



Climate change and need for proactive policy initiatives in Indian marine fisheries sector

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General Note



Article is recommended to print as color version in recycled paper. *Save Trees, Save Climate*.

ABSTRACT

The paper involves addressing the potential complexities of climate change interactions and their possible impacts in mainstreaming the cross-sectoral responses into governance frameworks. The paper reviews the global and national climate change conferences and policies and with the available literature, using a livelihoods framework, this paper synthesizes the pathways through which climate variability and change impact fisher folk livelihoods at the household and community level. For an effective policy

implementation balancing of results approach has to be adopted where the current needs are identified and potential adaptation strategies are explored and the wider implications for local livelihoods, fisheries management and climate policies. The policy should be coupled to broader economic reform opportunities to maximise win - win opportunities and should consider funding mechanism which is relevant to the sector.

Key Words: Climate change; Phenology shift; Phenotypic plasticity; Range shift

1. THE PREDICAMENT

As the world warms up to the concept of climate change, the IPCC states that the existing critical situation of marine fisheries is going to get complex with the passing years. The fourth assessment report of the Inter-governmental Panel on Climate Change predicts impacts of climate variability on changes in fisheries especially in coastal and estuarine waters, apart from non-climatic factors, such as overfishing, habitat loss and degradation contributing to chaos in the system. (1)

Addressing the potential complexities of climate change interactions and their possible impacts requires mainstreaming of cross-sectoral responses into governance frameworks. Action plans at the national level can have as their bases the Code of Conduct for Responsible Fisheries (CCRF) and related International Plans of Action (IPOAs), as well as appropriately linked policy and legal frameworks and management plans. Links will be required among national climate change adaptation policies and programmes as well as cross-sectoral policy frameworks such as those for food security, poverty reduction, emergency preparedness and others. The potential for spatial displacement of aquatic resources and people as a result of climate change impacts will require existing regional structures and processes to be strengthened or given more specific focus. Internationally, sectoral trade and competition issues are also likely to be impacted by climate change

India's Coast

The coastlines of Andaman and Nicobar Islands in the Bay of Bengal and Lakshadweep Islands in the Arabian Sea is 7517 km of which 81% (6100 km) is along the Indian mainland surrounded by Arabian Sea in the west, Bay of Bengal in the east, and Indian Ocean in the south. More than 40 million people reside along this coastline. There are 13 Coastal States and union territories susceptible to sea level rise in the country, with about 84 coastal districts affected by tropical cyclones. Four States (Tamil Nadu, Andhra Pradesh, Orissa and West Bengal) and one UT (Puducherry) on the East Coast and one of the States on the West Coast, Gujarat, are the States that are the most affected by cyclonic activities. The mega cities of Mumbai, Chennai, and Kolkata lie along this coastline. Additionally it is dotted with several major ports such as Kandla, Mumbai, Navasheva, Mangalore, Cochin, Chennai, Tuticorin, Vishakhapatnam, and Paradip.

A large portion of the population along the coastline is dependent on climate dependent activities such as marine fisheries and agriculture. Sea level changes and occurrence of extreme events such as cyclones and storm surges are of considerable significance for India as these adversely impact on human populations living in coastal regions and on islands as well as the sensitive ecosystems such as the mangroves (e.g. the Sundarbans). The flooding results in loss of coastal habitat and displacement of human habitations.

The threatening consequence due to coastal inundation and to identify coastal vulnerability should, therefore, be attached high priority during 12th FYP.

Observations and Projections

- The total frequency of cyclonic storms that form over north Indian Ocean does not show any significant trends during the period 1891-2008, but a slightly decreasing trend.
- An analysis of past tide gauge records of long duration for the Indian coastline regions gives an estimate of average sea-level-rise trend as 1.30 mm/year (Table 1) , which is consistent with the values reported elsewhere^{3,4}. However, in the Indo-Gangetic deltaic region, for instance at Diamond Harbour (Kolkata), the record shows a trend of 5.74 mm/year, which is partly attributed to the subsidence in the delta.
- Future global projections for a moderate climate scenario A1B indicate an average sea-level rise of 0.35 m towards the end of the century (Table 2)
- There is low confidence in the projections of tropical cyclones in the climate models. However, there is high confidence in studies indicate that mean sea-level-rise can cause increased flood risks associated with storm surges

Fisheries: (a) Oil Sardines- An increase in recruitment and catches of oil sardine during the post-southwest monsoon season along the coastal region, especially along the Kerala coast, is expected in the future due to warming, elevated Sea Surface Temperature (SST), favourable wind (and perhaps current) and increasing Coastal Upwelling Index (CUI) inducing higher chlorophyll-a concentration during the southwest monsoon. (b) The 13 Indian mackerel is able to take advantage of the increase in temperatures of subsurface seawater. Therefore, with increase in global temperatures and sea surface temperatures, it is likely to move northwards and deeper into the seas surrounding it (c) The threadfin bream spawns optimally in SST between 27.5 degree C and 28.0 degree C and when the SST exceeds 28.0 C, the fish shifts the spawning activity to seasons when the temperature is around the preferred optimum. Therefore in the climate change context, in the 2030s, if the SST exceeds 28.0 C during April to September, an increase in catch might take place in the comparatively cooler months of October to March.

Who assesses the happenings of climate change?

The Intergovernmental Panel on Climate Change is a specialised body jointly established by the United Nations Environmental Programme (UNEP) and the World Meteorological Organisation mandated to prepare scientific assessments on various aspects of Climate Change.

What are their mandates?

1. Present the physical science basis
2. Impacts, adaptation and vulnerability
3. Assessment for mitigation of Climate Change

2. THE GLOBAL SUMMITS AND POLICIES

Yearly conferences or summits were held internationally to assess progress in dealing with climate change which created a general path towards climate action. These conferences later became the key milestones in climate change with successful negotiations and framing of international climate change policy. The international response to climate change has resulted in several conferences which are indicated in Table 1.

Table 1 List of significant international climate change policy events

Date	Event	Description/Outcome
Nov-88	IPCC Established	World Meteorological Organization WMO and UN Environment Programme UNEP establish the Intergovernmental Panel on Climate Change IPCC.
Nov-90	IPCC and Second World Climate Conference Call for Global Treaty	The IPCC releases the first assessment report saying "emissions resulting from human activities are substantially increasing the atmospheric concentrations of greenhouse gases" leading to calls by the IPCC and the second World Climate Conference for a global treaty.
Dec-90		UN General Assembly Negotiations on a Framework Convention Begin
Jun-92		UNFCCC Opens for Signature at Rio Earth Summit
Mar-94	UNFCCC Enters into Force	Parties meet annually at the Conference of the Parties (COP) to negotiate multilateral responses to climate change.
Apr-95	COP 1	The Berlin Mandate establishes a process to negotiate strengthened commitments for developed countries, thus laying the groundwork for the Kyoto Protocol.
Dec-97	COP 3	adoption of the Kyoto Protocol, the world's first greenhouse gas emissions reduction treaty.
Nov-01	COP 7	formalize agreement on operational rules for International Emissions Trading, the Clean Development Mechanism and Joint Implementation
Feb-05		Kyoto Protocol enters force
Jan-06		Clean Development Mechanism Opens
Nov-06	COP 12	programme to address impacts, vulnerability and adaptation to climate change
Jan-08		Joint Implementation Mechanism Starts
Dec-10	COP 16	The Green Climate Fund, the Technology Mechanism and the Cancun Adaptation Framework are established.
Dec-11	COP 17	Governments commit to a new universal climate change agreement by 2015 for the period beyond 2020
Dec-12	COP 18	Launch of a second commitment period of the Kyoto Protocol.
Dec-13	COP 19	a rulebook for reducing emissions from deforestation and forest degradation and a mechanism to address loss and damage caused by

		long-term climate change impacts.
Dec-15	COP 21	An historic agreement to combat climate change and unleash actions and investment towards a low carbon, resilient and sustainable future was agreed by 195 nations at the 21st Conference of the Parties of the UNFCCC in Paris and adopted by consensus on 12 December 2015

International cases

The IPCC assessments are the scientific underpinning of international negotiations and provide unique insights into extreme events which call for a global treaty. The design of climate policy is influenced by how individuals and organisations perceive risks and uncertainties and take them into account. The major agreements in dealing with climate change are discussed below:

The United Nations' Framework Convention on Climate Change (UNFCCC)

The UNFCCC entered into force on 21 March 1994. The 195 countries that have ratified the Convention are called Parties to the Convention. The UNFCCC is a "Rio Convention", adopted at the "Rio Earth Summit" in 1992.

The Convention puts the onus on developed countries to lead the way. The idea is that, as they are the source of most past and current Green House Gas emissions, industrialized countries are expected to do the most to cut emissions on home ground.

The Convention takes this into consideration by accepting that the share of Green House Gas emissions produced by developing nations will grow in the coming years. Nonetheless, in the interests of fulfilling its ultimate goal, it seeks to help such countries limit emissions in ways that will not hinder their economic progress

The Kyoto Protocol

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets. Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities."

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords." Its first commitment period started in 2008 and ended in 2012.

Under the Protocol, countries must meet their targets primarily through national measures. However, the Protocol also offers them an additional means to meet their targets by way of three market-based mechanisms: (i) International Emissions Trading (IET); (ii) Clean Development Mechanism (CDM); and (iii) Joint implementation (JI).

The mechanisms help to stimulate green investment and help Parties meet their emission targets in a cost-effective way.

The Cancun Agreements

The Cancun Agreements form the pillars of the largest collective effort the world has ever seen to reduce emissions, in a mutually accountable way, with national plans captured formally at international level under the banner of the UNFCCC.

The Cancun Agreements, reached on December 11 in Cancun, Mexico, at the 2010 United Nations Climate Change Conference, represented key steps forward in capturing plans to reduce Green House Gas emissions, and to help developing nations protect themselves from climate impacts and build their own sustainable futures. The main objectives include: (i) Mitigation; (ii) Transparency of actions; (iii) Technology; (iv) Adaptation; (v) Forests; (vii) Capacity building; and (viii) Finance.

The objectives also include setting up the Green Climate Fund to disburse \$100 billion per year by 2020 to developing countries to assist them in mitigating Climate Change and adapting to its impacts.

The Durban Agreement

The United Nations Climate Change Conference at Durban in 2011, delivered a breakthrough on the international community's response to Climate Change.

The Durban outcomes looked to address these challenges in a more connected way by embodying a road map for implementation. On this map, four main areas of coordinated and complementary action and implementation, designed also to build and preserve trust among countries, were agreed viz. (i) Second commitment period of the Kyoto Protocol; (ii) The launch of a new platform of negotiations under the Convention to deliver a new and universal Green House Gas reduction protocol, legal instrument or other outcome with legal force by 2015 for the period beyond 2020; (iii) Conclusion in 2012 of existing broad-based stream of negotiations; and (iv) To scope out and then conduct a fresh global Review of the emerging climate challenge, based on the best available science and data.

National Plans, Programs & Policies

In India climate change suffered a back stage due to the lack of awareness and was not given adequate priority and the changes was not significant in the earlier years. Now the climate change effects are hard to endure because the untimely excessive and insufficient rains have become quite common in many regions affecting agriculture, further endangering food security to sea level rise and the accelerated erosion of coastal zones, increasing intensity of natural disasters, species extinction and spread of various diseases. Climate change will affect more poor people who are slum dwellers, squatters, migrants, people living in informal settlements which are generally situated in vulnerable areas. The following are the important programs implemented at the national level for neutralising the effect of climate change in the country.

India and Emissions:

India's emissions are estimated to be of the order of 1331.6 million tonnes of the carbon dioxide equivalent Green House Gas (GHG) emissions in 2007. The emissions indicate an annual growth of 4.2% from the levels in 1994. Whereas India's CO₂ emissions are only about 4% of total global CO₂ emissions and much less if the historical concentrations are taken into account. Still India has been conscious of the global challenge of Climate Change.

(i) National Environment Policy

National Environment Policy, 2006 outlines essential elements of India's response to Climate Change. These, inter-alia, include adherence to principle of common but differentiated responsibility and respective capabilities of different countries, identification of key vulnerabilities of India to Climate Change, in particular impacts on water resources, forests, coastal areas, agriculture and health, assessment of the need for adaptation to Climate Change and encouragement to the Indian Industry to participate in the Clean Development Mechanism (CDM).

(ii) Prime Minister's Council on Climate Change

The Prime Minister office set up a High Level advisory group on climate change issues which include: Government Representatives and Non- Government Members. The Council coordinates National Action Plans for assessment, adaptation and mitigation of Climate Change. It also advises the Government on proactive measures that can be taken by India to deal with the challenge of Climate Change. It will also facilitate inter-ministerial coordination and guide policy in relevant areas.

(iii) The National Action Plan on Climate Change (NAPCC)

The National Action Plan on Climate Change (NAPCC) coordinated by the Ministry of Environment and Forests is being implemented through the nodal Ministries in specific sectors/areas. National Action Plan on Climate Change (NAPCC) outlines existing and future policies and programs addressing climate mitigation and adaptation.

The plan identifies eight core "national missions" viz. National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a "Green India", National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change.

(iv) Climate Change Action Programme (CCAP)

Various other science initiatives are planned by the Ministry as part of the Climate Change Action Programme (CCAP). These include National Carbonaceous Aerosols Programme (NCAP), Long Term Ecological Observatories (LTEO), and Coordinated Studies on Climate Change for North East region (CSCCNE). The NCAP is a major activity involving multi-institutional and multi-agency study. e-Action Programme (CCAP). These include National Carbonaceous Aerosols Programme (NCAP), Long Term Ecological Observatories (LTEO), and Coordinated Studies on Climate Change for North East region (CSCCNE). The NCAP is a major activity involving multi-institutional and multi-agency study launched in 2011. In this initiative, Ministry of Environment and Forests will collaborate with the Ministry of Earth Sciences, the Indian Space Research Organization, the Ministry of Science and Technology and other associated agencies to enhance the understanding of the role of Black Carbon in climatic change through monitoring and assess the impacts of black carbon through various modeling techniques. The work programme envisages three Working Groups namely long term Monitoring of Aerosol, Impact of Aerosol on Himalayan Glaciers and Modeling of Black Carbon emissions inventory India and assessment of its impacts.

(v) National Action Plan on Climate Change (NAPCC) - 2008

The guiding principles of the plan are:

- Inclusive and sustainable development strategy to protect the poor
- Qualitative change in the method through which the national growth objectives will be achieved i.e. by enhancing ecological sustainability leading to further mitigation
- Cost effective strategies for end use demand side management
- Deployment of appropriate technologies for extensive and accelerated adaptation, and mitigation of green house gases
- Innovative market, regulatory and voluntary mechanisms to promote Sustainable Development
- Implementation through linkages with civil society, local governments and public-private partnerships
- International cooperation, transfer of technology and funding

India has among the world's lowest per capita greenhouse gas (GHG) emissions, yet is the fifth largest source of GHG globally when accounted in total tonnes (Pew Centre 2008).

This trend toward a 'multi-level governance' situation, with a more independent sub-national dimension, makes it important to study the forces that are driving and shaping policy at each level.

(vi) Indian Network for Climate Change Assessment (INCCA)

Steps have also been taken to increase capacity at the institutional level for conducting research into Climate Change science and making necessary assessments. The Ministry has already set up a network, namely the Indian Network for Climate Change Assessment (INCCA) comprising of 127 research institutions tasked with undertaking research on the science of Climate Change and its impacts on different sectors of economy across various regions of India. INCCA has helped the Ministry put together its Green House Gas (GHG) Emissions Inventories and in carrying out other scientific assessments at more frequent intervals.

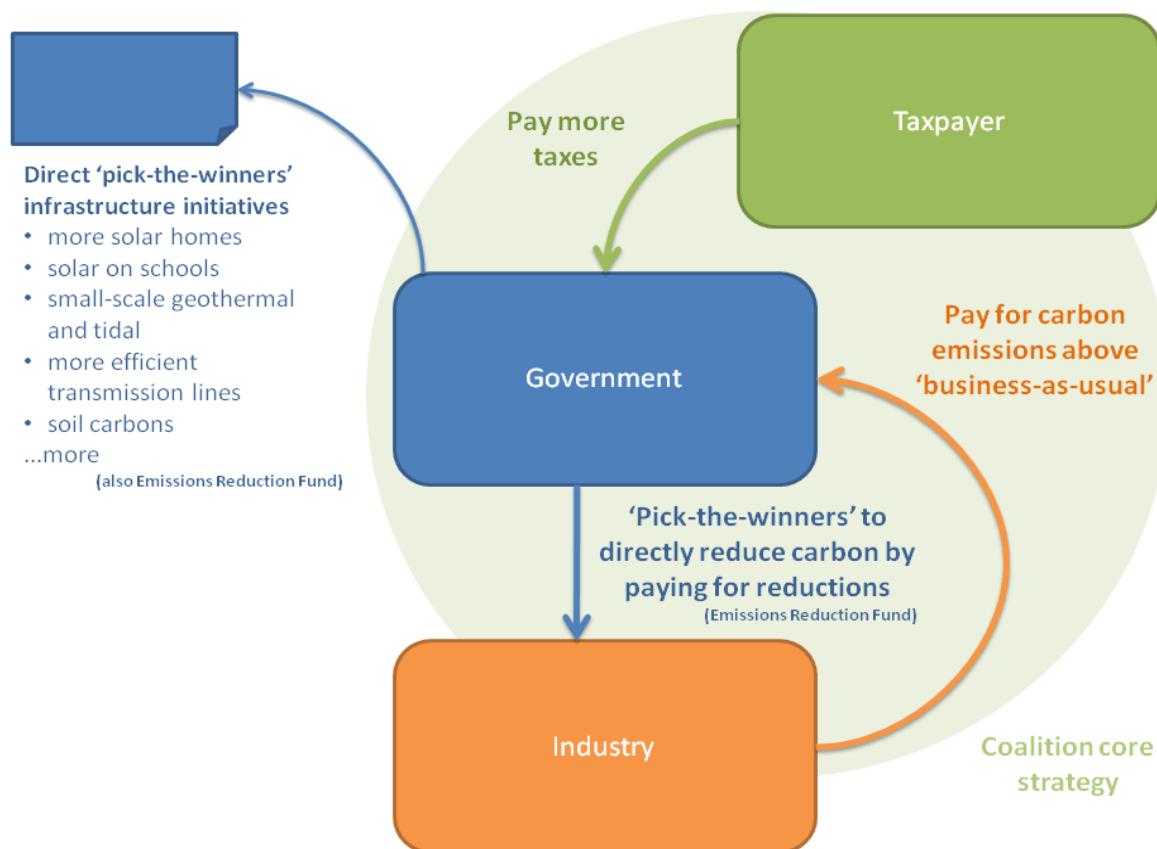


Figure 2 Coalition strategy for climate change policy

(vii) Twelfth Five-Year Plan and Climate Change

The Government has a domestic mitigation goal of reducing emissions intensity of Gross Domestic Product (GDP) by 20-25% by 2020 in comparison with 2005 level. The energy intensity of India's output has shown a declining trend owing to improvements in energy efficiency, autonomous technological changes and economical use of energy.

"Climate Change Action Programme (CCAP)" - a new thematic/umbrella Scheme has been approved by the Planning Commission for implementation during the 12th Five year Plan. The scheme aims at advancing scientific research, information and

assessment of the phenomenon of Climate Change, building an institutional and analytical capacity for research and studies in the area of Climate Change, and supporting domestic actions to address Climate Change through specific programmes and actions at the national and state level. The scheme comprises of eight activities, of which, three relate to scientific studies on Climate Change, two to institution and capacity building and three others to domestic and international actions.

(vii) Coalition core strategy

While framing the climate policy it is important that an effective balance of the major roles played by the climate change agents have to be considered. The major players of climate change include the government, local leaders, major emitters like industries, victims of climate change ie, the general public. The coalition strategy involves balancing of the national and the local agents for neutralising the effects of climate change which is represented in Figure 2.

An effective balance of TD and BU strategy is involved where the government should take infrastructure initiatives like encouraging solar homes, solar on schools, more efficient transmission lines etc and should identify the major emitters to directly reduce carbons by paying for reductions. The industries in turn have to pay for the carbon emissions above the prescribed standards.

3. FISHERIES IMPACTS

Climate change is modifying the distribution of marine and freshwater species. In general, warm-water species are being displaced towards the poles and are experiencing changes in the size and productivity of their habitats. In a warmed world, ecosystem productivity is likely to be reduced in most tropical and subtropical oceans, seas and lakes and increased in high latitudes. Increased temperatures will also affect fish physiological processes; resulting in both positive and negative effects on fisheries and aquaculture systems depending on the region and latitude. Climate change is already affecting the seasonality of particular biological processes, altering marine and freshwater food webs, with unpredictable consequences for fish production. Increased risks of species invasions and spreading of vector-borne diseases provide additional concerns. Differential warming between land and oceans and between polar and tropical regions will affect the intensity, frequency and seasonality of climate patterns (e.g. El Niño) and extreme weather events (e.g. floods, droughts and storms). These events will impact the stability of related marine and freshwater resources. Sea level rise, glacier melting, ocean acidification and changes in precipitation, groundwater and river flows will significantly affect coral reefs, wetlands, rivers, lakes and estuaries; requiring adaptive measures to exploit opportunities and minimise impacts on fisheries and aquaculture systems.

Type of changes	Climatic variable	Impacts	Potential outcomes for fisheries
Physical environment	Ocean acidification	Negative effects on calciferous animals, including slowed rates of coral growth	Declines in <i>production</i>
	Warming of upper ocean layers	Poleward shifts in plankton and fished species	Changes in <i>production</i> and <i>availability</i> of fished species

		Changes in timing of phytoplankton blooms Changing zooplankton composition	Potential mismatch between prey (plankton) and predator (fished species) and declines in <i>production</i>
	Sea level rise	Loss of coastal habitats. Saline intrusion into freshwater habitats	Reduced <i>production</i> of coastal marine and freshwater systems and related fisheries
Fish stocks	Higher water temperatures	Changes in physiology and sex ratios of fished species Altered timing of spawning, migrations, and/or peak abundance	Changes in timing and levels of <i>productivity</i> across marine and freshwater systems
		Increased invasive species, diseases and algal blooms	Reduced <i>production</i> of target species in marine and fresh water systems
	Changes in ocean currents	Effects on fish recruitment	Changes in abundance of juvenile fish and therefore <i>production</i> in marine and fresh water
Ecosystems	Reduced water flows & increased droughts	Changes in lake water levels Changes in dry water flows in rivers	Reduced lake <i>productivity</i> Reduced river <i>productivity</i>
	Increased frequency of ENSO events	Changes in timing and latitude of upwelling	Changes in pelagic fisheries <i>distribution</i>
	Higher water temperatures	Increased frequency and severity of coral bleaching events	Reduced coral reef fisheries <i>productivity</i>
		Changes in stratification, mixing, and nutrients in lakes and marine upwellings	Changes in <i>productivity</i>
Coastal infrastructure and fishing operations	Sea level rise	Coastal profile changes, loss of harbours and homes Increased exposure of coastal areas to storm damage	Costs of adaptation make <i>fishing less profitable, increased costs of insurance and/or rebuilding, increased vulnerability of coastal households.</i>

	Increased frequency of storms	Fewer days at sea, increased risk of accidents Aquaculture installations (coastal ponds, sea cages) at greater risk of damage	<i>Reduced viability</i> of fishing and fish-farming as livelihood options for the poor; <i>reduced profitability</i> of larger-scale enterprises, <i>increased costs</i> of insurance.
Inland fishing operations and livelihoods	Changing levels of precipitation	Where rainfall decreases, reduced opportunities for farming, fishing and aquaculture as part of rural livelihood systems	<i>Reduced diversity</i> of rural livelihoods; increased risks in agriculture; greater reliance on non-farm income
	More droughts or floods	Damage to productive assets (fish ponds, weirs, rice fields, etc.) and homes	<i>Increased vulnerability</i> of riparian and floodplain households and communities
	Less predictable wet/dry seasons	Decreased ability to plan seasonal livelihood activities	

Impact study

The impacts are likely to be different depending on the region, the species, and the state of the stocks – and can be either positive or negative. The effects of climate change on fisheries will impact both at sectoral and national levels. Climate change will probably affect production volumes, species mix, as well as methods of fishing. This will have consequences on the livelihoods and earnings of fisher-folk and on other actors operating in the fisheries sector. Moreover, a decline of fisheries due to the overexploitation of resources and climate change impacts may have wider negative implications at the national level affecting exports, employment, growth and GDP.

Fishers Impacts

The concern over the consequences of global warming for the food security and livelihoods is increasing for the world's fisherfolk and the nearly 1.5 billion consumers who rely on fish for more than 20% of their dietary animal protein. With mounting evidence of the impacts of climate variability and change on aquatic ecosystems, the resulting impacts on fisheries livelihoods are likely to be significant, but remain a neglected area in climate adaptation policy. Drawing upon our research and the available literature, and using a livelihoods framework, this paper synthesizes the pathways through which climate variability and change impact fisherfolk livelihoods at the household and community level. We identify current and potential adaptation strategies and explore the wider implications for local livelihoods, fisheries management and climate policies. Responses to climate change can be anticipatory or reactive and should include: (1) management approaches and policies that build the livelihood asset base, reducing vulnerability to multiple stressors, including climate change; (2) an understanding of current response mechanisms to climate variability and other shocks in order to inform planned adaptation; (3) a recognition of the opportunities that climate change could bring to the sector;

(4) adaptive strategies designed with a multi-sector perspective; and (5) a recognition of fisheries potential contribution to mitigation efforts.

The changes in distribution, species composition and habitats will require changes in fishing practices and aquaculture operations, as well as in the location of landing, farming and processing facilities.

The impact on infrastructure, ranging from landing and farming sites to post-harvest facilities and transport routes also affect safety at sea and settlements, with communities living in low-lying areas at particular risk. Water stress and competition for water resources will affect aquaculture operations and inland fisheries production, and are likely to increase conflicts among water dependent activities.

Livelihood strategies will have to be modified, for example, with changes in fishers migration patterns due to changes in timing of fishing activities. Reduced livelihood options inside and outside the fishery sector will force occupational changes and may increase social pressures. Livelihood diversification is an established means of risk transfer and reduction in the face of shocks, but reduced options for diversification will negatively affect livelihood outcomes (Kirit N Shelat et al. 2015; Dagar and Shakuntla Devi Dagar, 2015).

There are particular gender dimensions, including competition for resource access, risk from extreme events and occupational change in areas such as markets, distribution and processing, in which women currently play a significant role.

The implications of climate change affect the four dimensions of food security:

- availability of aquatic foods will vary through changes in habitats, stocks and species distribution;
- stability of supply will be impacted by changes in seasonality, increased variance in ecosystem productivity and increased supply variability and risks;
- access to aquatic foods will be affected by changes in livelihoods and catching or farming opportunities;
- utilization of aquatic products will also be impacted and, for example, some societies and communities will need to adjust to species not traditionally consumed.

4. LESSONS FROM OTHER COUNTRIES

Marine capture fisheries are at a crossroad. Their governance must incorporate a broader vision that includes the creation of both public and private benefits and continuous adaptation to change within and beyond fisheries. Institutional change that aligns private with public interests and builds on the experiences of successful fisheries governance can position fisheries in a changing world to conserve marine ecosystems and sustain livelihoods. The potential gains include restored habitats, biodiversity conservation, larger fish stocks, greater returns to fishers and their communities, increased food security, and poverty alleviation.

Bangladesh

Bangladesh is highly vulnerable to the effects of climate change in fisheries because of its economics, diets and social dependencies on fisheries sector. Climate change effects on fresh water culture fisheries in Bangladesh may be negative. Climate change affects the rainy season, increases the precipitation, creates the flood, and increases the fish habitat and if we take the proper adaptation method, it will boost up the production of inland capture fisheries. In coastal area, soil-water salinity and sea level rises have both positive and negative effect. Soil-water salinity and sea level rises may increase the shrimp and other brackish water fish and shell fish culture area, which will increase the production of high value fish products. Climate changes also affect the Sunderban (Roy and Hossain, 2015; Guha et al. 2015; Mukherjee, 2016), the world largest mangrove forest, resulting the loss of nursery ground of many

marine fish species and also abolishes them. As a consequence of climate change, pH change, temperature increase may affect the marine fish species and also increase the occurrences of intensive tropical cyclone and surge in the Bay of Bengal.

USA & Canada

The commercial fishery is managed by limiting the number of licences, area licences, and restrictions on fishing gear, areas, and seasons. Several buy-back schemes to reduce the number of licences have been instituted. The recreational fishery is managed by catch limits and closed seasons and areas. Climate change is and will affect both the ocean and fresh water environments of salmon, positively or negatively affecting salmon stocks depending on where they spawn and their ocean migration route. Recent changes in ocean temperatures resulted in large and rapid changes in abundance, changes which could occur again in the future. Climate change may impact fisheries governance as fisheries management science struggles to assess the impact of climate change on Pacific salmon, having to depend less on science than in the past. The most likely management structure in the foreseeable future involves continuation of the current system of a limited number of licences for each area and type of fishing gear. Management has tended to focus on maximizing the sustainable yield allowing as much fishing pressure as possible. Although the total number of licences is limited by area and gear type, fishers have responded by increased investment and effort. The values of the limited number of transferable licences are significant. The salmon treaty between Canada and the United States allocating the migratory salmon may need to be re-negotiated, even with uncertainty about future migration patterns. Agreements on fishing rights with aboriginal groups may also have to be re-negotiated.

France

Long-term changes in marine fish communities; investments and capital dynamics of French fleets exploiting the Bay of Biscay fisheries. A set of nine commercial species represent the targeted production of the French fleet in the Bay of Biscay: two pelagic species (anchovy and sardine), four demersal (cuttlefish, seabass, pollock and hake), and three benthic (monkfish, nephrops, and sole). The Bay of Biscay fisheries are mainly managed under conservation measures (TACs allocated under the Common Fishery Policy). Governance measures have been defined through capacity reduction programs since 1990. One of the main access regulation measures that were setup in the French context at the end of the 1980s was the adoption of the "Permis de Mise en Exploitation" or operation permit system, leading to a de facto limited entry scheme. Several studies of the Bay of Biscay shelf ecosystem have shown warming of surface waters during the last three decades. From recent research it appears a positive potential impact of climate change for anchovy and a negative potential impact for Pollack and monkfish. However, it is not possible to clearly separate the relative role of fishing impacts and the climate induced changes on the community. For the two "boreal species" (monkfish and Pollack), the impact of climate warming might be expected as cumulative with negative effects of fishing. For anchovy fished in the Bay of Biscay, the exploitation depends to a large extent on the yearly recruitment success, counteracting the potentially positive effect of global warming.

Australia

The Western and Central Pacific is a complex ocean fishery with island nations and foreign fishers taking purse seine and long line tuna catches in area to the north of Papua New Guinea. Independent states in the Pacific have several regional organizations such as the South Pacific Forum Fisheries Agency (SPFFA) and the Western Pacific Fishery Commission (WPFC). The majority of fishery production is by Distant Water Fishing Nations (DWFNs) under access agreements to FFA member states. Gaining economic benefits from domestic tuna fishery processing by island states is a priority to supplement income from access licence fees. The WPFC need

sustainable regional catch limits for long term prosperity. A massive ocean West to East water movement is related to La Niña years and will increase with the frequency and intensity of El Niño conditions [34]. The purse seine tuna fishery coincides with movement of the warm water front, strongly suggesting that there will be changes to this ocean fishery as ocean temperatures rise. Climate change will impact all industrial fishers and processors due to changes in the location of fishing sites with vessels spending several months of the year inside a national EEZ, as fish move to the high seas, or to an adjacent EEZ. This movement has implications for licensing of foreign fishing vessels and tuna canneries using local suppliers. The increased risk of fish availability will have implications for past and future capital investment past and future and labour requirements. Fishery governance systems need to be aware of potential climate change impacts in annual catches and the location of fish schools, increasing the variability in an already complex system.

Policy support

The policies are rules that can contribute to reform the existing economic distortions resulting from climate change. Complementary policies have to be adopted to restructure the economies of the affected, focusing on the identified felt needs that could have a good community response which help in identifying new opportunities. Therefore the climate policy should be designed in such a way anticipating the responses to climate change, to exploit the new opportunities and to minimise the impacts. The different approaches to climate change policies are discussed below;

Top down approach

The top down approach involves prioritisation of needs and developing policy elements based on the scientific knowledge. Identifying the problems ie, the ecological and environmental pressures on vulnerable ecosystems lead to negative ecosystem transformations thereby threatening the natural resources which in turn affect the fisher community who are dependent on the water bodies for their livelihood which causes labour migration and displacement in this sector which is the first phase. Once the problem is identified strategic planning process start at the second phase where new approaches and methods have to be adopted in order to address the issues and impacts of climate change. The ever best method is to arrange stakeholder workshops by creating awareness and imparting research outputs to the local officials who are the first responders when an extreme affects their community which will help in framing new strategies and plans to mitigate the effects of climate change so that they are empowered to address the issues by framing local policies including the protection of physical environment, public safety and can be better adapted to the climate change. These policies and plans are implemented in the third stage by creating awareness among the fisher community about the response mechanism to the climate variability and the recognition of opportunities which will bring to the sector. Top down frameworks tend to overlook the impacts and are well versed decisions to maintain the health of fisheries.

Bottom up approach

Bottom up approach is a participatory approach which focuses on the current felt needs of the fishers like low income, labour displacement, unemployment, migration, increased cost of fishing operations and the rising threat of food security among the fisher community. The second phase involves the micro planning process to address the felt needs of the community through desk study and interviews with the stakeholders for identifying the alternate livelihood options or the opportunities created by the climate change. The implementation phase involves imparting skill trainings for the identified income generation activities and the successful implementation of the conservation activities.

The existing climate change policies are blanket measures taken at a national level. The policies are not specific in terms of target population (fishers). In order to have an effective mechanism, a combination of Top Down approach and a Bottom Up approach is required.

Balancing of result approach

Balancing of top down and bottom up results in improving planning with local initiatives involves identifying and supporting the change champions (agents), and other efforts that are already underway. For an effective policy implementation balancing of result approach is essential where policy implementation is carried out through top to bottom whereas the felt needs are identified through bottom top approach.



E.g., providing subsidy, funds, trainings etc.e.g.; needs identified, alternate livelihood options

The current felt needs of the fishers are to be identified like labour displacement, seasonal unemployment etc which pave the way for providing alternate livelihood opportunities for the fisher community. The government has to sanction funds for providing skill trainings and other basic facilities for successfully placing the fishers in an alternate employment for their sustenance.

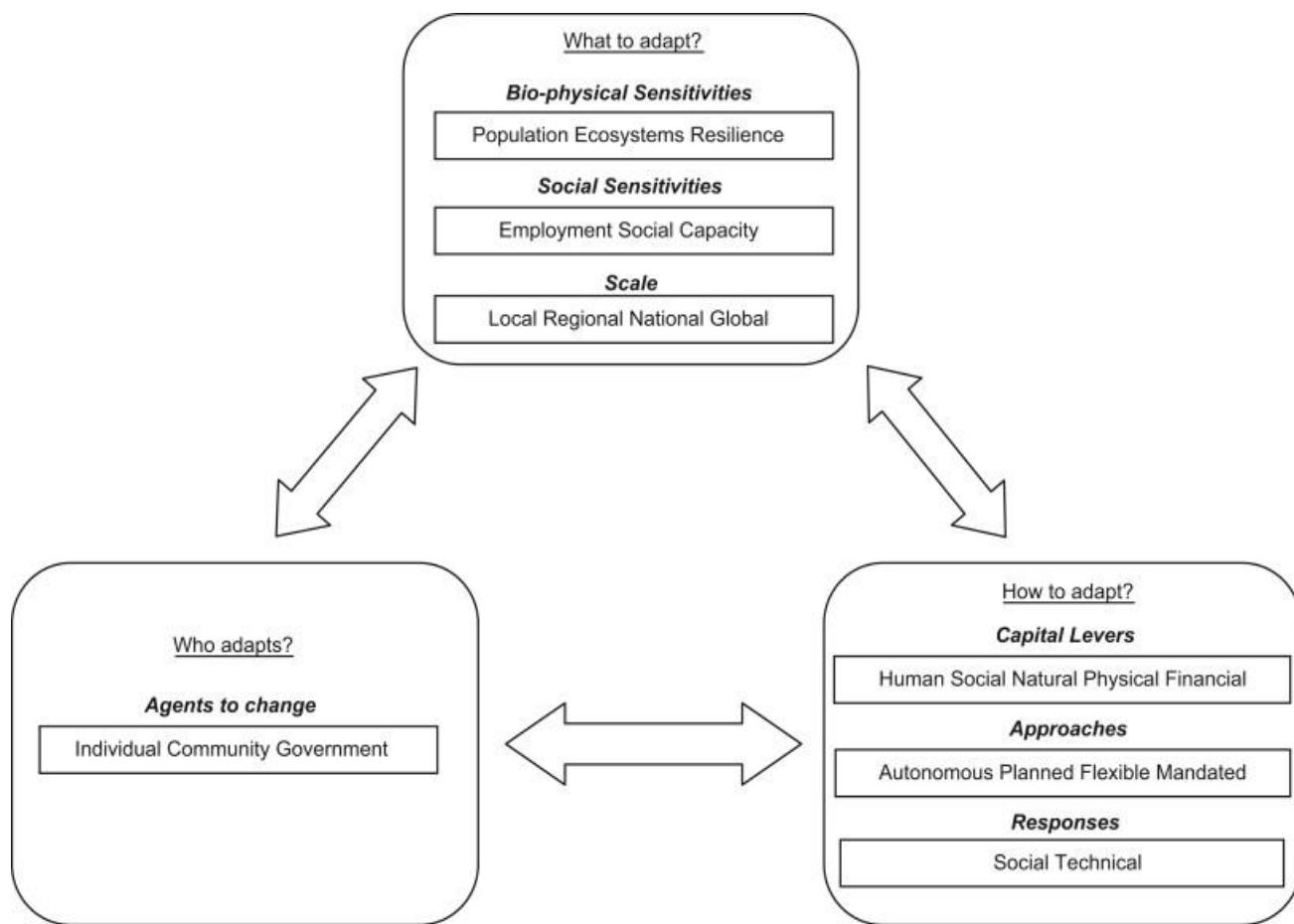
5. CONCLUSION

The climate changes and the increasing climatic variability are likely to exert pressure on marine fisheries sector and in the following years the situation will be more complex. Actions plans at the national level and linkages with regional policies have to be streamlined to be more specific focus. The extreme occurrence of sea level rise, glacier melting, ocean acidification and changes in precipitation, groundwater and river flows will significantly affect coral reefs, wetlands, rivers, lakes and estuaries will result in the spatial displacement of fisheries and the fishers requires the adaptive measures to be adopted in fisheries livelihoods which remain neglected in the climate adaptation policy. Therefore the climate policy should be designed in such a way anticipating the responses to climate change, to exploit the new opportunities and to minimise the impacts. The policy should be coupled to broader economic reform opportunities to maximise win - win opportunities. The policy makers should consider funding mechanisms which is relevant to the adaptation efforts in the fishery sector.

6. RECOMMENDATIONS

- Strengthen the global governance of fisheries
- Communicate clearly with the stakeholders, including public, on how climate change will affect fisheries
- Extend the use of rights – based management systems
- Protect ecosystem
- Stop environmentally harmful subsidies
- Focus on aquaculture and demand for sustainably caught seafood
- A number of mitigation and adaptation measures can be identified including:

- Estimating future production levels taking into account environmental variability and the impact that this may have on the growth of a stock and on its reproductive and mortality rates;
- Re-building fish stocks and improving fisheries governance, including institutional building of fisheries administrations and representative sector organisations;



- Developing tools for decision making under management uncertainties and expand societal knowledge;
- Adjusting fleet and infrastructure capacity and flexibility, controlling fishing effort and enhancing management systems;
- Creating alternative employment and livelihood opportunities, especially investing in education and training in alternative occupations;
- Expanding aquaculture along sustainable and equitable development goals with appropriate legal and regulatory framework;
- Enhancing emergency preparedness and response, and developing insurance and social safety schemes in the fisheries sector;
- Applying internationally fishery agreements and conventions more vigorously, and strengthen if necessary to accommodate and support climate change related activities
- Integrating climate considerations in investment in the sector, especially in infrastructure;
- Developing options for product and export diversification through appropriate economic and trade policies;

- Adopting measures to reduce the carbon footprint of the fisheries sector (promotion of fuel efficient methods, support low impact aquaculture, increase energy efficiency for fishing and storage methods) and providing payment for environmental services, particularly offering additional livelihoods options to poorer communities.
- Marketing and labelling of goods produced following recognized energy efficient standards (eco- labelling etc.)
- Mobilising financial resources to support such adaptation actions will be essential. Negotiators and policy makers have considered a number of funding mechanisms which may be relevant to adaptation efforts in the fishery sector.
- The Adaptation Fund, established to finance concrete adaptation projects and programmes in developing country –parties to the Kyoto Protocol;
- Multilateral and bilateral donors development assistance, including trade related development assistance programmes, like Aid for Trade (A4T) and the Enhanced Integrated Framework (EIF).

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