Options on Fisheries and Aquaculture for Coping with Climate Change in South Asia

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Fisheries and Aquaculture in South Asia

- Important sector for food and nutritional security
- Revenue-earning and employment generating
- Annual export from the region: 2596 million US $
- Full-time and part-time employment for 7.5 million people
- Nutritional Dependency Index very high for Maldives (100), Sri Lanka (62) & Bangladesh (58) (DFID, 2004)

Fisheries and Aquaculture in South Asia

- Annual Production: 8.5 million tonnes
  - *India:* *70.2%*
  - *Bangladesh:* *17.4%*
  - *Pakistan:* *7.2%*
  - *Sri Lanka:* *3.0%*
  - *Maldives:* *1.9%*
  - *Bhutan & Nepal:* *0.3%*

  - Marine capture: 50.3%
  - Inland capture: 11.5%
  - Inland culture: 38.2%

Issues

- Production from capture fisheries is stagnant for the last ten years: *overfishing, depletion of coastal fish stocks; competition among stakeholders*
- Aquaculture is not expanding as expected to new species and areas: *lack of adequate technical knowhow; legal, social & trade issues, fish disease problems*
- Climate Change exacerbates the situation

Issues linked to Climate Change

- Sub-sectors will be affected in the following order (IPCC, 2005): small rivers & lakes > coastal waters > large rivers & lakes > estuaries > high seas
- Climate change has not found a place in fisheries and aquaculture policy documents.
- Fisheries and aquaculture are often weak sector, which makes them more vulnerable, especially in conflicts with other sectors.

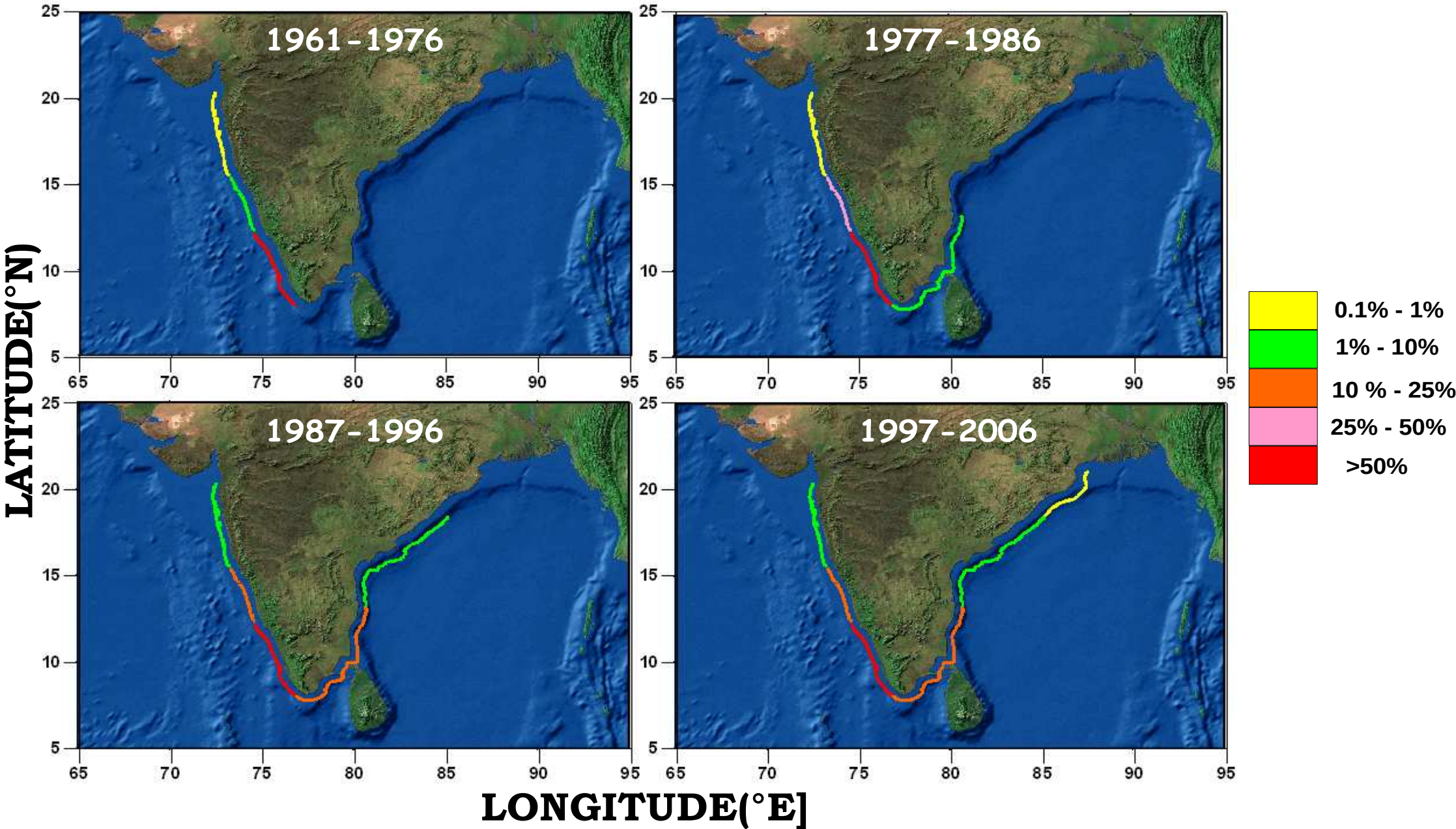
Changes in Distribution, Abundance and Phenology of Marine Fish

Being poikilotherms, even a difference of 1^{o}C or 0.1 unit pH in seawater or change in oceanic current direction and speed will affect distribution and life processes of many marine organisms including fish.

- *Category 1: Shift in latitudinal distribution*
- *Category 2: Extension of distributional boundary*
- *Category 3: Change in biomass*
- *Category 4: Shift in depth of occurrence*
- *Category 5: Phenological changes*

Extension of northern boundary of oil sardine

(the colored lines indicate percentage of All India oil sardine production)



Adaptable Marine Organisms

(species with wider ecological niches, greater mobility, fast growth, quick turnover of generations)

Small pelagics (clupeids, mackerel etc)

Threadfin breams

Cobia

Tunas

Squids

Pufferfish

Jellyfish

Vulnerable Marine Organisms

(species with narrow ecological niches, sedentary/sessile with calcareous exoskeleton, slow growth)

Corals

Sponges

Bivalves

Gastropods

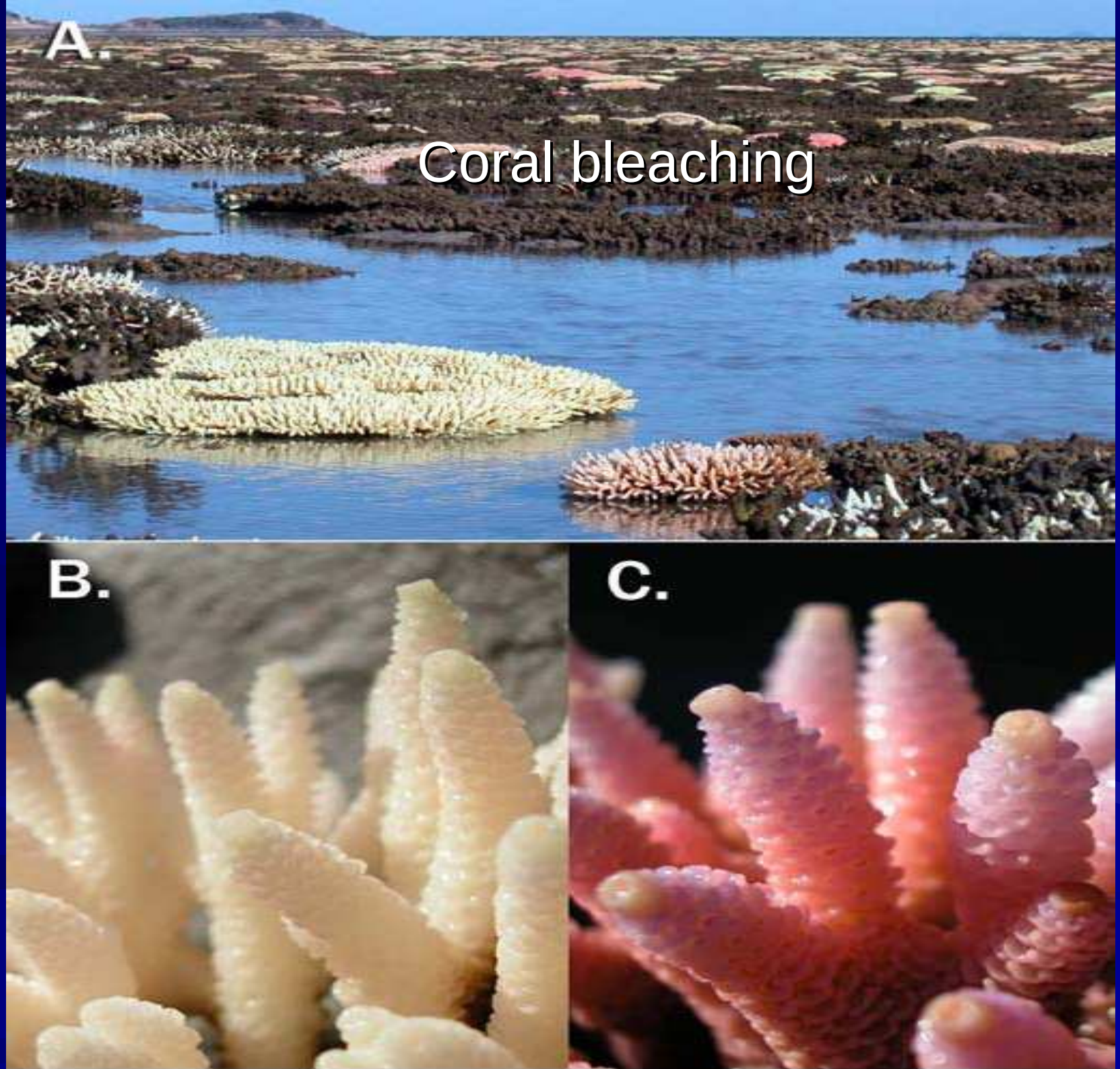
Echinoderms

Bombayduck, catfish, Hilsa

Large predatory fish (sharks, rays, seerfish)

Sea turtles

The immediate effect will be on the CORALS


A.
Coral bleaching
B.
C.

Projected demise of coral reefs in the Indian Seas

Region	Decline starts	Remnant
Andaman	2030-2040	2050-2060
Nicobar	2020-2030	2050-2060
Lakshadweep	2020-2030	2030-2040
Gulf of Mannar	2030-2040	2050-2060
Gulf of Kachchh	2030-2040	2060-2070

Changes in Marine Ecosystem and Fisheries

- These distributional shifts and phenological changes are expected to result in drastic changes in species mix and ecosystem structures and functions.
- This may cause erosion of economic returns to the fishermen.
- Fishermen may have to adapt by changing their craft and gear combinations depending on the available species.

Climate Change Impact on Subsectors

Causes	Marine capture	Inland capture	Aquaculture
Rise in water temp.	Change in growth, spawning &dispersal catch reduction	Change in growth, metabolism, spawning, dispersal	Change in growth, decrease in DO, Increase in disease
Rise in acidity	Damage to calcar-eous exoskeleton		
Sea level rise	Inundation, damage to properties & livelihood	Water salination; change in specie mix	Species may not tolerate salinity; growth reduction
Salination of aquifer		Change in species mix	Species may not tolerate salinity; growth reduction
Current speed & direction	Change in species dispersal; ecosystem changes; catch reduction		

Climate Change Impact on Subsectors

Causes	Marine capture	Inland capture	Aquaculture
Intense rainfall	Salinity reduction in coastal waters; species dispersal	Floods; damage to properties	Floods; damage to properties
Storm surges	Damage to properties & life	Damage to properties & life	Damage to property; loss of stocks, disease outbreaks
Floods	Salinity reduction in coastal waters; sp. species dispersal	Damage to properties	Damage to property; loss of stocks, disease outbreaks
Droughts		**Water availability**	**Water availability**, diseases; reduction in production
Intersectoral conflicts		Conflict with other water uses; fisheries not a priority	Conflict with other water uses; aqua-culture not a priority

Adaptive mechanisms

1. Identify adaptive fishing (*craft-gear combination*) and post-harvest practices (*reduce microbial load and contamination*) to sustain fish production and quality;
2. Support energy efficient fishing craft (*evolve emission standards*) and gear (*promote static gear*);
3. Identify new land use system for aquaculture;
4. Develop hatchery and grow-out technologies for new candidate species (*resistant to changing to higher temperature & salinity and disease resistance; develop feed*);

5. Plankton Restoration through Iron Fertilization

- Global phytoplankton production has declined by 6~9% (NASA)
- Iron fertilization is physical distribution of microscopic particles of micronutrient *viz*., iron in the upper oceans.
- Fertilization encourages growth of phytoplankton blooms, increases energy flow in marine food chain, and sequesters CO_2 from atmosphere.
- Each kilogram of iron can fix 83 t of CO_2 and generate 100 t of phytoplankton.

6. Cultivation of sea plants

- Sea plants are excellent carbon sequestering agents.
- *Kappaphycus, Gracilaria, Gelidiella, Sargassum* and *Ulva* are available in plenty in South Asia.
- Used as human food; rich source of agar and algin; fertilizer; cattle fodder; and for pharmaceutical and confectionary purposes.
- Standing stock in Indian waters is estimated as 2,60,876t
- Initial estimates by CMFRI indicate that they utilize 9052 t CO_2 per day.
- Mass cultivation of sea plants are possible in coastal waters.

7. Cultivation of halophytes

- *Salicornia* is a succulent, bushy, and salt & heat-tolerant plant in the coastal areas; can be raised using seawater.
- Stem edible; the plant yields edible oil rich in polyunsaturates, and usable as biodiesel.
- Uses C4 pathway.
- Improved variety (SOS-10) is cultivated in several parts of the world.
- A 2000 ha farm would yield total biomass of 30,000 t and 2500 t of seeds.
- Distributed in South Asia.
- Some countries plan to take seawater into deserts through ocean canals to nourish fish, shrimp, and *Salicornia* for biodiesel.

Salicornia brachiata

Kappaphycus alvarezii

Gracillaria verrucosa

Gelidiella acerosa

8. Artificial Reefs for Coastal Protection

- Multipurpose Artificial Surfing Reefs can be used for surfing, coastal protection and as fish and marine faunal aggregating devices.
- Sand filled geotextile containers of 40-50 m length form the reefs.
- Coast protection is derived from widening of the beach due to sheltering and wave rotation caused by the reef.
- Two Reefs have been sanctioned recently by the government for the southwest coast of India.

Multi Purpose Artificial Surfing Reef

Adaptive mechanisms (continued)

9. Action plans on
   - ***Code of Conduct for Responsible Fisheries***
   - ***Integrated Ecosystem-based Fisheries and Aquaculture Management***
   - ***Framework for expansion of aquaculture***
10. Consider gender and equity issues
11. Consider synergistic interaction between climate change and other factors (fishing, water availability, energy, agriculture etc)
12. Sharing information, and participation and collaboration at national, regional and international level.

Adaptive mechanisms (fiscal)

13. Finance allocation for
    - *risk reduction*
    - *prevention practices (early weather warning systems & recovery programs)*
    - *relocation of fishing villages from low lying areas*
14. Fiscal incentive for reducing the sector's carbon footprint, and other mitigation and adaptation options;
15. Self protection of stakeholders through financial mechanisms;
16. Consider climate change for fresh investments on infrastructure.

Conclusion

- A large number of poor fishermen and fish farmers represent a small and weak sector, which ensures food and nutritional security to one of the most vulnerable regions (South Asia) to climate change.

- The sector's contribution to CO_2 emission is very small, and can do very little to mitigate climate change.

- However, the sector has the potential to reduce the impact by following effective adaptation measures.

THANK YOU