"Dying fisheries in a changing environment: A study on livelihood strategies of fishery communities in Mumbai, India".

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17/05/2012

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Estimating economic impacts of climate change is very challenging because of a number of limitations, these are:-

➢ Uncertainties in measuring magnitude of GHG emissions
➢ Problem with deciding appropriate Discount rate
➢ The problem of Equity, developed and developing debate
➢ Estimating impacts under Different Scenarios
➢ Non-Market Impacts
➢ Extreme weather events, like: Mumbai flood (2005), odisha super cyclone (1999)

Over the years there is a shift in climate change policy from mitigation approach to adaptation approach and there by from economic impact assessment to socio-economic impact assessment and/or vulnerability analysis (Senapati and Gupta, 2012, *Interdisciplinary Environmental Review*, forthcoming).
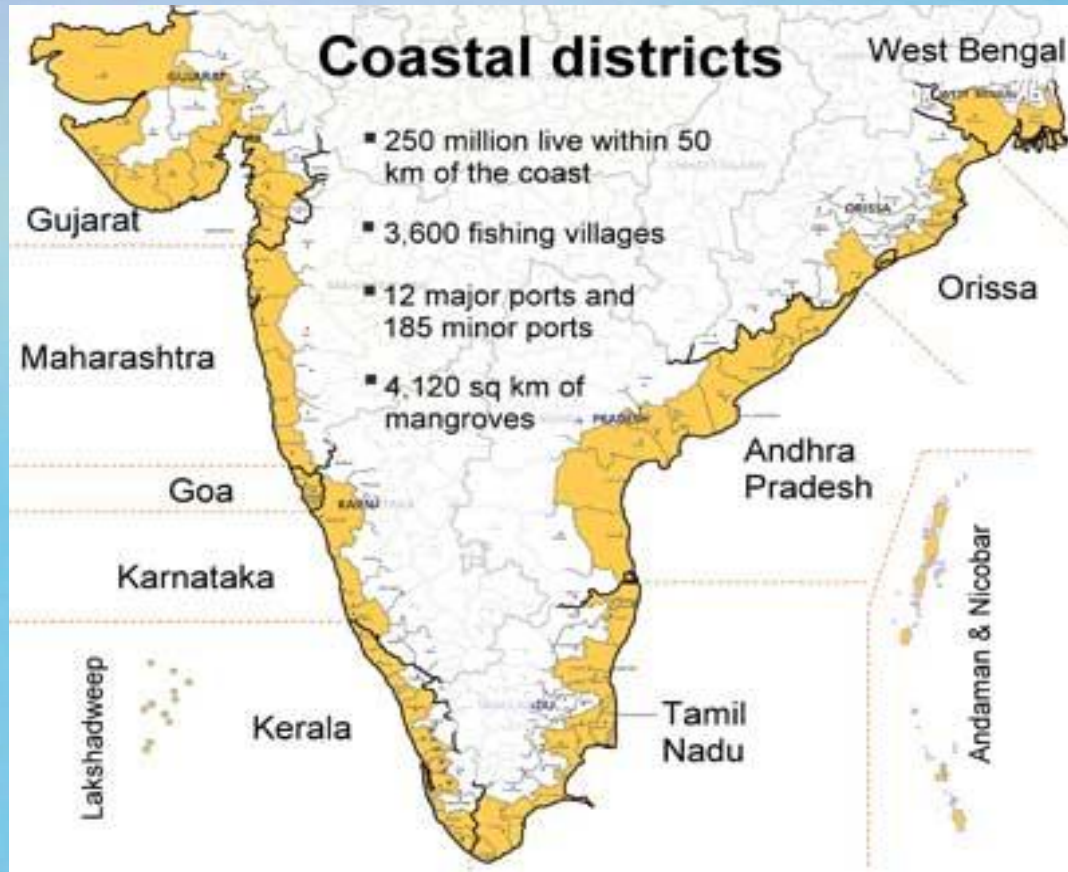
Climate Policy Approaches
(Pielke, 1998)

Mitigation & Adaptation

➤Costs of taking measures (Cline, 1992; Nordhaus, 1993; Tol, 2005; Stern, 2007)
➤IAMs (IPCC, 1995; Ackerman et al., 2009; Fuessel, 2010)
➤Costs and benefit analysis
➤Stabilization of the GHG emissions
➤Carbon taxes, kyoto protocol etc.
➤Trade-off (**Tol *et al.*,1998;** 2005b; **Patt *et al.*, 2010**)

Adaptation & Vulnerability

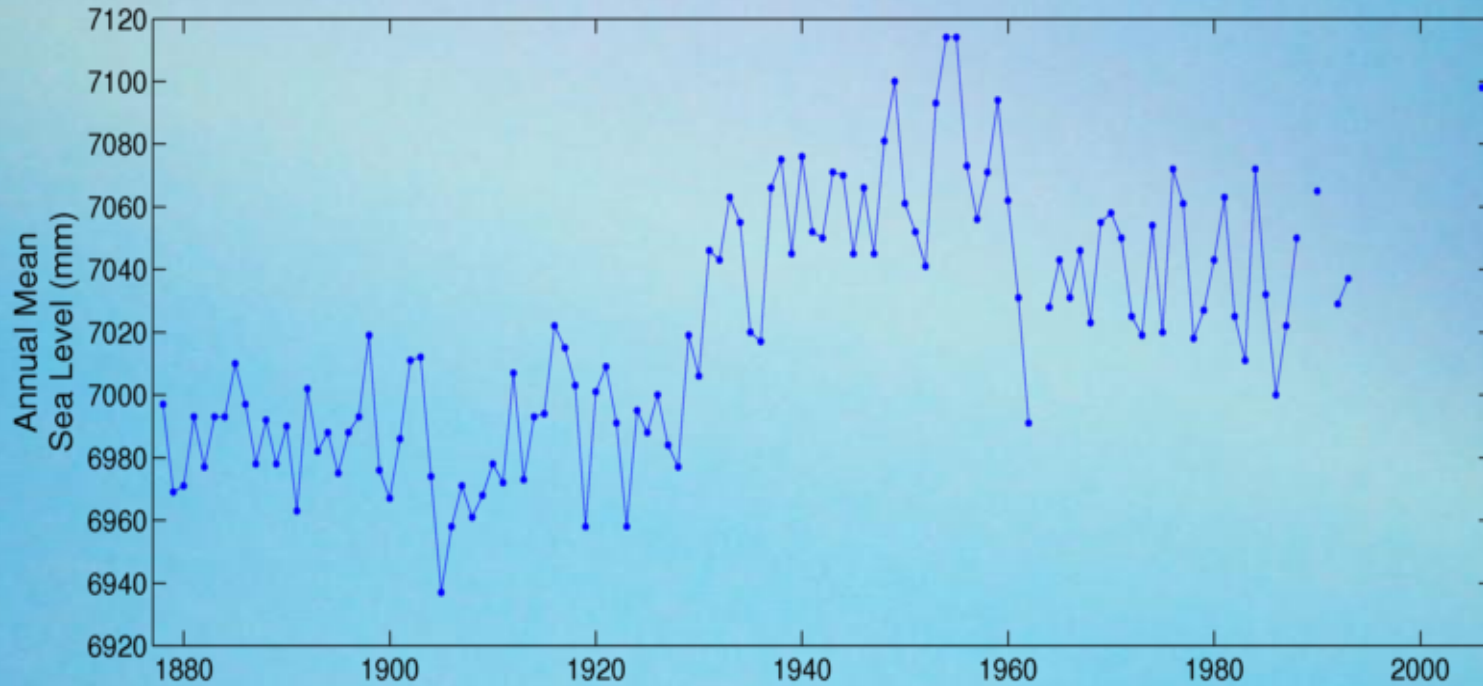➤Investment measures to reduce the cost of climate change.
➤Changing cropping pattern, building sea walls
➤Socio-economic impact analysis
➤Adaptation aims at reducing vulnerability to climate change
➤Vulnerability Assessment
➤ Vulnerability = f (Exposure, Sensitivity, Adaptive capacity) (IPCC, 2001b; Stern, 2007)

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Coast of India

Coastal districts

West Bengal

Gujarat

Maharashtra

Goa

Karnataka

Lakshadweep

Kerala

- 250 million live within 50 km of the coast
- 3,600 fishing villages
- 12 major ports and 185 minor ports
- 4,120 sq km of mangroves

Orissa

Andhra Pradesh

Tamil Nadu

Andaman & Nicobar

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❖The estimated SLR trend for the north Indian Ocean (at stations like Mumbai, Kochi in the Arabian Sea) and (Vishakhapatnam in the Bay of Bengal) is between 1.06 - 1.75mm/yr, with an average of 1.29mm/yr (Unnikrishnan and Shankar, 2007).

❖1-meter SLR for Indian coastal states will directly affect 5763 km^2 (0.41%) of the combined area of coastal states (JNU, 1993). A total of 7.1 million people are found to be at risk, representing 4.6% of the total coastal population.

❖The study found Mumbai as the most vulnerable district in terms of loss in area (19.9% or 86.75 km2) and population affected.

❖The failure of monsoon and change in rainfall pattern caused severe floods in the year 2002, 2005, and 2007. In July 2005, the city received 944 millimeters of rainfall in a 24-hour period, resulting in the most devastating floods in recent history leaving more than 1,000 people dead, mostly in slum settlements and low laying areas.

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Annual mean sea level rise data for Mumbai (1978-2006)

Source: http://www.psmsl.org/data/obtaining/stations/43.php

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Estimated economic losses due to the impact of climate change in Mumbai

Type of impact	Type of costs and period of impact	Cost in rupees (crores)
Dislocation due to extreme events of flooding of low-lying areas - every five years till 2050*	Cumulative costs over the period 2005–2050	407.6
Material damage to low-lying areas due to extreme events – every five years till 2050*	Cumulative costs over the period 2005–2050	6413
Mortality costs due to extreme events of flooding – every five years till 2050*	Cumulative costs over the period 2005–2050	3050
Disability-adjusted life years (DALYs) lost due to diseases like malaria, diarrhoea and leptospirosis**	Cumulative costs over the period 2005–2050	3153
Building-foundation damages for the period till 2050 due to sea-level rise***	Single-cost estimate for the year 2050	15 01 725
Tourism loss: less number of tourists visiting Mumbai****	Single-cost estimate for the year 2050, as compared with the base year 2005	19 63 500

Source: Kumar et al., (2008)

Fishing communities in India and Mumbai

The fisheries sector contributes significantly to the local and national economy, to employment and to food security

About 75 per cent of fish production in India is from coastal waters

There are 3,322 marine fishing villages and 7,56,212 households—a total of 3.52 million people—along mainland India's coastline of 6002 km (Marine Fisheries Census, 2005)

Nearly half of this population (over 1.6 million people) is engaged in active fishing and fishery-related activities

Versova fishing village Mumbai

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▪ Mumbai is the most populous city in India with population more than 12 million and population density of about 27,209 people per sq. km (Census, 2001), and a majority of them (nearly 60%) are live in slum areas.

▪Total 10,082 fisherman families with 50,075 population among them 5,988 are full time fisherman.

▪38.4% of the fish production (1,59,560 tonnes) in the Maharashtra state is from Mumbai for the year 2009-10.

▪There are 5 Talukas, 27 Fishing villages and 19 fish landing centres in Mumbai

▪Livelihoods of these people threatens most of the time (by SLR, flood, sea current, storm along with pollution, and Overfishing) and make them weak to further cope with and adjust with the city's living condition.

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The impact of Climate change on fisheries can be estimated through a diversity of direct and indirect pathways (Allison et al., 2005; Vivekanandan, 2006; Daw et al., 2008; Allison et al., 2009; Badjeck et al., 2010 and more recently Sumaila et al., 2011)

The ecological impacts of climate change on fisheries include-
Change in ecosystem processes, Change in yield i.e. fish stocks and production, Change in species distribution i.e. fish migration, Increased variability of catches, Changes in seasonality of production i.e. decrease in fishing season

**The Direct impacts of climate change on fisheries livelihood include-**
Damaged to infrastructure, Damaged to fishing gears, Increased danger at sea, Loss/gain of navigation routes, Flooding of fishing communities

The Socio-economic impacts of climate change on fisheries include-
Economic drain on fishermen, Rehabilitation, Increase in fuel costs, Reduced health due to disease,

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Study Region

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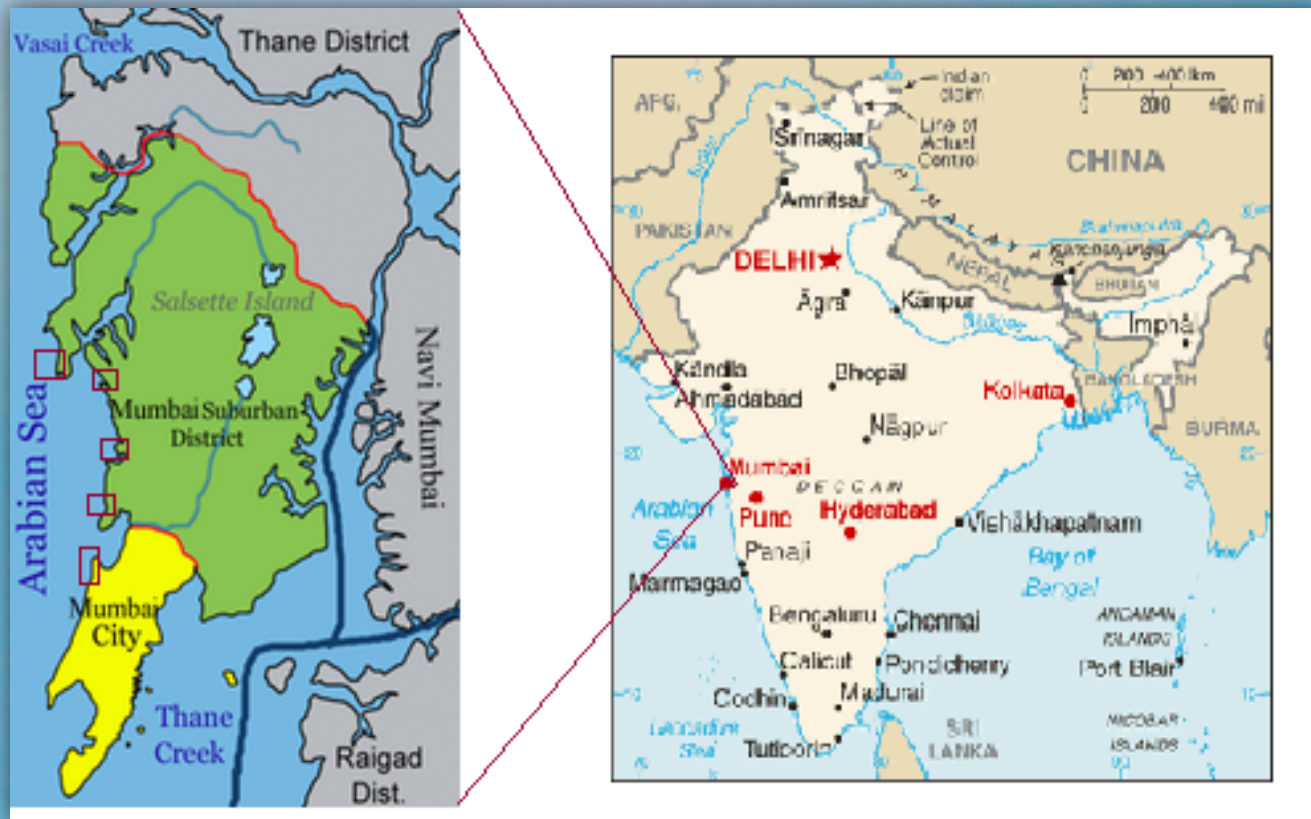
Discussion

Secondary data from Fishery census (CMFRI, 2005) and Govt fishery department

Primary data through a structured questionnaire (from 200 respondent, between August 2011 to February 2012) (from five different villages in Mumbai Versova, Madh , Mahim, Khar and Worli *see the picture in the previous slide*).

1. Demographic Information:

Age; more than 70% of the respondent are aged 40 and above, there is a huge decline in younger aged fisherman as they are looking for other jobs.

Education; more than 85% are studied up to High school ($10^{th}/12^{th}$), Government scholl in the locality is upto 10th class, so they stop education from there.

Occupation; 80% of the respondent are involve in fishing rest are in marketing mostly woman,

Number of working days; 40% works for 30 days in a month; another 40% works between 20-30 days,

Family type; more than 60% are nuclear family of members 5 or less than 5.

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2. Household Characteristics: Number of female, number of children below 14; 60% of the family having children below 14

The more number of children and aged people adds to the vulnerability of households

3. Physical Assets: Type of house; 55% having semi pucca,

Access to infrastructure, Type of boats; 30% having mechanized boat; 60 % having motorized boat, boat and net ownership: most of the boat owners are taken loans from the government and some times also borrowed money from middle man.

4. Family Income and expenditure: Total income from fishing and related activities; 70%,

Income trend over the years, household expenditure, expenditure towards fishing activities; diesel, labor payment

Borrowing, and Savings (savings, loan)

5. Climate change specific: Observations on climate,

	Rise in temperature	Rise in rainfall	Change in rainfall pattern	Rise in sea level	Rise in storm height and frequencies
Very High	30%	20%	53%	16%	20%
High	40%	24%	30%	47%	38%
Moderate	9%	34%	5%	14%	20%
low	10%	12%	1%	12%	9%
Very low					1%

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Impacts of climate change on fishing activities;

Whether experienced flood and storm (67%), if boat or net damaged due to flood (20%), storm damaged net (60%)

	Less availability of fish	Longer distance	Less availability of a particular fish	Loss of habitats	Loss of corals
Very High	66%	42%	29%	19%	2%
High	20%	40%	40%	31%	35%
Moderate	12%	8%	16%	28%	22%
low			5%	12%	22%
Very low					2%

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6. Marketing issues: existence of a organized market in the village (53%), distance travel, if selling fish to middleman (47%), pricing, if sell dry fish, whether women are more active in marketing

7. Health Issues: Type of diseases, if the incidence of diseases increased (malaria/dengue), who are more exposed (women and children), hospital facility in the village (most of the village residence opt for private hospital or have to travel long distance for medical facility)

8. Other Social issues: If member of any fishing communities, or any other group, the effect of urbanization on fishing (61% said with very high confidence that water pollution is major problem), whether involve children in fishing activities (most of them involve their children in fishing activities)

9. Adaptation measures: Measures from government like; training, insurance, early waning, knowledge of CRZ, help from NGOs, personal measures like; change in fishing practices, personal measures towards flood, whether predict the change in weather pattern

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<u>**Future work**</u>

Deriving House hold livelihood indicators by applying AHP technique

In case of climate change vulnerability assessment, the AHP model can be applied to indicators measurement of individual preferences by weighting and comparing the sub-components with each other (Eakin and Luis, 2008).

To estimate the Impact of climate change on household characteristics through Econometric analysis

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Thank You

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