SEA-LEVEL INFORMATION FOR DECISION MAKING

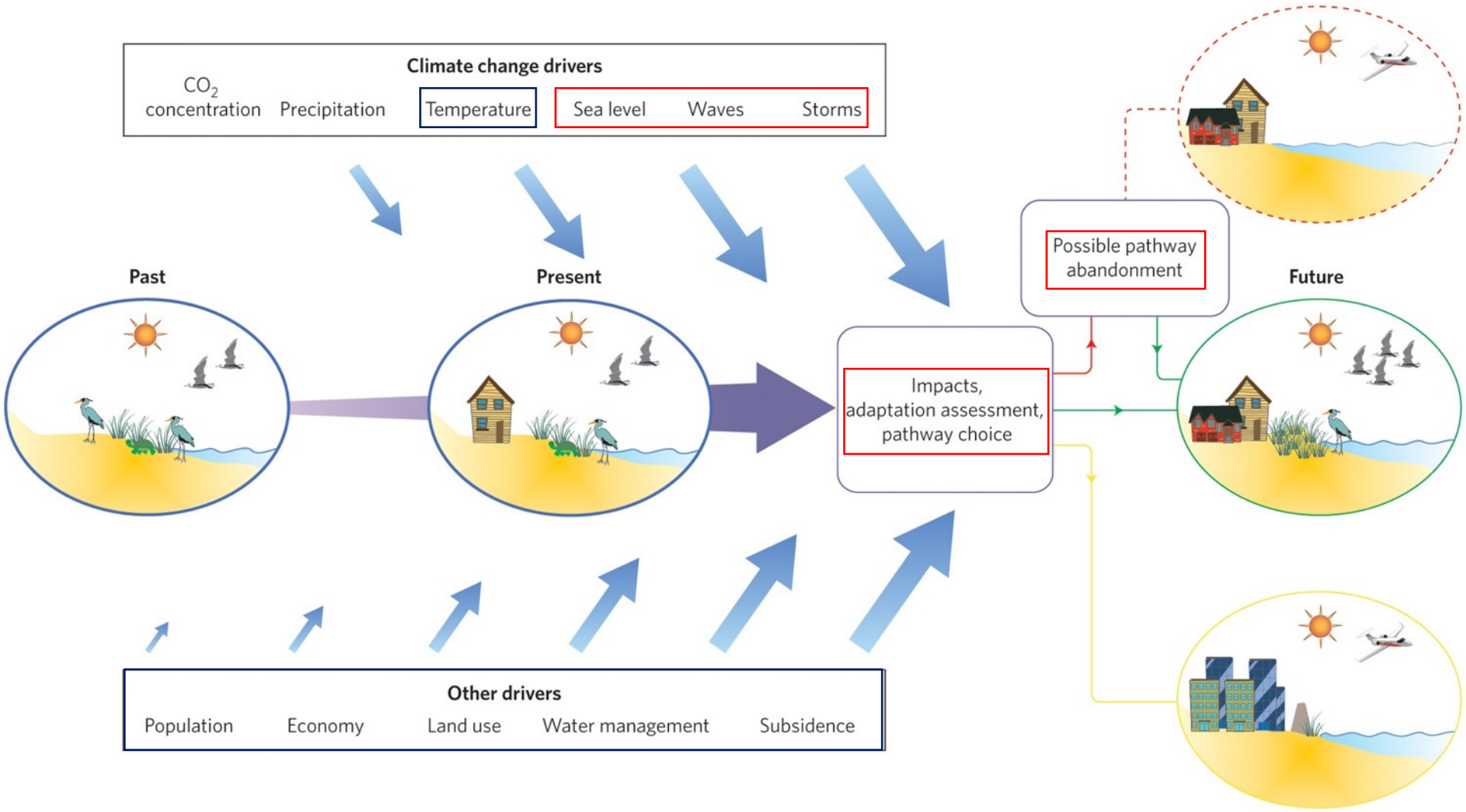
Gonéri LE COZANNET
BRGM (French Geological Survey)

Thanks to many colleagues who provided contributions

The science of global and UK sea-level projections
Progress, challenges and future directions
20th – 21st September 2021

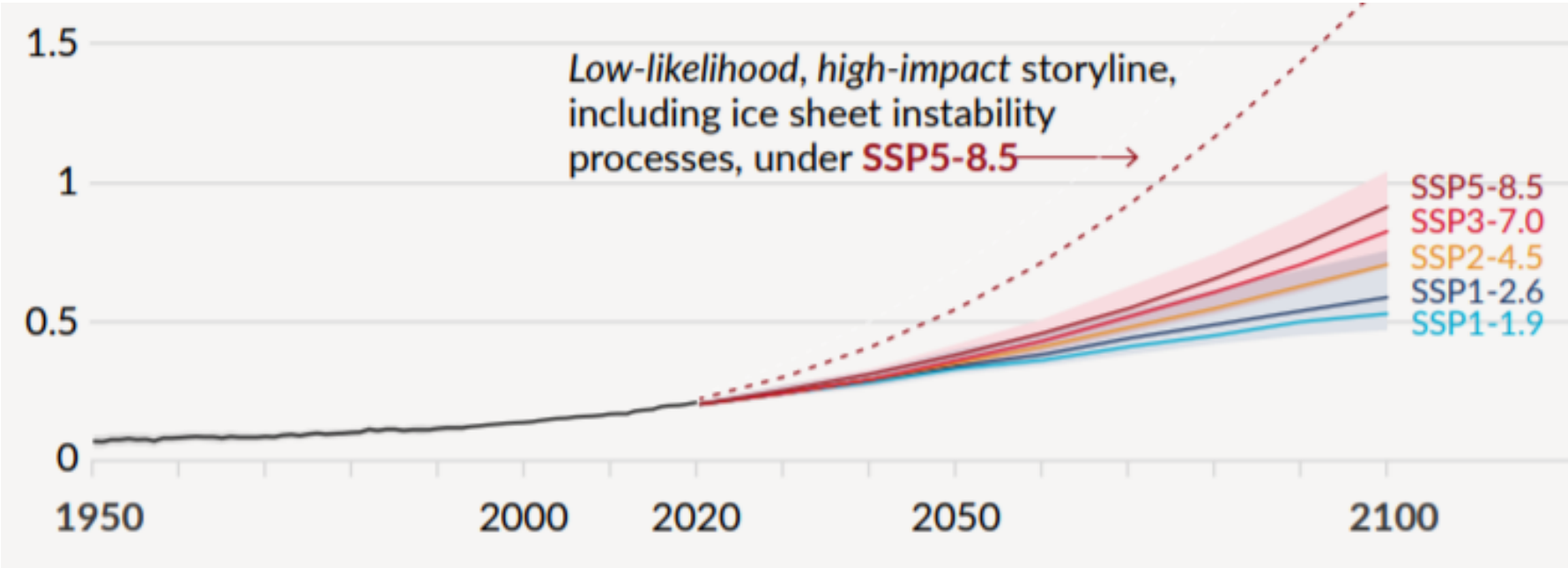
Sea-level rise will reshape coastlines for decades and centuries

but coastal management is concerned by many other urgent issues



Brown et al. (2014)

Sea-level rise risks are about to emerge from natural variability



IPCC, AR6 WG1 SPM – see also Sharples et al., 2020

Natural variability dominates ➔ *Stylized times of emergence*

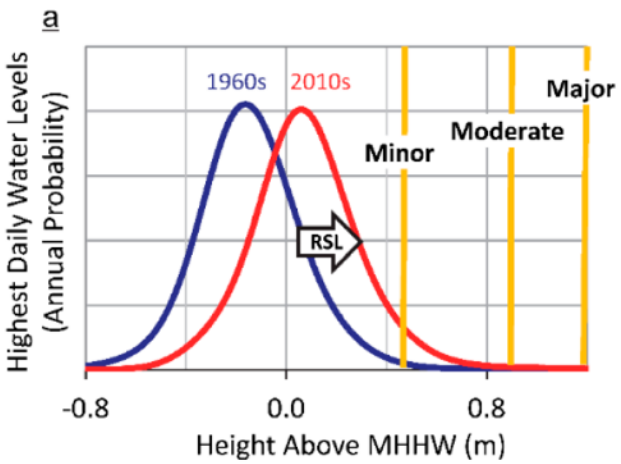
- High-tide chronic flooding
- Increased flooding during storms
- Increased salinization
- *Early responders* Increased erosion
- Permanent flooding

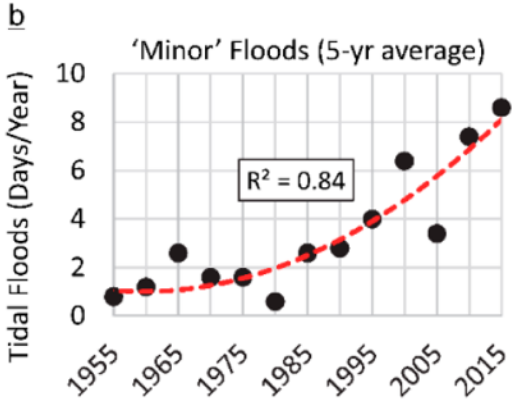
Sea-level rise adaptation is becoming urgent: High-tide chronic flooding

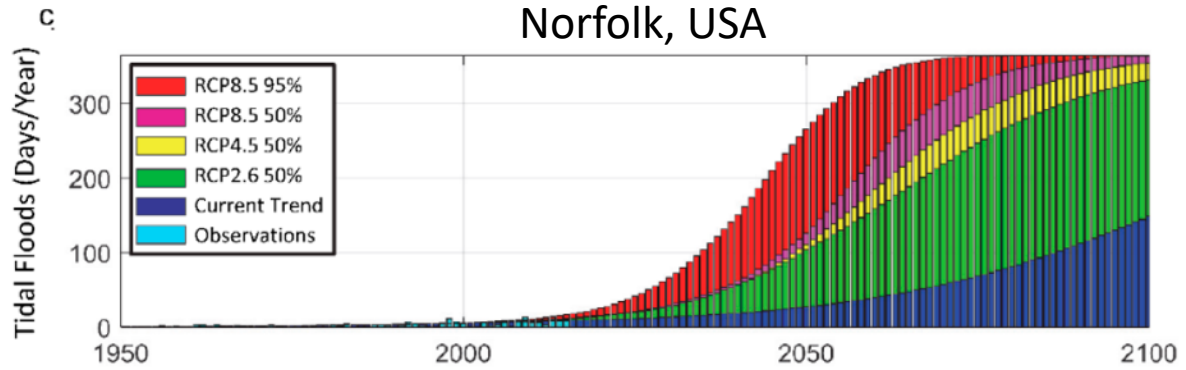
San Francisco Bay Keeper - Robb Most

Jason Minto/Delaware News Journal

- High-tide chronic flooding (Sweet and Park, 2014, Moftakhari et al., 2015, Karegar et al., 2017)
- Nuisance for coastal infrastructure management: port, airport, industries, commercial and residential assets in low-lying areas (Hino et al., 2019)

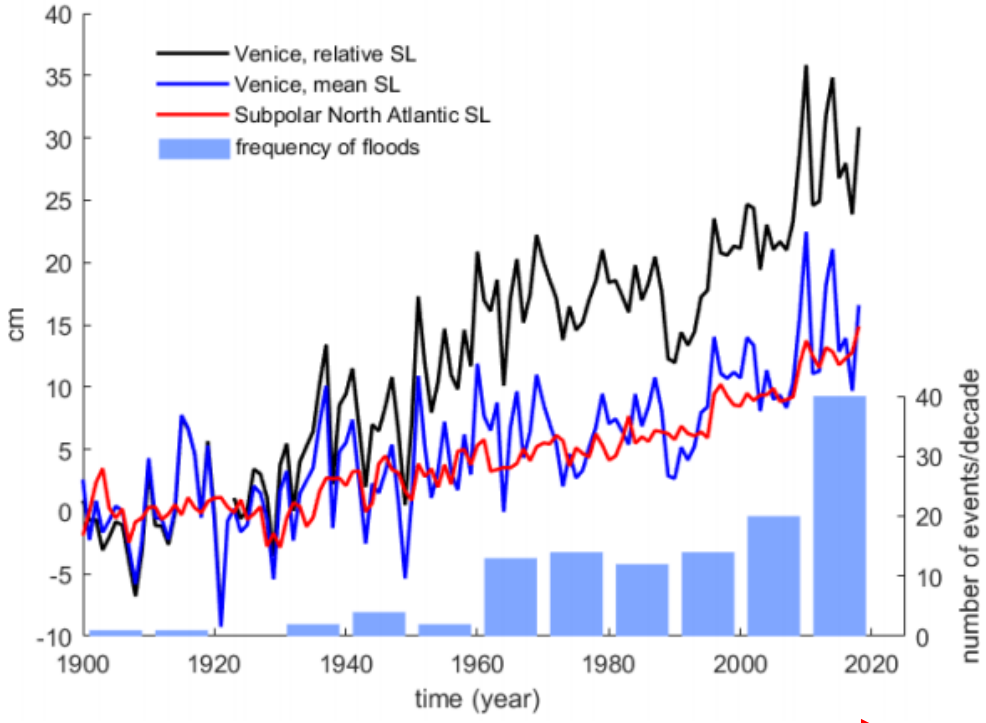


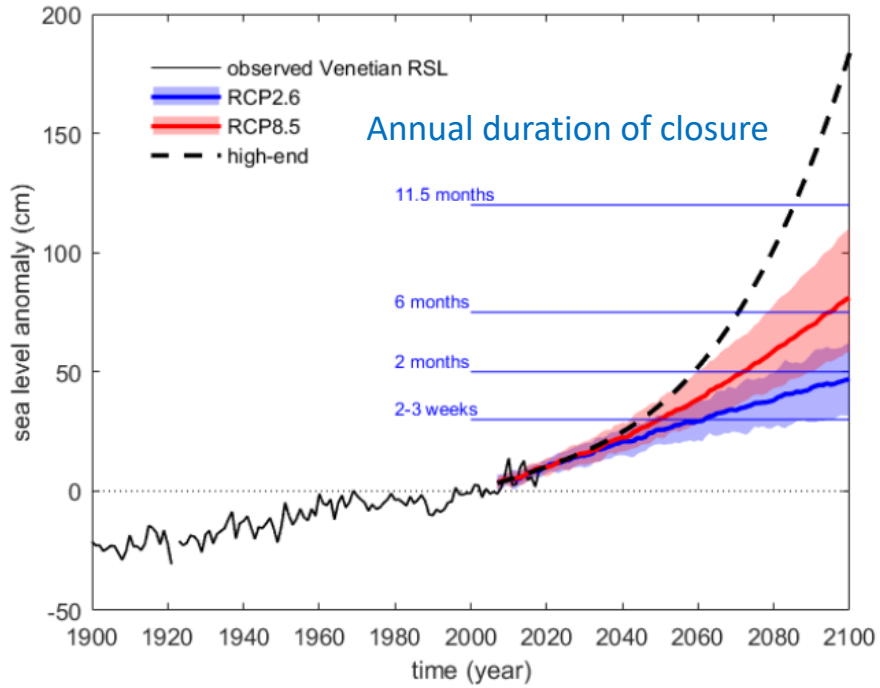




Sweet and Park, 2015; Le Cozannet et al., 2017

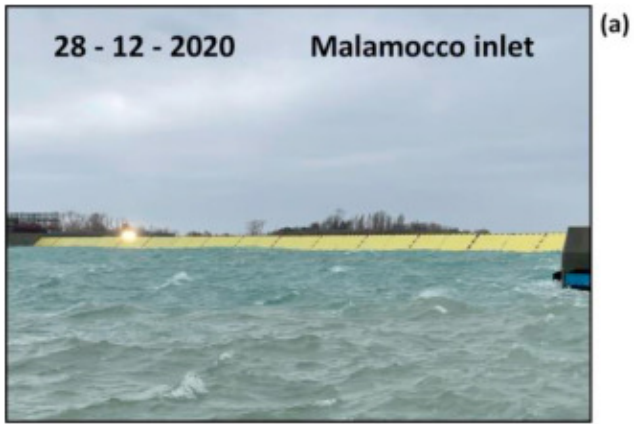
Coastal adaptation planning and implementation can require decades

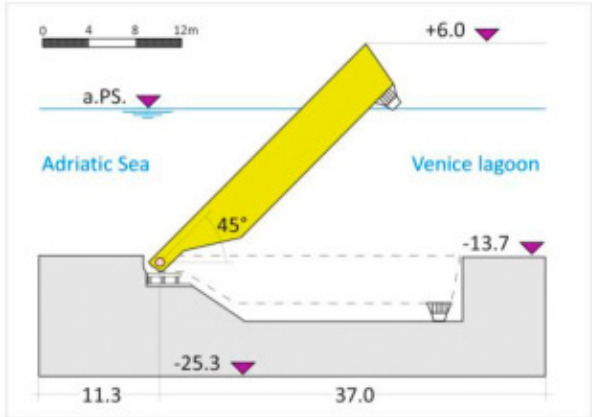




Proposed / Operational

Implementing the MoSE barrier took *decades*

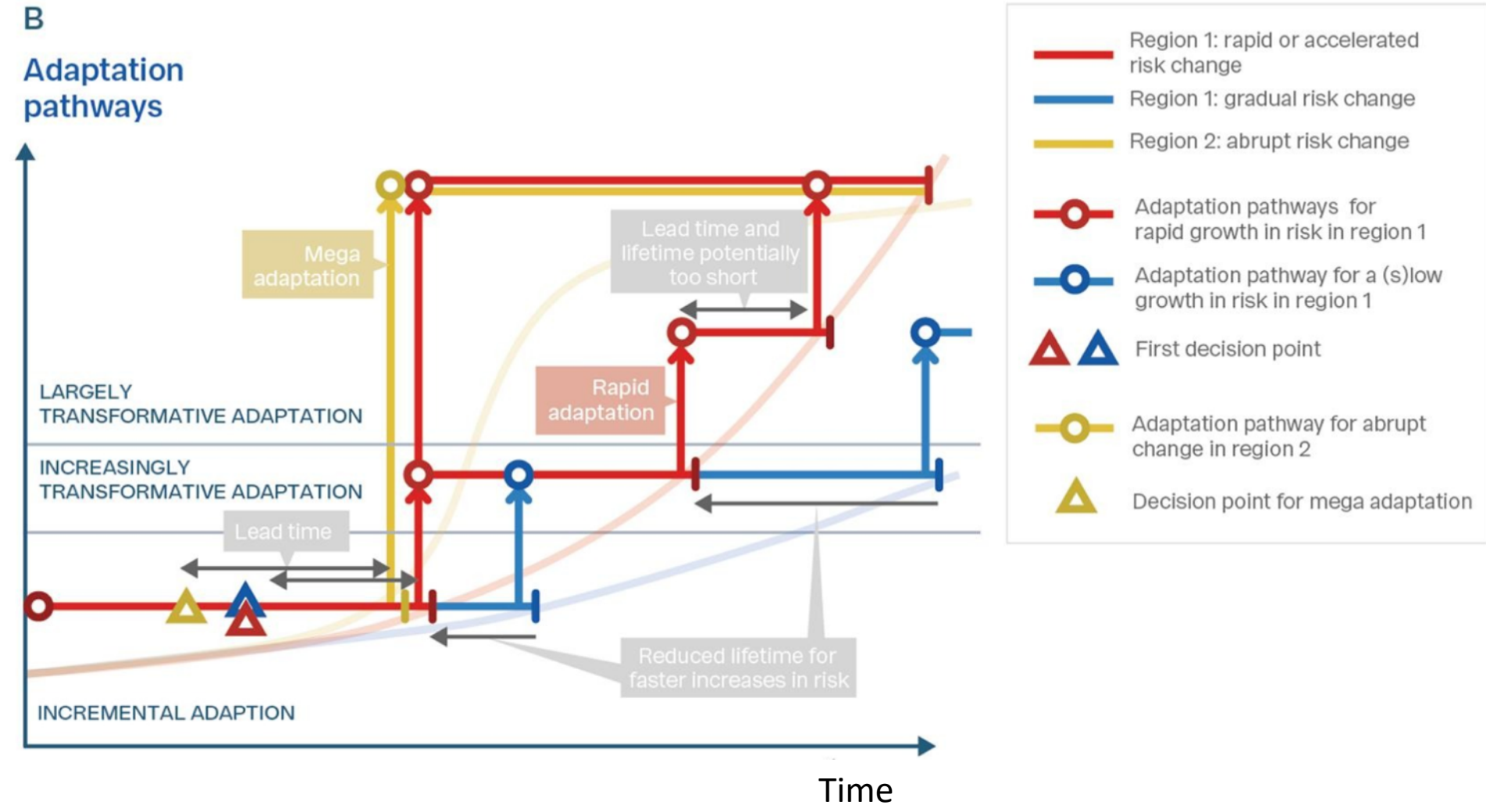




Lionello et al., 2021; Mel et al., 2021

As users adapt to sea-level rise impacts committed for 2030-2050, they also need to anticipate the next steps

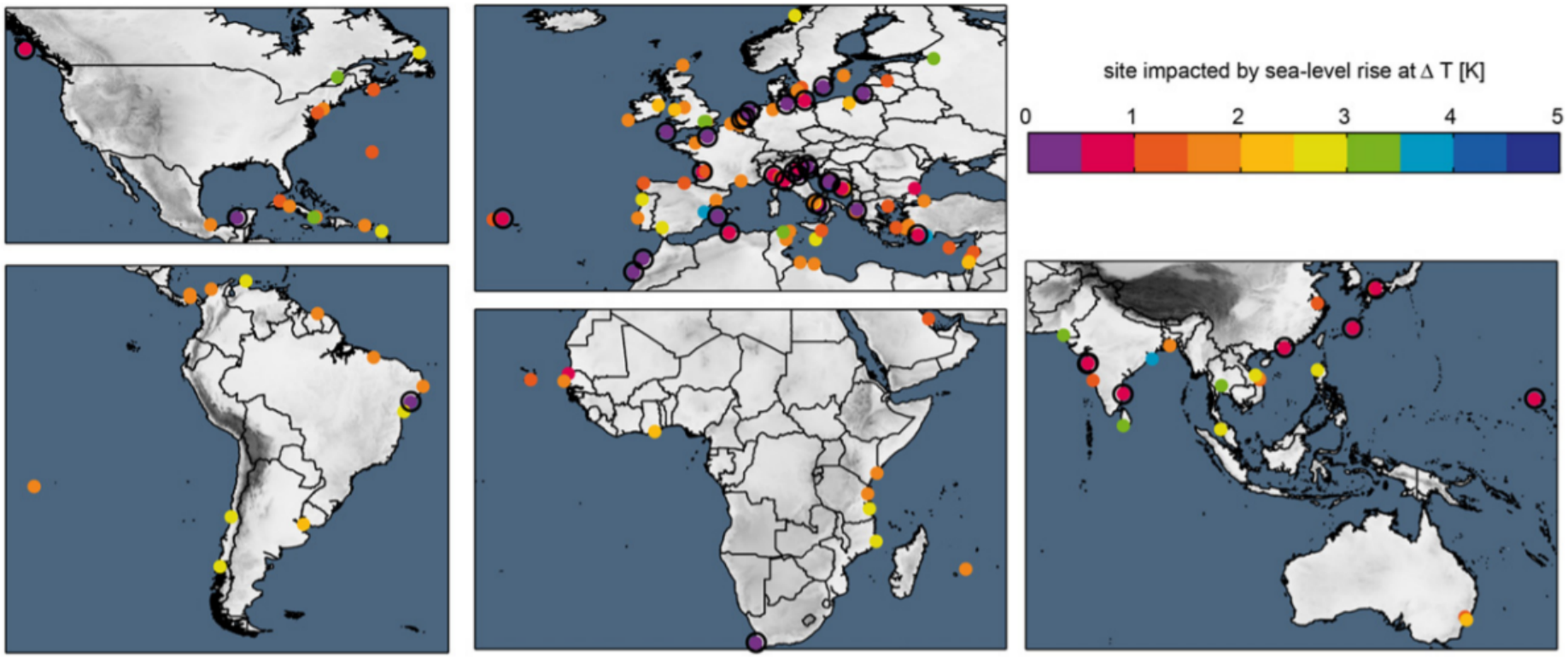
Considering that high-end scenarios can not be excluded beyond 2050



Haasnoot et al., 2021

Relevance of multicentenial sea-level rise scenarios

- Coastal natural heritage (Marzeion et Levermann, 2014; Reimann et al., 2018)
- Long-living infrastructure: cities, energy & transport infrastructure, ports (Clark et al., 2016)
- Coastal landfills, former industrial sites and polluted areas (Nicholls et al., 2021)
- Existential threat for island nations (SROCC, 2019)

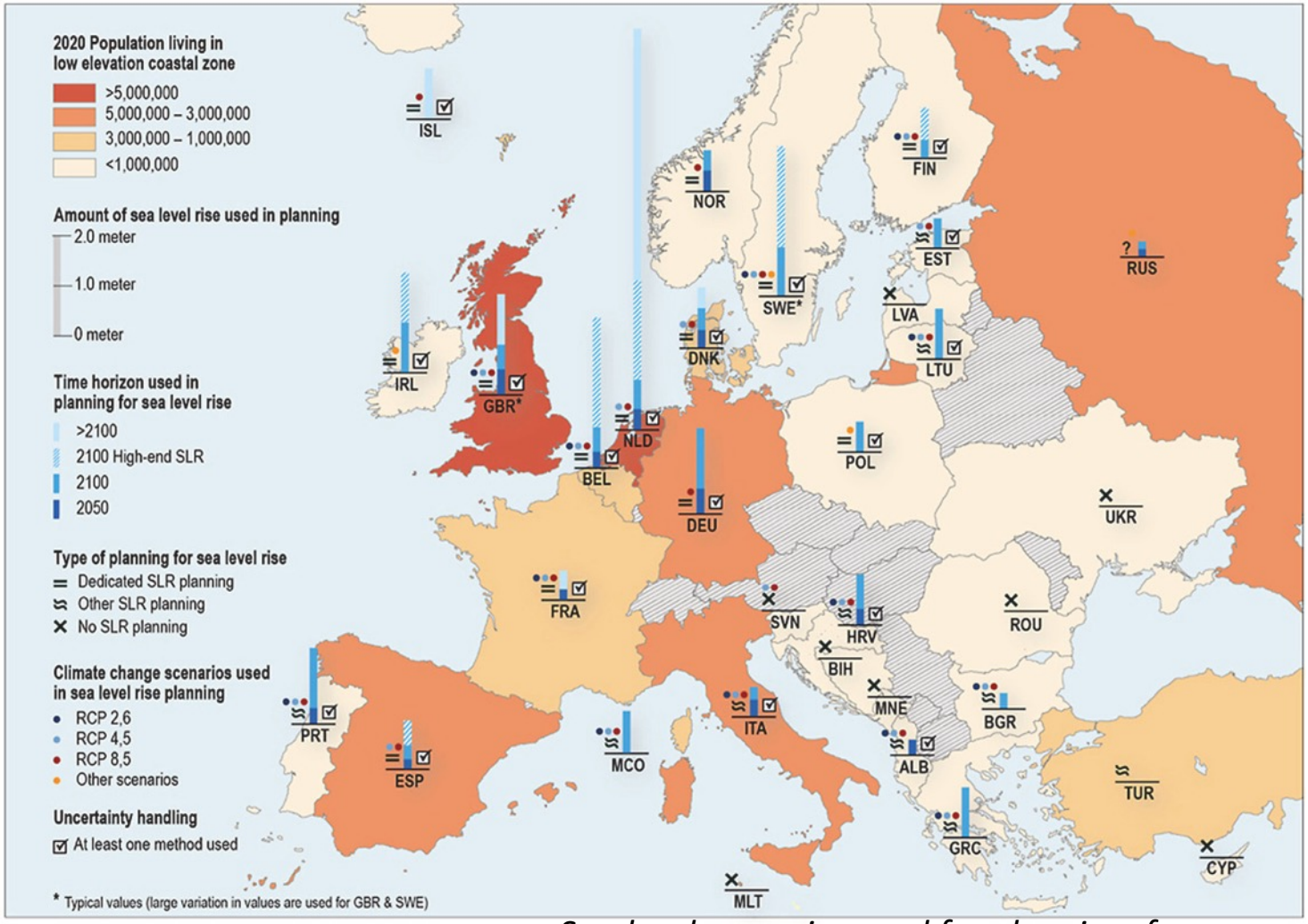


Unesco cultural heritage sites committed to be impacted for a stabilization of climate warming at ΔT

Marzeion et al., 2014

Sea-level scenarios are increasingly considered

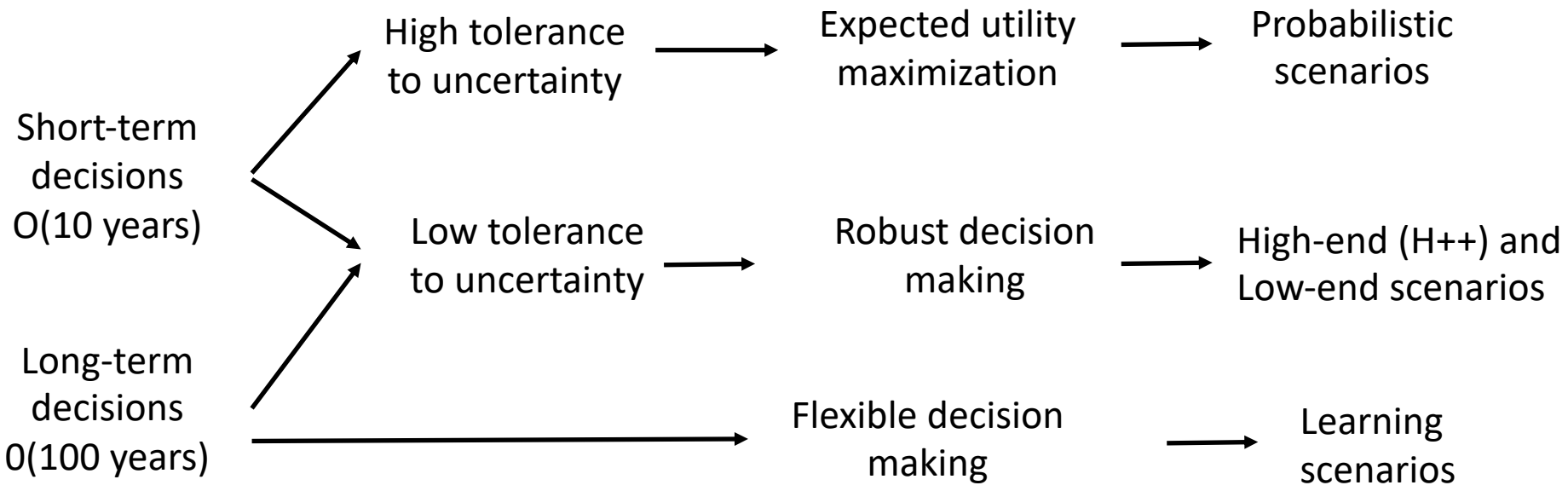
But they are used differently:
e.g. to inform future infrastructure maintenance
or to limit urban sprawl (land use planning regulation)



Sea-level scenarios used for planning, from a survey, in Europe

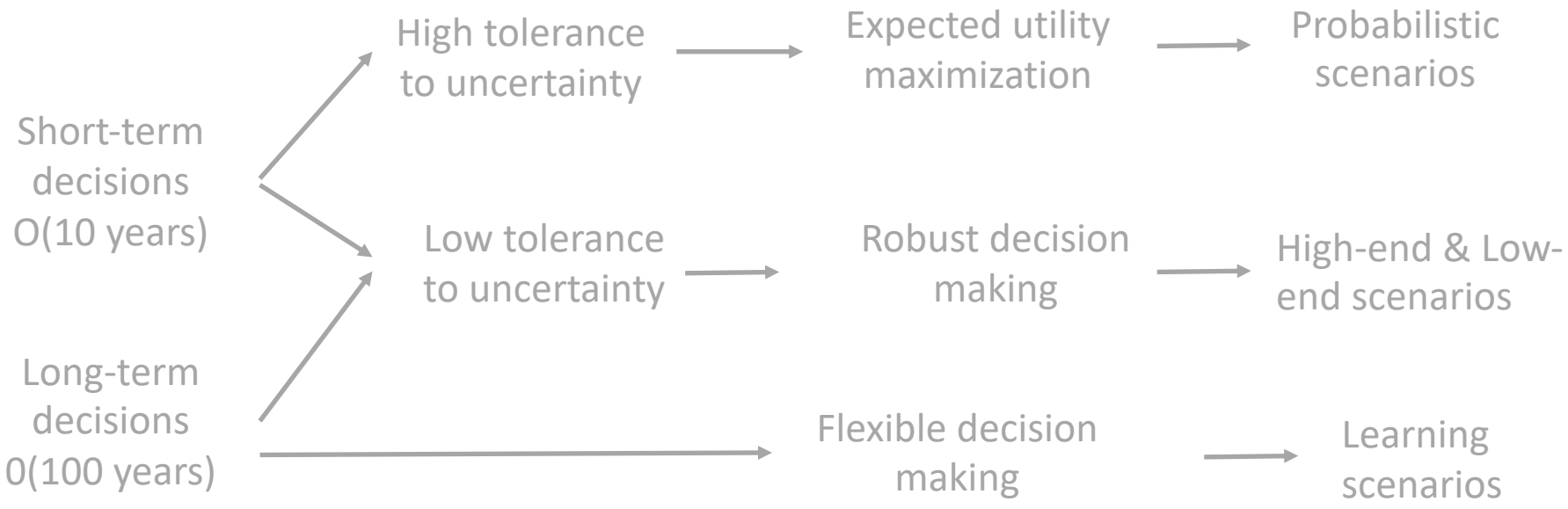
Mc Evoy et al. (2021)

Rather than uniform guidelines at national scale, scenarios targeted to the practitioner's profile can be delivered



Hinkel et al., 2019; Stammer et al., 2019

Sea-level information for coastal risk management



Example: the French Coastal Conservation Agency

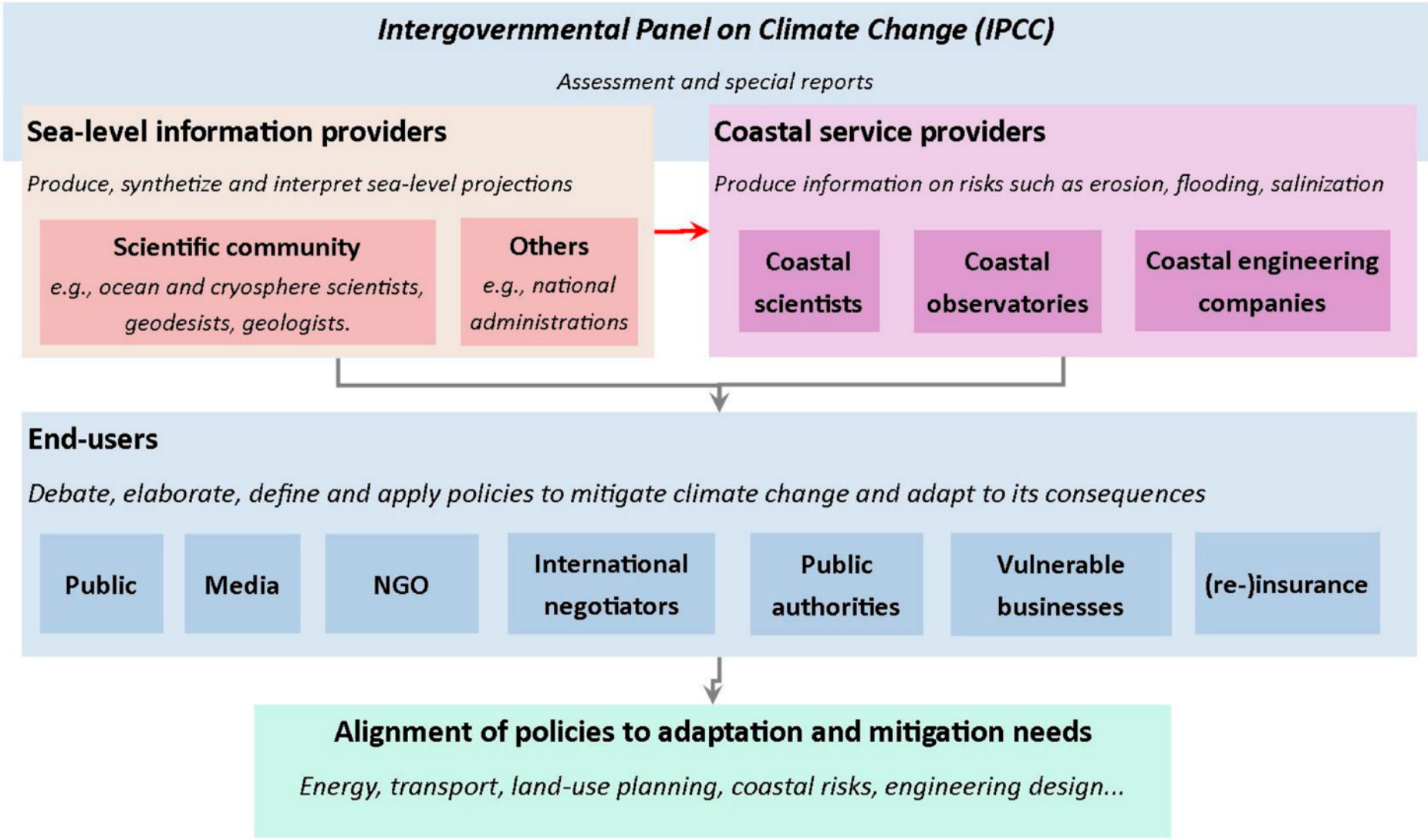
Protect CRYOSPHERE & SEA LEVEL

- Willing to implement soft adaptation strategies
- But need to demonstrate that their strategies has no impact to others

⇒ So far: 2050 median scenarios only

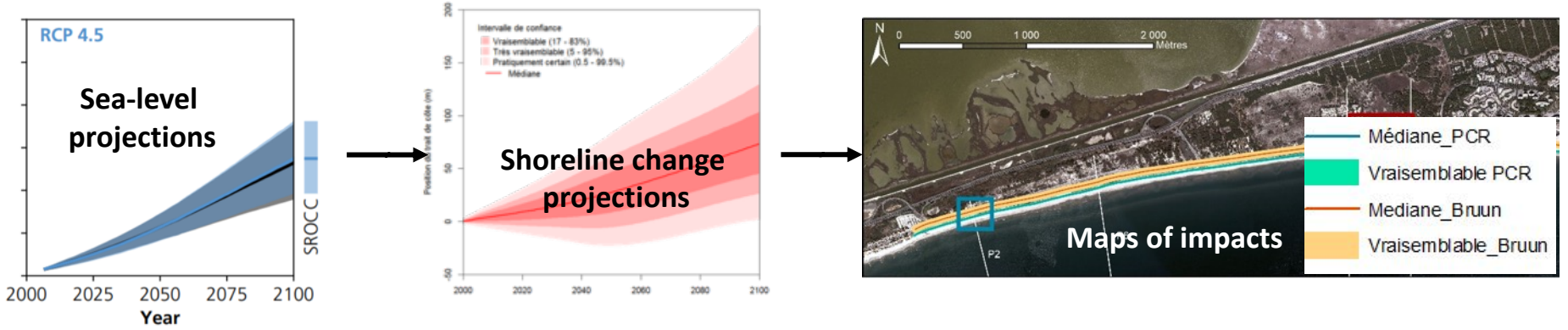
Hinkel et al., 2019; Stammer et al., 2019

Reducing coastal risks involves many stakeholders.
The landcape of users/providers is complex and still evolving

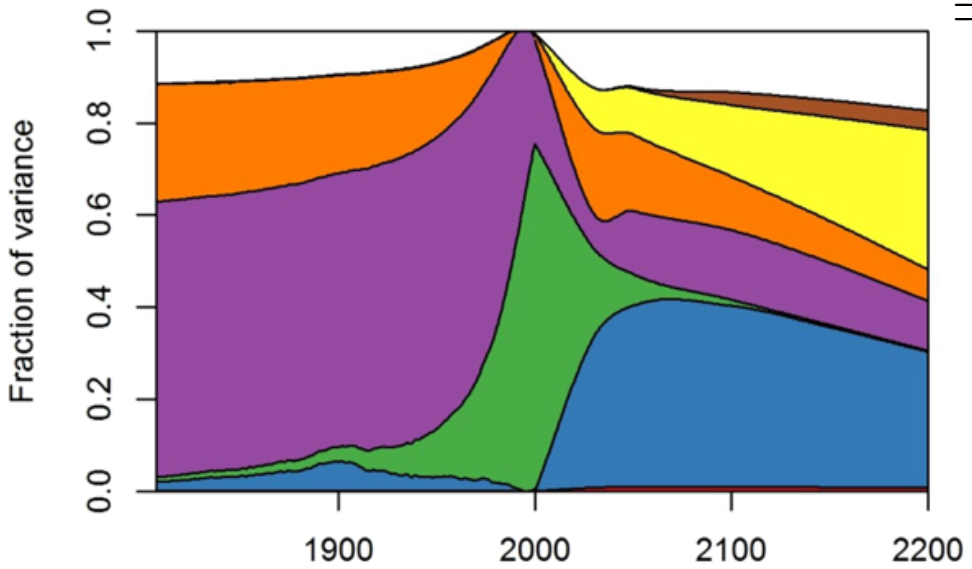


Le Cozannet et al., 2017

Coastal scientists and engineers are both users of sea-level information and providers of services for coastal adaptation



Where do coastal impact uncertainties come from?



⇒ Site & hazard dependant

- Climate change scenario
- Regional sea level rise
- Vertical ground motions
- Multidecadal trend
- Shoreline change variability
- Coastal impact model
- Beach slopes

⇒ **Requires sea-level scenarios with uncertainty (probabilistic, low/high-end)**

Le Cozannet et al., 2019

Information needs for coastal risk management

Sea-level rise scenarios are not the final product!

Objective: reducing risks = hazards x vulnerability(exposed assets)

$$\text{Hazard} = \int_{any\ event} \frac{water\ depth\ or\ velocity}{\text{return period}\ of\ events}$$

Exposed building

2 buildings,
not equally vulnerable

Information needs for coastal risk management

Sea-level rise scenarios are not the final product!

Objective: reducing risks = hazards x vulnerability(exposed assets)

Reducing/changing hazard

Requires information on erosion, flooding, salinization and how interventions modifies hazards

e.g.: Sea-level rise, HR-DEM (used with modeling), land cover (roughness), pressure, wind/waves heights (from altimetry, SAR), bathymetry, HR imagery (long time series)…

Reducing exposure

Requires information on land use

e.g.: land cover, inventories of exposed assets

Le Cozannet et al., 2020

Reducing vulnerability

Requires information on structural, systemic and social vulnerability

Coastal protection (= reducing the hazard)

Based on:

- Engineering solutions
- Sediment management
- Use of ecosystem-services

Effectiveness for rapid sea-level rise?

At the cost of ecosystem losses?

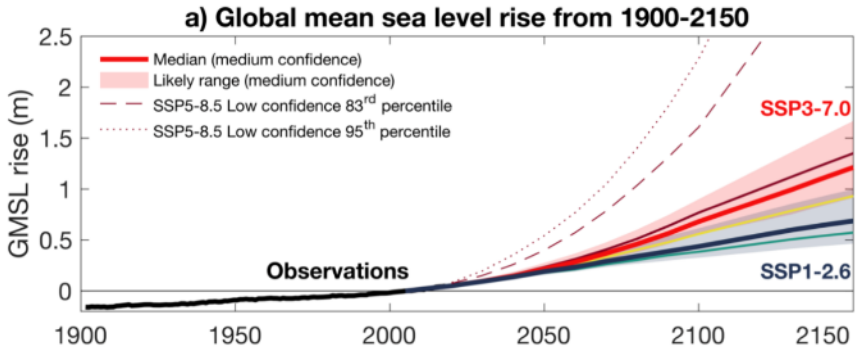
e.g.: creating natural buffer zones to reduce peak storm water levels

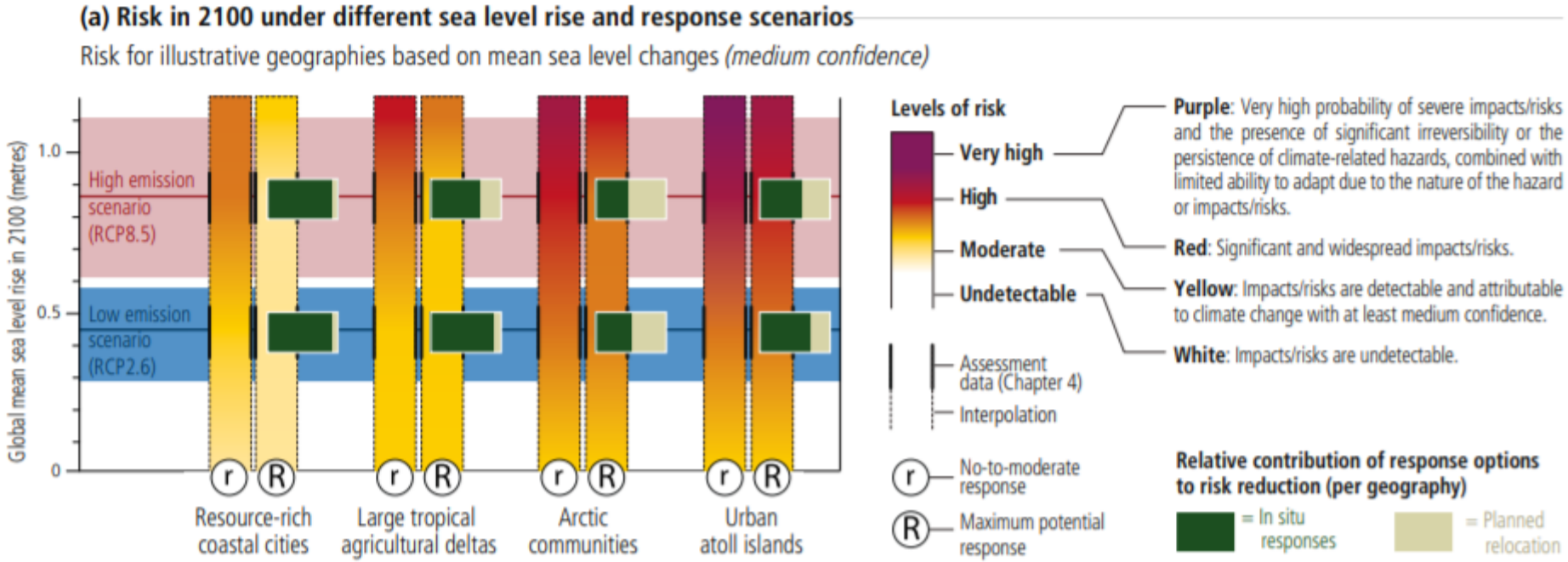
SROCC, 2019; Cooper et al., 2020.

A commitment to relocation due to sea-level rise?

Planning relocation will require:
- local to regional capacity building
- improving governance at all decision levels

This takes decades to set up.





AR6 SROCC, 2019; AR6 WG1 Chapter 9

Coastal adaptation governance is increasingly considering sea-level rise

Example: coastal adaptation in the french regulation

Maspataud et al.,

1997
Coastal Risk Prevention Plans (PPRL) Technical guidelines

2010
Xynthia storm
47 casualties
2.5 billion € direct losses

2011
Circular - 27 July 2011:
SLR scenarios in PPRL
Circular - 2 August 2011:
Priority municipalities for the implementation of PPRL

2014
Revised PPRL technical guidelines
Improved coastal flood modeling
Sea-level rise included

1986
"Loi Littoral"

2009-2010
"Grenelle" environmental laws

2011
Climate Change Adaptation Plan (PNACC)
Evaluated in 2013 and 2018

2012-...
National strategy for integrated coastline management (SNGITC)

2017-2019...
Toward new adaptation regulation
2nd French National Adaptation Plan for Climate Change - ***Being elaborated***

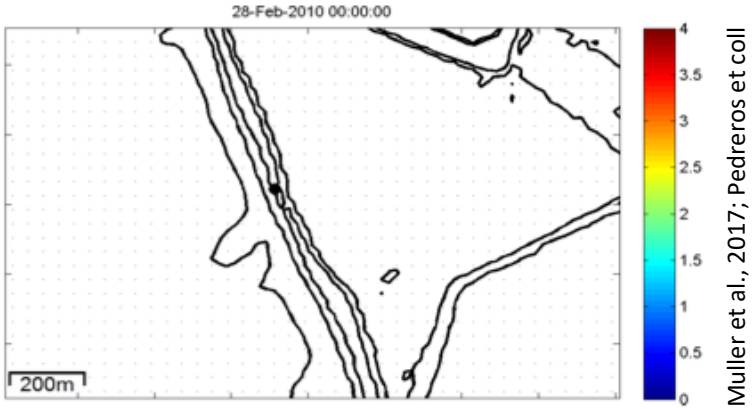
Many coastal adaptation needs are still poorly considered yet

⇒ *Need of international cooperation to share good practices*

Example: coastal adaptation in the french regulation

Successes	Issues	Ways forward
Limitations to further urbanization in hazard-prone areas	Public support	Improved regulation (ongoing)
Better understanding & modeling of coastal flooding during storms	Chronic flooding, erosion/accretion, cascading impacts (coastal landfills, polluted soils) still poorly considered	Research needs Improved technical guidelines
Future sea-level rise is anticipated	Up to 60cm only	User-centered approach toward coastal climate services

Need for knowledge sharing (e.g., WCRP Sea-Level Activities, JPI, etc.)



Sources: Muller et al., 2017; Pedreros et coll

brgm Géosciences pour une Terre durable

Conclusion

Mitigation of climate change has been urgent for 30 years.

Adaptation is now urgent too.

- Some early impacts are being attributed (e.g., chronic flooding)
- Planning and implementing adaptation takes decades
- Exposure and vulnerability generally continue to increase

How can we support adaptation:

- Providing sea-level (and hazard, exposure & vulnerability) scenarios
- Provide information on
  - the timing of impacts and adaptation,
  - feasibility and effectiveness
  - residual risks
- Providing success stories, where users have taken ownership of sea-level scenarios and acted accordingly
- International cooperation, to share case studies and approaches

THANK YOU FOR YOUR ATTENTION

g.lecozannet@brgm.fr

The science of global and UK sea-level projections
Progress, challenges and future directions
20th – 21st September 2021

Montalivet
February 2014

Photos: OCA, ONF, ULM Sud Bassin

THANK YOU FOR YOUR ATTENTION

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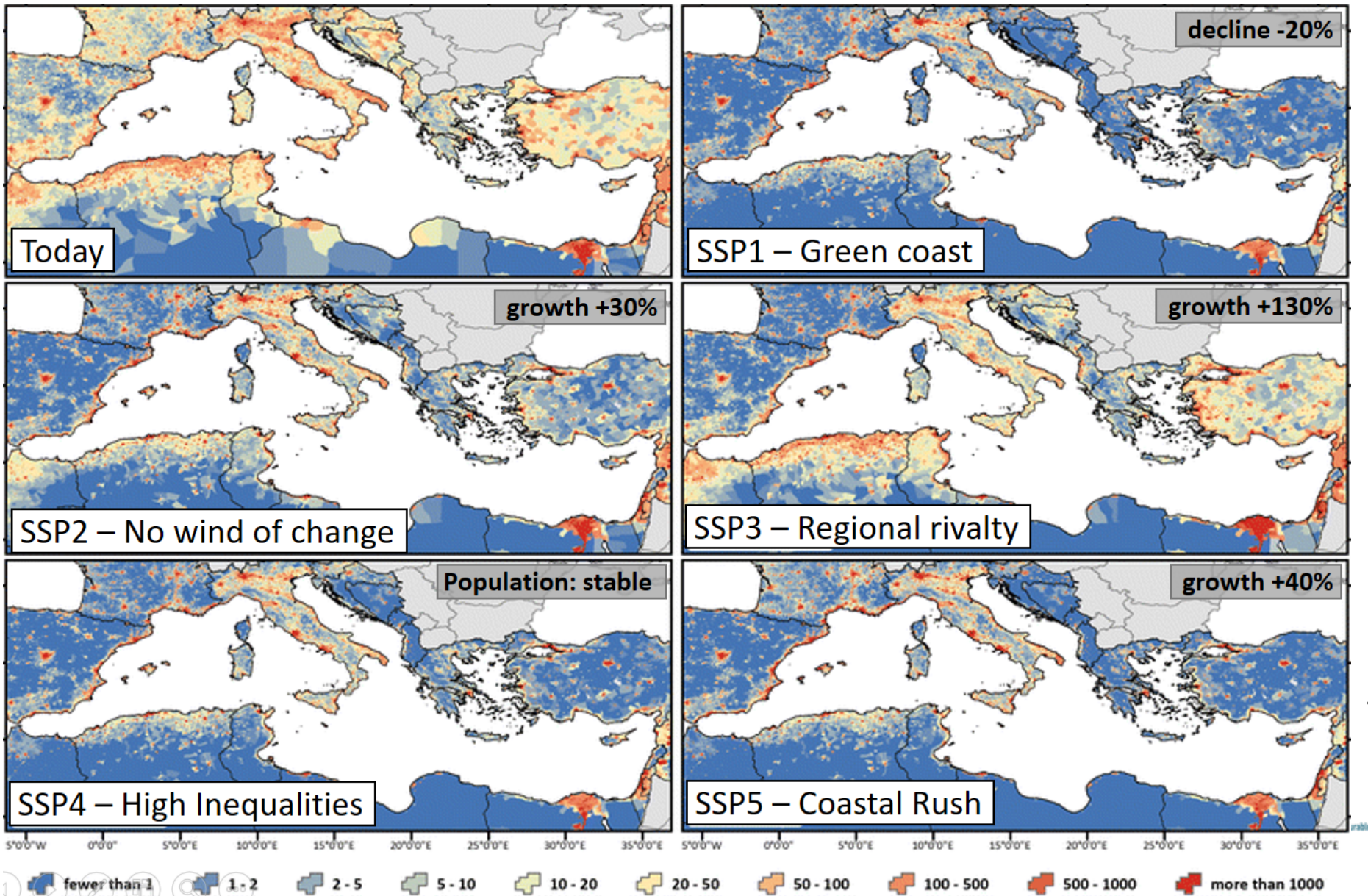
Reducing exposure: avoid new constructions or even relocate

Until 2050, coastal population is generally projected to increase

But not by 2100. Land use planning can help avoiding deadlocks



Reimann et al., 2017

Planned (or reactive) relocation is often not well accepted as an adaptation solution yet