CoastSpace project
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A framework for assessing the space needed for dune-based coastal adaption at multiple time scales

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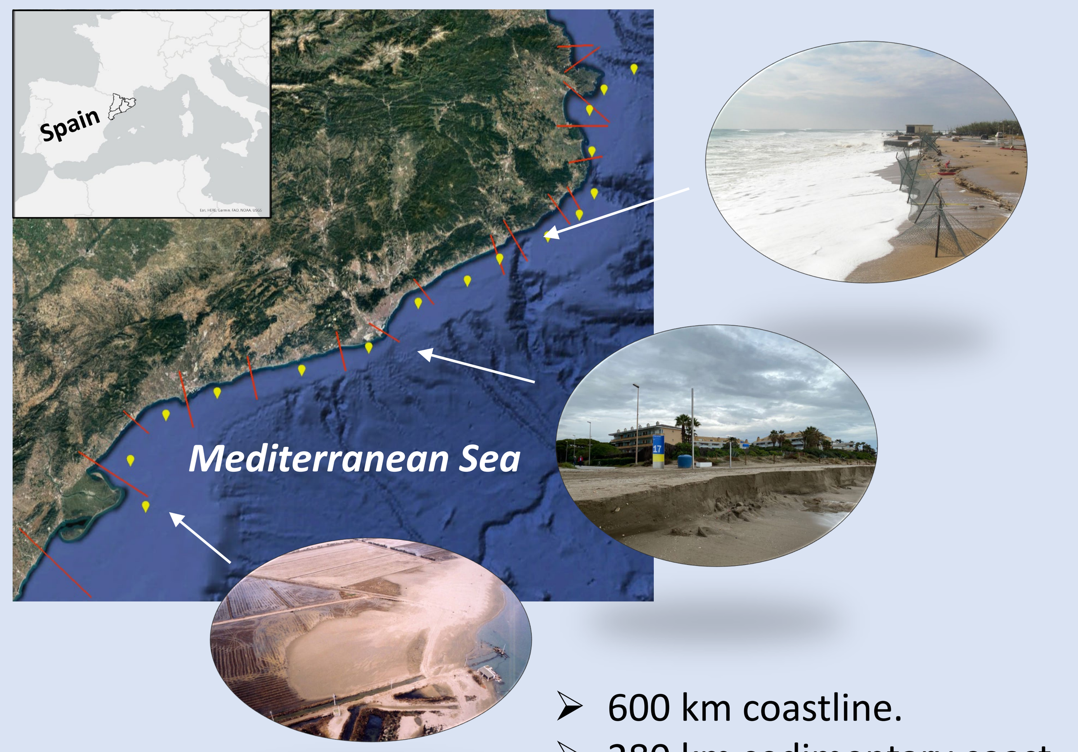
Motivation & Objectives

The Spanish Mediterranean coast is presenting hotspots of extreme exposure to recurrent coastal hazards. This situation is expected to worsen under the effect of sea level rise. In this context, nature-based solutions are becoming one of the main adaptation measures to be favored to become more climate resilient. Among the nature-based coastal protection methods, dune systems have been classified as essential for future coastal defense. It is therefore necessary to know which parts of the territory are most suitable for these adaptation measures.

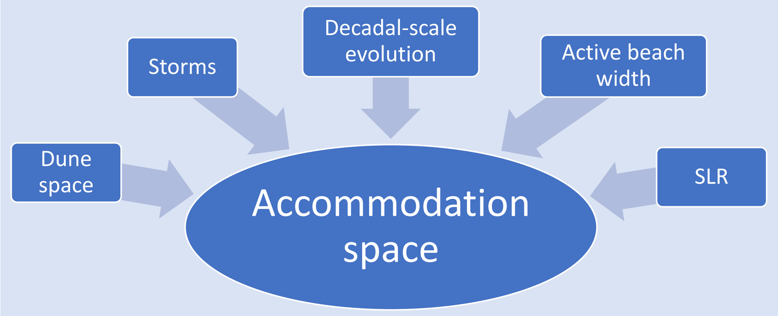
Within this context, this work presents a regional-scale framework to assess the accommodation space needed to adopt dune-based NBS planning as a coastal adaptation strategy, by integrating predictions of accommodation space needed to cope with coastal hazards under current and IPCC AR6 climate scenarios and for different time horizons relevant for planning purposes (up to 2100), and to enable dune development.

Study area

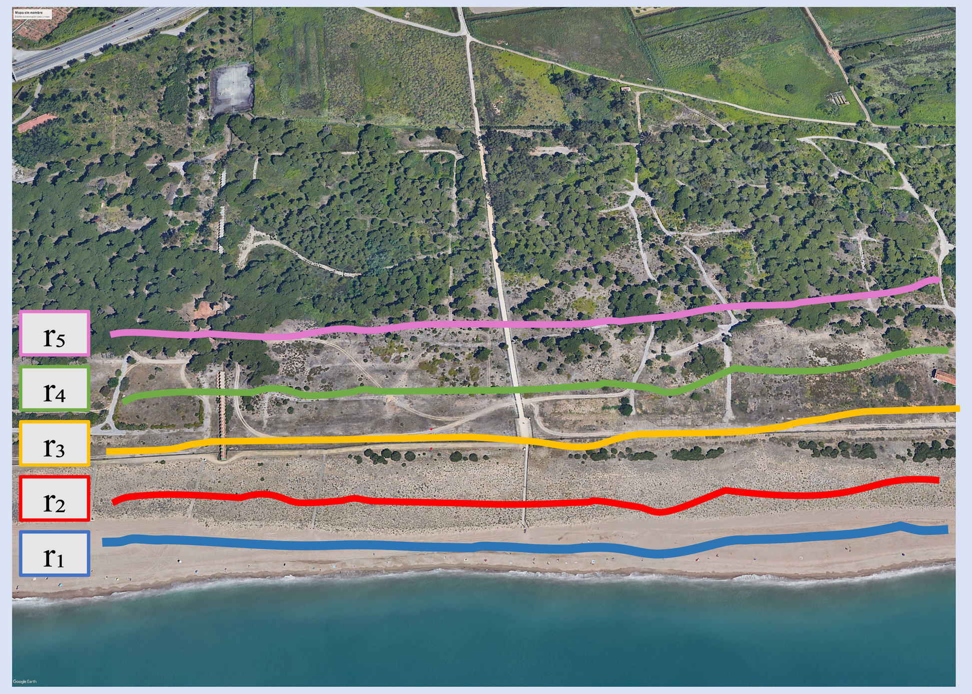


- 600 km coastline.
- 280 km sedimentary coast.
- 65 % of beaches at erosion.

Assessing the space needed



$$R_{tot}(t) = \sum (r_1, r_2, \ldots, r_n)t \qquad n = 5$$

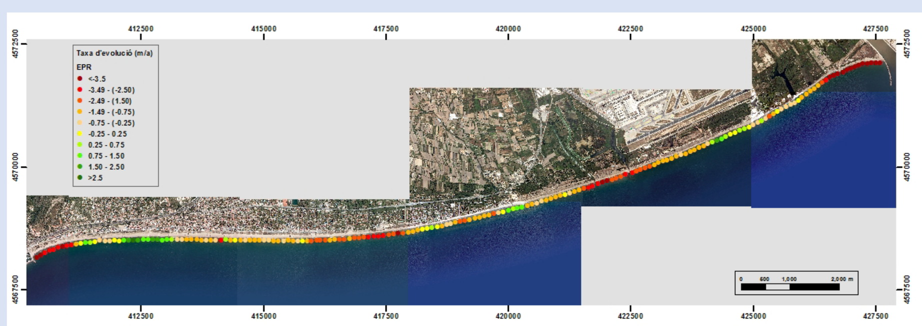


To obtain the total space needed (Rtot), we determine the contributions of each of the processes and add them together.

(r_1) Decadal-scale evolution

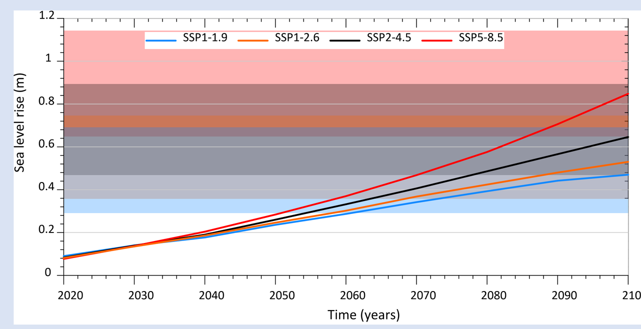
- Empirically derived.
- Aerial photographs 1995-2022.
- Evolution rate by linear regression.
- Profiles every 100 m.
- **16** Sectors characterized by mean + st dev.

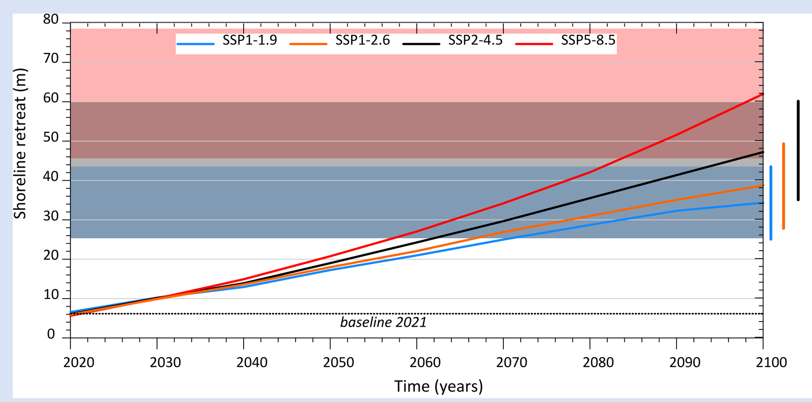
r_1 calculated for each sector by projecting the rate over the selected time frame assuming that evolutionary conditions will not change.



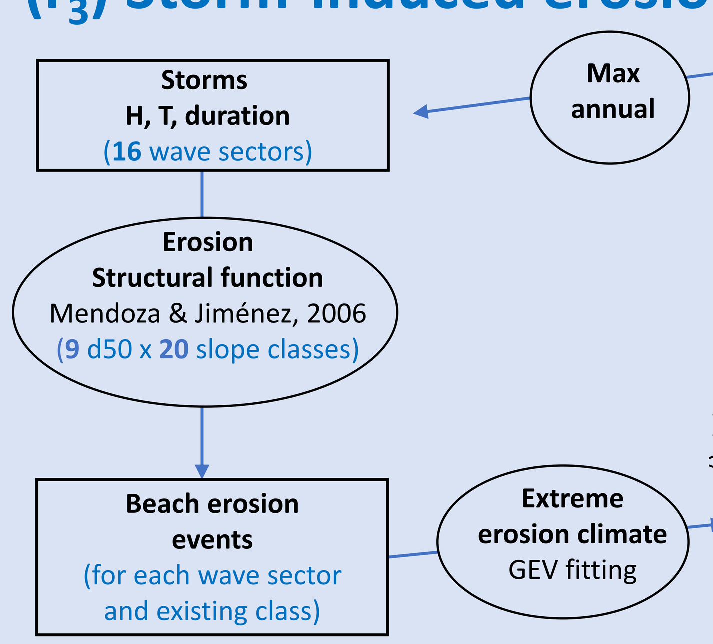
(r_2) SLR-induced erosion

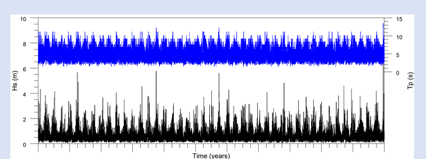
- Bruun rule.
- Applied to homogeneous sectors in function of shoreface slope (Athanasioau et al., 2020).
- IPCC AR6 SLR scenarios.
- Calculated for each coastal sector.



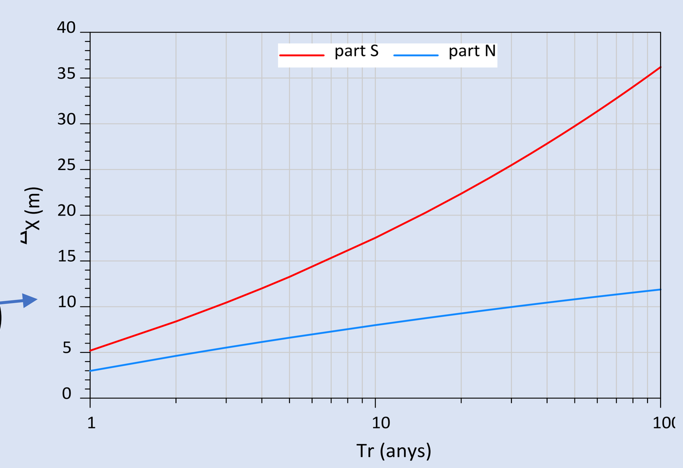


(r_3) Storm-induced erosion



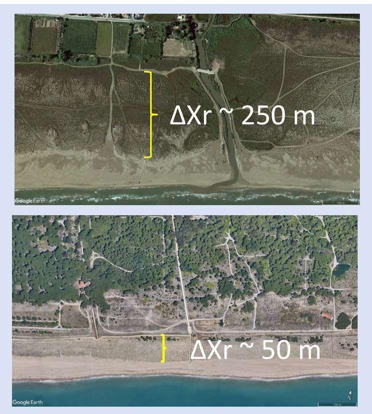


Wave time series 1958 -2020



(r_4) Dune space

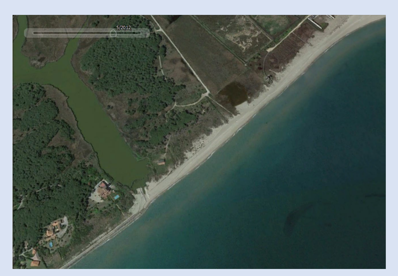
- Space for dune development.
- Empirically derived.
- Variable along the coast, f(space, level of development).



Garcia-Lozano & Pintó, 2018

(r_5) Active beach width

- Space for beach rebuilding.
- Controlled by local wave climate.
- Empirically derived where possible.
- Computation of overwash reach (Donelly'08).



Outcomes

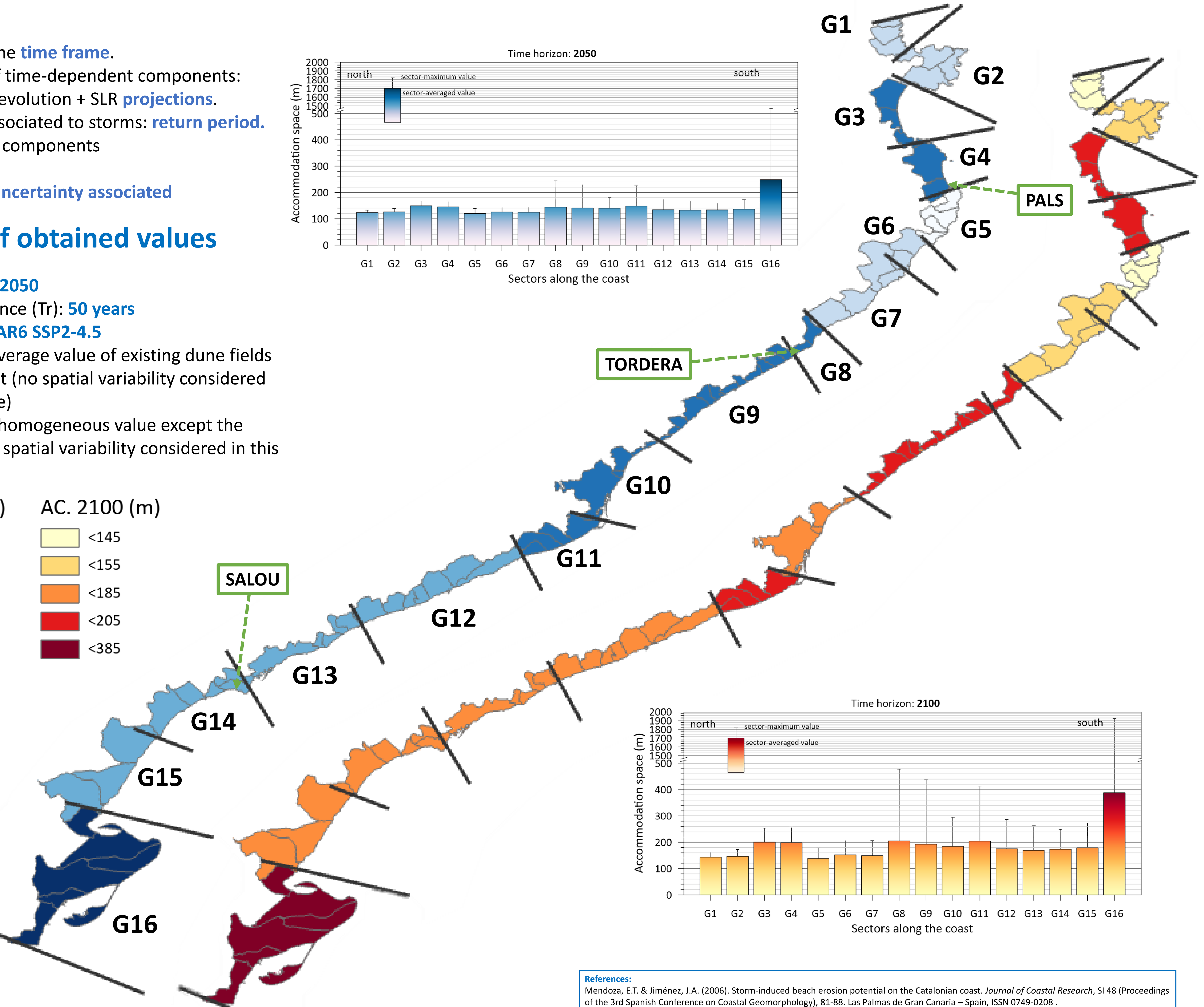
Method

- Definition of the time frame.
- Assessment of time-dependent components: decadal scale-evolution + SLR projections.
- Safety level associated to storms: return period.
- Addition of all components
- *Optional: + Uncertainty associated

Statistics of obtained values

- Time horizon: 2050
- Storm occurrence (Tr): 50 years
- SLR scenario: AR6 SSP2-4.5
- Dune space: average value of existing dune fields along the coast (no spatial variability considered in this example)
- Active beach: homogeneous value except the Ebro delta (no spatial variability considered in this example)

AC. 2050 (m)	AC. 2100 (m)
<120	<145
<130	<155
<140	<185
<150	<205
<250	<385



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Mendoza, E.T. & Jiménez, J.A. (2006). Storm-induced beach erosion potential on the Catalonian coast. *Journal of Coastal Research*, SI 48 (Proceedings of the 3rd Spanish Conference on Coastal Geomorphology), 81-88. Las Palmas de Gran Canaria – Spain, ISSN 0749-0208 .
Athanasiou, P., Van Dongeren, A., Giardino, A., Vousdoukas, M., Gaytan-Aguilar, S., & Ranasinghe, R. (2019). Global distribution of nearshore slopes with implications for coastal retreat. *Earth system science data*, *11*(4), 1515-1529.
Garcia-Lozano, C., Pintó, J., & Daunis-i-Estadella, P. (2018). Reprint of Changes in coastal dune systems on the Catalan shoreline (Spain, NW Mediterranean Sea). Comparing dune landscapes between 1890 and 1960 with their current status. *Estuarine, Coastal and Shelf Science*, *211*, 23-35.

Required accommodation space

A. Urban beach (Salou)

Unsuitable

B. Natural beach (Pals)

Suitable

C. Camping beach (Tordera)

Suitable with managed retreat