Climate Change SSF

SAMUDRA Monograph

Climate Change and Fisheries: Perspectives from Small-scale Fishing Communities in India on Measures to Protect Life and Livelihood

Venkatesh Salagrama

International Collective in Support of Fishworkers
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Acronyms and Abbreviations

AIG	alternative income generation
CCPMS	climate change preparedness and mitigation strategy
CCRF	Code of Conduct for Responsible Fisheries
CESS	Centre for Earth Science Studies
CIFE	Central Institute of Fisheries Education
CIFRI	Central Inland Fisheries Research Institute
CIFT	Central Institute of Fisheries Technology
CMFRI	Central Marine Fisheries Research Institute
CRZ	coastal regulation zone
CVI	coastal vulnerability index
CSO	civil society organization
DAT	distress alert transmitter
DOF	Department of Fisheries
FISHMARC	Fisheries Management Resource Centre
FRL	full reservoir level
FRP	fibre-reinforced plastic
GHG	greenhouse gas
GPS	global positioning system
HACCP	hazard analysis critical control points
HP	horsepower
HSD	high-speed diesel
IBE	inboard engine
ICAR	Indian Council of Agricultural Research
ICZMP	integrated coastal zone management programme
INCCA	Indian Network for Climate Change Assessment
IRTC	Integrated Rural Technology Centre
KSMTF	Kerala Swatantra Matsya Tozhilali Federation

LPG	liquefied petroleum gas
MFRA	Marine Fishing Regulation Act
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MLA	Member of Legislative Assembly
MMKS	Maharashtra Macchimar Kruti Samiti
MOEF	Ministry of Environment and Forests
MSSRF	M.S. Swaminathan Research Foundation
NAPCC	National Action Plan on Climate Change
NCDC	National Co-operative Development Corporation
NFF	National Fishworkers' Forum
NICRA	National Initiative on Climate Resilient Agriculture
OBM	outboard motor
PFZ	potential fishing zone
PPT	parts per thousand
PRI	*panchayati raj* institution
SAPCC	State Level Strategy and Action Plan
SDB	Sundarban Development Board
SETTD	Socio Economic Evaluation and Technology Transfer Division
SEZ	special economic zone
SIFFS	South Indian Federation of Fishermen Societies
SIFT	State Institute of Fisheries Technology
UNFCCC	United Nations Framework Convention on Climate Change
VAT	value-added tax

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EXECUTIVE SUMMARY

The study on "Climate Change and Fisheries: Perspectives from Small-scale Fishing Communities in India on Measures to Protect Life and Livelihood" has been undertaken by the International Collective in Support of Fishworkers (ICSF) with the following objectives:

- assess perceptions of fishing communities about the impact of climate variability/change on their lives and livelihoods;
- assess knowledge, institutions and practices of fishing communities of relevance to climate-change preparedness;
- identify adaptation and mitigation measures that may need to be adopted by fishing communities and the State in relation to climate change; and
- propose measures to protect the lives and livelihoods of small-scale fishing communities in the context of climate-change policies and programmes at different levels.

The study involved consultations with key fisheries-based stakeholders in selected locations in four States of India (Maharashtra and Kerala on the west coast, and West Bengal and Andhra Pradesh on the east coast). The methodology was piloted in April 2011 in Maharashtra. It was subsequently refined, and detailed consultations were undertaken in all four locations during July-August 2011. This report presents the key findings from the field interactions.

The study finds growing evidence that, in the perception of fishing communities, climate change has been influencing the viability of fishing operations, requiring fishers to take a wide range of adaptive and mitigation measures. However, climate change needs to be understood as adding a new dimension to the crisis already faced in the fisheries sector; field interactions indicate that climate change follows upon, aggravates, and is, in turn, aggravated by the larger processes affecting fisheries, and hence cannot be viewed as a standalone entity. It is also quite clear that while climate change is a global process, it is aggravated by local processes and practices, which means that efforts to address it must cover a range of activities from the global level down to that of the individual fisher in a remote fishing community. As such, the efforts to address climate change must encompass a wider range of activities, extending beyond those directly focusing on climate change alone, and

concentrating also on enhancing the overall resilience and adaptive capacities of fishing communities.

The key areas relating to climate change that have an impact upon the lives and livelihoods of fishers include:

- sea level
- sea-surface temperature
- sea-surface salinity
- wind patterns
- seasonality and seasonal patterns
- rainfall
- natural disasters
- waves and currents
- tidal action
- mud flows and turbidity
- shoreline changes (erosion and sedimentation)

The factors contributing to changes in these areas are frequently mixed, originating as much (often, more) from local processes as from global changes, and could be broadly categorized into natural (or global), fisheries and non-fisheries (external) factors. While fishers are frequently unable to understand or explain the natural processes affecting the changing sea and environmental conditions, their understanding of the more immediate causes involving the fisheries and the non-fisheries factors is quite good. Although the direct contribution of the fisheries sector to aggravating climate-change processes is considered to be low, there is evidence that some practices and processes within the sector could be exacerbating the impacts of climate change on the lives and livelihoods of fishers. These include:

- growing fishing fleet size, engine power and capacity;
- destructive and ecologically unsound fishing practices; and
- poor engine and fuel efficiencies.

External (non-fisheries) factors are more significant in terms of aggravating climate-change-related processes, and include a range of processes relating to, among others, industries, nuclear/thermal power plants, tourism, defence, ports and shipping, agriculture and irrigation, mining, and urban development. Their impacts include:

- pollution;
- competition for coastal space and resources;

- shoreline changes; and
- destruction of fish habitats and sensitive ecosystems.
- Increasing population, both within and outside the fishing communities, is said to put extra pressure on the resources, and further aggravate the climate-change processes and their impacts.

The impacts of the climate-change processes—which are frequently mixed up with those of a number of other factors in the fisheries sector—are felt by different fisheries stakeholders in the following areas:

- access to, and availability of, fish and other coastal resources (such as mangroves);
- fishing systems and conditions;
- terms of access to fishing grounds;
- fishing investments and returns;
- access to markets and terms of fish trade;
- quality of life;
- sea-safety concerns;
- traditional knowledge, practices and governance systems; and
- domestic economies.

The changed overall context contributes to increasing uncertainty and fluctuating incomes, which lead to contrasting responses on the east and west coasts. On the east coast (Andhra Pradesh and West Bengal), the fishers tend to fish less and diversify into several activities, ranging from working as fishing crew in other (west-coast) States to unskilled, low-paying, non-fisheries occupations within, and beyond, their area. On the west coast, the increasing uncertainty leads to a strategy to survive by fishing, for example, by investing more in the activity in order to go farther out into the sea and catch more fish. For the immediate future, this strategy may appear to be successful, but the long-term implications remain uncertain.

The impacts of climate change and related processes on women in fisheries are perceived to be significant on both sides of the coast, marginalizing women from their traditional occupations and increasing their burden by requiring them to earn more for household incomes.

In the face of the challenges affecting their livelihoods, the fishing communities are seen to be undertaking a range of adaptive and mitigation measures, not all of which are successful and some of which may even aggravate their overall condition as well as the climate-change processes. Some of the fisheries-related coping strategies adapted by the fishers to cope with the stresses they have been

facing (including the impacts induced by climate change) relate to:

- diversification in terms of targeted fish and fishing grounds;
- changes to fishing duration and fishing systems (in terms of boat sizes and onboard equipment, fishing gears, techniques and engine efficiencies);
- usage of migrant workers and technological innovations, alongside other cost-saving measures; and
- changing ownership and sharing patterns.

At the household level, occupational diversification is on the rise, while there are conscious efforts to educate the younger generation to give them an option to move out of the fisheries.

Currently, the level of institutional responses to climate-change impacts on fisheries is still in the early stages, and focused on technical aspects; the human and socioeconomic implications of the various changes are yet to be fully understood. Though the coast and coastal communities—coastal fishing communities, in particular—are widely regarded as among the most impacted by climate change, there is no specific focus in the National Action Plan on Climate Change (NAPCC) on the coastal ecosystem or on coastal communities. None of the eight missions set up under the NAPCC relate to the coast, and there is no specific mission on the coast. Moreover, in the State-level action plans currently being prepared, as well as in the research being undertaken, there is no effort to consult with coastal communities to seek their views on the perceived impact of climate change and the sort of responses that are needed.

In the absence of the fishers' representation in the decision-making processes, the various conservation measures being undertaken to protect sensitive species or ecosystems, seen as contributing to climate-change adaptation—and the way they are implemented—have been having an adverse impact on the fishing communities, further exacerbating their conditions. The role of civil society organizations (CSOs) in dealing with climate change in fisheries at the local levels is very limited, while the capacity of the fishworker organizations will need to be greatly strengthened before they can meaningfully assist fishing communities to cope with some of the changes or undertake mitigation measures or influence climate-change policy.

The existing institutional mechanisms of relevance to climate change and fisheries are characterized by:

- multiplicity of legal systems and processes, and the absence of unified/integrated frameworks to cope with the issues;
- protection and conservation programmes that attempt to exclude or

constrain livelihood activities in ecologically sensitive areas, aggravating the crisis of dependent communities;

- weakness of the support systems to help the fishers cope with the changes and the institutional responses to them;
- government programmes that aggravate the crisis;
- poor implementation, or weakening, of existing legislation;
- lack of controls on upstream processes; and
- lack of space for fishers in the decision-making/policy-formulation processes.

The final section of the study discusses the measures to help the fishers cope better with climate change and its impacts. While a comprehensive strategy to protect the lives and livelihoods of fishing communities in the context of climate change, which also addresses the issues identified above as well as the other major drivers of climate change, is obviously needed, this section identifies selected key measures considered as of high priority by fishing communities:

- enhance focus on coastal issues and representation of fishing communities in policymaking and research processes;
- increase awareness among fishing communities and other stakeholders;
- improve fisheries management through bottom-up adaptive processes;
- improve engine types and efficiencies for better economic and ecological impacts;
- address issues of sea safety and of migrant fishers;
- address non-fisheries issues that affect fisheries resources and the quality of life of fishing communities;
- strengthen planning and measures for disaster and disaster preparedness;
- improve access to basic services and decent housing; and
- promote livelihood diversification through consultative processes.

Climate Change and Fisheries: Perspectives from Small-scale Fishing Communities in India on Measures to Protect Life and Livelihood

1. INTRODUCTION

Climate change has been attracting growing attention for its immediate and potential impacts upon the environment and human populations. Marine and coastal ecosystems are considered to be extremely vulnerable to climate-change processes such as ocean warming and sea-level rise, which have a direct impact upon the lives and livelihoods of coastal fishing communities. A major limitation in the current engagement with climate change and its impacts on fisheries and fishing communities is that it is based mainly on technical studies—the perceptions and proposals of fishing communities themselves have received scant attention. There is no specific focus on coasts or fisheries in the national and State-level action plans on climate change, with the result that fishers will not only be unable to benefit from the measures proposed, but will also increasingly find themselves further marginalized and more vulnerable to the impacts of, and the responses to, climate change.

This report is the outcome of a study undertaken by ICSF, which aimed to highlight the perspectives of fishing communities on the implications of climate change and variability on their lives and livelihoods, and to highlight the importance of developing and implementing adaptation and mitigation measures through consultative processes to address their poverty and food-security issues.

2. OBJECTIVES OF THE STUDY

The main focus of the study is to obtain fishers' perspectives on the key climate-change related threats affecting their lives and livelihoods, in particular from changed work and occupational patterns and from changed distribution of fishery resources. The objectives are:

- assess perceptions of fishing communities about the impact of climate variability/change on their lives and livelihoods;
- assess knowledge, institutions and practices of fishing communities of relevance to climate-change preparedness;
- identity adaptation and mitigation measures that may need to be adopted by fishing communities and the State in relation to climate change; and
- propose measures to protect the lives and livelihoods of small-scale fishing communities in the context of climate-change policies and programmes at different levels.

3. METHODOLOGY

For the purpose of this study, climate change has been understood in the sense that the United Nations Framework Convention on Climate Change (UNFCCC) defines it: as "*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is, in addition to natural climate variability, observed over comparable time periods*"[1]. This provides greater scope to relate climate change to human activities (both fisheries-related and non-fisheries-related), and thus build it into the larger context of issues affecting fisheries and to identify holistic adaptation/mitigation strategies to cope with it.

The study began in January 2011 with a literature review focusing on different aspects of climate change of relevance to Indian coastal and fishing communities. The findings of the review were discussed at a scoping workshop conducted in Chennai in February 2011. Together, the literature review and the scoping workshop provided a range of key climate-change factors of importance to Indian fisheries, which were consolidated to develop a methodology for field studies.

The methodology for participatory consultations with key stakeholders in each location was piloted in Andhra Pradesh using a simple 4-C framework (**C**hange-**C**ause-**C**onsequence-**C**oping strategy), which involved:

- key climate-change-related *changes* affecting the lives and livelihoods of coastal fishers;
- main *causes* contributing to climate change in coastal areas;
- *consequences* (impacts) of climate change on lives and livelihoods in terms of access to various resources relating to life and livelihood; and
- *coping strategies* (adaptive/mitigation strategies) both by the fishing communities and by the relevant institutional stakeholders.

Alongside, the consultative process also discussed the fishers' ideas for more effective adaptation/mitigation measures at various levels (from the individual/community level to the national policy level) to better address the impacts of climate change.

Based on the methodology developed, field visits of about 10 days each were undertaken to the four States during July-August 2011, and the field interactions were conducted in collaboration with local organizations and fishworker unions. The field work in the selected locations involved informal interviews with groups as well as with individuals, with special attention paid to capture the perspectives of women and other vulnerable groups. Besides the fishing communities, other relevant institutional stakeholders in fisheries (government, research institutes, and CSOs) were also contacted to obtain their perspectives on climate change, and to determine the adaptive/mitigation strategies currently in place. At the conclusion of each State visit, a consultative workshop was organized to bring together the key stakeholders from the communities covered as well as from relevant organizations, and the findings from the field work were discussed, validated and updated. The four State presentations were used as the basis for consolidation of this study report.

4. STUDY LOCATIONS

Field work was undertaken in selected locations in the four coastal States of India, two on the east coast (West Bengal and Andhra Pradesh) and two on the west coast (Maharashtra and Kerala). The choice of the locations for the field work was based upon specific criteria related to socioeconomic and physical vulnerability to climate change, using the following information based on maps of:

- coastal vulnerability index (CVI)
- cyclone-prone areas
- housing (*katcha* and *pucca* houses) (based on CMFRI census)
- levels of literacy (based on CMFRI census)
- extension of the northern boundaries of oil sardine stocks

The specific coastal districts in which the field work was done were:

- Maharashtra: Mumbai and Thane districts
- Kerala: Alapuzha district
- Andhra Pradesh: East Godavari and Visakhapatnam districts
- West Bengal: South 24 Parganas district

Maps showing the specific locations covered by the study in each State are provided (see page 53). Given the small geographical area covered and the relatively short time available in each State, it is necessary to suggest that the conclusions of the study—although validated at different levels—should be treated as provisional and as a first step towards more intensive and detailed studies. All the same, the broad trends—which show remarkably similar patterns in all four States—are valid and applicable to a wider area than is covered by the study.

5. GENERAL CONTEXT OF FISHERIES IN INDIA

This section is intended to serve as a backgrounder to the overall context in fisheries in which climate-change factors are unfolding. In general, the level of socioeconomic development in the fishing communities is considered to be weak compared to other coastal dwellers, making them 'outliers' in the overall development processes. While the fishing communities in the west coast States l ike Gujarat and Maharashtra show a much better level of socioeconomic development, their counterparts on the east coast are much poorer, more vulnerable and less integrated into the mainstream. Some of the Sundarbans (Sunderbans) fisheries (in West Bengal) are possibly the least 'developed' among the four States, and the fishers here are the least equipped to handle challenges currently facing the sector or the emerging threats like climate change. Even in more developed States like Maharashtra, access to basic services like literacy, health, sanitation, and decent and safe housing is low among fishing communities, which reduces their capacity to understand and cope with the processes affecting their lives and livelihoods and to diversify or seek alternatives.

Since the 1990s, small-scale households in India have seen incomes from fishing fluctuating wildly, with the fishers on the east coast particularly hard hit by uncertain incomes. Although the modernization process—begun in the 1950s—contributed to improving small-scale fishers' access to technologies, resources, markets and incomes in the beginning, the inherent contradictions in the process led not only to a failure to bring the small-scale fishers out of their poverty, but actually made them more vulnerable to emerging threats such as climate change. The crisis in the sector is the outcome of a range of factors, which can be summarized, *inter alia*, as:

- overcapacity and capital-intensive fishing practices;
- uncertain fish catches and decline of several commercial species that contributed to much of the fishers' incomes;
- competition and conflicts for fishing grounds and fishery resources at sea, also affecting the traditional inter-relationships among the fishers on the coast;

- growing costs of production as a result of increasing investments in productive assets and their operations;
- rising levels of indebtedness (largely to informal sources), with cost of credit accounting for a sizeable proportion of the earnings;
- greater competition faced by women of fishing communities in accessing fish and markets, especially for higher-value fish; and
- long and uncertain market supply chains, consisting of several trader-intermediaries who could dictate the terms of access to the markets for the producers through credit linkages, preservation and transport systems, and market information.

In the face of the crisis, the support from the government to fisheries, particularly to small-scale artisanal fisheries, has remained paltry, and hardly commensurate with the scale of support that is actually required. More alarmingly, the economic potential of opening up the coastal space for industrial development has come to receive high policy priority, and the State has been taking an active role in developing vast stretches of coastal commons for industrialization, frequently alienating the fishers from their living spaces and livelihoods. At yet another level, the enforcement of several conservation policies and their implementation have led to further marginalization and even criminalization of traditional activities like fishing.

Thus, for the fishers, the crisis is an outcome of processes within the sector and, increasingly, one of competition with more powerful outside forces, backed by the State and its legal systems. The situation is exacerbated by the relative absence of strong institutional mechanisms among the fishers, hindering their ability to take collective actions or to put forth their responses in a meaningful manner. The customary community-based governance systems, which still prevail in some areas, lack the capacity to transcend the village (and/or caste) boundaries. Even their existing powers have been greatly weakened with: (i) the State's unwillingness to recognize their existence; (ii) the arrival of new State-backed structures and laws as well as new players from the outside; and (iii) the impact of external pressures that affect cohesion within fishing communities.

The fishers' responses to the crisis show a contradictory trend between the east and the west coasts. On the west coast, despite the various constraints faced by the sector, fisheries in Maharashtra—and, to a lesser extent, Kerala—are still a paying proposition, and here the response has been to increase the efficiencies of the fishing systems to undertake more intensive fishing operations. On the east coast (Andhra Pradesh and West Bengal), while a similar trend is observed in some

fisheries, the low level of surpluses and savings at the household level discourage fresh and additional investments beyond a particular limit, which forces the fishers to look beyond fisheries to meet their livelihood needs. Thus, the diversification effort in these States also involves moving into non-fisheries and non-traditional activities both within and beyond the local areas, often stretching to inter-State and even international migrations. The impacts of the crisis on women are manifested in their marginalization from fisheries activities and, mainly on the east coast, in the growing burden to find new means of work to support their families, putting new demands on their roles, effort and time. With the erosion of, or declining access to, common-pool resources like beaches, mangroves and grazing lands, they find it increasingly difficult to get supplementary income sources.

6. FISHERS' PERCEPTIONS ABOUT CLIMATE CHANGE AND FISHERIES

The following sections present the key findings from the interactions with the fishers in the selected locations and are thus about *the fishers' perceptions about climate change* rather than about climate change *per se*, although it incorporates additional information, insights and analysis obtained in interactions with other relevant stakeholders.

Prior to presenting the findings, one other point ought to be clarified. This relates to the need to maintain a sense of proportion in understanding climate change from two opposite perspectives:

On the one hand, climate change needs to be understood as a process already at work, although not always visible because it is covered under a welter of other concerns. In fact, in the fisheries sector, climate change is probably not a new problem at all; fishers have been experiencing its impacts since before the term itself acquired popular currency. Consequently, it is not often possible to differentiate climate-change issues from wider processes affecting fisheries, and it is probably just as well because *climate change itself is the cumulative outcome of several such actions and processes at different levels within and beyond the fisheries sector*. This is important to keep in mind in order to avoid ascribing climate change to some impersonal, global force or to consign it to a rarefied technical no-entry area, thus avoiding the responsibility of local and more immediate factors to the process.

On the other hand, there is need to curb the tendency to ascribe every change in fisheries (or any other sector/activity) to climate change, as appears increasingly to be the case, ignoring the other—more immediate—factors that need equal attention. Given the prevailing situation in fisheries, climate change will need to

be understood as one more layer in a complex web of factors affecting fisheries and fishing communities. While several changes in the sector could possibly link up with climate change, the cause-and-effect relationships are seldom linear or clear, and are frequently overlapping or interchanging. Under the circumstances, ascribing every—or even any—change directly or solely to climate change would call for abundant caution.

7. KEY CLIMATE-CHANGE FACTORS AFFECTING FISHERIES

Based on the literature review and the scoping workshop, a set of issues relating to climate change and climate variability was identified as having significant impacts (real and potential) upon Indian fisheries. In this section, a summary of the key changes relating to each climate-change/variability issue is provided from the fishers' perspectives.

7.1 SEA-LEVEL RISE

Sea-level rise is considered to be an important manifestation of global warming. In field interactions, sea-level rise did not come up as an issue in any of the study villages. Obviously, a 2-mm increase in sea level is rather difficult to perceive unless one is particularly watching for it. But that is a rather simplistic understanding of the issue; the increase in sea level is reported to manifest itself in a number of ways, affecting waves, currents and bottom pressure in the nearshore regions[2]. As the following sections will show, such manifestations of sea-level rise are being felt by the fishers, although the link between the different phenomena needs to be conclusively established. More recent work by CMFRI in Maharashtra indicates that some 75 coastal villages are vulnerable to inundation due to a projected 1-m rise in sea level, expected to happen over 20-50 years (Dr VV Singh, pers. comm).

7.2 SEA-SURFACE TEMPERATURE

Sea-surface temperature is considered to be an indicator of ocean variability as well as more complex ocean processes. As with sea-level rise, the fishers are unable to perceive a rise in sea temperature as a result of climate change. In Maharashtra and Andhra Pradesh, it is reported that temperatures have increased both at the surface and even more at the bottom, but this is attributed to intensive drilling, industrial discharges (especially the atomic power plant discharges in Maharashtra), chemical effluents and urban wastes. Not only are these sources more immediate, but the heat generated by these activities is so much greater than the natural global-warming process that the latter remains mostly hidden. One possible impact of rising sea-surface temperature being felt by the fishers might

relate to the changing fish composition in their catches. The small-scale gillnet fishers of Andhra Pradesh have reported that the depth of the surface gillnets, which was four fathoms in the 1980s, has now gone up to nine fathoms; the fishers contend that the pelagic species have descended to the lower layers from the surface due to variation in surface-water temperature.

7.3 SEA-SURFACE SALINITY

Sea-level rise could mean incursion of sea water into the coastal and upstream areas, making groundwater more saline, harming freshwater fisheries, aquaculture and agriculture, and limiting industrial and domestic water uses. There is much evidence of increased salinity in the nearshore seawater, in the creeks and rivers, and in the groundwater in certain locations. However, the critical factor which contributes to the increased salinisation of the coastal areas is not so much the sea-level rise as the drastic reduction in freshwater flows from the upstream. In all States, there is a strong perception that freshwater inflows into the sea have decreased considerably. In Andhra Pradesh, the sinking of bore wells for aquaculture in the 1990s has reportedly salinised the groundwater table, while in West Bengal, the construction of the Farakka Barrage and increased upstream demand for freshwater are reported to have reduced freshwater flows into the lower reaches of the coast. With weakened flows from the upstream, the seawater intrudes higher up in the creeks and rivers, and stays longer in the absence of a strong push from above. This affects the local ecological and biological conditions; however—except in some places in Andhra Pradesh—there is as yet limited evidence of salinisation of groundwater resources in the coastal areas.

7.4 WIND PATTERNS

In all four States, it has been reported that there have been significant changes in intensity and directional stability of winds over the last 20 years. The most critical change, with implications on fishing activities, has been the uncertainties in the direction of wind flows. Three broad trends are discernible:

- The seasonal wind patterns have changed; winds that should arrive at particular periods of the year do not appear on time, which leads to an overall disturbance in fishing conditions.
- The stability of wind flows in particular directions is very uncertain; a wind flows in a particular direction for a short duration before it changes and flows in a different direction. Sometimes, the change in direction takes only 15 minutes to happen.
- Some unusual winds have gained strength, while favourable winds have become sluggish.

Overall wind velocities have reportedly decreased, especially in the nearshore waters. While generally conceded to be a natural phenomenon, the construction of high-rise buildings on the coast is suggested in Maharashtra as one possible reason for this. The decrease in wind velocities is reported to have impacted upon the currents, upwelling processes, fish movements, navigation and fishing effort. At the same time, freak occurrences of very intense winds—causing tremendous losses within a very short time—are increasing.

7.5 SEASONALITY AND SEASONAL PATTERNS

The fishers are as dependent on the monsoons as the farming communities, and the consequences of a poor or delayed monsoon are just as hard for them. The timely arrival of monsoons, especially the southwest monsoon, remains the most critical requirement for productive fisheries. Increasingly, the monsoons have become quite irregular; even when they arrive on time, they seem less consistent in their behaviour. Staggered monsoons playing hide-and-seek and staying on much longer than usual (the southwest monsoon remaining active into November), and shifting and shrinking trends in the onset of the northeast monsoon (from October-December to November-December) have been reported as becoming the norm.

With changing seasonal patterns, fish availability has been affected, and some important seasonal fish species have reportedly declined in catches. In Andhra Pradesh, there is a reduction in intensity and duration of the southeast and east-southeast day winds during summer, affecting the arrival of small pelagic shoals. Unseasonal events are reportedly on the rise, which include heavy rains during the peak summer, and high temperatures (above 35 degrees Centigrade) during September-October. Such changes are reported to have an impact on the behaviour, breeding and migratory patterns of fish, especially in the Sundarbans and in the Coringa mangroves of Andhra Pradesh. In West Bengal, where culture fisheries and agriculture are important livelihood activities for fishers, this is reported to lead to mass mortalities, stunted growth and spread of diseases in culture operations, and severe upsets in seasonal cycles in agriculture.

7.6 RAINFALL

There have been some critical trends in rainfall patterns from year to year and within each year. Heavy downpours in certain years are followed by near-drought conditions in the following years, both being equally disastrous for fishing and other activities. Even within a year, rainfall is not spread evenly through a season; the entire annual rainfall occurs within a very short period, creating problems,

both immediate (swamping) and long-term (reduced upwelling). Thus, while the total annual rainfall may remain constant, its distribution being not uniform through the season means a severe upset of fishing and other activities.

Sudden rains

Sudden and intense downpours are a rising phenomenon that has had catastrophic effects on fish-drying operations in Maharashtra and Andhra Pradesh, effectively wiping out the business investments of a sizeable number of women. In both these States, the heavy, short-term, rainfall swamps the coastal villages and leads to waterlogging for extended periods of time, especially where natural water outlets have been extensively built over. Yet another hazard from short, intensive, downpours has been the flushing away of large quantities of land pollutants (near industrial areas) all of a sudden into the sea, leading to mass kills of nearshore fish.

The showers that signalled the onset of the southwest monsoon and that persisted for two or more weeks at a stretch (a phenomenon that in most States has a specific name and carries special economic, social and cultural connotations) have become rare. This seasonal downpour helped to churn the coastal waters and ensured upwelling, while also facilitating copious flows of freshwater into the system, which enabled fish breeding.

7.7 NATURAL DISASTERS

Ocean warming plays a major role in sea-level rise, intensified cyclone activity and heightened storm surges. For the fishers, especially those in Andhra Pradesh and Kerala, the unique—but devastating—tsunami of 2004 is a major indicator of climate change. Apart from the direct loss of lives and livelihood assets, the tsunami also left behind several other long-lasting impacts—biological, geographical/geological, economic and social—and still remains a largely inexplicable and terrifying phenomenon for the fishers.

The fishers observed that there have been changes relating to the location, frequency, direction and intensity of cyclones. In general, there is a relative decline in the number of cyclones and low-pressure areas along the coast. Contrary to the general perception of the cyclone as a destructive force, the fishers contend that it also has a more benign aspect in that it helped churn the sea, ensuring upwelling of nutrients from the deep, and helping the rapid transport of plankton masses from one area to another. The last major cyclone to have hit the central zone of Andhra Pradesh was the one in November 1996, a full 15 years ago. That it struck

an unusual spot (the relatively safer Godavari delta) not only affected the response time, but is also taken as an indication of change in the usual cyclonic patterns.

While there has been a general weakening in the seasonal cyclones that occurred at specific times during the year (May and November, in the case of Andhra Pradesh), the few cyclones that have hit the coast during the last 15 years have been far more catastrophic than the previous ones. The cyclone of 1996 in Andhra Pradesh, the 'super cyclone' of Orissa in 1998, and Cyclone Aila of 2009 in West Bengal are considered to be the most grievous of their kind to have hit the respective coasts. These cyclones were not only more intense, but also covered a more extensive area further inshore than ever before. Thousands of houses were partially or fully destroyed, and millions left homeless. In all these cases, the influx of seawater deep into the inland led to salinisation of the land and groundwater resources, making them unfit for agriculture for long periods, and creating drinking-water scarcity in the areas.

The transformation of cyclones from seasonal occurrences to irregular happenings has also resulted in inadequate preparedness of the coastal communities and government agencies to cope with them when they do occur. Thus, for instance, in Andhra Pradesh, three years of no—or minor—cyclones prior to 2010 was followed in that year by as many as four cyclone threats, leading to serious disarray within the administrative machinery.

Apart from the cyclones, the other serious natural disaster that the fishers faced earlier was the annual floods of the major river systems like the Ganga and the Godavari. Apart from their disastrous consequences for fish habitats, they also had a positive impact in terms of allowing a good mix of fresh and saline waters, cleaning up the rivers and creeks, flushing out the siltation from the river mouths, rejuvenating the coastal freshwater aquifers, and helping in the survival of mangroves. With uncertain rainfall year on year, and with the construction of dams across the major rivers, the annual floods have given way to more irregular, frequently man-made, events, which are far more catastrophic. Moreover, the steps taken to control floods have had their own implications. The *bund*s built in the Sundarbans to protect the human habitation from flooding have been counterproductive on at least two counts: (i) the process of flooding would help in depositing silt outside. (With the construction of *bund*s, this process has been disrupted—the silt remains in the river, elevating the river bed. Thus, the river is often seen to be flowing much above the land lying on the other side of the *bund*. This makes the *bund*s very prone to bursting and spilling.); (ii) the soft, unsettled soil makes the base of the *bund*s very unstable, putting them at risk of being swept away by the pressure of tidal or flood waters.

Localized disasters

Alongside such large-scale occurrences as the 2004 Indian Ocean tsunami and Cyclone Aila, there is an impression that the nature and scope of disasters has also become more 'localized', and their implications are more diffuse. Examples include:

- freak waves hitting one or a few boats at sea (Andhra Pradesh);
- individual villages (or specific households within a village) suffering from sudden swamping (Maharashtra and Andhra Pradesh);
- the coastline getting eroded in a particular area, making the surf crossing more difficult and leading to frequent capsize of boats (Andhra Pradesh);
- erosion leading to total loss of beaches in a few locations, wiping out the local beach-seine fisheries, reducing space for local fish landing, boat berthing, net mending and fish trade (Andhra Pradesh);
- a river course changing overnight to swamp or engulf a Sundarbans village (West Bengal);
- sudden downpours wiping out the investments of a section of the fishing communities (Andhra Pradesh and Maharashtra); and
- unpredictable upwelling causing accidents in Kerala.

7.8 WAVES AND CURRENTS

In most places, it was seen that the intensification of waves in one area is complemented by a weakening of the same in the neighbourhood. The cyclical pattern that characterized the movement of waves to the coast appears to be broken; rogue waves keep intruding into the cycle. The wave action in the coastal waters has become weaker as a result of weakening nearshore winds and increased siltation around river mouths. There is a perception that there has been a reduction in wave height, frequency and intensity. At the same time, wave action is much stronger in places where:

- beaches have been eroded and/or built over extensively;
- reclamation of land has taken place in the neighbourhood;
- natural barriers like mangroves have declined; and
- new barriers to water movement (like jetties and harbours) have come up.

The stronger wave action in these areas is reported to (i) destroy homes and other structures closer to the coast, and (ii) capsize boats as they near the coast and occasionally destroy them by dashing them against the shore. In the offshore or deep-sea waters, where the mechanized boats of Maharashtra, Kerala and West Bengal are increasingly operating, the waves are reported to have become stronger, leading to more pitching and rolling than previously. In West Bengal, the problem of increased pitching and rolling was highlighted as a major issue.

Currents in the nearshore waters have changed course for various reasons, both natural and man-made. Construction of harbours has been reported to contribute to significant changes in water currents in the nearby areas. Offshore, water currents may have changed course in areas where oil rigs and shipping movements prevail. Sudden and strong currents have been noted to be on the increase in Kerala and Andhra Pradesh waters, while the southern currents (*thekkan neeru*) that favoured the fishermen in Kerala have weakened. There is a reported weakening of currents in the creeks in both Sundarbans and in Coringa (Andhra Pradesh). Siltation is reported to have reduced water currents in the creeks of Vasai and Versova in Maharashtra.

7.9 TIDAL ACTION

Changes in tidal action are felt particularly in the estuarine regions, and evidence of both increase and decrease in tidal amplitude has been reported in the four States. An important (natural) phenomenon appears to be the fluctuations in tidal cycles based on the lunar phases. This is reflected in changes in fish availability in the creeks, where the operations are largely influenced by the tidal cycle. Increase in tidal influx from the sea is said to be caused due to less freshwater flows from upstream, and contributes to increased salinity along the upper reaches. Erosion of beaches has led to increased inundation of fishers' houses during the high-tide period in Maharashtra and Andhra Pradesh. Islands like Gosaba in the Sundarbans also suffer periodical inundation of the *bund*s and incursion of waters into the village as a result of higher tidal amplitude in the area.

Coastal constructions, siltation at the river mouths and along the creeks, and construction of tidal locks/*bund*s upstream reportedly decreased tidal action in several areas. As a consequence, the backwaters and tidal pools receive less tidal waters, and this reduces the breeding and nursery grounds for several estuarine species. Reduced tidal amplitude in the creeks also affects crab populations and aquaculture operations. It also makes the boats' passage through some creeks, and usage of some berthing places, impossible, requiring longer detours and berthing of boats away from the villages, all of which have attendant problems.

Vembanad Lake, Kerala

With the construction of the Thanneermukkam barrage, the tidal influx into Vembanad Lake in Kerala has stopped during months when the shutters are down. Prawns and other fishes that used to reach the lake for breeding have disappeared. Fish catches in the lake have reduced and have become unpredictable (with respect to the lunar cycle). Reduced interaction between the backwaters and the sea has led to changes in the local ecosystem.

7.10 MUD FLOWS AND TURBIDITY

Mud flows from upstream, which carried soil and nutrients to the lower reaches of the rivers, have declined in all States, mainly on account of reduced water flows, but also due to sand mining further upstream. Reduced mud flows decrease the nutrient content in the coastal waters, with consequences on fish breeding and nursery grounds. However, turbidity—which used to be mainly an outcome of mud flows—has increased due to effluent discharges upstream as well as directly into the coastal/estuarine waters. Turbidity has also been reported to have increased due to construction activities on, or near, creeks and beaches; oil spills from rigs and passing ships; and intensive drilling activities on the sea bed. The turbid waters now consist of both suspended solids (which clog the nets and fish gills) and dissolved matter (poisoning the waters and leading to mass mortalities of small fish).

The fishers of Andhra Pradesh reported that the water discharges during the southwest monsoon are more turbid than previously, and that the discharges consist more of dissolved matter. The seafloor is increasingly muddy, and the inshore waters more turbid, as a result. In West Bengal, changes in the rainfall patterns—from being uniformly spread through the season to fewer, more intensive, spells—are reported to lead to sudden increases in turbidity that drive away fish or kill them by clogging their gills. In the nearshore waters, the extent of turbidity is reported to have increased to an extent where the fishers cannot identify fish shoals based on the colour of water, as in the past.

The decrease in mud flows from the rivers is reported as a reason for the decline of *chakara*, the coastal mud banks formed along the coastal waters of Alappuzha in Kerala. These acted as a protection against wave action for the fishers venturing into the sea, and their depletion has made it difficult for them to cross the surf easily. The fishers believe that the *chakara* depletion was caused by the tsunami of 2004. Some fishermen believe that the depletion of *chakara* was also due to

the imbalance prevailing in the mixing of fresh water and salt water at the bar mouths.

7.11 SHORELINE CHANGES

Erosion and sedimentation are the most significant factors affecting the coastal areas and fisheries. Erosion, which is reported to affect 23 per cent of the shoreline along the Indian mainland (Vivekanandan, 2011:11), is a major threat faced by many fishing communities in all four States. Most villages—including major fishing centres like Vasai in Maharashtra and Uppada in Andhra Pradesh—no longer have a beach in which to berth the boats, land and trade the catches, dry the fish, and mend the nets. Even as many houses have been lost to the sea, space available for housing itself has been reduced in erosion-prone areas. Erosion has been the main reason for the loss of beaches; while diverse human actions are contributing to the increased erosion, natural processes like the change in wave patterns, and increased ferocity of cyclones and winds are perceived to be significant too.

With erosion of the coast, the shoreline does not slope gently into the sea, allowing the tides and waves to play out their energies before reaching the beach; it drops abruptly into the sea, causing the waves to be more intense and damaging when they hit the shoreline. Seawater intrusion into the villages is a perennial problem of increasing intensity in places like Satpaty and Vasai in Maharashtra and Uppada in Andhra Pradesh.

An issue of concern is the contention of the fishers in the Coringa mangrove area in Andhra Pradesh that the seaward side of the mangroves is being eroded significantly as well. This flies in the face of the idea that mangroves and other 'green belts' are considered a protection against erosion. Given the multiple threats that the mangroves are being subjected to in this area—oil exploration and refineries, shipping ports, aquaculture, effluent discharges from upstream—it is possible that the mangroves are reaching a threshold in terms of their natural resilience to cope with external threats.

Erosion and siltation go hand in hand, which is the reason why in the neighbourhood of the same areas being affected by erosion, there are problems of siltation that are equally severe for the local fishers. Siltation of the river mouths (i) obstructs the water flows from upstream; (ii) forms sand bars that obstruct fishing traffic in places like Satpaty; and (iii) changes the direction of water currents, tides and waves, which get deflected in other directions, causing more erosion, changing fish movements and affecting the local biodiversity in various ways. In Coringa,

closure of certain creek mouths in the estuary is reported to have changed the local landscape, affected fish behaviour (mud crabs, which were prolifically caught in the area, are fewer these days), and reduced space for breeding as well as the nursery grounds for commercial species like the tiger prawn.

It is in the Sundarbans that sedimentation tends to be a critical problem. The delta is a naturally dynamic entity: the simultaneous processes of erosion at one end and sedimentation at the other (forming the *char*s) means that the delta keeps being pushed downward into the sea, and the process has now reached a stage that it is encroaching upon what used to be considered as the richest shrimping grounds in the Bay of Bengal. Though a natural process, *char* formation is reported to be increasingly influenced by upstream processes like construction of barrages, expansion of towns at the expense of rivers (reducing their width), dredging, and ship wrecks at the river mouths. The new *char*s are reported to cause diversion of water channels, changing ecological conditions and upset fishing rhythms. The formation of a new *char* off Kakdwip reportedly acts as a major obstruction to fishing traffic, requiring long detours and consequent increase in time, effort and investment.

While erosion and sedimentation have always been a presence in the Sundarbans, they have undergone drastic changes in modern times. Sediments are not being properly flushed into the sea any more, with the consequence that the depth of rivers and creeks is decreasing constantly. Some river courses have been diverted, while several creeks have silted up. In some places like Kultuli, sedimentation has reduced the river into a small stream, very difficult to navigate even during mid-tide. The meandering rivers erode their embankments, break the dykes and enter the islands.

8. PROBABLE CAUSES OF CLIMATE-CHANGE ISSUES AFFECTING FISHERIES

The causes ascribed by the fishers in the study areas to the different changes discussed in the foregoing section could be broadly categorized into three:

8.1 NATURAL FACTORS

Changes in weather patterns relating to wind, seasonality, rainfall and natural disasters are considered to be affected by natural processes, the causes for which remain unknown. The 2004 tsunami is considered a major natural phenomenon in Kerala and Andhra Pradesh, with drastic impacts upon the sector. In the Sundarbans, being a dynamic ecosystem, a number of natural processes are

constantly at work, which include the 'ecosystem-on-wheels' phenomenon that pushes the delta deeper into the sea. The increasing incidence of *char*s is reported to be a natural phenomenon, increasingly supported by human actions.

However, more direct impacts such as sea-level rise, sea-surface temperatures and changes in acidity/alkalinity (pH) levels, attributed to climate change, the El Nino Southern Oscillation phenomenon, and precipitation, are little understood by fishers, let alone related to in a practical sense. This lack of awareness about the inter-relationships between the global and local patterns of climate change remains a gap in understanding its causes and consequences more meaningfully.

8.2 FISHERIES-RELATED FACTORS

Strictly speaking, fisheries-related factors make only a minimal contribution to the global climate-change phenomenon. However, several activities in the sector, such as overfishing and destructive fishing practices, do upset the marine ecosystems and fragile resources, thereby accelerating the climate-change processes. Examples of fisheries-related factors exacerbating the impacts of climate change include: increasing fishing fleet size, engine powers and capacities; destructive or ecologically unsound fishing practices; and poor engine and fuel efficiencies. Also, even where not directly contributing to climate change, these activities adversely affect the health of the resource base, undermining fishers' ability to cope with the changes.

8.3 EXTERNAL (NON-FISHERIES-RELATED) FACTORS CONTRIBUTING TO CHANGES

These are by far the most important causative factors with immediate impacts upon the sustainability of fisheries activities and longer-term impacts upon climate change, as well as the ability of the community to cope with such changes. They originate from diverse sources and vary from place to place, which makes it very difficult to pinpoint them or to suggest measures to address them. Nevertheless, as the discussion shows, it is vital to understand the diversity of factors that are in play in each local context, and to formulate appropriate adaptation strategies that are effective in each context. The impact of the external factors on fisheries is manifested in several ways.

i. Pollution

Pollution is a critical problem in all the four States visited, and its sources are as diverse as their effects on the fisheries and fishers. Sources of pollution in different study areas included: industries; urban/municipal wastes; tourism;

agriculture; aquaculture and hatcheries; shipping and sea ports; mining; nuclear/thermal power plants; oil refineries; and dredging and drilling activities (both nearshore and offshore).

In the villages covered in Maharashtra (close to Mumbai city), the sources of pollution appeared to be much more widespread and virulent than in the other States. Oil leakages from pipelines and oil rigs are reported to form into a black tar-like substance that covers large patches of sea surface and drifts to the shore, killing large numbers of fish in the process. The creeks in Versova and Satpaty are considered by one expert to be "one step ahead of being dead": the vegetation and the fisheries are dead in any case, and the creeks now pose serious human-health hazards as well. Effluent discharges have silted up the bottom of the creeks—in case of Versova, the average depth of the creeks is reported to have decreased from 10 fathoms to two fathoms, which affects the efficient flushing out of toxicants. It is reported that a large proportion of the mass obstructing the water flows into the Arabian Sea off Maharashtra consists of polythene covers and plastic bottles, which are also the main 'catch' for any fisher attempting to fish in the nearby waters. In Andhra Pradesh, as one fisherman remarked, "A large part of the catches in beach-seines consist not of fish, but of plastic bottles and polythene bags!" Vembanad Lake in Kerala is affected by large quantities of solid waste being dumped into it, while plastic wastes are reportedly contributing to clogging some of its channels.

In the Godavari delta areas of Andhra Pradesh, the untreated hot effluent discharged by the coastal industries directly into the sea is reported to lead to mass fish kills, and a consumer avoidance of fish from the entire area. Periodical effluent discharges from the sugar and other industries, as well as agricultural runoffs from upstream Godavari, pass through the numerous creeks downstream and leave devastation in their wake: mass deaths of all fish in the creeks, skin allergies and other health problems. The pertinent point to note here is the serious concern voiced by all fishers: that with more industries coming up all along the coast, there is every reason to believe that the pollution issue is likely to become more—and not less—severe.

In West Bengal, sewage from Kolkata, mixed with that of several towns downstream, is supposed to have an impact on the Sundarbans. Effluents from the various upstream industries, as well as from the port, are reportedly discharged untreated into the rivers, with severe consequences downstream. As a fisherman in Kultuli explained, the reason why the Bangladesh side of the Sundarbans is flourishing more than the Indian side in spite of the fact that the latter is protected through

a stringent conservation regime is that there are fewer upstream industries on the Bangladesh side, and hence less pollution to affect the mangroves.

II. Shoreline changes

The key shoreline changes brought about by external factors relate to increased erosion in some places, accompanied by excessive sedimentation in others. It is seen in Maharashtra and Andhra Pradesh that upstream sand-mining activities increase erosion along the coast, while sand mining from natural coastal barriers like sand dunes aggravates the rate of coastal erosion and increases the vulnerability of fishing habitations.

Alongside natural processes of siltation, dumping of inorganic wastes as well as other activities such as land reclamation and sand mining, construction of barrages and new irrigation channels contributes to increased siltation and clogging of the estuaries and river mouths downstream. In West Bengal, encroachment of human settlements into the river banks gradually decreases the width of the rivers and water channels, expediting the processes of erosion and siltation further downstream. In Andhra Pradesh, the construction of a new Godavari Anicut during 1977-86, increasing the full reservoir level (FRL) from the original three m to 13 m drastically reduced the water flows downstream, affecting the mangrove and other local biota, as well as increasing the processes of siltation and sedimentation. Construction of harbours, ports and fishing jetties, and land-reclamation activities also contribute to changing the course of the waves and currents, which begin to erode the coast in the neighbouring areas. The intensity of human activities in the Kakinada Bay has led to serious doubts about the survival of Hope Island, which—if it happens—could have catastrophic consequences for Kakinada city and its surroundings.

Mumbai has been facing increasing problems with waterlogging over the last decade because of rampant construction activities that obstruct the natural drainage processes, so the water remains locked inside the city. Construction of check dams and other obstructions to the natural flow of water in the creeks is reported to cause periodical swamping of fishing hamlets like Moregaon, which effectively bear the brunt of development activities elsewhere.

An important shoreline change in many parts of both Maharashtra and Kerala is the sea walls constructed for protection of the coastal areas from erosion. The fishers consider the sea walls to be only partly effective, managing temporarily to shift the problem to the neighbouring villages, which get eroded themselves eventually. The sea walls in most places are already yielding to erosion and lack of

maintenance. A geo-tube protection put up in Uppada fares no better. Another problem with the sea walls and the geo-tubes is the obstacle they present to the fishers both to get to the sea and to land their boats on the beach.

iii. Destruction of fish habitats and sensitive ecosystems

With the shelter that the fish got from mangroves being either destroyed or changed, fish breeding and nursery grounds are lost, and several traditional estuarine fish species have moved away or died out in the local waters. The construction of artificial barriers to the Coringa creeks for laying pipelines for an oil refinery in the neighbourhood is reported to have not only curtailed the fishers' movements to the sea and back, but has also affected fish movements in the creek, effectively wiping out some important fisheries like the mud-crab. In Maharashtra, several examples are provided of massive fish kills at the river and creek mouths as a result of sudden influx of toxic pollutants. Most dead fish were small and young, indicating that they had been recently hatched. Such occurrences have reportedly driven away fish from their traditional breeding grounds. In West Bengal, the frequent capsize of ships at the mouth of the Hooghly (as many as 22 ships have capsized during 2005-2010, according to the Kakdwip fishworkers' union) is said to lead to the discharge of large quantities of liquid and solid wastes into the sea, affecting not only the fishers' movements, but also the movements and breeding migration patterns of fish .

iv. Population pressure

In all four States, increased population within and outside the sector has been pointed out as putting pressure on the fisheries and fishing resources, reducing incomes (both overall and per capita), increasing competition and conflicts, and leading to the overall lack of sustainability of the sector. In Maharashtra and West Bengal, growing populations have been used to justify the increase in the numbers of fishing boats. The impact of increased populations is also reflected in heavily congested villages in all States in a context of growing competition for coastal spaces as well as of coastal erosion that has contracted the overall availability of land for fishing community settlements, and their already poor access to basic services. It also has implications on food security, literacy rates, healthcare and other basic needs in West Bengal and Andhra Pradesh. In the Sundarbans, the population has reportedly grown from 1.2 mn in 1951 to 4.5 mn in 2001, while the available resource base remained largely the same. (Actually, the area open to fishing has declined as a result of tiger-conservation measures.) Beyond the fishing communities, the increase in population is primarily felt on the living space; competition for living space pushes up land values, and leads to the alienation

of fishing communities from their traditional habitats. Increasing urbanization increases pollution, and puts pressure on basic resources like transport, drinking water and electricity.

9. CONSEQUENCES OF THE CHANGES UPON THE LIVES AND LIVELIHOODS OF FISHERS

This section summarises the broad trends characterizing the impacts of climate change upon the lives and livelihoods of the fishers, under different heads.

9.1 FISH RESOURCES

Fishers in all four States are unanimous in the assertion that the catches of commercially important fish from the open-sea fisheries as well as from the estuarine fisheries have declined over the last decade. The estuarine fisheries in Mumbai and Thane districts of Maharashtra are dead. Despite the declines, the main targeted species in all States remain the same as before. The quantities of landings—especially per boat—have come down, while a large proportion of these catches consists of juveniles and smaller fish, suggesting biological overfishing. According to the fishers themselves, 50 per cent or more of their catches of commercial fish consist of juveniles or immature fish (that is, fish that have not yet had an opportunity to breed), and their proportion could go well beyond 70 per cent during the post-monsoon period.

The seasonal cycle that influences the appearance of specific varieties of fish in different seasons is reported to be changing and becoming more uncertain; availability of a fish in the wrong season is considered as much a problem as its non-availability during the correct season, as the existing post-harvest and trade arrangements are unable to cope with the sudden influx of unexpected fish. There is unanimity of opinion that fish are abandoning their traditional nearshore habitats and moving into deeper waters. Some demersal species, including shrimp, which were caught close to the shore, are now caught in deeper waters. Three reasons have been suggested: (i) intensive fishing in the nearshore waters; (ii) increased pollution and other land-based activities affecting the coastal waters, and (iii) changes in the natural ecosystems influencing fish behaviour. The last is reported to have been particularly noticeable in the aftermath of the tsunami in Kerala and Andhra Pradesh.

With the destruction of traditional fish breeding and nursery grounds, several species which would appear in the mangroves during the breeding seasons have moved away. Most breeding migrations (especially of *hilsa* in the Godavari and

both *hilsa* (*Hilsa ilisha*) and *bhetki (Lates calcarifer)* in the Ganga) have declined to serious levels due to reduced post-monsoon flooding and other changes to the ecosystems. The decline in migration of *hilsa* in the Godavari has become so drastic as to raise fears that the fishery may be past recovery. The fishers assert that the decline in fish catches has as much to do with the loss of breeding opportunities for fish as with their increased capture. In many cases, the fishers are no longer able to even determine where the fish are now breeding.

Several important species have reported to have seriously declined or completely disappeared from the catches in all the States.

Maharashtra	Andhra Pradesh	West Bengal	Kerala
• Red snappers (*Tambi*) • Eels • Some species of a large shark • Sting rays • Mud-skippers	• Whitefish (*Lactarius lactarius; chidumulu*) • *Hilsa toil* (*kaatuka meenu*) • Pellone (clupeids) • Milk shark • Sawfish • Some spp of skates • Mudskippers (in certain areas)	• *Chandana ilis* (*Tenulosa toil*) • *Alta* and *Bauta* (metapenaeid shrimp) • *Dantne* (*Hemibargus menoda*) • *Liza* spp. • Milkfish (*Chanos chanos*) • Mud crab (*Scylla serrata*)	• White fish and White snappers • Cat fish • Sharks following prawns • Ribbon fish following anchovies

The disappearance of mud-skippers—which is an indicator species to determine the health of an estuarine ecosystem—in two States shows the extent of degradation of these extremely productive ecosystems. Other indicator species that are reported to have declined include jellyfish, dolphins and porpoises. Dolphins were reportedly profuse off the Thane coast until a decade ago, but the fishers cannot recollect having seen a dolphin in the last decade. Jellyfish declined from the coastal areas in the last decade. In Andhra Pradesh, the decline in the numbers of seagulls in many places (sometimes leading to their total disappearance) is remarked as an indication of the loss of the pelagic fish shoals that prevailed

quite close to the coast during the southwest monsoon until recently. There are few reports of new species appearing in the local catches. Sardines—an 'indicator species' as far as sea-surface temperature increase is concerned—have always prevailed in all four States. Two changes, however, may have happened:

- In Maharashtra and Andhra Pradesh, it is said the quantum of sardine landings has increased over the last 10-15 years; in Andhra Pradesh, the increased availability—and marketability—of sardines is considered to be the reason for the proliferation of the ring-seines. Conversely, it is suggested that the sardines had always been there, and it is only the introduction of ring-seines that increased their landings. Still, the occurrence of huge sardine shoals off the Godavari river mouths, where they had been less prevalent before, indicates a changing distribution pattern.

- In Andhra Pradesh, where a species of lesser sardines (*Sardinella gibbosa; guddi kawwallu*) predominated earlier, it is the oil sardine (*Sardinella longiceps; nooni kawwallu*) that has increased in the catches.

Simultaneously, in Kerala, which is the traditional home for sardines and mackerels, the two species have moved away from local waters and also shifted to deeper waters. Several important species of fish and high-value shrimp too have become rare in the catches, while some traditional species in Vembanad Lake have reportedly disappeared. In West Bengal, octopus and creek loach are reported to have been new appearances in the Sundarbans. Also reported in the same area are large groupers, essentially a marine species, which may indicate increasing salinity in the Sundarbans. In Kerala, puffer fish has become abundant and are seen as a major cause of destruction of fishing nets.

The fishers opined that fish caught in the nearshore waters where industrial and other human activities are widespread look somewhat different in terms of size, shape and colour. Stunted growth and abnormal shapes or protrusions are seen in such fish. An important concern raised by the fishers in Andhra Pradesh, especially from Visakhapatnam district, relates to the proliferation of 'dead fishing zones', which act as a sink to absorb toxic pollutants and where no fish or even plankton can grow; it is said that there are some 20-30 dead fishing zones off Visakhapatnam coast alone.

9.2 OTHER COASTAL RESOURCES

The mangroves in the Sundarbans are reportedly in good health, and it is even likely that their extent has increased over time. However, the larger changes in the overall environment have led to some changes in the Sundarbans ecosystem as

well. Some important species of *sundari* (*Heretiera fomes*), rhizophora, nypa (*Nypa fruticans*), etc. have declined. The *sundari* has become less robust, growing crooked, and its seed frequently rotting away without taking root. It is said that there are more salt-tolerant varieties than previously, indicating that there has been an increase in salinity in the Sundarbans. While not as robust as the Sundarbans, the mangroves of Coringa in Andhra Pradesh seem to be surviving, though increasingly under various external stresses. From the fishers' perspective, the extent of mangroves has decreased, and much of the fisheries-related biodiversity has declined. The size of the mangrove trees has reportedly decreased, so the height of the forest itself is reduced. In either case, there is no perceived correlation between the changing mangrove composition and fish behaviour or breeding patterns.

Maharashtra presents the bleakest picture of the state of mangroves: wherever they had existed, most mangroves have either been destroyed for development purposes or are dying out due to various pressures. Near Moregaon, where mangroves existed, it is reported that the booming real estate value in the area led to the mangroves being levelled to make way for the construction of colleges and even housing for some senior administrators.

Besides the mangroves, casuarina plantations (in Andhra Pradesh) and coconut plantations (in Kerala) formed major coastal vegetation, and, in both cases, there has reportedly been a decline. Reduced greenery in coastal areas is said to be the result of space becoming a major constraint with erosion as well as the growing demand for land. As a result, even existing green belts are removed to make way for new activities.

9.3 FISHING SYSTEMS

The various changes in the ecosystems, fish resources and the economic conditions of fishing have led to a decline in the small-scale and artisanal fishing systems, which depended upon the inshore waters for their existence. In Andhra Pradesh, the traditional fishing systems—wooden log *kattamaram*s (catamarans) and 'shoe *dhoni*s'—are declining, as also the use of sails as a means of propulsion. In the Sundarbans (Jharkhali and Gosaba), the fishers reported that the number of traditional boats has decreased by half in the last decade. Where such small-scale activities continue to exist, it is mostly as subsistence operations. The adaptive strategies undertaken by the more modern small-scale fishers (FRP boats in Andhra Pradesh, *dol*-netters and purse-seiners in Maharashtra and Kerala) are costly and frequently transform the boats so much that it is no longer possible to classify them as 'traditional' or 'small-scale'. Overall, there has been a reduction in the number of fishing days, and the fishers aver that most of the trips do not recoup their costs.

The decline of fish catches in the nearshore waters necessitates shifting fishing operations to the offshore and deep sea, and this requires a range of adaptations, which, in turn, necessitate big investments in capital and operating costs. In Andhra Pradesh, the boatowners who are unable to make the investments either sell their boats (when they can) or just operate them for as long as they are in working condition. These boats lie idle at the jetties for extended periods and—lacking regular maintenance—pose a serious risk to the safety of the crew at sea. In West Bengal, several fishers in Kultuli reported to have sold their boats, unable to make the necessary investments. In one case, an ex-boatowner—who had six boats of his own—worked as a labourer on one of the boats he had once owned. In the same place, there are said to be a large number of boats waiting to be sold off, but lack of buyers has meant that they remain idle on the shore. In both West Bengal and Andhra Pradesh, there are reported cases of boats being dismantled for their wood.

9.4 CHANGING TERMS OF ACCESS TO FISHING GROUNDS

Alongside the shift to deeper-water fishing by the mechanized trawlers in Maharashtra and West Bengal and the gillnetters in Andhra Pradesh, many boats also undertake journeys parallel to the coast. This naturally means the boats moving into fishing grounds used by other fishers within the State and in the neighbouring States. Increasingly, there is resistance from the local fishers to the entry of outsiders into their waters. The traditional relations of reciprocity are being repudiated, and there are instances of confrontation both at sea and on the shore. The Maharashtra *dol*-netters straying into Gujarat waters is said to lead to skirmishes with the local fishers from Jaffrabad, while migrating fishers from Kerala, Karnataka and Goa entering Maharashtra face resistance from the local fishers. Within the creeks of the Godavari and in the Kakinada Bay, fishing-boundary disputes have increased, leading to conflicts and long bouts of litigation between villages. The long-standing dispute for the beach-seining rights on Hope Island, off Kakinada, makes for an interesting—if complex and ultimately futile—case study of the conflicts that increasingly weaken the traditional relationships as a result of declining access to, and availability of, fish. In West Bengal, for the marine fishers of Kakdwip, the competition for fishing grounds is said to come from three sources: (i) the increasing numbers of boats from the same area; (ii) boats from other parts of West Bengal (Digha) and other States (Orissa and Andhra Pradesh); and (iii) boats from other countries (mainly Bangladesh, but also Thailand, Taiwan and—increasingly—Sri Lanka). The fishers of the Sundarbans consider the Bangladesh fishers to be their major competitors.

9.5 FISHING CONDITIONS

In all States, with increased fishing distances, basic navigation and other activities have become more difficult. While the overall number of fishing days by small-scale boats has decreased, the number has increased (over fewer fishing trips) in case of the larger fishing vessels like trawlers and *dol*-netters. Such changes do mean harder working conditions and additional pressure on the physical and emotional wellbeing of the crew. Siltation in the creeks and river mouths makes negotiating into the fishing grounds more difficult as it requires long roundabout diversions, with implications on time, effort and expense. In Uppada, the erosion of the beach requires the fishers to take their boats into a creek about two km to the north for berthing, giving rise to logistical and security concerns. For the fishing crews in West Bengal, travelling longer distances from the coast and facing the risk of straying into Bangladesh waters raises several concerns relating to safety as well as overall wellbeing. A more serious problem is the Sundarbans tiger reserve, where the tigers are less feared than their armed custodians. Charges of frequent harassment and fines are routine.

The changing conditions in fishers' access to fishing grounds require them to switch from their traditional beach-based operations to central locations such as fishing harbours. The centralization of fish landings requires the boats—and traders, especially women—to travel longer distances to get to the harbours, incurring extra costs and loss of rest time. For women of fishing communities, this also means declining access to fish, particularly higher-value fish, given the higher competition at such centralized locations from economically powerful traders and exporters.

9.6 FISHING INVESTMENTS AND RETURNS

In Maharashtra, a *dol*-netter costs up to Rs3 mn (56,931 USD) to build, and the annual operating costs for one boat could be in the range of Rs2 mn (37,945 USD). Naturally, few people are able to own and operate the *dol*-netters with their own resources. All the same, the continuing National Co-operative Development Corporation (NCDC) support and the relatively good returns from fishing seem to encourage several crew members to become boatowners themselves. The average income from fishing to the owners and the crew in Maharashtra remains higher than in other sectors, and significantly so when compared to fishing incomes in the other three States. In Kakdwip and Namkhana in West Bengal, fishing is considered a high-investment affair, with less certainty of good returns. Even in the estuarine fisheries of the Sundarbans, there is a reported increase in investments—for ice, transport of catches on motorized boats, and for monofilament nets that require more frequent replacement than the nylon or cotton nets used earlier.

Andhra Pradesh presents a fairly similar picture to West Bengal, with probably a larger idle capacity in mechanized fishing. Only half the mechanized boats in Kakinada are reported to operate at any given time of the year. Although occasional good fishing seasons and bumper harvests still occur, the uncertainty of the whole operation makes fishers and traders unwilling to take risks with fresh investments. In the small-scale sector, it is said that for every new ring-seine boat constructed, 10 traditional boats disappear from the sector. Overall, the incomes from fishing in Andhra Pradesh are falling, and the fishers frequently fare worse in comparison with wage labour in other sectors like agriculture.

The situation is not much different in Kerala, although fisheries in the State are developed on stronger and more robust foundations to be able to overcome the predicament facing the Andhra Pradesh fishers. Traditional fisheries are considered to have been caught in a spiral of increasing investment and operational costs, coupled with progressively falling catches per boat, which reflect on the effective returns. In the mechanized sector, only people with sufficiently deep pockets to invest large sums on a consistent basis are able to survive.

The most significant aspect of fishing in all four States is the high level of indebtedness prevailing in the sector, covering all types of stakeholders, although the boatowners are, by far, the most affected. While in Maharashtra and, possibly, Kerala, the indebtedness can be considered to be in the nature of a usual business transaction, thanks to the access to NCDC and Matsyafed support, the same cannot be said of the other States, where the large proportion of credit comes from informal sources, which charge high rates of interest (direct or indirect). The existing trade-based credit linkages also reduce the fishers' ability to diversify into capturing other (cheaper, but more reliable) species of fish, to move into another area for fishing, or to move out of fishing altogether, thereby aggravating the causes and consequences of climate change, as well as curtailing the fishers' access to adaptive and mitigation strategies.

9.7 FISH TRADE

Given that the main species have remained more or less constant in all four States, there are no serious implications on fish trade from the changes relating to fisheries and climate change. On the other hand, there are some areas where fish trade has an impact on possibly aggravating the climate-change impacts of fisheries.

Firstly, mainly in Maharashtra, the markets seem to respond very well to the rising costs of production as well as to the overall decline in important species by providing commensurate increases in fish prices. This means that in most fisheries, any shortfall in the overall catches is adequately compensated by additional revenues

from fish sales, thereby masking the magnitude of the crisis or at least allowing the fishers to avoid taking it seriously, with possible long-term consequences for the sector as a whole as well as on climate change. Most boatowners are aware that there will come a time when any increase in price cannot offset the decrease in the quantum of fish supply, but they feel that such an eventuality is some way off yet.

Secondly, and related to the above, it has been suggested in Maharashtra that the pricing policy of the shrimp-export companies involves taking into account the cost of fuel (among other costs) when determining the procurement price from mechanized trawlers. The prices that the companies actually pay to the fishers for export varieties bear little relation to the international prices, and allow the former to hold on to a major proportion of the profits, which is also made possible by the monopolies of access to trade information. Now, with large margins of trade, the companies can afford to hike up the procurement prices *to an extent that the additional burden on the fishers is compensated* whenever the price of fuel shoots up. In other words, the mechanized boats do not necessarily feel the impact of increasing fuel costs, which allows them to continue their operations without needing to seek ways of curtailing costs and improving efficiencies. It is possible that this is a general strategy applicable in most parts of the country.

While increasing returns do compensate the falling catches in the east-coast States as well, there are instances when the threshold limit is crossed seasonally, which tells upon the incomes and—given that the returns from one operation are frequently used as operating costs for the next—the viability of operations. In other words, the extent of market-derived subsidies is not adequate to fill the shortfalls in incomes, which is forcing people to move out of the fisheries. Relating this to the Maharashtra context, one might predict a recurrence there of a similar experience in due course.

Alongside the general decline in fish available for local consumption, there has been a paradoxical rise in the number of local fish sellers, especially women, in Maharashtra and Andhra Pradesh. With declining incomes from fishing, former housewives have had to seek income sources of their own and, for obvious reasons, fish trade is the immediate option. In Maharashtra, according to the women fish traders of Moregaon, the entry of migrants from Uttar Pradesh and other parts of Central India (called '*bhai log*')—forced out of their traditional occupations due to a host of changes, including climate-change factors—into fish trade in Mumbai has reduced the market share for the local women fish sellers.

In Andhra Pradesh, the concentration of fish landings to centralized locations has frequently meant that a proportion of the fish sold there would still find

their way to the same rural markets as before, except that this involves a higher expense in their procurement and sale. In another paradox, the fishers from the Godavari delta sell their own fish at the central markets in Kakinada, while, back in the villages, their wives purchase cheaper fish brought from the same market by another set of fish traders.

9.8 QUALITY-OF-LIFE ISSUES

The impacts of the various changes are felt at the level of the fishing communities in various ways in different States in a context where fishing communities are widely known to have already poor access to decent housing and other basic services. The main shoreline change in many villages has been the virtual disappearance of beaches. For both adults and children in fishing villages, to whom the beach is a virtual home-cum-office-cum-recreation centre, the loss of beaches has several social, economic and cultural connotations. In villages like Uppada, with the living space being increasingly eroded, it is only the poorer people who continue to live in thatched huts on the beaches, exposing themselves to the daily pounding of the waves, and facing the risk of losing their home and hearth sooner rather than later.

A striking manifestation of the erosion of the coasts and beaches has been the overcrowded condition in most fishing villages in all States, squeezed as they are also by developments on the landward side. The growing number of households within a short geographical area causes congestion, which has other downstream effects: difficulties in access to the beaches for transport vehicles, waterlogging, and insanitary living conditions, and lack of privacy. The inability to expand or renovate existing houses also leads to overcrowding within the households. The discharge of untreated pollutants into the seawater is another cause for concern: apart from its impacts upon the quality of fish, it also constitutes a serious health hazard for adults and children alike, leading to frequent skin infections and digestive disorders in fishing communities. This is aggravated by the time-honoured tradition of the fishers to defecate on the beaches, a tradition that is still thriving in Maharashtra and Andhra Pradesh in spite of the loss of the beaches themselves.

Increased inundation and waterlogging in the coastal communities has been the outcome of several factors, mostly external to the communities themselves, but they seem to be paying a disproportionately high cost, especially near cities like Mumbai. In fact, going by the standards of living and access to basic services in a fishing hamlet like Moregaon in the heart of Mumbai, supposedly the most cosmopolitan city in India, it can be said that the fishers continue to remain 'outliers' from the larger societal processes even here.

In Andhra Pradesh, it has been reported that marine fishers face problems with impaired eyesight as a result of longer exposure (with increased day fishing) to sunlight reflecting from the sea. In Kerala and Andhra Pradesh, declining fish catches and harder working conditions reportedly exacerbated alcoholism among the men.

In West Bengal, the already weak access to basic services—transport and communications, electricity, healthcare, education, drinking water—characterizing the Sundarbans communities is further aggravated by processes like erosion. Although some new developments like construction of bridges and access to mobile phones have improved conditions, the overall capacity of the Sundarbans fishers to cope with future challenges to their lives and livelihoods remains low.

9.9 SEA-SAFETY CONCERNS

The need to shift to deeper fishing grounds has led to increased sea-safety concerns; however, few precautions are observed on board to ensure the safety of the crew, especially during long voyages. While some improvements have been observed with GPS and other technological improvements in some fisheries, especially on the west coast, the issue of sea safety is still only poorly addressed, owing to the reluctance of the boatowners to invest in anything that offers no economic return. In Andhra Pradesh, the condition of several mechanized boats is extremely poor, with even basic safety equipment like life jackets missing. Critical inputs like mast lights, communication systems and compasses are either absent or do not function. Together with the poorly maintained engines, this state of affairs is a sure recipe for disaster.

Sea-safety concerns are higher in the case of the small fibre-reinforced plastic (FRP) fishing boats in Andhra Pradesh, which operate at greater distances from the shore and at depths of over 100 fathoms. The increasing numbers, size and power of FRP boats also occur in a vacuum as far as the quality standards in construction are concerned, which has serious sea-safety implications for the fishers. There is little evidence that such practices have increased accidents or deaths at sea, but the conditions of boats remain a matter of concern.

In Maharashtra, apart from the fears of working on the deep sea, a major danger lies in the potential for collisions with passing ships. The fishers complain that the ships stray from their scheduled paths; it is also likely that the fishing boats themselves might be straying into the shipping lines. This endangers any fishing boat hit by a passing ship, especially during the night. Matters are not much helped by the fact that there is no mechanism to obtain compensation from the ships for damages incurred or for the loss of life. One major adaptation in Maharashtra to

the increasing risks for going deeper into the sea has been to recruit migrant fishers who—being practically at the end of their tether—are willing to go where the local fishers will not, or will do so only if given more more facilities or payment.

9.10 WOMEN IN FISHERIES

At a general level, with the centralization of fishing operations due to a range of factors, women's access to fish, especially higher-value fish, has been affected. In Maharashtra, the men could largely (if only in the short term) overcome the changes affecting the sector through a range of adaptations, but the implications are more serious for the women in fish trade. Traditional fish-drying activities have been affected due to (i) loss of space due to erosion and to ever-increasing real estate values; and (ii) unseasonal rains destroying huge quantities of fish drying in the open, effectively wiping out the entire investment of the processors within a few hours. In Andhra Pradesh, and possibly other States as well, the changing conditions in fisheries are forcing the women to supplement their husband's earnings through a range of activities. The women are increasingly diversifying into agriculture and the construction sector to work as wage labourers, in the process depressing wages in these areas. In Kerala, with several processing plants facing problems of uncertain supply of products and the export requirements necessitating the centralization of processing activities, employment opportunities for women have declined. Drying and fresh-fish trade have also become more difficult, and many women are switching to coconut coir making and wage labour.

In West Bengal, the women had a prominent role in net making and mending, shrimp-seed collection, fish trade, and dried-fish production and trade. With the arrival of company-manufactured nets, net making ceased to be a women's activity, but net mending is still carried out by them in good numbers. Shrimp-seed collection continues despite efforts to curtail it, but this is reported to be out of compulsion rather than choice. Although traditionally involved in agriculture, fish culture and other local activities, the women in the Sundarbans are also diversifying out of their areas to work as domestic and industrial workers or to run petty businesses in the neighbouring towns.

9.11 TRADITIONAL KNOWLEDGE, PRACTICES AND SYSTEMS

The changes in the weather and the sea conditions, with consequent changes in fish behavioural patterns, have led to traditional knowledge and institutions becoming less effective to some extent in fishing activities, and the chances for its revival are considered to be slim. Changes in wind and current patterns, as well as the distances needed to be travelled to the fishing grounds, have made

traditional practices like using sails and oars for propulsion difficult. The use of new technologies like FRP and synthetic fishing gears, and onboard engines, makes traditional self-help practices useless. Pollution and other disturbances in the seas, together with the use of engines, make the traditional practice of identifying fish shoals from a distance by eyesight and hearing impossible. The shifts from traditional fishing grounds and the application of intensive fishing practices also make traditional governance systems—already weak—even weaker. Competition for the dwindling fish catches may also be leading to fissures in the traditional bonds and kinship ties characterizing intra- and inter-village relationships. With the new generation of youth in the fishing communities showing little interest to continue with tradition, the opportunities for passing on the traditional knowledge and practices—whatever is left of them—into the future are bleak.

9.12 IMPACTS ON DOMESTIC ECONOMY

The incomes from fishing are increasingly insufficient to cater to the needs of households in several fishing communities on the east coast. Evidence for this comes from the widespread prevalence of indebtedness, regular mortgaging of gold and other ornaments, increasing diversification into other activities, and dependence on multiple sources of income at the household level. That the surpluses from good fishing periods are no longer sufficient to tide over the lean periods and the seasonal ban periods is a complaint heard in all States. A less noticed effect of the concentration of fish landings to central locations and the shift of markets to distant urban centres has been the marginalization of large numbers of ancillary workers involved in, or dependent upon, the rural fishing economy.

10. ADAPTATION OR MITIGATION MEASURES (COPING STRATEGIES) UNDERTAKEN BY THE FISHERS TO ADDRESS THE CHANGES

At the level of the individual fishers, irrespective of overall landings either at a landing centre or nationally, a critical change over the years has been the declining availability of, and access to, fish, which is coupled with growing needs for investment that marginalize a number of poorer fishers from fishing. Consequently, the fishers' responses tend to be focused mostly on addressing these concerns and—more significantly—meeting their immediate livelihood needs. This section focuses on the adaptation strategies implemented by the fishers.

10.1 FISH RESOURCES

There is limited evidence of changes in the main species targeted in the different fisheries; however, the catches increasingly consist of a range of lesser varieties along with the target species. Several varieties of fish previously either not targeted at all, or discarded at sea, are now being landed. In West Bengal, for instance, Bombay Duck, sardines, tuna, and some species of catfish that used to be discarded earlier are now being utilized. Similar experiences are noted in the other States, especially Andhra Pradesh, where many motorized and non-motorized operations now focus less on shrimp and more on other varieties in order to reduce risks and better target the new domestic urban markets. Small pelagics—little in demand until recently—are being increasingly targeted so much so that ring-seines have become the mainstay of small-scale fishing in several areas. In Maharashtra, mechanized trawlers diversified their operations to catch squid and cuttlefish alongside shrimp. In Kerala, the bigger mechanized fishing vessels are modified to target a variety of fish apart from shrimp, including cuttlefish, squid and some fish species, and even undertake hook-and-line fishing targeting tuna.

10.2 FISHING GROUNDS

The changes in the nearshore waters, and the decline of fish catches necessitate shifting fishing operations to the offshore and deep sea. Diversification of fishing grounds takes place both vertically and horizontally from the shore. In Maharashtra, the trawlers have shifted to fishing grounds over 100 nautical miles away from the coast, while the *dol*-netters travel longer distances horizontally along the coast, frequently fishing off Gujarat waters. The small-scale, coastal OBM gillnetters have shifted operations up to 10-12 nautical miles from the shore. In West Bengal, the Sundarbans fishers of the Gosaba region have moved their fishing grounds from within two km from the village to over 10 km; the marine fishers of Kakdwip operate at distances of over 100 km, with fishing depths having increased from 50 fathoms to over 100 fathoms. The gillnetters of Kultuli have shifted their operations from estuarine fishing to the sea.

In Andhra Pradesh, the motorized gillnetters—whose operations were confined to less than 20 fathoms until the late 1990s—have increased their fishing distances enormously, travelling up to 50 km from the shore and almost entirely fishing in waters beyond 30 fathoms. The estuarine fishing boats of the Godavari delta have moved their fishing grounds to the open sea. Similar shifts have been reported from Kerala also.

10.3 FISHING DURATION

The increase in fishing distances naturally requires that each fishing trip be of longer duration. In Maharashtra and West Bengal, the fishing duration has increased from three to four days to two weeks. The Kerala boats undertake much longer voyages. Even small-scale fishing systems like the gillnetters in Maharashtra and the fishing boats operating in the Sundarbans in West Bengal try to spend extended periods at the fishing grounds by organizing mother-boats to carry their catches to the shore at frequent intervals. Thus, in Versova, five or six gillnetters undertake fishing as a group, taking turns to send one boat back every day to carry the day's catches collectively to the shore, while the rest continue fishing. This allows the boats to save on fuel, time and effort to travel to the shore every day, to stay out longer at sea and to help each other out in case of emergencies, while all the time managing to keep in touch with their families on the shore. In the Sundarbans, the non-motorized traditional craft licensed to operate on the periphery of the tiger reserve use the services of motorized boats for transporting their catches back to the villages/markets at regular intervals.

The reverse to the general trend of increasing fishing duration comes from Andhra Pradesh. Here, the mechanized boats undertake fewer fishing trips in order to reduce risk: to the extent possible, the owners avoid sending their boats out fishing unless they are sure of covering their costs. They have also switched from fishing voyages of long duration—which lasted up to 14 days in the early 1990s—to shorter fishing trips of four to five days, and increasingly prefer one-day operations, which keep costs low and also help sell the catches without losses. The arrival of the ring-seines into the small-scale fisheries of Andhra Pradesh also reduced the fishing duration for motorized fishing boats to 12 hours, from the previous 18-36 hours when these boats were involved in gillnetting.

10.4 FISHING SYSTEMS

In Maharashtra, increased fishing duration of the *dol*-netters gave rise to the need for bigger capacity in the fish hold in order to keep larger quantities of fish, and for more efficient insulated systems to store more ice over longer durations. The fish hold in a typical *dol*-netter has increased in capacity from five tonnes to 15 tonnes, and the number of nets carried on board has grown from 10 to 25 (over the last decade). The increase in fishing equipment—nets, floats and sinkers, ice—and other requirements for fishing and subsistence during the voyage, has led to a doubling in size of the *dol*-netters. In West Bengal, the need to carry trawl nets along with gillnets required the width of the boat to be increased from 12 ft to 17 ft. In a more direct climate-change-related adaptation, increased wave action

in the Sundarbans required the height of the boats to be increased by one ft to 2.5 ft.

In Kerala, the ring-seine nets have grown extremely large, which has required an increase in the size of the purse-seiners, making these supposedly small-scale, artisanal fishing systems into something much bigger and more powerful than most mechanized trawlers. A single purse-seiner is reported to be able to catch as many fish as were caught by 50-60 small *vallam*s (country boats) in the past.

In Andhra Pradesh, the FRP *nava*s used for ring-seine operations have increased in size from 30 ft to over 42 ft, and their engine power, breadth and depth have increased correspondingly as well. The non-motorized wooden *nava*s of the Godavari delta are giving way to motorized FRP boats to enable fishing in the open seas.

There is increasing preference in fishing operations from carrying one specific net to a range of different nets, and from carrying certain species-specific nets to more general fishing gears that are able to capture a wider range of fish, so as to maximize catches. With uncertainties in availability of fish, the number of fishing nets on board a vessel increases, so that the fishers can make use of any net at short notice. In Maharashtra, in the small-scale OBM gillnetters, the use of monofilament gillnets (*ghaghra* and trammel nets) has increased, and a wider variety of species are now targeted. In Kakdwip and other places in West Bengal, trawl nets—though frowned upon in the early stages—have now become a regular feature on the mechanized boats. Unlike in the other States, the boats here continue to carry sizeable numbers of gillnets alongside the trawl nets, and use them interchangeably, depending on the fish availability. In the Sundarbans, the number of nets has increased from one to three, while the mesh sizes in the tidal *behundi* nets have decreased from 50 mm to 10-15 mm. In Andhra Pradesh, the FRP boats have become very versatile in terms of their operational orientation by operating gillnets, trammel nets, boat-seines, ring-seines, hooks-and-line, longlines, and traditional/mini-trawl nets, thus managing to be active round the year. This inevitably means higher expenditure and more effort on the engines.

Bigger hulls and longer voyages must be supported by an increase in the engine capacities: the *dol*-netters in Maharashtra and the gillnetters of Kultuli (West Bengal) have increased their capacity from the earlier one to two cylinders (20-25 hp) to six cylinders (over 100 hp). A similar increase is noted in the case of trawlers in all the States, rising from 100 hp to 300 hp in the case of West Bengal. While longer distances and fishing trips mainly account for the increase in engine power, competition with other boats appears to be a more important reason.

10.5 FISHING CONDITIONS

The shift to deeper waters is accompanied by increased hardships and risks to the crew, and these are sought to be addressed through the use of migrant labour, some technological innovations and group-based operations.

I. MIGRANT CREW

In-migration into fisheries is mostly confined to the west coast, especially Maharashtra. Although there is some in-migration into the West Bengal trawl fisheries, the overall numbers of in-migrants are fewer, compared to the out-migrants into other activities. There are few in-migrants into Kerala fisheries and practically none into Andhra Pradesh fisheries. In Maharashtra, with fleet sizes still growing as more crew members acquire new boats and the non-fishing communities disdaining to work in fisheries (or probably not skilled enough to do so), the employment of migrant fishing crew from the east coast—Andhra Pradesh and Orissa—and from north India has been on the rise in several villages (like Gorai).

Migrants into fishing: Twice damned by climate change?

The migrant labourers are mostly victims of various changes (including such climate-change factors as drought, failure of monsoons, etc.) in their own areas, and are frequently desperate enough to settle for any job that offers a regular salary. By accepting to work in offshore waters under harsh conditions, they might well be putting themselves at risk from natural disasters and other climate-change-related/induced phenomena.

The main attraction for employing migrants might lie in their willingness to work for low wages and in almost any kind of working conditions. The owners provide on-shore accommodation to the migrants (unlike in Gujarat where the migrants practically live on the trawlers), a strategy that helps to ensure the fishers' availability for work at all times. With no roots in the local soil, and being occasionally the objects of suspicion, the migrant fishers are also more pliable and undemanding. While for the fishers from the east coast, working in the west-coast boats might not pose many problems, it is more difficult to understand how the north Indian migrants—mostly from agrarian communities—manage to get used to the new demands placed on them. Issues related to the migrants' incomes from fishing, their quality of life at sea and on shore, the sea-safety conditions, and their domestic lives remain little understood and largely problematic from a human-rights perspective. In the fisheries policies of each State, the migrants

are practically invisible, which aggravates their vulnerability to the harsh working conditions and to climate change. What is, however, certain is that by willing to take risks that the shift to deep seas and longer voyages force upon the systems, they contribute to the survival of the sector itself.

II. Technological innovations

The use of GPS is considered to be a major factor in both Maharashtra and West Bengal in reducing time, effort and fishing costs, as the boats are able to get to the target fishing stations a lot easier than before. The economic and climate-change implications of the GPS (which reduces wastage of fuel to get to the fishing grounds) are considered to be significant. Similarly, the use of wireless communication—vessel-to-vessel and vessel-to-shore—has been reported to improve fishing efficiencies, emergency responses and shore arrangements for preservation, transport and trading. Mobile phones are ineffective in deeper waters, but they are used extensively in small-scale operations and in every aspect of shore-based activities.

In Andhra Pradesh, the rather under-utilized shore-to-vessel communication systems set up to provide advance warning in case of cyclones has proved to be a technology with a lot more potential than just disaster preparedness. The fishers use it to share news of good fishing grounds and to make trade arrangements while still at sea, thereby saving considerable resources, time and effort.

PFZ information as a guide for good fishing areas

According to CMFRI (Mumbai), which has an ongoing project on climate change and fisheries, access to potential fishing zone (PFZ) information, along with that of the wind speeds and direction, is said to help fishers cope with the changes in the marine ecosystem. However, the fishers attending the Maharashtra consultation contended that, based on their personal experience, the PFZ information—when and if available—leads to three problems:

sustainability-related: By directing all boats to the good fishing zones, the access to information might aggravate overfishing for specific species in specific areas;

equity-related: The need for access to information and to the necessary technical expertise to make use of it will mean that only the big boats will be able to make use of it and capture all shoal fish long before they are anywhere near the shore, thereby depriving the smaller fishers of a livelihood; and

economic: The PFZ information is based on planktonic profusion in the surface waters, and the fishers found only algal blooms—and no fish—when they actually travelled to the suggested areas, which meant a loss of fishing time, effort and investment.

While the fishers in Maharashtra have firsthand experience of using PFZ information, those in Andhra Pradesh and West Bengal have only seen the display boards installed in some major fishing centres. The information displayed was quite old by the time it was received, and the boards themselves did not work after a while.

III. Group-based operations

Keeping sea safety in deeper seas in view, the Maharashtra trawlers have begun group-based operations, with 15-20 boats operating together for mutual safety and exchange of information. While some of these groups are owned by the same person, many are individually owned and come together strictly for safety reasons, while keeping the actual fishing operations independent of one another. In Kakinada, Andhra Pradesh, the mechanized boats increasingly operate in groups. In order to save fuel and time, one of the boats is delegated to scout the prospective fishing grounds so the rest could follow only when there is potential for catching prawns. Occasionally, they fan out in different directions and keep in

contact with one another to share the news if good catches are sighted. Similar practices are noted in the artisanal sector too: in villages like Venkatanagaram, there is a process of 'twinning' where two boats agree to work as a unit. Interestingly, the arrangement does not involve two boats fishing together; in fact, it depends upon them using two different varieties of nets in different fishing grounds. When they come back, the returns from the catches are pooled and shared equally among all crew members, irrespective of the contribution made by the individual boats. This is a risk-reduction strategy which, by doubling the chances of obtaining a good catch, ensures that the fishers manage to earn something even when they could not catch anything by themselves. A similar risk-reduction strategy is reported to operate in ring-seines in Kerala.

10.6 FISHING INVESTMENTS AND RETURNS

i. Consolidation of the ownership of assets

In Maharashtra and West Bengal, there is a trend towards boatowners operating more than one boat, which is a strategy to balance the incomes: the losses from one boat are compensated by the profits from the others. In Kakdwip, there is a consolidation of boat ownership, with the traders (*aratdar*s) changing into fleet owners. Individual ownership of 14 boats or more is reportedly common. The new fleet owners also own ice-plants and other input-supply sources, besides continuing their trading operations, thus effectively remaining in control of the whole system, which even the independent boatowners cannot avoid any more. Single boatowners who are unable to increase their fleet size prefer to sell their boats and work as crew members, which is a strategy to reduce risks even though it might mean earning less and also a climb-down in terms of social status.

ii. Decentralization of ownership of assets

In Andhra Pradesh, the changing patterns of ownership of beach-seines provide an interesting adaptation. As beach-seining became increasingly non-viable, a trend towards communal ownership of nets became evident. A group of fishers shares the cost of buying a net, and the returns are distributed at the rate of two shares per member—one share for his investment and the other for his labour. Even when a member does not take part in fishing, he still gets a share, while the fisher who takes his place at hauling in the net receives the other share. This arrangement has the advantage of enabling the fishers to spread the returns over a large number of families, albeit very thinly.

III. CHANGED SHARING PATTERNS

It is reported that in some fisheries in Maharashtra and in the trawl fisheries of Andhra Pradesh, the payment system for the crew has shifted from wage labour to sharing the net incomes. (In some cases, a via media solution of part wages and part sharing is also prevalent.) An ongoing tussle between the boatowners and the crew in Visakhapatnam relates to the owners reducing the share of the crew from 12 per cent to 8-9 per cent from the gross earnings. In Kerala, the mechanized crew undertake hook-and-line operations alongside trawling in order to increase their catch shares.

10.7 FISH TRADE

The fast-growing domestic demand for fish has led to a reorientation of the trade strategies in favour of urban markets, helped by improved transportation and preservation systems. With a larger proportion of local landings from Maharashtra and Kerala going into exports even as the local demand for fish keeps increasing, the fish trade in these States has come to depend on imports from other States, mainly on the east coast. This growing outstation demand helps the fishers on the east coast to diversify to other, non-traditional, species when the commercial species decline in catches. Thus, where new species have come to dominate the local landings—such as sardines off the Godavari river mouth—there does not appear to be any problem in finding them good markets; thanks to the reach of mobile phones and better transport systems, the traders from distant markets seek fishers out and buy the fish as soon as they are landed. This burgeoning demand for unusual local landings gives rise to such species eventually being targeted as the main catch (as happened with the arrival of ring-seines in Andhra Pradesh) and leads to a diversification of effort. While this has possibly helped the fishers to survive in the face of the crisis, it has also meant that the cheaper varieties of fish are moving away from local markets and poorer consumers.

In West Bengal and Andhra Pradesh, the growing ex-state demands for important fish has led to the secondary varieties of fish moving into the top slots vacated by the prime species. Interestingly, this has led to a change in the preferences for fish even in a relatively conservative State (in fish-eating terms) like West Bengal, where there is increasing appreciation of fish like sardines, skates, rays and Bombay Duck that had few takers earlier and were largely discarded at sea or on the beaches.

10.8 DISASTER RISK REDUCTION

Early-warning systems have become more efficient in the last 10 years, with the ubiquitous television and mobile phones providing opportunities for better relay

of information than was possible in the past. Every major disaster since the Andhra Pradesh cyclone of 1996 (the Orissa 'super cyclone' of 1999, the Indian Ocean tsunami of 2004, and Cyclone Aila of 2009) has given rise to increasing emphasis on early-warning systems as well as several government- and CSO-funded disaster risk-reduction programmes, with the result that the information flows to the coastal communities have reportedly improved. However, the improvements in information flows are not always followed up with better planning for disasters at the settlement level or the construction of disaster-resistant housing and erection of cyclone shelters, which leave the poorer stakeholders as vulnerable to disaster as ever. In the Sundarbans, cyclone/flood centres are very rare, and there is inadequate stock of rescue and relief materials. Local people have not received adequate training in rescue and relief.

10.9 COPING STRATEGIES AMONG WOMEN

In Maharashtra, it is reported that women fish traders in Mumbai also include some non-fish items in their merchandise brought from neighbouring villages, so as to increase their earnings. Several women from fishing communities in Mumbai and from neighbouring villages work in the city as domestic help and industrial and construction workers. Younger, educated, women work as shop assistants and telephone operators.

In Andhra Pradesh, the women in some villages started diversifying their activities in the 1990s and are seen to be involved in a range of fisheries and non-fisheries activities. The most significant change for them has been the micro-finance initiatives in the rural areas in the last decade; the government's own programmes of micro-credit support have been important in organizing the women, and this groundwork helped the groups to seek and obtain support from the formal banking sector and, later, from private micro-finance initiatives. There are at least three ways in which the access to micro-finance helped the women: (i) to enhance their own business activities; (ii) to help their husbands acquire or replace fishing and related tools; and (iii) to overcome their dependence upon the informal—and highly expensive—private moneylenders. Obviously, the micro-finance story has had its pitfalls, and not all women in all areas have benefited equally from it. What is, however, clear is that the women's access to formal credit sources not only helped increase their confidence, but also their status within the households.

In the Sundarbans of West Bengal, the women have always had a diversified livelihood profile, but what has changed for them is the increased migration of their men out of the area. In the absence of their husbands, the burden on the women is much higher. The extent to which they have learned to cope with the new challenges is not clear. The women's involvement in non-traditional activities

like petty trade and as domestic help in urban centres has been increasing. Several educated women are reported to have been working as health workers and volunteer teachers in places like Gosaba.

10.10 DOMESTIC ECONOMY: DIVERSIFICATION STRATEGIES

There is evidence that in States like Andhra Pradesh and West Bengal, the household economy is no longer based on fishing—or the men's incomes—alone. Going by the range of activities that the fishers in all States—including Maharashtra—have moved into in recent times, it is clear that both compulsion and opportunity act as the motors of diversification. All the same, there is only limited evidence of out-migration from fishing on the west coast, largely because the incomes are still quite good and consistent. On the east coast, in Andhra Pradesh and, increasingly, in the Sundarbans fisheries of West Bengal, there is a growing trend of migration into both fisheries and non-fisheries-related activities outside their area. The one strong 'pull' factor contributing to the migrations appears to be the promise of regular and consistent incomes, while there are several 'push' factors (discussed in the foregoing sections) driving the process.

Most non-fisheries migrations are into urban (construction) and industrial activities, and the poor skills of the migrating fishers are both an advantage and a disadvantage to them in obtaining employment in these areas; the advantage is that they get ready employment in any activity, while the disadvantage is that they get very low wages compared to a more skilled or even semi-skilled artisan. Alongside wage labour, most West Bengal fishers are also active in managing petty businesses in the neighbouring towns and in Kolkata. The migration out of the State by West Bengal fishers appears to be individually oriented (unlike in other States like Andhra Pradesh and Orissa, where such movements are more group-based), hence, it is difficult to trace definite patterns about their migrations.

The migrants to the other areas are said to return to their native villages seasonally or whenever the local fishing conditions are reported to be good, stay for a few months and then return. Although not necessarily well paid (earning about Rs200 per day), the migrants are said to fare well with the incomes, and are even able to improve their conditions back in the villages with good housing, a better lifestyle and new expenditure, which trigger the interest of other people to move out as well.

10.11 LITERACY

In all four States, increasing emphasis is being placed on educating children as a strategy not necessarily to encourage the next generation to move out of fishing

as much as to give them a choice (or, at least, a notion of a choice) that the adults themselves never had: to decide whether to remain in fishing. That a majority of the youngsters are interested in moving into non-fisheries activities is a fact in all States. The educated youth take on an increasingly active role in mediating the relations between their communities and the larger society. In villages like Naigaon, a number of youth have shifted away from fishing altogether, and taken on a range of employment in Mumbai city, besides looking after the affairs of their fisheries co-operative societies and also pursuing the government to establish their rights to the coastal land on which they live. These educated youth are able to relate to the larger and longer-term issues and to adapt to new 'realities' more easily. Critically, they have the capacity to articulate their ideas of what needs to be done, and, coming as they do from within the sector, their ideas reflect the aspirations of the community much better than has been the case until now.

11. CONCLUSION: THE VIABILITY AND SUSTAINABILITY OF THE COPING STRATEGIES IN PLACE

The fishers' responses to climate change (albeit as part of a greater range of challenges confronting them) are many, and vary from place to place. In theory, the strategies adopted by the fishers could fall into three broad categories:

- those addressing the factors causing a condition/change;
- those addressing the condition/change itself; and
- those addressing the consequences of the condition/change.

In practice, the fishers' responses relate almost entirely to meeting their more immediate livelihood needs. That most changes attributable to climate change appear to be beyond the scope of the fishers even to understand, let alone address, is one factor inhibiting a more active response to it. Consequently, the fishers' responses to the changes are by way of learning to live with them and their impacts. Without a deeper awareness among the fishing communities of the fundamental causes, and a stronger role for them in planning and decisionmaking, the various strategies adopted by the fishers have varied outcomes, ranging from partly successful adaptations to those completely failing or even aggravating the climate-change factors in the long term.

11. 1 INSTITUTIONAL CONTEXT OF RELEVANCE TO CLIMATE-CHANGE PREPAREDNESS IN FISHERIES

The nodal agency for addressing issues of climate change in India is the Ministry of Environment and Forests (MoEF). The Prime Minister released India's first National Action Plan on Climate Change (NAPCC) on 30 June 2008, outlining existing and future policies and programmes addressing climate-change mitigation and adaptation. The plan outlines existing and future policies and programmes for addressing climate-change mitigation and adaptation, with a focus on eight 'missions': (i) pursuing solar energy; (ii) urging energy efficiency; (iii) creating a sustainable habitat; (iv) conserving water; (v) preserving the Himalayan ecosystem; (vi) creating a 'green' India; (vii) creating sustainable agriculture; and (viii) establishing a strategic knowledge platform for climate change. The expectation is that the respective ministries with lead responsibility for each of the eight missions will develop objectives, implementation strategies, timelines, and monitoring and evaluation criteria. The coastal ecosystem is not specifically addressed as part of the national plan.

Coastal issues, however, are very much included in climate-change research currently being undertaken. The Indian Network for Climate Change Assessment (INCCA), a network-based programme that brings together over 120 institutions and over 220 scientists from across the country to undertake scientific assessments of different aspects of climate-change assessment, has recently prepared a report that provides an assessment of the impact of climate change in 2030s) on four key sectors of the Indian economy, namely, (a) agriculture; (b) water; (c) natural ecosystems; and (d) biodiversity and health in four climate-sensitive regions of India, namely, the Himalayan region, the Western Ghats, the coastal area and the northeast region. Several research institutes, including CMFRI, CIFE, CIFRI and the Centre for Earth Science Studies (CESS) are also involved in climate-change research, with CMFRI taking the lead in research on climate-change implications for fisheries under the ICAR's National Initiative on Climate Resilient Agriculture (NICRA) programme. Informal interactions with the scientists involved in climate-change-related work during the course of the study, however, pointed to certain constraints, such as the lack of co-ordination within the research community: each climate-change project has its own agenda that does not necessarily add up to a cohesive programme at the national or sub-national level; inadequate support—in terms of men, materials and money–despite strong commitment to tackling climate change; and weak technical capacity for modelling, a critical component of climate-change studies. Further, it is also apparent that the technical aspects of climate change receive great attention, while the socioeconomic, extension and applied parts remain largely unexplored.

A significant problem from the perspective of coastal communities is the fact that in the State-level action plans currently being prepared, as well as in the research being undertaken, there is no effort to consult with coastal communities to seek their views on the perceived impact of climate change, and the sort of responses that are needed. They also point out that the technical focus of all these initiatives, with an emphasis on finding macro-level technical fixes to climate-change issues, is problematic, given that the reality at the local level is far more complex, requiring a response that also takes into account socioeconomic and other fisheries and non-fisheries factors that are locally relevant in the context of climate change.

During the field study, there was no evidence of formal *Panchayati Raj* institutions (PRIs) having any role to play in fisheries or in matters related to climate change. Traditional community-based governance systems exist in parts of Andhra Pradesh, Maharashtra (*koli samaj*) and Kerala (*karayogam*s), but their overall involvement in fisheries management and climate-change issues is limited. Other fishworker associations (for example, boatowners' associations, women's groups and co-operatives), though important, have, as yet, a very limited understanding of climate-change implications on fisheries. State-level fishworker unions exist in all four States (some affiliated to the National Fishworkers' Forum, NFF), but it can be said that the overall organization among the fishing communities is hardly proportionate to the magnitude of the problems they are facing. Barring few exceptions like the Ramakrishna Mission Ashrama at Nimpith in West Bengal, the extent of involvement of CSOs in climate-change aspects in fisheries is meagre in all the States.

All the same, there is growing awareness about climate change in the government as well as in the CSOs working in the sector; however, perceptions about climate change vary from person to person, prompting one scientist to liken them to the case of five blind men describing an elephant.

The Department of Fisheries in all four States have no specific focus on climate-change issues. However, they implement a range of programmes and schemes that directly or indirectly help fishers cope with the causes and consequences of climate change. These programmes cover four broad areas: (i) development; (ii) welfare; (iii) management; and (iv) sea safety, disaster preparedness, mitigation, rehabilitation and insurance. However, these are not woven into a cohesive whole with climate change as the common strand.

During the field interactions, several critical institutional and policy issues (including the climate-change issues) were highlighted by the fishers as having an impact upon the fisheries sector and on fishing communities, and upon the

fishers' ability to cope with them. Some of these are highlighted below:

- There is a multiplicity of policies, legislation and institutional processes affecting the coast. The lack of institutional mechanisms to ensure coherent policies and linkages—both horizontal (that is, between different ministries and departments) and vertical (between the central and the State governments and between the top and bottom levels of the administration)—leads to contradictions and lopsided implementation, with fishers paying the cost.
- Coastal protection and conservation programmes (such as coastal and marine national parks and sanctuaries) are a major constraint for the fishers. In a majority of cases, fishers have been excluded from decisionmaking, and the impacts have been uniformly negative, leading to increased vulnerability and decreased livelihood security. Going by their implications on the lives and livelihoods of fishers, one might say that the implications of future conservation-oriented policy responses to climate-change impacts could well be to alienate all coastal dwellers from their traditional habitats and livelihoods.
- Support systems to cope with the challenges are weak. Most development support such as fuel subsidies as well as packages for rehabilitation (for example, in cases of displacement), compensation (for example, for loss of life at sea) and insurance (for example, for older or vulnerable fishers) are considered to be out-of-date, inadequate and inappropriate to address the emerging needs and concerns of the fishers, or to help them diversify.
- Developmental and support programmes aggravate the crisis in fisheries. The continuing support for additions to fleet strength; fuel subsidies, particularly high in States like Maharashtra; and construction of new ports, breakwaters and sea walls without proper needs assessment, technical feasibility, suitable design and appropriate maintenance arrangements are all said to contribute, in the long term, to the increasing unsustainability of the activities.
- The existing legal provisions are poorly implemented. Apart from the lack of appropriate legal frameworks for ensuring compliance with global and national standards on various issues, most existing legal provisions are not implemented fully or in the right spirit, giving rise to concerns related to fisheries management, pollution, habitat degradation, sea safety, and other coastal development initiatives.
- There is a weakening of existing legal provisions, such as the relaxation of the monsoon ban to 47 days, and exemption for one- and two-cylinder boats in Maharashtra from the fishing ban.

- There is a lack of control on upstream processes, such as construction of dams or industrial development, resulting in reduced freshwater flows, sedimentation and erosion, and increased pollution, which have impacts upon the downstream ecosystems and fisheries.
- No adequate focus is given to fishing-settlement-level planning to enhance the capacity to cope with natural disasters and other climate-change-related developments. Inadequate attention is paid to the continued weak access to basic services, such as education and healthcare.
- Critically, there is no space for fishers in the wider development/conservation processes, with the result that the measures (a) fail to enhance the fishers' capacity to cope with climate change effectively; and (b) alienate them from their traditional habitats and livelihood activities.

12. MEASURES TO PROTECT LIVES AND LIVELIHOODS OF SMALL-SCALE FISHING COMMUNITIES IN THE CONTEXT OF CLIMATE CHANGE: SUGGESTIONS FROM THE FISHERS

A comprehensive strategy to protect the lives and livelihoods of fishing communities in the context of climate change, which also addresses the issues identified above as well as the other major drivers of climate change, is obviously needed. This section will identify selected key measures considered high-priority by fishing communities, from their own specific realities.

12.1 ENHANCE FOCUS ON COASTAL ISSUES AND REPRESENTATION OF FISHING COMMUNITIES IN POLICY AND RESEARCH PROCESSES

Pointing out that the NAPCC has no specific focus on coastal issues, despite the widely acknowledged vulnerability of coastal areas and coastal communities to climate change, a key demand of fishworker organizations is for a separate 'coastal mission' as part of the NAPCC. They also seek policies and measures, developed in consultation with fishworkers, to build the adaptive capacity of fishing communities to deal with threats from climate change and climate variability. In this context, a specific demand is that the externally aided integrated coastal zone management programme (ICZMP) being implemented should integrate the proposals and perspectives of fishing communities, and should be subject to public discussion and monitoring. It is also necessary that fishing communities be consulted during the preparation of State Level Strategy and Action

Plan (SAPCC). With reference to research, there is need for participatory methodologies that specifically draw on the knowledge and experiences of fishing communities, and for a greater socioeconomic focus in research.

12.2 INCREASE AWARENESS AMONG FISHING COMMUNITIES AND OTHER STAKEHOLDERS

There is need to raise awareness at the fishing-community level about climate change and its possible impacts, including through sharing of research findings in appropriate formats. In several places visited during the study, there were indications that at least some community members were aware of these. In most places, while the 'climate change' terminology was new to people, once it was unpacked into its more comprehensible components, they could relate to it almost immediately and provide a range of examples and personal experiences. However, what is not so clearly apparent to the fishers are the linkages between climate change and the changes in their own operating conditions, such as the changed fish composition or declining fish availability. Correspondingly, there is even less awareness about how their own practices are linked to climate change, including to climate-change adaptation and mitigation. There is thus a need to bring home this aspect more forcefully, and also to persuade communities to undertake more responsible fishing and post-harvest practices.

Some other areas where the fishers' awareness will need to be enhanced are given in the course of discussing the other recommendations. There is also need to raise awareness among the nodal agencies dealing with climate change, as well as among fisheries departments and research institutions, about the human and socioeconomic dimensions of climate change, in order that these parameters are reflected in practical actions and measures, and in research frameworks.

12.3 IMPROVE FISHERIES MANAGEMENT THROUGH BOTTOM-UP ADAPTIVE PROCESSES

Promoting responsible and equitable forms of fisheries management will, among other things, contribute to enhancing the ability of fishing communities to cope with possible climate-change impacts. In this regard, several steps are urgently required. In the perception of the fishers, measures that are important to consider include: weeding out destructive fishing methods; putting a ceiling on the numbers and size of fishing boats; and the banning of destructive fishing gear such as small-mesh nets at the source, that is, at the manufacturing stage itself. The fishers suggest that the fishing gear manufacturing companies should obtain environmental clearances periodically to prove that their nets are made to the

applicable fisheries management standards. That fishers themselves have a role in self-regulation was also acknowledged.

Given that the anticipated impacts of climate-change-related processes on fisheries remain uncertain, it is essential to ensure that fisheries management is *context-specific and adaptive*, to be able to respond in a timely manner to the local changes and impacts observed. In this context, fishing communities stress the need for participatory, bottom-up approaches that offer more flexibility, such as co-management and community-based management.

However, the concerns of fishing communities about these approaches need to be kept in mind. There is concern that under the guise of co-management, the ultimate authority will remain with the government, with the member-fishers co-opted into a course of action that the government has already decided upon. Also, going by the experience of joint forest management in some coastal plantations of casuarina in Andhra Pradesh, the fishers contend that the process of sharing frequently involves the fishers bearing the costs while the government takes the benefits. With regard to community-based management, the contention of the fishers (especially the women) is that, even in a supposedly community-based system, decisionmaking is seldom an equitable process. In most traditional systems, women and asset-less fishers are excluded from the decision-making process and, even otherwise, it is frequently the more powerful and affluent fishers who dominate the process, to the detriment of the lesser fishers. Thus, in the idealized constructs about community participation, the issue of power and how it manifests in different overt and covert ways is frequently ignored, and the resultant systems could actually make things worse than before.

12.4 IMPROVE ENGINE EFFICIENCIES FOR BETTER ECONOMIC AND ECOLOGICAL IMPACTS

An important factor in ecological and economic terms in fishing is the nature of the boat engines and their efficiencies. There is a strong demand for more energy-efficient engines both as a way to reduce operational costs (with fuel accounting for up to 50 per cent or more of the total costs) and to reduce carbon emissions. There is need for research institutes and engine manufacturers to focus upon developing appropriate engines, suitable for the increasingly difficult sea conditions. Non-conventional or alternative fuels such as LPG, solar and wind energy, as well as appropriate usage of sails in conjunction with the engines, will need to be researched and—where successful—popularized. Further, in the small-scale sector, there is a need for improving the fishers' understanding and capability to cope with the engines and their maintenance. In the absence of such expertise,

the boatowners complain about the frequent need to carry engines over long distances for repairs, and having to pay high prices even for small malfunctions, losing precious fishing time in the process.

12.5 ADDRESS ISSUES OF SEA SAFETY AND OF MIGRANT FISHERS

Climate-change-related processes may have an impact on issues related to safety at sea. All fishing boats—irrespective of size and technical efficiency—should have quality certification as to their seaworthiness, which needs to be periodically renewed after thorough tests. The example the fishers used in this context was that of motor vehicles, which undergo several rigorous tests and are subjected to frequent checks. All boatbuilding units must be compulsorily registered, the registration itself being given to those with trained equipment and manpower, to ensure quality compliance and basic norms of safety. All boatbuilding activities should follow a HACCP process and the construction activities properly documented so as to fix responsibility when anything goes wrong. All boats should be registered and compulsorily insured prior to leaving the boatbuilding yards. Distress alert transmitters (DATs) should be provided to all seagoing boats on a subsidized basis. Similarly, GPS and fish-finders should be made available to the fishers at subsidized rates. There is need for increase in the coverage and the quantum of insurance support to cover all active fishers against a wider range of calamities, with adequate compensation ensured to support the affected families.

Another critical area that needs attention is migrant fishers, in a context where migration is increasingly being adopted as a strategy, whether or not in response to climate-change-related factors. Ensuring strong institutional support for the migrants needs to be a priority, as also mechanisms to keep track of their wellbeing from time to time, and to assist their families back in their villages to cope with the changes that migration forces upon them.

12.6 ADDRESS NON-FISHERIES ISSUES THAT AFFECT FISHERIES RESOURCES AND THE QUALITY OF LIFE OF FISHING COMMUNITIES

Addressing issues such as pollution and destruction of coastal habitats due to non-fisheries-related causes is absolutely vital, given the sheer scale of their impacts and the fact that they seriously undermine the present livelihoods of fishing communities as well as their ability to adapt to possible impacts of climate change. This requires more determined policy-level actions covering multiple sectors and a diverse range of stakeholders in the government (central and State), the private sector and the coastal communities themselves. The need for such a

comprehensive multi-sectoral approach that seeks to ensure the sustainability if coastal ecosystems, cannot be overemphasized.

12.7 STRENGTHEN PLANNING FOR DISASTERS AND DISASTER PREPAREDNESS

Coastal fishing communities are considered to be highly vulnerable to natural disasters such as cyclones, typhoons, storm surges and tidal waves. The need to develop settlement-level plans, keeping in mind the vulnerability to such natural disasters, is essential. In this context, there is need to take note of the provision in the Coastal Regulation Zone (CRZ) Notification, 2011, which requires States to prepare detailed plans for the long- term housing needs of coastal fishing communities, keeping in mind the need for expansion, sanitation, safety and disaster preparedness. The planning process must take note of factors such as the growing problem of overcrowding in many fishing settlements, particularly those in urban and semi-urban areas, where pressure from urban growth and other developments are squeezing the spaces available to coastal fishing communities. Poorer households are often forced into higher-risk areas along the coast, increasing their vulnerability to natural disasters.

12.8 IMPROVE ACCESS TO BASIC SERVICES AND DECENT HOUSING

Fishing communities in several States continue to lack proper access to education, healthcare, sanitation, roads and decent housing. Urgent attention is needed to address these issues. This will also, directly and indirectly, improve the capacity of fishing communities to cope with climate-change-related processes. Better education, for example, will enhance the livelihood choices available to the younger generation, while access to decent housing will also help reduce damages to life and property during natural disasters.

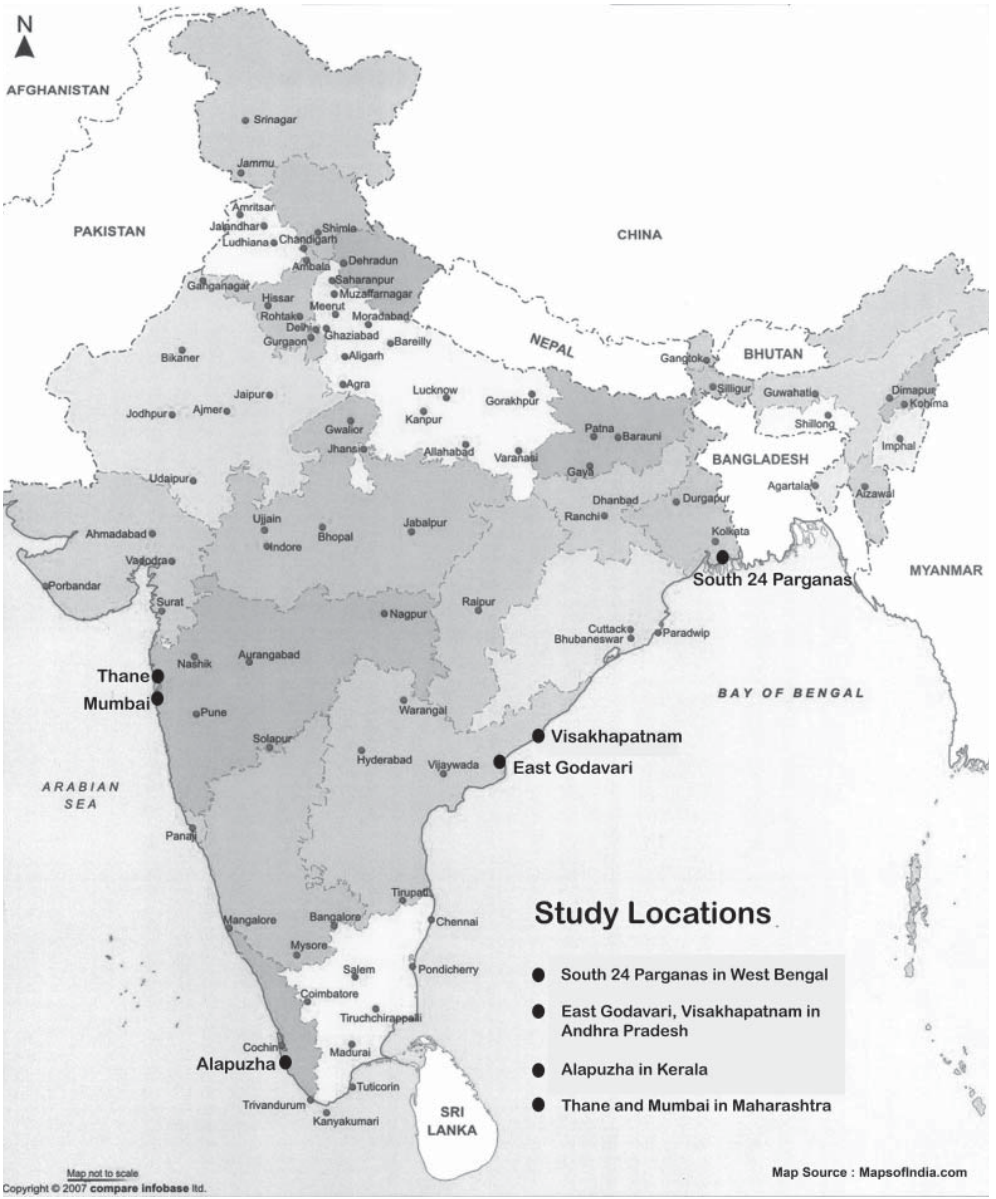
12.9 PROMOTE LIVELIHOOD DIVERSIFICATION THROUGH CONSULTATIVE PROCESSES

In situations where there is need to diversify from fisheries-related activities, it is best to draw on the options and choices already being explored by fishing communities, rather than imposing externally driven, and frequently inappropriate, options. Communities' own strategies have the unique advantage of building upon their strengths (or at least taking cognizance of their weaknesses), and hence strengthening the positive aspects of their strategies would yield better benefits in the long term.

Endnotes

1. UNFCCC. Article 1: Definitions(emphasis added), cited in Ahana Lakshmi, 2011: Review of Literature on Climate Change, as part of the ICSF Study Climate Change and Fisheries: Perspectives from Small-Scale Fishing Communities in India on Measures to Protect Life and Livelihood, Draft.
2. Vivekanandan E, 2011. Climate Change and Indian Marine Fisheries, Marine Fisheries Policy Brief-3, Kochi: Central Marine Fisheries Research Institute. 97p.

MAP OF STUDY LOCATIONS



SAMUDRA Monograph

Climate Change and Fisheries: Perspectives from Small-scale Fishing Communities in India on Measures to Protect Life and Livelihood

Through consultations with key fisheries-based stakeholders in four States of India, this study attempts to assess perceptions of fishing communities about the impact of climate change on their lives and livelihoods. It also evaluates the traditional knowledge, institutions and practices of fishing communities that are relevant to climate-change preparedness. The study identifies adaptation and mitigation measures that may need to be adopted by fishing communities and the State in relation to climate change. Based on this overall analysis, the study proposes measures to protect the lives and livelihoods of small-scale fishing communities in the context of climate-change policies and programmes at different levels.

This study will be useful for researchers, policymakers, students and anyone interested in climate change and its potential effects on the lives and livelihoods of small-scale fishing communities.

ICSF is an international NGO working on issues that concern fishworkers the world over. It is in status with the Economic and Social Council of the UN and is on ILO's Special List of Non-governmental International Organizations. It also has Liaison Status with FAO. As a global network of community organizers, teachers, technicians, researchers and scientists, ICSF's activities encompass monitoring and research, exchange and training, campaigns and action, as well as communications.

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