MODELLING RISK REDUCTION MEASURES TO MINIMISE FUTURE IMPACTS OF STORMS AT COASTAL AREAS

ÓSCAR FERREIRA

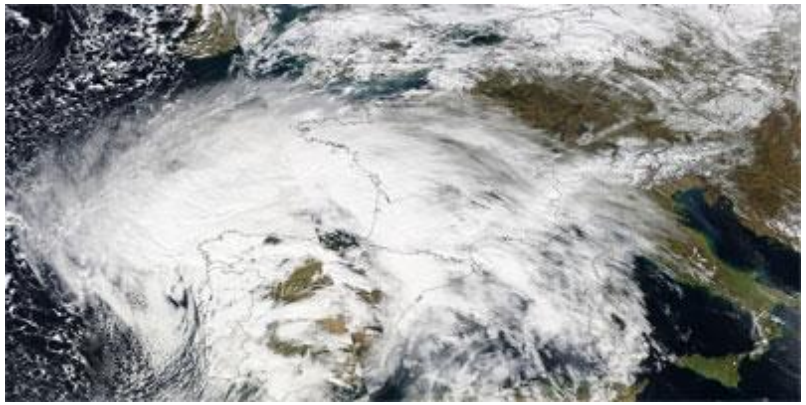
CIMA/FCT – UNIVERSITY OF ALGARVE

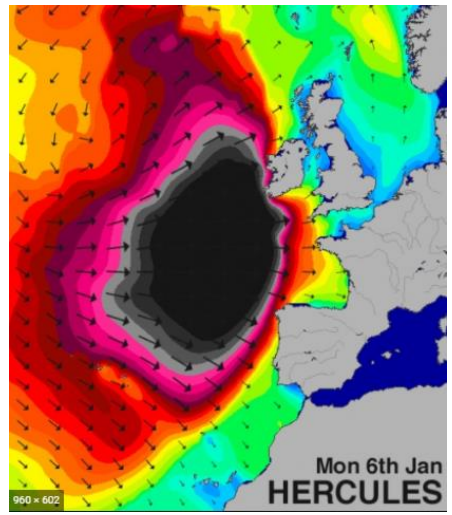
WORKSHOP TÉCNICO
Gestão do risco de inundação costeira

UAlg CIMA
UNIVERSIDADE DO ALGARVE

1. Introduction and Motivation

- Storms promote high-impact and cause coastal risk (e.g., Xynthia and Hercules, Europe, 2010, 2014; Katrina and Sandy, USA, 2005, 2012)





1. Introduction and Motivation

- Increasing risk (prob. hazard * consequences) due to:
  a) Increase in hazard intensity/frequency due to
    - storminess changes
    - sea level rise
    - increase extreme sea levels

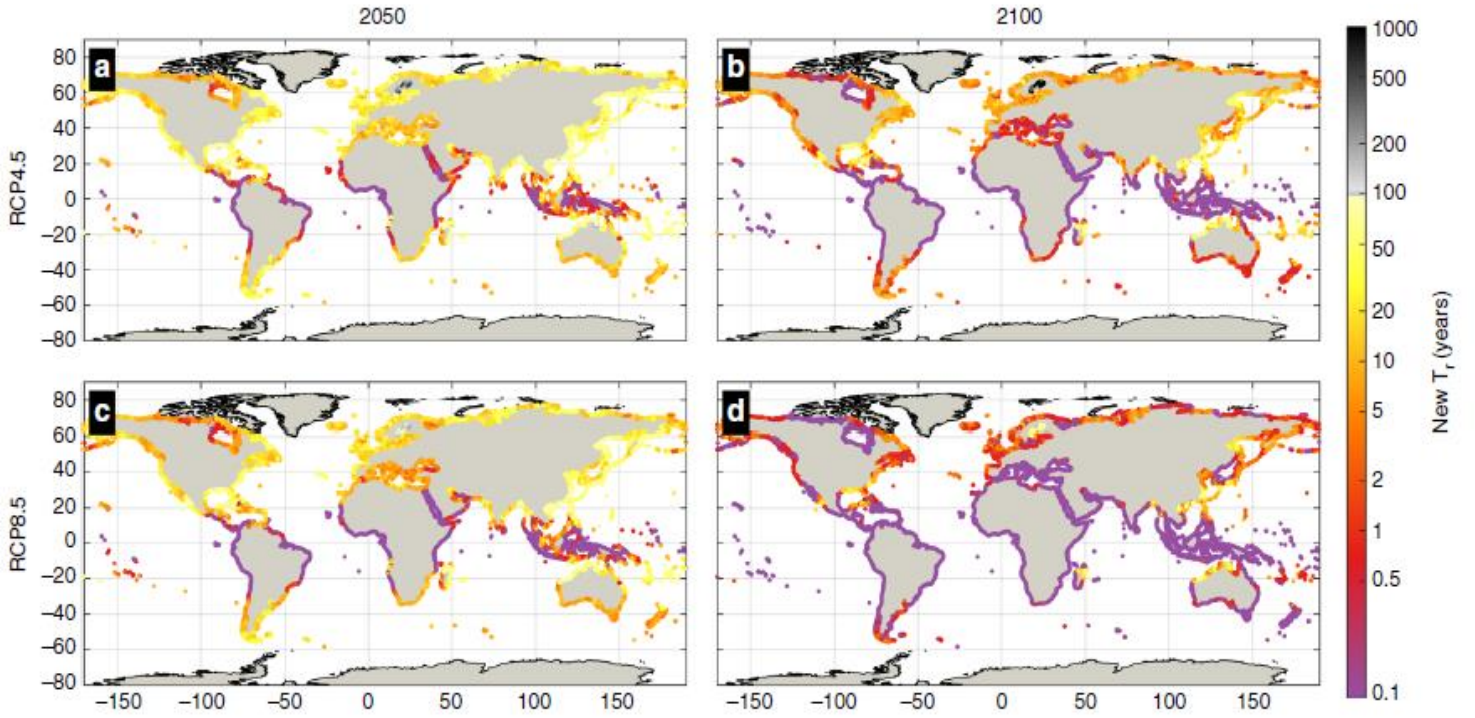


Fig. 8 Future frequency of the present day 100-year ESL. Colors show the return period of the present day 100-year ESL under RCP4.5 and RCP8.5 in 2050 (**a**, **c**) and 2100 (**b**, **d**), based on the median values. Note that the color scale is not linear

Increase of global average 100-year extreme sea levels between 2000-2100 of 58-172 cm
Vousdoukas et al., 2018 (Nature Communications)

1. Introduction and Motivation

- Increasing risk (prob. hazard * consequences) due to:

  b) Increase in consequences due to increased coastal development (including economic value)

1. Introduction and Motivation

- In the absence of further investments in coastal adaptation, the present **expected annual damage** of € 1.25 billion is projected to increase by two to three orders of magnitude by the end of the century, ranging between 93 and € 961 billion.
- The current **expected annual number of people exposed** to coastal flooding of 102,000 is projected to reach 1.52–3.65 million by the end of the century.

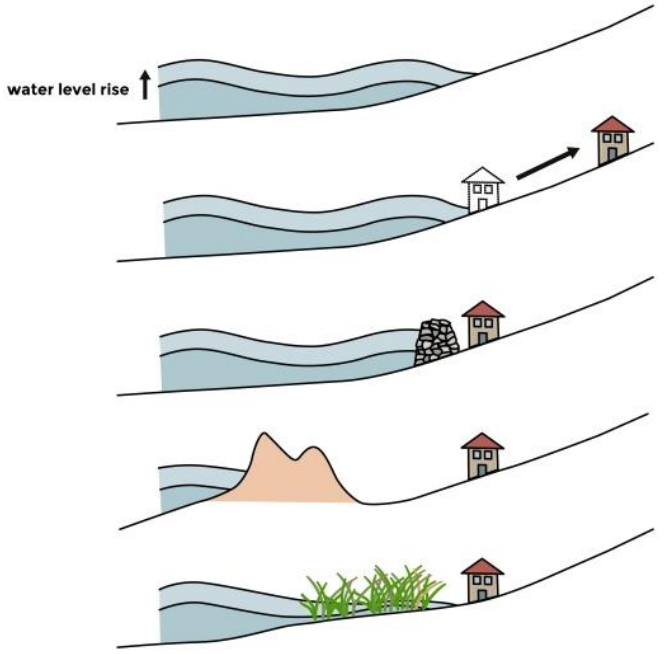
Vousdoukas et al., 2018 (Nature Climate Change)

1. Introduction and Motivation

Need to assess risk + Test Disaster Risk Reduction measures

Implement DRR at models and simulate their response including climate change scenarios

Need to evaluate DRR measures effectiveness and choose the optimal ones

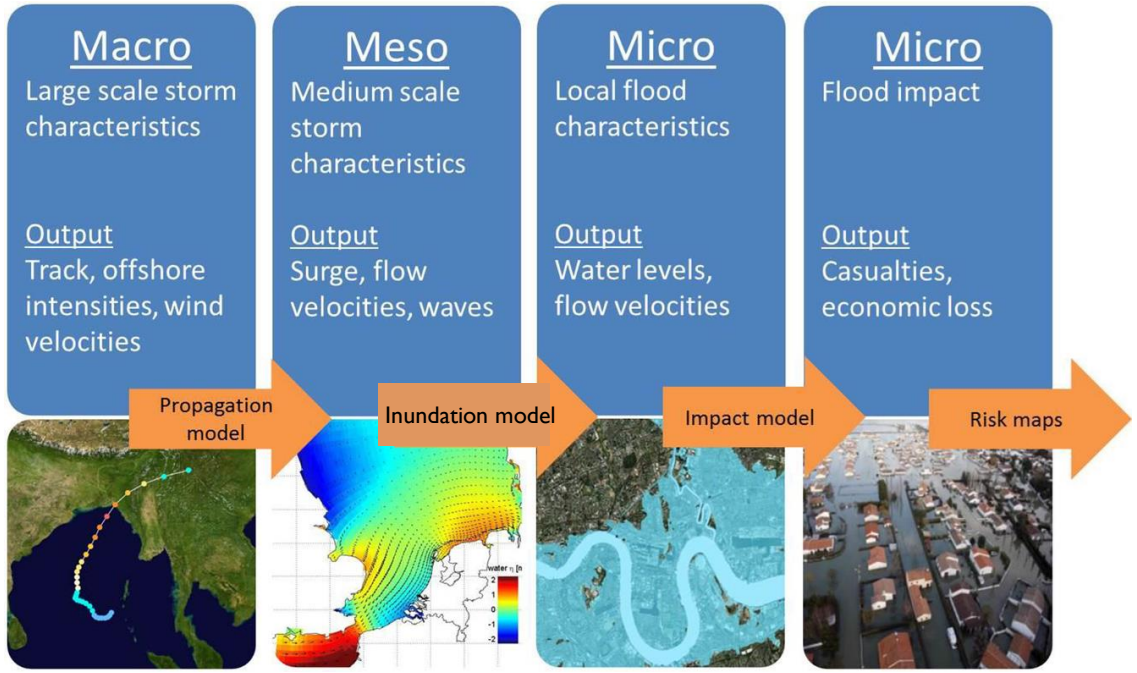


2. Goal

Present approaches to test DRR and their effectiveness in minimising the impacts of coastal storms

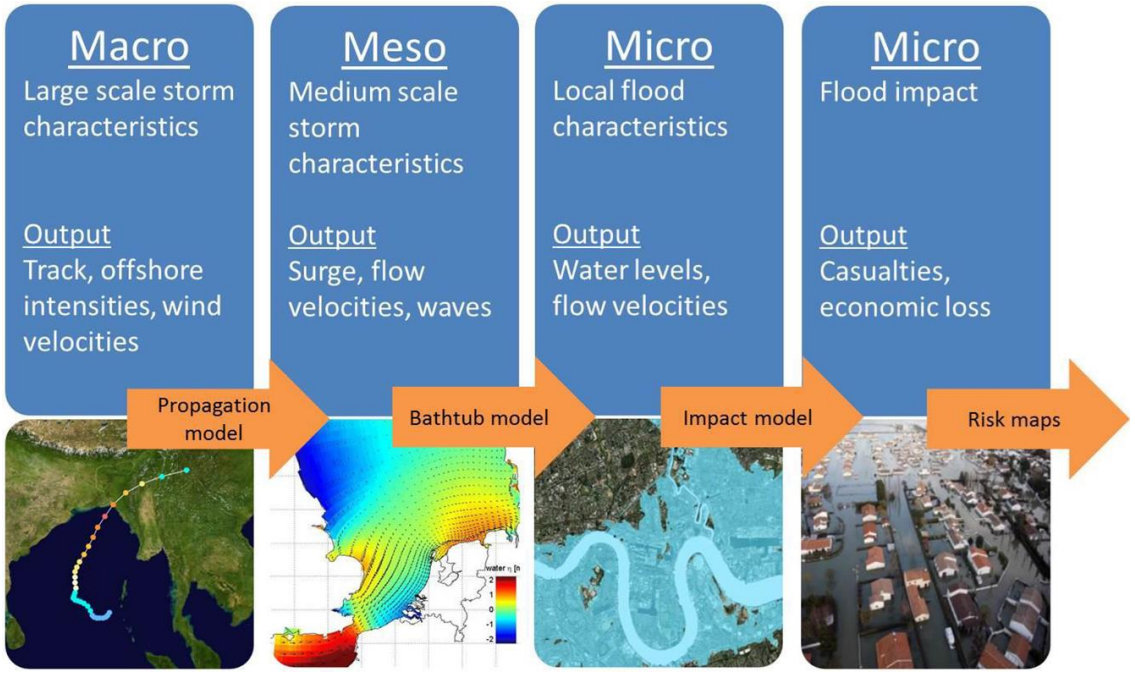
3. Modelling the impact of coastal storms

- Currently done by using a model train (hydrodynamic and morphodynamic modelling) that calculate the hazard
- The results are translated into relationships that relate hazards with the damage at the receptors (e.g. damage curves)



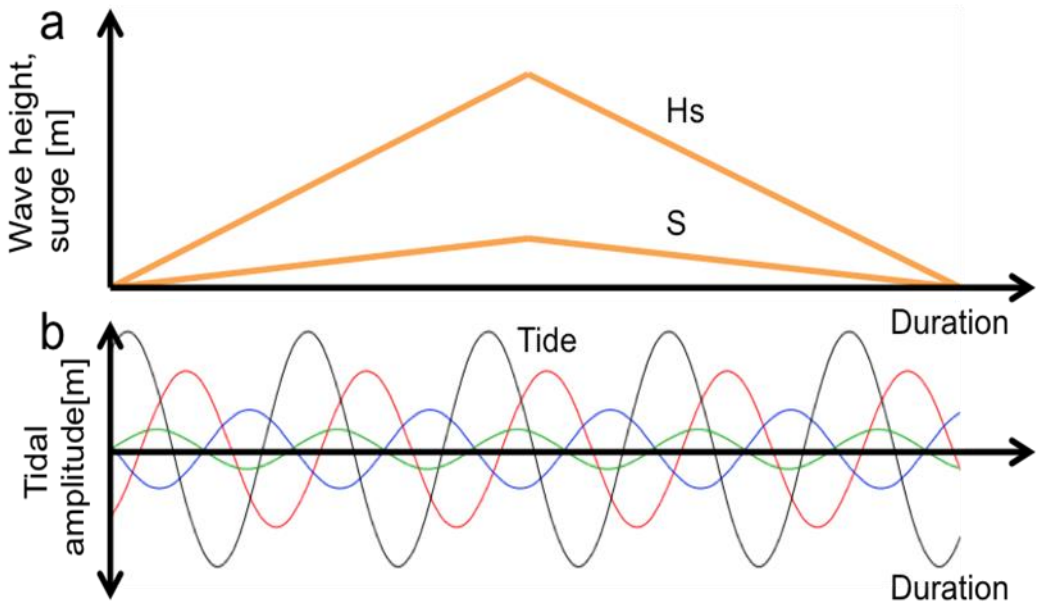
3. Modelling the impact of coastal storms

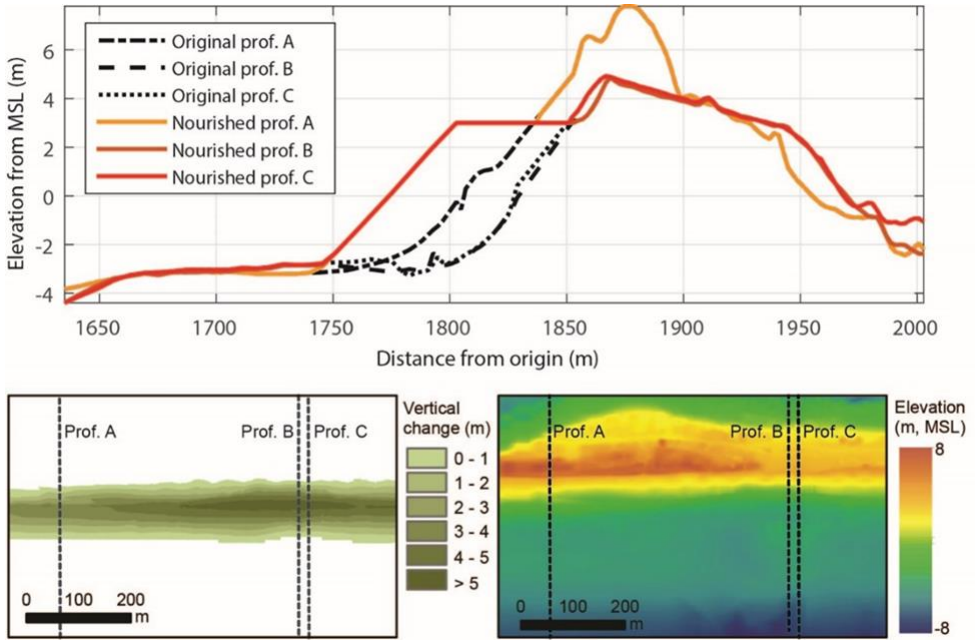
- Can be used as
  - Early Warning Systems (before the storm and upgraded as the forecast improves)
  - Decision Support Systems – namely to assess Disaster Risk Reduction measures effectiveness (requires upgraded morphologies or management actions)
  - Define the impact of climate change scenarios



4. Modelling DRR measures including climate change

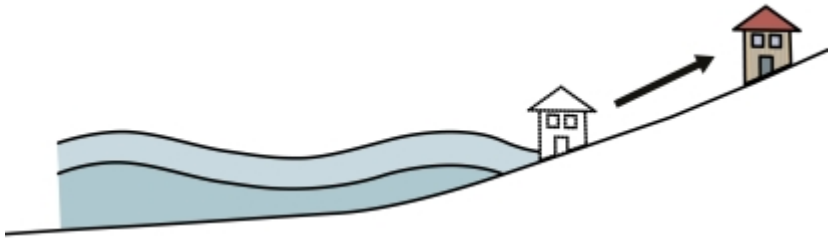
- Risk reduction measures are rarely modeled and even less frequently they incorporate climate change effects
- There is a need to:
  - Compute storm impacts with and without DRR in place
  - Assess current and future (climate change) DRR effectiveness



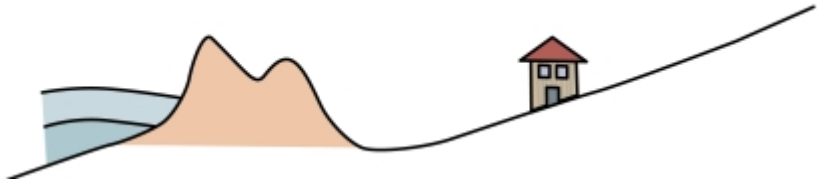


4. Modelling DRR measures including climate change

- Different types of DRR require different approaches (Jagger et al., 2018):
  - *Exposure-reducing measures* (move receptors, e.g. house relocation) – the model do not needs to be rerun (no changes at the hazard)



  - *Pathway-obstructing measures* (change the morphology, e.g. beach nourishment) – the model needs to be rerun (hazard changes)



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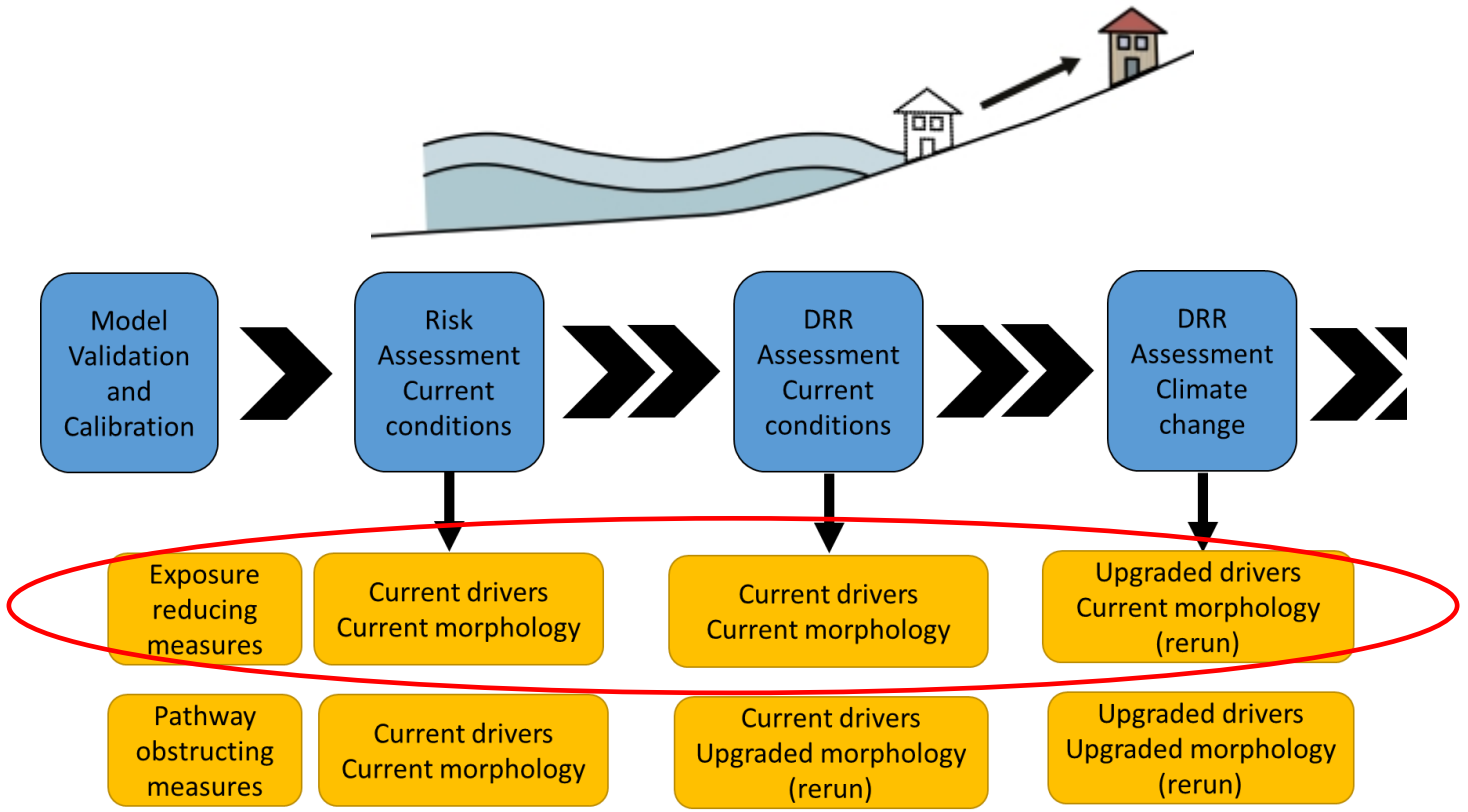
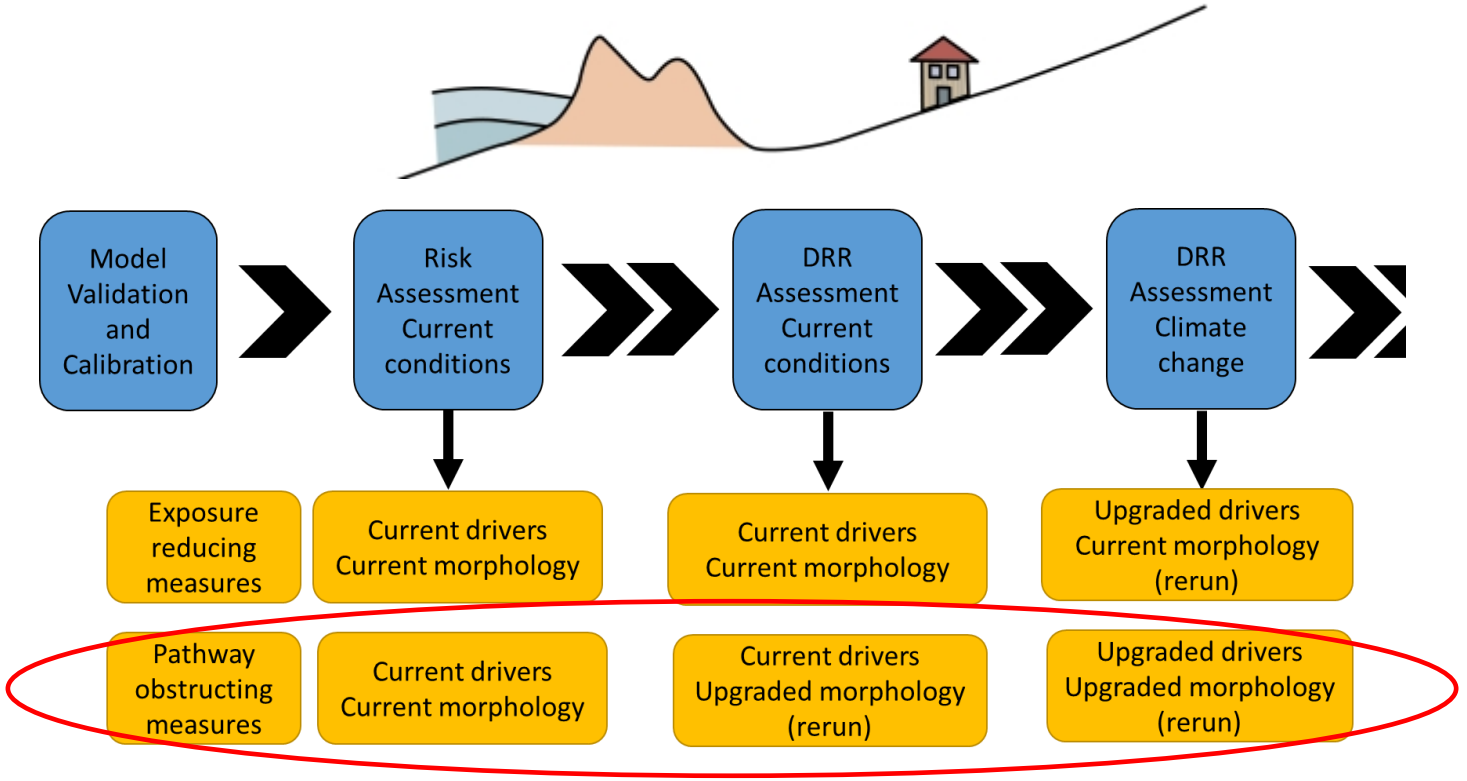


4. Modelling DRR measures including climate change

- Different types of DRR require different approaches (Jagger et al., 2018):
  - *Pathway-obstructing measures* (change the morphology, e.g. beach nourishment) – the model needs to be rerun (hazard changes) for current and future conditions

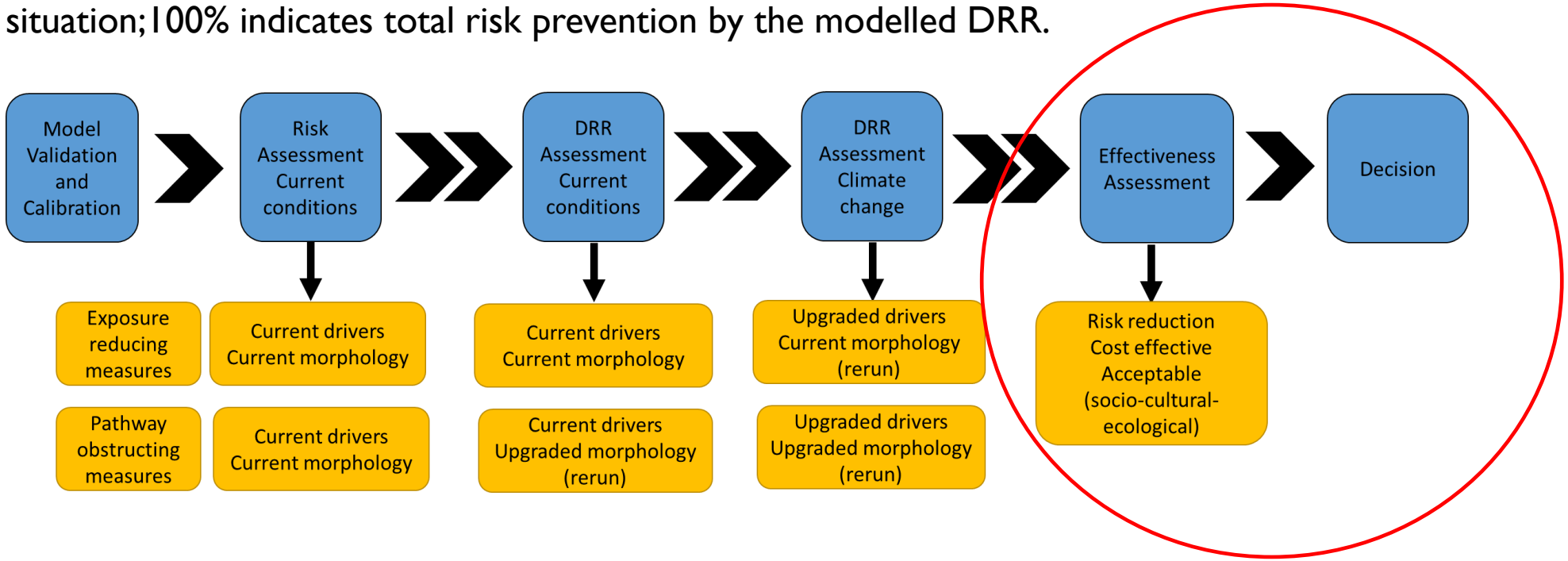


4. Modelling DRR measures including climate change

- Effectiveness assessment of DRR measures

$$Ie = 100\,\%\; x\; \frac{(\%\; damage\; current\; situation\; -\; \%\; damaged\; with\; DRR)}{\%\; damage\; current\; situation}$$

A zero (0%) value means that the DRR measure had no benefit when compared to the current situation;100% indicates total risk prevention by the modelled DRR.

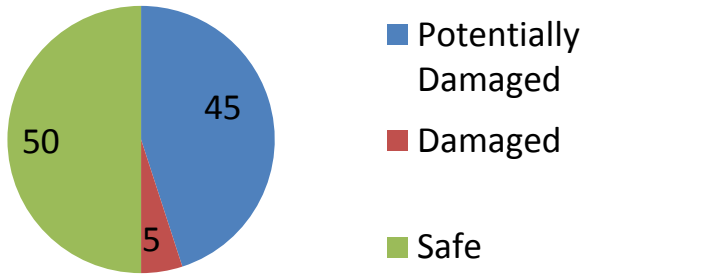


4. Modelling DRR measures including climate change

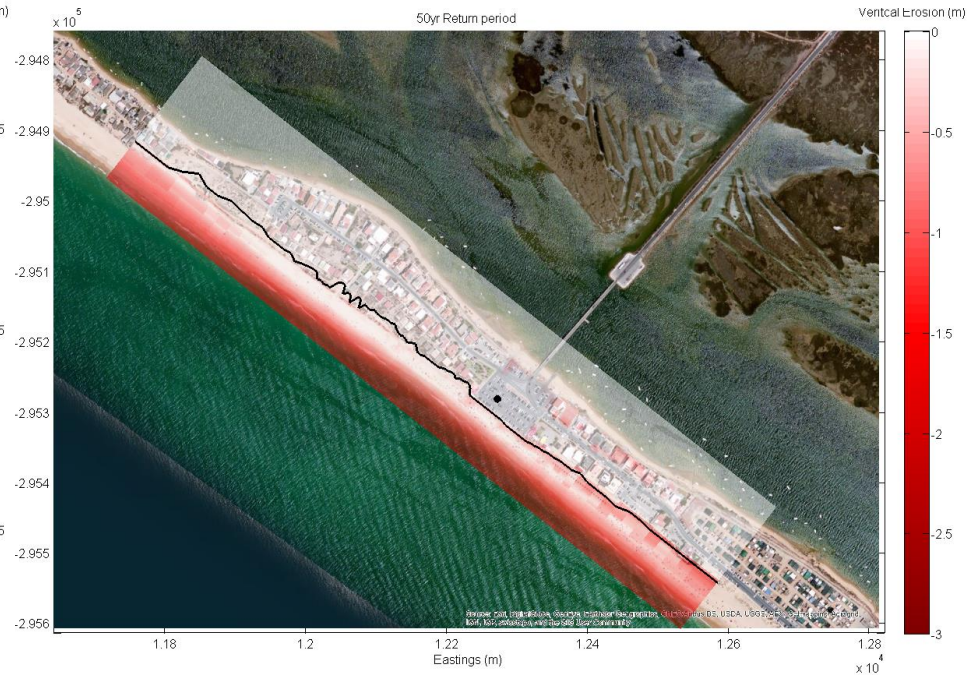
- Effectiveness assessment of DRR measures - Example

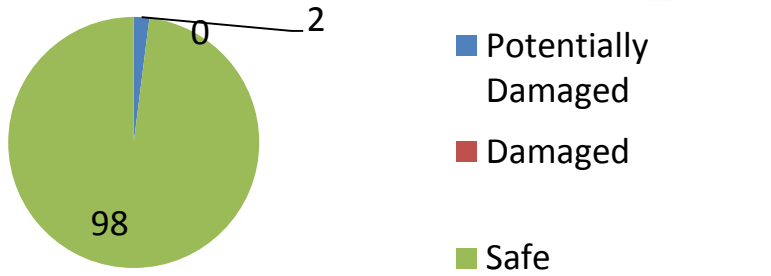
Hazard/DRR measures (Erosion - Nourishment) (Storm return period ≈ 50 years)

Current Conditions



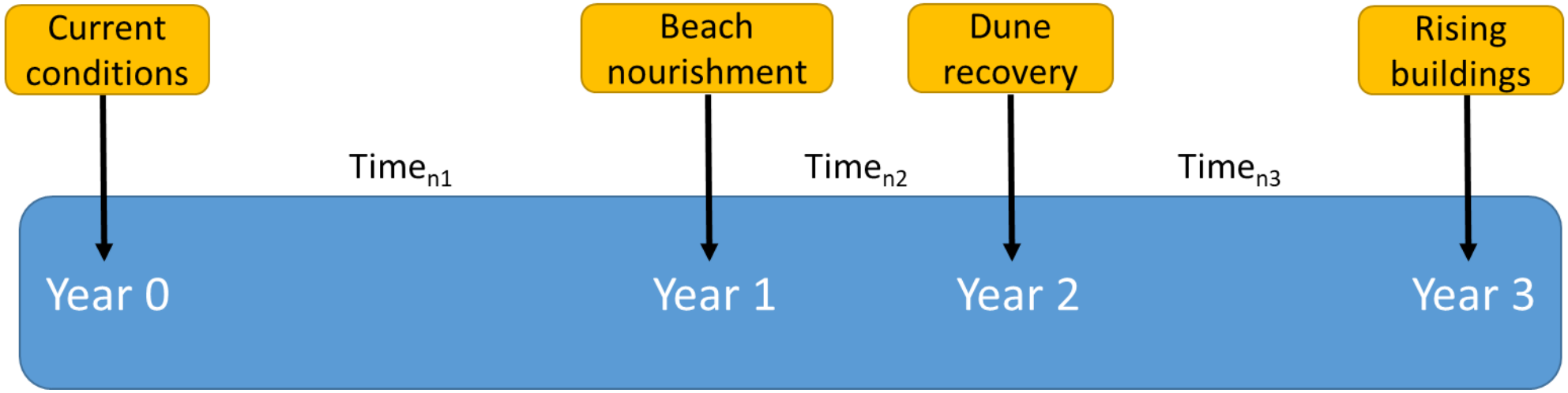
Nourishment





4. Modelling DRR measures including climate change

- Timeframe for implementation of selected DRR measures
  - DRR assessment performed ex-ante (years/decades) including climate change
  - Reanalysis according to new data/information
  - Defining at which time the measure(s) should be implemented to optimize resources
  - Definition of local timeframes for coastal management



5. Limitations and future developments

- Modelling limitations
  - Lack of quality data (e.g. water discharge, inundation extent) for most regions
  - Need of local model calibration and validation against data - limits application
  - Difficulty of direct use of models by stakeholders (e.g. coastal managers)

- Need of better defining vulnerability relationships between hazard indicators and exposed elements (e.g. damage curves; limits of building collapse; limits of threat to life)

- Extend the effectiveness analysis to economic/ecosystem/social-cultural aspects including cost-benefit analysis

- Account with indirect impacts (cascade effects)

6. Final remarks

- Proposal of a generic approach to test adaptation and risk reduction measures, considering climate change, including the definition of a coastal management time frame

- Proposal of an effectiveness assessment index to evaluate the modelled results for each DRR measure

Thank You/Obrigado