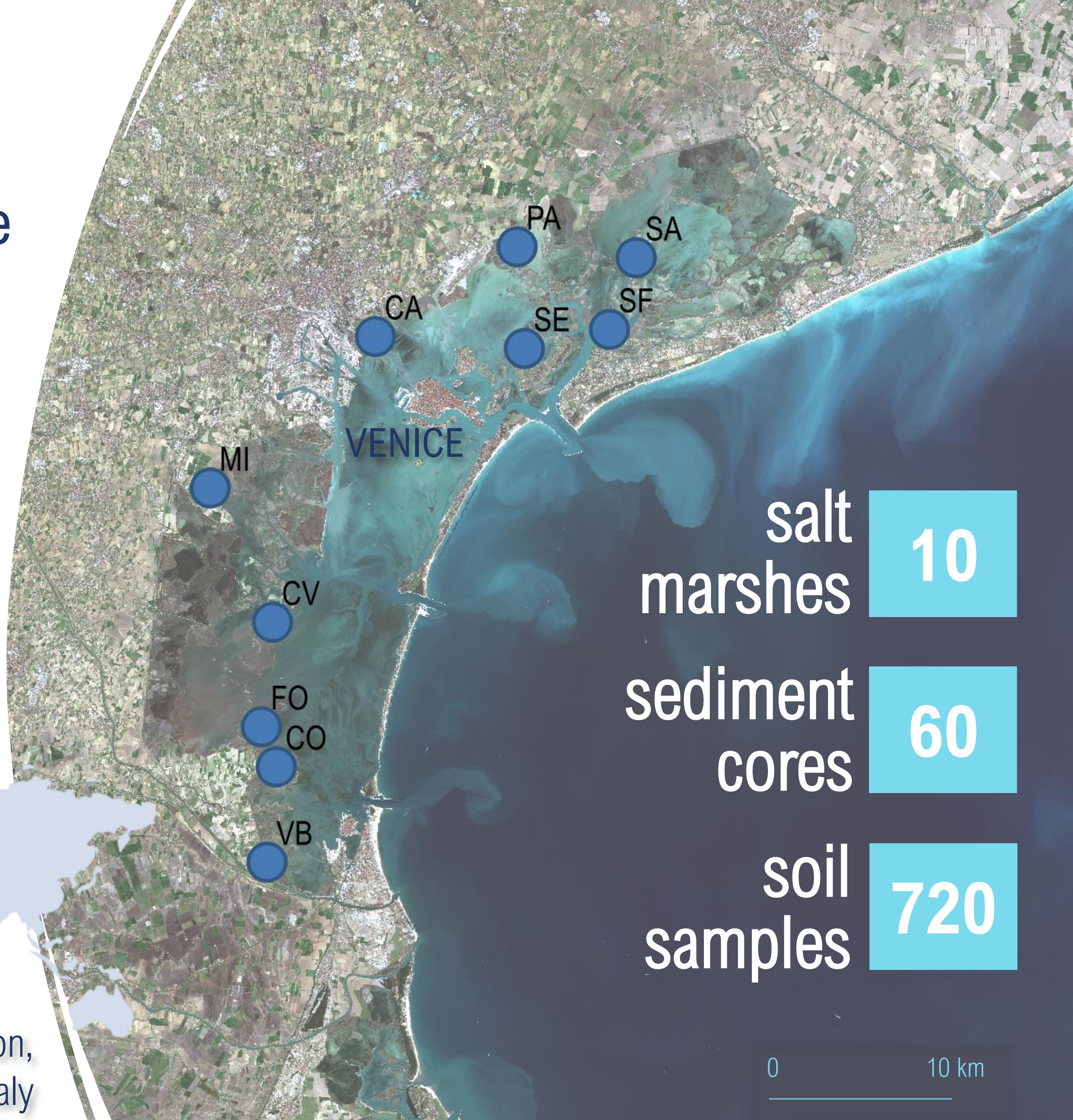


Spatial and vertical patterns of Soil Organic Matter and Carbon in the salt marshes of the Venice Lagoon (Italy)

- Area ≈ 550 km2
- Mean water depth ≈ 1.5 m
- Semidiurnal microtidal regime
- RSLR ≈ 3.5 mm/yr (last 50 years)



Venice Lagoon,
north-western Adriatic Sea, Italy



Spatial and vertical patterns of Soil Organic Matter and Carbon in the salt marshes of the Venice Lagoon (Italy)

Soil characteristics:

- Dry Bulk Density (dry weight/volume)
- Grain size distribution (laser diffraction)

Organic Matter:

- % organic matter (Loss On Ignition)
- Organic Carbon Content (Elemental Analysis - conversion equation)

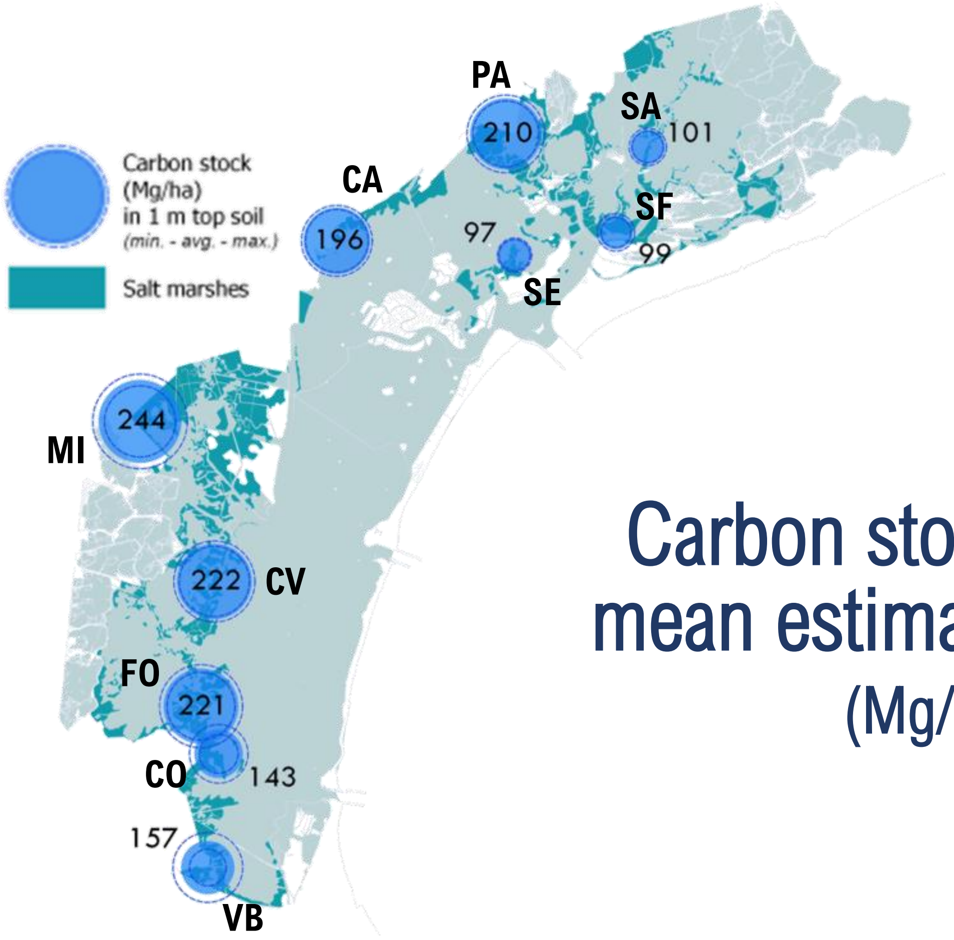
Morphological and vegetation characteristics

salt marshes **10**

sediment cores **60**

soil samples **720**

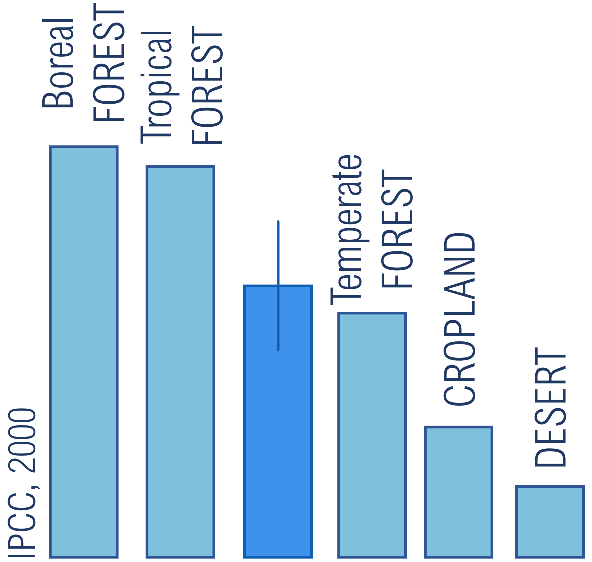
Organic content variability



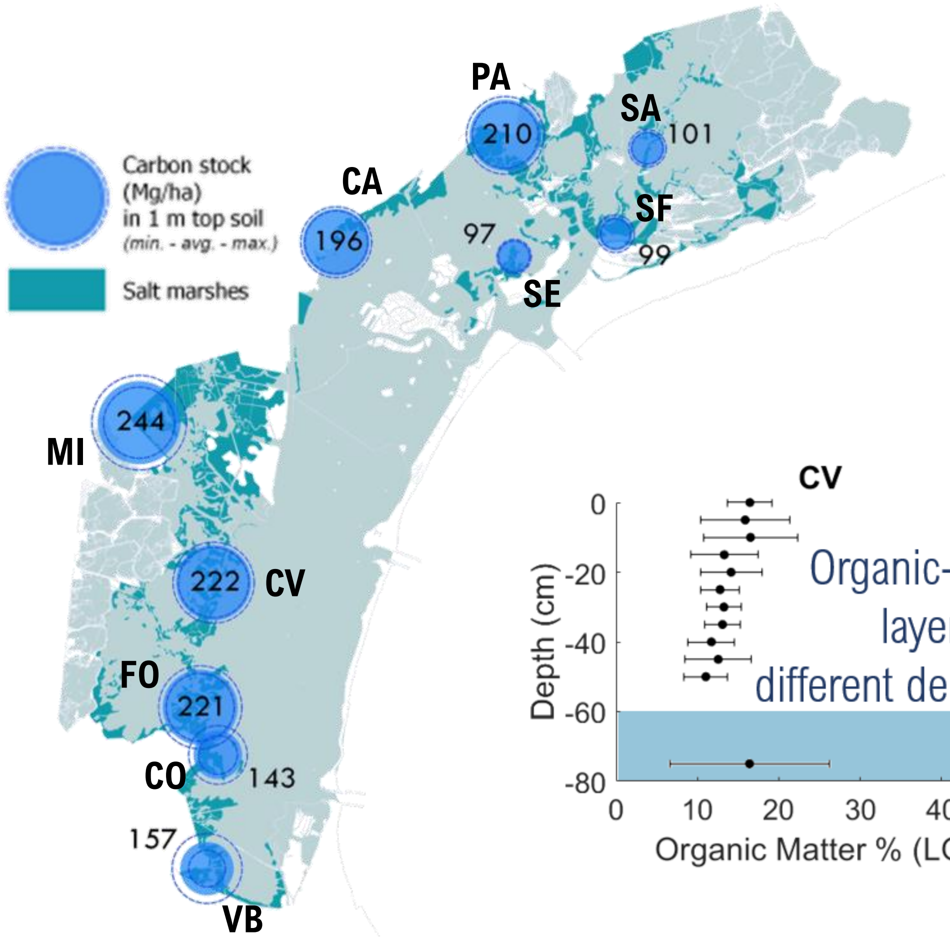
Carbon stock mean estimate (Mg/ha)

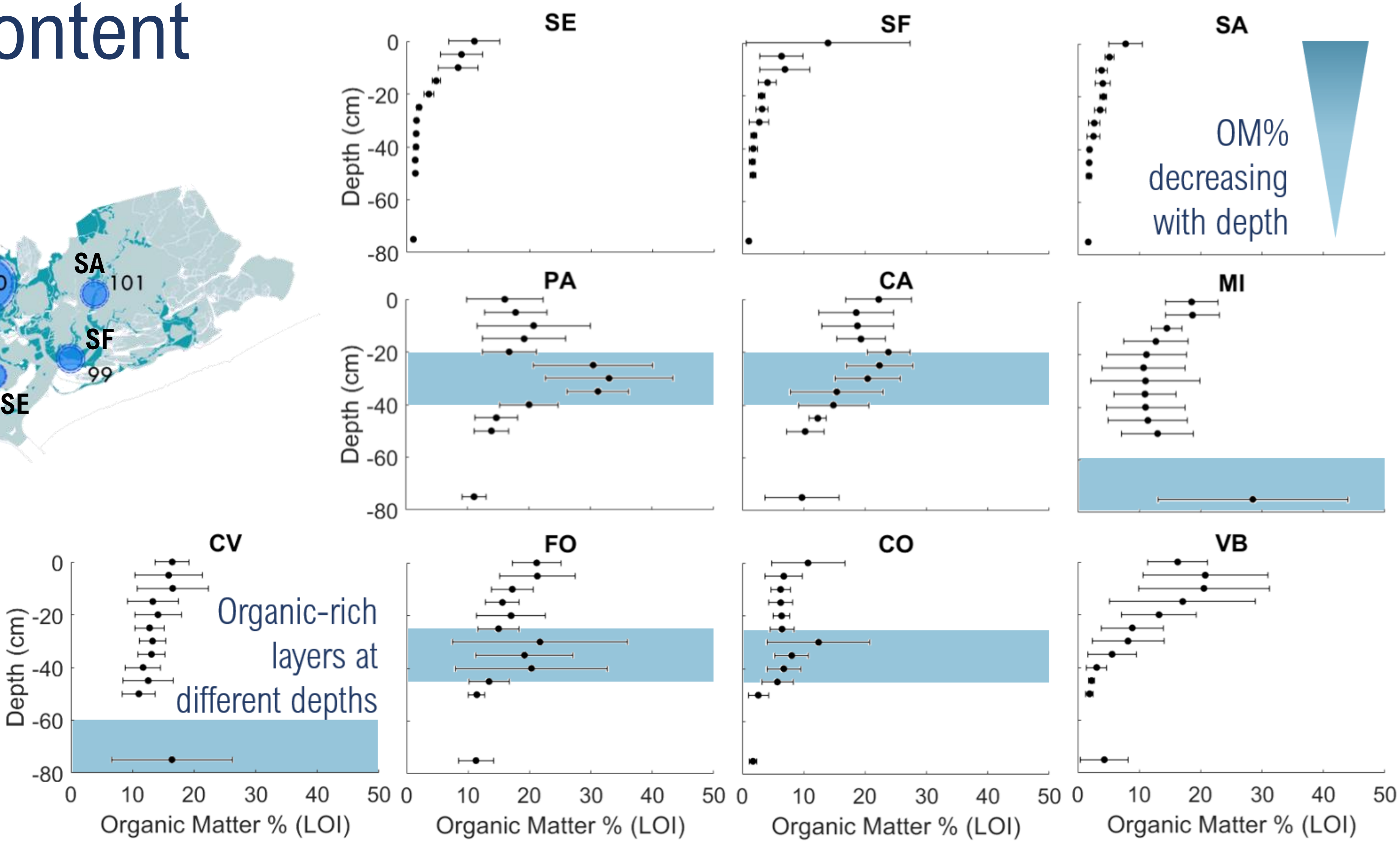
169

± 57

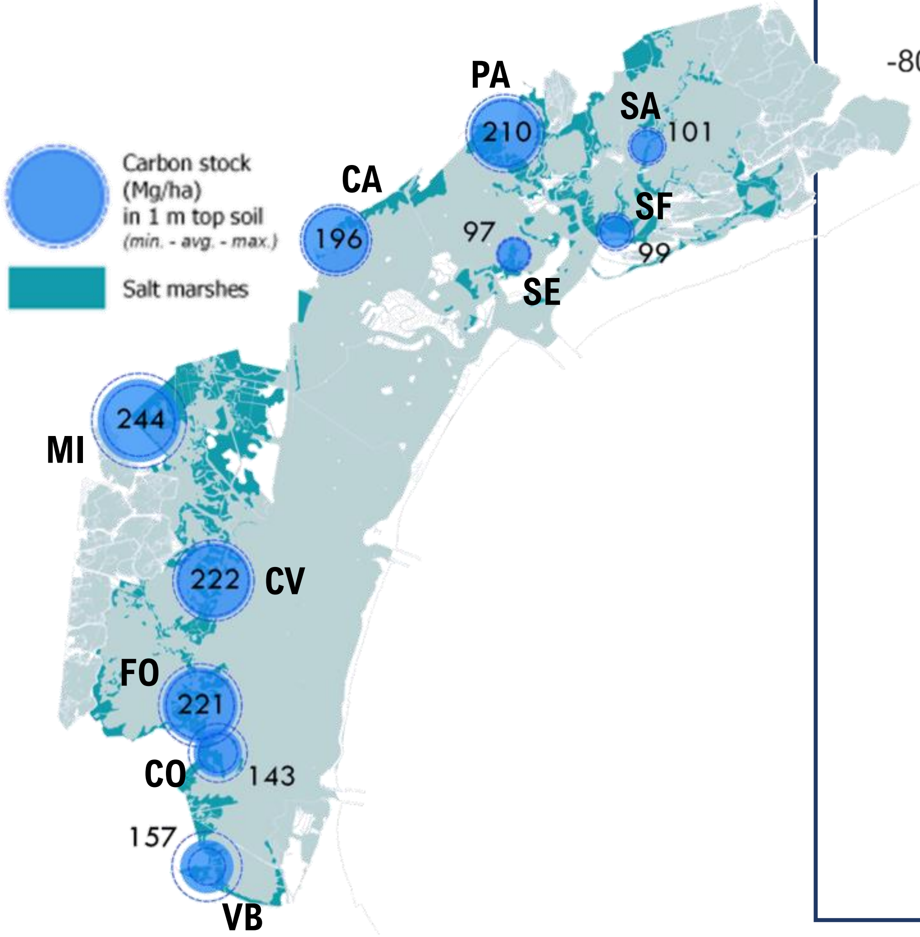


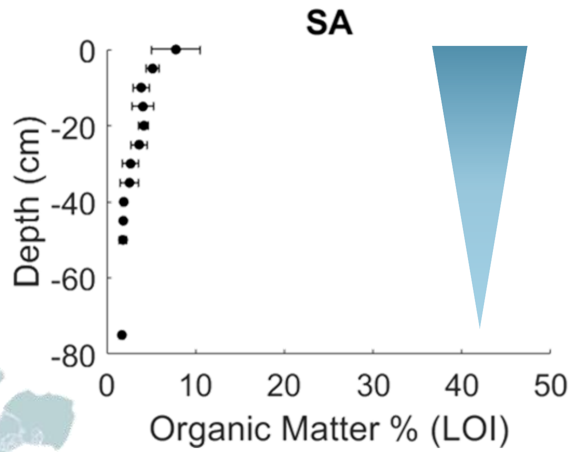
Organic content variability





Organic content variability

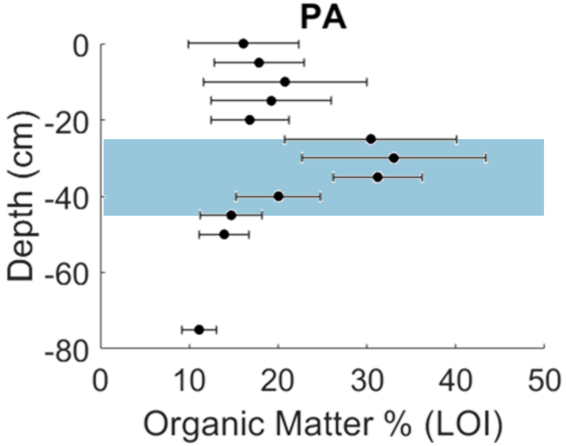


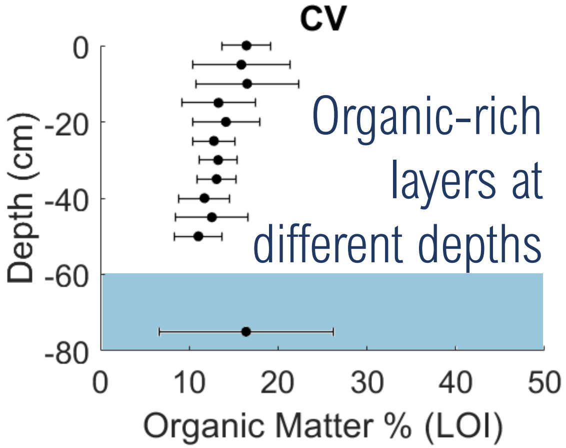


- 5 cm
salt marsh deposits

- 60 cm
tidal flat deposits

- 10 cm
roots and stems of *Phragmites australis* colonising Pagliaga salt marsh





Organic-rich layers at different depths

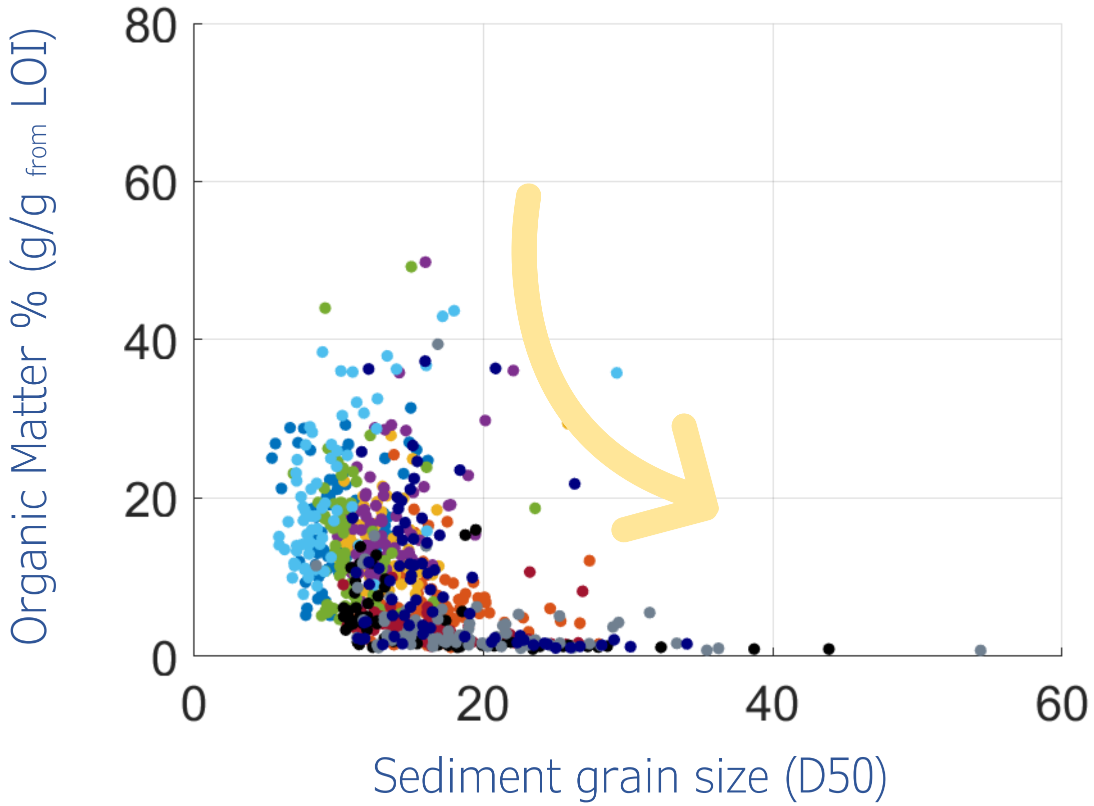
- 80 cm
fragment of reeds, traces of pre-existing brackish environments

Sediment grain size and marsh morphology

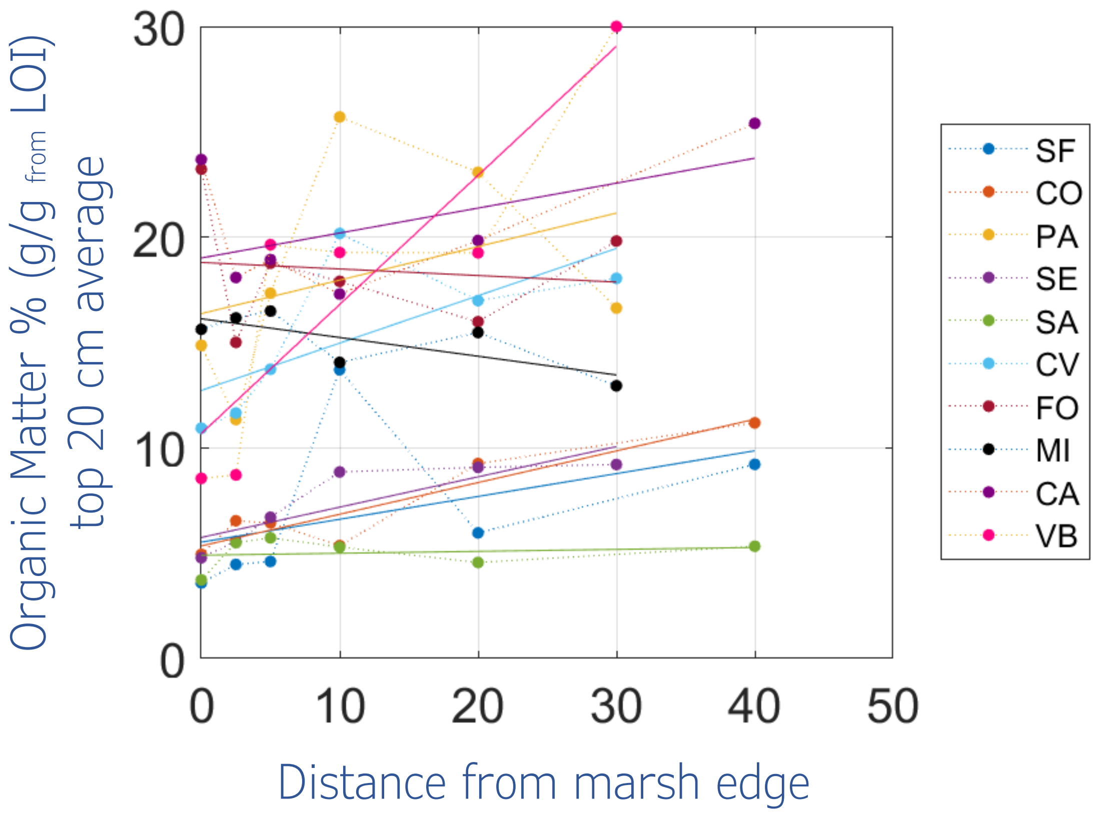
↘ higher organic content occurring within finer sediments

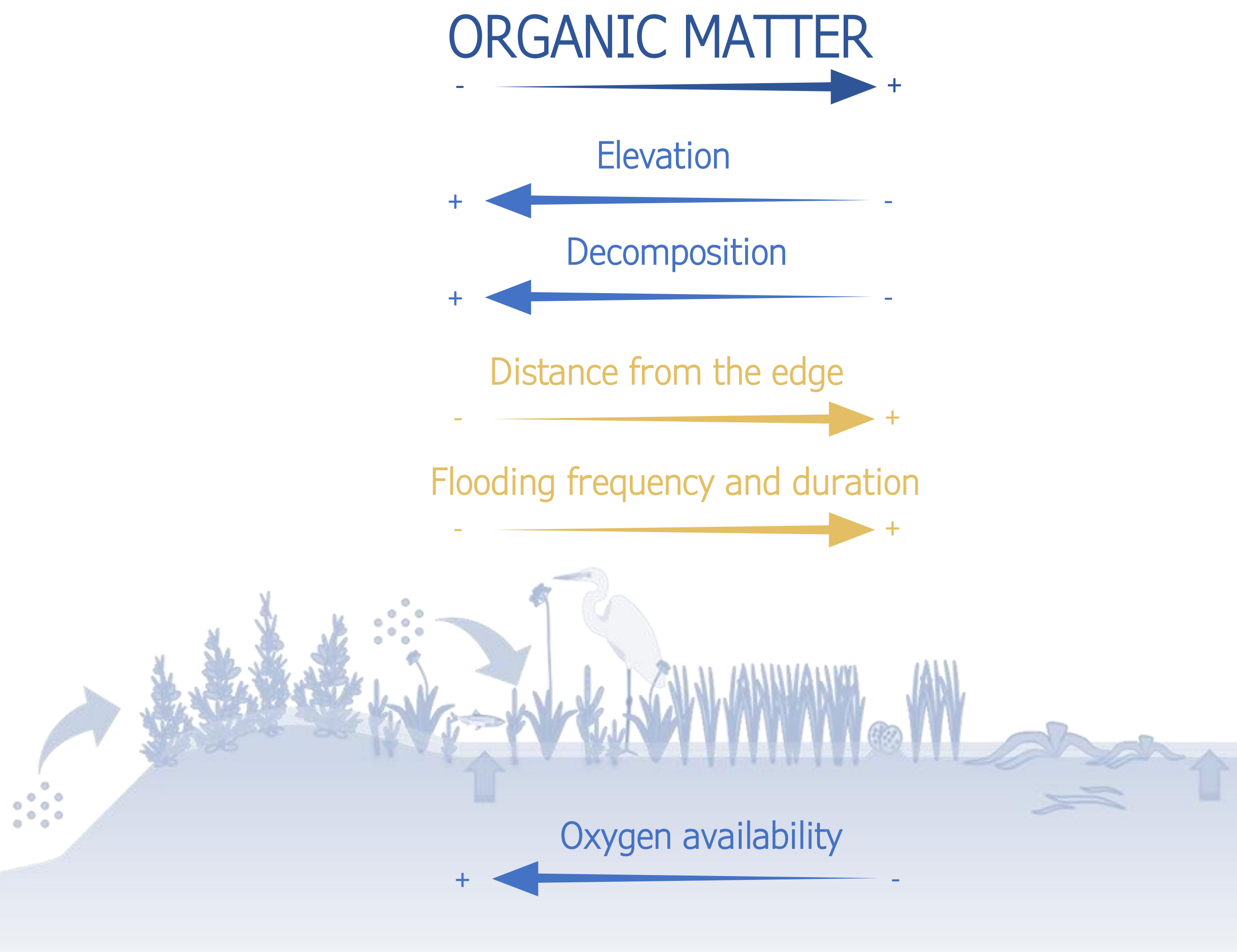
↘ more particulate organic matter

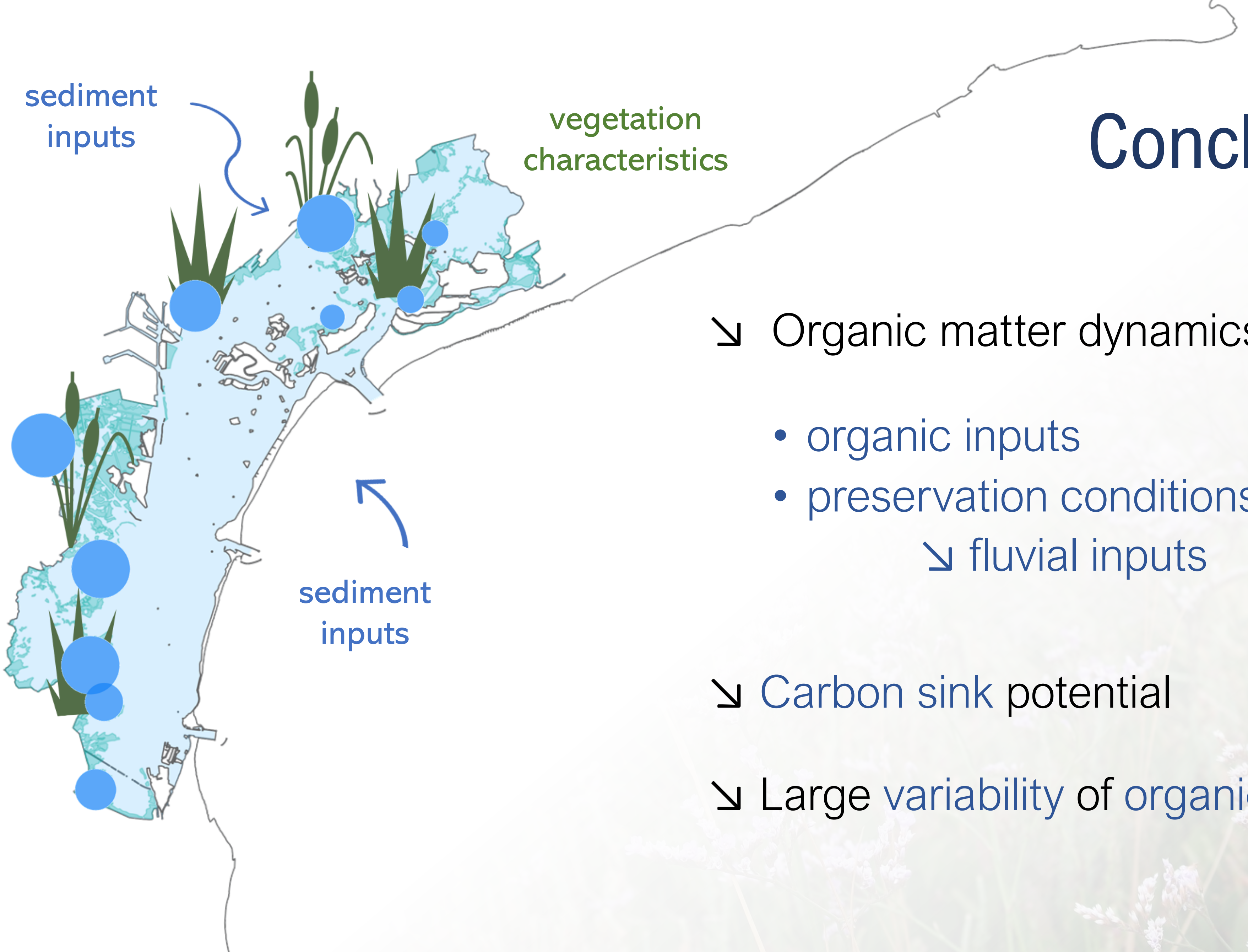
↘ better preservation conditions



Sediment grain size and marsh morphology







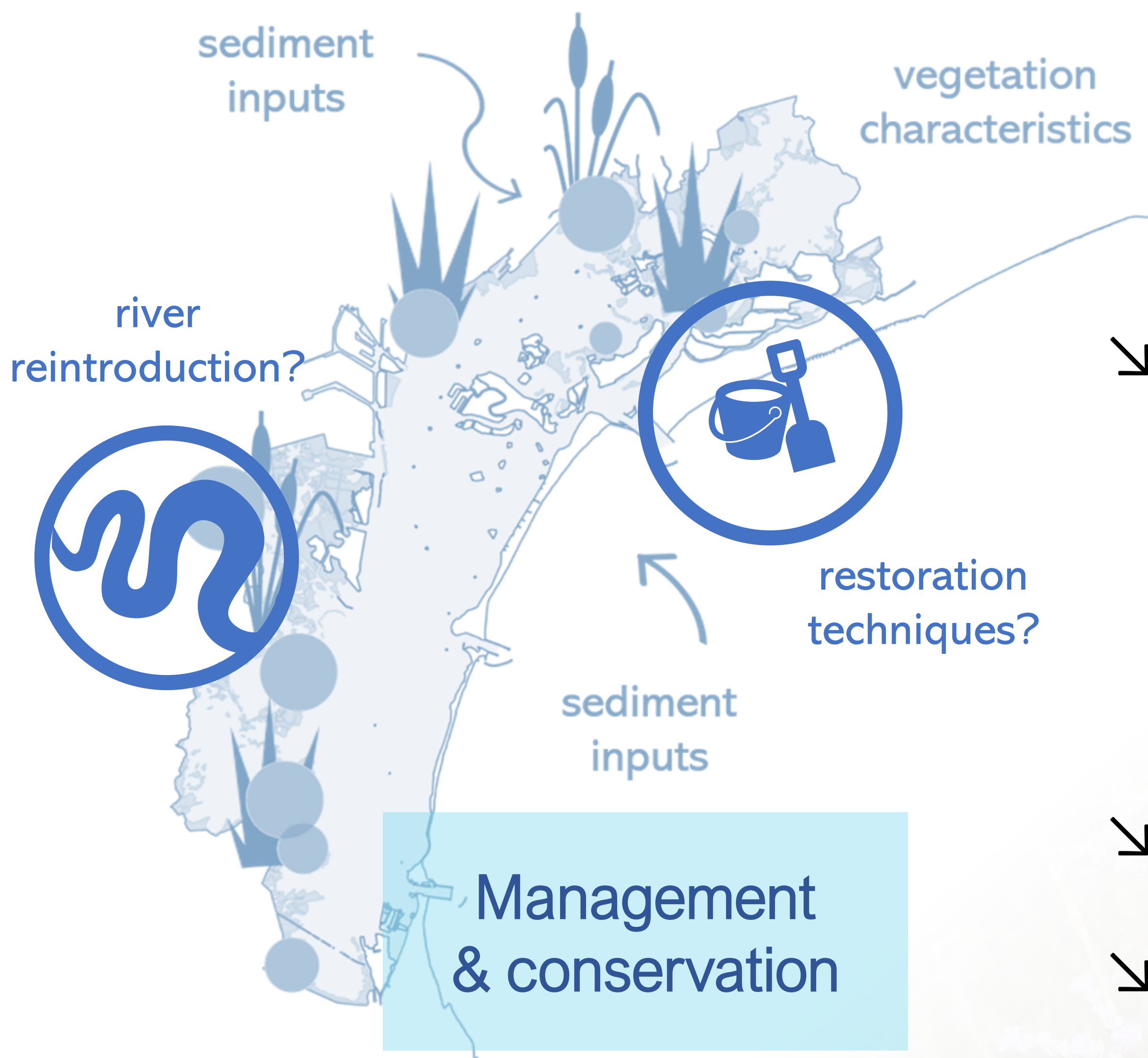
Conclusions

↘ Organic matter dynamics key drivers:

- organic inputs
- preservation conditions
  ↘ fluvial inputs

↘ Carbon sink potential

↘ Large variability of organic content



Conclusions

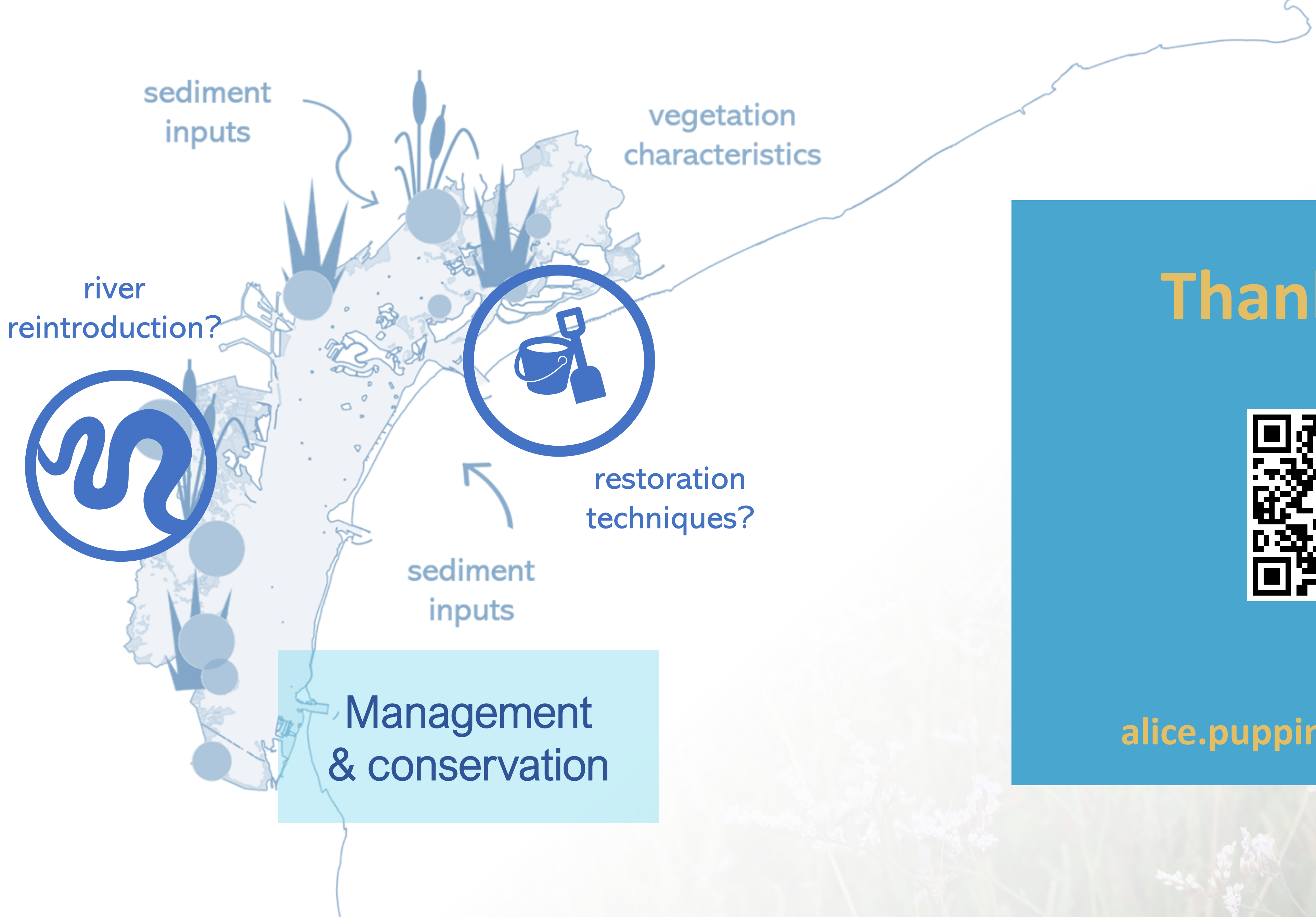
↘ Organic matter dynamics key drivers:

- organic inputs
- preservation conditions

  ↘ fluvial inputs

↘ Carbon sink potential

↘ Large variability of organic content



Management
& conservation

Thank you!

alice.puppin@phd.unipd.it

References

Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C. and Silliman, B. R., 2011. The value of estuarine and coastal ecosystem services, Ecol. Monogr., 81(2).
Chmura, G. L., Anisfeld, S. C., Cahoon, D. R. and Lynch, J. C., 2003. Global carbon sequestration in tidal, saline wetland soils, Global Biogeochem. Cycles, 17(4), 22–1.
Craft, C. B., Seneca, E. D. and Broome, S. W. , 1991. Loss on ignition and kjeldahl digestion for estimating organic carbon and total nitrogen in estuarine marsh soils: Calibration with dry combustion, Estuaries, 14(2), 175–179.
D'Alpaos, A., Lanzoni, S., Marani, M. and Rinaldo, A., 2007. Landscape evolution in tidal embayments: Modeling the interplay of erosion, sedimentation, and vegetation dynamics, J. Geophys. Res. Earth Surf., 112(F1).
Duarte, C. M., Middelburg, J. J. and Caraco, N., 2005. Major role of marine vegetation on the oceanic carbon cycle, Biogeosciences, 2(1), 1-8.
Ewers Lewis, C. J., Young, M. A., Ierodiaconou, D., Baldock, J. A., Hawke, B., Sanderman, J., Carnell, P. E. and Macreadie, P. I., 2020. Drivers and modelling of blue carbon stock variability in sediments of southeastern Australia, Biogeosciences, 17(7), 2041–2059.
Howard, J., Sutton-Grier, A., Herr, D., Kleypas, J., Landis, E., Mcleod, E., Pidgeon, E. and Simpson, S.. 2017. Clarifying the role of coastal and marine systems in climate mitigation, Front. Ecol. Environ., 15(1), 42–50.
Lovelock, C. E. and Duarte, C. M., 2009. Dimensions of blue carbon and emerging perspectives, Biol. Lett., 15(3).
Perillo, G. M. E., Wolanski, E., Cahoon, D. R. and Hopkinson, C. S.: Coastal wetlands: an integrated ecosystem approach, Elsevier., 2009.

References

Macreadie, P. I., Anton, A., Raven, J. A., Beaumont, N., Connolly, R. M., Friess, D. A., Kelleway, J. J., Kennedy, H., Kuwae, T., Lavery, P. S., Lovelock, C. E., Smale, D. A., Apostolaki, E. T., Atwood, T. B., Baldock, J., Bianchi, T. S., Chmura, G. L., Eyre, B. D., Fourqurean, J. W., Hall-Spencer, J. M., Huxham, M., Hendriks, I. E., Krause-Jensen, D., Laffoley, D., Luisetti, T., Marbà, N., Masque, P., McGlathery, K. J., Megonigal, J. P., Murdiyarso, D., Russell, B. D., Santos, R., Serrano, O., Silliman, B. R., Watanabe, K. and Duarte, C. M., 2019. The future of Blue Carbon science, Nat. Commun., 10(1).

Marani, M., D'Alpaos, A., Lanzoni, S., Carniello, L. and Rinaldo, A., 2007. Biologically-controlled multiple equilibria of tidal landforms and the fate of the Venice lagoon, Geophys. Res. Lett., 34(11).

McLeod, E., Chmura, G. L., Bouillon, S., Salm, R., Björk, M., Duarte, C. M., Lovelock, C. E., Schlesinger, W. H. and Silliman, B. R., 2011. A blueprint for blue carbon: Toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2, Front. Ecol. Environ., 9(10), 552–560.

Mudd, S. M., Howell, S. M. and Morris, J. T., 2009. Impact of dynamic feedbacks between sedimentation, sea-level rise, and biomass production on near-surface marsh stratigraphy and carbon accumulation, Estuar. Coast. Shelf Sci., 82(3), 377–389.

Nellemann, C., Corcoran, E., Duarte, C. M., Valdés, L., De Young, C., Fonseca, L. and Grimsditch, G., 2009. Blue carbon: A Rapid Response Assessment. [online] Available from: http://www.grida.no/files/publications/blue-carbon/BlueCarbon_screen.pdf, 2009.

Perillo, G. M. E., Wolanski, E., Cahoon, D. R. and Hopkinson, C. S.: Coastal wetlands: an integrated ecosystem approach, Elsevier., 2009.

Supplementary

SOIL CARBON STOCK (Howard et al., 2014)

Carbon content (%)	= 0.40 * %OM + 0.0025 (%OM)^2 (local conversion equation)
Soil Carbon Density (g/cm^3) for each interval of the core sampled	= Dry Bulk Density * Carbon Content (%) (conversion equation)
Carbon content in each interval (g/cm^2)	= Soil Carbon Density * interval thickness
Carbon content in 1 m core (g/cm^2)	= Σ Carbon content in each interval

CARBON ACCUMULATION RATE

Carbon uptake	Average of Soil Carbon Density in the reference interval (top 5 cm) (g/cm^3) * Salt-Marsh Accretion Rate (cm/yr)