Climate Change Vulnerability Assessment (CCVA) Toolkit

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- CCVA: inform management priorities for biodiversity conservation and climate change adaptation strategies

WIO CCVA toolkit will:

- provide guidelines and a methodology for consistent CCV assessment in the WIO
- provide climate data that can be used for consistent CCV assessments in WIO
- carry out CCV assessment for key critical habitats

CCVA Outline

- Climate Change: Regional Context
  (temperature, rainfall, SLR)

- A review of vulnerability frameworks
  -Integrated vulnerability frameworks

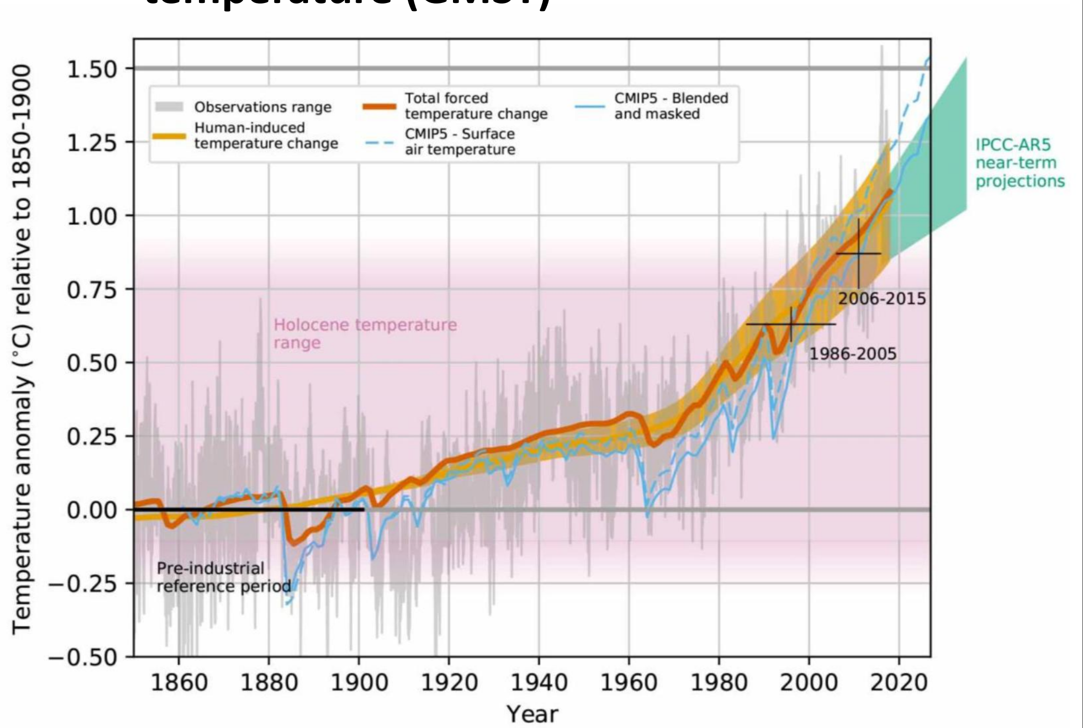
- CCV assessments
  - Coral Reefs
  - Seagrass
  - Mangroves

- Envisaged outputs: Climate Change assessments, CCVA guidelines & methods, datasets, CCVA for key ecosystems

Climate Change: global context

- approximately 1°C (±0.2°C) above pre-industrial levels in 2017, increasing at 0.2°C (±0.1°C) per decade

Evolution of global mean surface temperature (GMST)



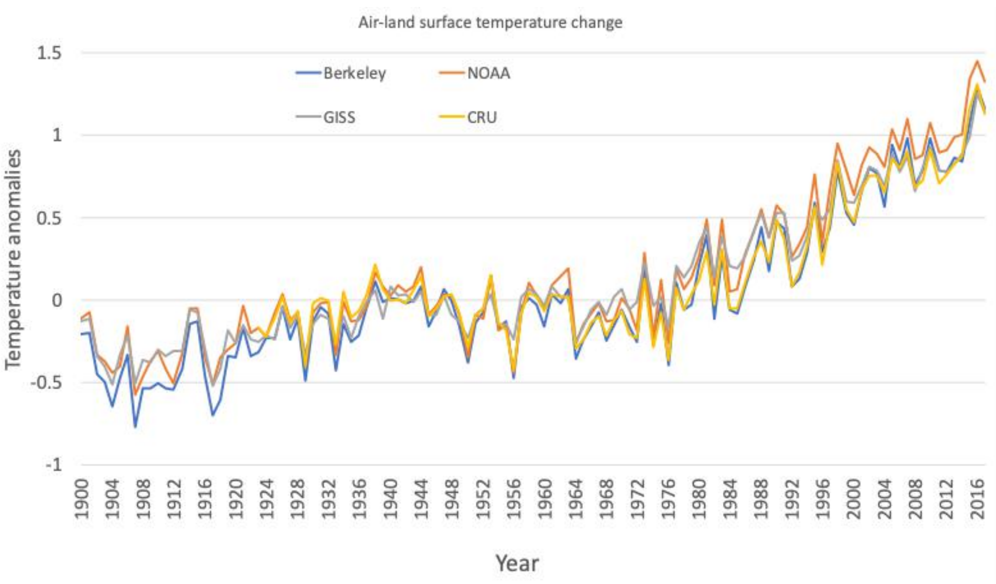
- Spatial variability in warming, average warming over land higher than over the ocean

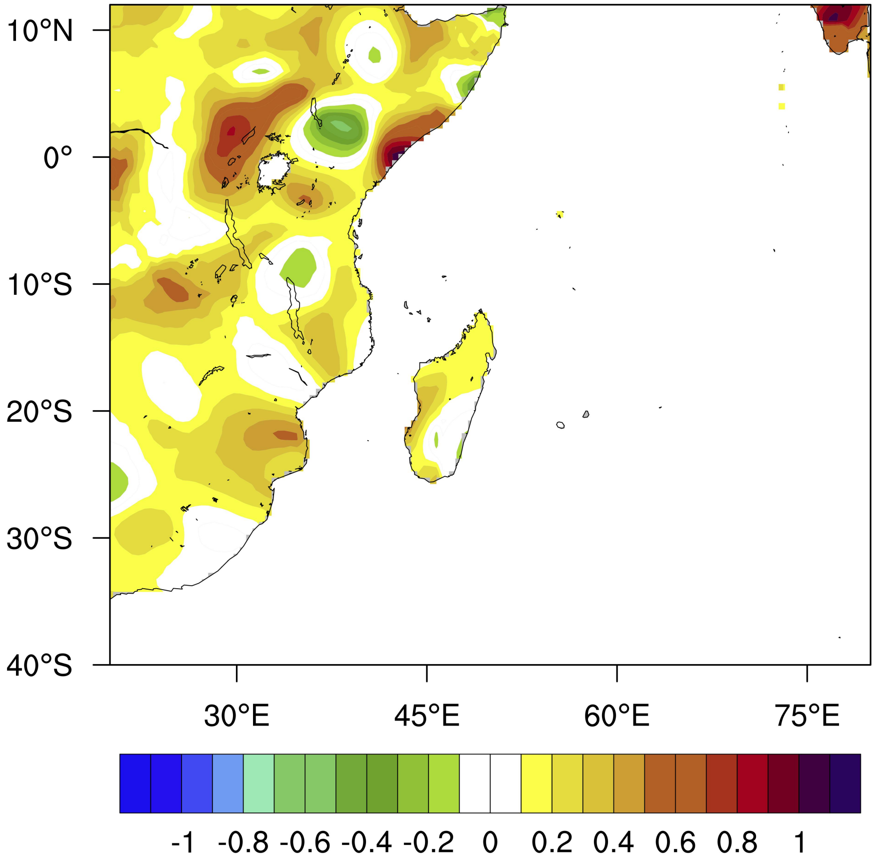
- Past emissions alone are *unlikely* to raise global-mean temperature to 1.5°C; past emissions do commit to other changes, such as further sea level rise

Source IPCC AR5 report, 2018

Climate Change: regional context

- Land-surface air temperature

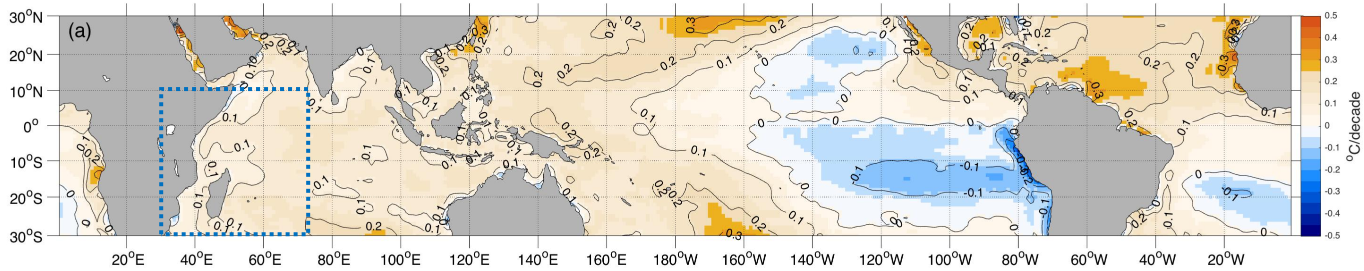


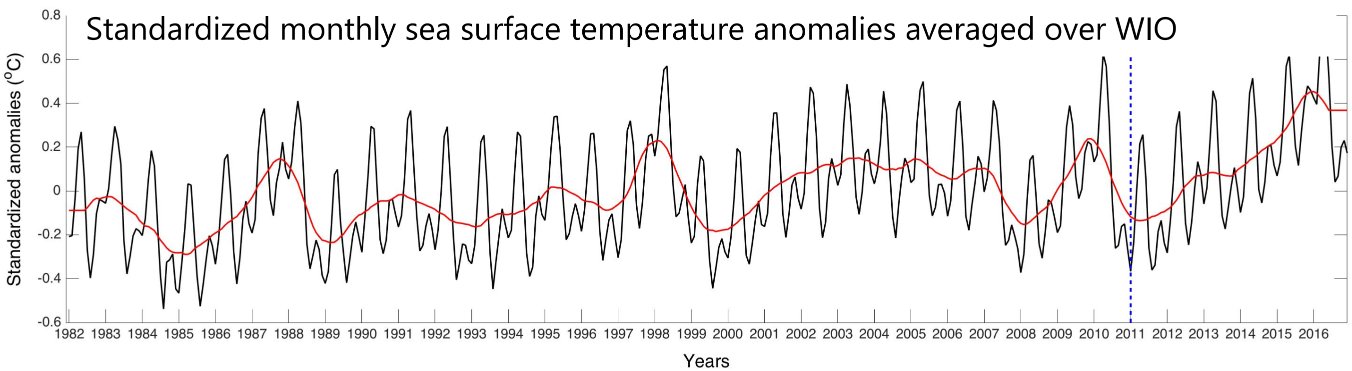


- Earths average land-surface air temperature has increased by about 0.6°C since 1980 relative to the period 1961 to 1990

Climate Change: regional context

Sea surface temperature: 1981-2016





SST projections averaged over the Exclusive Economic Zones

EEZ	SST trend (°C/decade)	SST trend category
Madagascar	0.20	fast warming
Kenya	0.19	Moderate warming
Comoros	0.11	Moderate warming
Mayotte	0.11	Moderate warming
Mauritius	0.13	Moderate warming
Chagos	0.14	moderate warming
Somalia	0.07	Slow warming
Tanzania	0.09	Slow warming
Mozambique	0.05	Slow warming
South Africa	0.08	Slow warming
Seychelles	0.09	Slow warming
Reunion	0.10	Slow warming
Europa	0.08	Slow warming
Bassas da India	0.09	Slow warming
Juan de Nova Island	0.09	Slow warming

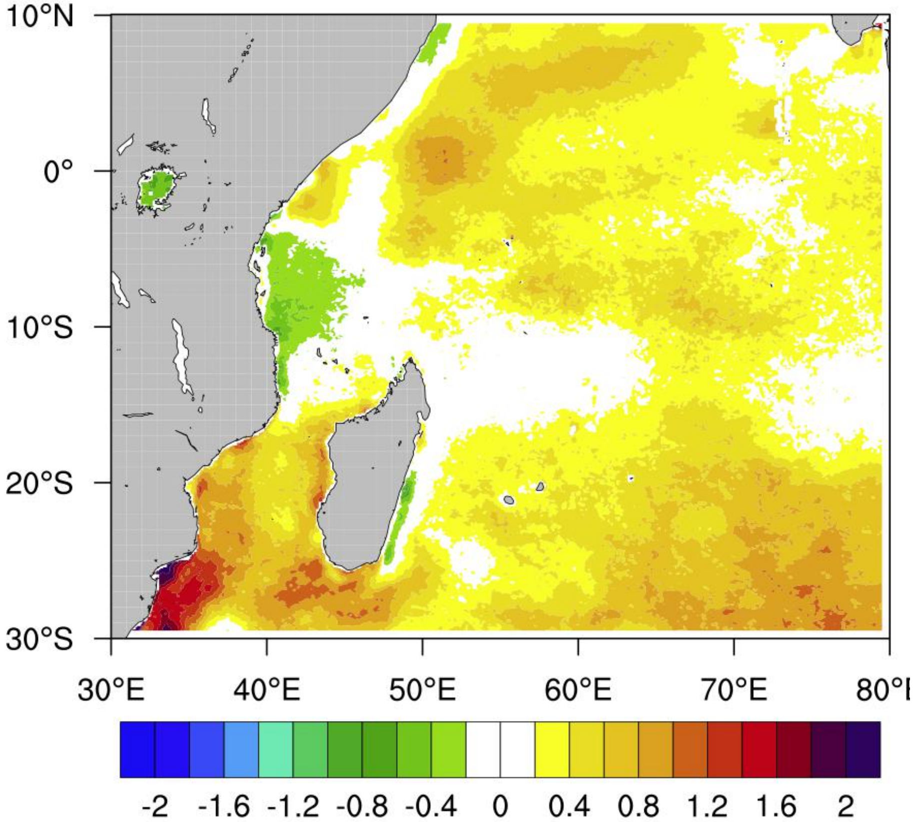
- The western Indian Ocean has warmed steadily since 1982 until present by 0.65°C (at 0.1°C/decade).
- 1998, 2010 and 2016 were the warmest years over the western Indian Ocean.
- From 2011 to 2016, SSTs have been increasing steadily resulting in longest bleaching thermal stress.

Long-term trends were calculated from annual SSTs for each EEZ.
All EEZ in the region showed warming trends in SST, with the highest rates of warming observed in Madagascar (0.20°C/decade).

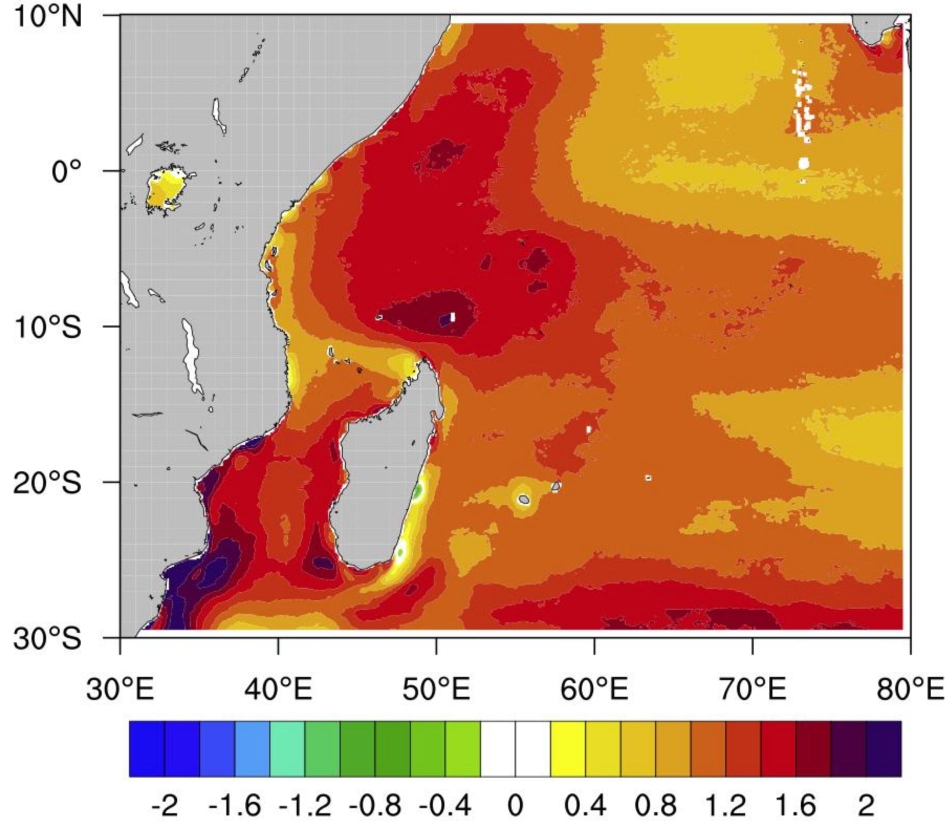
Climate Change: regional context

- Future SST projections (E. Scenario 4.5)

2050



2090



Climate Change: regional context

- Future SST projections

	Current SST anomalies	Projected SST anomalies					
		RCP4.5			RCP8.5		
EEZ	2017	Near-term (2019–2039)	Mid-term (2056)	Long-term (2070–2099)	Near-term (2010–2039)	Mid-term (2056)	Long-term (2070–2099)
Madagascar	1.08±0.39	0.66±0.63	1.73±0.63	2.22±0.67	0.70±0.63	2.52±0.66	4.17±1.20
Kenya	1.18±0.32	1.18±0.19	2.33±0.19	2.89±0.18	1.22±0.18	3.24±0.19	4.55±1.77
Comoros	0.64±0.05	0.34±0.09	0.90±0.09	1.15±0.10	0.35±0.10	1.30±0.10	2.20±0.11
Mayotte	0.55±0.04	0.26±0.11	0.82±0.11	1.07±0.11	0.28±0.10	1.22±0.11	2.12±0.11
Mauritius	0.17±0.19	0.63±0.12	1.15±0.13	1.37±0.15	0.63±0.12	1.51±0.16	2.37±0.19
Chagos	0.18±0.12	0.54±0.12	1.07±0.11	1.37±0.12	0.55±0.12	1.57±0.12	2.45±0.11
Somalia	0.48±0.36	0.74±0.50	1.32±0.50	1.61±0.49	0.74±0.49	1.77±0.50	2.66±0.76
Tanzania	0.66±0.16	0.34±0.11	0.90±0.12	1.16±0.13	0.37±0.12	1.33±0.13	2.16±0.60
Mozambique	0.43±0.19	0.73±0.33	1.26±0.32	1.54±0.33	0.74±0.34	1.68±0.34	2.30±1.26
South Africa	0.19±0.80	1.14±0.61	1.62±0.60	1.85±0.58	1.15±0.60	1.94±0.58	2.53±1.11
Seychelles	0.44±0.22	0.83±0.11	1.40±0.12	1.67±0.11	0.85±0.12	1.85±0.12	2.78±0.12
Reunion	0.54±0.20	0.85±0.15	1.94±0.15	2.35±0.15	0.87±0.14	2.64±0.15	4.35±0.16
Europa	0.43±0.11	0.65±0.05	1.14±0.05	1.48±0.05	0.67±0.06	1.64±0.06	2.57±0.06
Bassas da India	0.50±0.07	0.62±0.08	1.16±0.07	1.43±0.09	0.60±0.04	1.57±0.03	2.50±0.03
Juan de Nova Island	0.58±0.06	0.60±0.04	1.10±0.04	1.43±0.03	0.61±0.08	1.55±0.08	2.48±0.10

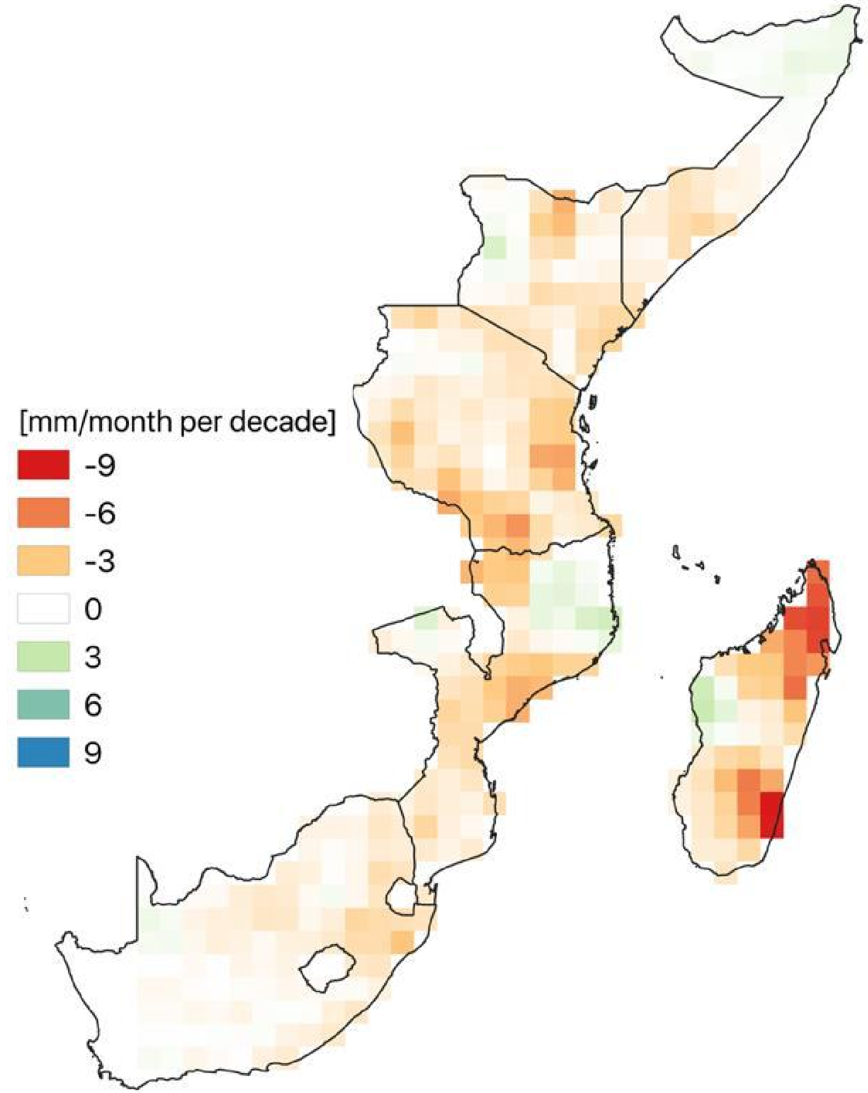
- Most coupled general circulation models (CGCMs) project a stronger SST warming in the western equatorial Indian Ocean than in the eastern equatorial Indian Ocean, reminiscent of the interannual Indian Ocean dipole (IOD) mode.
- WIO projected SSTs: 1°C to 4°C higher by end of the 21st century
- While basin wide changes are expected, it is critical to examine changes along continental margins which supply more than 75% of fish catch (IOC-UNESCO and UNEP, 2016)

Climate Change: regional context

- Precipitation

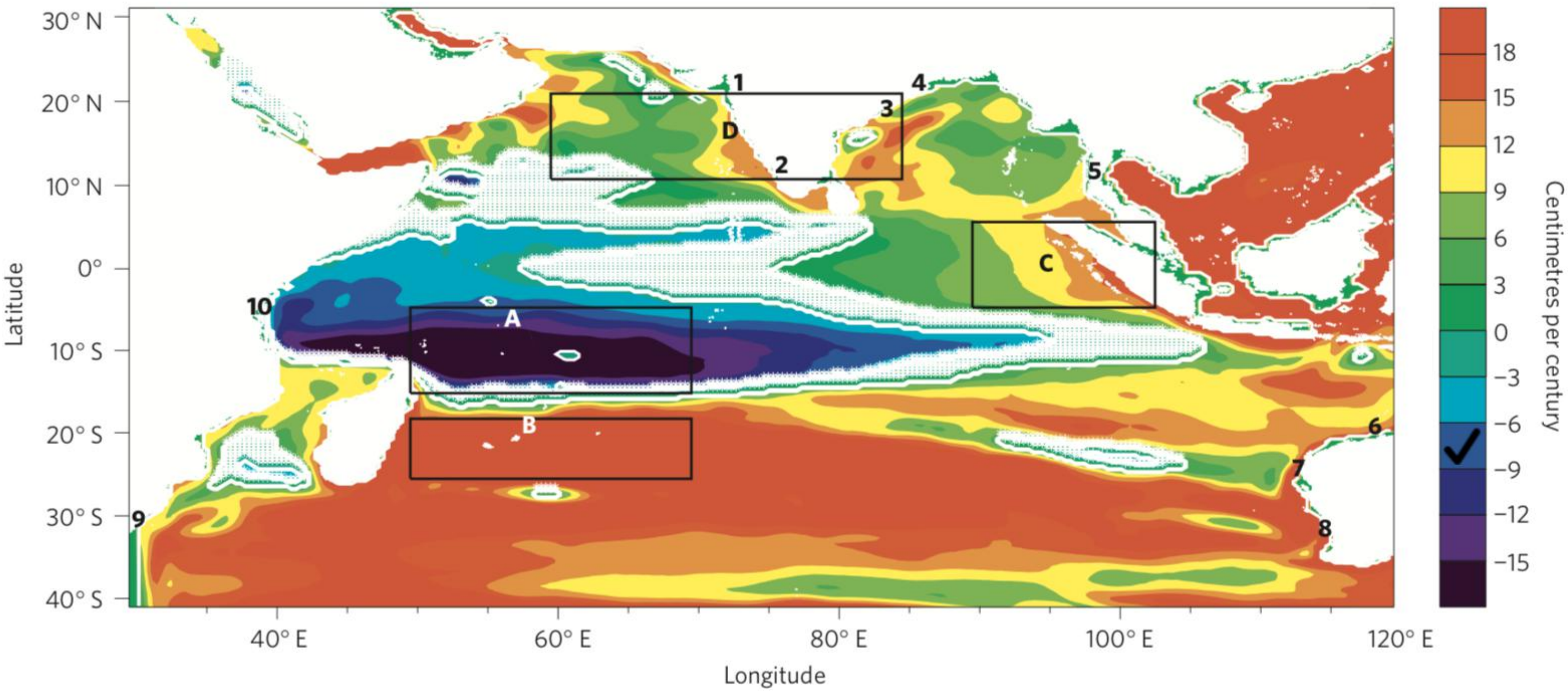
- Over the past 40 years, there has been a decreasing trend in long rains over East Africa which has led to widespread famine affecting over 10 million people during 2010–2011 (United Nations Office for the Coordination of Humanitarian Affairs 2011).

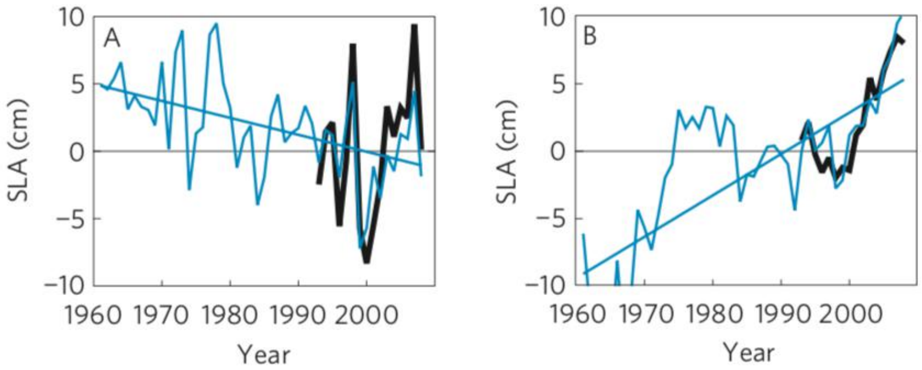
- Overall, rainfall in the region has decreased over the decades by around -1.5 mm/ per decade between 1960-2017, which implies that the climate is drier.



Climate Change: Sea level rise

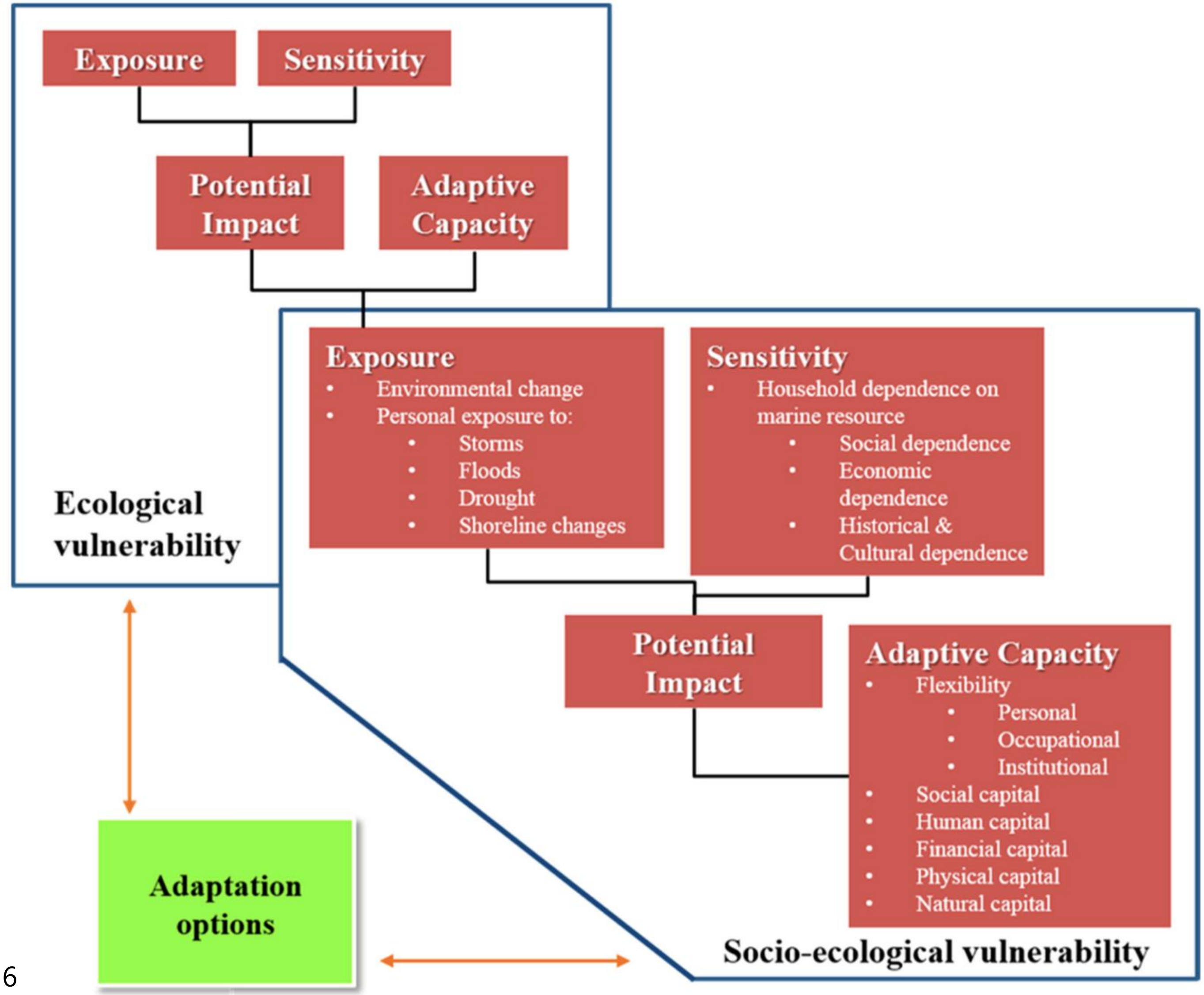
- Sea-level rise trend during 1961-2008





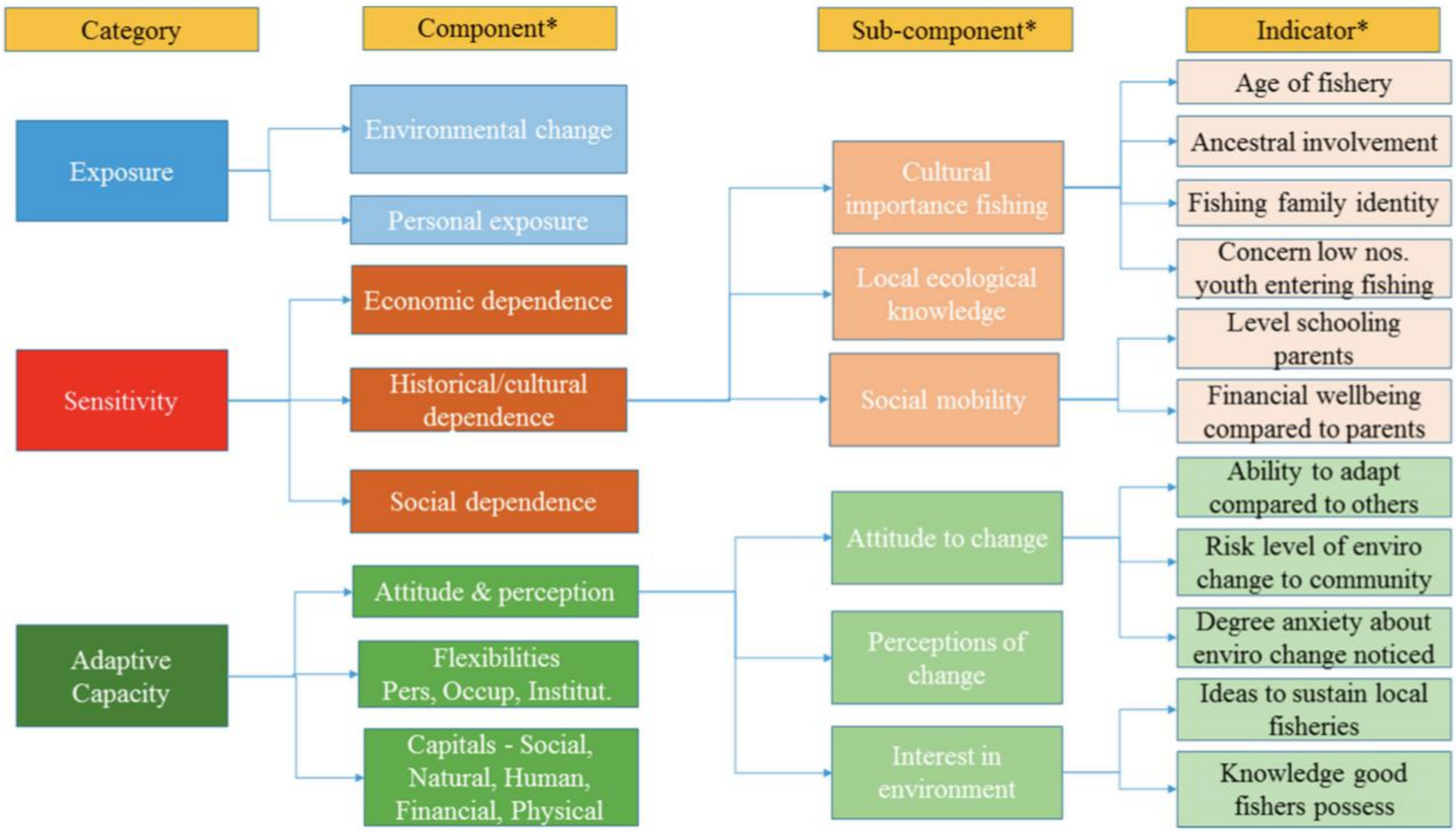
Han et al. 2015

Assessing coastal community vulnerability across scales: an integrated framework



Aswan et al. 2016

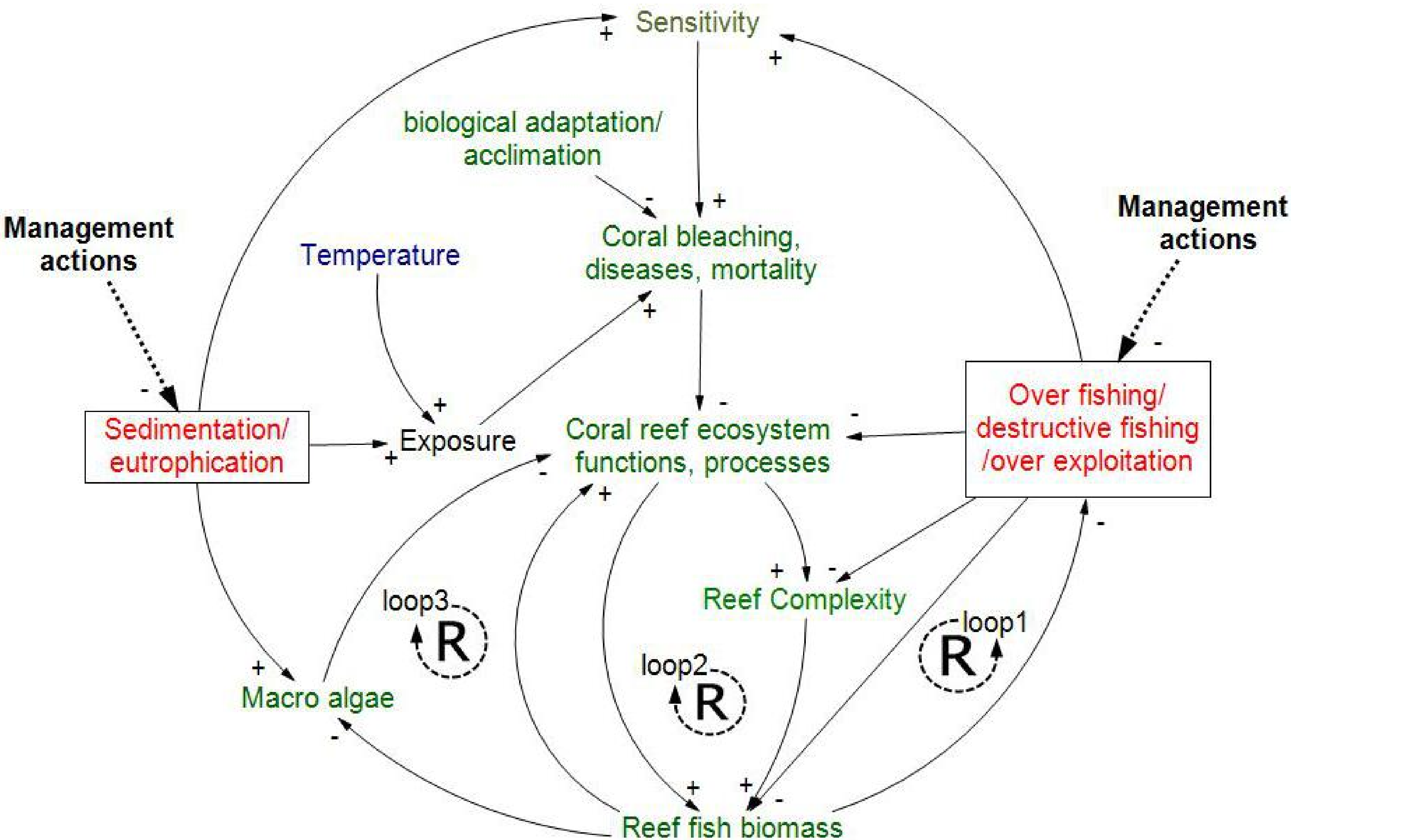
Socioecological vulnerability



coral reefs vulnerability to Climate Change

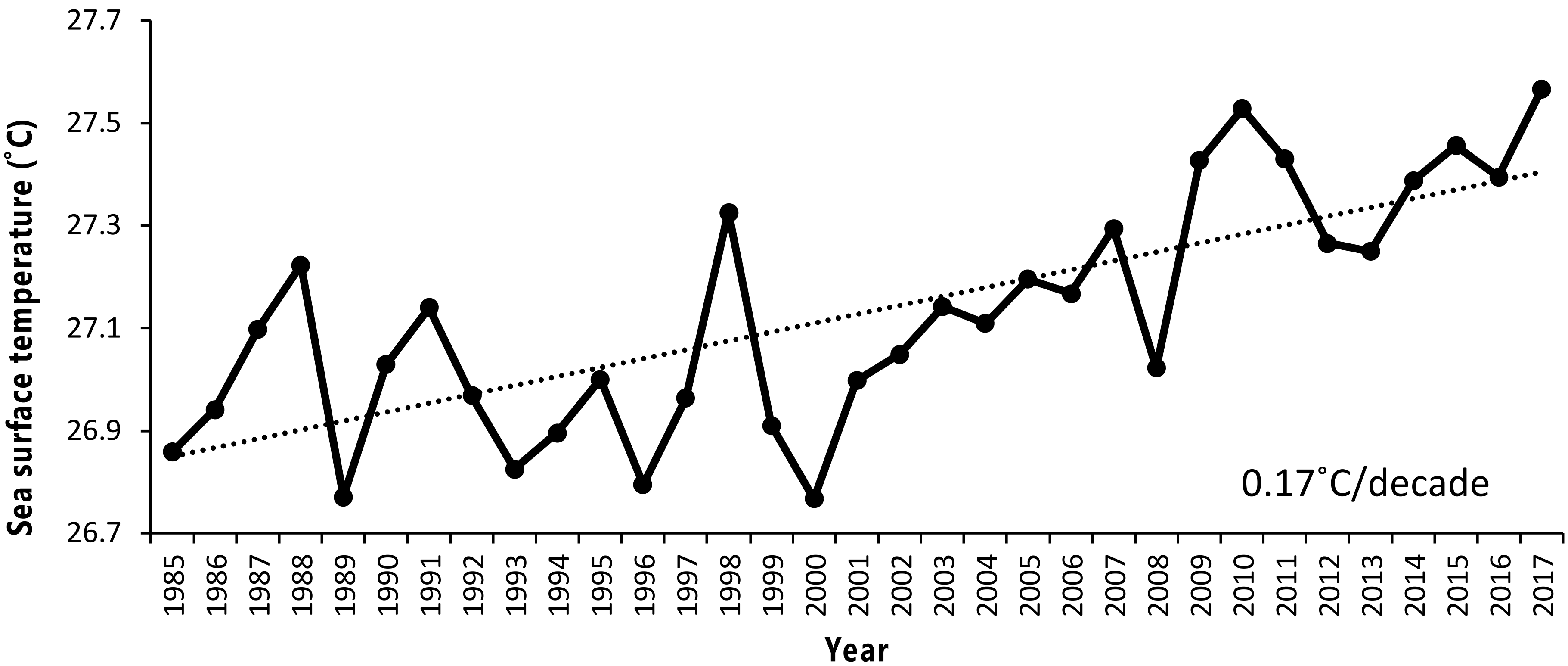
- Climate variability varies spatially in magnitude and frequency
- Corals have been impacted and are slow to adapt
- Need for supporting spatially adaptive management
- Local management is no longer sufficient to ensure the future of coral reefs. Protecting reefs requires complimentary national and global efforts to limit warming to 1.5°C

Coral reef biophysical and human coupled system



SST and Coral reefs

- While few systems are likely to benefit from climate change, coral reefs are particularly vulnerable.
- Mass coral bleaching events is occurring more frequently in the region causing serious damage to over 25 percent of the coral reefs



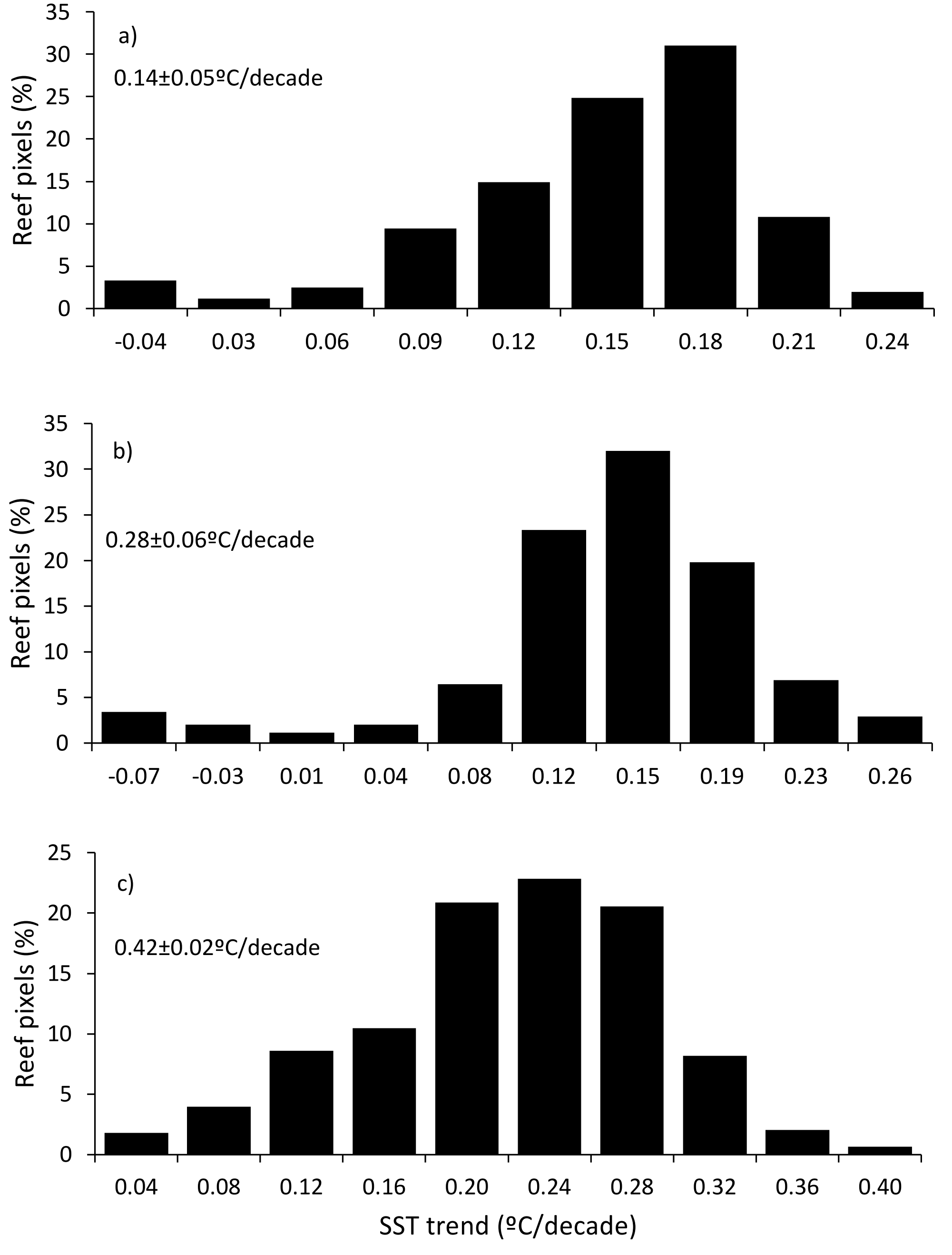
SST and Coral reefs

Histograms of thermal history metri
for reef locations (n = 2422) in the
WIO region for:

(a) Annual trend show reef SST warming at 0.14°C/decade.

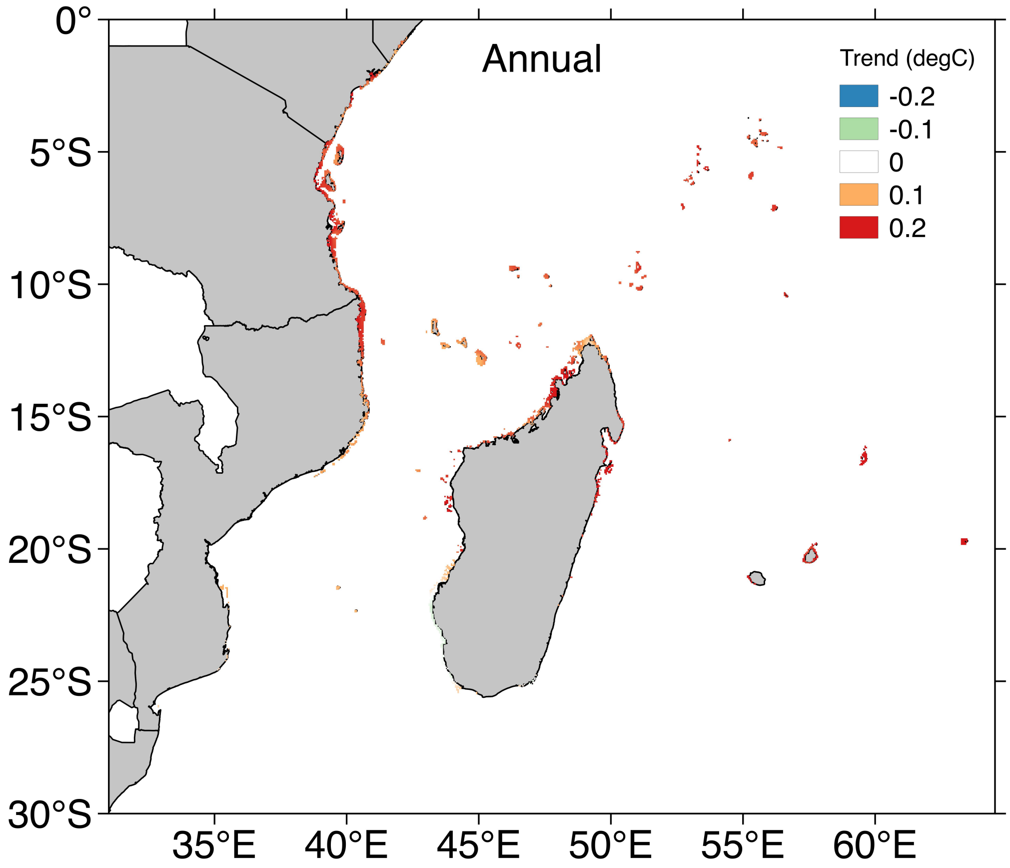
(b) Warm-season (Jan-May) SST shc warming at 0.28°C/decade.

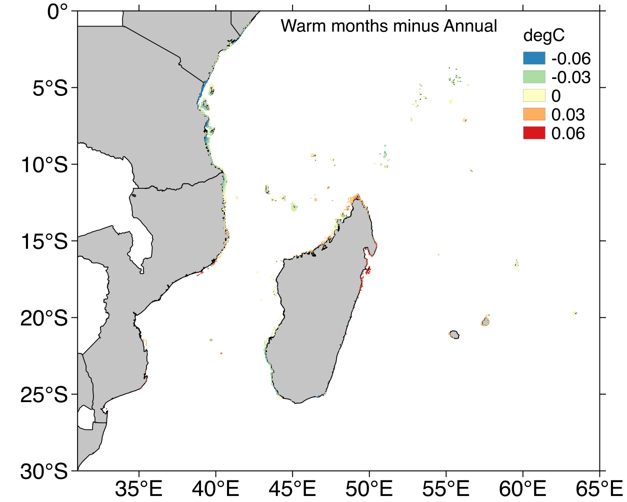
(c) Cool-season trends (June-Octob SST show accelerated warming a 0.42°C/decade.

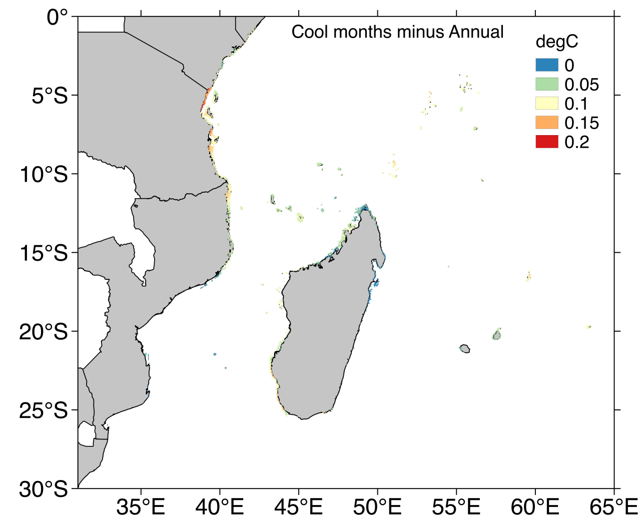


- It is evident that non bleaching months are warming faster compared to bleaching months and the annual mean

SST

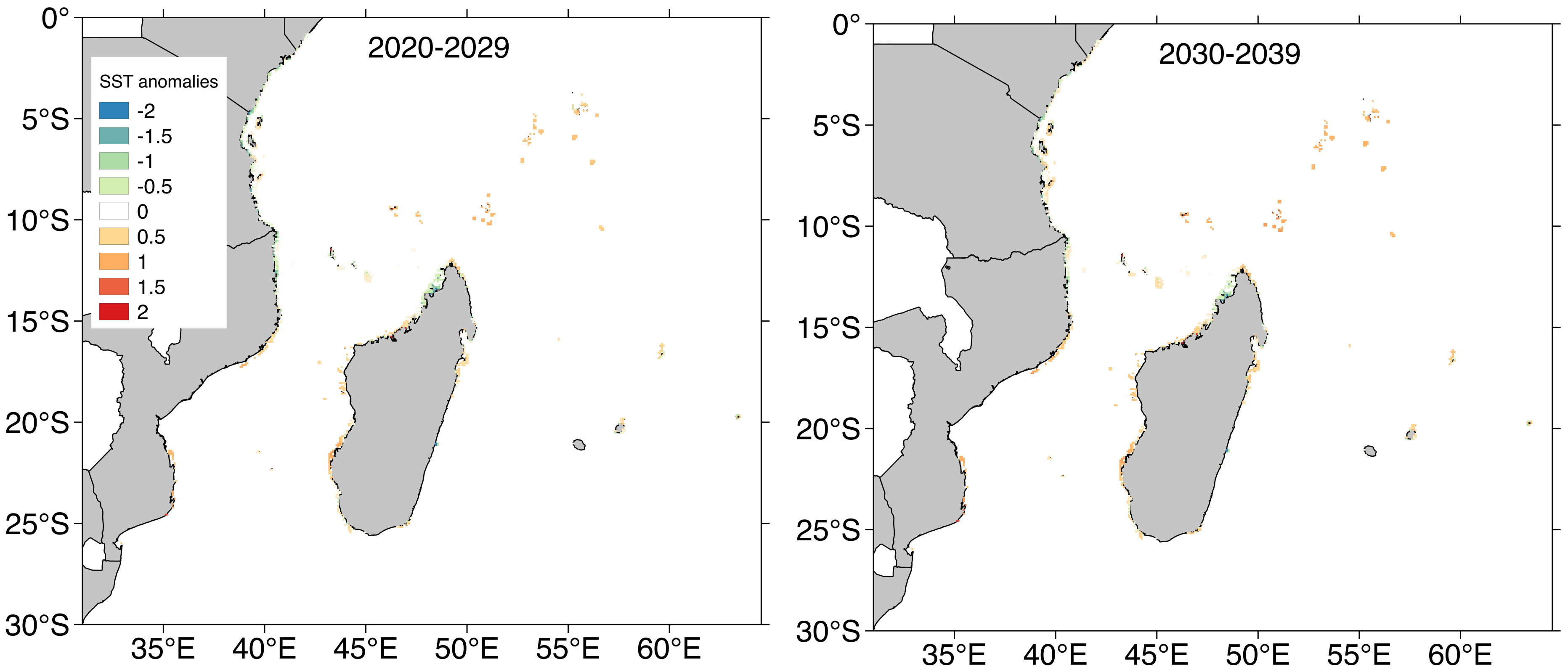






- non-bleaching months (June-Oct) are warming faster compared to the bleaching months (Jan-May) relative to the annual trend

- Local-scale projections of coral reef futures

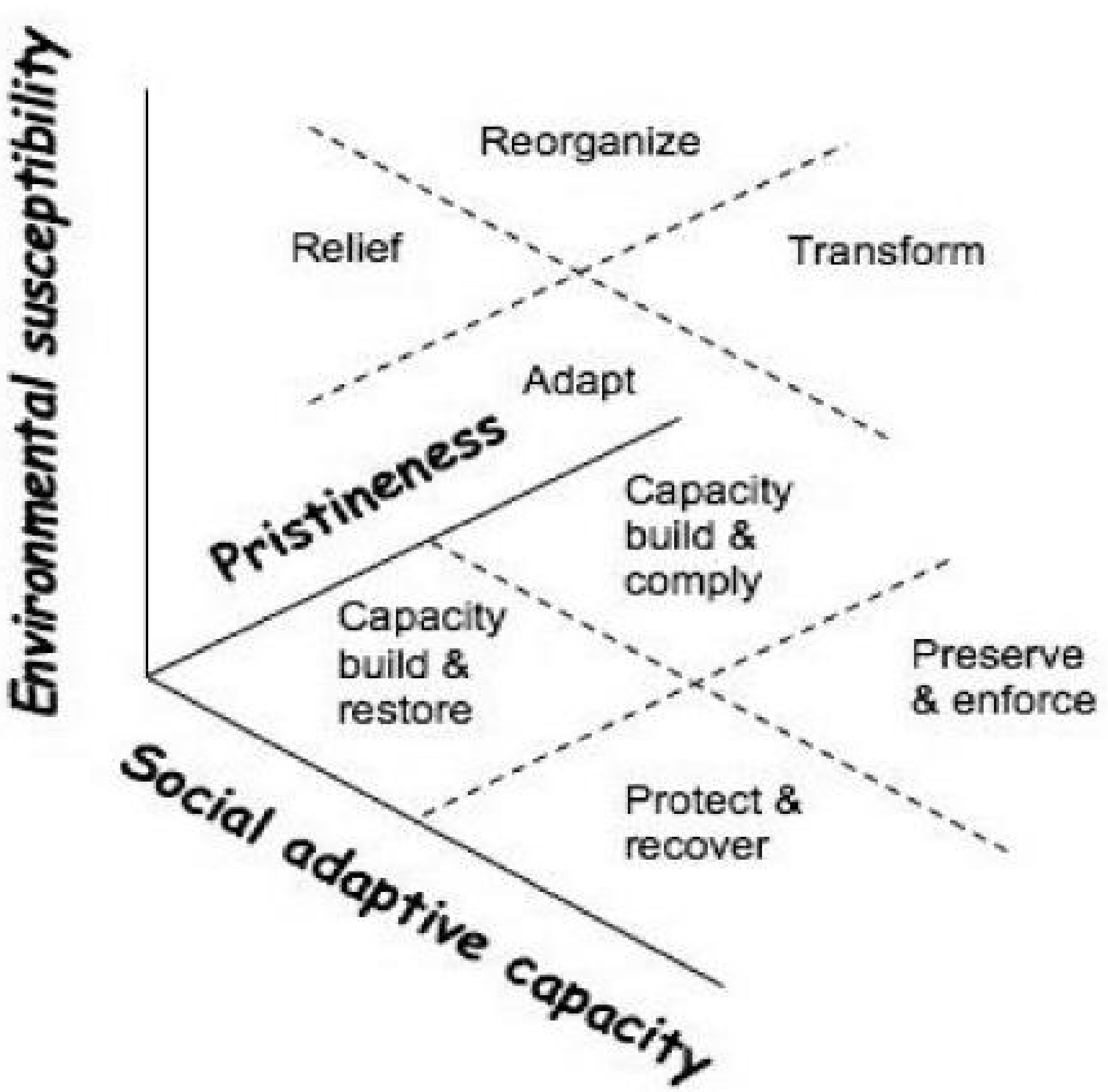


- RCP45 indicate that by 2039, most reefs in the region will be exposed to temperatures below the 1.5°C

- Onset of recurrent severe bleaching heat stress events under Representative Concentration Pathways (RCP) 8.5 and 4.5

		Future Severe Stress - RCP8.5		Future Severe Stress - RCP4.5	
Country	**Reefs**	a) Projected year of 2x/decade	b) Projected year of annual	a) Projected year of 2x/decade	b) Projected year of annual
Kenya	Malindi	2035	2044	2041	2051
	Watamu	2034	2043	2036	2055
	Kisite	2041	2049	2052	2074

Potential policy actions

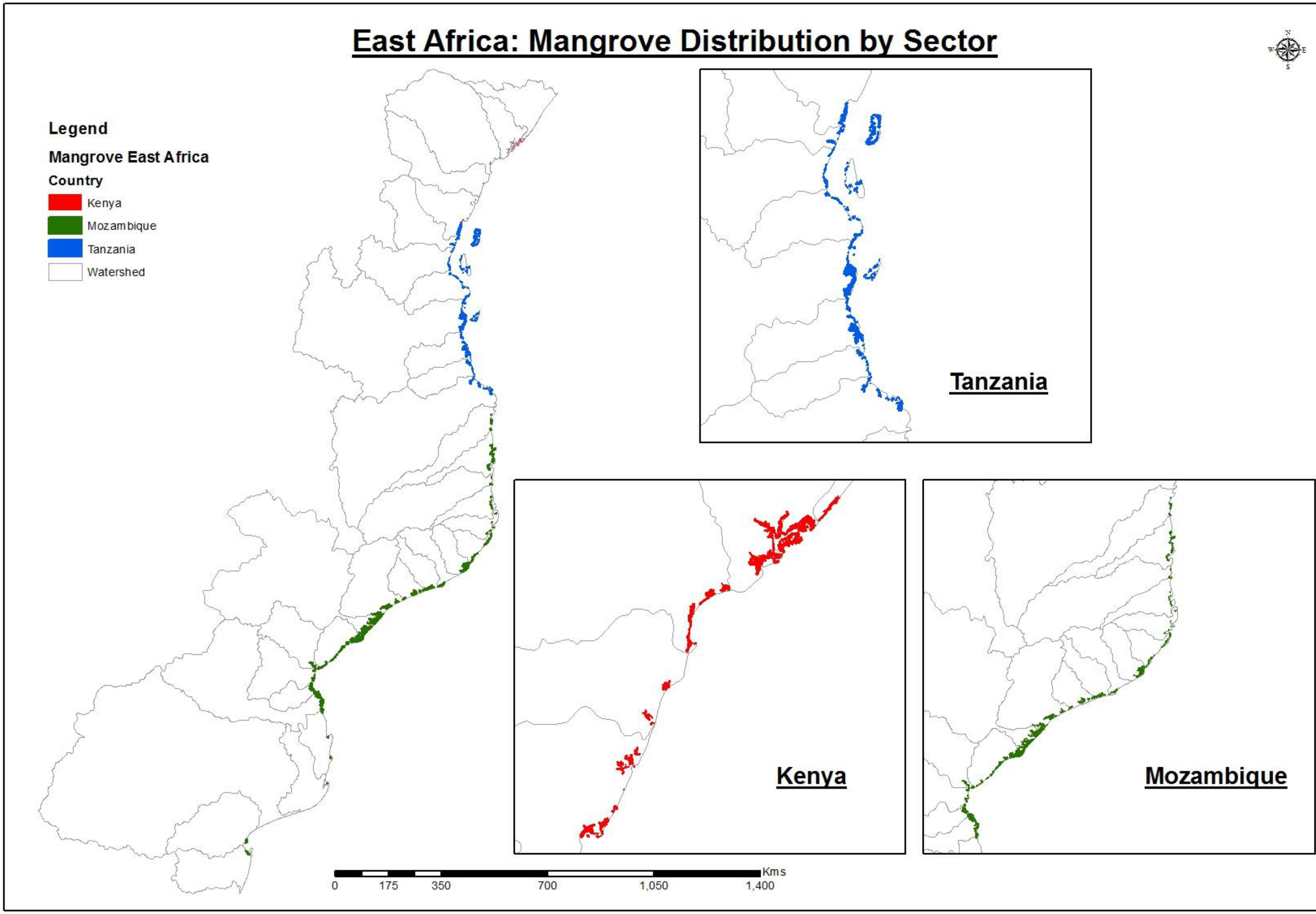


Regional Vulnerability Assessment of Mangroves to climate change and human pressures

J. Bosire, J. Maina, J. Kairo, S. Bandeira, S. Semesi, J. Rubens, M. Mwita, C. Macamo, H. Ralison, B. Kirui, C. Magori, L. Scott, S. Mittra

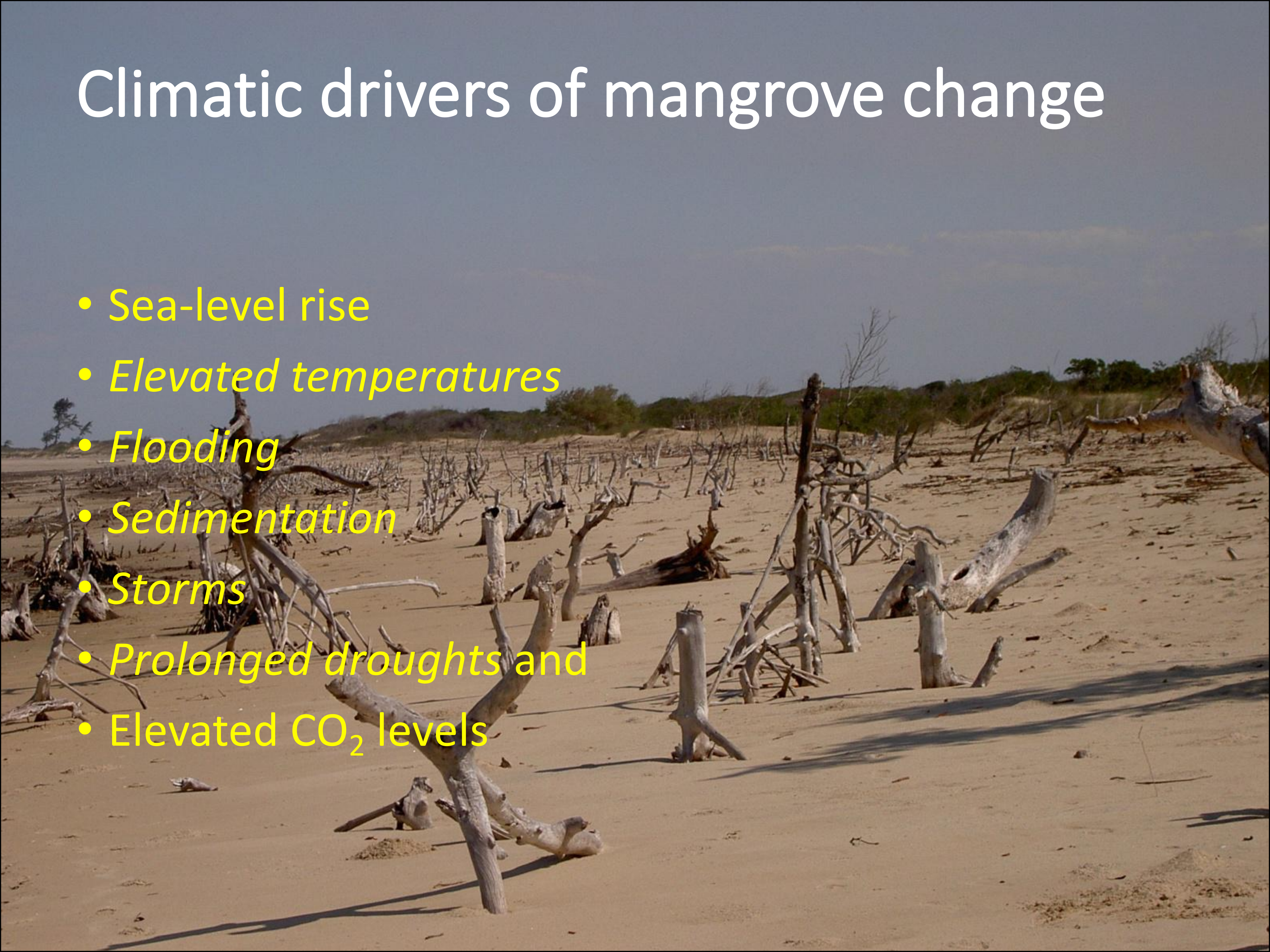
Vulnerability Assessments

- Spatial multi-criteria evaluation (SMCE)
- Expert input – sectors and variables


East Africa: Mangrove Distribution by Sector
N
W
E
S
Legend
Mangrove East Africa
Country
Kenya
Mozambique
Tanzania
Watershed
Tanzania
Kenya
Mozambique
0
175
350
700
1,050
1,400
Kms

Climatic drivers of mangrove change

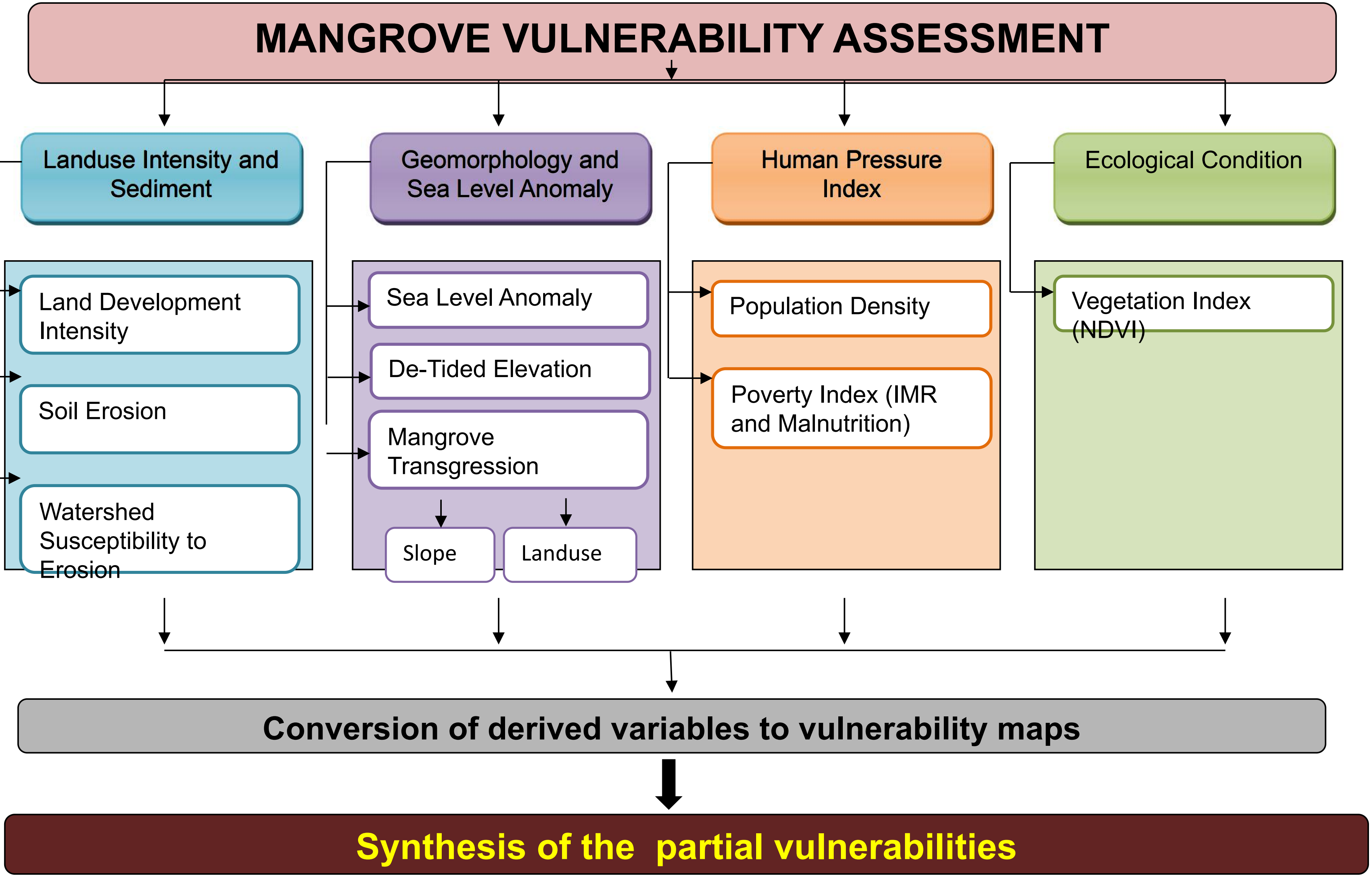
- Sea-level rise
- *Elevated temperatures*
- *Flooding*
- *Sedimentation*
- *Storms*
- *Prolonged droughts* and
- Elevated CO_2 levels



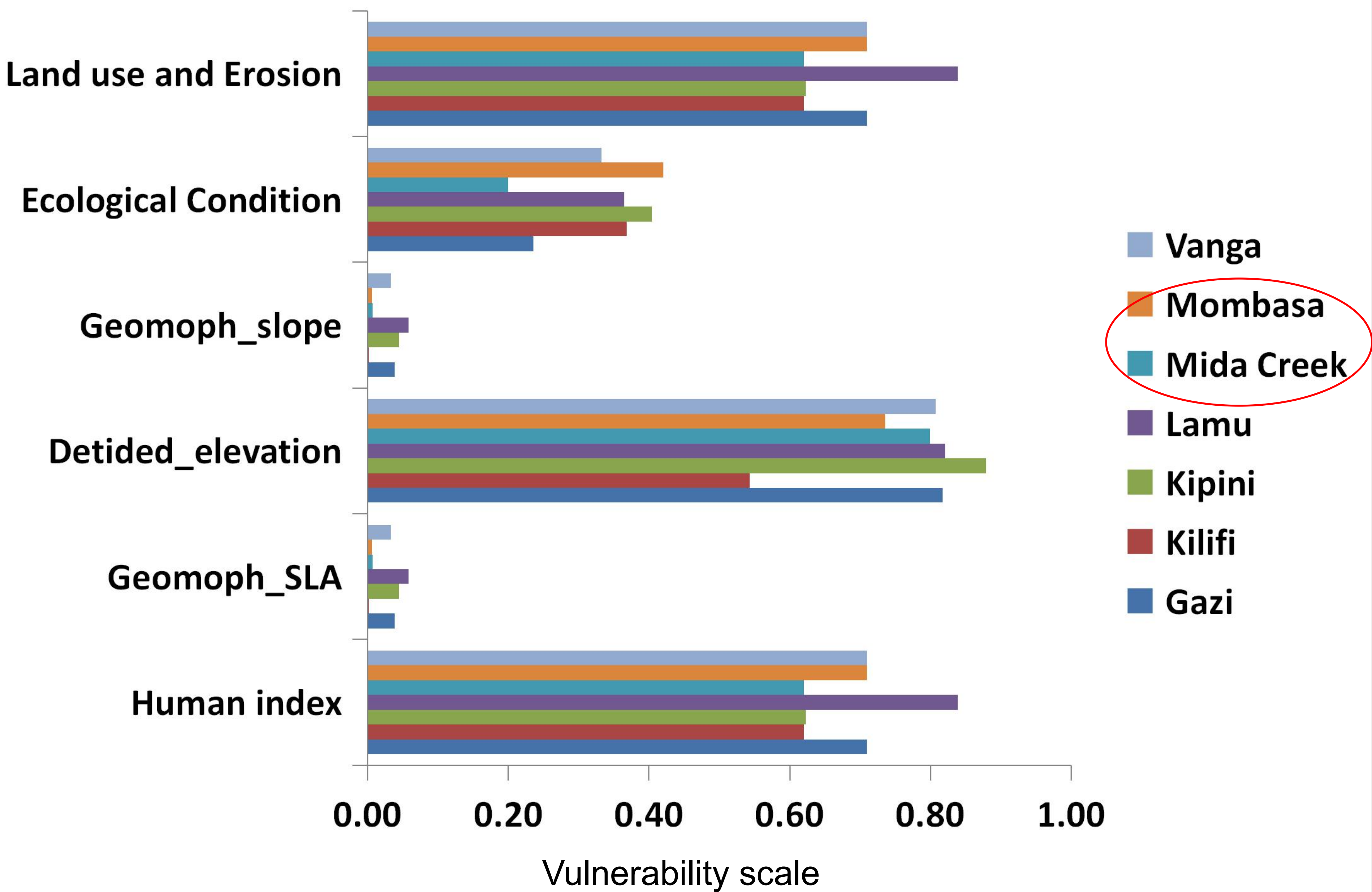
Variable roles in an ecosystem

- Reinforce
- Balance/reduce
- Synergistic and antagonistic

CONCEPTUAL FRAMEWORK



KENYA


Land use and Erosion
Ecological Condition
Geomoph_slope
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Geomoph_SLA
Human index
0.00
0.20
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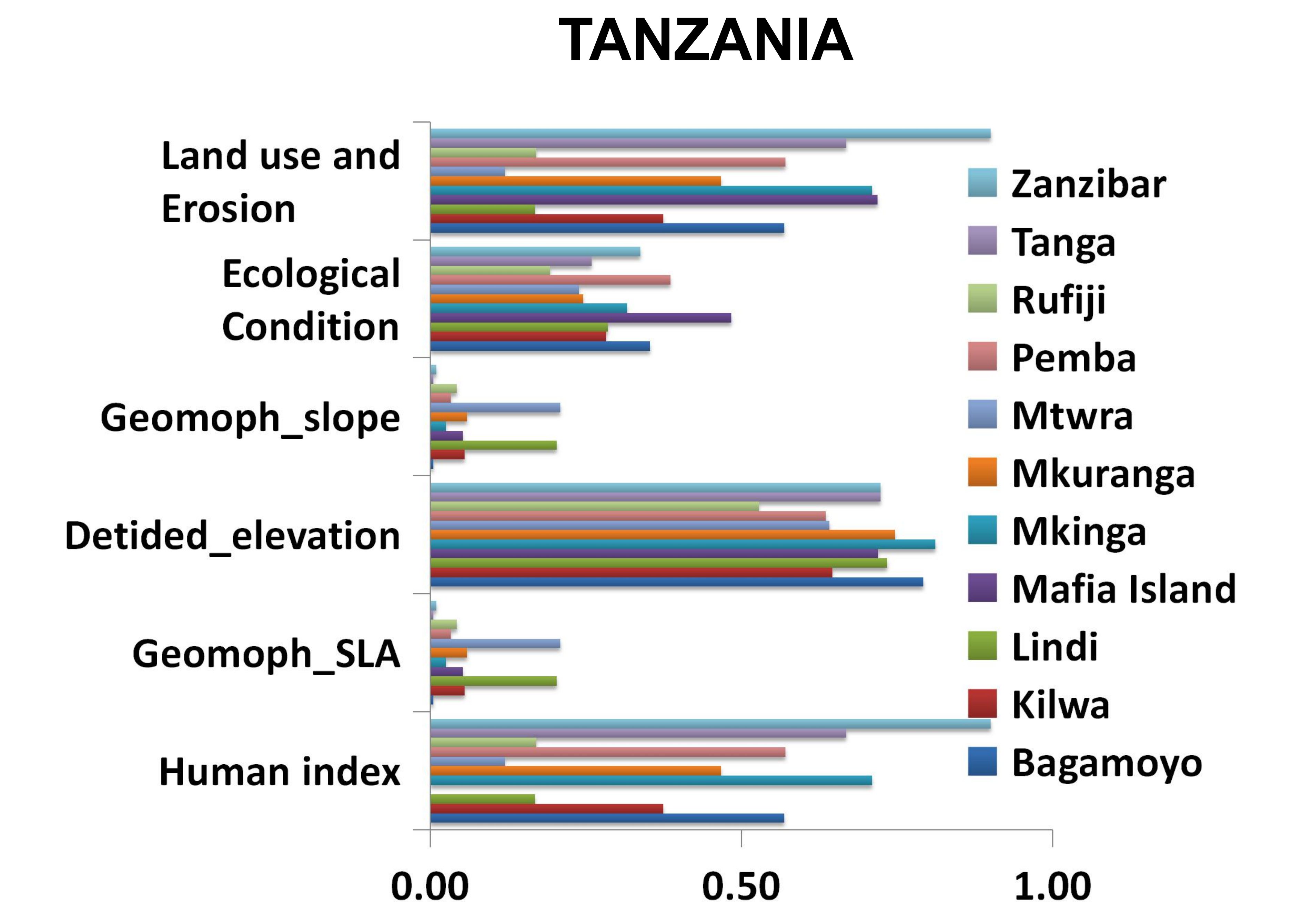
1.00
Vulnerability scale
Vanga
Mombasa
Mida Creek
Lamu
Kipini
Kilifi
Gazi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Land use and Erosion
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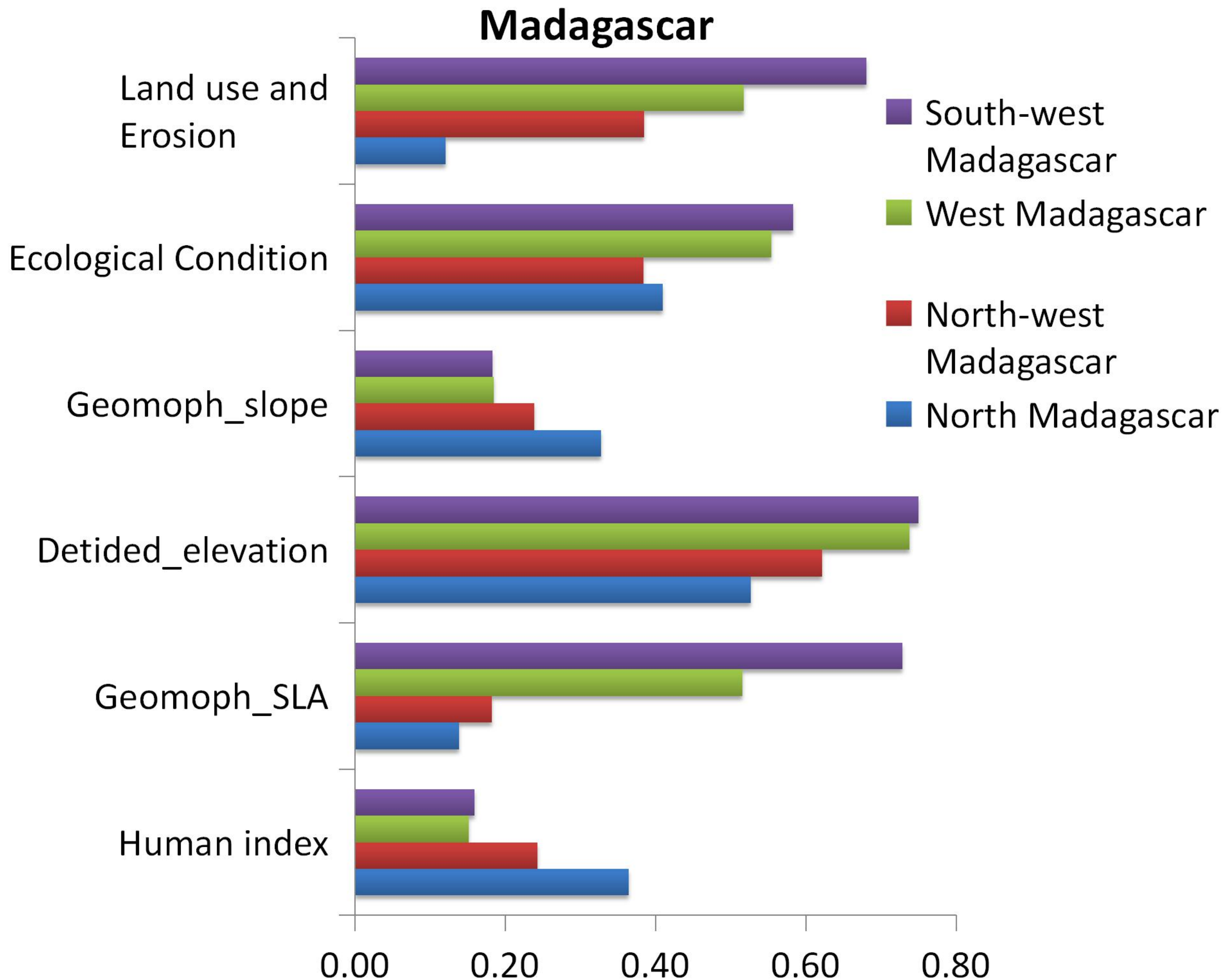
Rufiji
Pemba
Mtwra
Mkuranga
Mkinga
Mafia Island
Lindi
Kilwa
Bagamoyo


Madagascar
Land use and Erosion
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Human index
South-west Madagascar
West Madagascar
North-west Madagascar
North Madagascar
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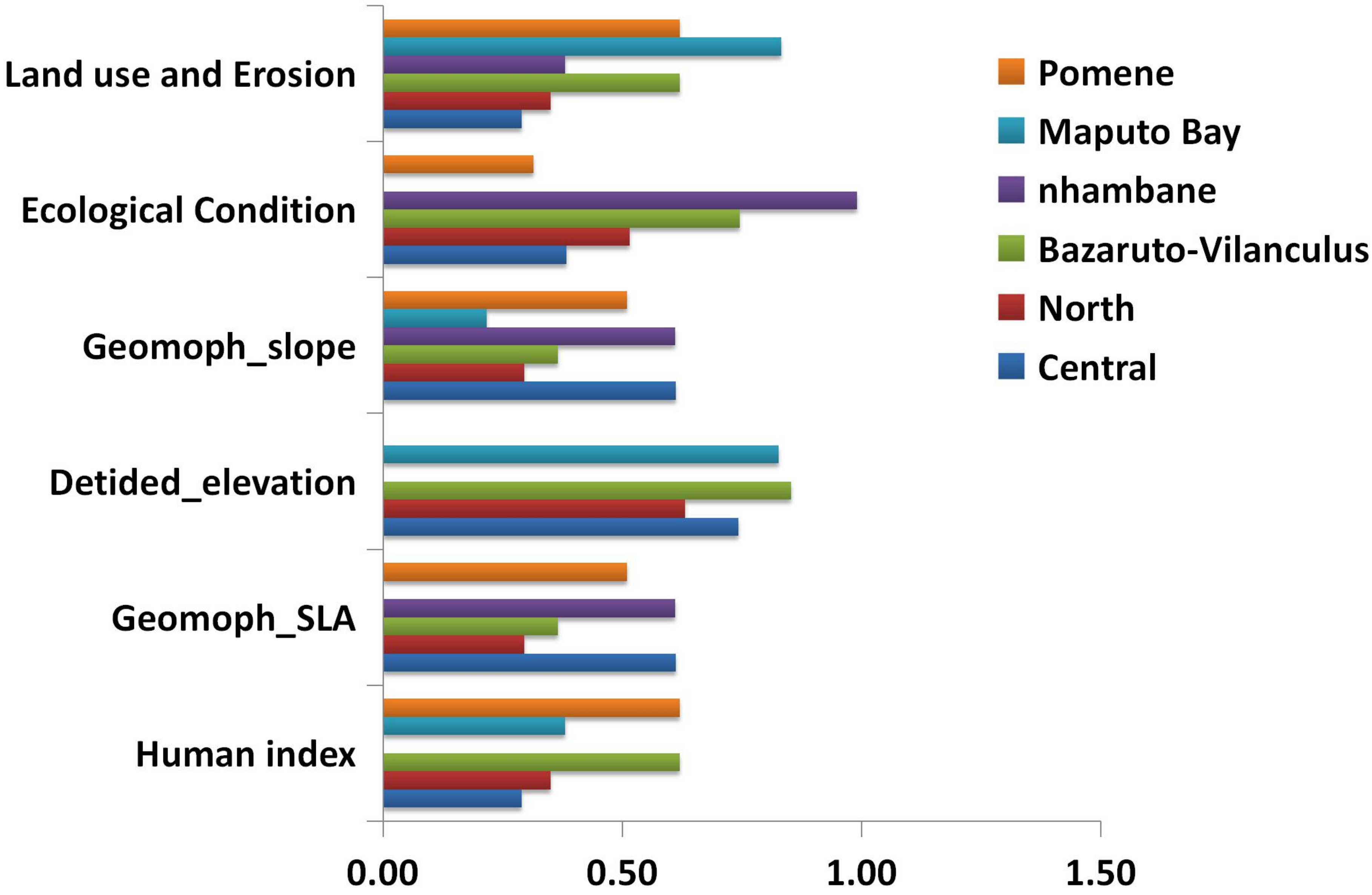
MOZAMBIQUE


Land use and Erosion
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Human index
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Pomene
Maputo Bay
nhambane
Bazaruto-Vilanculus
North
Central

Sea grass: distribution and vulnerability

Key Drivers	Seagrass (Present /Absent)	Vulnerability components

Key Drivers

- Relative Wave Exposure
- Rainfall
- Substrate
- Rivers (Present/Absent)
- SST
- Tides (High/Med/Low)
- Human pressure (Travel Time)
- Bathymetry (High/Med/low)
- Sea Level Anomaly

Seagrass (Present /Absent)

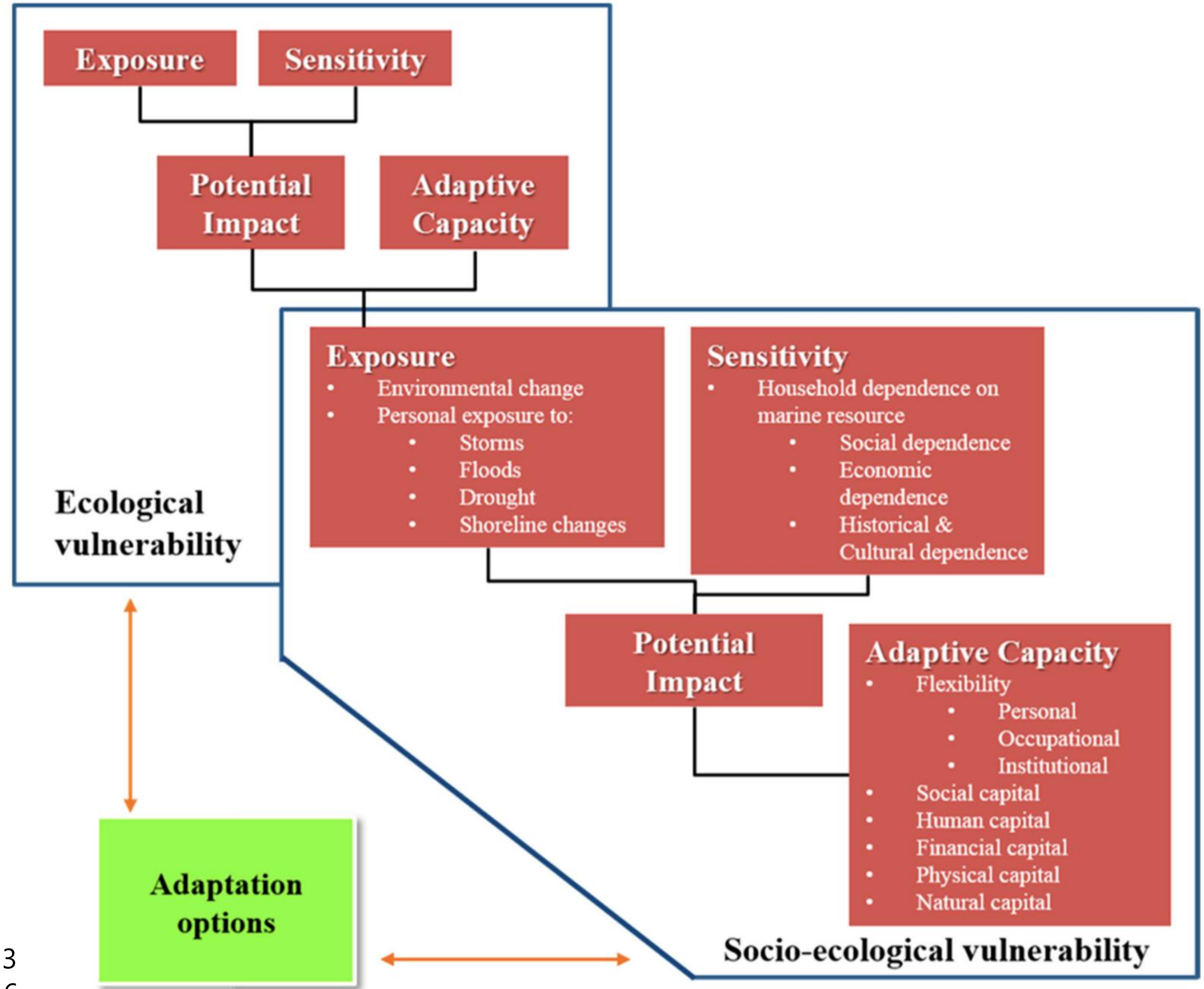
Vulnerability components

Exposure

Sensitivity

Adaptive capacity

Assessing coastal community vulnerability across scales: an integrated framework



Cinner et al 2013
Aswan et al. 2016

Thank you