Coastal vulnerability assessment, adaptation and mitigation opportunities in climate hotspots in Kerala, India

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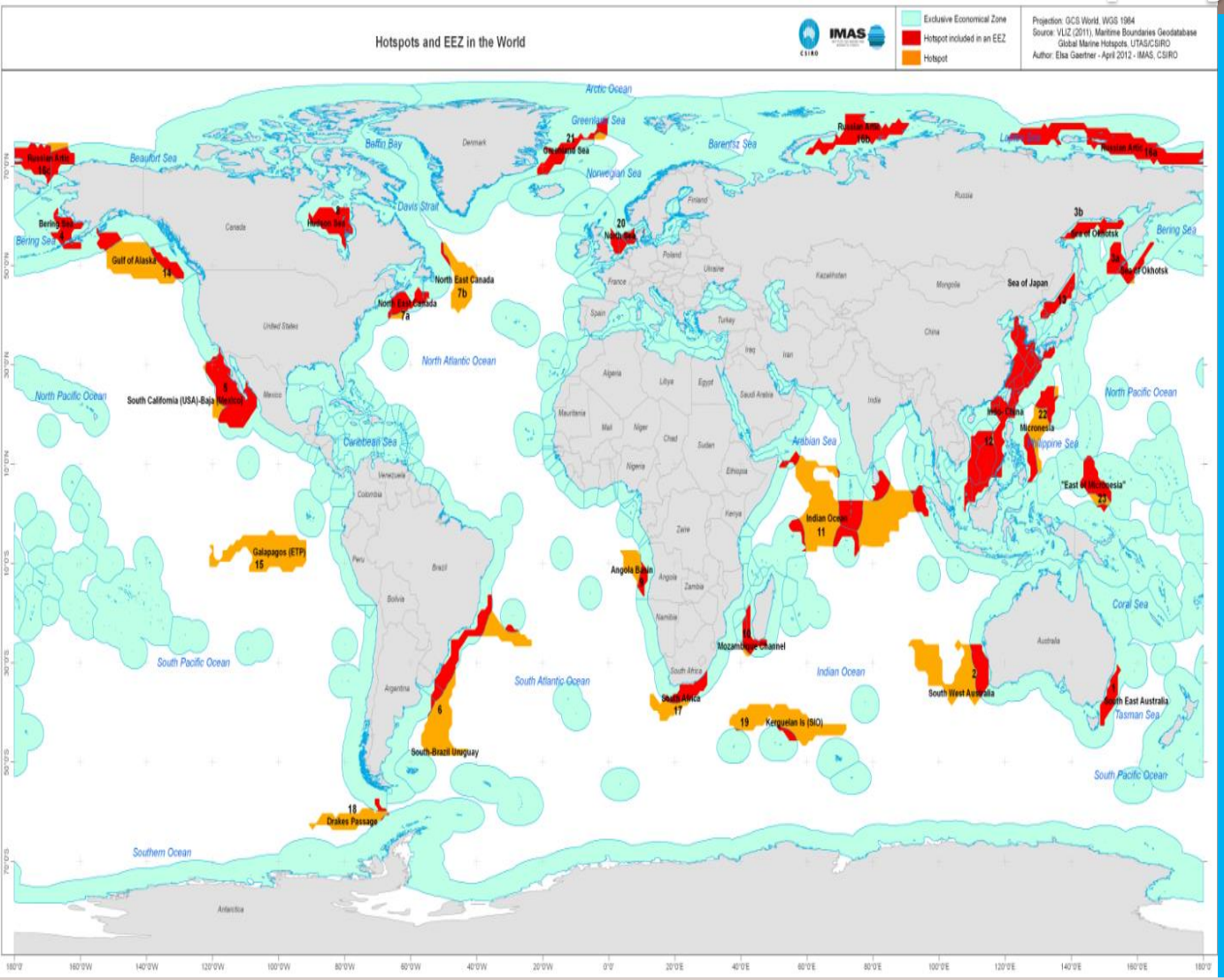
Focus areas of GULLS project



Hemisphere hotspots

Ocean regions experiencing fast warming and those with heightened social tensions as a result of change

- **Southern Africa**
- **Southern Australia**
- **Western Australia**
- **Mozambique channel**
- **Southern India**
- **Brazil**

The fastest warming ocean regions and the overlap with national EEZs

Project focus on countries adjacent to several of these regions in the Southern hemisphere

The GULLS Approach

A holistic approach has been developed and applied to five southern hemisphere hotspot regions: Brazil, India, the Mozambique Channel, Southern Benguela (South Africa) and South East Australia. The project is to deliver a comprehensive set of options to reduce coastal vulnerability and position vulnerable coastal communities for an improved future.

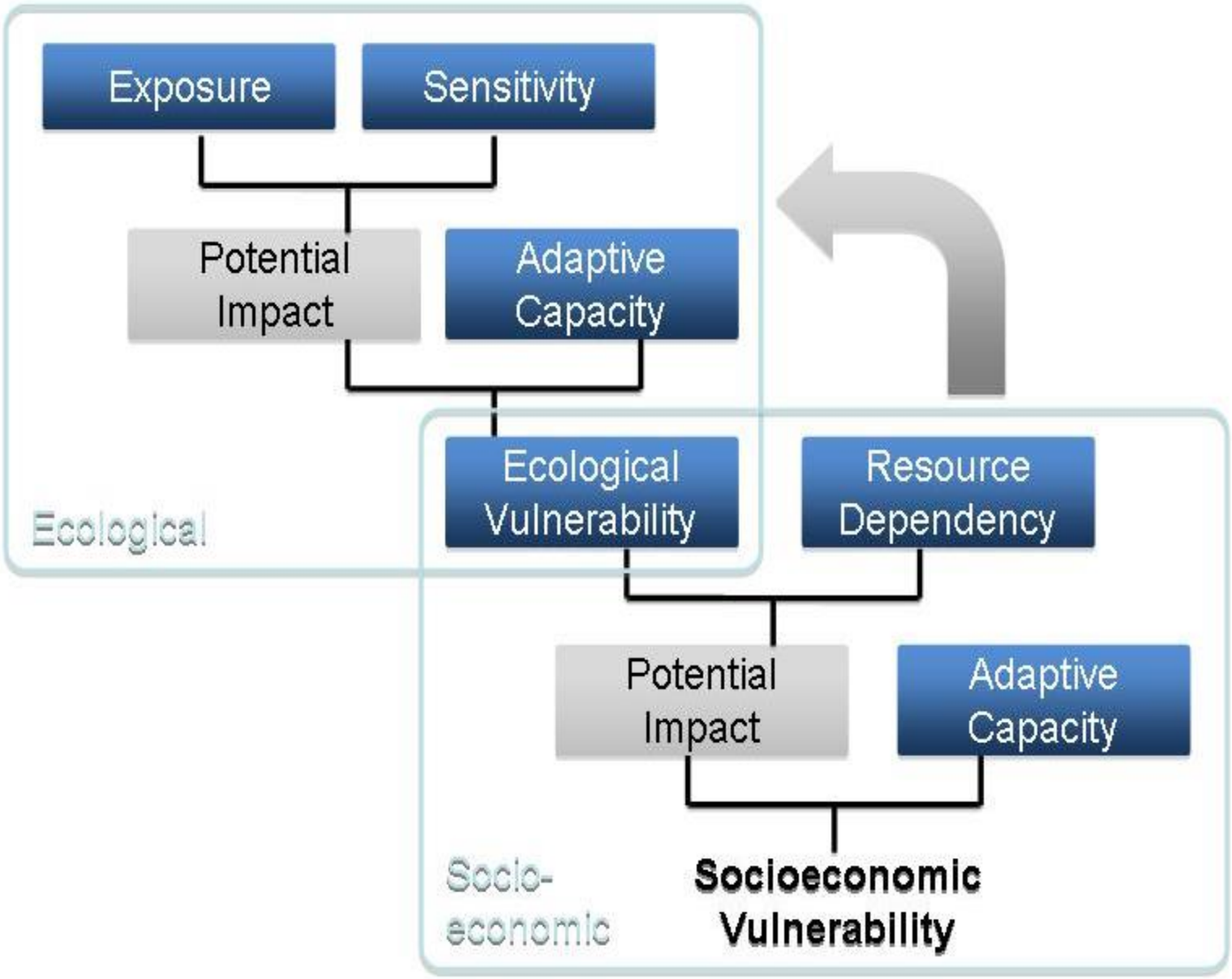
GOAL

This project contributes to improving community adaptation efforts by characterizing, assessing and predicting the future of coastal-marine food resources through the provision and sharing of knowledge across regional "hotspots".

Objectives

- Assessing the coastal vulnerability of identified climate change hotspots.
- Identifying the livelihood dependency of coastal community on fisheries and their Alternative Livelihood Options (ALOs).
- Deliver alternative options in terms of adaptation and transformation within coastal communities.
- Engaging the different stakeholder towards a climate resilient fisheries management practices and fisher livelihoods.

Vulnerability Model *(modified from IPCC)*



Identified Climate change Hotspots in India

Identified Hotspot area

- **South West India hotspot- Kerala** (Trivandrum, Kollam, Alappuzha and Ernakulum Districts)

- **South East India hotspot- Tamil Nadu** (Tuticorin and Ramanathapuram districts- encompassing Gulf of Mannar and Palk bay)

Trophic modeling of South Kerala ecosystem

- South Kerala- hotspot identified: **Zone K1-K6** (Thiruvananthapuram, Kollam, Alappuzha and Ernakulam)

  - Habitat Area Calculated for South Kerala Hotspot : **18,059 Km²**

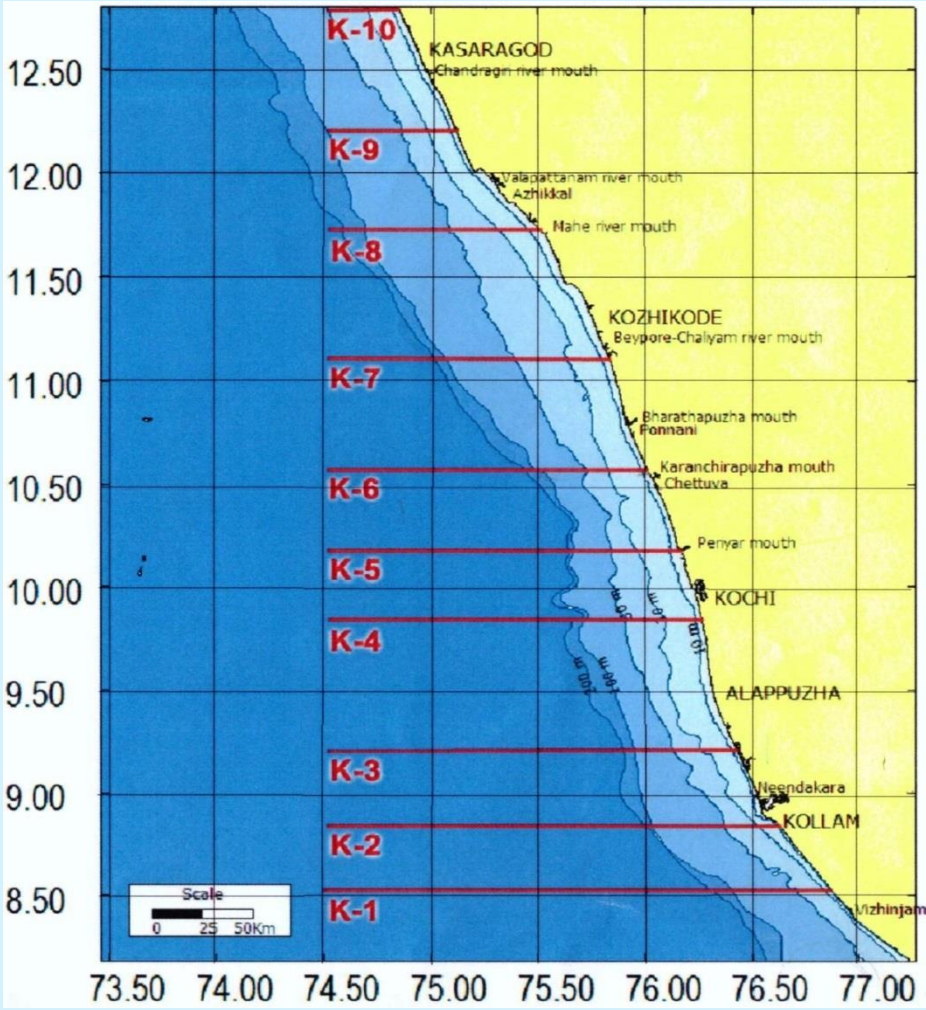
  - Data Collection for trophic modeling

a) 26 groups identified

b)Collected and processed "Catch" data for the years 2010-14

c)Components - production biomass ratio, consumption biomass ratio, bio mass, diet composition

- Model mass balanced
- Ecosim simulations - Different SST scenarios



Parameter	Value	Units
Sum of all consumption	7699.058	t/km²/year
Sum of all exports	3015.089	t/km²/year
Sum of all respiratory flows	4684.936	t/km²/year
Sum of all flows into detritus	3400.692	t/km²/year
Total system throughput	18799.779	t/km²/year
Sum of all production	9174.311	t/km²/year
Mean trophic level of the catch	3.245	
Gross efficiency (catch/net p.p.)	0.002	
Calculated total net primary production	7700.000	t/km²/year
Total primary production/total respiration	1.644	
Net system production	3015.064	t/km²/year
Total primary production/total biomass	42.365	
Total biomass/total throughput	0.010	/year
Total biomass (excluding detritus)	181.752	t/km²
Total catch	18.244	t/km²/year
Connectance Index	0.339	
System Omnivory Index	0.431	
Total market value	2207679.000	1
Total shadow value	0.000	1
Total value	2207679.000	1
Total fixed cost	0.000	1
Total variable cost	1766143.000	1
Total cost	1766143.000	1
Profit	441535.500	1
Ecopath pedigree index	0.316	
Measure of fit, t*	1.599	

- The total system throughout: 18,799.779 t/km²/year (represents the size of the entire system in terms of flow)
- Gross efficiency of the fishery: 0.00236 (close to that of the Berring ecosystem)
- The ecosystem system omnivory index of 0.431 indicates the complex feeding interactions in the ecosystem.

Species Sensitivity Assessment to climate change

- Evaluated the relative sensitivity of key 36 commercial fisheries species to climate change impacts .
- The scoring of criteria : scale of 1–3, 'Low', 'Medium', and 'High'.

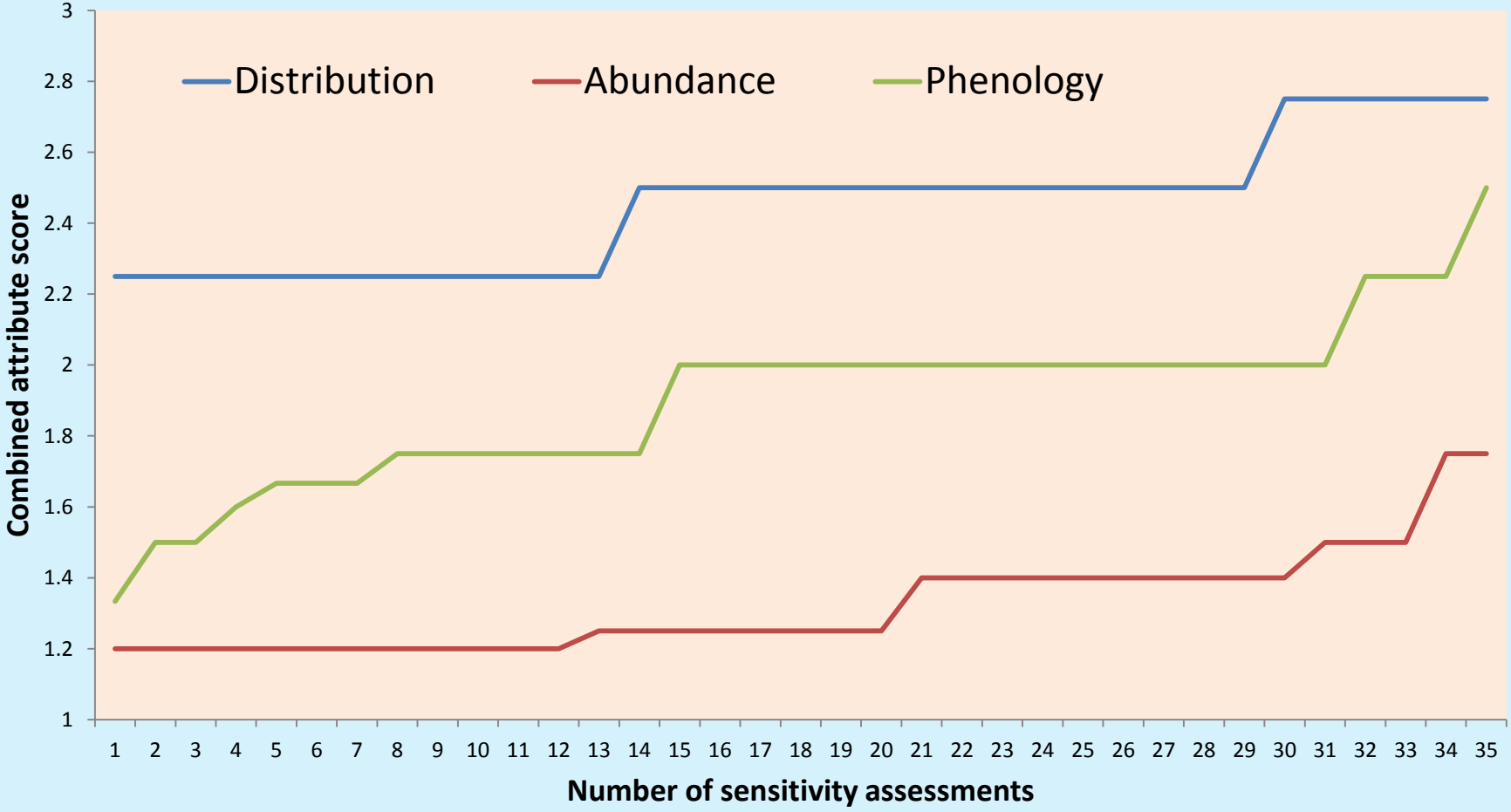
Attributes and criteria to estimate sensitivity

- **Abundance**
  - Fecundity
  - Recruitment Period
  - Age at maturity
  - Feeding habit
- **Distribution**
  - Larval duration
  - Juvenile movement
  - Spatial availability
- **Phenology**
  - Environment as cue for spawning
  - Environment as cue for metamorphosis
  - Spawning periodicity
  - Migration(Juvenile/ adult movement)

- Based on literature collections
- Expert judgements
- Data quality scoring guidelines (3-Adequate Data,2-Limited Data,1- Expert Judgment ,0-No Data

		Abundance						Distribution					Phenology					
Sl No.	Species	Fecundity – egg production	Recruitment period (into the fishery)	Average age at maturity	Generalist vs. specialist	Spawner biomass	Avg	Capacity for larval dispersal	Capacity for adult/juvenile movement	Physiological tolerance	Spatial availability of unoccupied habitat in the region for critical life stage	Avg	Environmental variable as a phenological cue for spawning or breeding.	Environmental variable as a phenological cue for settlement or metamorphosis.	Temporal mismatches of life cycle events	Migration (seasonal and spawning)	Avg	Total
1.	*Auxis rochei*	1	1	1	2	NA	1.25	3	3	2	2	2.5	2	3	1	2	2	**5.75**
2.	*Carcharhinus limbatus*	3	1	1	1	1	1.4	3	3	2	3	2.75	2	NA	NA	2	2	**6.15**
3.	*C.macrostoma*	1	1	1	3	1	1.4	3	3	3	2	2.75	3	1	1	1	1.5	**5.65**
4.	*Decapterus ruselli*	1	1	1	2	2	1.4	3	3	2	1	2.25	3	3	1	1	2	**5.65**
5.	*Dussumieria acuta*	1	1	1	2	NA	1.25	3	3	2	1	2.25	3	NA	1	2	2	**5.50**
6.	*E.affinis*	1	1	1	2	1	1.2	3	3	3	2	2.75	3	2	2	2	2.25	**6.20**
7.	*Epinephelus diacanthus*	1	1	1	2	NA	1.25	3	3	2	2	2.5	NA	NA	1	2	1.5	**5.25**
8.	*johnieopsis sina*	1	1	1	2	2	1.4	3	3	2	2	2.5	NA	2	1	1	1.33	**5.23**
9.	*Lactarius lactarius*	1	1	1	2	1	1.2	3	3	2	2	2.5	3	2	1	1	1.75	**5.45**
10.	*Leiognathus bindus*	2	1	1	3	NA	1.75	3	3	3	2	2.75	3	2	1	1	1.75	**6.25**
11.	*loligo duvaceli*	2	1	1	2	1	1.4	2	3	2	2	2.25	2	3	1	2	2	**5.65**
12.	*M.dobsoni*	1	1	1	2	1	1.2	2	3	2	2	2.25	2	2	1	2	1.75	**5.20**
13.	*Megalaspis cordyla*	1	1	1	2	1	1.2	3	3	2	2	2.5	3	2	2	2	2.25	**5.95**
14.	*Nemipterus randali*	1	1	1	2	1	1.2	3	3	2	2	2.5	3	2	1	2	2	**5.70**
15.	*Otolithes ruber*	1	1	1	2	1	1.2	3	3	2	1	2.25		2	2	2	2	**5.45**

Sensitivity scores plotted from highest to lowest for each of the three attributes. 3 = most sensitive/high risk, 1 = least sensitive/low risk



Sensitivity scores of major species based on Ranks

Sl No.	Species	Abundance	Distribution	Phenology	Total	Rank
1.	*M.dobsoni*	1.2	2.25	1.75	5.20	1
2.	*Johnieopsis sina*	1.4	2.5	1.33	5.23	2
3.	*Epinephelus diacanthus*	1.25	2.5	1.5	5.25	3
4.	*P.stylifera*	1.25	2.25	1.75	5.25	3
5.	*S.devsi*	1.4	2.25	1.75	5.4	4
6.	*Priacanthus hamur*	1.25	2.5	1.67	5.42	5
7.	*Lactarius lactarius*	1.2	2.5	1.75	5.45	6
8.	*Otolithes ruber*	1.2	2.25	2	5.45	6
9.	*Rastrilleger kanagurta*	1.2	2.25	2	5.45	6
10.	*Sardinella longiceps*	1.2	2.25	2	5.45	6
11.	*Scomberomorus commerson*	1.2	2.25	2	5.45	6
12.	*Dussumieria acuta*	1.25	2.25	2	5.5	7
13.	*Penaeus indicus*	1.25	2.5	1.75	5.5	7
14.	*Portunus sanguinolentus*	1.4	2.5	1.67	5.57	8
15.	*Charybdis feriatus*	1.5	2.5	1.6	5.6	9

Garrette analysis- Impact of climate change on resources

Parameters	Score	Rank
Catch reduction	**73.04**	**I**
Increased efforts in fishing	65.66	II
Migration of fishes	47.73	V
Varied Catch composition	57.70	III
Shift in spawning seasons	42.24	VIII
Temporal shift in the species availability	57.47	IV
loss in craft and gear	46.62	VI
Occurrence of invasive species	46.30	VII
Alterations in fishing seasons	41.26	IX
Depletion of farm and inventories	35.60	XI
Non availability of regular species	35.96	X

Socio Economic Vulnerability assessment

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effect of climate change, including climate variability and extremes

Exposure (E) : The nature and degree to which fisheries production systems are exposed to climate change

Sensitivity (S): Degree to which national economies are dependent on fisheries and therefore sensitive to any change in the sector

Potential impact (PI) : All impacts that may occur without taking into account planned adaptation

Adaptive capacity (AC) : Ability or capacity of a system to modify or change to cope with changes in actual or expected climate stress

Vulnerability

V= *f* (PI, AC)

Coastal vulnerability assessment under GULLS

- Coastal villages selected as hotspots for study: (600 samples each)

South-west:-Elankunnapuzha, Beemapally and Poonthura(Kerala)

South East : Ramanathapuram (Tamil Nadu) –(Analysis under process)

A composite vulnerability index was prepared

Vulnerability (V) = Exposure (E) + Sensitivity (S) - Adaptive Capacity (AC)

- A total of 198 indicators were identified

  (E-36, S-37, and AC-126)

- Mapped using Open domain Quantum GIS (QGIS).

- The vulnerability indices were computed for the normalized data set (0 and 1) using the Patnaik and Narain method (2005)

$$x_{ij} = \frac{X_{ij} - \min_i\{X_{ij}\}}{\max_i\{X_{ij}\} - \min_i\{X_{ij}\}}$$

if ↑ relationship with vulnerability

$$y_{ij} = \frac{\max_i\{X_{ij}\} - X_{ij}}{\max_i\{X_{ij}\} - \min_i\{X_{ij}\}}$$

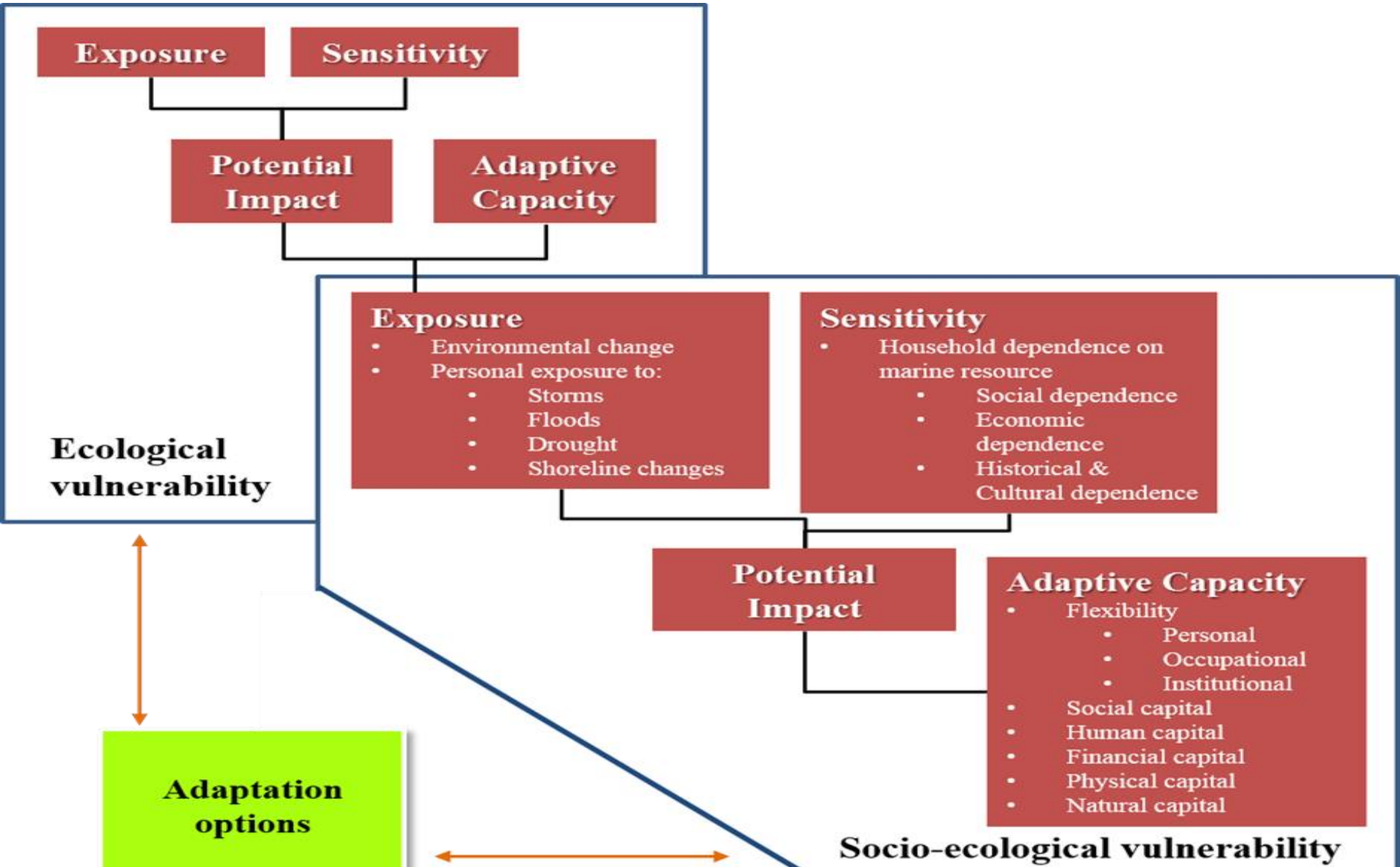
if ↓ relationship with vulnerability

- The data analysis was done using the common scoring framework and analysis method (1-4 scale) given by GULLS international team.
- Poonthura is more vulnerable than Elamkunnapuzha.

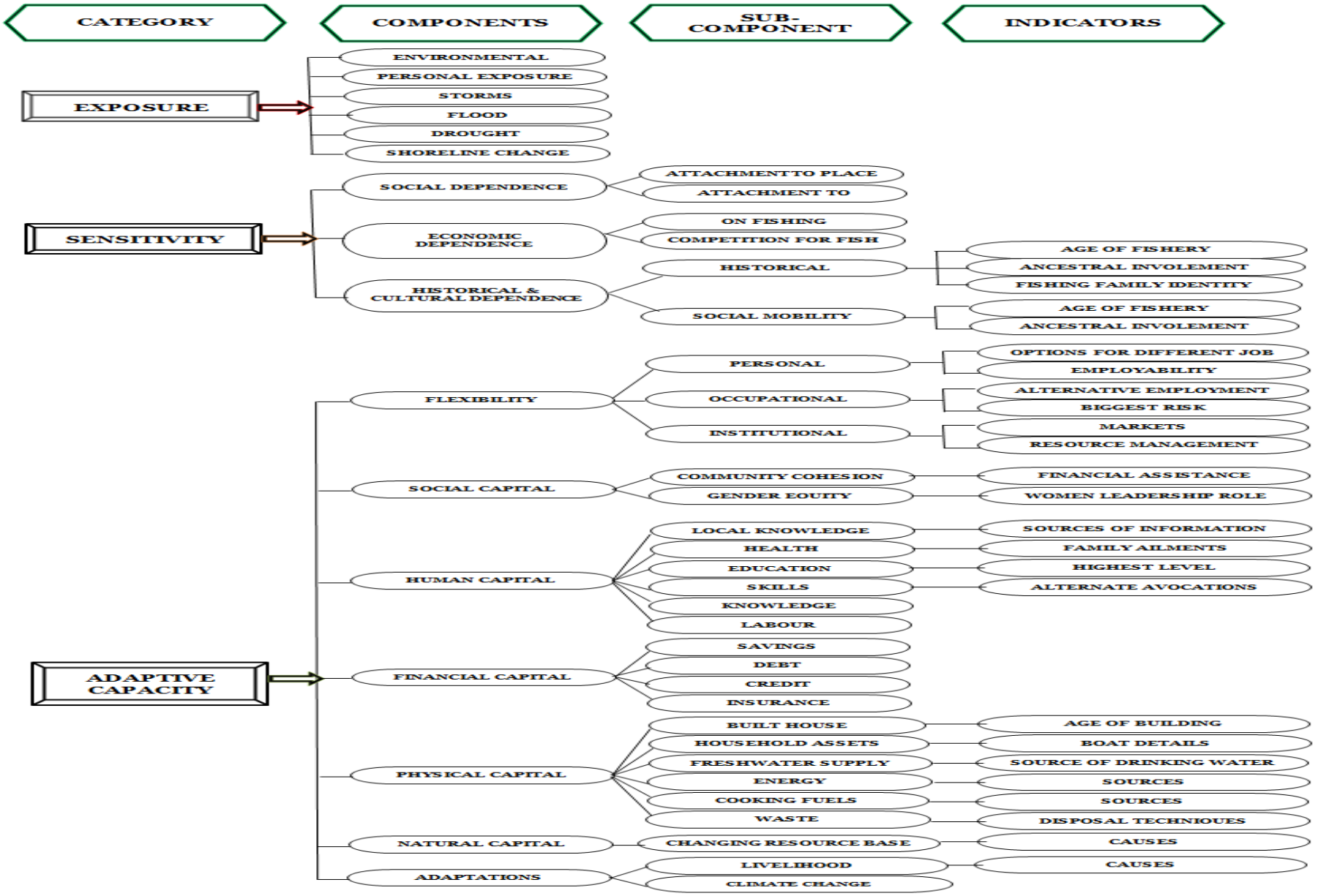
Coastal vulnerability Index of selected hotspots

Region	Sensitivity	Exposure	Adaptive capacity	Overall vulnerability
Poonthura	2.80	2.57	2.52	2.85
Elamkunnapuzha	2.67	2.70	2.57	2.80

Conceptual framework for assessing coastal community vulnerability

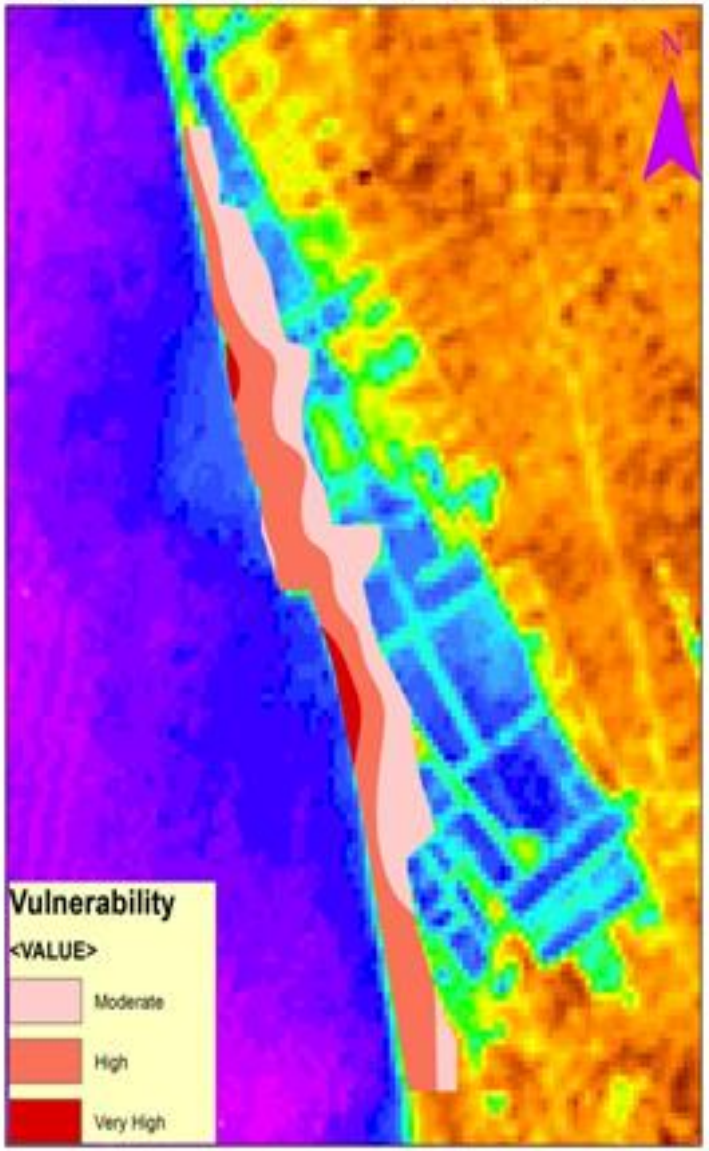


Category of the integrated framework with Exposure, Sensitivity and Adaptive Capacity with different components and its indicators

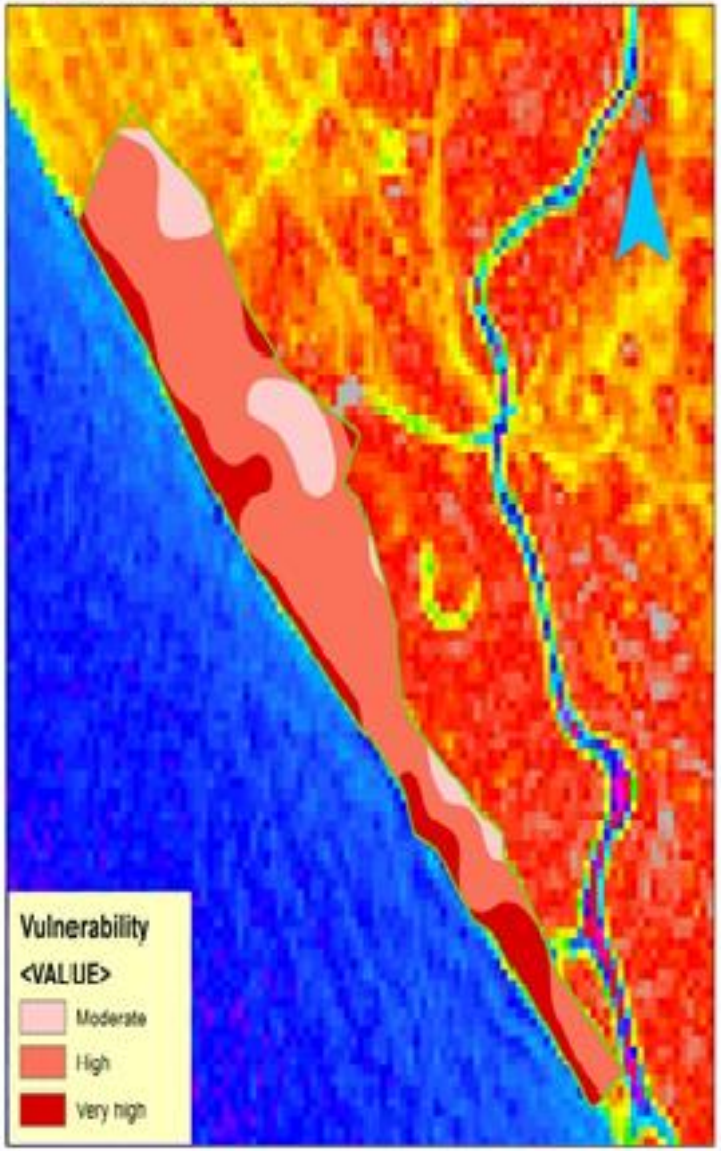


Overall Vulnerability

Spatial distribution of Vulnerability of Elamkunnapuzha Village

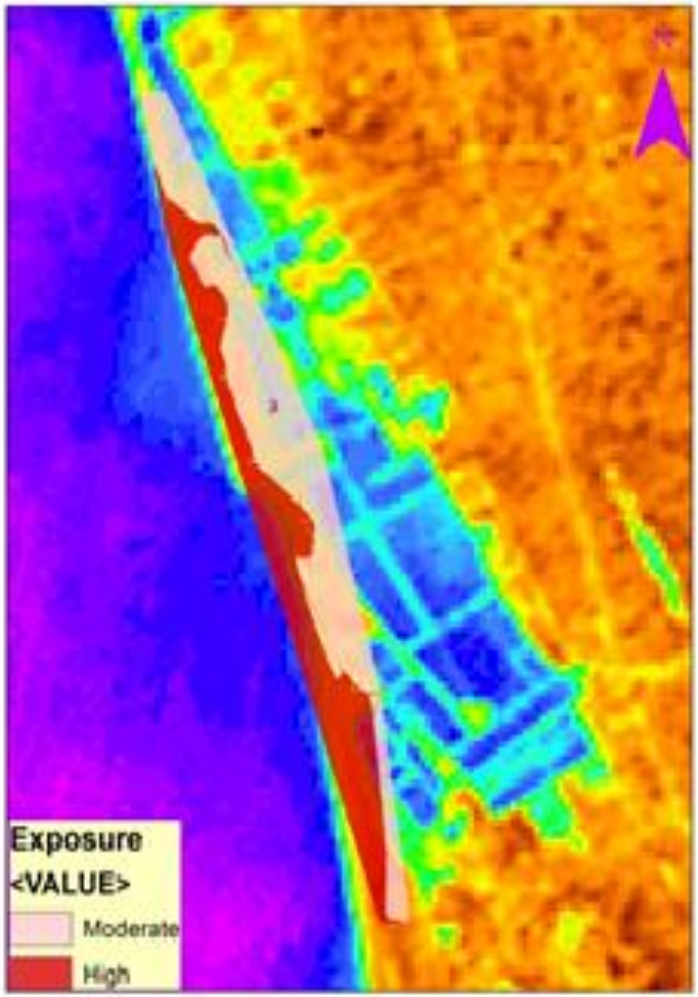


Spatial distribution of Vulnerability of Poonthura village

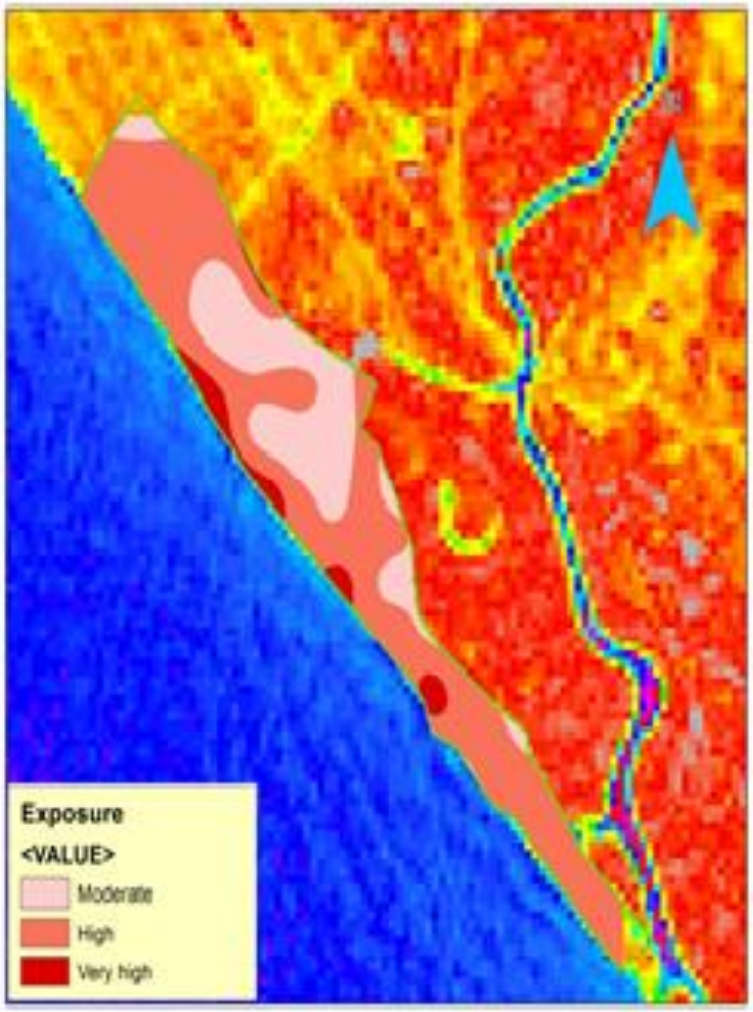


Potential Impact- Exposure

Spatial distribution of Exposure of Elamkunnapuzha Village

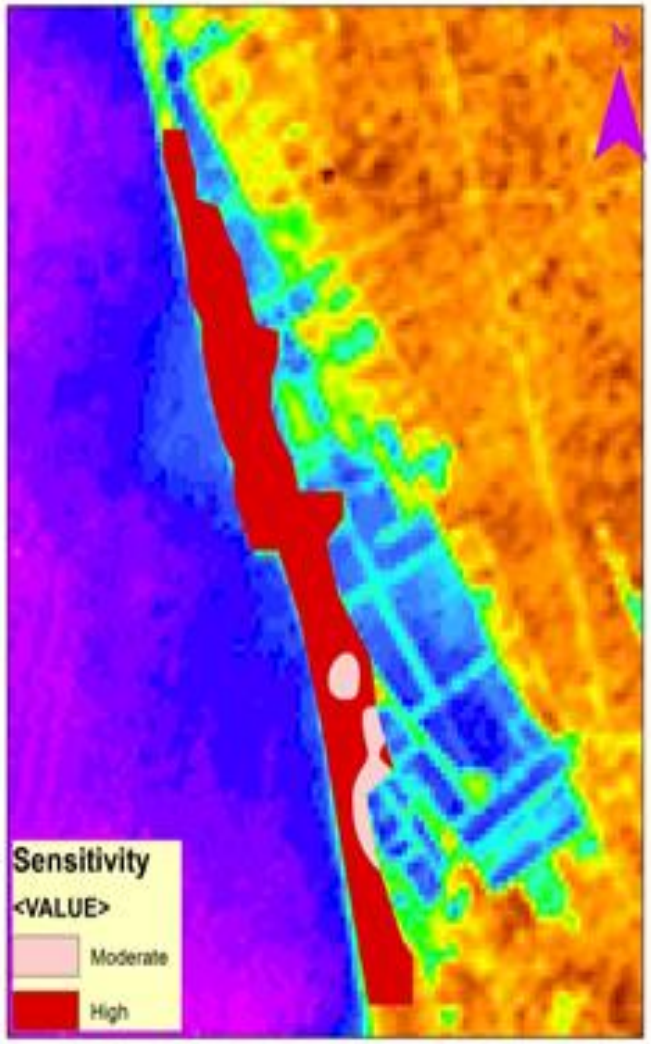


Spatial distribution of Exposure of Poonthura village

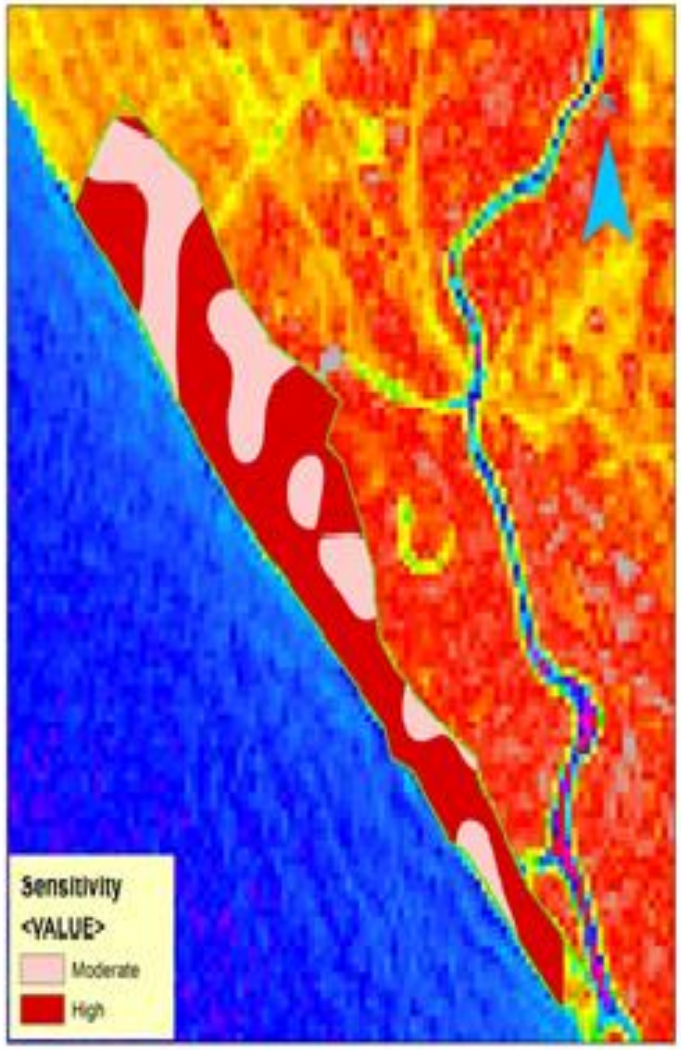


Potential Impact- Sensitivity

Spatial distribution of Sensitivity of Elamkunnapuzha Village

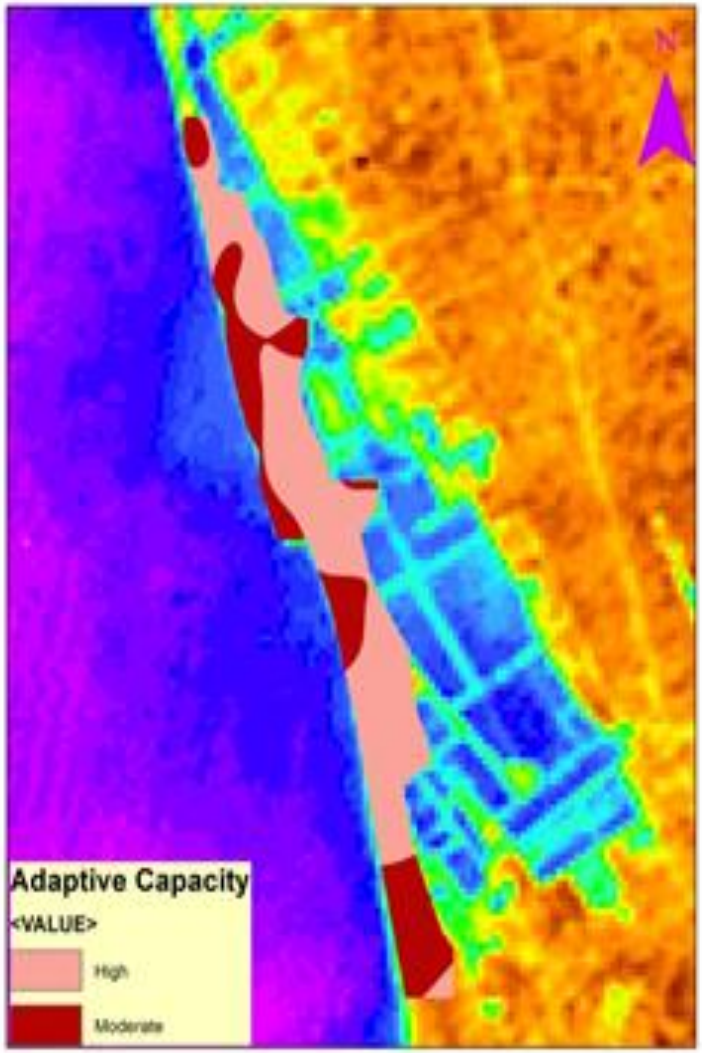


Spatial distribution of Sensitivity of Poonthura village

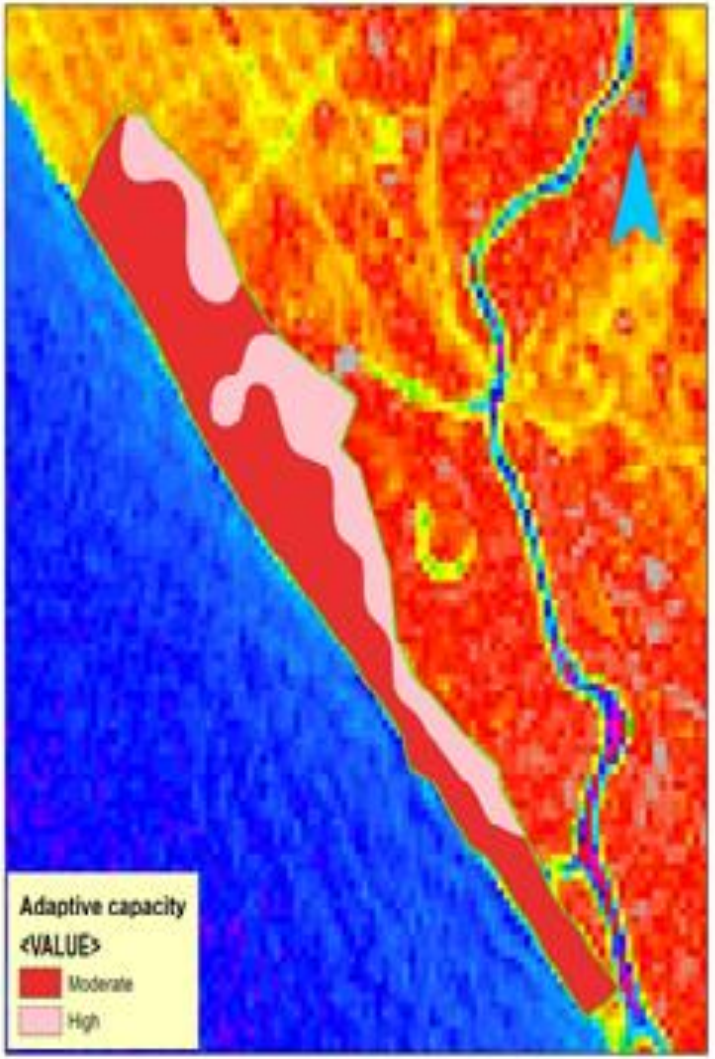


Adaptive Capacity

Spatial distribution of Adaptive Capacity of Elamkunnapuzha Village

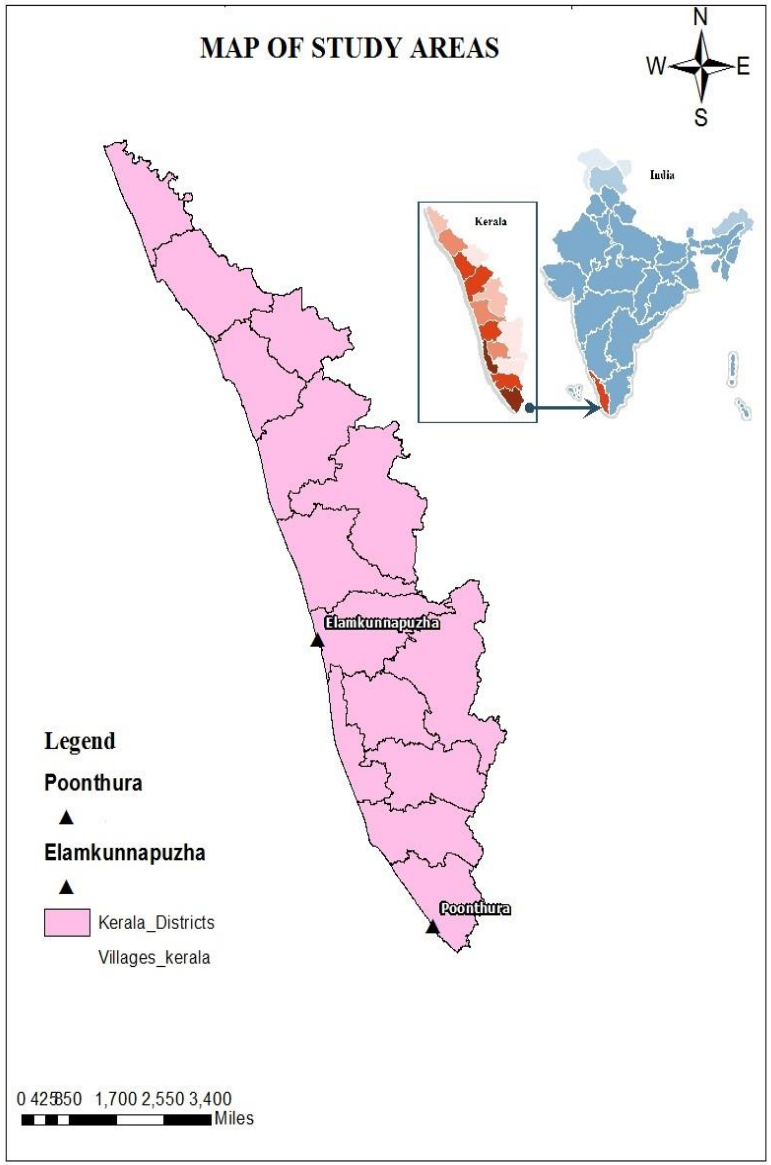


Spatial distribution of Adaptive Capacity of Poonthura village



Assessing Alternative Livelihood Options

- Data select: Primary sources and secondary sources.
- Pre tested survey schedules
- Focus group discussions were held in select coastal villages
- A total sample of **1259** respondents was selected from the coastal villages of Poonthura and Elamkunnapuzha
- Data collected on- socio economic demographic view of the respondents, level of awareness of fisher folk about climate change, fisher's perception on the impacts of climate change on resources etc.
- The primary data was collected during the period between May – July 2017.



Adaptation Measures suggested

Measures	Poonthura		Elamkunnapuzha	
	Score	Rank	Score	Rank
Organic Farming	50.32	IV	45.62	V
Increase Energy Efficiency	61.45	III	62.35	II
Reduce Food Waste	66.13	II	60.52	III
Rain Water Harvesting	27.1	VIII	50.12	IV
Transportation Alternatives	49.16	V	37.33	VI
Avoid Products with Lot of Packaging	73.39	I	70.56	I
Use Paper Judiciously	37.58	VI	30.56	VII
Limit The Use of Fossil Fuels	18.65	IX	19.54	IX
Pricing Carbon	30.81	VII	27.23	VIII
Others	17.42	X	16.52	X

Alternate Livelihood Options

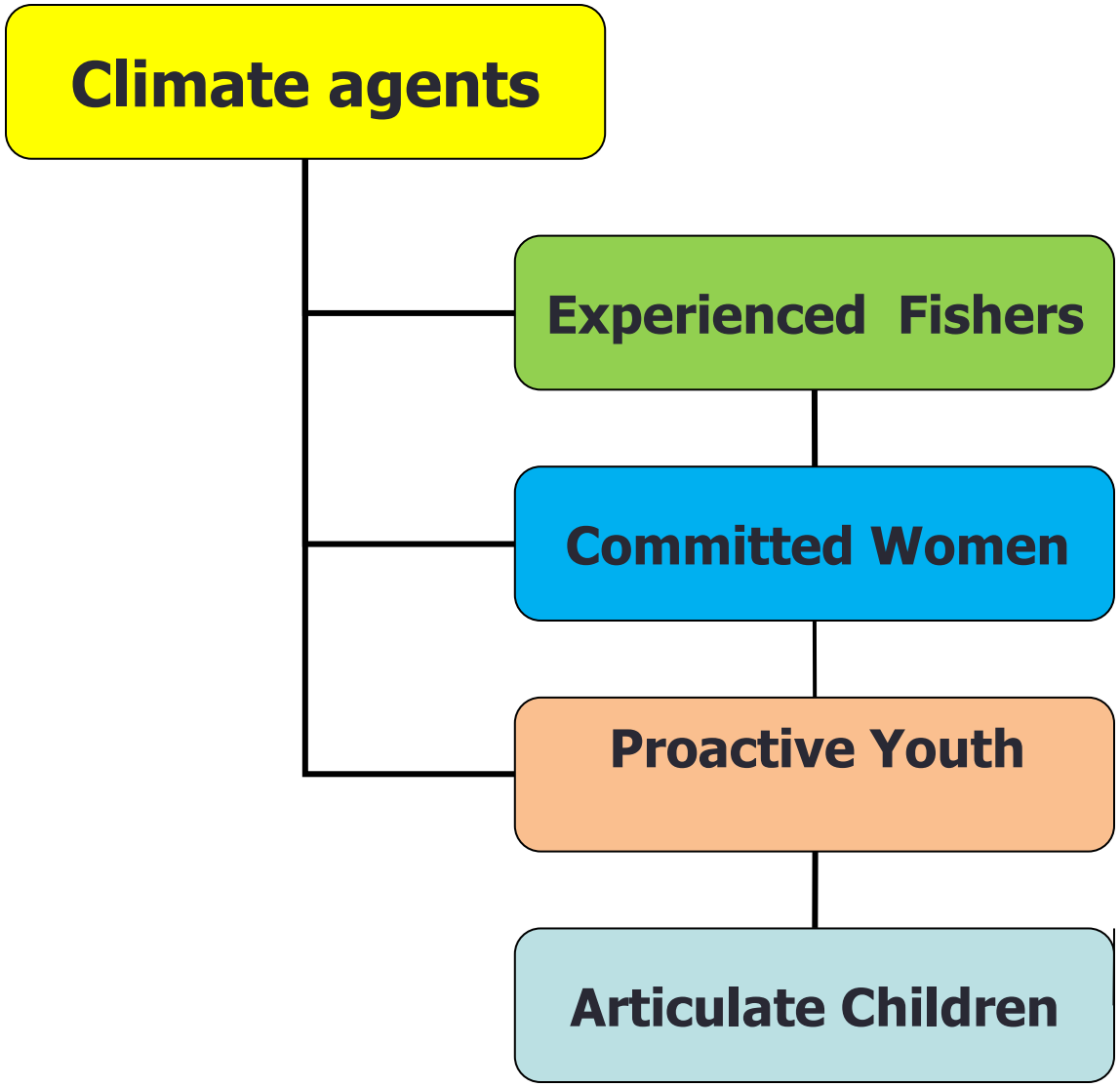
- **30.47 %** (32 % from Elamkunnapuzha and 19 % from Poonthura) have alternative livelihood options
- Whereas **69.52%** (61 % from Elamkunnapuzha and 67 % from Poonthura) have no alternative livelihood options other than fishing
- **75.955 %** are willing to participate in adaptation and mitigation programmes
-
- **61%** are willing to take part in individual climate change activities followed by household and social roles.
- The top five ALO' prefered by fishermen-
  - Daily wage labour,
  - SHG, Small scale industry,
  - Service Industry
  - Masonry/carpentry

Fisher's - Awareness, preparedness and mitigation level

- The level of knowledge on climate change is inadequate with **24.7%** respondents aware and **75.1%** heard about climate change
- The major sources of information are media (**44%**), friends and relatives (41%), and state government organizations (**21.5%**).
- The existing indigenous technology knowledge is based on wind, colour and nature of sea (**37%).**
- Community involvement and mobilization exists among fishermen in terms of coordinating activities in response to natural hazards/events (**16%**).
- The level of governmental support is not adequate (**72%**) in fishers' perception.

Climate change agents

- Section of the society with better education, experience and multiple avocations
- Various programs were conducted to identify and develop **climate change agents** from different age and gender groups
- Influence and inspire general community in the entire process
- Ensure the involvement of maximum people in the process.



Communication / Awareness

- ClimEd - an instructional material has been developed as a part of the study.

- ClimEd is published in different series; so far five ClimEd series each in Hindi, Malayalam, English and Tamil (20 nos) have been developed.

- Each series focus on different aspects of climate change they are:
  ClimEd Series –I "Know Your Warming Planet"
  ClimEd Series- II "Learning & Coping Climate Change"
  ClimEd Series- III "Societal role in curbing climate change"
  ClimEd Series IV "Climate Change and Policy"
  ClimEd Series V – Households in combating climate change

ClimEd Series-English

ClimEd Series: I

Know Your Warming Planet

ICAR - CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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Ernakulam North P.O 1603
Ernakulam 682 018
Website: cmfri.org.in

ClimEd Series- II

Learning & Coping
Climate Change

ICAR- CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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Ernakulam North P.O 1603
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Website: www.cmfri.org.in

ClimEd Series III

Societal role in curbing climate change

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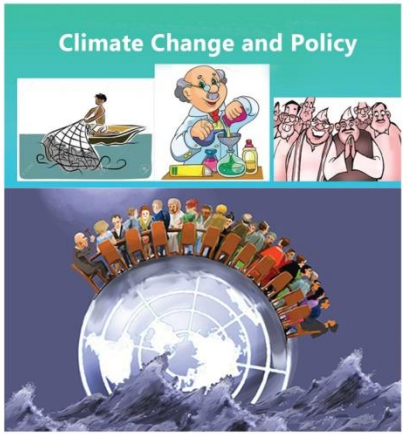
Climed Series IV

Climate Change and Policy



The world is changing.....Are we??? Shouldn't we???

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ClimEd Series: V

Households in combating climate change

"If we contributed, then we need to fix it"

ICAR- CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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Website: www.cmfri.org.in

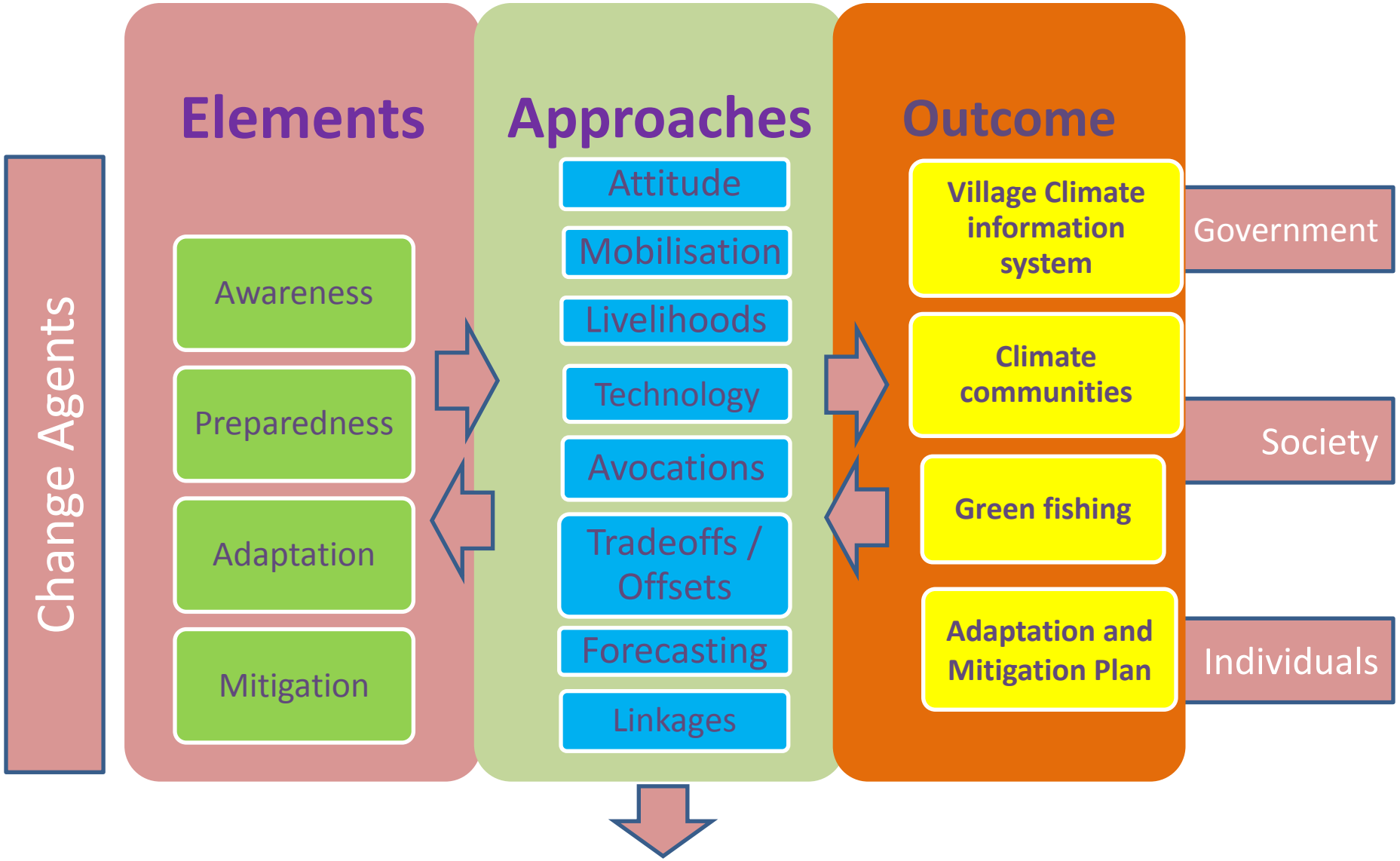
Awareness - Fish Cemetery

- Fast approaching a scenario of - biodegradable plastic waste destroys the ecosystem of the aquatic organisms which results in harmful effects to marine life, due to consumption of degraded micro-plastics was explained through the Fish Cemetery installation

- Participated in the Biennale

https://www.youtube.com/watch?v=CWVDb92Z4DY

CreVAMP Framework



Achievements

- Climate change as a science has been transferred to fishers
- Climate change have been incorporated into Panchayath planning
- Were able to identify climate change champions
- Build linkages with national and international climate change agencies
- Perpetuated into tropical fisheries sector

GULLS Website – Marine hotspots

http://www.marinehotspots.org/index.php/featured-projects/gulls

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Global learning for local solutions: Reducing vulnerability of marine-dependent coastal communities

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South West India

Summary

The state of Kerala, located at the extreme southern narrow strip of the Indian sub-continent is wedged between the Arabian Sea to the west and the Western Ghats to the east. It is lying between 8°18', 12° 48' North latitudes and 74° 52', 77° 22' East longitudes. Kerala's coastline of 590 km with 187 landing centres spreading over nine coastal districts and the Exclusive Economic Zone (EEZ) extends up to 200 nautical miles far beyond the continental shelf, which covers an area of 218,536 Sq km provide opportunities in traditional fishing in inshore waters from ages.

The hotspot area of south west India comprises of four coastal districts (South Zone: Thiruvananthapuram & Kollam and Central zone: Ernakulam and Alapuzha), and the rationale behind the section of this particular location is i) It falls within the upwelling ecosystem of the south-west coast of India,ii) this region has rich diversity and supports substantial marine and estuarine fisheries iii) identified as major spawning gyre of many pelagic species based on fish and larval surveys iv) has extensive system of backwaters.

Oceanographical context

The Indian subcontinent divides the northern Indian Ocean into two basins - the Arabian Sea and Bay of Bengal. The Arabian Sea is known for the intense annually reversing monsoon winds and high evaporation. Even though the Ekman transport is less during northeast monsoon than during southwest monsoon, especially south of 10°N, the heat transport south of the Arabian Sea keeps similar amplitude as that of south-west monsoon. Among the western boundary currents Somali Current of Arabian Sea is unique due to its strength and the reversal during monsoon season. The studies indicate a presence of two-gyre circulation system in the western Arabian Sea during south west monsoon. Another notable feature is the upwelling of cool subsurface waters in the Arabian Sea during the summer monsoon.

South West India: At a Glance

Hotspot size

590km (coastline)

Depth regime/continental shelf

The continental shelf area is 39,139 Sq.km, the area within the 18m depth range accounts for 5,000 sq.km, the area between 18-73m is approximately 25,000 sq.km and 73-182 is the balance of the area.

Percentage of hotspot area inside countries EEZ

The Exclusive Economic Zone (EEZ) extends up to 200 nautical miles far beyond the continental shelf

What percentage of the country's EEZ does the hotspot area constitute?

Extractive marine resource use (e.g. rec – comm. - charter fishing – trends and some specific geographically defined activities)

Pelagic Fisheries, Demersal Fisheries, Crustacean Fisheries, Molluscan Fisheries

Outline of non-extractive use of the coast (e.g. tourism –recreation)

Coastal tourism of Kerala is the composite of beach tourism and backwater tourism.

Main economic

Challenges

- Difficult to impart the concept of climate change as a science to the fishers
- Climate change cannot be delineated out of the many factors affecting fishermen livelihood
- Cost to ex-chequer
- Find alternate livelihood options
- Strengthening value chain
- Resistance to move from their present ambience


Thank You