ASSESSMENT OF ANTHROPOCENE COASTAL RESILIENCE. A CASE STUDY IN MATALASCAÑAS (SW SPAIN)

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Introduction

Modern coastal biomes are heavily influenced by human activities, creating human-shaped coastal systems. This has led to a potential conflict between managing the economic and business aspects, while also maintaining a sustainable environment. Resilience is a key factor in managing this conflict, as it broadly refers to the ability of a system to absorb impacts. Nonetheless, the concept of resilience is ambiguous and requires rigorous empirical assessment, with different assessments depending on the context.

Currently, the two most considered approaches to coastal resilience are engineering and ecological resilience (Fig. 1; Holling, (1973)). However, for both approaches, there is a lack of research on methodologies to measure them.
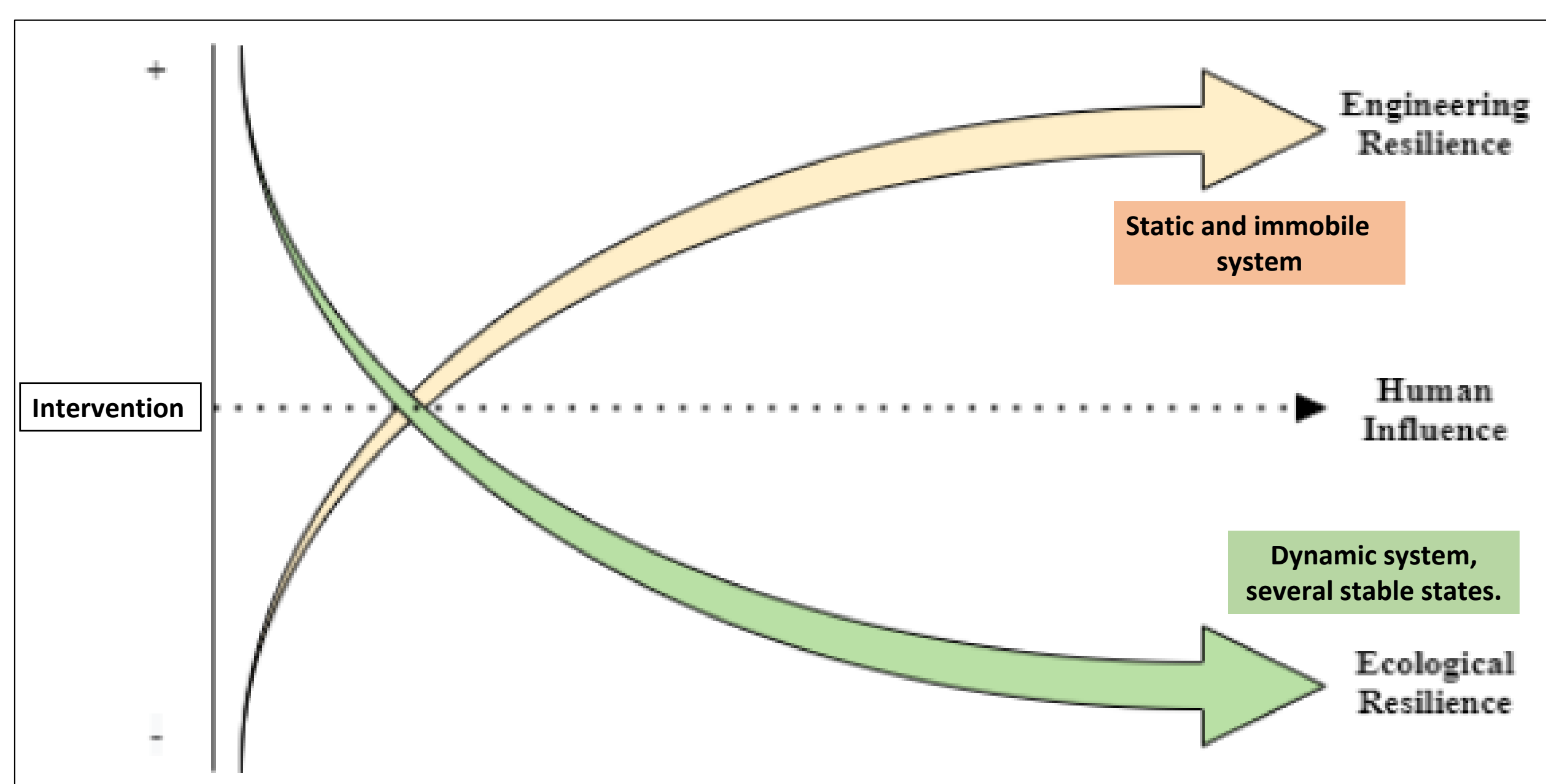

Figure 1. Conceptual model showing the type of resilience a coast approaches based on human influence. Source: Malvarez et al. (2021).

Objectives

To contextualise the concept of resilience

To understand the current behaviour of the urban beach.

To propose a methodology of easy implementation to measure coastal resilience
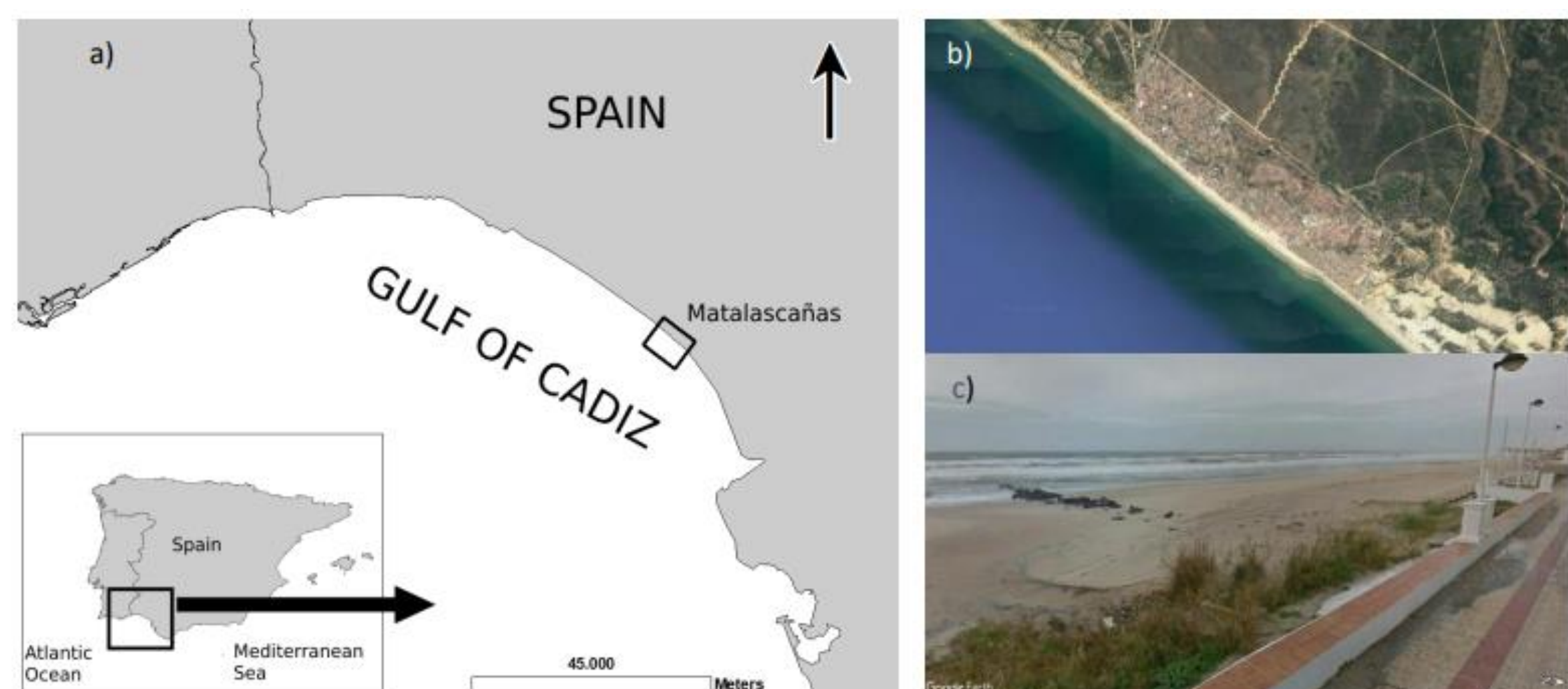
Methods & Materials

Figure 2. a) Location of the study site b) Aerial photography from Google Earth. c) Photography of a groyne taken from Google Earth's Street View.

- Matalascañas (Fig. 2) was originally a local beach for bonding, but urbanisation in the 1960s led to its development as a touristic destination.
- Although there are less than 3000 registered , during the summer months, there is a significant increase of population due to tourism (100,000 people in 2011 !!!), which the town and its infrastructure are not prepared to handle.

That doesn't sound right...

If Eroding ~ not resilient

ENGINEERING RESILIENCE

Historical Orthophotography searching and processing

Digitisation of the dune foot:

Analysis of the beach's behaviour using DSAS

Resilience Assessment based on shoreline movement

Table 1. Years used to digitise the dune foot and error of the dune foot position (m) calculated as indicated in del Río & Gracia, (2013)

Digitised year	Error calculated for the dune foot position (m)
1956	1
1977	1
1984	1
1998	1
2001	1
2004	1
2008	1
2010	0.5
2013	0.5
2016	0.5

$$Ep = \sqrt{G^2 + R^2 + D^2}$$

$$Erate = \frac{\sqrt{Ep_1{}^2 + Ep_2{}^2}}{T}$$

0.05 m/yr

Shoreline change rate error

Results & Discussion

As initially expected, Fossil Dunes are mostly eroding, while the active dunes are in a state of accretion, both confirmed by high r-squared values. Areas near Matalascañas were found to be approaching a stability state, with a sudden decrease in r-squared. Only a minimal area near Matalascañas shows an increase in LR2, which could not be considered representative of the beach (Table 2 and 3)
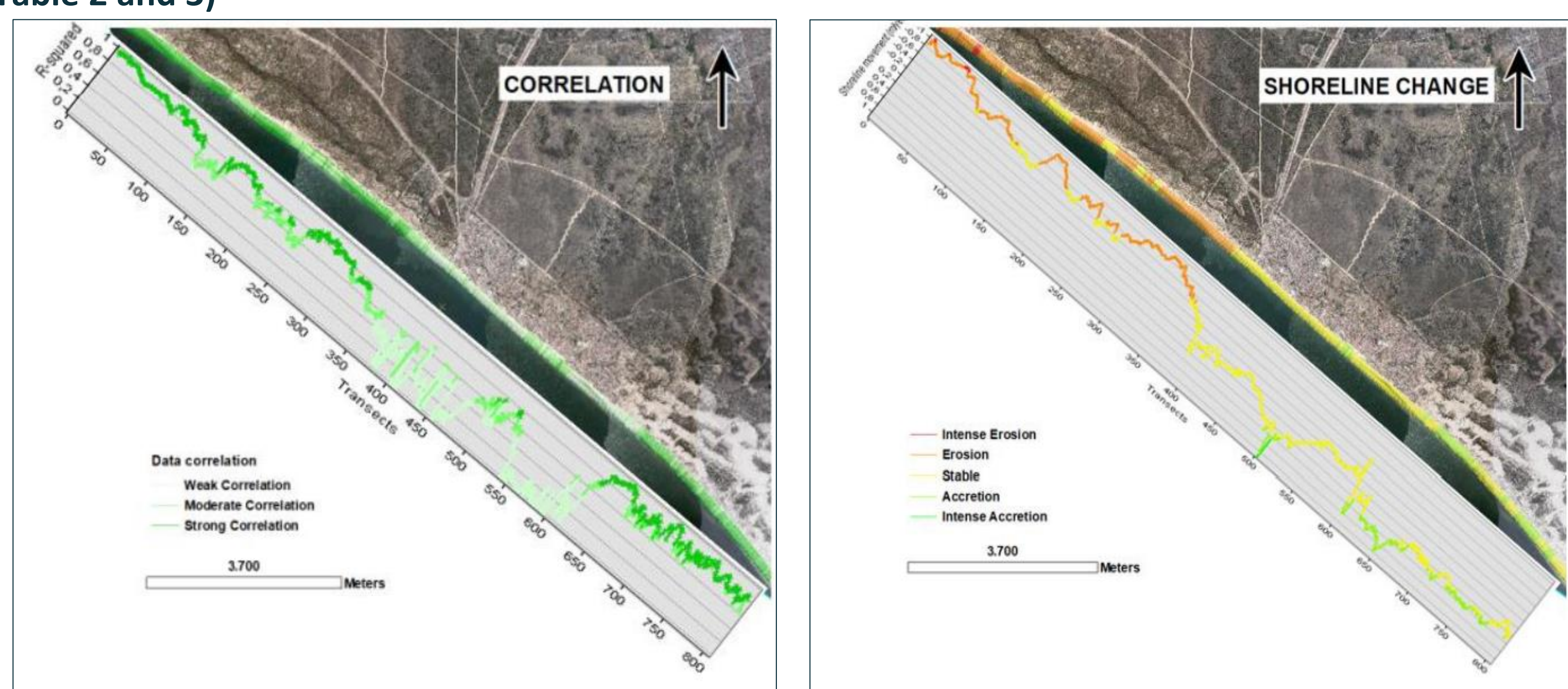

Figure 3. a) r-squared calculated between all considered dune foots. Values < 0.5 were considered of weak correlation; an r-squared of 0.5 – 0.7 was considered a moderate correlation and an r-squared of > 0.7 was considered of strong correlation, as indicated in Simon & Moore, (1996); b) Shoreline movement obtained from DSAS. different levels of movement where categorised based on and Luijendijk et al., (2018) criteria: Intense accretion (> 1 m/yr), accretion (0.5 – 1 m/yr), stability (-0.5 – 0.5 m/yr), erosion (-0.5 – -1 m/yr) and intense erosion (< -1 m/yr).

From the study, we could infer that the area related to the fossil dunes is not resilient, while the active dunes are (Fig. 4). However, although Matalascañas was measured to be resilient, human structures have prevented the sediment loss, portraying an "artificial" state resilience (Fig. 5).

The methodology used to measure shoreline change has limitations when applied to highly urbanised areas, and there were gaps in the data used. However, it is suggested that the methodology could be useful for urban planning and development to determine whether a location is suitable for infrastructure construction.
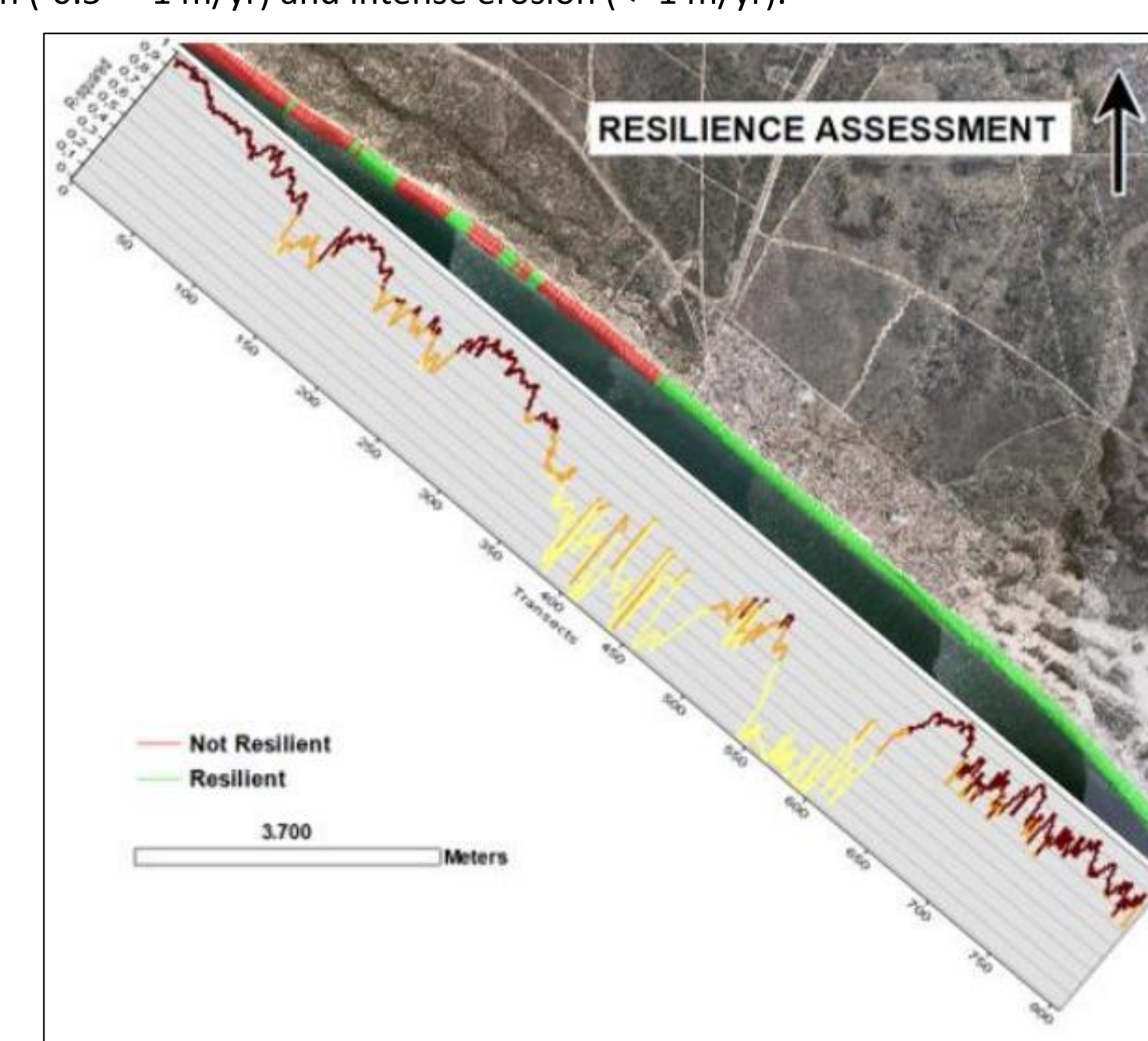

Figure 4. Resilience assessment with R-squared values for reference.

Measuring resilience is much more difficult than we first thought...
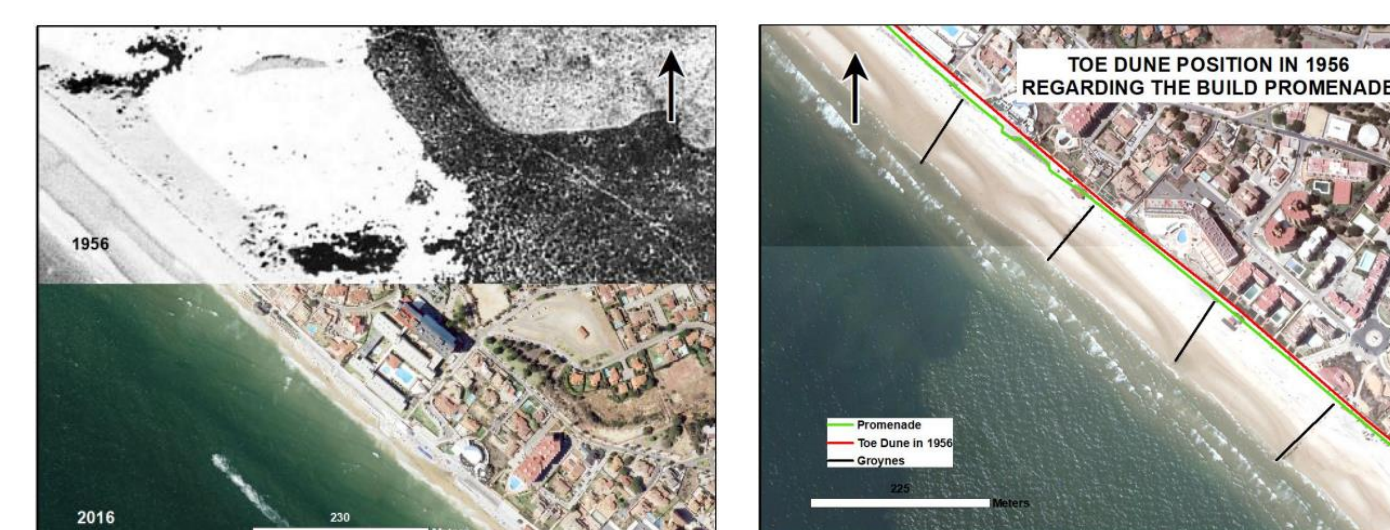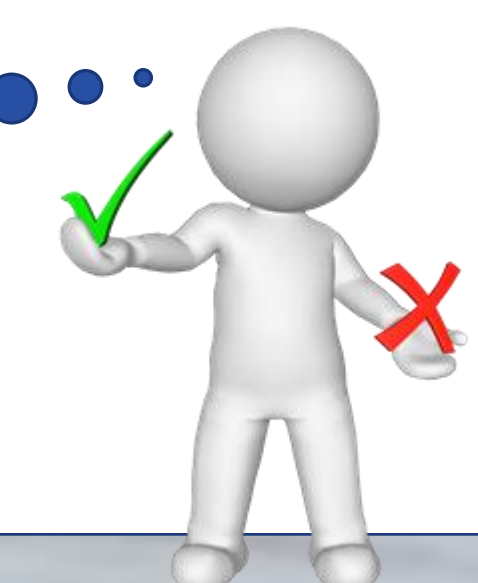

Figure 5. Intense urbanisation of the beach. a) Comparison between the beach in 1956 and 2016 b) Position of the promenade in 2016 compared to the toe dune in 1956. Groynes digitised for contextualisation. .

Conclusions

- The goal was measuring Engineering Resilience. Hence concepts such us stability are understood from the approach that the coast is still.
- The methodology failed to understand the behaviour of already urbanised coasts
- The methodology serves the purpose of being a beforehand tool, of easy implementation, to get an overall idea of the coastal behaviour prior the start of edification or similar invasive human action
- Matalascañas is set in an unsustainable place for the long-term, resulting in a need for constant human intervention to maintain the main beach in that artificial state of resilience

And still looking for ways to include the social and economic aspect in the methodology, reaching an integrated resilience

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