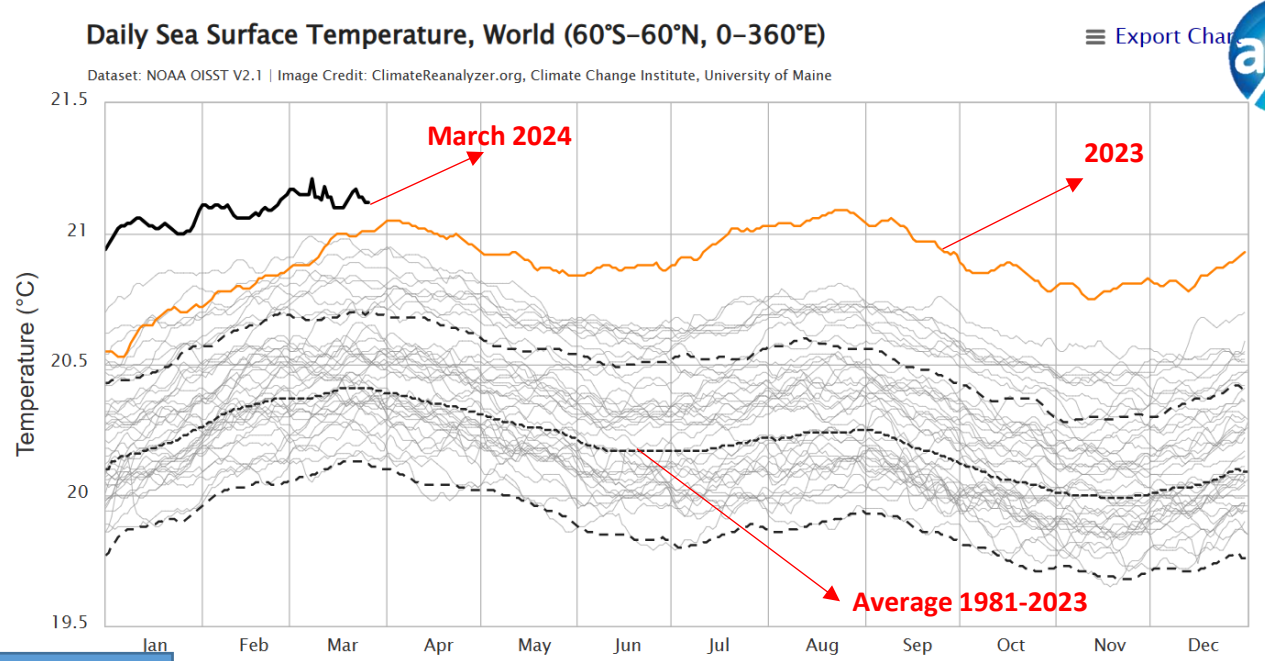
Is there something to do against coastal erosion?

Case of Yucatán, Mexico

March 2024

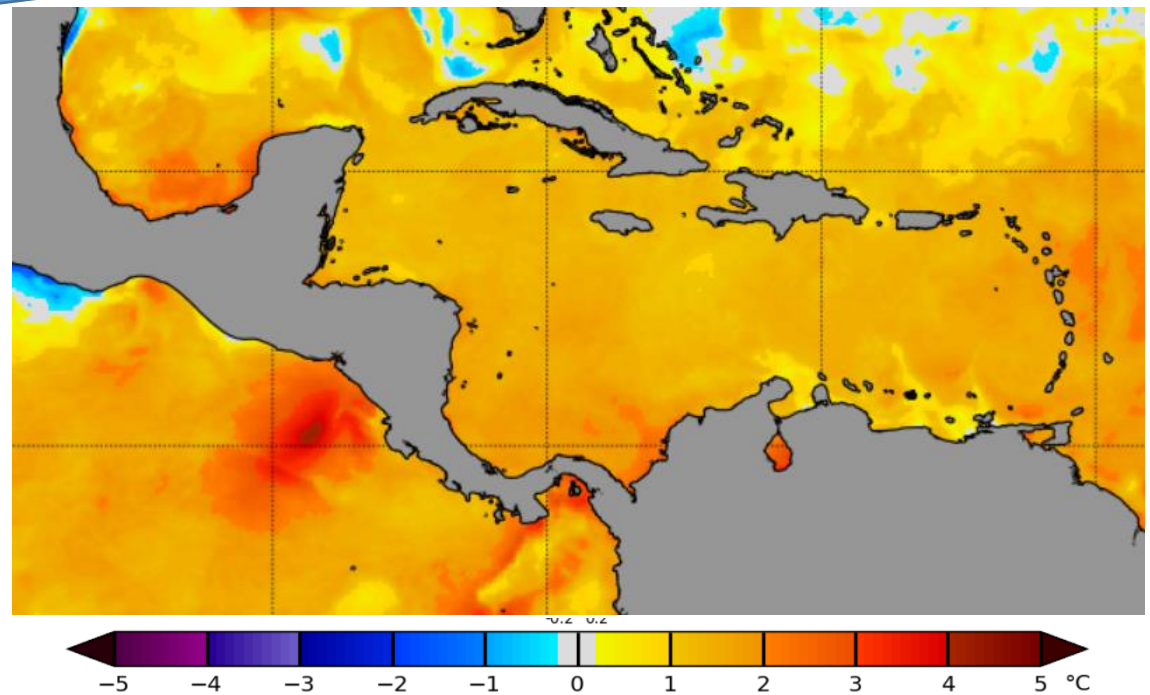
The problem

- Climate change seems irreversible for at least the next few decades. Rising sea temperatures will not stabilize soon



Daily Surface temperature, World
Fuente: www.climateReanalyzer.com

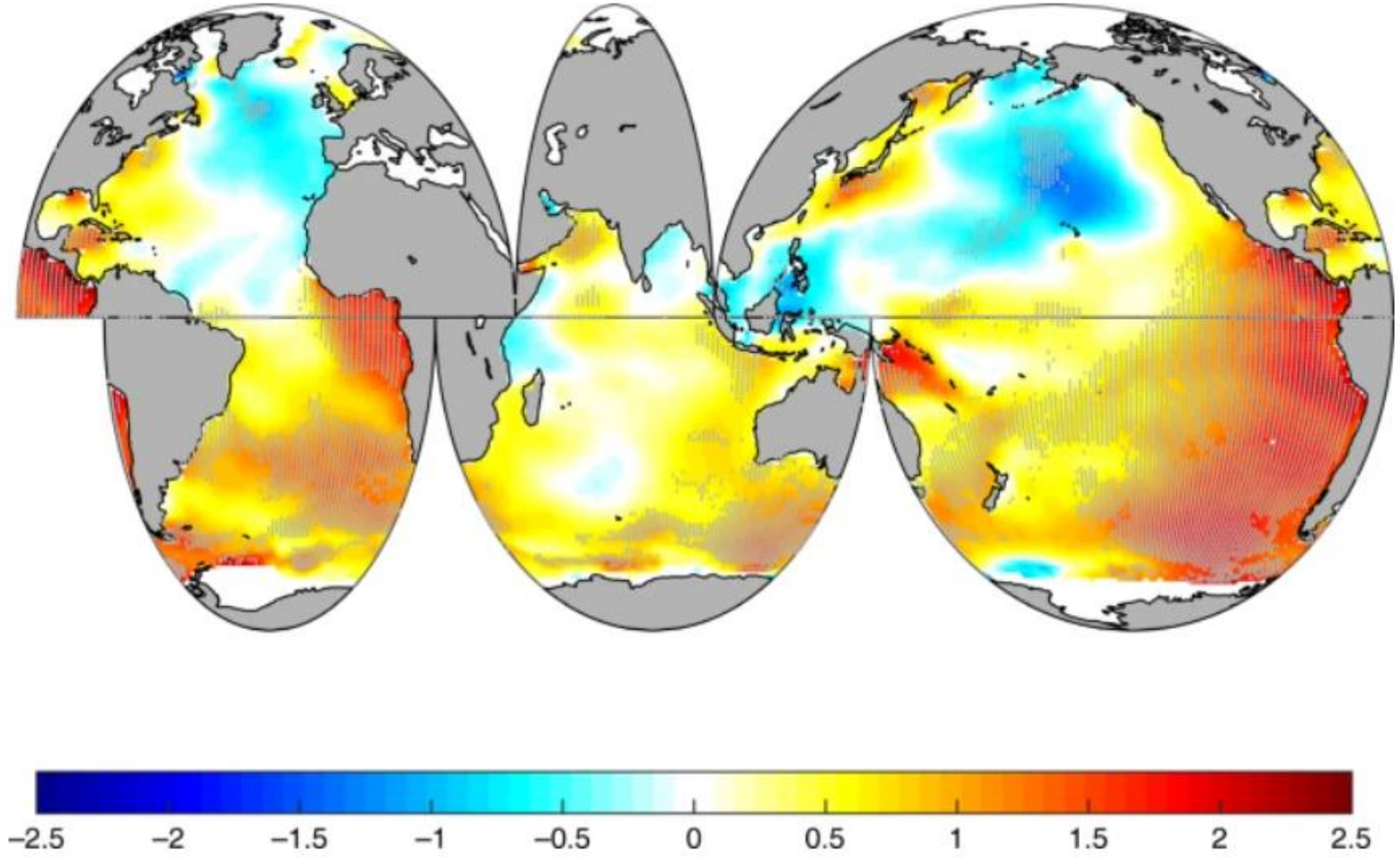
- The temperature anomaly in the Caribbean region is between 1 and 2 degrees C



Daily Surface temperature anomaly
Fuente: www.coralreefwatch.noaa.gov

The problem

- There is a direct correlation between the increase in sea surface temperature and the increase in wave energy that reaches the coasts



Percentage increase in wave energy per year, period 1985-2008

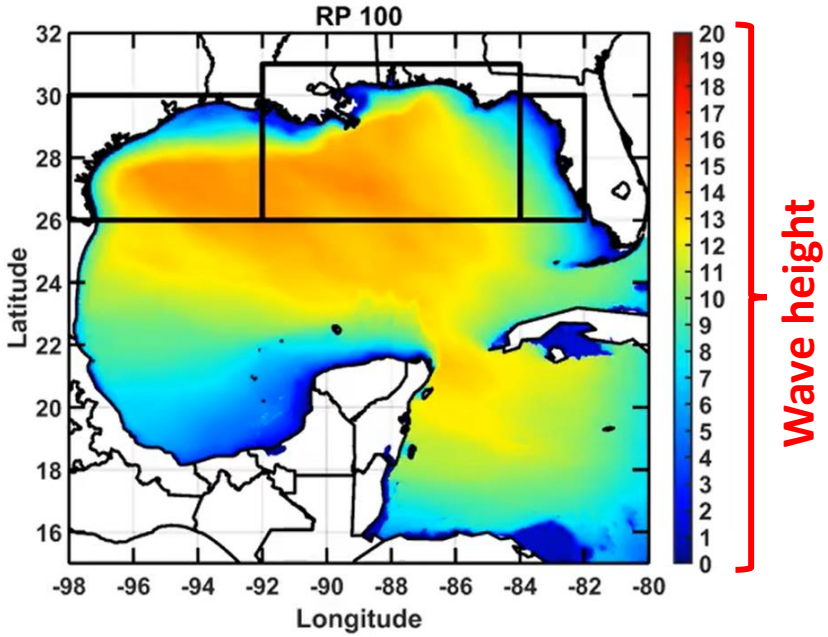
Source: Nature comunications Vol 10, Article number 205(2019)

Climate Change AFFECTS AND ERODES beaches?

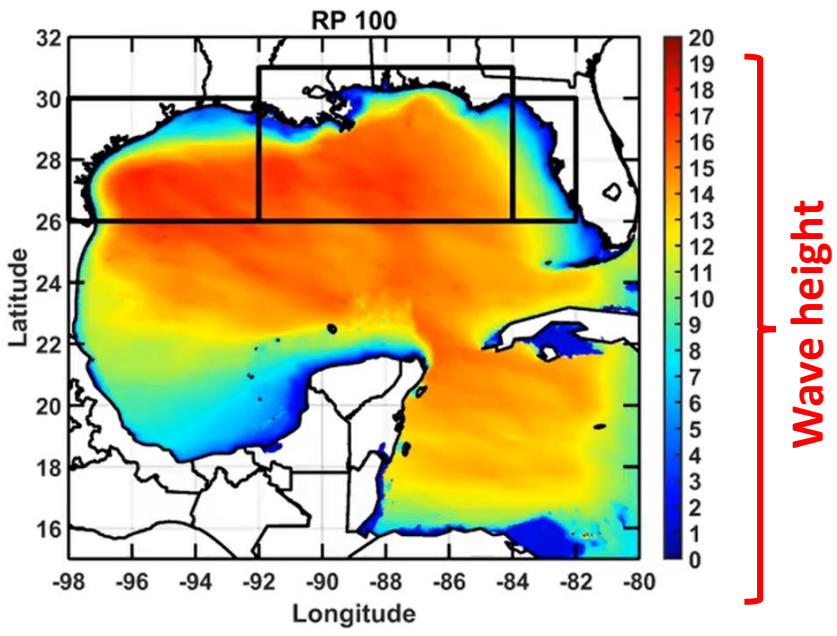
YES

How?

The increase in temperature has a direct relationship with the increase in wave energy that is expected in the coming decades. This increase is the main component of beach erosion.



Clima actual de oleaje
(1975 – 2005)



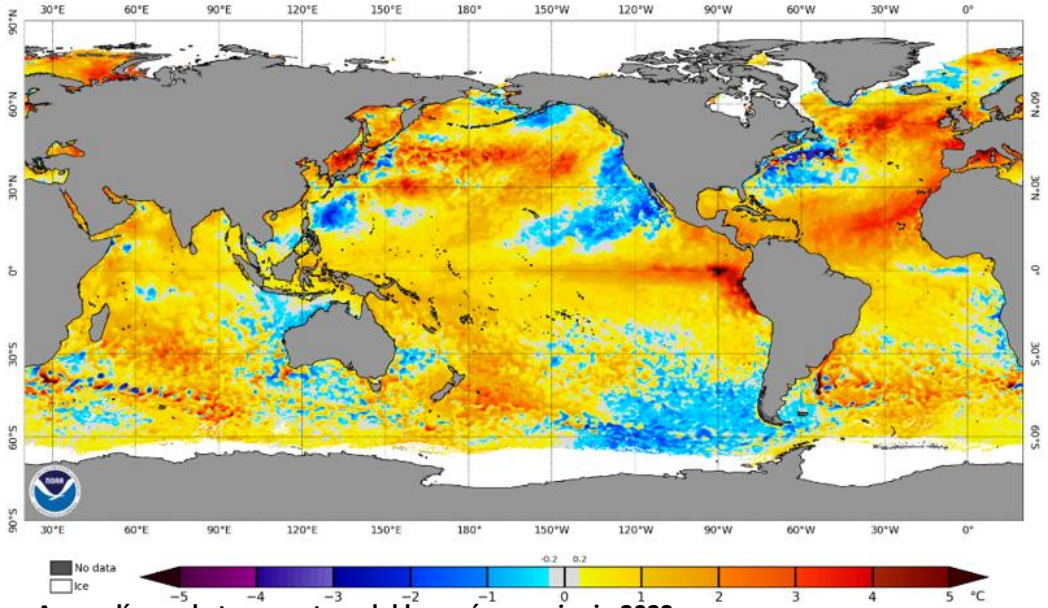
Clima de oleaje bajo escenario RCP 8.5
(2070 – 2100)

At the end of the century, wave heights are expected to be much higher than they are now.

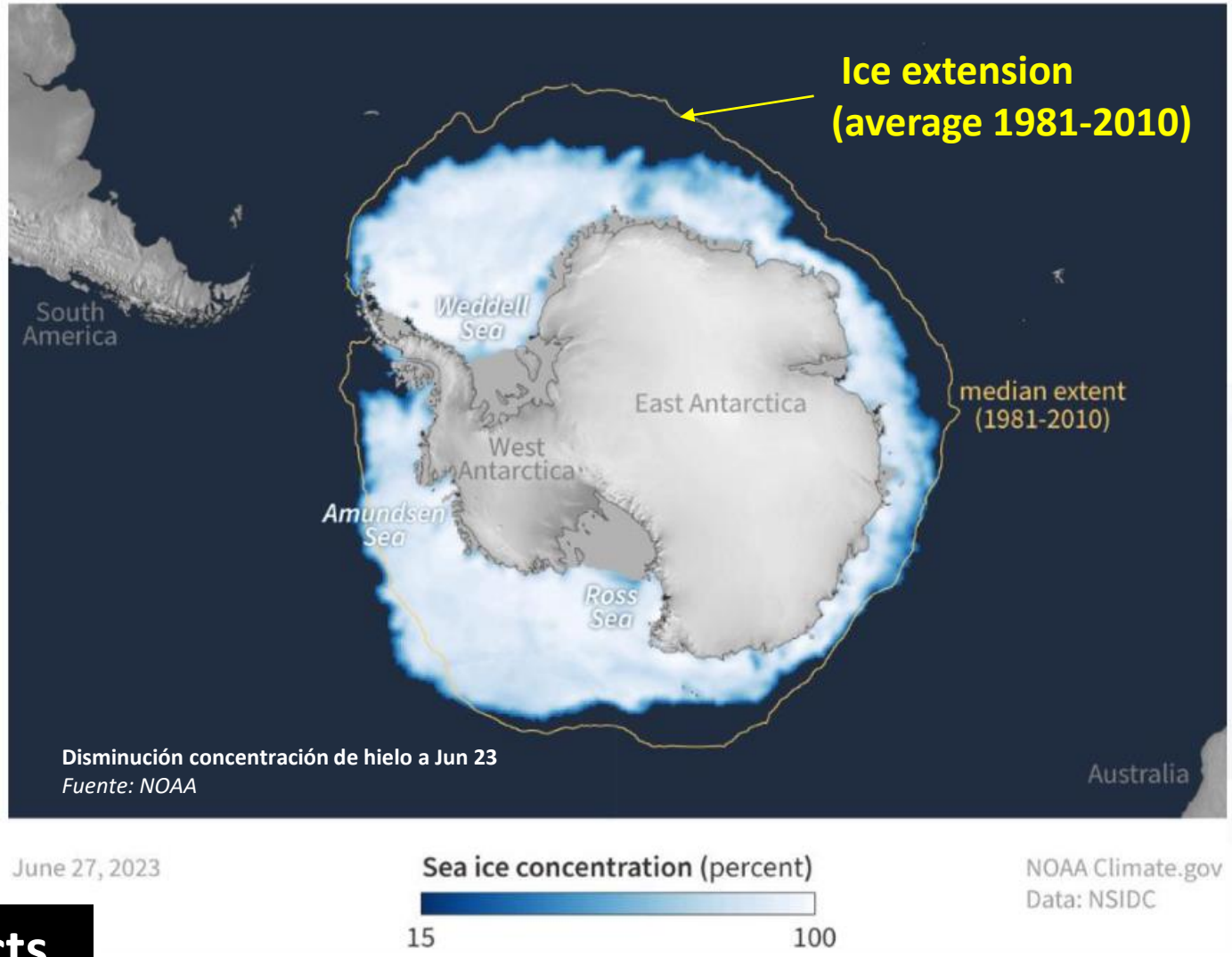
Wave height T=100 years.

Source: Mexican Ocean Energy Center CEMIE-O / UNAM 2021

What does the warming of the oceans, the melting of Antarctica, have to do with the erosion of the beaches in Yucatan? EVERYTHING



Anomalías en la temperatura del los océanos a junio 2023
Fuente: www.CoralReefWatch.noaa.gov



Disminución concentración de hielo a Jun 23
Fuente: NOAA

There is no way t ignore it:

- the sea warms up
- It generates more waves
- There is more capacity of the waves to remove sand from the beaches
- there is no more sand

Therefore: It is absurd to ignore these facts in any beach recovery action

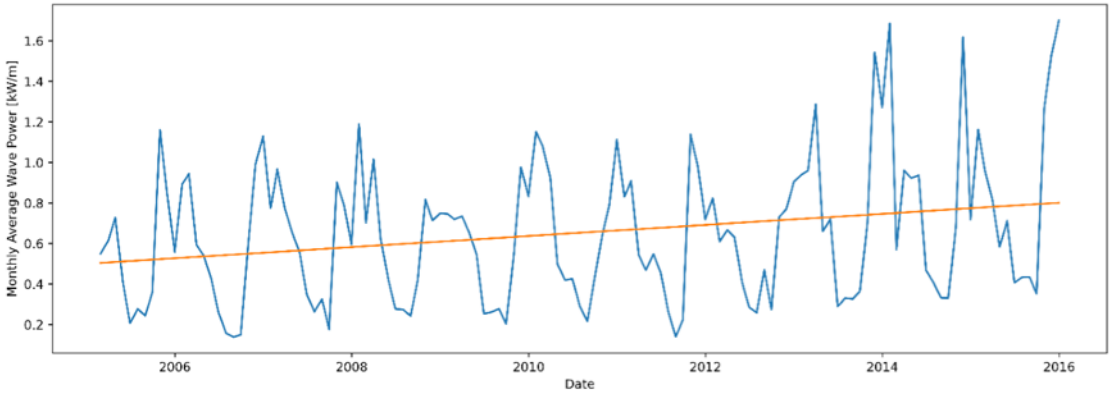
Does it mean that beaches will be permanently vulnerable to erosion as long as climate change is not contained?
NO DOUBT

https://edition.cnn.com/2020/03/02/world/beaches-disappearing-climate-change-sea-level-rise/index.html

Note: All references consulted agree on the same expected erosion prospects for the future of beaches.

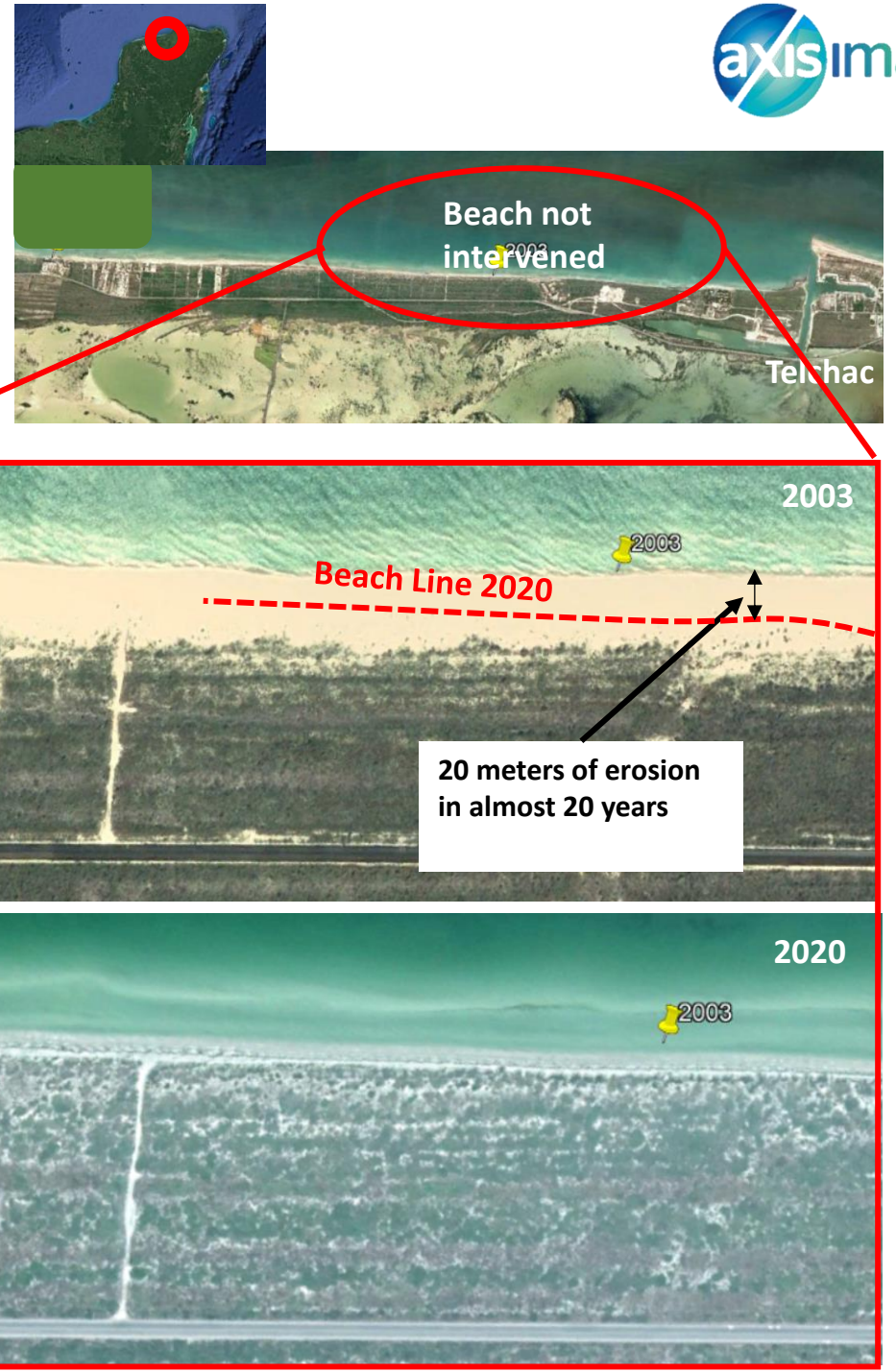
What can we expect in the beaches of Yucatan?

The same as in many of the beaches worldwide: **Permanent erosion for decades to come.** Every year the wave energy that causes erosion increases.



Monthly analysis of wave strength from 2005 to 2016. It indicates an increase in wave energy of more than 1% per year.

Source: prepared by CCELL-AXIS with data in Yucatan from the National Oceanic and Atmospheric Administration (NOAA)



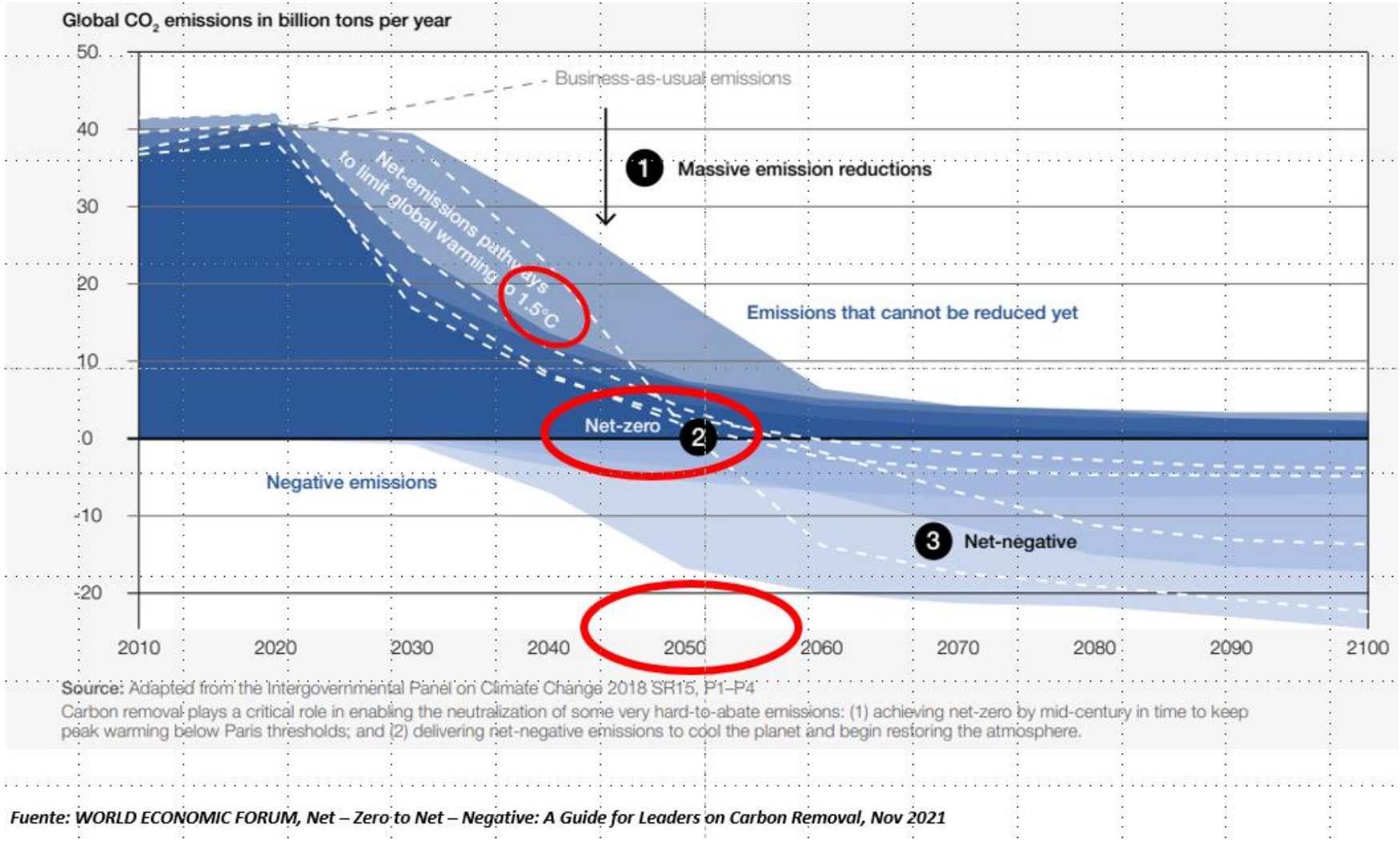
Example of natural erosion without human intervention in the western area of the port of Telchac: 20 meters of erosion in just under 20 years; More than 1 meter of erosion per year

Can this process be stopped? That the beaches stop eroding permanently?

- **NO, as long as the goal of limiting the temperature increase to 1.5 degrees by 2050** according to the Paris agreement, endorsed at COP 26 and reaching ZERO CO2 EMISSIONS, is NOT achieved.

- **Today the permanent retreat of beaches is inevitable.**

- If the goal of ZERO CO2 EMISSIONS by 2050 is not achieved, **the most pessimistic prospects,** of losing a large part of the planet's beaches, **will be real.**



Fuente: WORLD ECONOMIC FORUM, Net – Zero to Net – Negative: A Guide for Leaders on Carbon Removal, Nov 2021

Note: There are other local reasons that cause erosion, such as retention and sand in the Port of Telchac, which will not be commented on in this analysis.

What can we do thinking about the long term?

- Recover a system with DUNE and with the LOW submerged (sand bar). These two elements are the foundation of the beach. **The beach is just a consequence of a low and healthy DUNE**

- Years of high vulnerability of beaches are coming, where it will be key that the communities in all countries manage to reduce CO2 emissions. Meanwhile, the communities settled on the beach, have to strive to return the beaches, little by little, to the natural conditions of dynamic coastline. **Each community will have to decide what it wants to do.**
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- A stable beach, with individual beaches interconnected over tens of kilometers (case of the Telchac – Progreso section), requires having as much sand in motion as possible. **This is a principle of coastal stability that no one in the technical and scientific community doubts.**
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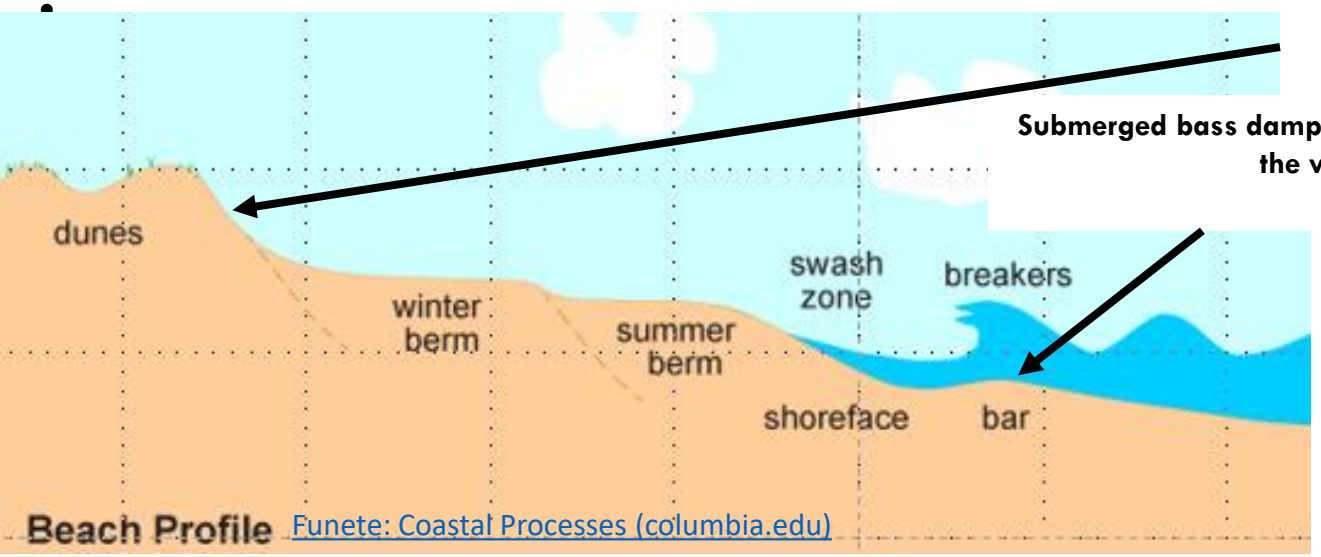
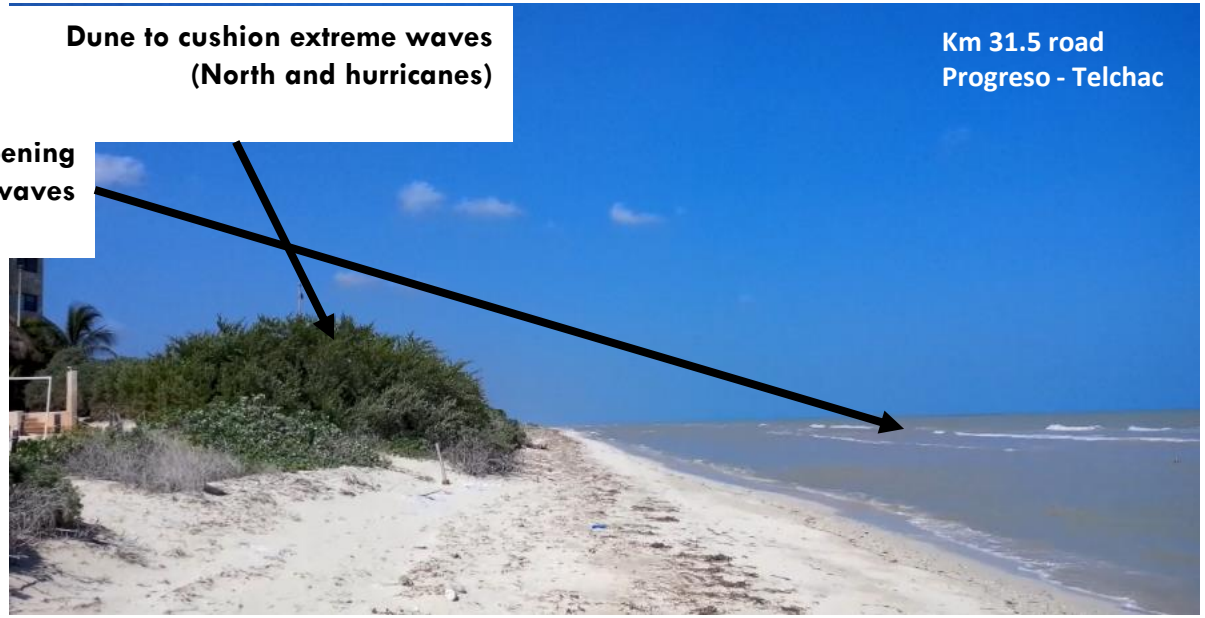


Funete: Coastal Processes (columbia.edu)



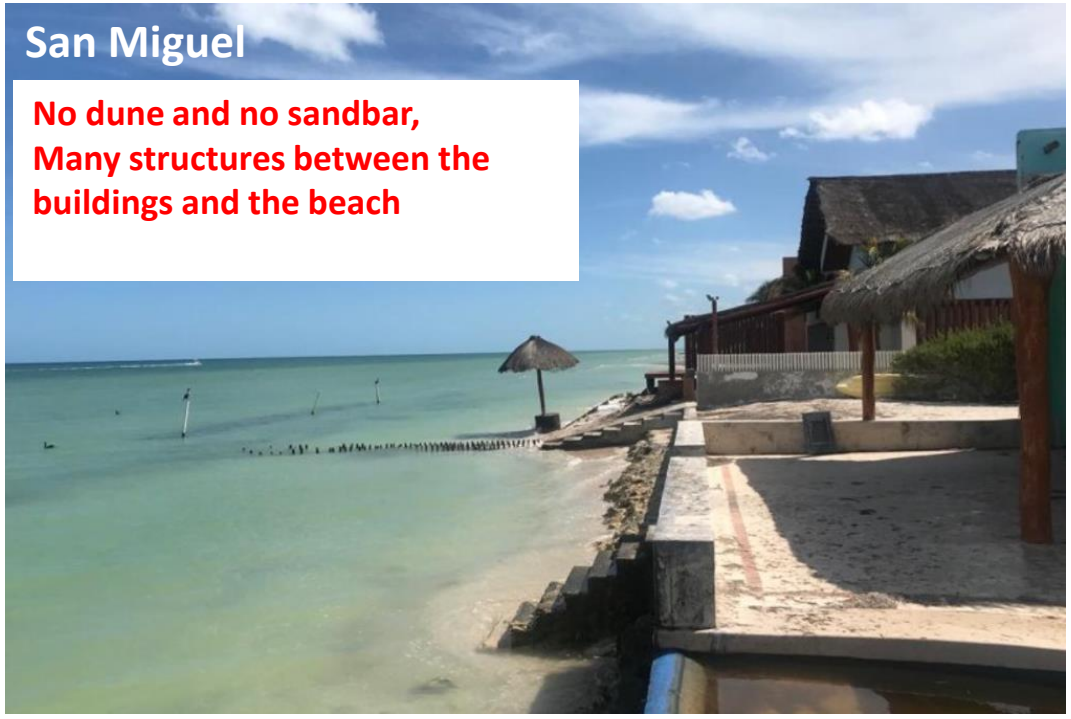
Stable Beach Profile

Why do some beaches erode between Progreso and Telchac and others do not if they have the same waves and the same sand?

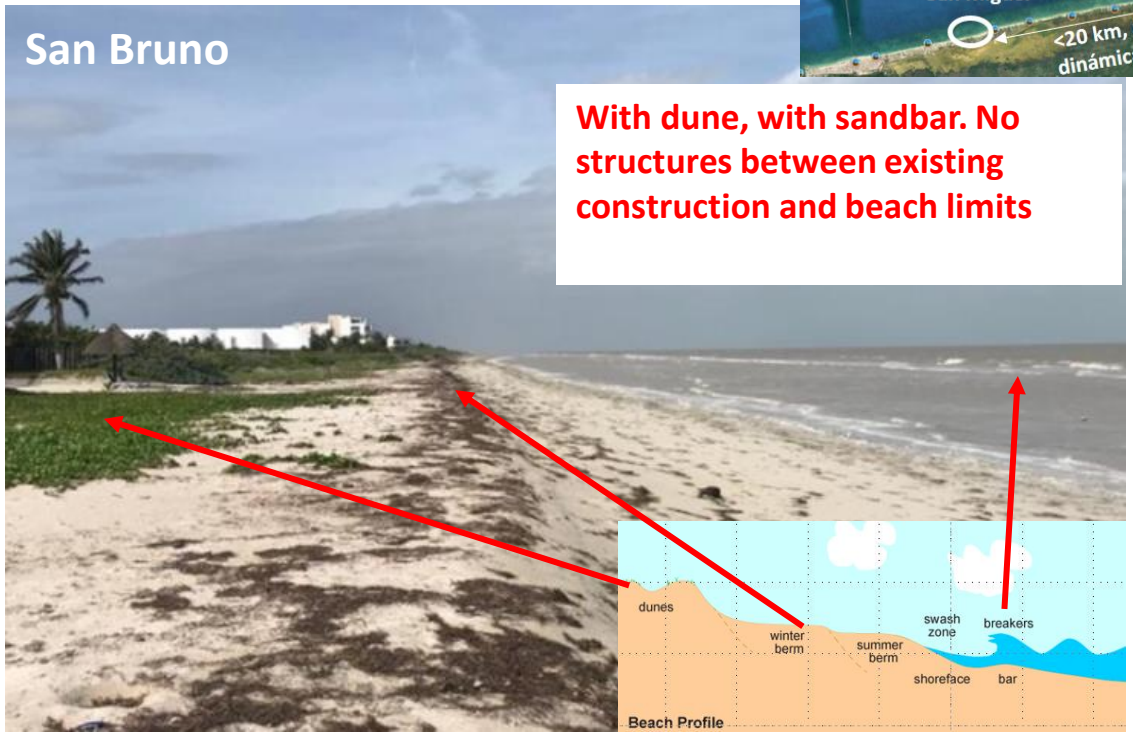
- Between Progreso and Telchac the only aspect that distinguishes stable beaches from highly eroded beaches is the intervention in them. **The more they are intervened, the more they erode.**

- There are communities between Progreso and Uaymitun that, with their intervention have **only accelerated the erosive process** by few years.

- On the other hand, **the communities that protect their dune and their sandbar** (simply letting them rest in natural conditions), **will extend the stability of the beach for several years,** even in the worst-case scenario of meeting the climate change agenda.



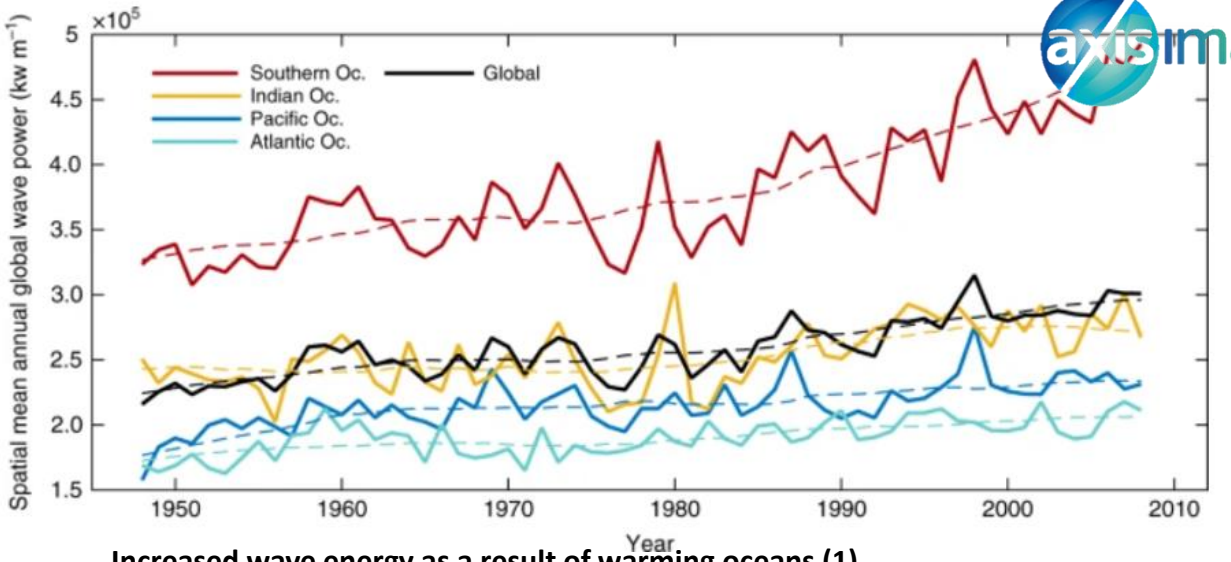
SAN MIGUEL, KM 12
Very complicated scenario. They are 20 years ahead of the expected natural erosion. Difficult to reverse until much of what has been put in is removed



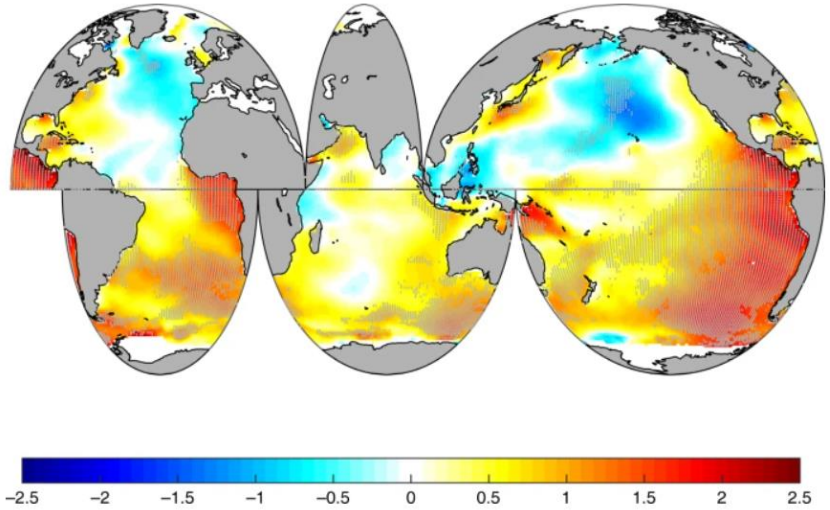
SAN BRUNO KM 31.5
Very favorable outlook to face the climate emergency and have healthy beaches for more years in the worst scenario of the climate agenda.

What we know:

- The link between global warming and the increase in wave energy that causes erosion is real. This is worldwide (1).
- In the case of Yucatan, as long as the increase in temperature of the oceans is not reversed, each year the extreme events in winter will be slightly higher than the previous year.
- The amount of sand in the system is less and less and the waves that impact the beaches will be increasingly destructive.
- Wave-induced currents will carry less and less suspended sand to feed beaches
- Less suspended sand combined with more wave energy makes the erosive beach process inevitable
- **<u>Therefore, the solutions that worked a decade ago, replicating them identically, does not guarantee beach stability and can be counterproductive.</u>**



Increased wave energy as a result of warming oceans (1)



Percentage increase in wave energy per year, period 1985-2008 (1)

Nota (1) Fuente:Nature comunications Vol 10, Article number 205(2019)

San Miguel:

What's going on? In a few years we went from a stable beach to a dysfunctional one

Porque hay playa?

Porque SI hay arena circulando. Las playas se alimentan unas a otras

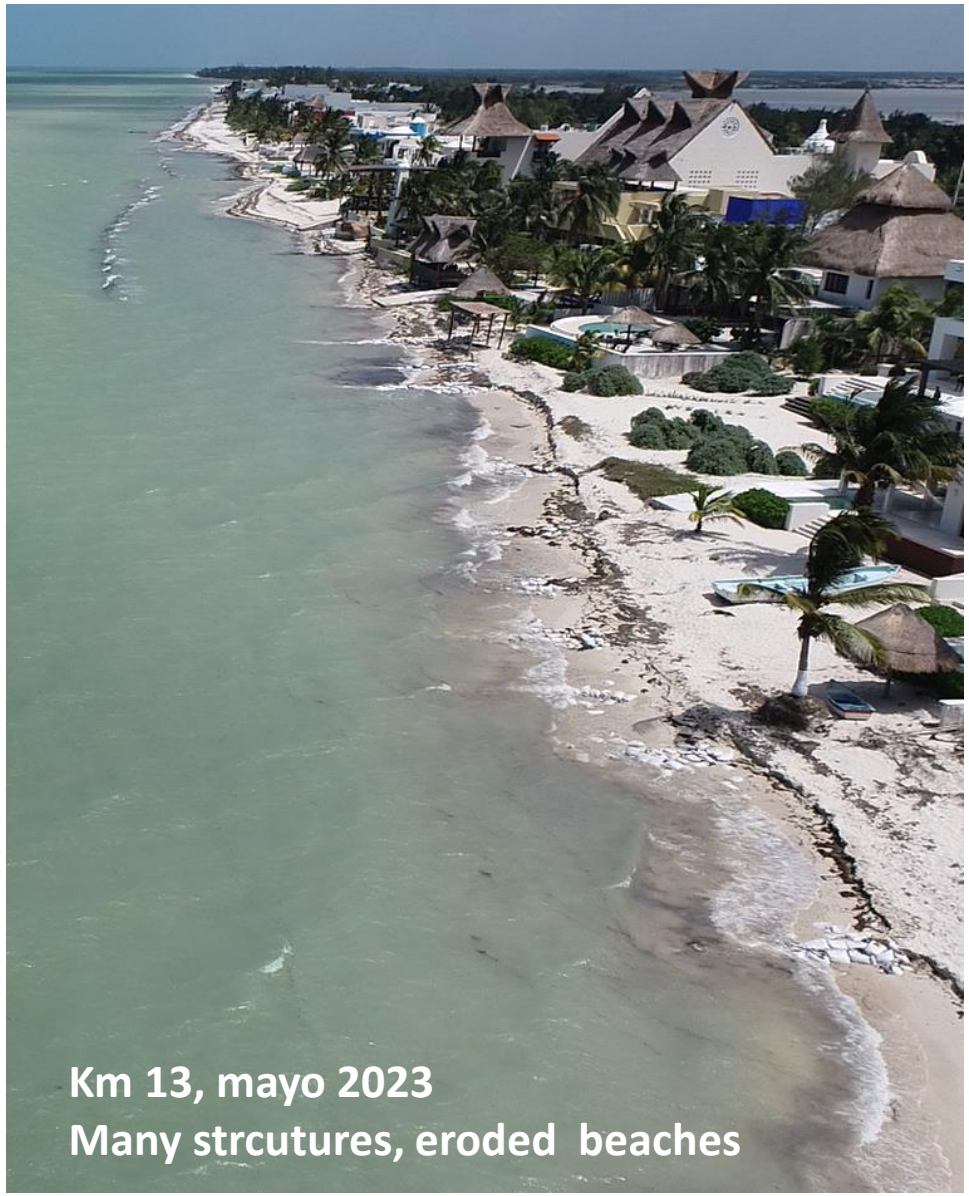
Porque NO hay playa a pesar de que hay estructuras que funcionaron en el pasado?

- Porque hay demasiadas intervenciones sin coordinación unas con otras
- Porque hay menos arena circulando
- Hay mas energía de oleaje que transporta menos arena en suspensión
- La arena que hay se retiene en segmentos de playa y se impide que alimenten otras playas al OESTE, al mismo tiempo que no son alimentados por playas al ESTE

What is the decision that the communities that have interests in the beach have to make (Applies worldwide and therefore to Yucatan):

- **<u>Do we want to give the battle not to lose the beaches in a few decades irreversibly???</u>**

  Answer: Let´s remove all structures that affect natural motion of sand (most of them) and leave a minimum of structures that do help littoral drift in a integral sustainable process. Let´s adapt tyo global climate needs. The reality is that there is not much time left.



Km 13, mayo 2023
Many strcutures, eroded beaches

Conclusions

- The comprehensive and definitive solution to the erosion problem in Yucatan is unknown. There are only theories, opinions and strategies. But no one can give certainty of a solution now.

- However, it is essential to understand that the situation becomes more complex every day. The permanent deterioration of beach systems is evident. Climate change and its impact on beaches is real. The worst-case scenarios of irreversible loss of beaches are dramatic and possible. It is a big mistake to think that what worked a few years ago, will work again if we replicate it.

- Recovering the balance of sand in motion and putting it into circulation may be the best long-term strategy (perhaps the only sustainable one) and allow the Yucatan community to fight several decades against erosion.