# LIFE ADAPT CALA MILLOR

## Diagnòstic del sistema platja i escenaris de futur per a Cala Millor

Cofinanciado por la Unión Europea

11.06.2026 – Taller de capacitació administracions locals i entitats socioeconòmiques

#LIFEAdaptCalaMillor

# Equipo de trabajo D.3.4

## **0.1** Dimensión física

Àngels Fernández-Mora *

Elena Sánchez-García

Lluís Gómez-Pujol

Alejandro Orfila

Marta Marcos

## **02**. Dimensión ambiental

Daniel García Veira *

Alejandro Orfila

Núria Marbà

Lluís Gómez-Pujol

## **03**. Dimensión socio-económica

Bartolomé Pascual Fuster *

Jaume Rosselló Nadal *

Elena Sánchez-García

Lluís Gómez-Pujol

## **04.** Dimensión urbana

Àngels Fernández-Mora *

Elena Sánchez-García

## **05**. Cartografía impactos

Elena Sánchez-García *

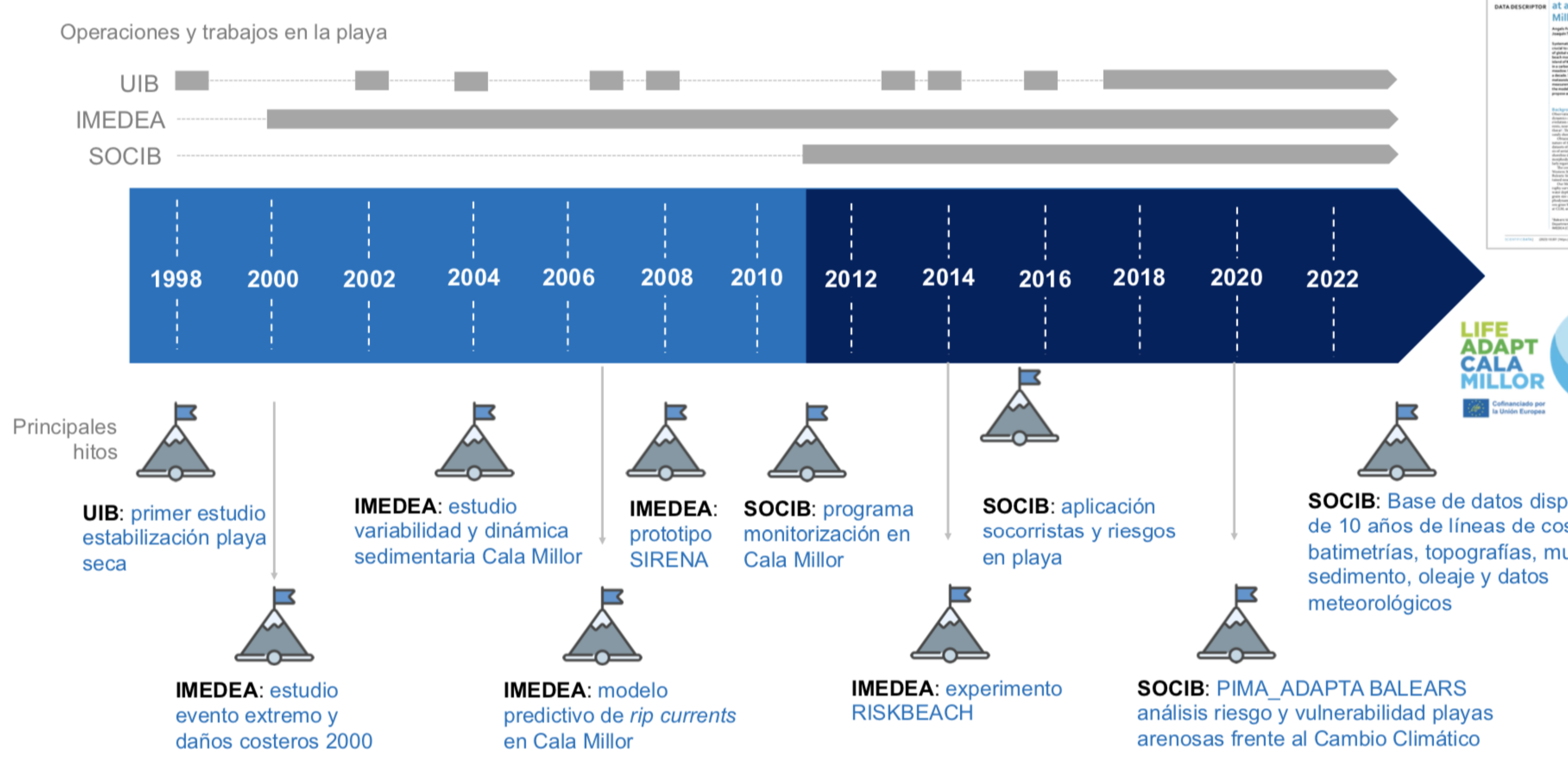
Daniel García Veira

Cofinanciado por la Unión Europea

www.LifeAdaptCalaMillor.com

# 25 ANYS D'OBSERVACIONS

## CALA MILLOR UN LABOTARI NATURAL DE REFERÈNCIA INTERNACIONAL



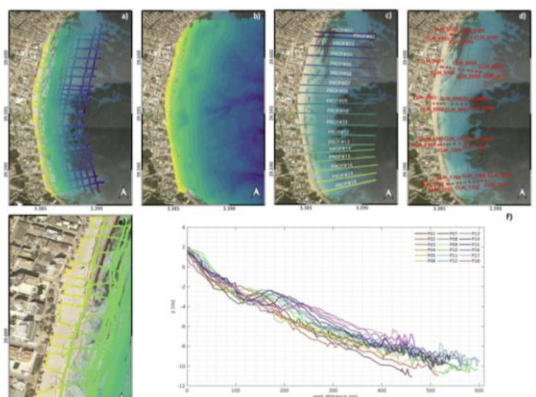

LIFE ADAPT CALA MILLOR

Cofinanciado por la Unión Europea

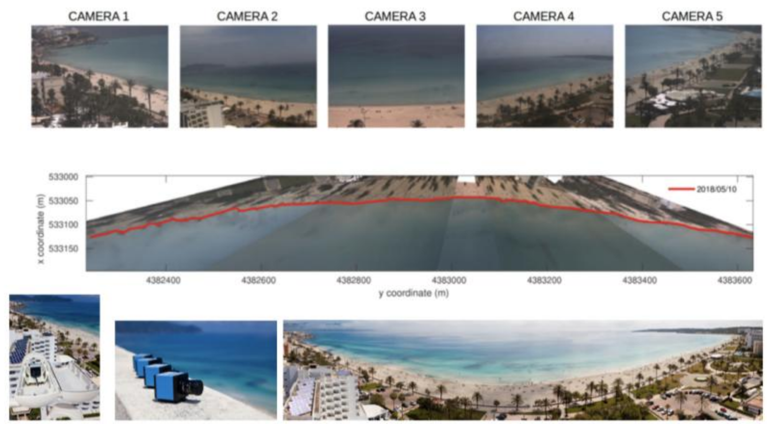
www.LifeAdaptCalaMillor.com

# 25 ANYS D'OBSERVACIONS

## El sistema modular de monitorización de playas (2011 – actualidad)



https://apps.socib.es/beamon




El programa de seguimiento continuo y sistemático de la playa de Cala Millor (CLM) se puso en marcha en 2011 como un proyecto clave del Servicio de Monitorización de Playas del Sistema de Observación y Predicción Costera de las Islas Baleares (SOCIB). Proporciona costeros sostenidos en el tiempo y de alta resolución, lo que contribuye a la investigación de la morfodinámica costera.

El Sistema Modular de Monitorización Integral de Playas (MOBIMS) comprende: (i) **levantamientos batimétricos** y topográficos **bianuales**, (ii) un sistema de monitorización de 5 cámaras para extracción de **líneas de costa bimestrales**, (iii) mediciones **horarias** de **oleaje** y nivel del mar, (iv) **datos meteorológicos** en tiempo real, y (v) muestreo anual de **sedimentos** y **análisis granulométricos**.

## Formación e investigación

3 TFG

8 TFM

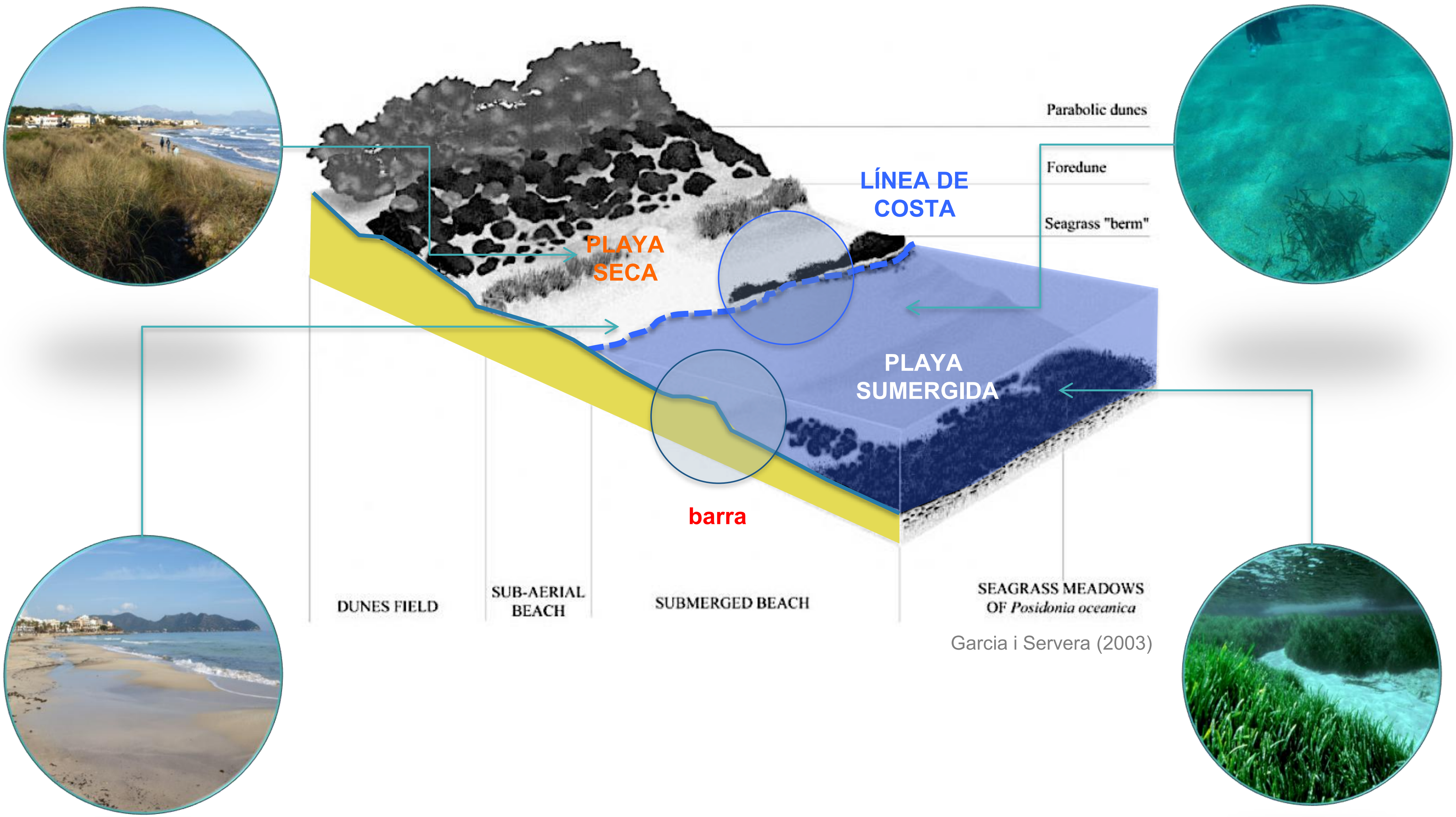
4 PhD
+ 2 en curso

64 CAMPAÑAS
3 EXPERIMENTOS

48 ISI PAPERS
6 PROY. INVESTIGACIÓN

## Un laboratorio natural para el estudio de playas mediterráneas (contribuciones relevantes)

# EL CONCEPTE DE PLATJA

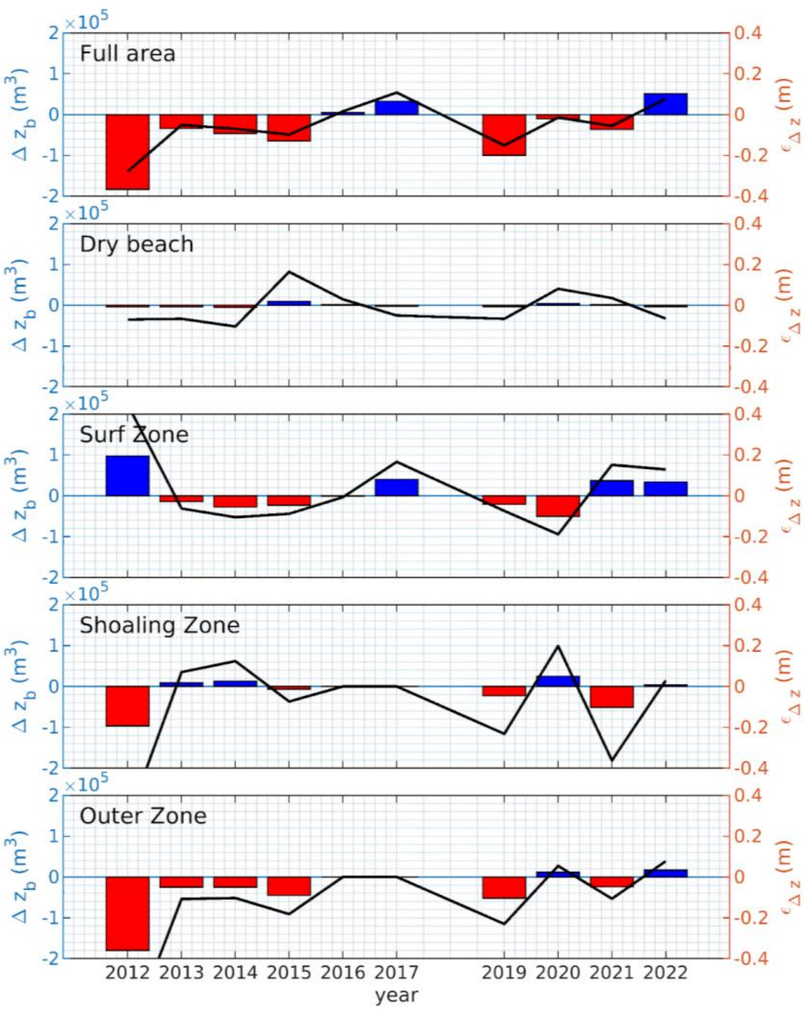


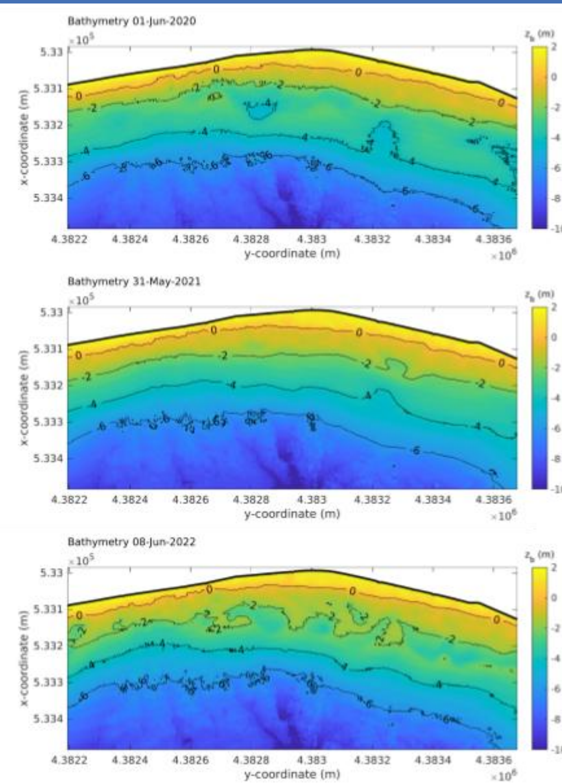

Garcia i Servera (2003)

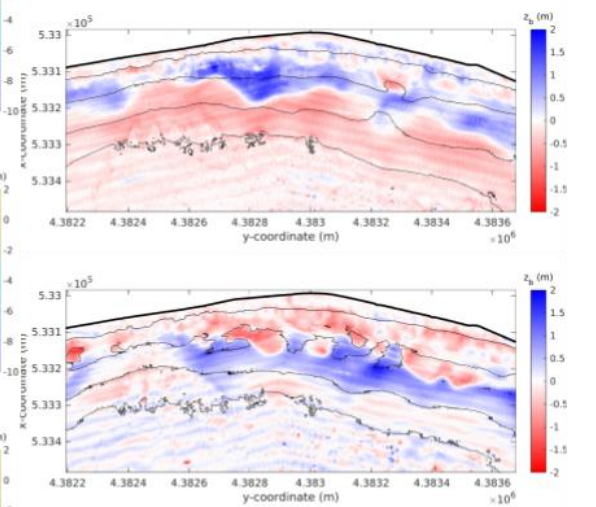
Cofinanciado por
la Unión Europea

www.LifeAdaptCalaMillor.com

# **Balanç sedimentari** (la comptabilitat del sediment)




Notably, between 2021 and 2022, the final sediment balance indicated an influx of 52,000 m³ of sediment into the control area

- En termes de balanç sedimentari s'observa una pèrdua tènue de sediment (-0,14 m³/m²) a partir dels estudis batimètrics.
- És raonable, tenint en compte la ciclicitat detectada que part d'aquest sediment no ha sortit del Sistema sinó que resta a localitzacions properes, fora del domini de monitorització.

LIFE ADAPT CALA MILLOR

Cofinanciado por la Unión Europea

www.LifeAdaptCalaMillor.com

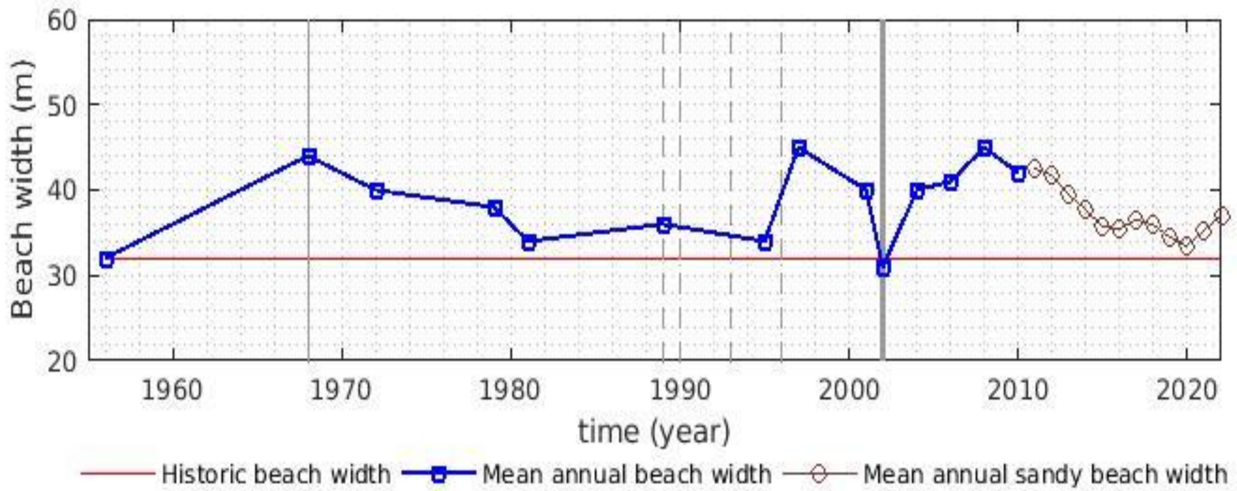
# **Balanç sedimentari** (la comptabilitat del sediment)

| | **Dry Zone** $Z \geq 0$ m | **Surf Zone** $-4 \leq Z < 0$ m | **Shoaling Zone** $-6 \leq Z < -4$ m | **Outer Zone** $Z < -6$ m | **Full beach** |
|---|---|---|---|---|---|
| 2012-2011 | -4,000 (-0.07) | 97,000 (0.44) | -97,000 (-0.65) | -180,000 (-0.79) | -183,000 (0.28) |
| 2013-2012 | -4,000 (-0.07) | -14,000 (-0.06) | 9,000 (0.07) | -25,000 (-0.11) | -34,000 (-0.05) |
| 2014-2013 | -6,000 (-0.10) | -28,000 (-0.10) | 12,000 (0.12) | -25,000 (-0.10) | -46,000 (0.07) |
| 2015-2014 | 10,000 (0.16) | -23,000 (-0.09) | -7,000 (-0.07) | -45,000 (-0.18) | -65,000 (-0.10) |
| *2016-2015* | 2,000 (0.03) | -2,000 (~0.00) | — | — | *~0.0 (~0.00)* |
| *2017-2016* | -3,000 (-0.05) | 40,000 (0.16) | — | — | *37,000 (0.11)* |
| *2019-2017* | *-8,000 (-0.07)* | *-21,000 (-0.07)* | *-23,000 (-0.23)* | *-53,000 (-0.23)* | *-105,000 (-0.15)* |
| 2020-2019 | 10,000 (0.08) | -51,000 (-0.19) | 25,000 (0.20) | 11,000 (0.05) | -5,000 (~0.00) |
| 2021-2020 | 2,000 (0.03) | 37,000 (0.15) | -51,000 (-0.36) | -24,000 (-0.11) | -36,000 (-0.06) |
| 2022-2021 | -3,000 (-0.07) | 34,000 (0.13) | 4,000 (0.03) | 17,000 (0.07) | 52,000 (0.08) |
| 2022-2017 | -5,000 (-0.15) | -19,000 (-0.08) | -30,000 (-0.30) | -40,000 (-0.24) | **-94,000 (-0.14)** |

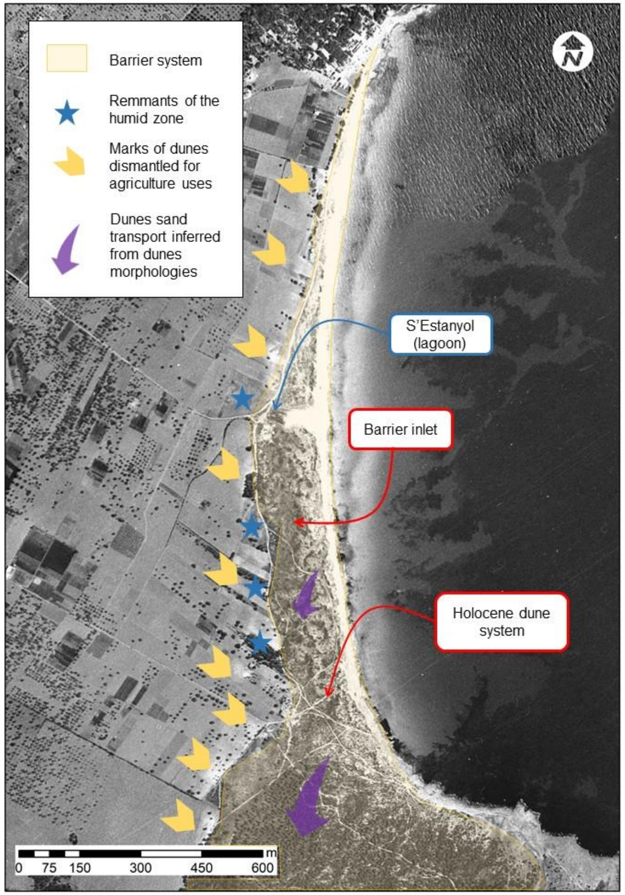
www.LifeAdaptCalaMillor.com

Cofinanciado por la Unión Europea

# L'eficiència de les regeneracions

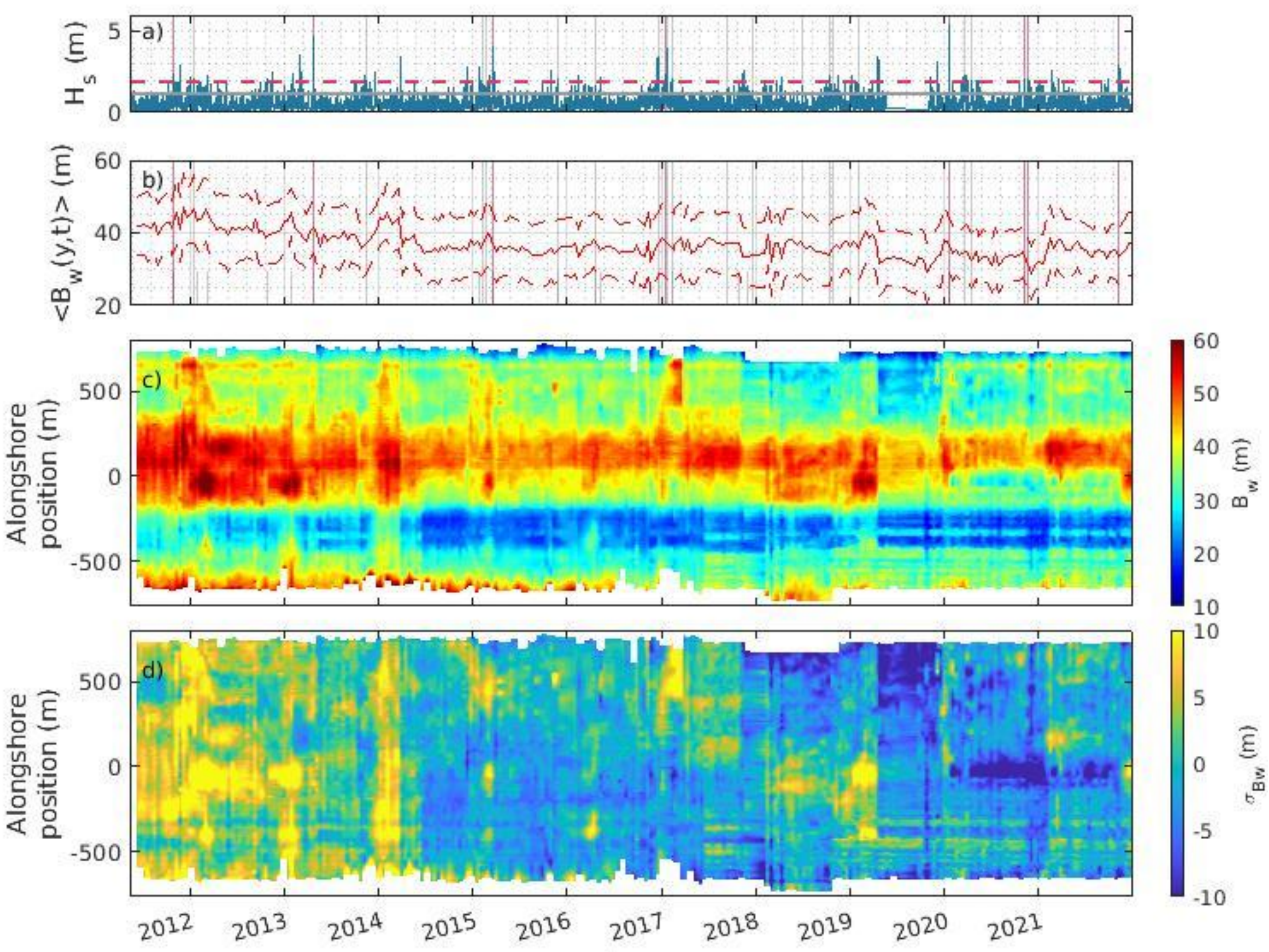


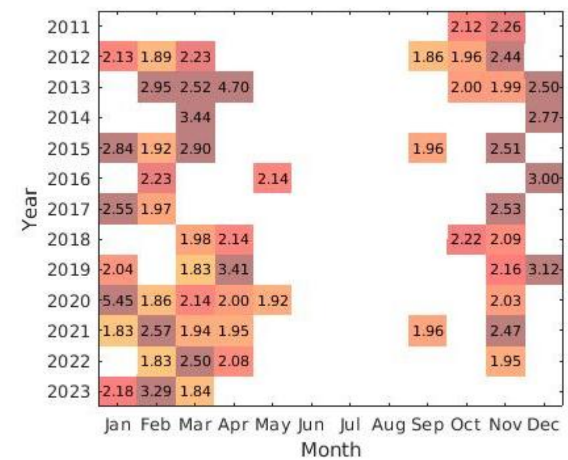

| Cala Millor reported sand nourishments | |
|---|---|
| **Year** | **Volume ( m³)** |
| 1968 | ?; but Promenade construction and dismantling of the dune ridge of >65,400 $m^2$ |
| 1989 | ? |
| 1990 | 8,000 |
| 1993 | 5,400 |
| 1996 | 4,759 |
| 2002 | > 40,000 |
| Total | > 58,149 |

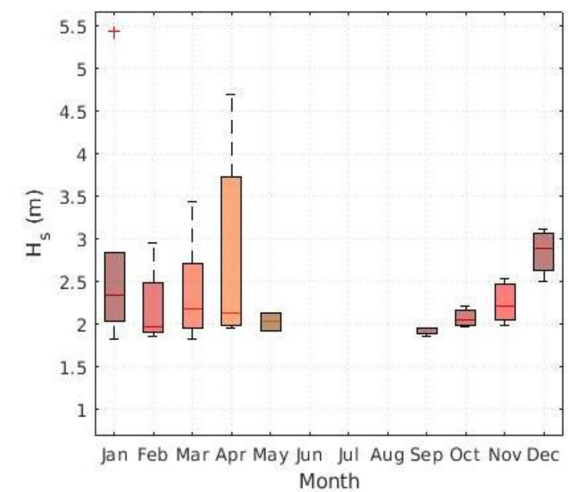


www.LifeAdaptCalaMillor.com

# La variabilitat natural amaga, de moment, els impactes del SLR ?



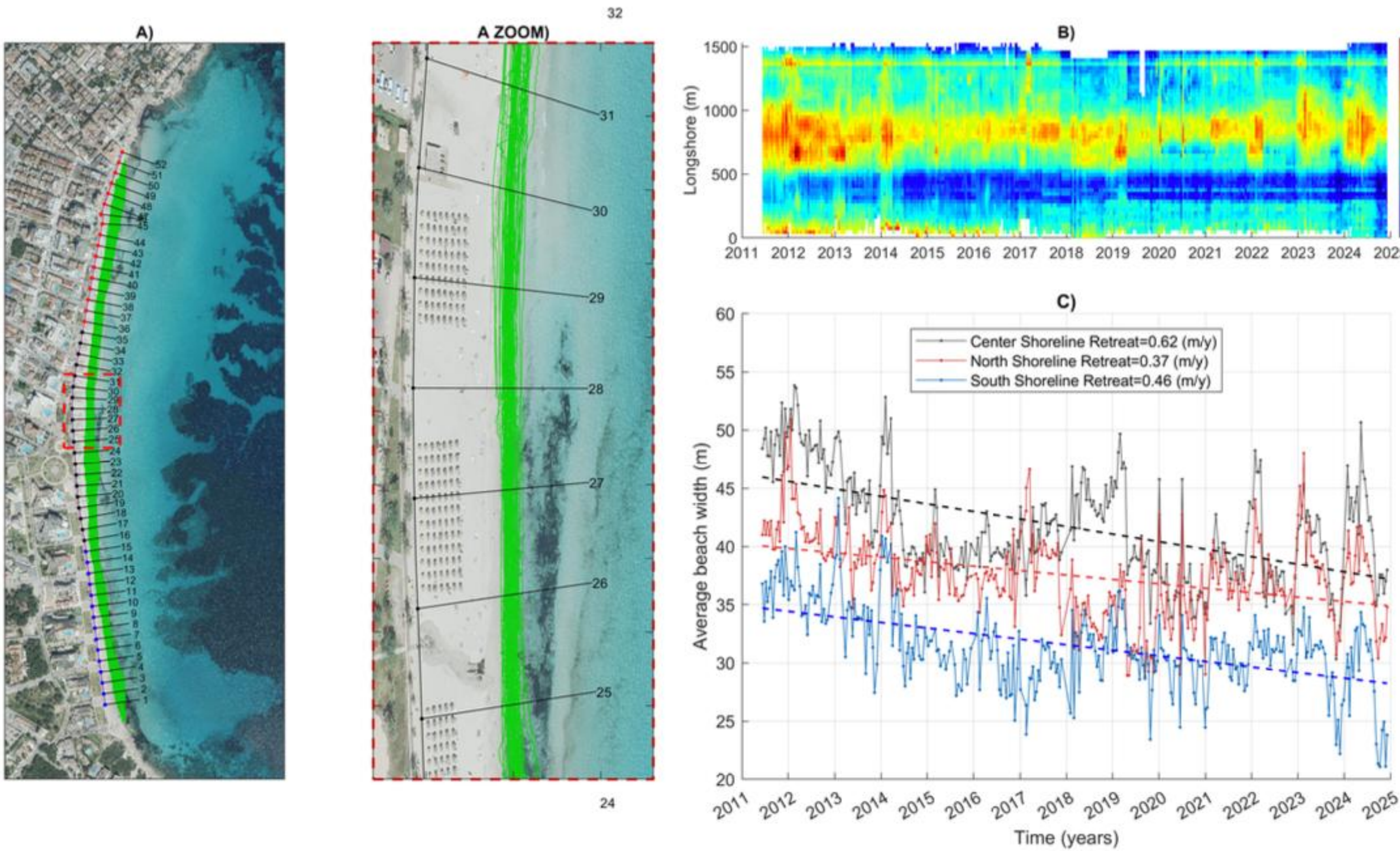



LIFE ADAPT CALA MILLOR

Cofinanciado por la Unión Europea

www.LifeAdaptCalaMillor.com

# La variabilitat natural amaga, de moment, els impactes del SLR ?



# La variabilitat natural amaga, de moment, els impactes del SLR ?

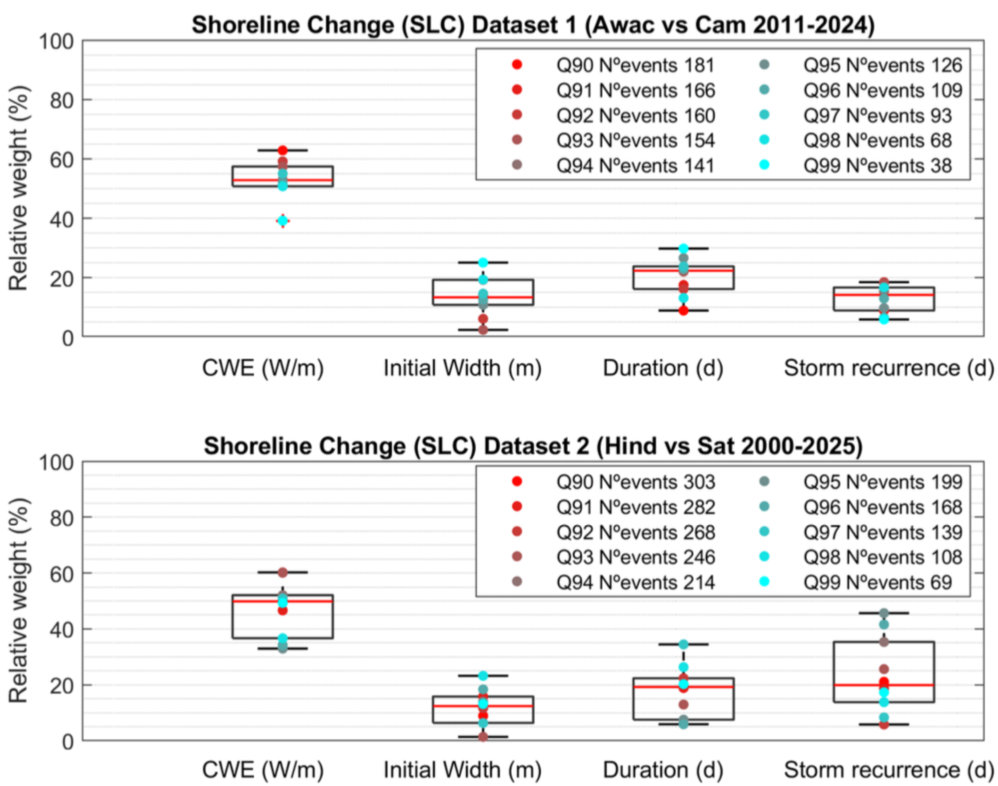
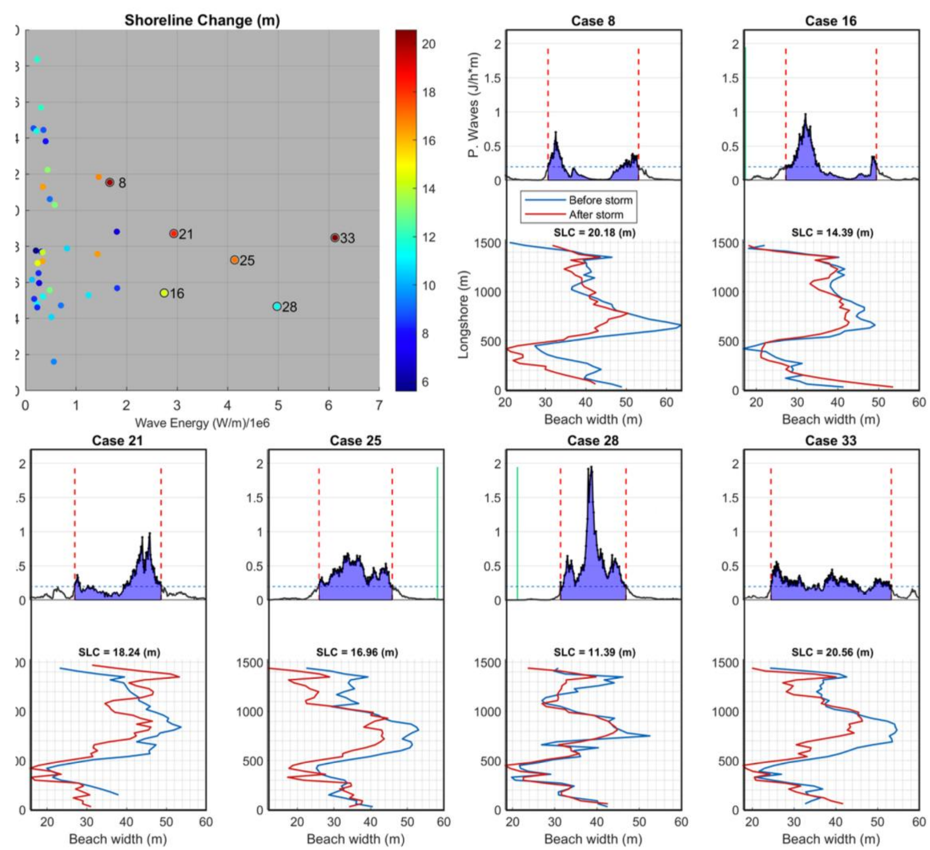
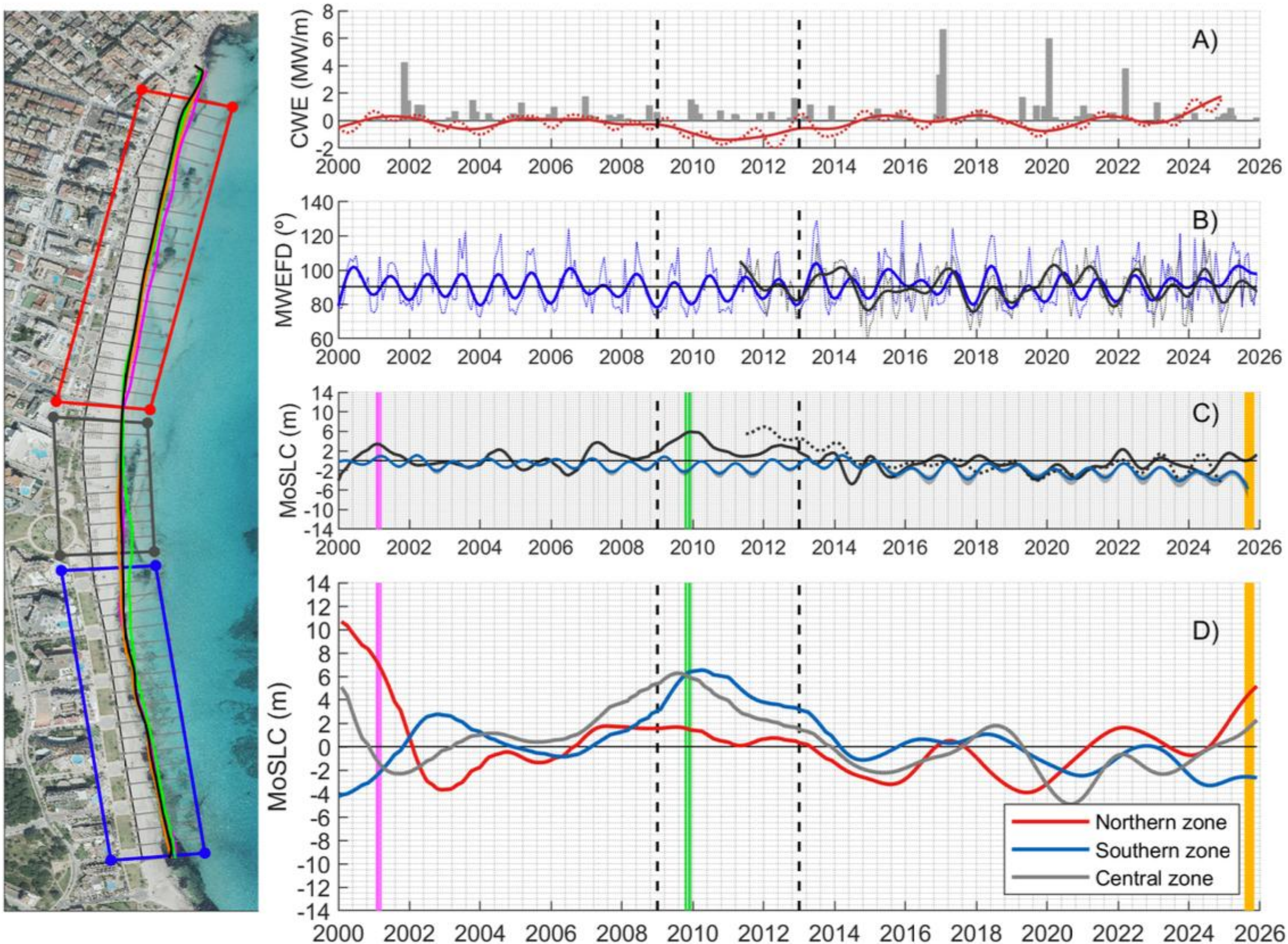
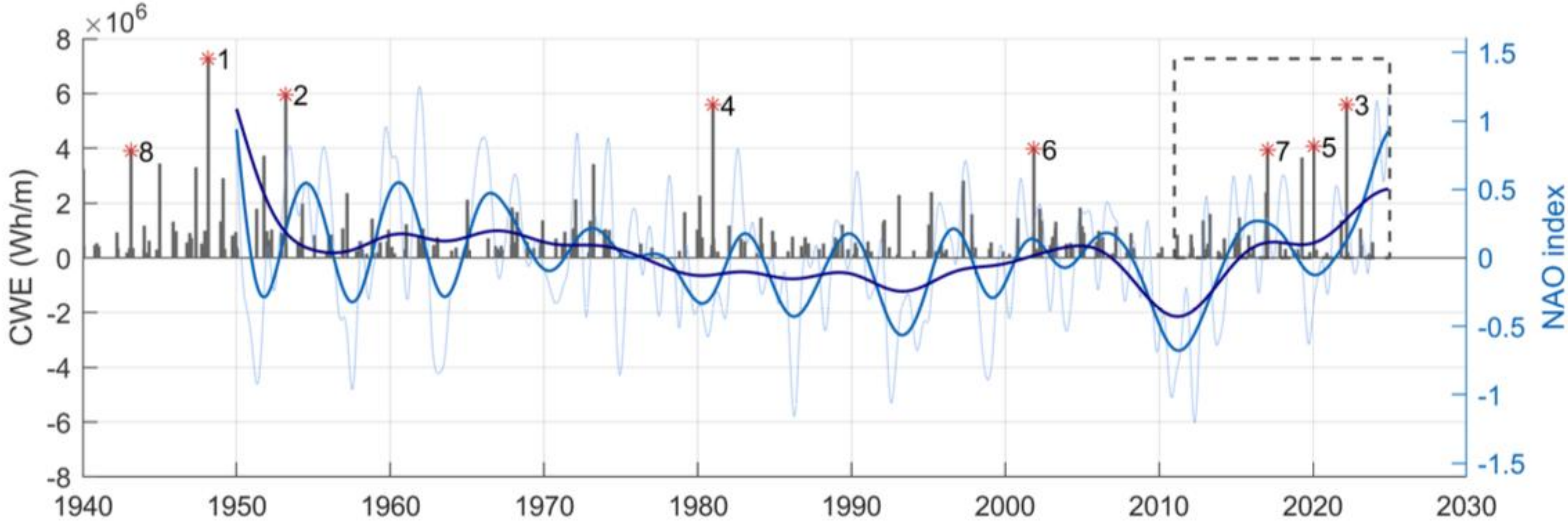


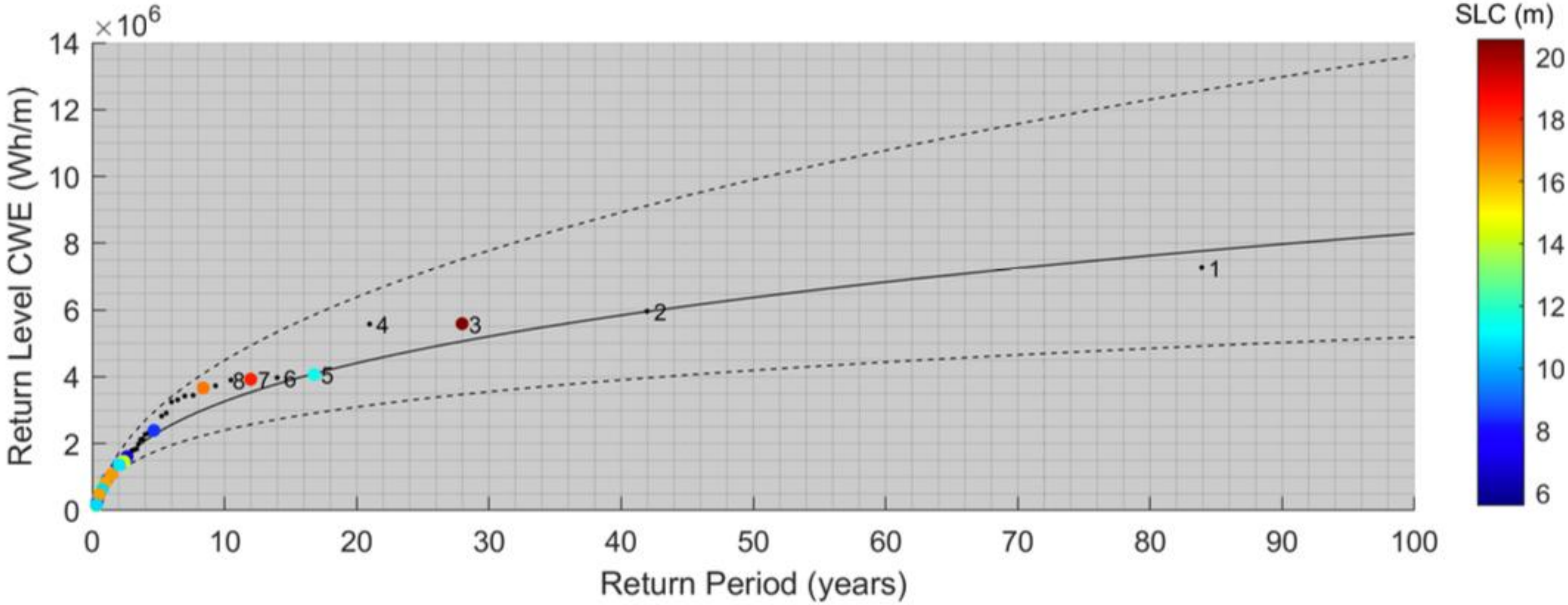

**Figure 3.** Relative contribution of explanatory variables in the multivariable shoreline-change model considering different upper-quantile thresholds used to define extreme wave events. Results are shown for Dataset 1 (AWAC wave forcing and camera-derived shoreline change, 2011–2024; upper panel) and Dataset 2 (hindcast wave forcing and satellite-derived shoreline change, 2000–2025; lower panel). Boxplots represent the distribution of relative predictor weights obtained across all analysed extreme-event thresholds (Q90–Q99). Coloured markers indicate the individual model results for each quantile threshold, with the corresponding number of detected extreme events listed in the legend. Predictors include cumulative wave energy (CWE), pre-storm beach width, storm duration, and storm recurrence.





CWE (MW/m)
A)
MWEFD (°)
B)
MoSLC (m)
C)
MoSLC (m)
D)
Northern zone
Southern zone
Central zone


×10^6
CWE (Wh/m)
NAO index
1
2
3
4
5
6
7
8
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030


×10^6
Return Level CWE (Wh/m)
Return Period (years)
SLC (m)

LIFE ADAPT CALA MILLOR

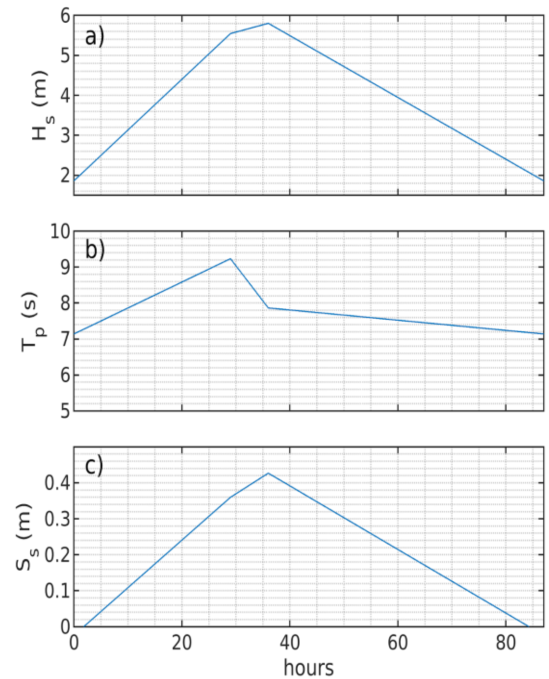
Cofinanciado por la Unión Europea

www.LifeAdaptCalaMillor.com

# El problema important a mig termini (2050 o 2030): SLR

| IPCC Sc | Forcing | Current (2023) | 2030 | 2050 | 2100 |
|---|---|---|---|---|---|
| RCP-4.5 | Sea level | | PERMANENT (Pf) | PERMANENT (Pf) | PERMANENT (Pf) |
| | Sea level + wave and storm surge T100 | EXTREME (Ef_P0) | EXTREME (Ef_P0) | EXTREME (Ef_P0) | EXTREME (Ef_P0) |
| | Sea level + wave and storm surge T100<br>Corresponding *P. oceanica* meadow | | EXTREME (Ef_Pt) | EXTREME (Ef_Pt) | EXTREME (Ef_Pt) |
| RCP-8.5 | Sea-level | | PERMANENT (Pf) | PERMANENT (Pf) | PERMANENT (Pf) |
| | Sealevel + wave and storm surge T100 | | EXTREME (Ef_P0) | EXTREME (Ef_P0) | EXTREME (Ef_P0) |
| | Sea level + wave and storm surge T100<br>Corresponding *P. oceanica* meadow | | EXTREME (Ef_Pt) | EXTREME (Ef_Pt) | EXTREME (Ef_Pt) |

*Summary of simulations and resulting flooding events for Cala Millor.*



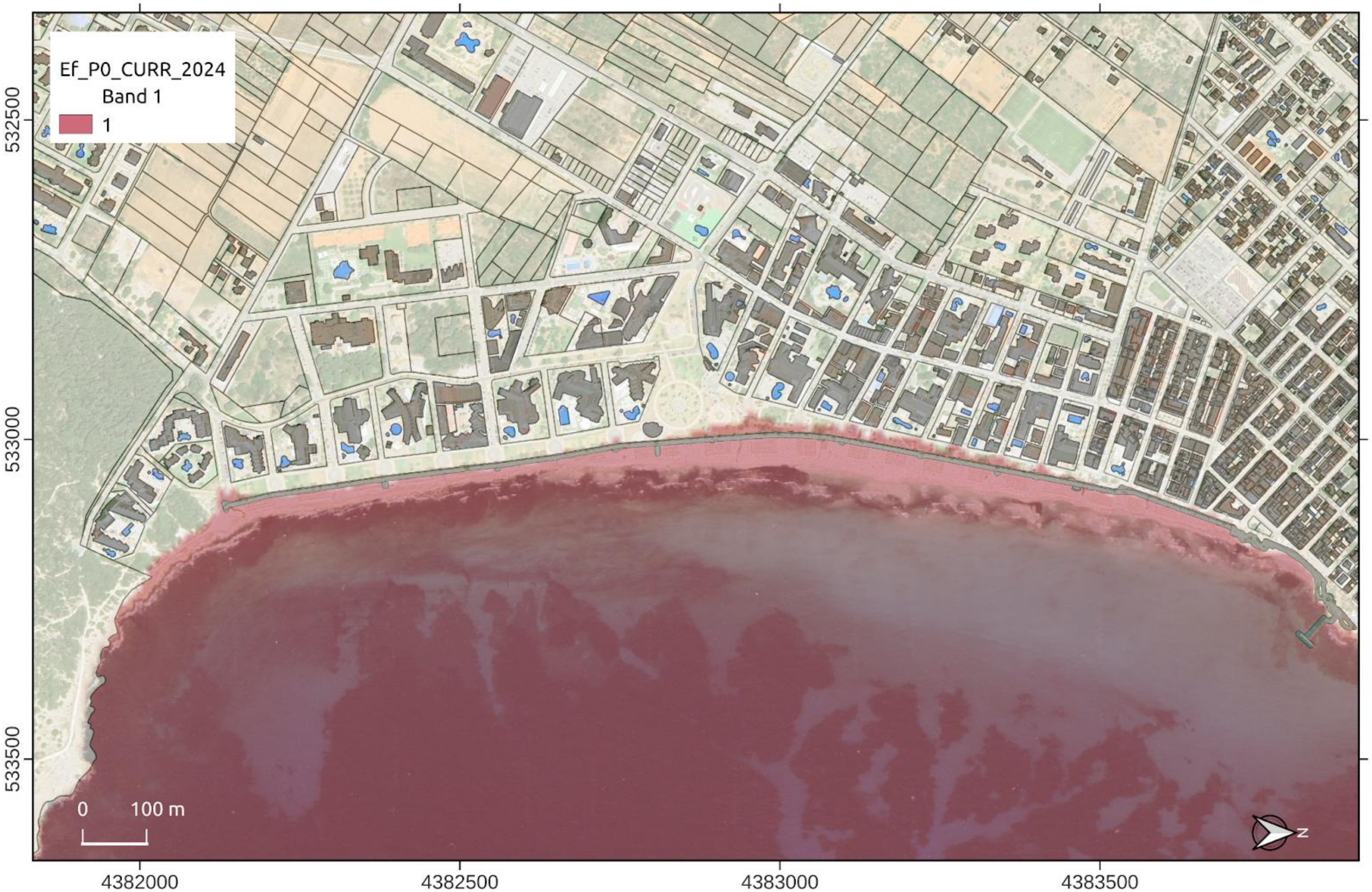

Synthetic reference storm of T100 for Cala Millor: a) Significant wave height; b) Peak period and c) Storm surge.

LIFE ADAPT CALA MILLOR

Cofinanciado por la Unión Europea

www.LifeAdaptCalaMillor.com

# El problema important a mig termini (2050 o 2030): SLR




*Current Extreme Flooding (Ef_P0) map (2024 year).*

# El problema important a mig termini (2050 o 2030): SLR

| RCP scenario | Time-horizon | Pf ($m^2$) | Ef (Po) ($m^2$) | Ef (Pt) ($m^2$) | Beach width (m) |
|---|---|---|---|---|---|
| - | 2024 | - | 71,400 | - | 32.75 |
| RCP4.5 | 2030 | 4,900<br>(2,800; 8,075) | 78,500<br>(74,500; 83,500) | 75,100<br>(72,000; 79,600) | 26.1<br>(24,08; 27.6) |
| | 2050 | 8,375<br>(4,025; 14,700) | 83,700<br>(78,500; 91,800) | 87,400<br>(78,200; 101,900) | 23.91<br>(19.78; 26.71) |
| | 2100 | 19,300<br>(8,975; 31,700 ) | 112,500<br>(86,800; 205,100) | 117,200<br>(101,500; 240,500) | 16.84<br>(9.16; 23.51) |
| RCP8.5 | 2030 | 4,900<br>(2,925; 8,075) | 78,200<br>(71,400; 82,400) | 74,700<br>(69,800; 77,400) | 26.1<br>(24.08; 27.49) |
| | 2050 | 8,975<br>(4,550; 15,750) | 82,600<br>(79,400; 94,300) | 91,500<br>(81,000; 98,400) | 23.51<br>(19.10; 26.33) |
| | 2100 | 24,425<br>(15,750; 43,900) | 145,700<br>(100,800; 723,600) | 155,100<br>(101,200; 190,850) | 13.61<br>(1.69; 19.1) |

*Flooded surface in $m^2$ from 2024's emerged part in the different climatic scenarios and for the three confidence intervals (min, mean, max). The flooded maps considered are "Permanent flooding (Pf)"; "Extreme flooding with Posidonia oceanica of current state (Ef-Po)"; "Extreme flooding with Posidonia oceanica dependent on the scenario (Ef-Pt)". Finally the average value of the beach width in m.*

LIFE ADAPT CALA MILLOR

Cofinanciado por la Unión Europea

www.LifeAdaptCalaMillor.com

# El problema important a mig termini (2050 o 2030): SLR

*PERMANENT FLOODING*

*RCP-4.5*

*RCP-8.5*


*2030* *2050* *2100*

# El problema important a mig termini (2050 o 2030): SLR

*EXTREME FLOODING (including changes on seagrass meadow dissipation)*

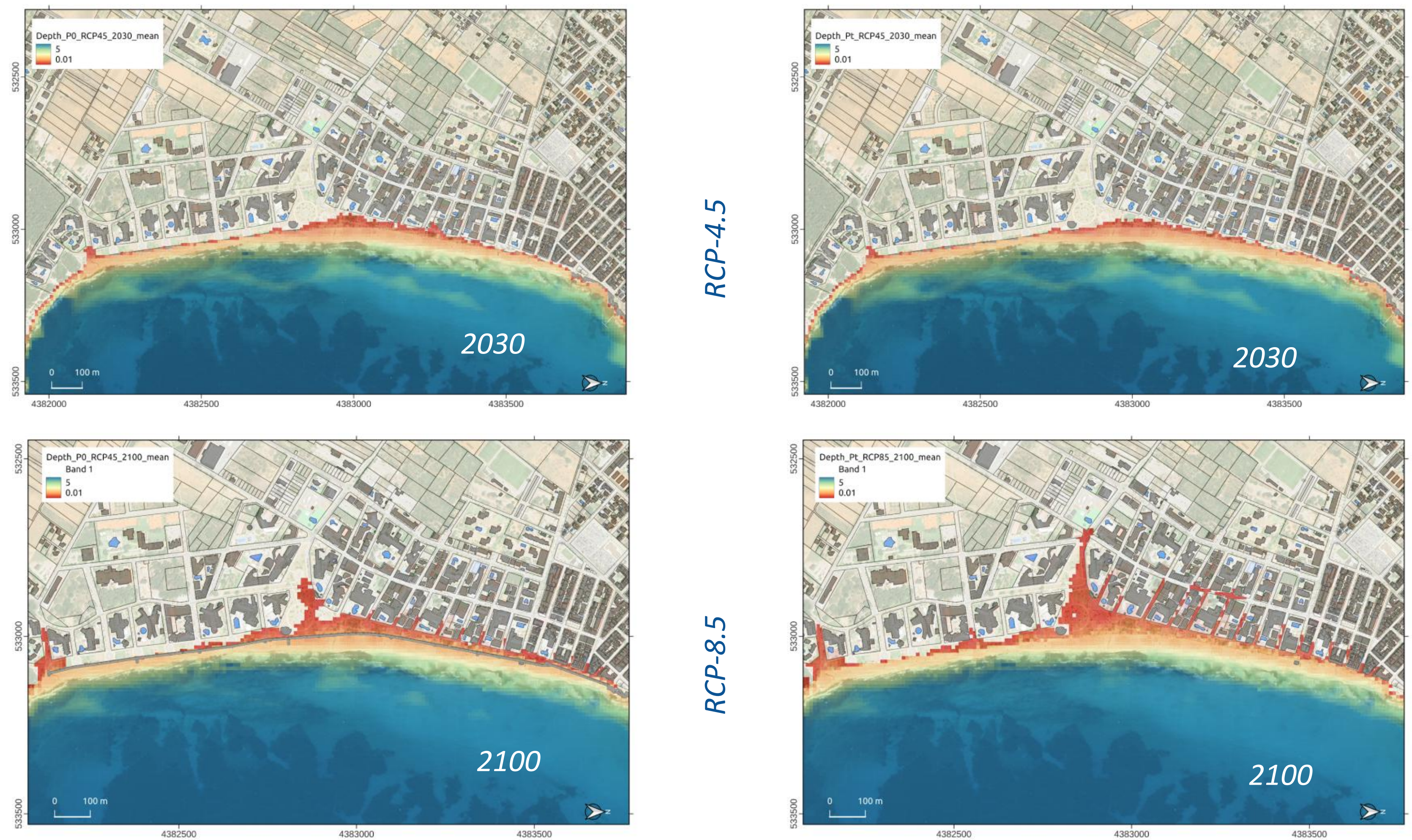
*RCP-4.5*

*RCP-8.5*


*2030* *2050* *2100*

# El problema important a mig termini (2050 o 2030): SLR

*Extreme Mean flooding water depth (m) for invariant seagrass meadow*




*Mean flooding water depth (m) for dependent seagrass meadow*

www.LifeAdaptCalaMillor.com

Cofinanciado por la Unión Europea

# El problema important a mig termini (2050 o 2030): SLR

| | | Lost Value in thousand euros (in percentage) | | |
|---|---|---|---|---|
| | | Min/P25 | Mean/P50 | Max/P75 |
| RCP4.5 | 2030 | 672,280 (25.1%) | 765,009 (28.6%) | 880,919 (33.0%) |
| | 2050 | 741,826 (27.7%) | 904,101 (33.8%) | 1,135,922 (42.5%) |
| | 2100 | 927,283 (34.7%) | 1,321,379 (49.4%) | 1,785,021 (66.8%) |
| RCP8.5 | 2030 | 695,462 (26.0%) | 765,009 (28.6%) | 1,112,740 (41.6%) |
| | 2050 | 765,009 (28.6%) | 927,283 (34.7%) | 1,275,015 (47.7%) |
| | 2100 | 1,182,287 (44.2%) | 1,506,836 (56.4%) | 2,225,481 (83.2%) |

***Table 17.*** *Projected Lost economic value in thousand euros and in percentage during the period 2024-2100 under scenarios RCP4.5 and RCP8.5*

The total economic value of the Cala Millor area has been estimated at 2.673 billion euros. Rising temperatures, but especially the loss of beach surface area due to climate change, will lead to a loss in value of the area of between 25% and 83% depending on the scenario considered.