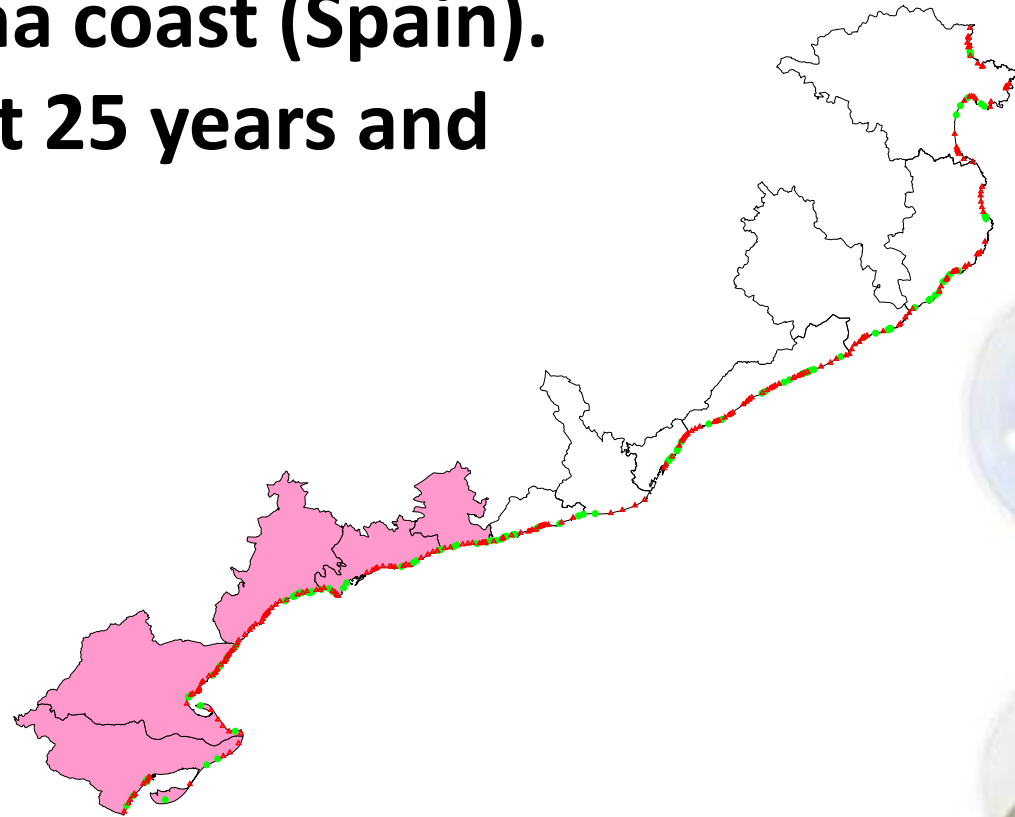


# Beach restoration in the Tarragona coast (Spain). Sand management during the last 25 years and future plans

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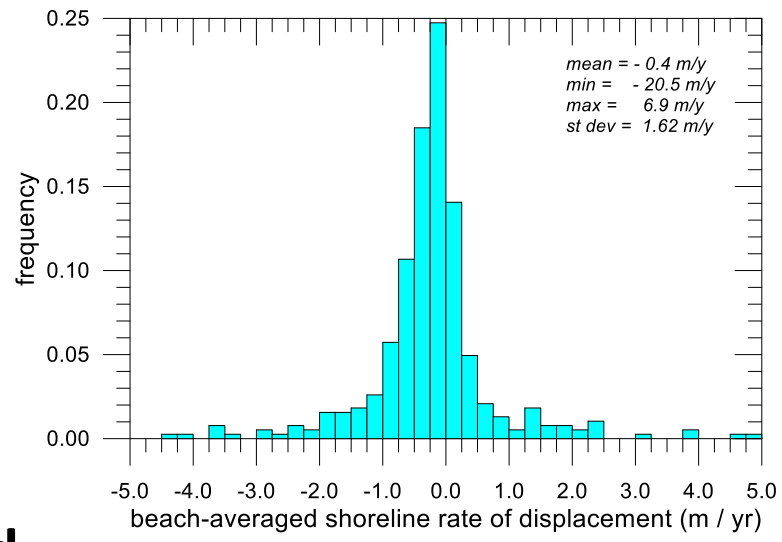
**José A. Jiménez**  
**Herminia I Valdemoro**  
*Laboratori d'Enginyeria Marítima*  
*Universitat Politècnica de Catalunya-BarcelonaTech*



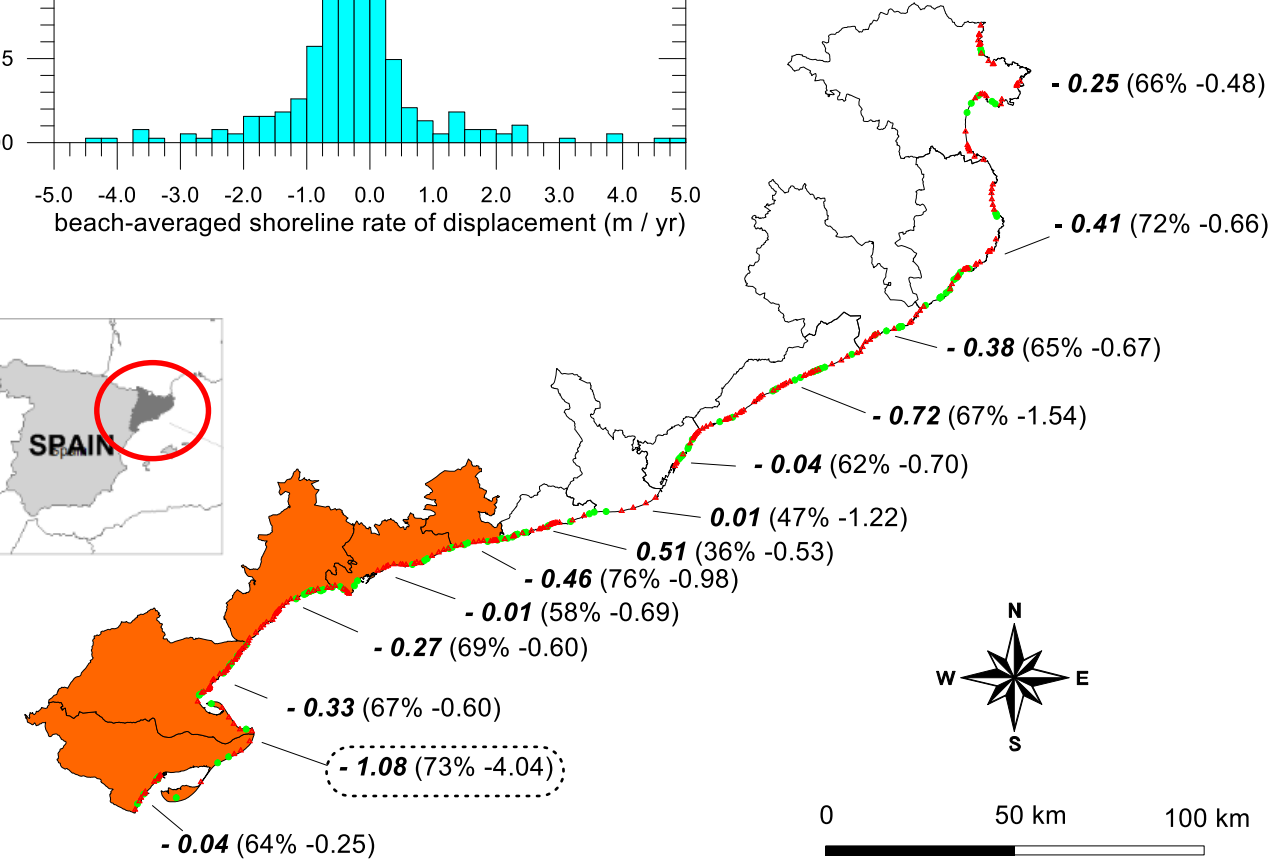
# Background

- The Catalan coast has about 270 km of beaches, from which about 65 % are experiencing **long-term erosion** under current conditions.
- **Coastal damage has significantly increased** during the last decades (Jiménez et al 2012).
- Tourism provides about 11 % of the Catalan GDP and, **coastal tourism** is the major contributor to the sector.

**Beaches are becoming a scarce basic resource !!**



*Average shoreline rate of displacement (in bold), % of eroding shoreline and average erosion rate (in brackets)*



# Current coastal protection measures

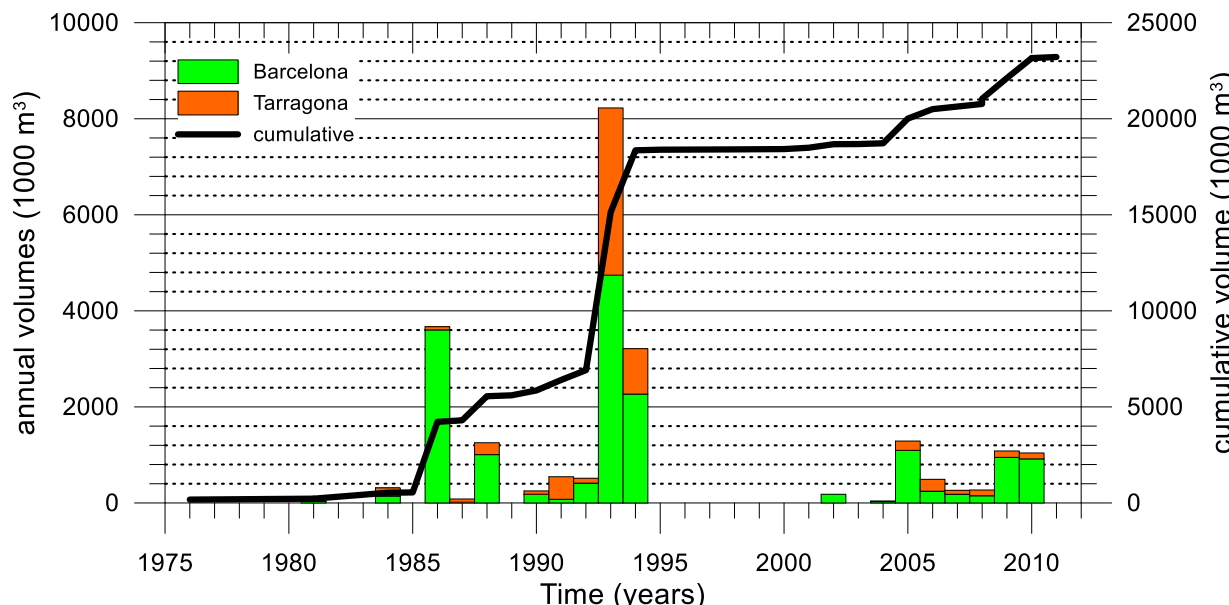
- Beach nourishment
- Coastal structures

Total amount in 25 years slightly larger than Sand Motor (South-Holland, 2011).



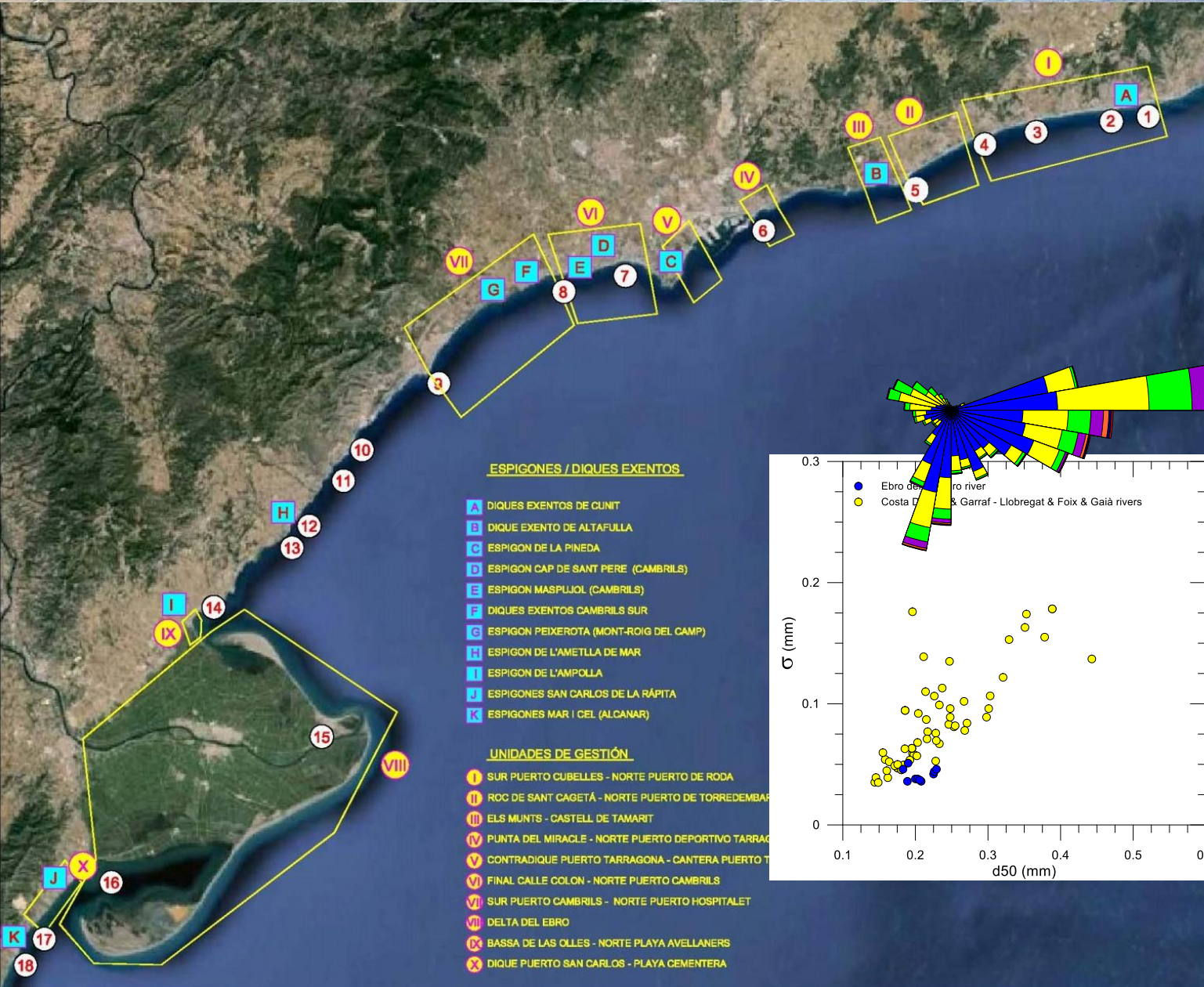
## Objectives

- To review **beach nourishment strategy** (and its results) in the Tarragona province to maintain/ restore/enhance beaches during the last decades.
- To **assess the sustainability of a long-term adaptation strategy** based on the use of sediment to cope with future threats.



# Boundary conditions

- About **121 km beaches** (51 km Ebro delta), **69 % retreating** at an spatially averaged rate of **-0.6 m/yr** (-2.2 m/yr if only eroding coast is accounted for)
- Fine to medium **native sands** (natural sources no longer effective).
- Non-continuous sandy coastline – different **coastal cells** with limited alongshore sediment exchange. Natural (headlands) and artificial (groins & det breakwaters) **obstacles**.
- Variable net **SI transport rates**.

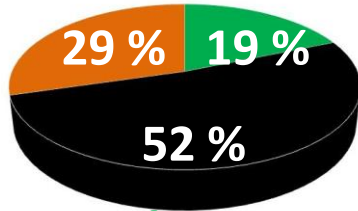


# Beach nourishment

- 239 operations until 2013 (9.033 Mm<sup>3</sup>)

- 63 % < 10,000 m<sup>3</sup>

- 85 % < 40,000 m<sup>3</sup>



- Three sediment sources: sand redistribution; quarry; nearshore dredging.

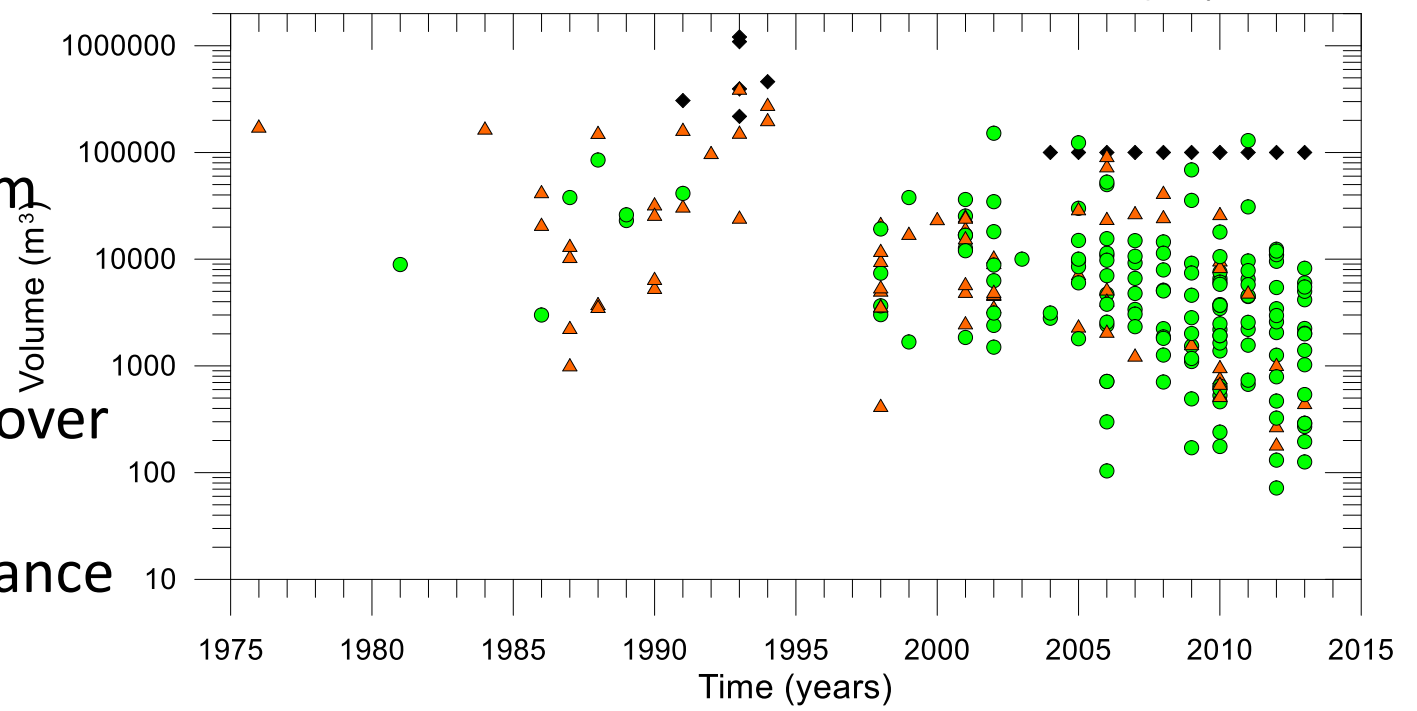
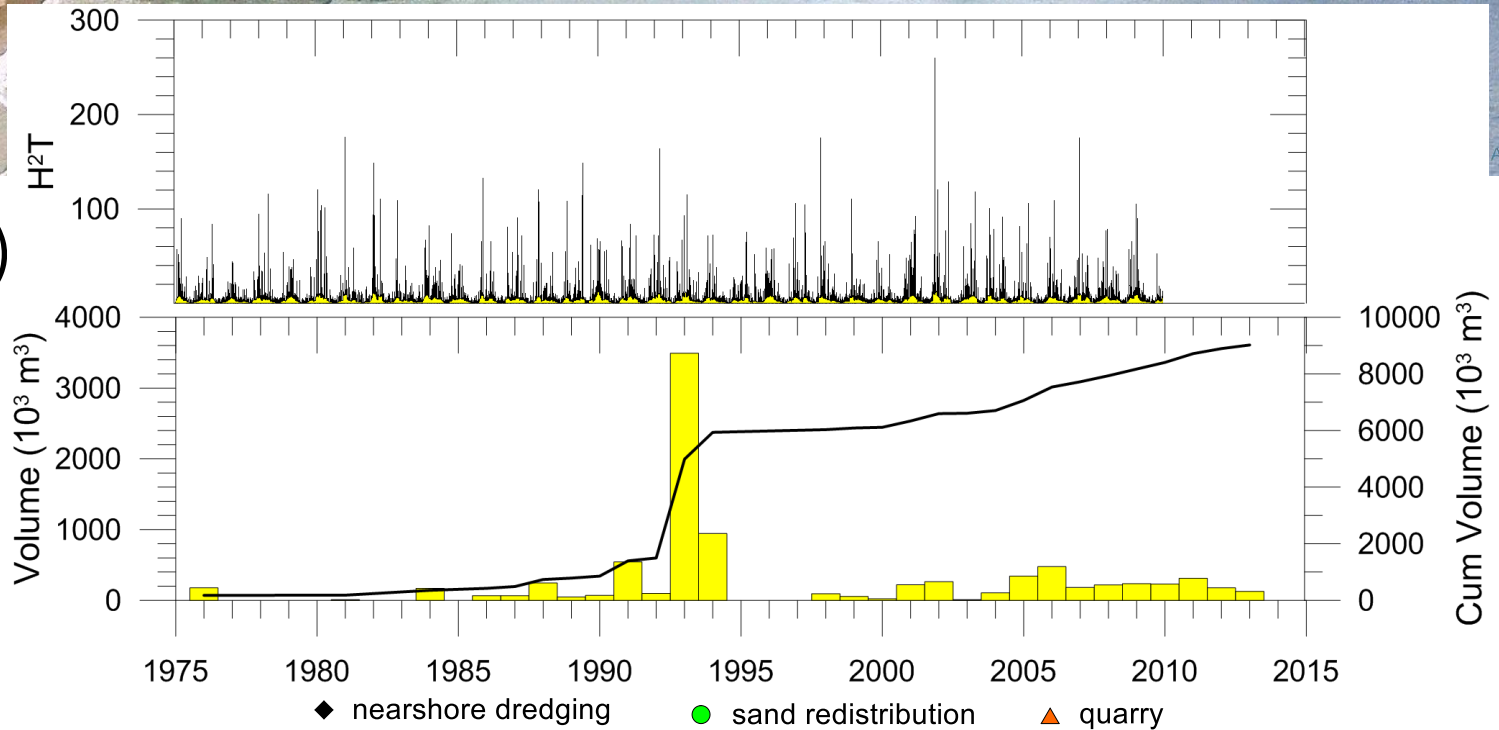
- Borrow sediment size

- redistribution-dredging  $\leq 0.4$  mm

- quarry  $\geq 0.7$  mm

- Large operations (> 0.2 Mm<sup>3</sup>) to recover fully eroded beaches (1990-95).

- Recent (small) operations: maintenance + emergency (post-storms)

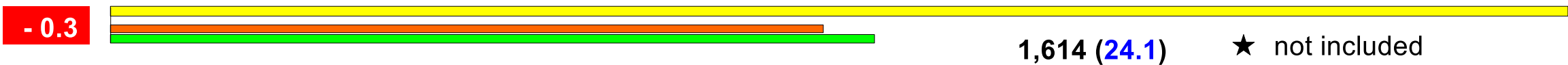
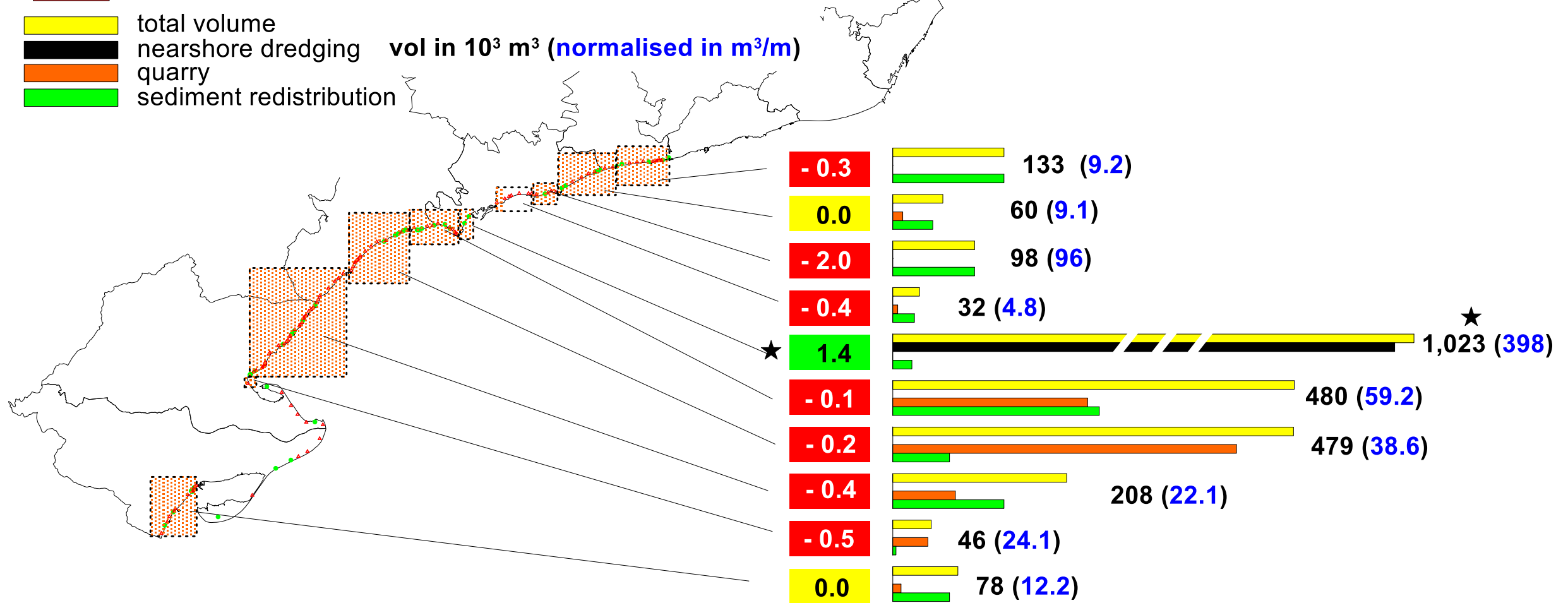


# Beach nourishment & shoreline evolution (after 1995)

**-X.X** spatially averaged shoreline rate of displacement at decadal scale (m/y)

total volume  
 nearshore dredging  
 quarry  
 sediment redistribution

vol in  $10^3 \text{ m}^3$  (normalised in  $\text{m}^3/\text{m}$ )

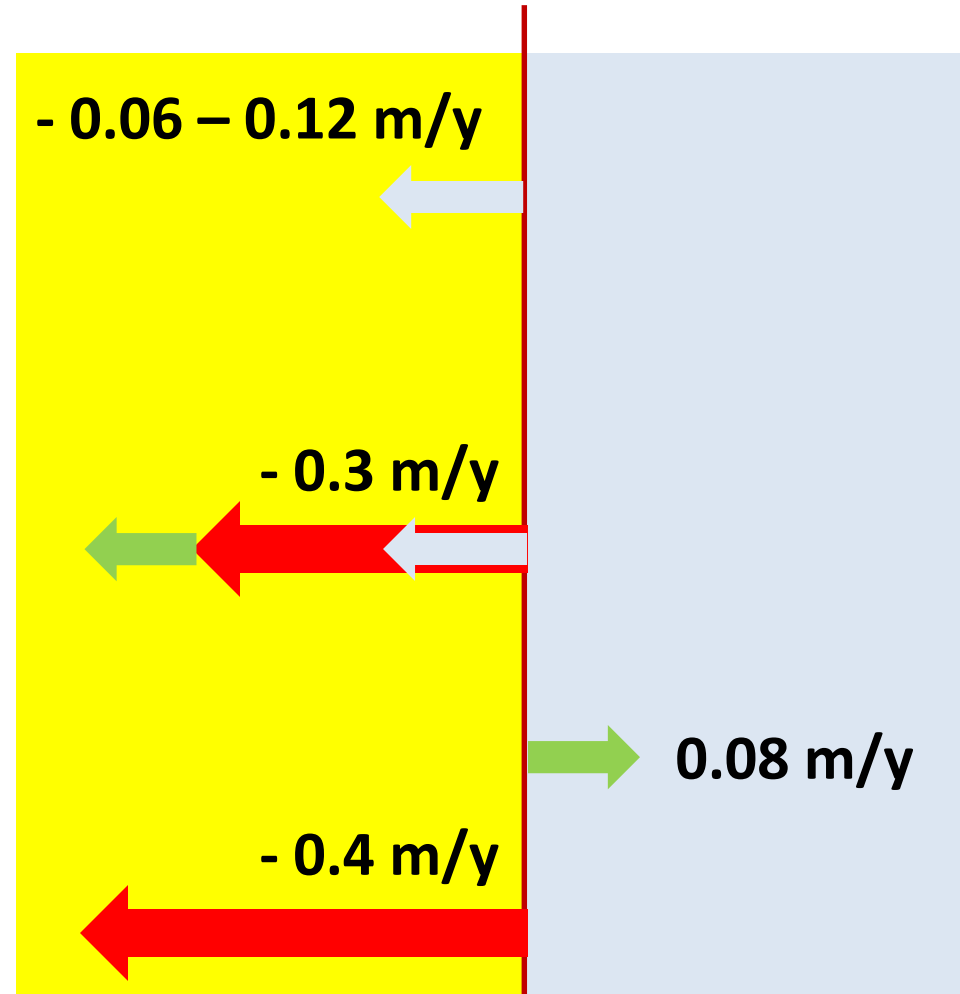


# LT shoreline changes components

**SLR-induced retreat** (guess with Bruun applied at regional scale for current SLR [varying between 0.6 mm/yr – 1.2 mm/yr])

**Measured LT shoreline rate of displacement** at current conditions

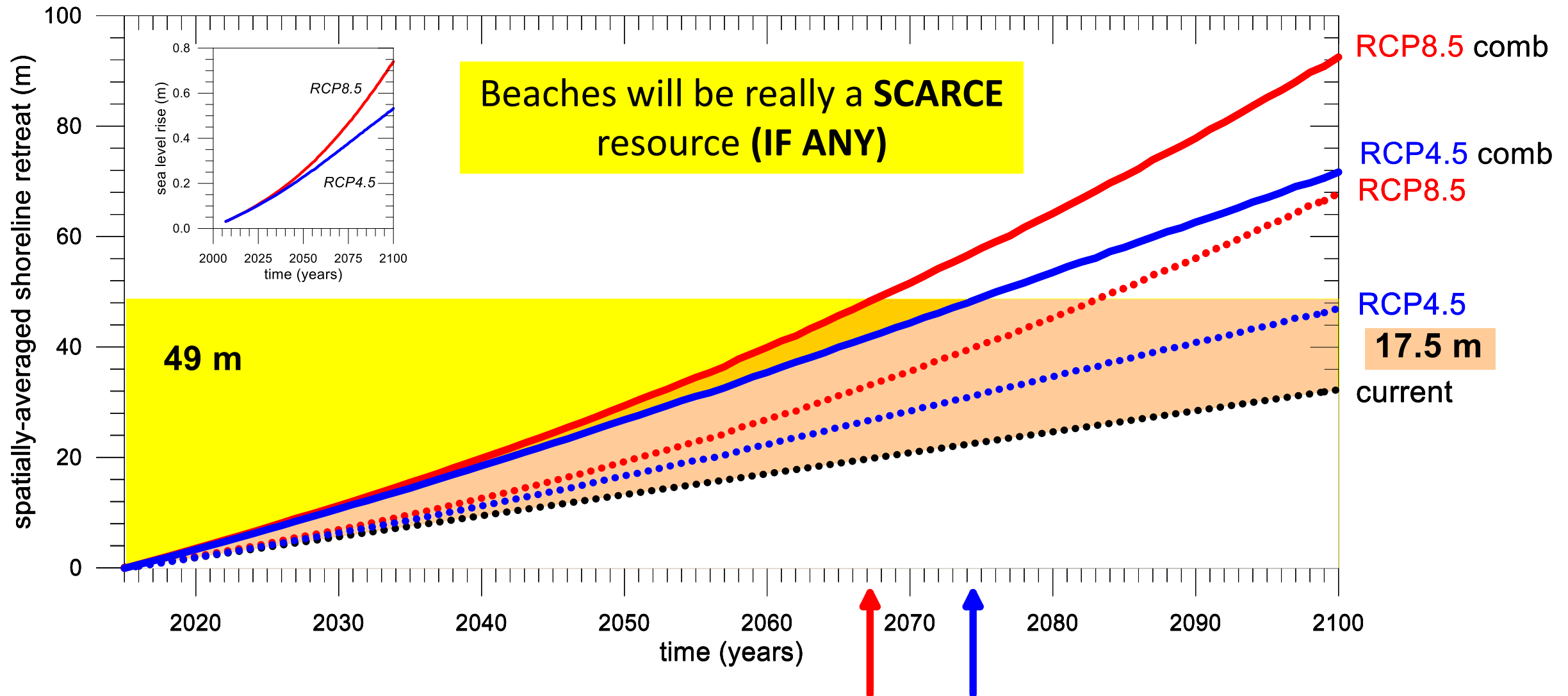
**External sediment supplies**  
Beach nourishment from external sources: **quarry** + nearshore dredging  
(Equivalent shoreline change by redistributing the volume in a 8 m high beach profile [ $dc+B$ ])



**current (natural) conditions LT spatially-averaged shoreline rate of change**

# Spatially-averaged shoreline projections

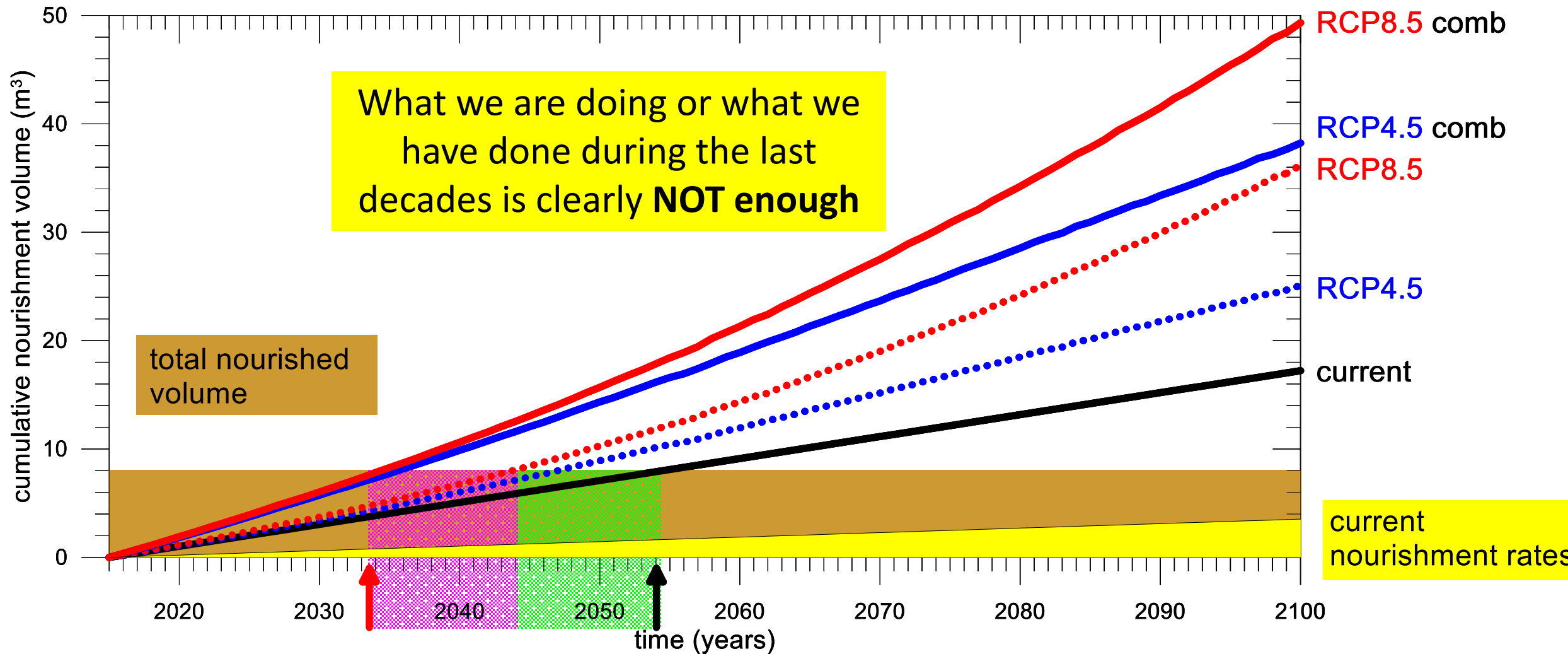
## The remaining spatially-averaged beach width





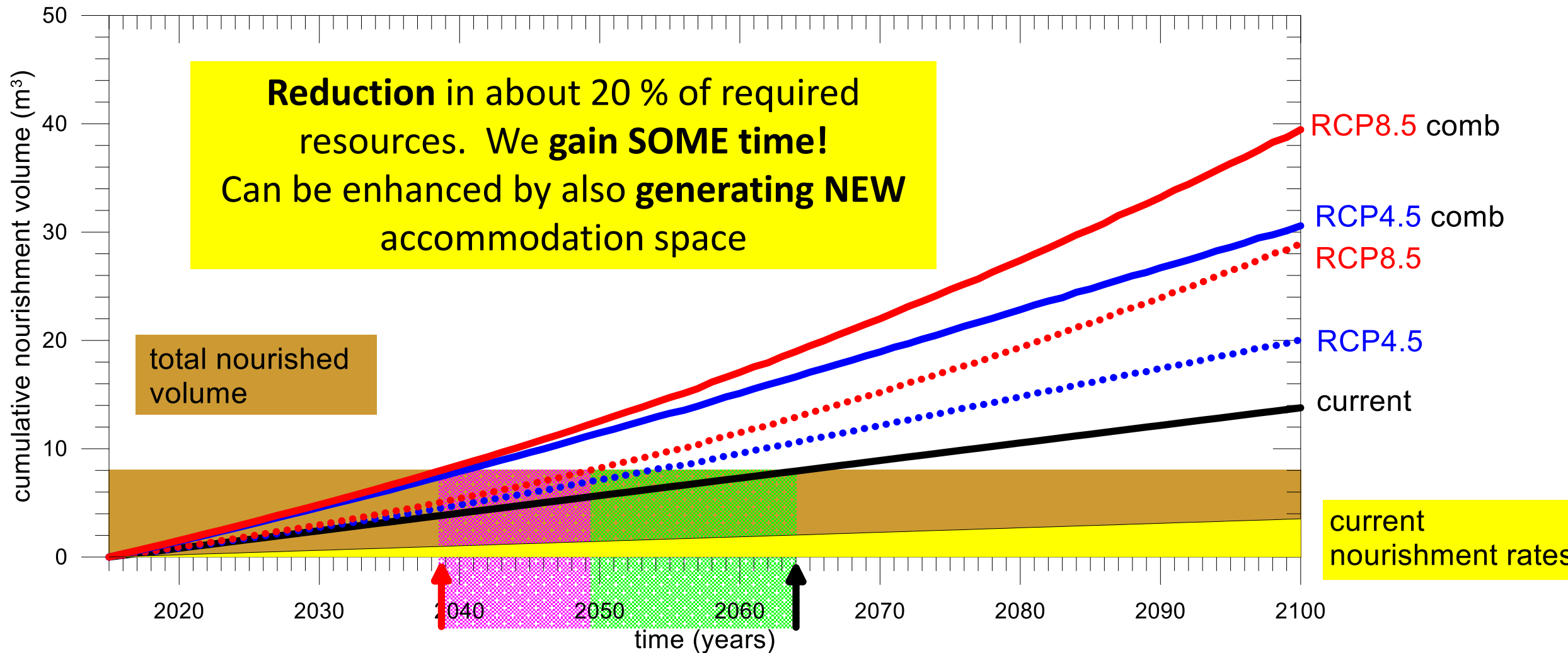
# Future sediment volumes for coastal adaptation (I)

Volume (minimum) required to **MAINTAIN** the current (2015) averaged-beach width



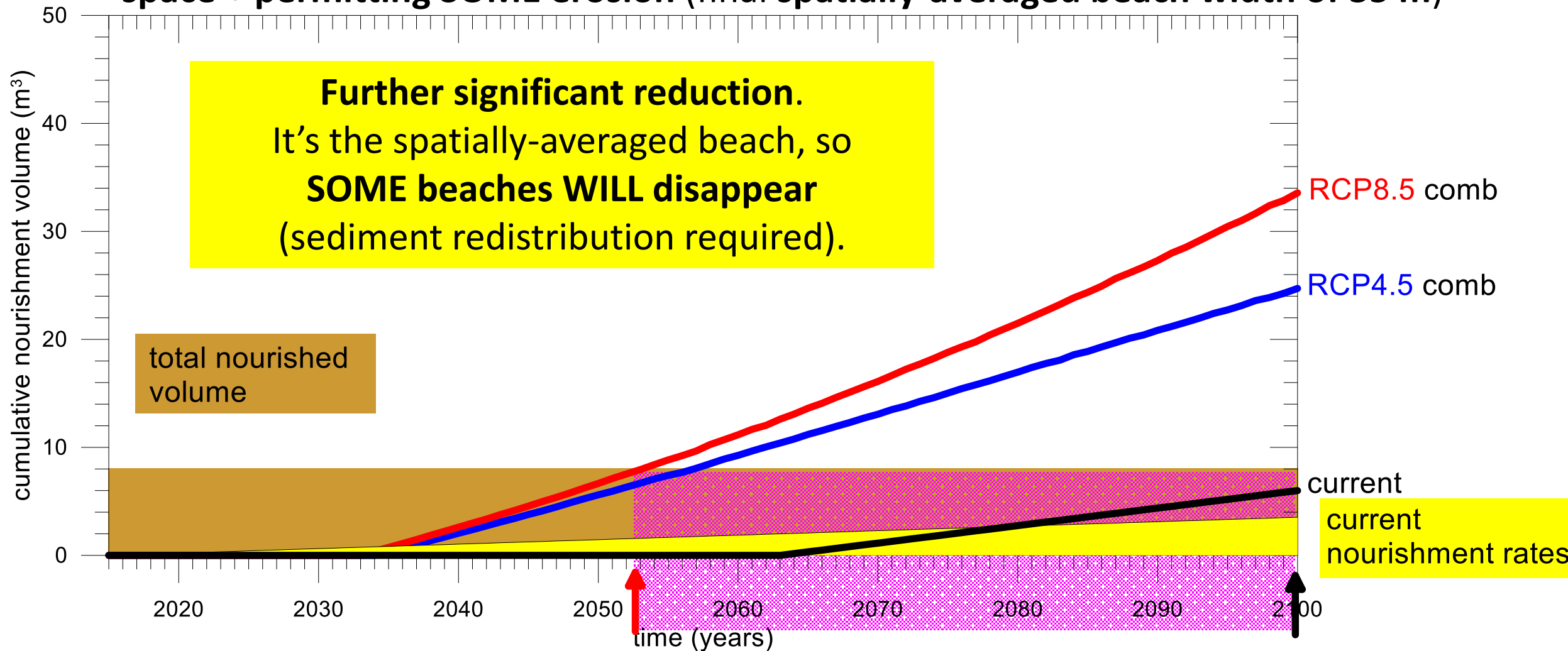
# Future sediment volumes for coastal adaptation (II)

Can we **REDUCE** the required volumes? The effect of **accommodation space**



# Future sediment volumes for coastal adaptation (III)

Can we reduce **FURTHER** the required volumes? The effect of **accommodation space + permitting SOME erosion** (final spatially-averaged beach width of 35 m)



- Current nourishment strategy is implicitly at **short-term** scale – **beach maintenance and post-storm recovery**.
- In spite of this, beaches show **structural erosion** which will be aggravated by SLR (**beaches are becoming a SCARCE resource**).
- Required volumes for **maintaining** beaches at their current state may exceed up to **five times** the volume of total nourishment done since 80's.
- Required volumes can be reduced by **smart(?) long-term strategy (facilitating accommodation space + defining an optimum width + sediment redistribution)**.
- In spite of this, a **good evaluation of a strategic sediment reservoir** is needed (**current verified suitable sediment about 5 Mm<sup>3</sup> is not enough**).

# Acknowledgements



***M-CostAdapt*** Project

<http://mcostadapt.upc.edu>

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(MINECO/AEI/FEDER, UE)

