Vulnerabilities of Fishing Communities to Ecological and Climate Changes

A pilot study in Dharavi Bet in Mumbai

Institute for Community Organization Research

This study was sponsored by
Indian Network on Ethics and Climate Change
501 Kurupam Castle, East Point Colony
Visakhapatnam 530 017
Andhra Pradesh

Users may reproduce materials from this document subject to the condition that they acknowledge the source and send a copy of the document in which it has been reproduced to ICOR

Institute for Community Organization Research
St. Pius College, Aarey Road
Goregaon (E), Mumbai 400 063
Phone: 91-22-29270953 / Tele-fax: 91-22-29270523
Email: icor@mtnl.net.in
July 2011

Contents

Preface

The rise in global temperature is warming up the seas and consequently sea levels are rising. This will have adverse effects on ocean ecosystems and fisheries, coastal land and coastal communities. A warming sea will possibly affect fish population and distribution, and the rising sea and higher tides will erode and submerge coastal land and displace settlements along the coast; saline water infusion inland will affect coastal agricultural land and inland water sources.

With a long coast line of about 7,500 km and several low-lying coastal areas, India is particularly vulnerable to coastal erosion and flooding. The National Institute of Oceanography estimates that the sea level along the Mumbai coast has been rising at an average of 1.2 mm a year but some other regions in Asia have reported a rise of 3 mm per year. The Intergovernmental Panel on Climate Change (IPCC) has estimated that the sea level would rise by an average of 49 cm during this century against an actual rise of 17cm during the whole of the previous century.

In this context, Institute for Community Organization Research (ICOR) carried out a study of the impact of local ecological changes, global warming and coastal flooding on fishing communities in the Mumbai suburbs of Manori, Gorai and Uttan (administratively, Uttan is in the neighbouring Thane district) and also met officials of state fishers' organizations, state fisheries officials and environmental and marine fisheries scientists to supplement the community surveys. The objective was to find how ecological and climate changes have affected, or are likely to affect, fishing communities and their livelihood, and their perceptions of the reasons for the changes, if any. The focus was on the vulnerabilities of artisanal and small-scale fishers.

I am grateful to Prabhakar Nair who was responsible for the study. I specially thank Henry Sequeira and Kalpana Dabre who gathered some of the information. I am also grateful to Juliet Maben for her secretarial work.

ICOR is extremely grateful to Indian Network on Ethics and Climate Change (INECC) for the generous financial and inspirational support which has made this publication possible. Being part of INECC for the past 15 years has been an enriching experience for the staff of ICOR.

15 July 2011

Allwyn D'Silva
Director, ICOR

THE TROUBLED SEA AND SMALL FISHERS

Among the predicted results of global warming are a rise in land and sea temperatures, changes in weather patterns, climate-related extreme events, sea level rise and consequently coastal land erosion and flooding, more intense tropical cyclones and storm surges. These will affect farming, fishery, forestry, etc and livelihood based on these sectors in the tropical countries.

Poor and marginalized communities who depend on natural resources and local ecosystems such as land and water (rainfall, river, sea, etc) for livelihood will be particularly vulnerable. Any adverse effects on these resources will affect their livelihood, more so in the long run when climate change impacts are expected to intensify. This pilot study looks at the *likely impacts of environmental and climate changes* on communities in one such climate-sensitive sector – *fishery* — in Dharavi Bet (Dharavi Island, which is surrounded by the sea and creeks) in the far-northern suburbs of Mumbai (not to be confused with Dharavi, a large slum area, in the middle of Mumbai city).

It must be noted that overfishing and chemical pollution of the oceans have already created serious problems in fishery the world over. Global fish stocks are depleting following years of intensive fishing by corporations and big fishers using high technology. “Over three-quarters of all marine fish species are below, or on the brink of falling below, sustainable levels”, says a recent report in *The Economist*, London.[1] Artisanal and small-scale fishers, with their limited means and capacity, find it hard to compete with corporations and big fishers for these dwindling resources.

In India too, policy measures introduced in the 1950s and the 60s to boost fish production and export using mechanized trawlers and other sophisticated fishing technologies led to intensive fishing in the coastal waters, the traditional domain of artisanal and small-scale fishers. Though mechanized trawlers and other new fishing crafts and gear helped raise production, later, as the rate of growth in production started sliding, it was clear that the growth had come at the cost of sustainability of fisheries resources. Not only did these policy measures marginalize fishers who did not have the capital or access to capital to invest in the new technologies but the unregulated exploitation of fishing resources by others, including investors from outside the traditional fishing communities, led to a depletion of fish stocks in the near-shore waters and a decline in fish catch by artisanal and small-scale fishers. For example, the annual per capita fish catch by artisanal fishers in the country dropped from 2,590 kg in 1980 to 420 kg in 1996-97.[2] Surveys among several fishing communities across the four southern states of Andhra Pradesh, Tamil Nadu, Kerala and Karnataka by the Central Marine Fisheries Research Institute (CMFRI) some years ago showed that a decline in fish catch was the major problem they faced.[3]

Any impact of climate change on fisheries resources and the livelihood of fishing communities need to be assessed in this context. Global warming and climate change can cause changes in marine ecosystems and coastal habitats, exacerbating some of these problems, and poor fishers and communities who lack the resources to adapt to the changes will be particularly vulnerable.

Fishery, which is an important source of food and the only source of livelihood for a large number of artisanal and small-scale fishers, is sensitive to changes in the climate. Climate

change can cause changes in aquatic ecosystems and productivity. Changes in sea surface temperatures, ocean currents, sea water upwelling (a process of vertical mixing which brings the colder nutrient-rich water from the bottom of the sea to the surface near the coast), etc can "substantially alter fish-breeding habitats and food supply for fish and ultimately the abundance of fish populations in Asian waters", noted the Intergovernmental Panel on Climate Change (IPCC) in its exhaustive report, *Climate Change 2007,* published that year. "Recent studies suggest a reduction in primary production in the tropical oceans because of changes in oceanic circulation in a warmer atmosphere," it said. As the tropical seas warm up, it will also drive some varieties of fish, especially commercially important varieties, to cooler waters and more suitable habitats in the northern seas (at higher latitudes) or to cooler waters deeper in the sea. Such northward fish migrations from the warmer tropical seas have been reported in international scientific journals.[4] Higher temperatures and acidification of the sea (because of increasing carbon dioxide concentrations in the sea) will damage or destroy coral reefs and the rich marine life they support. Coral reefs host about 25 per cent of the world's marine species.

Rising sea temperatures will also cause the sea level to rise and flood low-lying coastal regions. The global sea level, which rose at an average of 1.8 mm a year from 1961 to 2003, is expected to rise by up to 59 cm (1.8 ft) during this century, as estimated by the IPCC. (The rise could be higher if water flowing into the oceans from melting glaciers and ice sheets is taken into account.) This can submerge large stretches of low-lying coastal land, jeopardize the livelihood of coastal communities, and lead to their displacement. Salt water incursion into coastal land will be another problem.

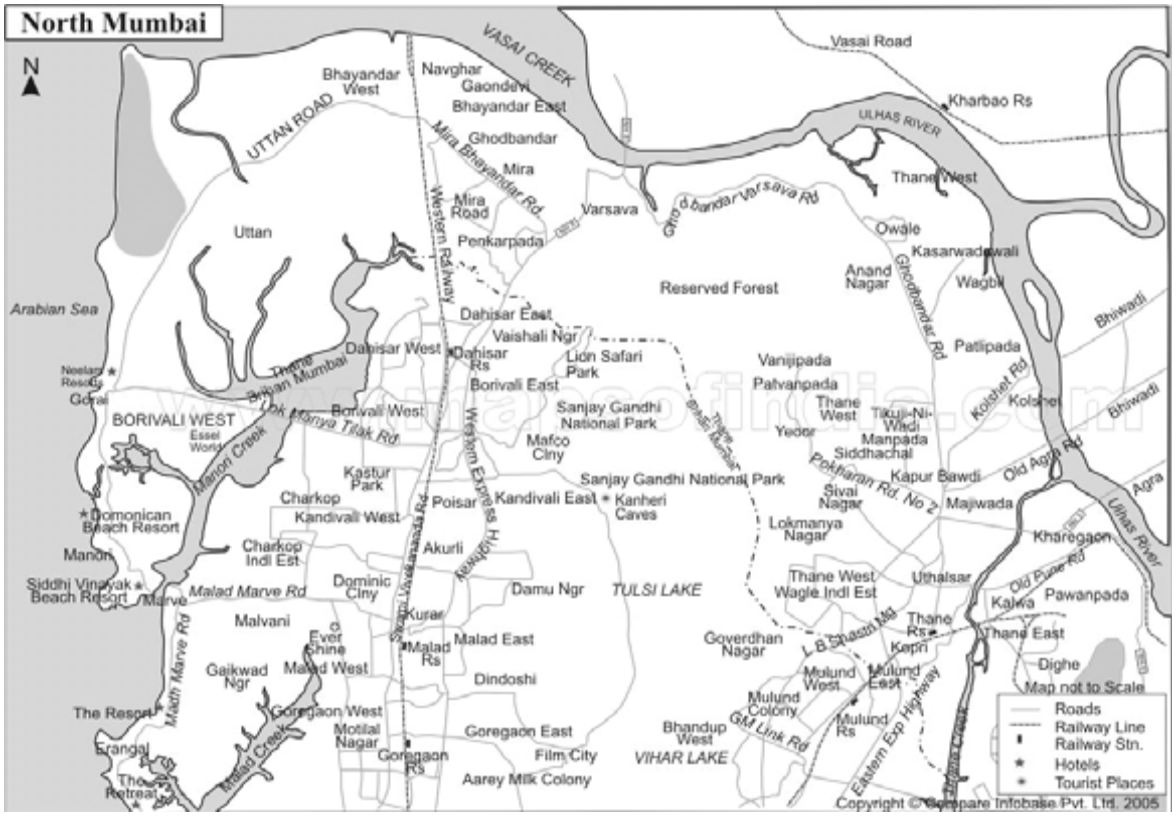
Fishing villages in India

Of the 2,643 fishing villages dotting the Indian coast, 458, with a population of about a million, are within 100 metres of the high tide line.[5] This, along with how high or low they are relative to the mean sea level, is an indicator of their vulnerability to the dangers of sea level rise. To take an example, Kerala has the largest number, about 200, of such vulnerable fishing villages, and they have been facing some of the impacts of global warming. According to Anto Elias, a fisher and secretary of the Kerala Swatantra Matsya Tozhilali Federation (Kerala Independent Fish Workers' Federation), the rising sea level, combined with rampant sand mining, has "rendered at least 10,000 people homeless" along the Kerala-Kanyakumari (in Tamil Nadu) coast. Salt water from the sea is contaminating drinking water sources in the coastal villages. "Global warming has also meant warmer waters and a change in the direction of ocean currents, and these have affected the amount of plankton available for fish to feed", he says. (Plankton, the tiny plants and organisms, on which fish feed, is the base of the ocean food chain.) "Many species of fish, especially the smaller varieties, have disappeared, and bigger fish have also dropped in abundance".[6]

Mumbai and its suburbs have about 27 traditional fishing villages. Institute for Community Organization Research (ICOR) sought to study the vulnerabilities fishing communities in the three fishing villages of Manori, Gorai and Uttan (all in Dharavi Bet) faced from ecological and climatic changes. A preliminary discussion with the communities showed that fish catch was declining in some of these villages, and, in their perception, overfishing, chemical pollution of

the coastal waters and environmental changes were the main causes. Except for some experienced fishers, others were not much aware of how climate change can affect marine fisheries and the coastal ecosystem, though they said weather patterns and conditions in the sea were changing.

Location of Manori, Gorai and Uttan in the north of Mumbai



(Source: http:www.maharashtratourism.gov.in/mtdc/HTML/MaharashtraTourism/images/ma...)

ICOR therefore carried out a pilot study in these three villages, during the years 2009 and 2010, to find out how overfishing, pollution and environmental changes affected the communities' local ecosystems, fisheries resources and livelihood, and further what impact climate change is likely to have on the communities. *The focus was on artisanal and small-scale fishers* within the communities.

How have the factors mentioned above affected their fisheries resources and livelihood over, say, the past two decades? What are the problems they face today, and how are they coping with them? How is climate change likely to affect them in the future? And, in the face of these problems and uncertainties, how do they perceive their future? ICOR discussed these issues with various groups, including fishers' co-operative societies in these villages and also fisherwomens' groups. ICOR also talked to officials of the Maharashtra Machhimar Kriti Samiti (Maharashtra Fishermen's Action Committee) and scientists in environmental and fisheries

research institutes to supplement the community surveys. The outcome of the community studies and discussions with others is reported in the following pages.

DHARAVI BET – A BRIEF BACKGROUND

Dharavi Bet stretches from Manori creek (also known as Gorai creek where it passes along Gorai village upstream) in the south to Vasai creek in the north (see map), straddling Mumbai and Thane districts (Uttan administratively comes under the neighbouring Thane district). Significantly, over 60 per cent of the total marine fish catch for the five coastal districts of Maharashtra comes from these two districts. Dharavi Bet comprises about 10 villages from Manori in the southern end to Uttan (including Uttan-Pali, Pathan Bunder and Uttan-Chowk) in the north, and has a population of about 1.5 lakh. About 70 per cent of the population depends on fishing and fishery-related work for livelihood; the rest lives on farming, farm labour, petty trade, salt pan work, catering to tourists and other sundry services. About 10 per cent of the population works in Mumbai city, mainly as industrial and unskilled workers and also in offices, hospitals and malls. Till a few decades ago, many fishing families also practised seasonal farming. Over the years, many have sold their farmland (because of the rising cost of farming and falling returns) and have been entirely depending on fishing and related work for livelihood; some fishing families, however, continue seasonal farming.

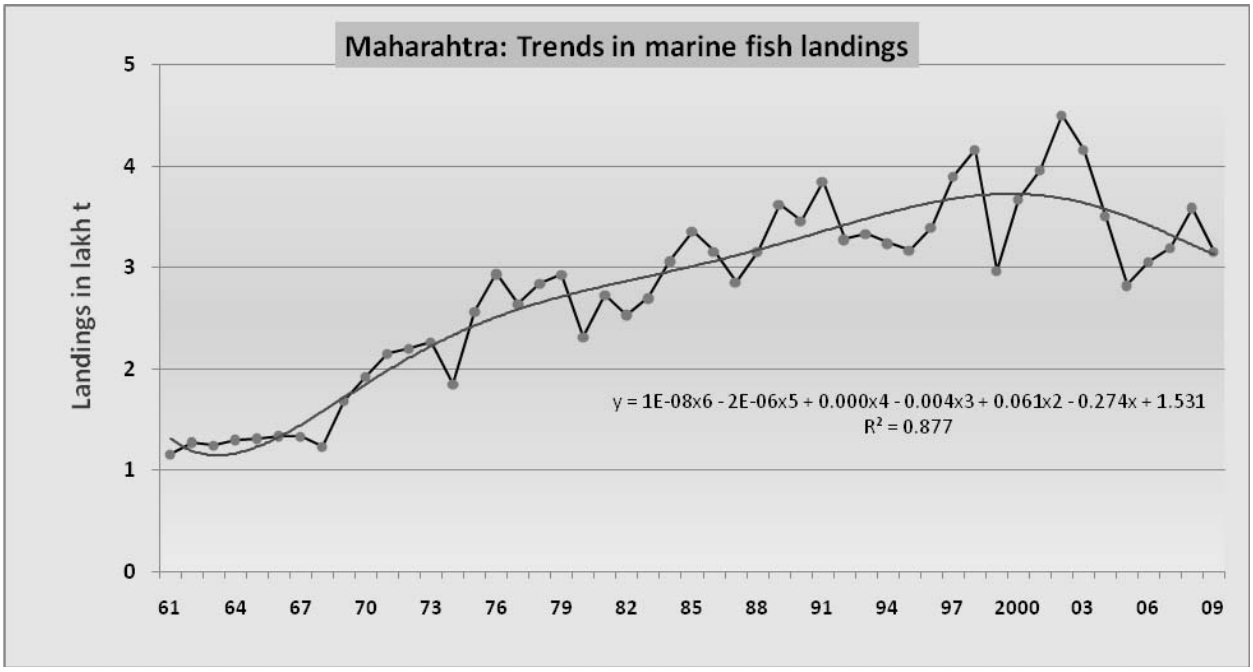
The map shows Manori and Gorai (in Mumbai district) and Uttan (in Thane district). Manori/Gorai creek is in the south and Vasai creek in the north

Among the fishers, the majority, around 85 per cent, are artisanal (using non-motorized boats) and small-scale (using motorized boats with limited capacity). Traditionally, they fished in the coastal waters up to 4-5 km (much less for artisanal fishers) from the shore and in the creeks, and they could get a good catch of a variety of commercially valuable fish from these waters. Coastal fishery in fact provided them with “assured food and livelihood” till about a couple of decades ago, say the fishers. But this is not so any more. Things have been changing. These

changes, however, need to be seen in the wider context of fishery-related and other developments in the state over the past few decades.

Overfishing and pollution take a toll

In the 1970s and 80s, as in the rest of the country, mechanized shrimp trawlers and purse-seines were introduced in Maharashtra to increase fish catch and exports. To cater to the rising demand for shrimps, big fishers resorted to intensive and indiscriminate trawling in the coastal waters where traditional fishers had enjoyed customary community rights over local resources. With their huge but small-meshed nets, the trawlers swept up everything from the sea, including juvenile and baby fish and all other organisms that came in the way. This affected the replenishment of fish stocks and destroyed the marine ecosystem. Spurred by the initial increase in the catch and rising fish prices, the number of fishing boats too rapidly increased. Not to be left without any catch, small fishers caught whatever was available in the coastal waters, including juvenile fish. The overexploitation of resources eventually led to a decline in the rate of fish catch. After rising steadily for over four decades and peaking at about 4.5 lakh tonnes in 2002, the state's annual marine fish catch started declining, dropping to 3.16 lakh tonnes in 2009 (the graph shows the annual fish landings and the general trend line in



Central Marine Fisheries Research Institute, Mumbai

fish catch over the period 1961-2009). In 2010, it fell further to 2.25 lakh tonnes. Apparently, fish production in Maharashtra has crossed sustainable levels.

Within this general trend of decline, there was a sharper drop in high-value fish (or what is generally known in the market as 'quality fish') catch, which is economically important to fishers, especially artisanal and small-scale fishers. Quality fish such as pomfret, prawn, lobster, *ghol* and *koth* (the croakers group) and *surmai* (seer fish), which fetched a higher price in the

market, gave them a better income. Pomfret catch, for example, dropped from around 15,000 tonnes in 1989 to about 4,800 tonnes in 2009. Fish such as pomfret and Bombay duck *(bombil)* are considered economic mainstays of traditional fishers in the state. Bombay duck catch dropped from a little less than 40,000 tonnes in 1990 to around 20,000 tonnes in 2009.

Overall, over the past decade, high-value fish catch (priced above Rs.50,000 per tonne at current prices) in the state declined from 1,09,000 tonnes in 2000-01 to 45,000 tonnes in 2007-08 before recovering to 83,200 tonnes in 2008-09. Excluding the highest-priced fish such as prawn, lobster and pomfret (priced above Rs.70,000 per tonne) within this group, the catch of other high-value fish, priced between Rs.50,000 and Rs.70,000 per tonne, saw a steep fall from 60,136 tonnes in 2000-01 to 17,029 tonnes in 2007-08 and further to 3,284 tonnes in 2008-09.

Overfishing and trapping juvenile fish on a large scale had apparently affected the sustainability of fishery resources and production levels. Catching juvenile fish was a massive biological loss for fishery; allowing fish to mature and spawn would have greatly enhanced production.[7] Mature fish would have also fetched a much higher value in the market. So everyone is concerned, and everyone agrees that the number of boats and mesh sizes of fishing nets need to be regulated, though nothing much is being done about the problem.

Coastal fishers in Mumbai faced another problem — pollution of the coastal waters and the creeks from domestic and industrial wastes. These included sewage, chemical wastes and garbage, especially plastic wastes, which often ended up in the sea. Sewage contains bacteria which consume the oxygen in the water, and this makes it difficult for fish to survive. Chemical pollutants cause toxicity. The large-scale destruction of mangroves and coastal wetlands (for real estate and infrastructure development), the spawning and nursing grounds for a variety of fish, added to the problem.

Indiscriminate fishing by trawlers and pollution have taken a heavy toll of many varieties of quality fish in the Mumbai coast, says Dr. Sushant Chakraborty, Principal Scientist, at the Central Institute of Fisheries Education (CIFE) in Mumbai. Among these varieties are pomfret, croakers (*ghol* and *koth)*, perch (*karkara*), eel (*wam*) and threadfin (*dara*). This has hit artisanal and small-scale fishers the hardest because the coastal waters, their traditional fishing ground, has now hardly any fish. And if the trend continues, there will be no fish in the coastal waters after a few decades, warn environmental scientists.

This view is reinforced by Ram Bhau Patil, president of the Maharashtra Machhimar Kriti Samiti. “Uncontrolled fishing and faulty fishing practices have led to a decline in the fish population and have even led to some species disappearing from the sea”, he says. “The extremely small mesh size of the nets the big boats use traps even the small and young fish. The bigger boats are the culprits whereas the smaller ones are the sufferers. Declining fish catch and productivity has a greater impact on small fishers’ livelihood. They have no subsidiary or secondary income.”

Climate change could further affect fishery in various direct and indirect ways – leading ultimately to changes in the marine environment, disruption of fish breeding and growth cycles, a decline in productivity and yields. Some fisheries scientists and experienced fishers suggest

that this could also be a factor contributing to the decline in the stocks of some varieties of fish in Mumbai's coastal waters. Not everyone agrees, though.

THE CHANGING SCENE IN DHARAVI BET

All these problems – overfishing, pollution, ecological degradation and climate change – are evident and overlapping in Dharavi Bet.

Overfishing: Overfishing is a problem, and has contributed much to a decline in fish stocks in Dharavi Bet, according to most fishers. Fish catch per unit of effort and also per head has fallen, and fishers see overfishing as the primary reason. More families now own fishing boats and many families have more than one boat, especially big fishers. Well-equipped boats and trawlers from other parts of the state and from the neighbouring Gujarat have also been coming and fishing here. (The Maharashtra government now plans to curb and penalize trawlers from other states encroaching on its coastal waters.) So even where there is no fall in the total fish catch, catch per head or per boat has dropped because of the increase in the number of boats.

Ecological degradation and pollution: Coastal fishery resources include (besides the coastal sea) estuaries, creeks, coastal wetlands and mangroves. Wetlands and mangroves are biologically very productive and are the breeding grounds for a variety of fish. Acting as natural barriers, these also protect coastal land and communities from erosion, floods, tidal waves and storms. However, in urban and suburban areas undergoing rapid expansion, such as in Mumbai, these resources are subject to development-induced environmental changes.

As mentioned earlier, Manori/Gorai creek on the south and Vasai creek on the north form the boundaries of Dharavi Bet; on the west is the Arabian sea. To the east is the hinterland, including the Mira-Bhayandar townships, about 7-8 km away. Running along the coastal strip, in different areas, are hills, forests and farm land, which produce rice and a variety of fruits and vegetables; besides fish, Dharavi Bet supplies fresh fruit and vegetables to Mumbai city. Numerous ponds and lakes dot the land. Thick mangrove forests run along the creeks. There are also long stretches of marshy land and salt pans along the creeks. Dharavi Bet thus had a rich and bio-diverse ecological system.

As Mumbai frenetically expanded towards the northern suburbs in the 1980s and then to the far-north in the 90s, rapid urbanisation and real estate development started in the hinterlands of Dharavi Bet. This growth, like in other suburbs was unplanned and unregulated. Hectic construction (both legal and illegal) reduced open spaces and the green cover, reclaimed marshy land and destroyed large stretches of mangroves along the creeks; poor local inhabitants also cut mangroves for fuel wood. The mangroves and creeks also became dumping grounds for construction debris and garbage. Fishers have therefore been struggling to save the mangroves and, following their campaigns, the mangroves have been recently declared to be protected forests by the Central government. The Manori-Vasai mangrove belt is in fact one of the 38 mangrove forests in the country marked for intensive conservation and management by the Central Ministry of Environment and Forests.

The creeks and the coastal waters are polluted with untreated sewage, chemical effluents from industries, and garbage, mainly plastic wastes. The ubiquitous plastic wastes, carried down by wind and water to the creeks and coastal waters, has become a threat to marine life and fishing; fishers in Dharavi Bet complain that they often get more plastic wastes than fish in their nets. Oil contamination from off-shore oil rigs and tankers has added to the problem.

The environment in the creeks has deteriorated, and this has depleted fish stocks in the creeks. The Manori creek, for example, has come under "increasingly heavy environmental stress", says a recent study[8] by scientists at the National Institute of Oceanography (NIO). The oxygen content in the creek water has depleted over the past 25 years – from 5.1 ml per litre of water in 1982 to 1.6 ml/litre in 2007, which is below acceptable levels. A water quality index (a composite measure of water quality which takes into account several factors) of less than 55 "indicated unacceptable aquatic conditions" in the creek. Heavy metal contamination (from industrial pollution) and salinity levels too have increased (mainly because of the run-off from the salt pans and reduced fresh water flow) over the past 15 years. All this has resulted in "poor biodiversity" (such as of mangrove varieties) and "low productivity" both of flora and fauna in the creek. "The prevailing status of Manori creek warrants immediate clean-up action for improving biological and environmental qualities", says the study.

Climate change: Weather patterns and the climate too have been changing. Rainfall is now erratic and unpredictable, and, more often, occurs in short, intense spells. The monsoon, the communities observe, starts a little later and ends earlier than before, lasting about three months instead of the traditional four months; there is more rainfall in the later months of the monsoon than in the early period of June and July. Summer is extending and winter is getting shorter. Land temperatures are rising (the *average maximum temperature* in Mumbai rose by 1.62^{o} C in a little over a century from 1901 to 2007). Sea surface temperatures are also increasing because of which now there are more stormy winds (particularly in October-November), stronger thunderstorms and lightning. Surface temperature in the Arabian Sea has been consistently rising since the 1940s with the annual average temperature ranging from 29.2^{o} C in the Lakshadweep region in the south (closer to the equator) to 27^{o} C in the Gulf of Kutch in the north in 2000. These annual average temperatures are estimated to rise by 3^{o} to 3.5^{o} C by the end of the century.[9] Coastal waters off Mumbai are currently warming at about 0.3^{o} C per decade.[10] The sea level off the Mumbai coast is rising at an average of 1.2 mm a year, according to a study by the NIO.[11]

How have all these factors affected, or are likely to affect, fisheries resources, coastal land, farming and livelihood in Manori, Gorai and Uttan villages? And how have fishers responded to this changing situation?

MANORI, GORAI AND UTTAN – DIVERSE RESPONSES

As a general trend, fishers in the three villages say *fish stocks have depleted in the coastal waters* because of overfishing and pollution and there is not much fish available in these waters. Many varieties have moved away from the coast or into deeper waters, making it *difficult for artisanal and small-scale fishers to access them* with their limited boat capacity and fishing gear. Fishing time and efforts too have increased. The "productivity of big fish" or high-value fish such as pomfret, seer, croakers and threadfin has markedly fallen, and some varieties have almost "disappeared" commercially. Fewer fish varieties are available now and in smaller sizes. Even smaller fish such as *mandeli* and Bombay duck are "not available near the coast" unlike in the past.

In Manori and Gorai together, the average annual fish catch dropped from 18,400 tonnes for the five-year period from 1994-95 to 98-99 to 13,354 tonnes for the period 2004-05 to 2008-09. In Uttan, there was no fall in the average annual catch over these periods (the fall was only marginal, from 20,000 tonnes to 19,300 tonnes, see Table 1). Overall, Manori and Gorai are thus more affected than Uttan. Fishers in Uttan have generally gone in for higher-capacity boats, modern fishing equipment and different types of fishing nets to catch whatever varieties are available; there is thus greater mechanization and diversification in Uttan. However, because of the increase in the number of boats, fish catch per boat or per head has decreased, particularly for artisanal and small-scale fishers. In Manori, the number of boats increased from 70 to about 140 over the past 15 years, in Gorai,from 30 to 180 and in Uttan from 200 to 800.

Table 1. Trends in fish catch in Manori, Gorai and Uttan (5-year averages of annual fish catch since 1994 - 95)

Years	1994-95 to 1998-99	1999-00 to 2003-04	2004-05 to 2008-09
*Manori / Gorai	18,400 tonnes	10,575 tonnes	13,354 tonnes
Uttan	20,000 tonnes	15,500 tonnes	19,300 tonnes

Note: *combined fish landings for the Manori and Gorai zone. Data extracted and adapted from Annual Fish Production Reports, Department of Fisheries, Government of Maharashtra, for various years

Fishers who have gone in for higher-powered boats (which can go far out and stay longer in the sea) and modern and diverse fishing gear have managed to cope with the changes. Higher fish prices (relative to the price rise in other commodities) and an increase in the catches of some varieties of fish such as ribbon fish (*bala*), the price of which has been steadily rising over the years, have benefited big fishers and helped offset income losses to some extent for small-scale fishers. Artisanal fishers in all the villages have suffered.

On a rough estimate, artisanal fishers earned around Rs 60,000, small-scale fishers Rs. 80,000 to Rs.1.5 lakh, and big fishers Rs.5 lakh to 8 lakh a year, depending on the catch in the main fishing season of August to December (in Uttan, incomes generally are on the higher side). Artisanal and other lower-end fishers' incomes have generally declined; in bad seasons, the fall

can be as much as 30-40 per cent. For artisanal fishers, a good catch and hence income is no longer assured. Many have therefore given up fishing and work as crew on big boats or transport materials for big boats at sea. This generally gives them an assured income of around Rs. 50,000 a year, and, in a good season, it could be much higher.

Climate change (of which they have become aware only recently) is adding to the problems, the fishers suggest. Changes in cloud, rainfall, wind and tidal patterns and also in sea conditions have made it more difficult to locate and catch fish based on these and other traditional "indicators". Intense rains hinder fishing. Fishing is also becoming more hazardous because of rising tides, stormy winds and cyclones, they say. Changes in weather patterns are also affecting farming.

Within this general pattern, problems and fishers' responses in the three villages vary to some extent.

Manori

Manori has a population of about 8,000, with about 75 per cent involved in fishing and related work; 10 per cent are in services. About 20 per cent of the fishing families have farming as secondary occupation. Among the fishers, about 90 per cent per cent are artisanal and small-scale. All, including the big fishers here, however, use only one type of net (because of the higher cost of other types of net which, they say, they cannot afford) – the *dhol* net or bag net (unlike fishermen in Gorai and Uttan who use bag net and different types of gill net which allow them to catch a wider variety of marketable fish). Fishers in Manori are thus the least adapted to the changes occurring in fishery.

Even so, till about a couple of decades ago, they could get a lot of fish in the coastal waters, including shrimp *(jawala*), prawn, Bombay duck, *mandeli* (golden anchovy) and often high-value fish such as pomfret and seer. Fish such as Bombay duck and *mandeli* were part of the daily catch. There were lot of prawns near the coast. Now there are no big prawns; both the size and the catch have reduced. Catches of Bombay duck and *mandeli* have also fallen. Fishers observed that "some fish such as Bombay duck and *mandeli*, are moving to deeper waters", though they do not know the reason for this. They cannot catch fish such as mackerel and sword fish with their *dhol* nets, and they cannot have other nets which are more expensive. As for the profitable pomfret, the catch has drastically fallen over the years. In 2010, they could get pomfret for only one month (with two catches) while the normal pomfret season lasts 3-4 months, from mid-August to December. And, in January 2011, boats had to be docked for about a month for lack of any fish, said the experienced Dhuming Tari, chairman of the Manori Fishermen's Sarvoday Sahakari Society.

Because there is not much fish in the coastal waters, boats need to go farther into the sea. While a fishing trip for a small boat earlier took about 2 hours, now it takes 4-5 hours or even longer which means higher costs even as fish catch has decreased. Even the big boats have to go farther, 50 km or more, into the sea but often return with less catch than before. Ribbon fish catch has been increasing, and so also *jawala catch.* Meanwhile, pollution has driven off fish

from the Manori creek where earlier they could get a variety of fish and earn a good income even during the off-season.

The economic impact has been harder on artisanal and small-scale fishers whose incomes have dropped by 10-25 per cent. Lower income has affected their livelihood and lifestyles, and they have been seeking financial support from the local church (the fishing community in Dharavi Bet is predominantly Christian) as well as the fishermen's co-operative society.

This may offer some temporary relief. To cope with the situation in the long run, fishers in Manori need to have bigger boats and different types of nets, says Dhuming Tari. Of course, overfishing and pollution need to be stopped so that the coastal fish stock could be replenished but if fish continue to move farther or deeper into the sea, small fishers will not be able to catch them with the boats and nets they now have. They lack the capital to buy big boats and different types of nets. So fishermen in Manori want subsidies from the government when the fish catch is poor.

Because of all this, there is a new awareness about the need for education and alternative occupations in the community. Earlier, education was not considered important, and children were taken out of school after some minimal education – boys were initiated into fishing at an early age and girls told to help with the domestic chore, fish-drying, etc. Now they prefer to send their children, both boys and girls, to school and college (in Mumbai city) so that they can take up other jobs and services. Manori therefore has a higher level of education and occupational mobility than Gorai and Uttan, and the fact that Manori is much closer to the city (a regular and short ferry service across the creek connects the village to the main city) than the other two villages has helped. Among the educated in Manori, about 50 per cent have finished high school (10th standard) and 30 per cent 12th standard (pre-university stage or junior college as it is popularly known); about 20 per cent are graduates.

Many, including women, have taken up jobs in Mumbai suburbs; some women teach in schools. With this trend, which is likely to strengthen in the future, Manori's educational, social and occupational profiles will change in the next few decades, notes Dhuming Tari. Many more will be educated and in other jobs. This is significant in view of the fact that fishing communities generally have poor occupational mobility compared to farmers and other occupational communities. Greater occupational mobility will to some extent help fishers in Manori tide over their problems.

Gorai

Gorai has a population of about 6,800, of which 60 per cent are fishers, 30 per cent depend on farming and 10 per cent are in services. Of the fishers, again, about 90 per cent are artisanal and small-scale. But their main source of livelihood, coastal fishery, "is destroyed because of overfishing, sewage, chemicals and garbage", says Noel Keny, chairman of the Gorai Machhimar Sahakari Sanstha (Gorai Fishermen's Co-operative Society). "There is no fish in the coastal waters, they have moved far off", he adds.

In the past 15 years, the number of boats in the village has increased six-fold — from 30 to 180, resulting in overcrowding in the coastal waters. Besides, trawlers come from other parts of the state and also from Gujarat. Coastal fish resources have dwindled, and fish catch has decreased. The quality of the water near the coast and in the creek has changed, and this has also affected fishing in the creek which earlier gave some income for small fishers, particularly during the off-season. The big boats from Gorai now go up to Okha in Gujarat in search of a good catch using different types of nets and equipment but small fishers cannot afford to do this. Small fishers in Gorai generally use only *dhol* nets while big fishers use *dhol* nets and gill nets.

Catches of commercially valuable fish have declined. Pomfret catch, which used to give them a good income, has fallen significantly; pomfret, a coastal fish,was generally easily available within 2 km of the shore but overfishing and pollution have brought down pomfret stocks. Rising fish prices have helped protect incomes to some extent but a bad season still hits small fishers hard. For example, three years ago, the fall in pomfret catch was so drastic that "we measured the catch per fishing trip in kilograms instead of the usual tonnes", said Neville D'Souza, of the fishermen's co-operative society. Small fishers' incomes dropped by 30-50 per cent during the main fishing season. In 2010, as in Manori, Gorai also had only one or two catches of pomfret; there was a lot of ribbon fish, though, and fishers are surviving on it, according to Noel Keny.

Because of the increasing uncertainties in coastal fishing, many artisanal fishers have given up fishing and now work as crew on the big boats which assures them some income. Fishing families also sell the high-priced fish they catch and buy cheaper fish or meat or other food from the market for consumption in what can be called a market-mediated coping measure; also, when the fish catch is poor, they eat more dry fish. Some fishing families have revived vegetable and fruit farming in homesteads for greater food security.

As in fishing, there are uncertainties in farming (30 per cent of the population in Gorai depends on farming) because of the increasing costs of farm inputs, poor returns, and changing weather patterns. Rice is the main crop. The long use of farm chemicals has degraded the soil, lowering farm productivity, and now erratic rains and higher temperatures are affecting crop cycles and yields. Crops mature faster with less yields, say the farmers. Whereas earlier they had generally fixed sowing and harvesting cycles, now they are not sure when to plant or harvest the crops because of the changes in the rainfall pattern.

Uttan

Sixty-five per cent of Uttan's population of 30,000 is engaged in fishery, 30 per cent in other related occupations and 5 per cent in services. About 85 per cent of the fishers are artisanal and small-scale. Thus Uttan has the largest number of fishing boats (around 800) as well as the largest section of big fishers, owning big mechanized boats. In fact, except for artisanal fishers, most others have upgraded, modernized and diversified their fishing equipment and nets in response to the decline in fish catch in the coast. Some of the fishers own more than two big boats and employ migrant labour from other parts of the state and also from outside the state.

So, unlike in Manori and Gorai, the overall fish catch in Uttan has not fallen but, because of the increase in the number of boats, catch per boat has decreased. As elsewhere, the productivity and catch of big fish has decreased and fishing efforts have increased. Some commercially valuable varieties like *ghol, khoth* and threadfin are not available; pomfret and prawns are declining and available very far from the coast. Lobsters have disappeared because of pollution and disturbances in the sea (mainly caused by constant bottom-trawling). "Twenty years ago, whenever we were short of food, we just went out, quickly caught some lobsters and brought them home to cook", said James Culaco of Uttan. "Now we cannot find lobsters." Of late, even small fish such as Bombay duck and *mandeli,* earlier found in plenty near the coast, are getting scarce or moving away from the coast and also deeper into the sea, say the fishers. The Vasai creek, which used to offer a good catch of a variety of fish, is polluted with domestic and industrial wastes, and has hardly any fish.

For small fishers, when the catch is poor, there is loss of income despite the rise in fish prices. This often leads to debts. In many families, fish consumption also decreases, according to women's groups. Some prefer to sell fresh fish and buy cheaper food from the market or eat dry fish. A poor season also affects people who depend on fishery-related work such as fish sellers (who buy fish from boat-owners and sell it in the market), boat crew, boat repairers and other service men. Some poor women who earn a living by buying and selling fish turn to work as house maids when the season is bad or when they cannot afford to buy the fish. Similarly, under difficult family circumstances, girls go for construction work.

Some fishing families in Uttan have farming as a secondary occupation, and some households now grow seasonal vegetables which helps cope with income loss to some extent. However, increased temperatures and erratic rainfall are affecting crops, including vegetable crops (cucumber, gourd, radish, carrot, leafy vegetables, etc). New pests are emerging, especially in rice, papaya, shoe flowers, etc. Farmers ascribe this to excess rain and inadequate sun. Studies elsewhere show that "local weather changes can cause disruption in flowering/fruiting cycles and changes in pest profile".

However, unlike in Manori, youth in Uttan, including some graduates, prefer or are compelled to continue with fishing because of their inability to get jobs that will give them a higher income than in fishing. The cost and the inconvenience of commuting to the city, far away, for work is another deterrent. So the dependency on fishing as a source of livelihood continues, or rather is increasing, though the sustainability of these livelihood for small fishers is becoming increasingly uncertain (this is discussed in more detail later).

CLIMATE CHANGE AND LIKELY IMPACTS

Rising sea surface temperature

The Arabian, Sea, as mentioned earlier, has been warming. A warmer sea can affect fish breeding cycles, and fish production and survival rates. It will also disturb nutrient supplies to fish, alter fish habitats and cause migration to areas more suitable in terms of food availability and temperature. Fish may move to generally cooler waters deeper in the sea (surface waters being warmer than deeper waters) or the relatively cool waters in the northern latitudes. Oil sardines and mackerels, for example, are two such species in the Arabian Sea whose habitats are extending northwards because of the rising temperature.[12] According to marine fisheries scientists, these species are now moving from the southern seas off Kerala and Karnataka to northern areas off Maharashtra and Gujarat coasts. (Northward migration or extension of habitat of sardines has also been reported in the Bay of Bengal.)

The Indian mackerel, a surface-dwelling fish of commercial value, is not only extending its habitat northwards but is going deeper into the sea. Mackerel has been traditionally caught by "artisanal fishers using surface-drift gillnets". As a result of the temperature rise, it is now being increasingly caught by large bottom-trawling boats. During the decade 1997-2006, around 18 per cent of the mackerel catch in India came from the north-west coast compared to only 7.5 per cent during 1961-76. Also, the share of mackerel caught by bottom-trawling (at about 50-metre depth) boats in the national catch increased from only 2 per cent in 1985 to 10 per cent in the mid-2000s. "This shows that the fish descends down to deeper waters to overcome warmer surface waters", conclude scientists at the Central Marine Fisheries Research Institute.[13]

Such fish migrations can cause problems for resource-constrained small fishers. How will it impact their fish catch and livelihood if, as the sea warms further, more varieties of fish move deeper into the sea? For example, if surface-dwelling small fish such as *mandeli* and *bhiljee* (white sardine) in Mumbai's coastal waters migrate to deeper waters, marginal fishers may not be able to catch them with their current practices and nets, says Dr. Vinay Deshmukh, Principal Scientist at the Central Marine Fisheries Research Institute in Mumbai. Surface-dwelling seer fish and black pomfret (*halwa*), which have high commercial value, could also go deeper into the sea. A rise in sea temperature can eventually change the composition and relative abundance of fish varieties in a given habitat. This may require changes in fishing equipment and practices (types of net, boat, etc), which smaller fishers may not afford. For example, small fishers in northern Maharashtra do not have "effective nets" to catch mackerel, point out fisheries scientists. As a result of all this, they may be further marginalized.

Changes in sea temperature can also trigger changes in breeding cycles and growth and survival rates of most surface-dwelling fish. At higher temperatures, fish will start maturing faster and will have fewer eggs, reducing production; fish larvae will also be vulnerable to temperature changes. Catches of vulnerable fish species may thus decrease and some species may "disappear" in commercial terms.

As sea temperatures rise, higher salinity of the sea (caused by the increased evaporation of sea water and reduced flow of fresh water into the sea) is another concern raised by fishers. How will higher salinity affect productivity in the coastal waters, asks Ram Bhau Patil. Higher salinity can affect fish productivity in some coastal ecosystems. The question has significance from another point view – what will be the effect of higher salinity interacting with the chemical pollutants in the coastal waters? A recent study in the east coast of the country (Gulf of Munnar in Tamil Nadu) indicated that higher salinity can react with mercury (from industrial effluents) in the sea "to produce adverse effects on fish resources and fish production, particularly in the mangroves".[14] Other studies have indicated that higher temperatures can enhance the toxicity of marine pollutants such as mercury and cadmium.

Rising sea level and coastal habitats

The sea level is rising at an average of 1.2 mm per year along the Mumbai coast. Though several factors contribute to coastal erosion, stuides show that a sea level rise of 1 mm per year can in general cause the shoreline to recede by up to 0.5 metre a year.[15]

A rising sea can change coastal fish-breeding habitats and other ecosystems. It can cause land erosion and, in the long run, inundation, leading to loss of these habitats, livelihood and displacement. As discussed earlier, the IPCC estimated the sea level to rise up to 59 cm (1.8 ft) by the end of this century, but more recent studies, taking into account the flow from the fast-melting glaciers in Antarctica, show that this rise could be as high as 1.4 metre (about 4.5 ft). This greatly enhances the threat of flooding and salt water infusion (affecting coastal farming and water resources). India is in fact among the 27 countries in the world identified as most vulnerable to sea level rise by the United Nations Environment Programme, and low-lying Mumbai has been identified as one of the major coastal cities in the world more vulnerable to flooding. Some estimates indicate that a sea level rise of 8-30 cm will have a serious impact on the Mumbai coast.

In Dharavi Bet, Gorai and Uttan are at sea level while Manori is a little above the sea level. All three villages however, touch the high tide line and are hence vulnerable to sea level rise. Gorai faces perceptible erosion of the coast, and the government is building a stone wall (about 1.9-km long) to check the erosion. Uttan-Pali has been seeing a gradual shrinkage of its beach space; whereas earlier the beach was wide enough to dock three rows of boats in the off-season, now there is space for only one row. Shrinkage of beach space is also reducing the space available for drying fish, an important economic activity. According to fishers, the seaside walls built to protect private houses close to the sea in the southern parts of the city (particularly in Versova) and the massive reclamation of marshy coastal land for real estate development have contributed to this erosion up north.

Tides are slowly rising higher, observe the fishers. The occurrence of higher tides is also increasing. According to the Brihanmumbai Municipal Corporation, because of global warming, the number of days when unusually high tides or tides of above-normal height (above 4.5 metres in the Mumbai coast) occur in the monsoon has been increasing over the past few years.[16] When such higher tides coincide with heavy rainfall, it can flood coastal homes and

settlements as seen in Mumbai in the past few years. In Gorai and Uttan-Pali, for example, fishers say sea water enters houses close to the sea at higher tides when these occur with heavy rainfall. If the tides rise beyond the current levels, “we will have problems”, said a fisher in Gorai. If the sea level rises by 30-60cm (1-2 ft), saline water will enter homes and farms, and also contaminate water in the wells and ponds, mainly used for irrigation. Land productivity may suffer or the land may turn unproductive. (Though not yet seen much in Dharavi Bet, salinity has been affecting coastal land and farming in the neighbouring Vasai village across the Vasai creek.)

If the land erosion and flooding gets worse, some of the fishing communities in the villages will have another problem – they may not only lose their houses but also their right to alternative housing because the coastal land they live on belongs to the government, which means they have no legal title to the land or the house (though in many areas in the city fishing communities have been given legal rights to their houses). This leaves their housing rights to the mercy of the government.

Cyclones and storm surges

Besides a rise in the sea level, a warmer sea can cause more intense cyclones and storm surges, exposing coastal settlements to the risk of heavy damages and fishing operations to greater risks and losses. As the surface temperature in the Arabian sea increased, the “occurrence of most intense cyclones” in the region has also increased five-fold since 1995.[17] And if this trend continues, it will have serious safety and economic implications for coastal communities, especially for fishing communities. It may be recalled that Cyclone Phyan, which hit the Maharashtra coast in November 2009, narrowly missed Mumbai.

Fishing communities in vulnerable areas thus face three-fold risks: decline in traditional fisheries; erosion, flooding, loss of land and possible displacement; and damage to settlements, habitats, farm land and other economic assets from cyclones and storm surges, and increased risks at sea.

Table 2. Climate change impacts on fisheries, and coastal habitats and settlements

Types of Change	Impacts
Increase in sea water temperature	Severe climatic variations and frequent extreme events
Changes in sea water temperature and rainfall	Changes in ocean current dynamics and ocean ecosystems Effects on the distribution of fish varieties Decline in production of fish stocks Migration of fish, changes in spawning time
Increased incidence of extreme events (floods, storms, cyclones, etc)	Increased risks at sea, and loss of fishing time and efficiency of fishing Increased damage and disruption of coastal homes and habitats
Changes in acidity through increased carbon dioxide concentration and acidification	Effects on calciferous animals (e.g., shell fish, shrimps, crabs, lobsters, corals, echinoderms such as star fishes, sea urchins and brittle stars) Potential decline in production for such calciferous marine resources
Sea level rise	Loss of fish-breeding and nursery habitats like mangroves, estuaries and coral reefs; reduced production of coastal and related fisheries Threat to coastal habitats, human settlements and farmland, and possible displacement Increased exposure of coastal areas to storm surges and damages
Changing levels of rainfall and less predictable rainy/dry periods	Impact on the ability to plan livelihood activities (e.g., fishing and farming), and greater economic vulnerabilities

Table adapted from the paper "Building adaptive capacity to climate change" in the series Policy Briefs and Development Issues, United Nations Food and Agriculture Organization, 2007

SOCIO-ECONOMIC IMPACTS AND AN "UNCERTAIN FUTURE"

The decline in fish catch and income has had its socio-economic impacts on artisanal and small-scale fishing families, especially on women. Since most families depend solely on fishing for livelihood, when there is no fish catch, there is no income, or when fish catch is poor, income gets affected. This may affect food consumption (fish consumption, the main source of protein and minerals for fishing families) to some extent as seen earlier, education, healthcare, etc. And the resultant psychological stress exacerbates the physical stress involved in fishery and fishery-related work, as seen in psycho-social studies of the communities.[18]

If there is a fall in income, children's education also gets affected, with the axe first falling on girls' education. If a family cannot afford to continue educating both boys and girls after the primary level (which is now considered essential) or at some higher stage, the girls are taken out of school and asked to help with fishing work. As one woman respondent in Uttan put it, "if income gets affected, expenses have to be cut, education gets affected and loans have to be taken".

Women are the "backbone" of fishery-related work once the catch lands – they sort the fish, preserve it, take it to the market, and also dry and process the fish. Women, for example, are required to spend long hours drying fish in open ground and the hot sun. Rising temperature and unpredictable rainfall (which spoils the drying fish) are making their work more difficult and stressful. As temperatures rise, preserving the "freshness" of fish for the market is also becoming a problem for small fishers, requiring the use of more ice and entailing greater expenses. If the fish does not "look fresh", it may not fetch a good price, say the women.

Women have also been facing some health problems. As they spend long hours out in the open, selling fish or drying and processing it, higher temperatures combined with high humidity cause greater dehydration (given the nature of their long outdoor work, fisherwomen tend to eat irregularly and drink very little water). Urinary tract and kidney problems are increasing, though the causes are not clear. Many women, particularly pregnant women, are anaemic, according to local medical doctors.

Fluctuating temperatures and extreme weather are also increasing the incidence of viral fevers. Of late, there has been an increase in the incidence of malaria (studies elsewhere have linked a rise in the incidence of malaria with a rise in temperature which promotes the growth and spread of malaria-carrying mosquitoes). Respiratory diseases are rising because of increasing air pollution. Backaches (more among men) and pain in the knee joints (more among women) are chronic problems in the community, particularly among those above the age of 40 years. Medical services, public as well as private, in the area are totally inadequate. In cases of major medical problems, they need to go to far-off clinics or hospitals in the city, which is too expensive and a heavy burden on their financial resources. It often ends up in debts for the poor.

Uncertain future and lack of alternatives

Faced with the problems of dwindling fisheries resources, declining yields and increasing stress and risks at sea, many artisanal and small-scale fishers in Manori, Gorai and Uttan see an "uncertain future" as far as their livelihood is concerned. Youth now account for about 40 per cent of the total workforce in fishing in the three villages. Their general educational levels are up to seventh or eighth standard, going up to 10th standard in some cases. These youth apparently have few occupational options. Many parents would not like their children to continue with fishing because of the arduous physical work, the risks and the uncertain future in fishing. For the same reasons, many youth would like to shift to other occupations but lack of higher education, special skills and also communication skills in English have been a handicap in securing jobs in the city with better remuneration than in fishing.

Two trends can be seen, though, within this general situation. Youth (including graduates) from better-off fishing families in villages which are far from the city prefer to continue with fishing and related work because of the poor salaries they get in city jobs and the cost and the problems of commuting to the city; this is particularly so in Uttan, and to some extent in Gorai. In Manori, on the other hand, because of the greater uncertainties of fishery-based livelihood, proximity to Mumbai city and easier access to educational institutions, more youth prefer to get educated and move to city-based jobs. As Dhuming Tari said, educational levels in Manori will rise and there will be more youth working in other sectors in the next few decades.

In any case, one thing is clear – the old mindset that gave no importance to education is changing. Traditional fishing communities now realise that they "cannot continue to depend on fishing alone" for livelihood. At the same time, good educational and job opportunities are lacking in Dharavi Bet, and commuting to the city for higher (college level) education is too expensive. So some youth are turning to vocational training such as "computer courses" or seeking jobs in restaurants and the hospitality and tourism industries. Early drop-outs from school still continue, though. In the long run, reduced livelihood options in the fishery sector and the perception of increasing hazards will "force occupational changes" in these communities.

Meanwhile, new threats of "developmental displacement" are adding to the communities' uncertainties about the future. Concerted efforts are afoot, by real estate developers, tourism and entertainment industries and promoters of Special Economic Zones in collusion with the government, to take land away from the fishing communities for developing special water-front tourism and entertainment zones. Fishing communities in Dharavi Bet have been fighting long-drawn-out legal battles against these efforts under the banner of Dharavi Bet Bachao Samithi (Save Dharavi Bet Committee). For now, they have held off the threat following a favourable court verdict. But,with real estate, entertainment and tourism industries still eyeing the coastal land, a larger battle for their traditional rights to the land, local fishery resources and livelihood looms ahead.The new Coastal Zone Regulation Rules make some exemptions for redevelopment of old settlements within 500 metres of the high tide line in Mumbai, and fishers' groups are concerned that this would provide an entry into the area for real estate developers. This will eventually lead to further conflicts between local fishing communities who solely depend on coastal resources for livelihood and those who seek to make big profits from the use of this coastal land for speculative and entertainment purposes.

MEASURES TO PROTECT FISHERY AND LIVELIHOOD

Policy measures to increase fish production and exports have led to intensive and indiscriminate fishing and overexploitation of coastal fisheries resources, undermined sustainability of these resources and marginalized artisanal and small-scale fishers over the past few decades. Chemical pollution of the coastal waters near industrial cities such as Mumbai has also contributed to driving away fish from these traditional resource base of marginal and small fishers. Climate change now further threatens their ecological systems, fisheries resources and livelihood.

Community leaders from all the villages surveyed suggested a series of measures to replenish and sustain fishery resources and productivity, arrest the deterioration of the coastal ecology, and protect the livelihood of fishing communities.

To start with, they call for strict measures to stop indiscriminate and excessive fishing to promote sustainability. There are too many big boats and trawlers around, using small-meshed nets. Mesh sizes (smaller meshes do not allow small and juvenile fish to escape when caught along with bigger fish) and the number of big boats need to be strictly regulated. (Maharashtra now has about 4,200 trawlers while the sustainable number would be only 2,000, according to marine fisheries scientists.) Trawlers should also be restricted from fishing in the near-shore waters where artisanal and small-scale fishers had enjoyed customary rights over the resources; besides, trawlers destroy local marine ecosystems. Fishing zones for small fishers and trawlers and other big mechanized boats should therefore be clearly defined and enforced. So also, fishing seasons need to be restricted to avoid fishing in fish-spawning and breeding seasons. One suggestion is that the current ban on fishing for two months (from mid-June to mid-August in Maharashtra) should be extended to at least three months for five years so that fish stocks could get replenished (though there are not many takers for this suggestion among fishers). Poor fishers should be given subsidies for loss of income during this period.

Immediate measures are needed to improve the coastal environment. Pollution of the coastal waters and the creeks should stop, and the creeks need to be cleaned up to provide a healthy habitat for fish, mangroves and other plant life. The city's sewage and industrial wastes should be treated before pumping them into the sea, and coastal waters need to be regularly monitored for pollution. Strong measures should be taken to protect mangroves and wetlands which are breeding grounds for fish. Mangroves also need to be developed as natural shields against flooding and storms to reduce the impact of climate change.

Climate change is, of course, a larger problem and needs to be countered at several levels – local, regional, national and international through various measures and forums. Fishery in general does not contribute much to global warming. However, at the local level, measures such as increasing the green cover, growing trees along the coastline, maintaining wetlands and expanding bio-diversity can help as mitigating and adaptive measures against climate change.

Fishery is an important economic activity dominated by marginal and small-scale fishers who are generally the victims of ecological degradation and climate change. But their voices are not

heard much at national and global climate talks and policy-making bodies. Their voices should therefore be heard at these policy-framing bodies and various other forums.

In fishery, changes in the marine environment and shifts in fish habitats and fish distribution patterns require adaptation, diversification and the upgrading of fishing gear, craft and capacity to suit the changes. But poor fishers' capacity to do so is limited, and they need help in capacity-building. In the absence of this, they will lose out, even where the changes may be potentially beneficial. Traditional fishing practices, suited to the changing local conditions, need to be identified and improved if necessary. This will help artisanal fishers.

Management of coastal fisheries for sustainability and equity is important. A community-based approach to resource management, built on the awareness of the long-term implications of the current unsustainable and destructive fishing practices, will promote equitable sharing of resources and responsibility. New techniques of community-based fish-breeding and harvesting should also be developed to help small-scale fishers. All this will need close collaboration between fisheries scientists and fishing communities.

The likelihood of coastal erosion and flooding demands judicious use of coastal land, particularly in vulnerable areas. Faulty land use and local environmental degradation often enhance the impact of climate change and natural disasters. Giving land rights to fishers and creating awareness of such issues would motivate them to protect and improve their environment. Other precautionary measures include early warning of storms and cyclones at sea and cyclone shelters on land.

To enhance fishing communities' income, fishery-related and other economic activities, collective as well as individual, should be developed and supported. These could include processing fish into various value-added products, poultry and animal husbandry, and making candles, garments and other such products. In Uttan, for example, fisherwomen's groups are making pickles from fish for the market. Fishing communities also need good facilities for storing, drying and processing fish, particularly in view of rising temperatures and erratic rainfall. Better public healthcare facilities are another requirement since illnesses affect fishers' physical capacity to work and strain their limited financial resources.

In the long run, dependency on fishery as the sole source of livelihood needs to be reduced and occupational mobility encouraged. This means the provision of better educational and alternative job opportunities to fishing communities. Several youth from fishing communities in Mumbai city, where educational facilities are easily available, have been going in for higher education and taking up other jobs. However, in Dharavi Bet, except in Manori to some extent, dependency on fishery is increasing.

INDIAN NETWORK ON ETHICS AND CLIMATE CHANGE

INECC is a loosely structured national network comprising individuals and organisational representatives interested in the climate issue from a micro-macro perspective. It connects the issues of climate change to larger sustainable development and social justice concerns. In this context, INECC perceives policy changes in favour of communities who are most impacted by the climate crisis.

The key *objectives* of INECC are:

- To facilitate the voice of the marginalized majority from specific local contexts to be considered for policy action
- To undertake research and documentation on issues relating to climate change, sustainable communities and their implications especially for marginalized communities
- To undertake educational and other programmes with, and on behalf of, marginalized social groups and communities on causes, responses and other dimensions of climate justice
- To explore and undertake pilot initiatives towards promotion of sustainable development technologies and practices
- To focus on environmental ethics for individual and social action
- To shape perceptions of the youth around this agenda, specifically on the key issue of social justice

INSTITUTE FOR COMMUNITY ORGANIZATION RESEARCH

The Institute for Community Organization Research (ICOR) is a non-profit organization established in 1989 and registered under the Society Registration Act 1860 and the Bombay Public Trust Act 1950.

ICOR's primary goal is to come up with a body of knowledge indigenous to India and its culture that will enable the empowerment of grassroots workers/non-government organizations (NGOs)/community-based organizations (CBOs) in the field of human development. Towards this end, ICOR is mandated to focus on:

- Undertaking empirical research and analysis of available data on fundamental concepts relevant to human development, including studies of organizations involved as benefactors or beneficiaries or initiators of human development process
- Developing models of monitoring and evaluative studies in the field of human development
- Documenting and disseminating information to individuals and organizations involved in the pursuit of human development
- Training in research and social analytical skills
- Collaborating and networking with other organizations in training, research and community-building activities that will further the understanding and practice of human development.

ICOR'S thrust

The institute has adopted the following nine-point thrust which may be classified under three heads:

Target groups

- Work with and for people's organizations, NGOs and CBOs
- Networking through and with like-minded organizations to further the ICOR thrust
- Collaborate with those committed to people's empowerment

Inputs relating to:

- Concepts relevant to community organizations
- Global trends relevant to community organizations
- Processes at work in various organizations, especially people's organizations, NGOs and CBOs, and devising alternative target-group-specific models
- Seminars and training programmes flowing from these works and addressed to specific groups and bodies

Outputs

- Documentation that is specific and service-oriented
- Periodic publication of research papers in addition to other publications