Assessing impacts, resilience, and action for coral reefs of French Polynesia in the face of global environmental change

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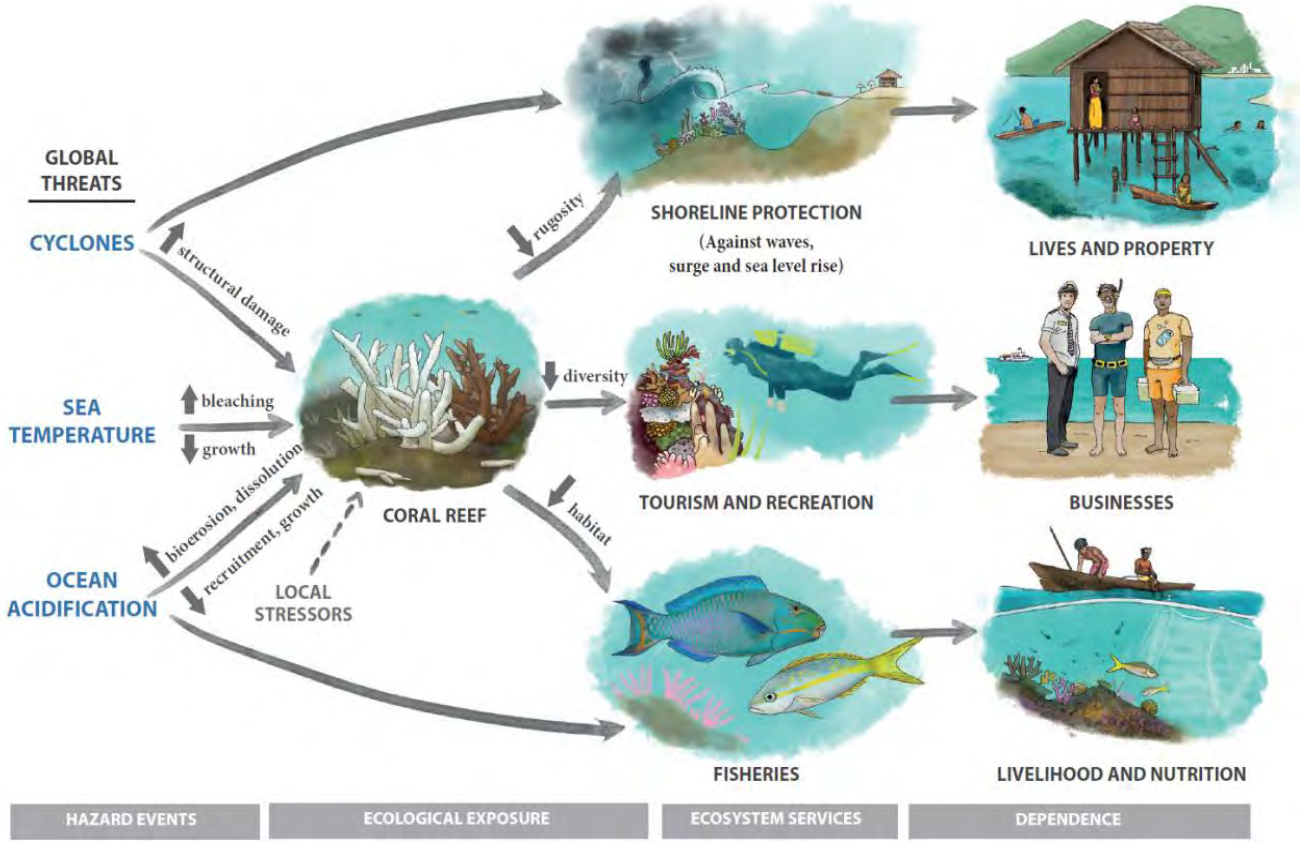
Chain of climate impacts on coral reefs and people



Pendleton, L., **Comte, A**. *et al.* (2017). *Plos One.*

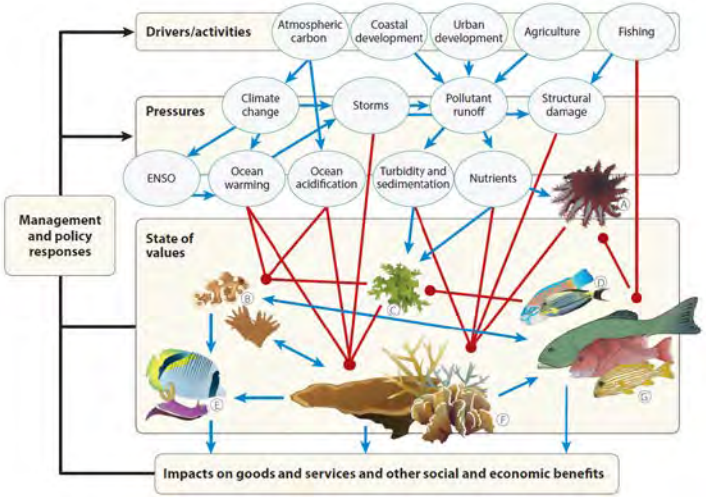
Objectives of the study : Vulnerability and resilience to inform management in French Polynesia

Management strategies exist but decision-makers need information on vulnerability and adaptation :

- Assessment of vulnerability
- Creation of simple indicators from complex resilience processes
- Review of the range of adaptation options
- Integrate science and local knowledge
- Confronting existing management plans

Scientific complexity vs. Political decisions making

- Describe complex interactions
- Long-term studies
- Disciplinary studies



Source: Anthony, 2015

Vs

- Simple indicators
- Short term decision making
- Multiple objectives

Article 113

Pour stopper la perte de biodiversité en outre-mer et préserver son rôle en faveur de l'adaptation des territoires au changement climatique, l'État se fixe comme objectifs, avec l'appui de ses établissements publics sous tutelle et en concertation avec les collectivités territoriales concernées :

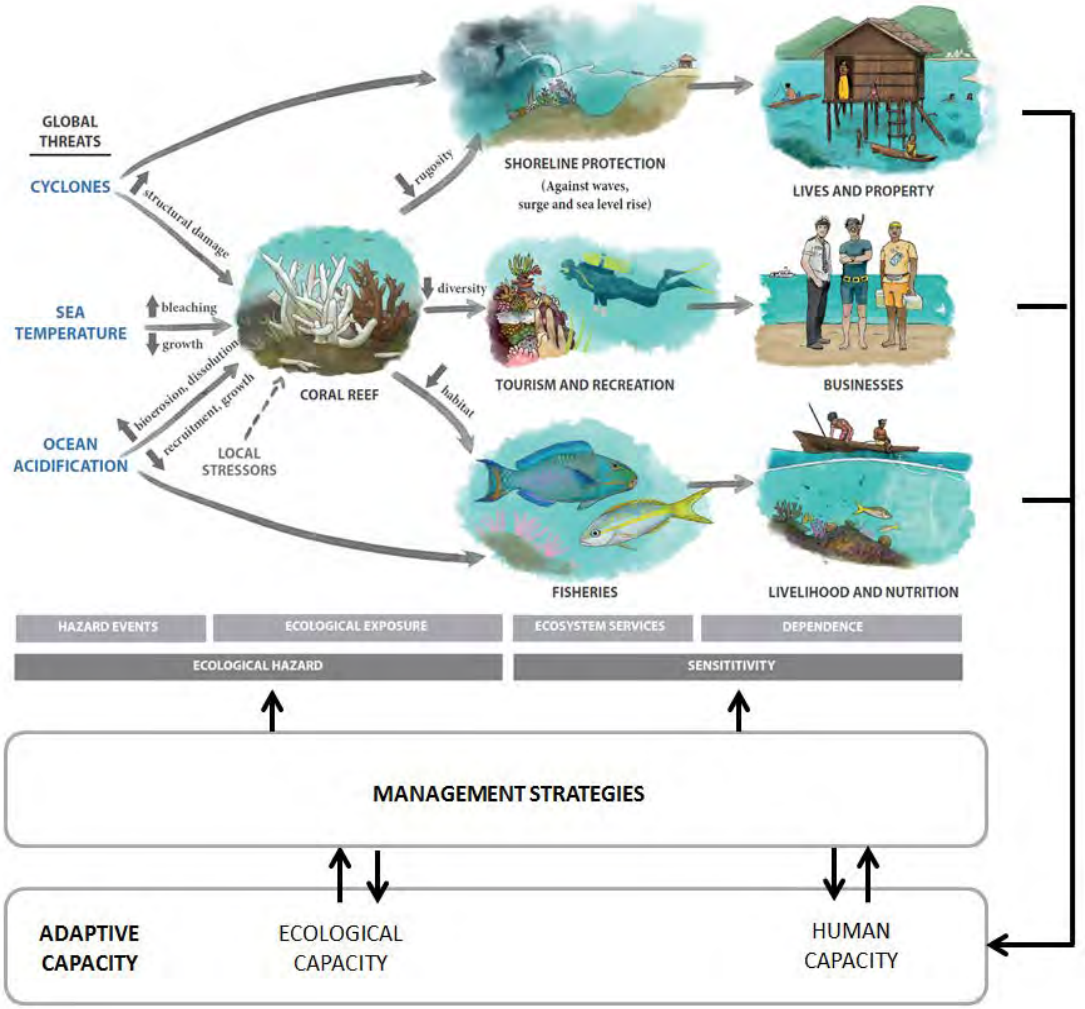
1° D'élaborer et de mettre en œuvre un programme d'actions territorialisé de protection de 55 000 hectares de mangroves d'ici à 2020 ;

2° D'élaborer, dans le cadre de l'initiative française pour les récifs coralliens et sur la base d'un bilan de l'état de santé des récifs coralliens et des écosystèmes associés réalisé tous les cinq ans, un plan d'action contribuant à protéger 75 % des récifs coralliens dans les outre-mer français d'ici à 2021. Dans le cadre de ce plan d'action, l'État se fixe pour objectif d'interdire, dans les zones sous souveraineté ou juridiction françaises, les opérations de dragage des fonds marins dans lesquels des récifs coralliens sont présents, à l'exception des opérations de dragage qui visent à assurer la continuité du territoire par les flux maritimes. En outre, les opérations de dragage des fonds marins qui visent à assurer la continuité du territoire par les flux maritimes doivent éviter au maximum la destruction des récifs coralliens ;

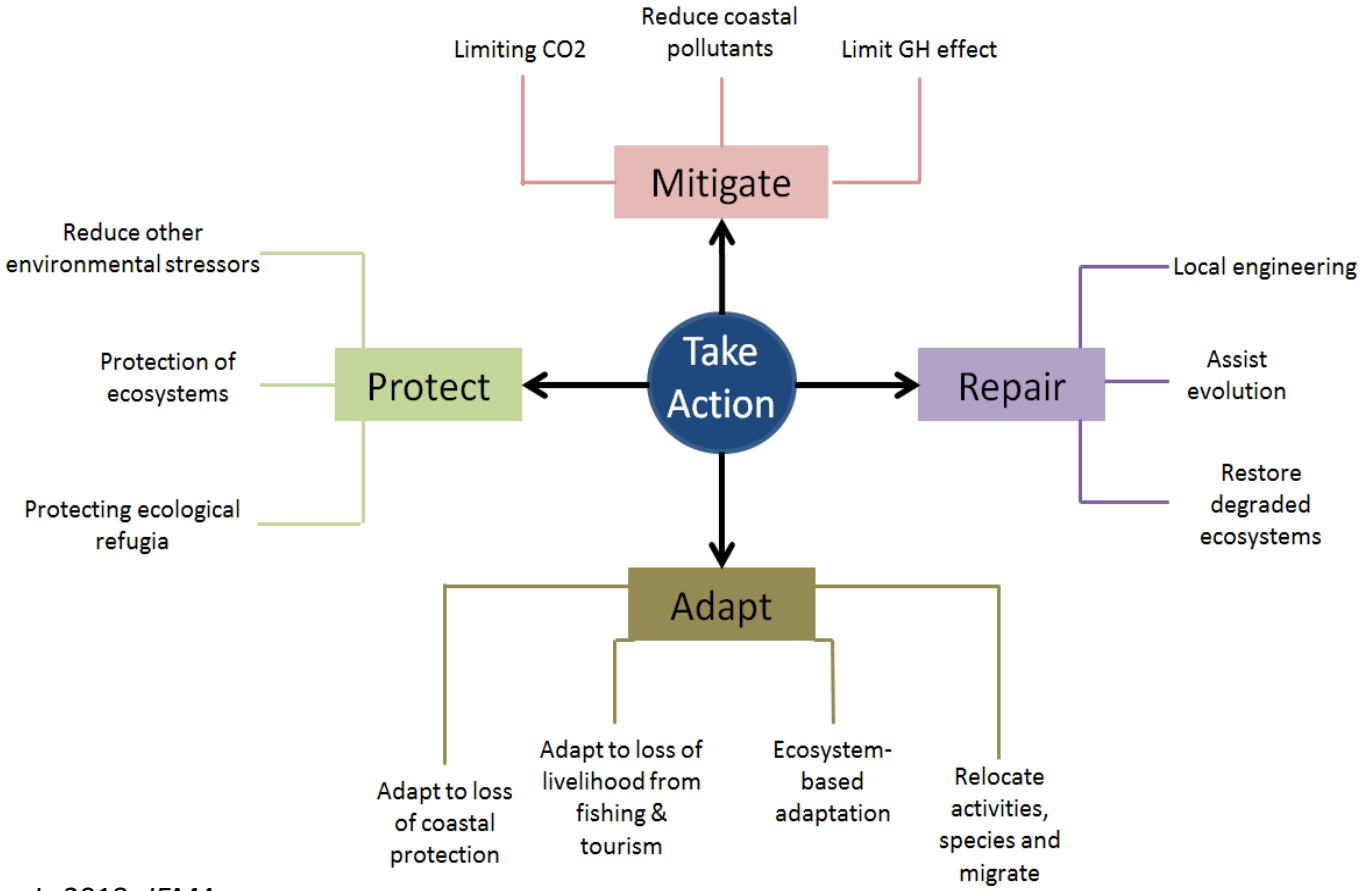
3° D'expérimenter la mise en place d'un réseau d'aires protégées s'inspirant du réseau Natura 2000.

Source: French law on biodiversity, 2015

Vulnerability & adaptation for coral reefs SES

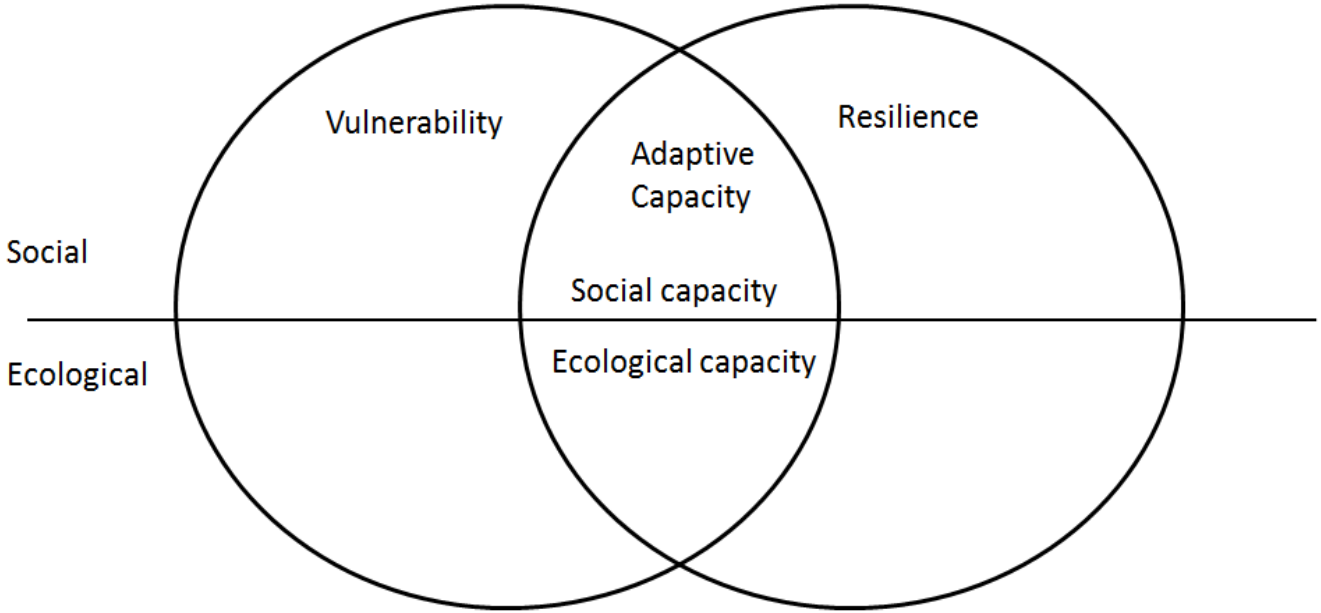


Strategies to deal with GEC on coral reefs and people

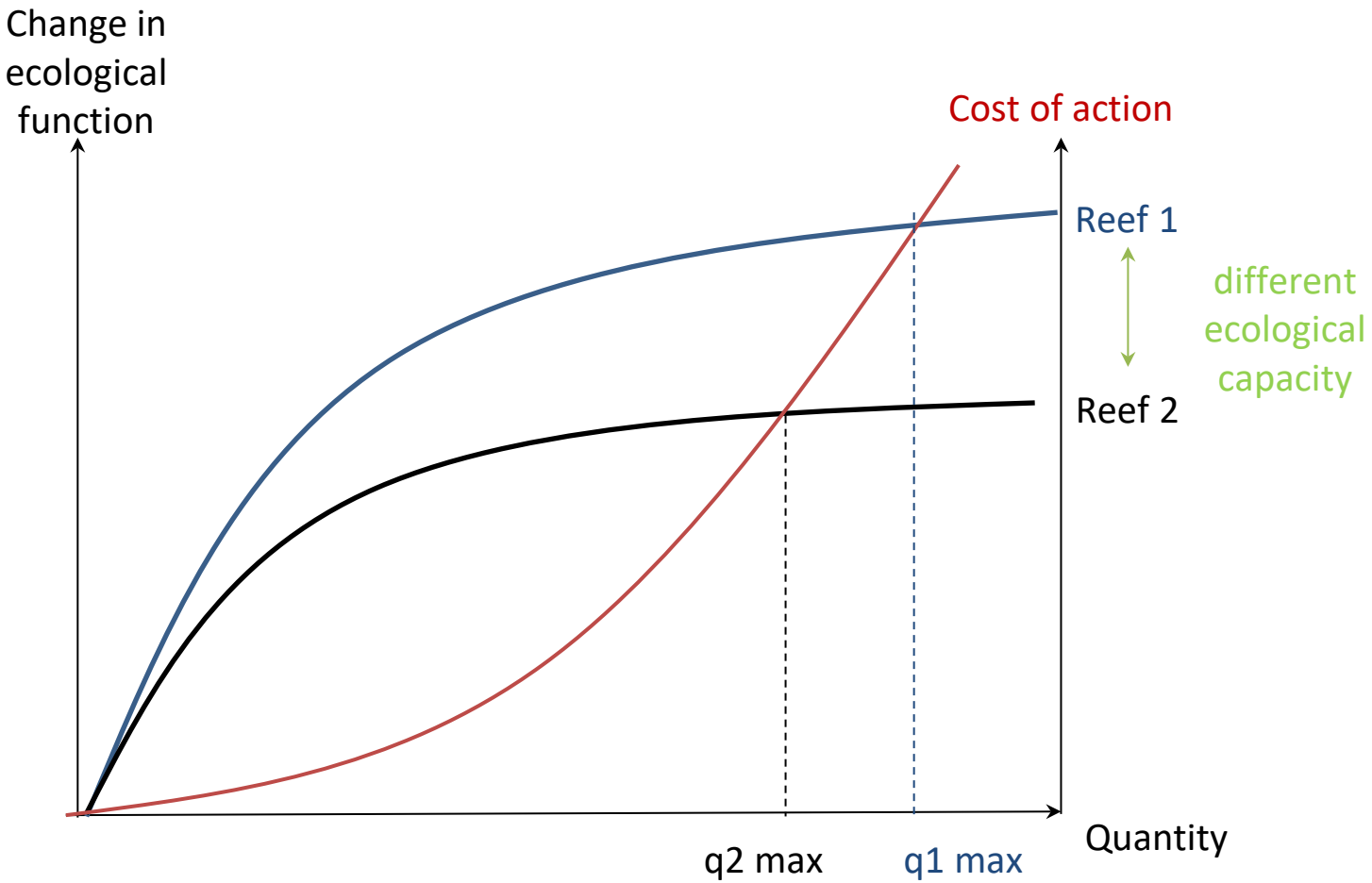


Comte, A. Pendleton, L. 2018. *JEMA*

Adaptive capacity as the common component of resilience and vulnerability. Modified from (Engle 2011)

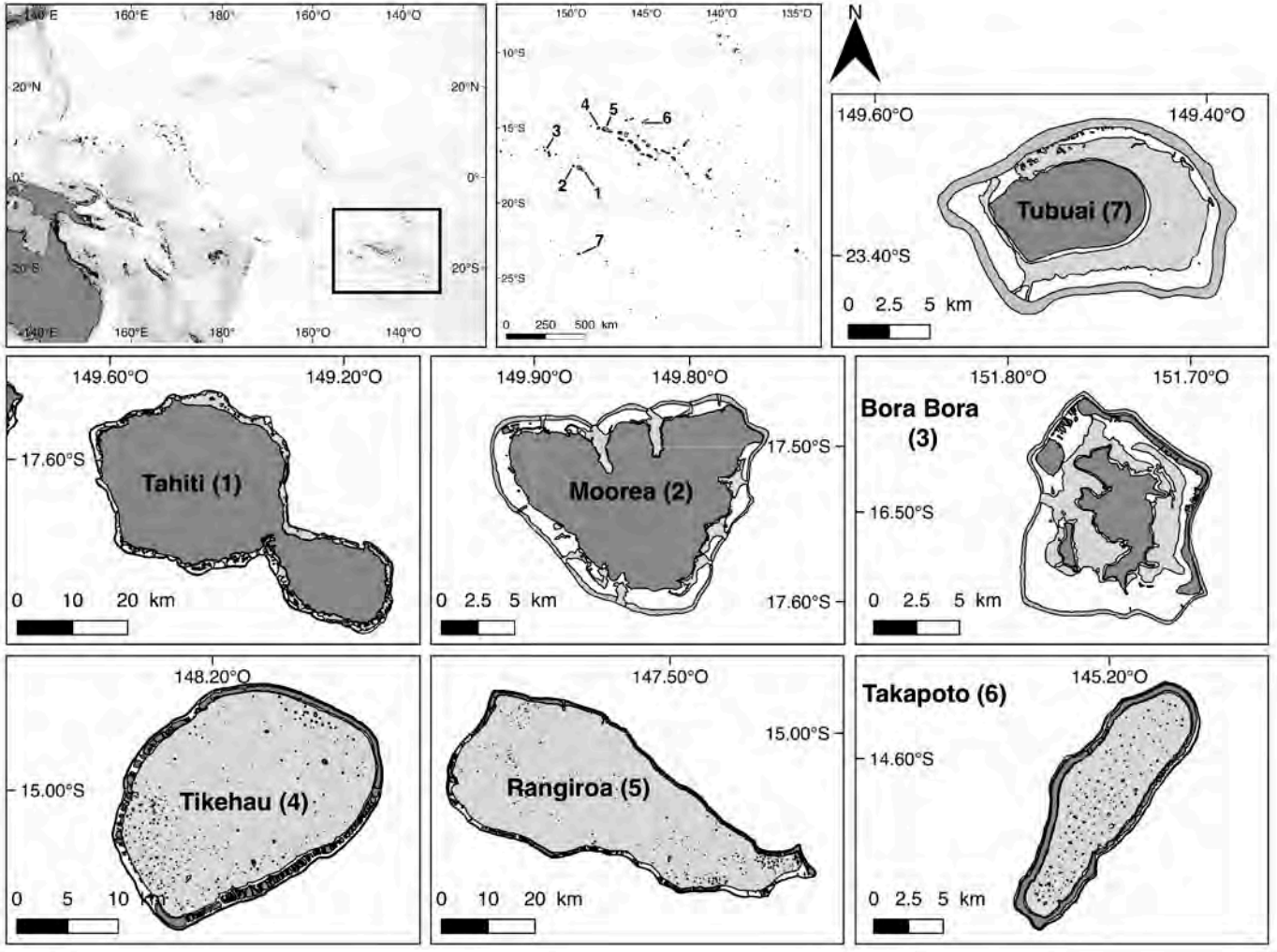


Ecological limits to prioritize action

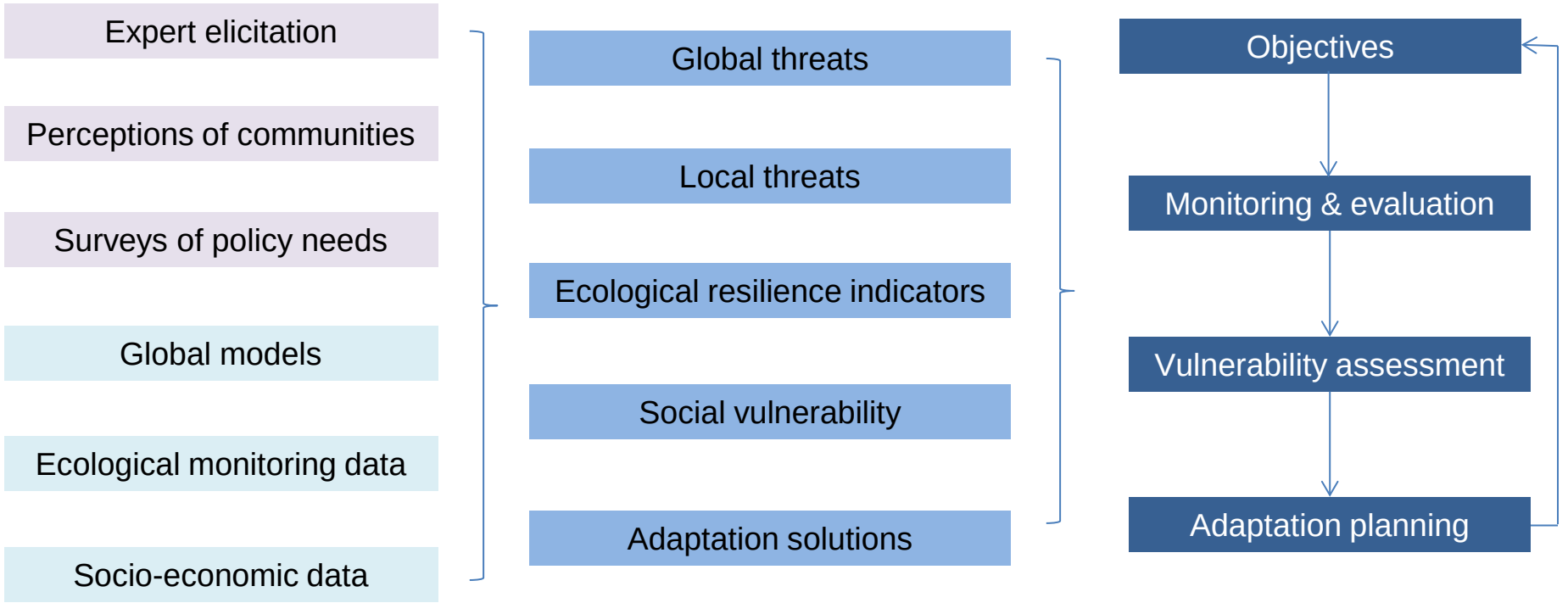


French Polynesia

- 118 islands
- 280000 people
- Potential climate refugia
- High dependence on coral reefs
- Low availability of socio-economic data
- Long-term ecological data



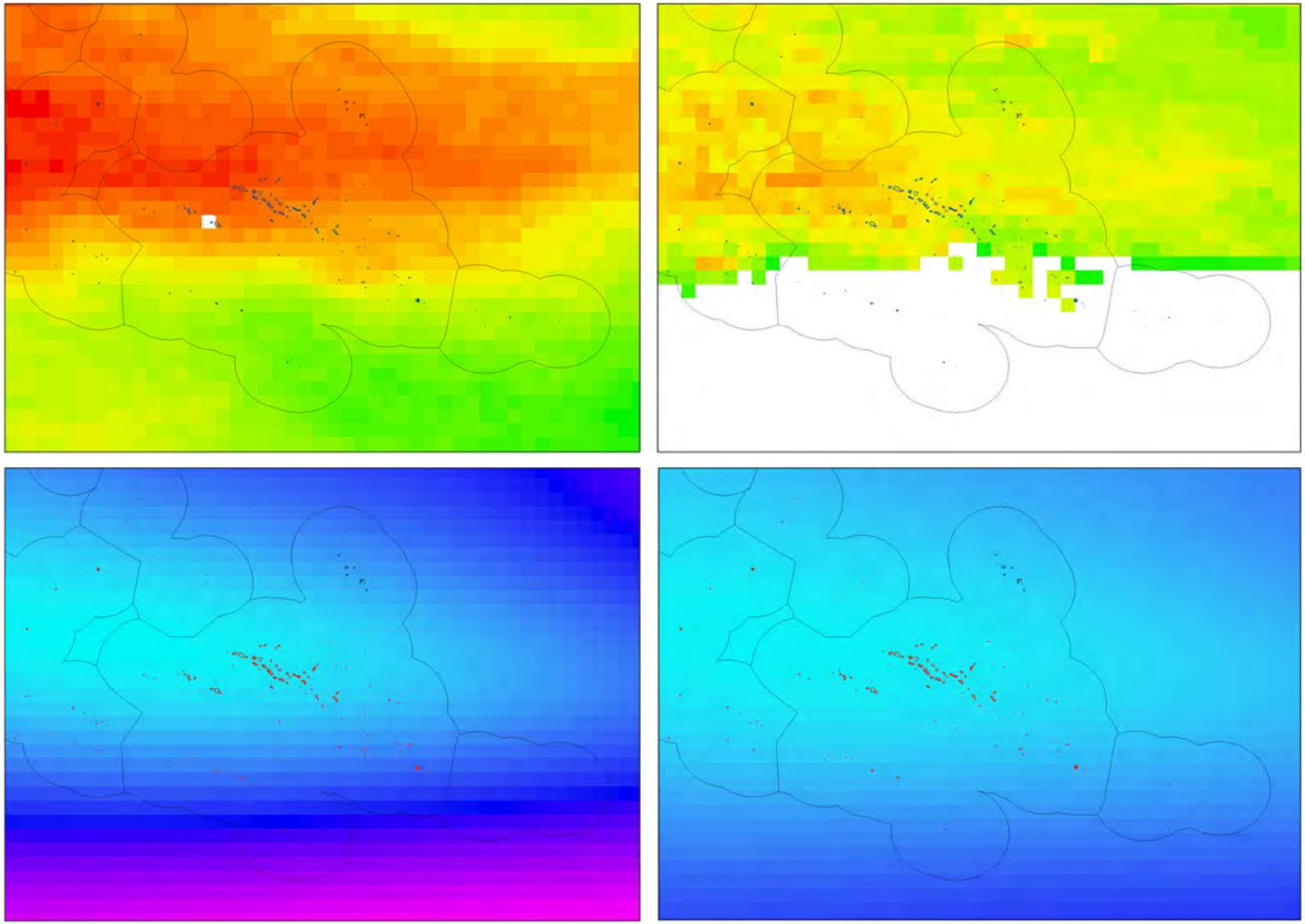
Methodology



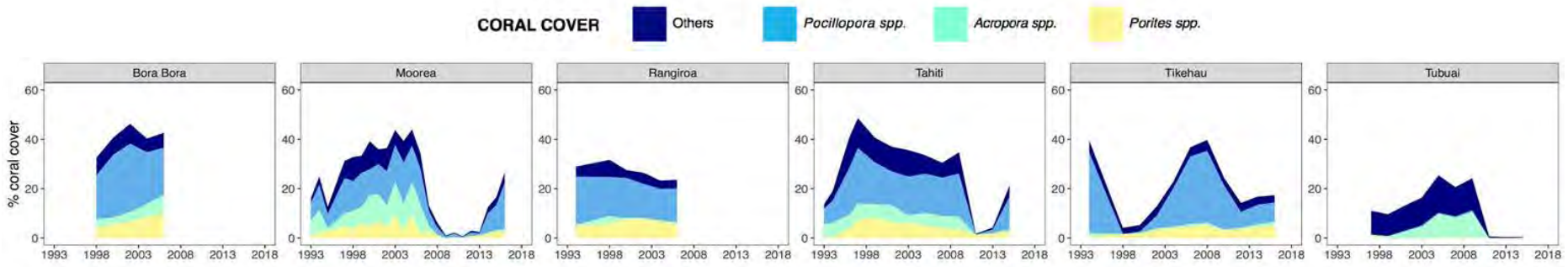
Climate effects: Warming and acidification

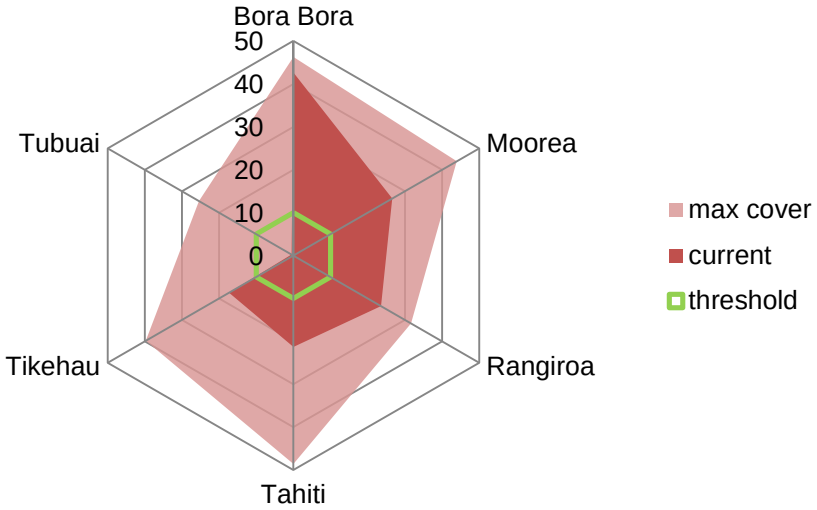
RCP 8.5

RCP 2.6

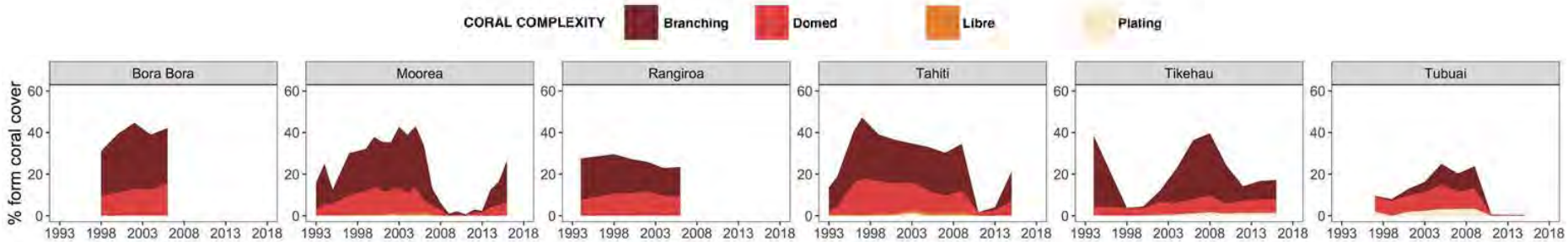


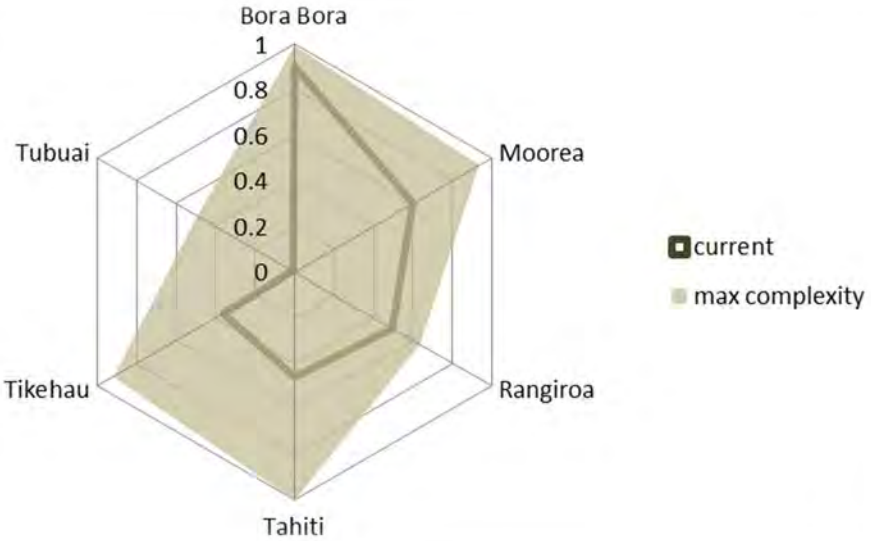
Changes in coral cover



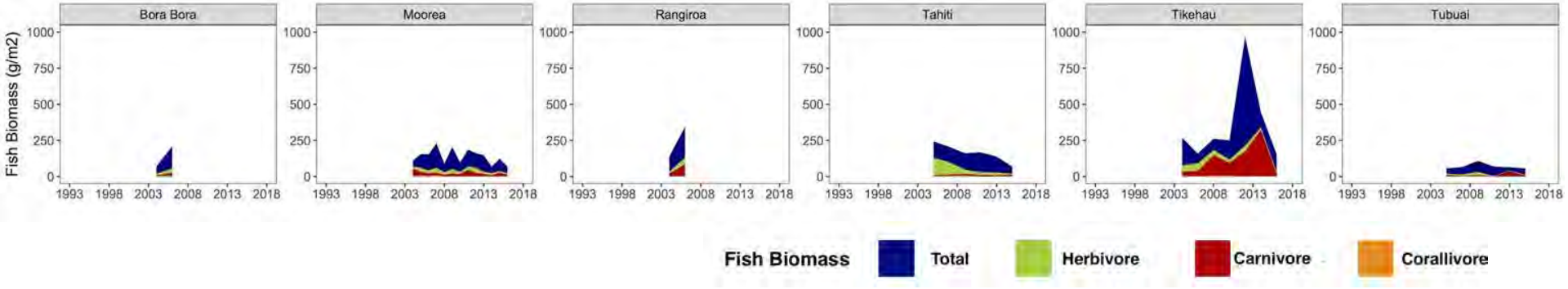


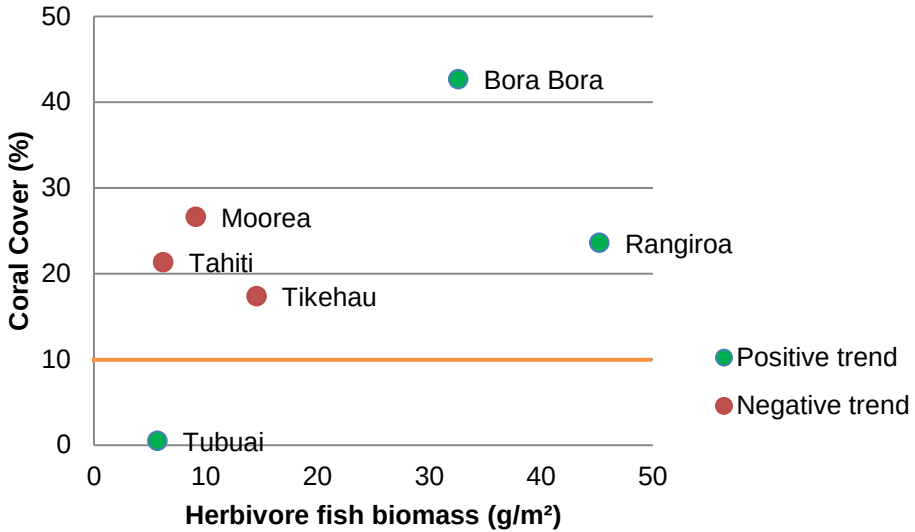
Changes in structural complexity





Change in herbivorous fish





Local knowledge

- Perceived state of the reefs
- Changes in reef-related activities (coping mechanisms)
- Perceived threats
- Proposed solutions

Local knowledge : ecological change and coping strategies

Island	Tubuai			Rangiroa			Rangiroa			Tikehau			Tikehau			Moorea			Moorea		
Number of surveys	6			8			2			5			1			4			3		
Number of people	9			10			2			6			2			8			3		
Activity	fishing			fishing			diving			fishing			diving			fishing			diving		
Change	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0
Corals	67	0	33	38	38	25	100	0	0	80	20	0	100	0	0	75	25	0	0	100	0
Fish	83	0	17	75	0	25	50	0	50	100	0	0	100	0	0	75	25	0	0	67	33
Invertebrates	67	0	33	50	0	50	0	0	100	40	0	60	0	0	100	75	0	25	0	0	100
Algae	0	50	50	0	50	50	0	50	50	0	60	40	0	0	100	25	50	25	67	33	0

- Fishers coping strategies
  - Create organizations, fish less, individual fishing, change gear, change boats, change fishing spots regularly, fish further from home, switch to agriculture, only fish to fill demand, find new export markets, fish middle size classes, move to city, kill taramea starfish
- Divers coping strategies
  - Change diving spots, feeding, kill taramea starfish

Local knowledge : perceived threats

Island	Tubuai			Rangiroa			Rangiroa			Tikehau			Tikehau			Moorea			Moorea		
Number of surveys	6			8			2			5			1			4			3		
Number of people	9			10			2			6			2			8			3		
Activity	fishing			fishing			diving			fishing			diving			fishing			diving		
Threats	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0
Sea surface temperature	0	0	100	63	0	38	100	0	0	40	0	60	100	0	0	75	0	25	100	0	0
Ocean acidification	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
Sea level rise	0	0	100	25	0	75	0	0	100	40	0	60	0	0	100	25	0	75	0	0	100
Tides	17	0	83	25	0	75	0	0	100	40	0	60	0	0	100	25	0	75	0	0	100
Winds, waves and currents	17	0	83	75	0	25	100	0	0	40	20	40	0	0	100	25	50	25	33	33	33
Cyclones	50	0	50	63	0	38	100	0	0	80	0	20	0	0	100	50	0	50	67	0	33
Marine pollution	0	0	100	38	0	63	50	0	50	0	0	100	100	0	0	50	0	50	0	0	100
Plastics	0	0	100	25	0	75	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
Agriculture pollution	67	0	33	0	0	100	0	0	100	0	0	100	0	0	100	50	0	50	0	0	100
Coastal development	0	0	100	13	0	88	0	0	100	0	0	100	0	0	100	75	25	0	33	0	67
Sedimentation and freshwater	0	0	100	0	0	100	0	0	100	0	0	100	100	0	0	75	0	25	0	0	100
Physical damage	33	17	50	50	0	50	0	0	100	0	0	100	0	0	100	50	0	50	0	0	100
Fishing techniques	83	0	17	50	0	50	50	0	50	0	0	100	100	0	0	100	0	0	0	0	100
Overfishing	67	0	33	75	0	25	50	0	50	60	0	40	100	0	0	100	0	0	67	0	33
Algae	0	0	100	63	0	38	50	0	50	80	0	20	0	0	100	75	0	25	33	0	67
Invasive species	0	0	100	38	0	63	0	0	100	40	0	60	0	0	100	0	0	100	0	0	100
Crown of thorns starfish	50	0	50	13	0	88	50	0	50	40	0	60	0	0	100	50	25	25	33	0	67
Tourism (surface)	0	0	100	0	0	100	50	0	50	0	0	100	0	0	100	50	0	50	67	0	33
tourism (diving)	0	0	100	50	0	50	50	0	50	20	0	80	100	0	0	25	0	75	33	0	67
Fish farms	0	0	100	50	0	50	0	0	100	20	0	80	0	0	100	0	0	100	0	0	100
Human behavior	17	0	83	38	0	63	0	0	100	0	0	100	100	0	0	50	0	50	33	0	67
Research	0	0	100	13	25	63	0	0	100	20	0	80	0	100	0	50	25	25	0	0	100
Sunscreen	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	25	0	75	0	0	100
Sharks	17	0	83	13	0	88	0	0	100	40	0	60	0	100	0	50	0	50	0	0	100
Ciguatera	67	0	33	25	0	75	0	50	50	20	0	80	0	0	100	25	0	75	0	0	100

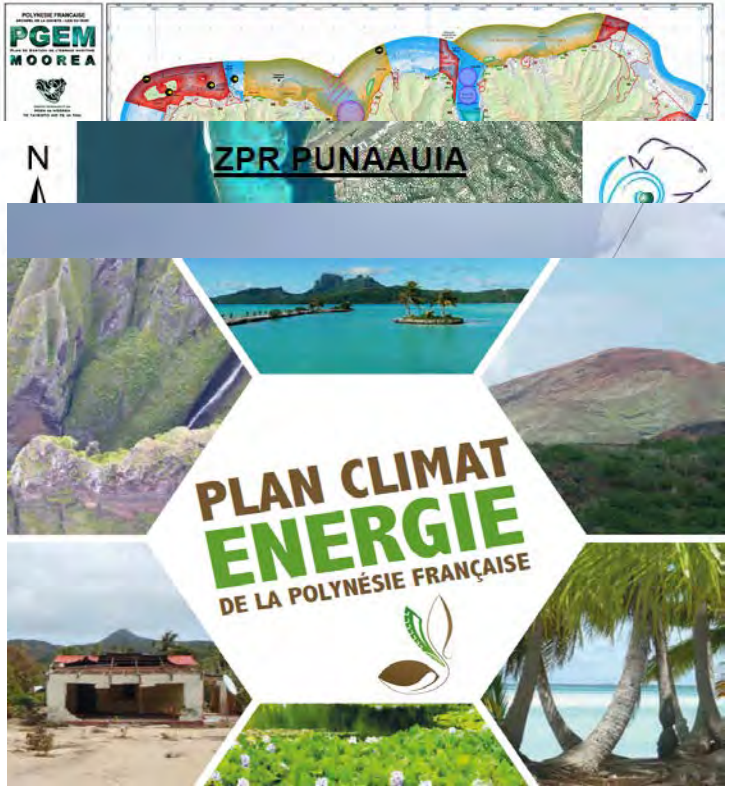
Local knowledge : proposed solutions

- Fishers proposed solutions
  - Natural variability / act of God so nothing to do, respect nature and people, respect between fishers and divers, respect between young and old fishers
  - Enforce existing protection zones, reduce litter, create *Rahui*, forbid some fishing techniques, forbid diving, stop feeding, fix pollution from infrastructure and agriculture, mooring zones
  - less capitalism, increase tourism, diversify economy, build seawalls, develop aquaculture, increase price of coprah, use algae for fertilizers

- Divers proposed solutions
  - Change behavior of fishers, change behavior of tourist operators
  - Create MPAs, create mooring zones

Climate adaptation : recommendations for State level decision-makers

- Climate-proofing existing policies
  - Marine spatial planning (PGEM, Biosphere reserve)
  - Fishing regulations (ZPR, Rahui)
  - Land-use (PGA, agriculture)
  - Economic development (tourism, infrastructure)
  - Health and safety (ciguatera, extreme weather events)
  - Biodiversity (Shark sanctuary, restoration)
- Adaptation planning
  - Climate plan (PCE)
  - Awareness raising for decision makers and managers



Future work

- Test how much resilience indicators selected by experts influence observed recovery of coral reefs
- Finalize socio-economic dependence and adaptive capacities indicators
- Test for robustness/sensitivity of indicators

- Integrate ecological monitoring data with local knowledge

- Propose decision framework to prioritize action
- Interact with Decision-makers to fit our results to their needs

- Expend analysis for Moorea where data at finer scale is available

Merci!

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