

The Indian Youth Climate Network

Submission to the UNFCCC

Nairobi work programme on impacts, vulnerability and
adaptation to climate change (SBSTA)

Submission under the area of socio-economic information



The Indian Youth Climate Network has researched , pondered , discussed and reached consensus on the following policy submission regarding the socio economic spheres of adaptation programmes in India. India being a developing nation and having to cater to various spheres of developmental challenges , we felt that the four most important and relevant spheres of socio economic information in regard to India would be : Urbanisation, Gender, Health and Union Budgets.

Urbanisation and urban planning in India needs to be integrated with planning of waste management and water management and also needs to integrate all other aspects of the green economy. Considering that 68% of our population is in the rural areas and wants to transition into the urban areas, migration and urban expansion is a burning issue. This transition should be guided by well drafted adaptive practices that would ensure greener livelihoods and sustainable lifestyles.

The woman is the silent decision maker. She forms the core of the family and sacrifices her resources for her children if required. In the age of eco- feminism we must ensure that by providing better adaptive practices we are not neglecting the need of the woman or her importance in the family.

Climate change has huge indirect implications on health. The health risks have increased for diseases like Malaria and Cholera in India and incorporating this aspect in adaptive practices in India is essential.

If we have to transition into a greener economy, our country must reflect this in the various policies, programs and incentives it highlights in the union budget. The budget document forms the market signals and it is important for us to involve the business community as well as extend the work of the government in adaptation measures.

The policy team at IYCN comes from varied academic background from engineering to economics. Most of us are full time student and some of us working. Its been an arduous task of putting together this report and coordinating the working of various sub groups.

We hope this document is given due consideration and our recommendations implemented. A small but little step in combating climate change.

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Climate Change Related Health Risks An Indian Case Study

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Abstract

FOR India, climatic changes will significantly alter the health of humans and natural ecosystems. It is now proven that the changing climate has the potential for abrupt and widespread economic consequences. Increasing temperatures and projected changes in the hydrological cycle will lead to an increase in temperature-related illnesses, vector-borne diseases, health impacts related to extreme weather events (particularly, floods and droughts), and health effects due to food insecurity. Increase in coastal water temperatures would and subsequent drinking water contamination will pose a serious threat of cholera. The phase of rapid and uncertain natural disasters has already begun (with India facing one of the hardest drought in past 83 years) and climate change impacts will lead to an increased frequency of hot days, heat waves, droughts (declining water tables, crop failures, etc) and natural disasters. The study/report outlines effects of climatic change with regard to infectious diseases; extreme weather events; and ecosystems such as forests, agriculture, marine habitat and water.

For fast developing economies like India, the period till 2030 is most crucial and most relevant today as far as health services and adaption practices are concerned. This is because; most decisions that could be affected by climate risks involve a perfect balance between human health and economic growth. The paper outlines the desperate need of strategies to enhance population adaptation in order to promote measures that are not only appropriate for current conditions, but which also build the capacity to identify and respond to unexpected future hazards. The restoration and improvement of general public health infrastructure will reduce population vulnerability to the health impacts of climate change.

In the longer-term, and more fundamentally, improvements in the social and material conditions of life and the reduction of inequalities within and between populations are required for sustained reduction in vulnerability to global environmental change.

1. Pressure on health service due to climate change; Main projections of IPCC report

Compared to international health standards, India has relatively unfavorable or low health standards. There is serious shortage of manpower and resource management especially in rural areas (that provide health services to poor sections of society) and that is main reason why India ranks even below than low income countries. The number of physicians per 10,000 populations for the world is 7, for India it is 1.5 which is at par with low income countries. For public sector, the figure is paltry 2. Similarly, number of nurses per 10,000 populations in India is 8, while it is 33 for the world and 16 for low income countries. There are over 250 medical colleges in the modern system of medicine and over 400 in Indian system of medicine and Homeopathy (ISM&H). The country produces over 25000 doctors annually in modern system of medicine and a similar number of ISM&H practitioners, nurses as well as para professionals.

Indian Health Statistics:

Total population: 1,151,751,000

Gross national income per capita
(PPP international \$): 2,460

Life expectancy at birth m/f
(years): 62/64

Healthy life expectancy at birth m/f
(years, 2003): 53/54

Probability of dying under five (per
1 000 live births): 76

Probability of dying between 15
and 60 years m/f (per 1 000
population): 276/203

Total expenditure on health per
capita (Intl \$, 2006): 109

- The global average surface warming (surface air temperature change), will increase by 1.1 - 6.4 °C.
- The sea level will rise between 18 and 59 cm.
- The oceans will become more acidic.
- It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent.
- It is very likely that there will be more precipitation at higher latitudes and it is likely that there will be less precipitation in most subtropical land areas.
- It is likely that tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures.
- Temperature > 50°C in Western India in 1994.
- Mumbai in Maharashtra experienced more than 994mms of rainfall on 25th and 26th July, 2005; deaths>1000.
- Consecutive droughts between 2000 and 2006 affected 11million people in Orissa.

Climate change will definitely present major challenges for the health system such as improving awareness and education for health professionals and the public, improving monitoring and surveillance and extending public health services to prevent climate related illness.

It is anticipated that sudden change in climatic conditions will increase the number of deaths and will affect the older and much younger population more, primarily because of lack of capacity building. If the weather pattern changes, it will increase in the distribution of malaria, dengue and other vector-borne diseases. Following are some commonly known climate related health impacts, found in Indian society:

Fig. 1



Temperature – related deaths

- Prolonged exposure to high temperatures can cause heat exhaustion, cramps, heart attacks and stroke.
- Nearly 100 people have died in India in 2009 itself.



Vector – borne diseases

- Malaria, Filaria, Kala-azar, Japanese Encephalitis, Dengue, viruses and other pathogens carried by mosquitoes.
- Heavily influenced by climatic conditions, particularly humidity, rainfall and temperature.



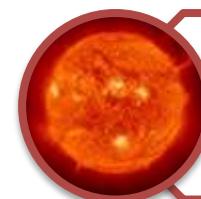
Food – borne diseases

- Bacterial contamination of food, prominent during summers in India.
- Insecurity in food production - Malnutrition, hunger, particularly in children (47% children in India are underweight)



Water – borne diseases

- Excessive rainfall events transport contaminants into waterways and drinking water supplies.
- Proliferation of pathogens that arise from sewage into fresh water sources.



Exposure to solar radiation

- Higher environmental temperatures enhance exposure to ultraviolet radiation..
- Generally bright days pose a treat of skin cancer, especially to people living in Western India.

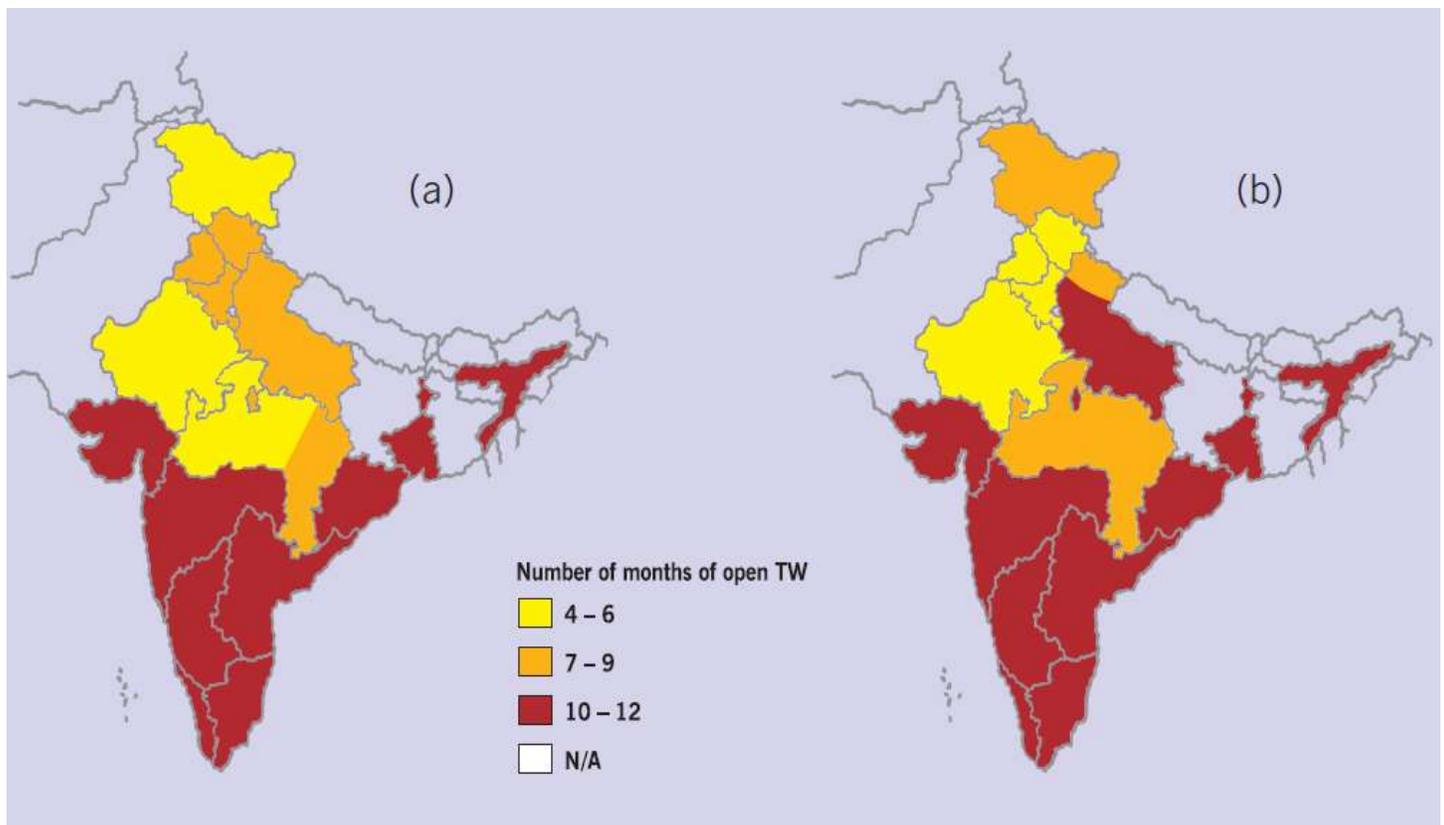


Respiratory diseases

- The incidence of asthma has been shown to be connected to average temperatures.
- TB, asthma & bronchitis and pneumonia⁽¹⁾.

CASE STUDY: *Predicted changes in Malaria incidence due to climate change*

A NPL (National Physical Laboratory, New Delhi) study focused on malaria, a vector borne disease, because of its prevalence in India. The project considered the present malaria scenario in seven states with large tribal populations that are particularly vulnerable to malaria, and investigated climate determinants which are conducive to malaria parasite growth and transmission (defined in terms of temperature, precipitation and humidity). Using the climate determinants and future temporal and spatial projections of disease in India has been identified. The climate determinants were prepared by statistical analysis of meteorological parameters and malaria incidences. These environmental determinants in conjunction with each other seem to have major impacts on occurrences of malaria in those regions. **Transmission windows (TWs)** for malaria are predicted to increase with climate change. For most vectors of malaria, the temperature range of 20°C – 30°C is optimal for development and transmission. A relative humidity higher than 55% is optimal for vector longevity, enabling the successful completion of sporogony. Analysis of average temperature, humidity, precipitation and incidences indicate that the maximum incidence occurs in the months of June, July and August when the relative humidity is in the range of >60% and <80%, at temperatures ranging between 25°C to 30°C. This window shifts from state to state depending on the arrival of the monsoon.



2. Methodology and Risk Analysis

The Third Assessment Report (Intergovernmental Panel on Climate Change-2001) concluded that vulnerability to climate change is a function of exposure, sensitivity, and adaptive capacity. A 0.68°C increase in surface temperature, per century is expected for Indian subcontinent. Further to this is an observed increasing trend in annual mean temperature. Also, warming is expected to be more pronounced during post monsoon and winter seasons. Extremes in maximum and minimum temperatures are also expected to increase leading to rapid mountain glacier retreat in the Himalayas, (meltwater from the Himalayan glaciers contributing a sizeable portion of river flows to the Ganges, Brahmaputra, Indus, and other river systems). Public health, to a large extent, depends on safe drinking water, sufficient food, secure shelter, and good social conditions. A changing climate is likely to affect all these conditions.

Hence, the system for risk analysis consists of vulnerability (V) and probability (P). Here, V is a function of exposure, sensitivity and adaptive capacity.

- **Exposure (E)** is the number of people affected by the climate change event (excessive rainfall). For the purpose of analysis we will take three levels with guide words as: *high, medium and low*.
- **Sensitivity (S)** is the degree to which the human population is affected, adversely, by climate-related stimuli. Climate-related stimuli encompass all the elements of climate change, including mean climate characteristics, climate variability, and frequency and magnitude of extremes. For the purpose of analysis we will assume three levels of sensitivity with guide words as: *very, less, not*.
- **Adaptive capacity (AC)** is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, or to cope with the consequences. For the purpose of analysis we will consider health services as system and will take three levels with guide words as: *high, medium and low*.
- **Vulnerability** is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. the vulnerability of a given system or society is a function of its physical exposure to climate change effects and its ability to adapt to these conditions.
- **Probability** is the likeliness of the happening of climate related event.

$$\text{Risk (R)} = \text{Vulnerability (V)} \times \text{Probability (P)}$$

$$\text{Vulnerability (V)} = f(\text{E,S,AC})$$



Testing of initial hypothesis is still under development as the latest, reliable and most relevant data collection for the same is underway. And hence, only after final calculations and findings, the final results on health impact assessment could be discussed. It calls for a combination of procedures, methods and tools by which a policy, project or hazard may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population. Achieving and international cooperation on health risk assessment under pre-decided guidelines would help to move the climate change policy discussion beyond the environmental impact domain and into the social and public health impacts arenas.

The effects of GHG emissions on human health differ somewhat from the effects of other risk factors in that they are mediated by a diversity of causal pathways (McMichael et al. 1996; Patz et al. 2000; Reiter 2000) and eventual outcomes, typically long delays between cause and effect, and great difficulties in eliminating or substantially reducing the risk factors. An additional challenge is that climate change occurs against a background of substantial natural climate variability, and its health effects are confounded by simultaneous changes in many other influences on population health (Kovats et al. 2001; Reiter 2001; Woodward et al. 1998). Empirical observation of the health consequences of long-term climate change, followed by formulation, testing and then modification of hypotheses would therefore require long timeseries (probably several decades) of careful monitoring.

The potential health impacts of climate change are an essential input to policy discussion on reducing greenhouse gas emissions and on social adaptation to climate change. Societies must respond despite the unavoidable uncertainties. Indeed, national governments have a responsibility, under the UN's Framework Convention on Climate Change (1992), to carry out formal assessments of the risk to their population's health posed by global climate change. Currently, in most countries, sector differentiation and the associated policy environment neither facilitates nor fosters intersectoral collaboration. Within the health sector, resources are allocated primarily in relation to dealing with existing problems, taking some account of the relative burden of disease.

3. Predictions and Facts

The results presented in section 3, are based on the research and climate change models already accepted by a larger section of scientific community. This section is dedicated to understand the risks to human health from climate change.

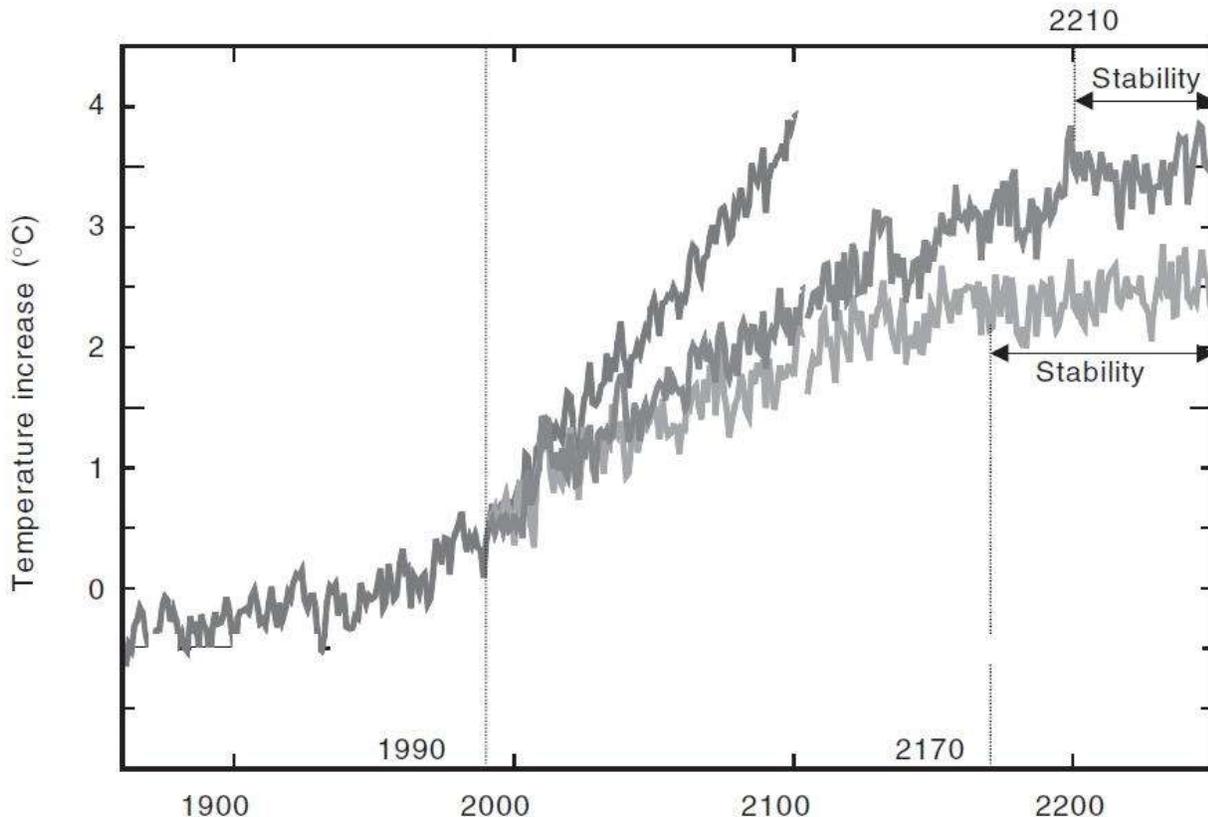


Fig. 2
The global average temperature rise predicted from the unmitigated emissions scenario (upper trace), and mission scenario which stabilizes CO₂ concentrations at 750ppm (middle trace) and at 550 ppm (lower trace).
[Source: Hadley Centre (1999), Michel et al. 1996]

A very important study on “High-resolution climate change scenarios for India for the 21st century” (K. Rupa Kumar et. al.) has used state-of-art regional climate modelling system, known as PRECIS (Providing Regional climates for Impacts Studies) developed by the Hadley Centre for Climate Prediction and Research, for India to develop high-resolution climate change scenarios. The present day simulation (1961–1990) with PRECIS is evaluated, including an examination of the impact of enhanced resolution and an identification of biases. The warming is monotonously widespread over the country, but there are substantial spatial differences in the projected rainfall changes. West central India shows maximum expected increase in rainfall. Extremes in maximum and minimum temperatures are also expected to increase into the future, but the night temperatures are increasing faster than the day temperatures.

Extreme precipitation shows substantial increases over a large area, and particularly over the west coast of India and west central India.

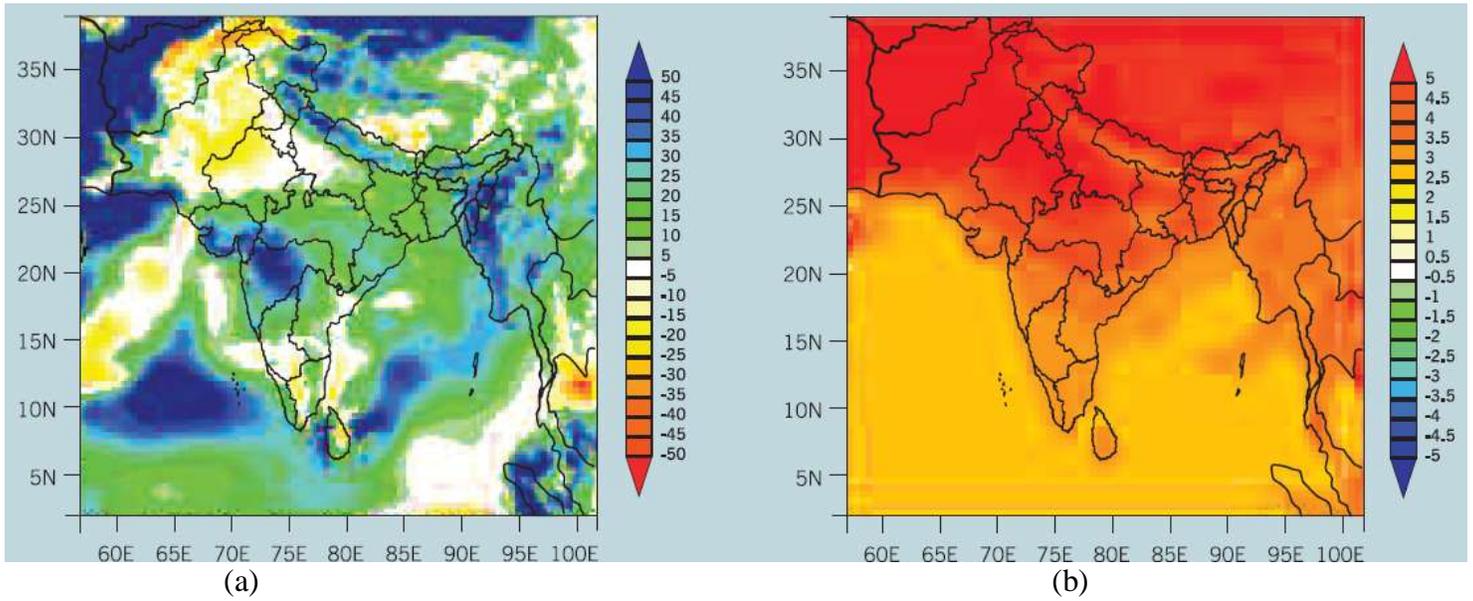
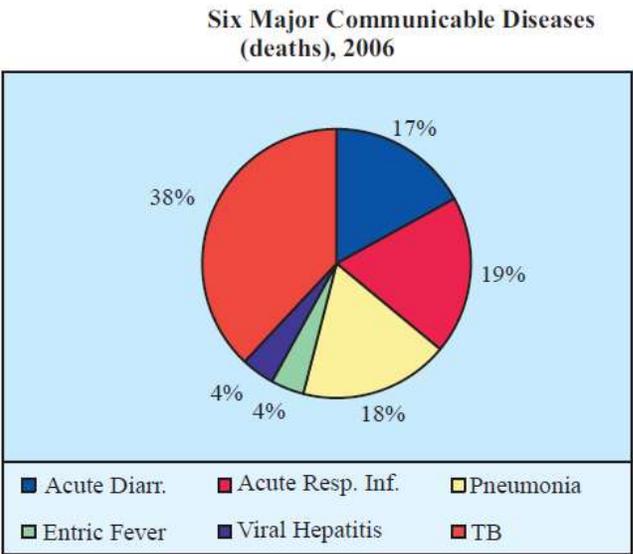
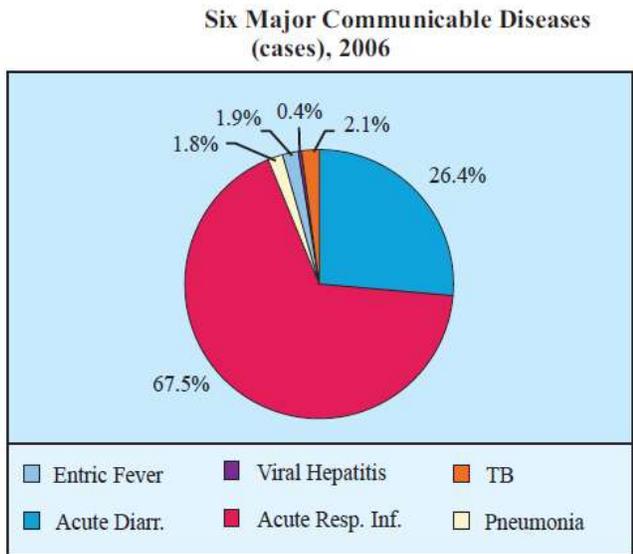


Fig. 3
Spatial patterns of the changes in (a) summer monsoon rainfall (%) and (b) annual mean surface air temperature (°C) for the period 2071-2100 with reference to the baseline of 1961-1990, under economic growth scenario.



Source: Monthly Health Condition from Directorate of Health Services of States/UTs

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Fig. 4
Major diseases in India.

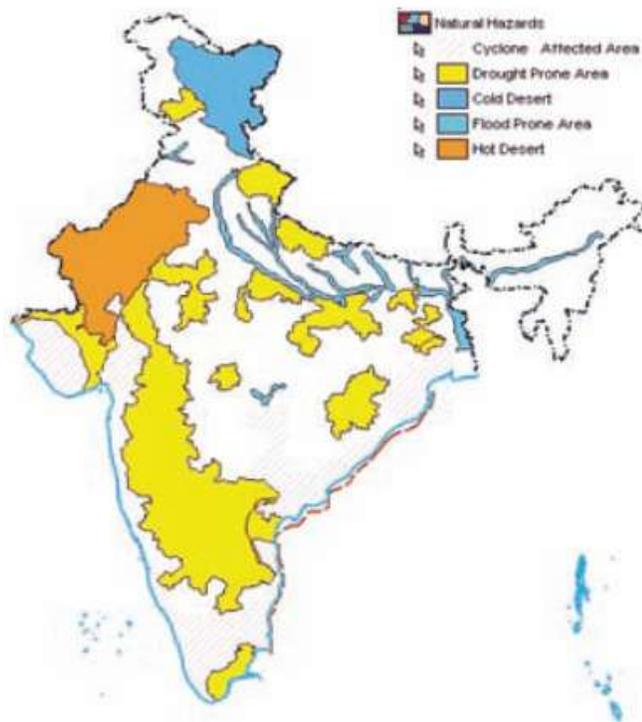


Fig. 5
Natural Hazards Affected Areas of India
 (Source: *State of Environment Atlas of India, 2007*,
 Ministry of Environment and Forestry)

Climate signals observed over India in the last 100 years show an increasing trend in surface temperature by 0.3°C, a change in the spatial pattern of rainfall and occurrence of more intense and frequent extreme temperature, rainfall and cyclone events. As a result, there is growing concern about the changing pattern over the years of some of the diseases that are directly influenced by the variable climate. Changes in the climate may affect vector-borne diseases in several ways, namely, their survival and reproduction rates, the intensity and temporal pattern of vector activity and the rates of development, survival and reproduction of pathogens within vectors. Applying the same criteria as under the climate change conditions in the 2050s, it is projected that Malaria is likely to persist in Orissa, West Bengal and Southern parts of Assam, bordering North of West Bengal. However, it may shift from the central Indian region to the South Western coastal states of Maharashtra, Karnataka and Kerala. Also the Northern states,

Adaptation will be necessary to address impacts resulting from warming which is already unavoidable due to past emissions. A wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to future climate change. There are barriers, limits and costs, but these are not fully understood. Because of the global and national delay in putting into practice any effective mitigation strategies, more effort will have to be put into adaptation measures to limit the societal consequences of the changes in climate which are already occurring.

In the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC AR4) the rise in mean annual surface air temperature all over globe is projected to be 1.4 to 5.4°C. The projected rise for South East Asian region (East Asian region) is 1.5 to 3.6°C (2.3 to 4.1°C). According to the latest IPCC report night temperatures will rise faster than the day temperatures, reducing the diurnal temperature range. These results are consistent with the observed trends over South Asia. The intense precipitation events associated tropical cyclones are likely to increase over Southeast Asia.

Health Impacts of Climate Change in India:

Very limited research is being done to study the correlation between climate change and health. While lot of work is being done in different sectors, there is lack of coordination between different sectors. Environment burden by diseases category (DALYs per 1000 capita) per year as reported in Country Profile of Environmental Burden of Diseases released by WHO HQ, Geneva, 2007 is as under:

Disease group	World's lowest country rate	Country rate	World's highest country rate
Diarrhoea	0.2	14	114
Respiratory infections	0.1	10	56
Malaria	0.0	0.3	32
Other vector borne diseases	0.0	1.7	4.2
Lung cancer	0.0	0.3	2.5
Other cancers	0.5	1.2	4.1
Neuropsychiatric disorders	1.4	2.3	4.4
Cardiovascular diseases	1.3	4.5	13
COPD	0.0	2.7	4.7
Asthma	0.3	1.3	2.4
Musculoskeletal diseases	0.5	0.7	1.5
Road traffic injuries	0.3	2.5	10
Other unintentional injuries	0.9	9.5	19
International injuries	0.1	1.5	7

Research on potential health impacts of climate change is being carried out in India. There is lack of coordinated efforts in research being carried by different sectors also. Data being generated by different sectors needs to be shared to study correlation between health related events and factors responsible for their occurrence. There are gaps in health surveillance data also in terms of timeliness, completeness and accuracy.

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Impact of Budgetary Allocations on Climate Change

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Introduction:

In its manifesto¹ of the Lok Sabha 2009 General Elections, the leader of the ruling coalition, the Indian National Congress had declared the following:

- *We will protect India's natural environment and take steps to rejuvenate it*

It had stated Climate change was a serious challenge for the world community and had acknowledged that India too has begun to feel its impact in different ways. The Congress-led UPA government had already unveiled a **National Action Plan for Climate Change**, by the time the Budget for the financial year 2009-10 was tabled in the parliament. This plan highlights eight priorities of the Indian government to increase the use of renewable energy.

The plan was bolstered by the announcement of Ministry of New and Renewable Energy plan to provide \$100 Billion in solar subsidies over the next 20 years and an increase in solar energy generation to massive 20,000 MW from the current meagre 2 MW.

Impact Analysis of Budget 2009:

It remains to ponder whether the Government has been able to take any step forward in meeting these tall claims and high goals. The impact of the Indian Budget 2009 on Climate Change can be better understood if we segregate the impact points into longer horizon and hence indirectly affecting and shorter horizon and hence directly and immediately affecting points.

Longer Horizon – Indirectly Affecting

Impact Point	Analysis
² Special one-time grant of Rs 1000 million to the Indian Council of Forestry Research and Education, Dehradun	Will churn out experts in this field with more research taking place in the field of Climate Change
³ Plans to increase the budgetary outlay for the National River and Lake Conservation Plans to Rs 5620 million in 2009-10	Success of such plans lies in long-term commitment on the Govt's part
⁴ Set up expert group to advise on a viable and	If the recommendation of the expert

¹ Source: Indian National Congress Manifesto; 2009 General Elections

² 62nd Article of 2009-10 Annual Budget

³ 61st Article of 2009-10 Annual Budget

⁴ 35th Article of 2009-10 Annual Budget

sustainable system of pricing petroleum products	group results in bringing the petroleum prices in sync with global crude-prices, then it will give a boost to investment in Renewable sector and also discourage overdependence on oil.
⁵ Increased allocation for the Accelerated Power Development and Reform Programme (APDRP) by 160% to bridge the huge power demand-supply gap	No mention of the share of renewable in this programme. So, the impact can't be analyzed perfectly
⁶ Enhance allocation for housing and basic amenities to urban poor to Rs 3,973 crore	Without a sustainable energy policy backing this programme, it will add on to the existing power demand-supply gap

Shorter Horizon – Directly Affecting

Impact Point	Analysis
⁷ Fully exempt petro-diesel blended with bio-diesel from excise duty, and to reduce the basic custom duty on bio-diesel from 7.5% to 2.5%.	Will decrease the blending costs and hence encourage the use of petro-diesel blended with bio-diesel. It will also help raise the present blending-level by oil-marketing companies from 5% to a greater level.
⁸ Retention of duty of 4% on products like Compact Fluorescent Lamps	Will discourage the transition from Incandescent Bulb to CFL
⁹ Proposal to provide necessary funds for the National Action Plan on Climate Change	No specific financial outlay highlights the non-committal attitude of the Government
¹⁰ Decrease in the ad valorem duty on cars of engine capacity more than 2000cc from Rs 20,000 to Rs 15,000 per unit	An increase in sales of these large, gas-guzzling cars, resulting in more fuel consumption and even greater emissions. This is a retraction of last year's budget that had introduced this extra duty.
¹¹ Reduction in excise duty on Petrol driven trucks from 20% to 8% to bring it at par with Diesel driven trucks	Preference of petrol driven trucks over diesel trucks, leading to more CO ₂ emissions as petrol has greater fuel economy producing less CO ₂ per km. ¹²
¹³ Reduction of basic customs duty on permanent magnets-a critical component for Wind Operated Electricity generators from 7.5% to 5%	Speed up the setting up of Wind Power plants, one of the most promising renewable energy sources in India. <i>“This will help combat global-warming</i>

⁵ 24th Article of 2009-10 Annual Budget

⁶ 22nd Article of 2009-10 Annual Budget

⁷ 122nd Article of 2009-10 Annual Budget

⁸ 120th Article of 2009-10 Annual Budget

⁹ 60th Article of 2009-10 Annual Budget

¹⁰ 126th Article of 2009-10 Annual Budget

¹¹ 127th Article of 2009-10 Annual Budget

¹² Source: http://www.ace.mmu.ac.uk/Resources/Fact_Sheets/Key_Stage_4/Air_Pollution/26.html

¹³ 111th Article of 2009-10 Annual Budget

In spite of the declaration of the ambitious **National Action Plan for Climate Change**, the Finance ministry has not focussed on its funding and financial needs. On the analysis of these impact points and their probable effects on Climate Change, it is clear that the Government has lost an important opportunity to play an active role in the Global Climate Change movement.

Impact Analysis of 11th Five Year Plan:

- 1) First National Environment Policy, May 2006. As well as re-engineering of the environment clearance process and Environment Impact Assessment (EIA) Notification.
 - 2) Integrating environment considerations into policymaking in all sectors of economy – infrastructure, transport, water supply, sanitation, industry, agriculture, and anti poverty programmes.
 - 3) Focus on including environment as a concurrent subject in the constitution.
 - 4) Formulation of the scheme of Paryavaran Vahinis at the district level, or committees of concerned citizens.
 - 5) Setting up an independent, statutory body on sustainable development.
- Afforestation
 - Participatory Forest Management or Joint Forest Management (JFM).
 - Project Tiger, India & Eco development Project was implemented under Global Environment Facility (GEF).

Strategy for the Eleventh Plan

- The monitorable target of the Eleventh Five Year Plan is to increase the forest cover by 5% of the total geographical area.
 - Enabling environment for social and participatory regimes should be the aim of Central efforts, as is being done through the JFM mode under the National Afforestation Programme.
 - Undertake activities in project mode with earmarked funding, as is done in the externally aided projects.
- Air Quality Improvement
 - Action Plans for improvement of air quality have been drawn for 16 identified cities.
 - The entire Air Quality Monitoring network should be expanded from the current 308 stations to 1000 stations.
 - Effective urban transport planning.
 - Control of vehicular pollution should have high priority in planning for a clean urban environment.
 - i. Uniform fuel quality and emission standards across India.
 - ii. Use of diesel in private vehicles must be discouraged.

¹⁴ As mentioned by Pranab Mukherjee, the Finance Minister of India

iii. The government should impose higher annual taxes on personal transport, which should be used to create a dedicated fund for public transport.

- Water Quality Improvement
 - Charters on Corporate Responsibility on Environmental Protection in respect of 17 categories of highly polluting industries.

Strategy for the Eleventh Plan

- Integration of the NRCP and National Lake Conservation Plan (NLCP).
- The DLCP was approved by the government at a cost of Rs 298.76 crore in September 2005.
- National Lake Conservation Plan (NLCP); till date the estimated approved cost is about Rs 565 crore.
- The wastewater management strategy needs to emphasize the use of state-of-the-art Geographical Information System (GIS)-based decision support systems.

- Waste Management
 - The Ministry of New and Renewable Energy (MNRE) has formulated a National Programme on Energy Recovery from urban and industrial waste.

Strategy for the Eleventh Plan

- Assistance for projects for treatment and disposal of hazardous and biomedical waste.
- Avoidance of waste going to the landfill should be the priority for all ULBs.
- Issues related to handling of industrial, hazardous and bio-medical wastes are also dealt under JNNURM and UIDSSMT.

- Mountain Ecosystems
 - Establishment of an autonomous institute, the G.B. Pant Institute of Himalayan Environment and Development (GBPIHED).
- Environmental Awareness and Education
 - The Environment Education in School System project & Introduction of environmental concepts in Business/Management Education.
 - National Environmental Monitoring Programme (NEMP): Unified NEMP for ecology, environmental chemistry, public health, and socio-environmental studies.
- Environmental Research and Development
 - Environmental policies and programmes will be supported by strong research backup.
 - 'Environmental Research Grants' programme focuses on the relevant areas such as clean technologies, preventive strategies, hazardous substances management, and so on.
 - Special programmes on Ecosystem Health, Pollution and Health, Ecological Footprint, NTFP regeneration ecology, Invasive species, Fire Ecology, and Forest-Watershed Services.

- Proper co-ordination and management of research amongst agencies like Indian Council of Forestry Research and Education (ICFRE), ICAR, CSIR, DBT, DST, and UGC, as well as multilateral and bilateral donors and private foundations.

New schemes (Environmental)

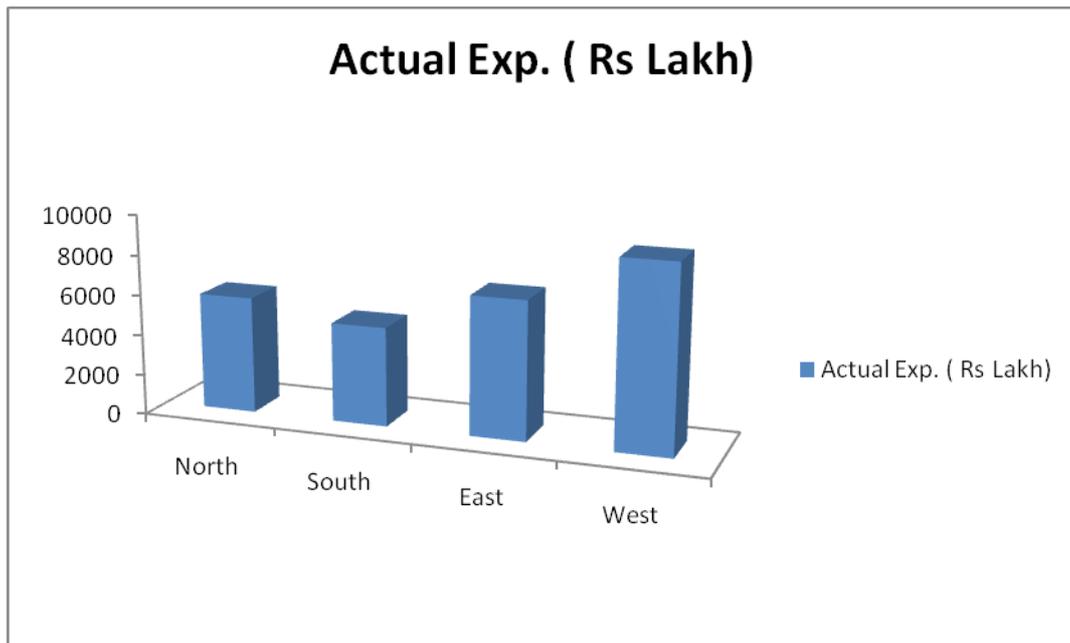
- 1) EPCO-Madhya Pradesh and Strengthening Natural Resource Management and Farmers Livelihood in Nagaland (EAP)
- 2) Strengthening of Environment Information Centre
- 3) National Coastal Management Programme
- 4) Capacity building EIA and Revised Environmental Clearance Process
- 5) Promotion of Bilateral Cooperation

Financial performance in the Tenth Five year plan

S.No	Schemes/Programmes (Environmental)	Financial Performance Tenth Plan (Rs in crore)
1.	Central Pollution Control Board (CPCB)	140.06
2.	Common Effluent Treatment Plants (CETP)	20.10
3.	Establishment of Environment Protection Authorities and Environment Commission and Tribunal	13.83
4.	Assistance for Abatement of Pollution and Environment Policy and Law	25.00
5.	Clean Technologies	5.18
6.	Environmental Impact Assessment (EIA)	12.35
7.	Industrial Pollution Prevention Project (EAP)	13.55
8.	G.B. Pant Institute of Himalayan Environment and Development	37.00
9.	Research and Development	20.78
10.	Environment Education, Training, and Awareness	118.16
11.	Centres of Excellence	33.28
12.	Environmental Information System (ENVIS)	19.55
13.	National Natural Resource Management System (NNRMS)	22.74
14.	Environment Management Capacity Building Project (EMCB) (EAP)	46.14
15.	Adaptation and Capacity Building Project on Climate Change (ACPCC)	26.99

Source: Ministry of Environment and Forest (MOEF).

Tenth Plan Actual Expenditure in Environment sector (States and UTs)



Source: Planning Commission.

Policy initiatives in other developed countries & recommendations for India:

European Commission, the executive branch of the European Union of 27 member states, has led the world in its policies and setup to fight climate change. Some of the legislations, proposals, initiatives and acts can be taken as precursors for the developing countries like India that will have to reduce its emissions sooner or later. Some of the policies and steps to tackle climate change that have been already implemented in EU and USA, and can be adopted by us is enumerated below:

1. The EU has **phased out 100 watt incandescent light bulbs** and this will save enough energy to power 23 million households every year and will reduce CO₂ emissions by 32 million tons each year, or about one-tenth of the world's annual emissions of the greenhouse gas.¹⁵

Incandescent light bulb recommendation for India: Though India cannot phase out all its incandescent bulbs all at once. There should be a concerted effort on the Government's part to gradually shift to CFL, which are environment friendly. One word of caution is the safe disposal of these CFL lamps which have harmful levels of mercury in them.

2. The European Union will **include aviation into the EU Emissions Trading Scheme (ETS)** from 2012. This will increase the carbon trade and also have incentives for greener air-travel.¹⁶

Air travel emissions recommendation for India: Greener air travel looks a far-fetched idea in India, since the airline industry is itself grappling under threat to its very existence. But, in the long-term, the Government can look at imposing cap on airline carbon emissions.

3. The European Commission has proposed a directive to **enable environmentally-safe capture and geological storage of CO₂**. It is also working towards enabling legal framework for CCS.¹⁷

CCS Recommendation for India: Approximately half of India's current annual CO₂ emissions of over 1300 Mt is from large point sources that are suitable for CO₂ capture. In fact, the 25 largest emitters contributed around 36% of total national CO₂ emissions in 2000; indicating important CCS opportunities (IEA GHG 2008). . Further, because of the abundance of coal in India, combined with rapidly growing energy demand, the government of India is backing an initiative to develop up to 9 "Ultra-Mega Power Projects." This will add approximately 36 GW of installed coal-fired capacity in India.

CCS research, development and deployment activities

- Establishment of the Indian CO₂ Sequestration Applied Research (ICOSAR) network which facilitate dialogue with stakeholders and to develop a framework for activities and policies studies.

¹⁵ Source: http://ec.europa.eu/news/energy/090901_en.htm

¹⁶ Source: <http://www.reuters.com/article/environmentNews/idUSTRE49N4VI20081024?sp=true>

¹⁷ Source: http://ec.europa.eu/environment/climat/ccs/work_en.htm

- Participation in the Carbon Sequestration Leadership Forum and the International Partnership for a Hydrogen Economy (IPHE), joining the US on the Government Steering Committee for the US FutureGen project, the US Big Sky CCS partnership, and the Asia Pacific Partnership for Clean Development and Climate.
4. It has officially published **legislation on CO₂ emissions from passenger cars** in the form of Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars. This has proposals to limit value curve, have phasing out requirements and points to long term innovation to arrest the increasing pollution due to passenger cars.¹⁸

Vehicular-pollution recommendation for India: With the advent of smaller cars in the ‘Nano’ price- range, India is going to face serious environmental problems originating from vehicular pollution. So deal with this the Government should impose ‘pollution tax’ on vehicles similar to the road-tax, that has been prevalent since so long.

5. The Government of Spain has taken, over a span of two decades, effective policy measures like **encouraging Public Private Partnership** for diffusion of Wind Power. This has helped Spain achieve the maximum utilization of wind-potential.

PPP recommendation for India: India is still in the developing phase of Public Private partnership with many new policies and guidelines still to be put in place. This makes PPP not a very attractive option for the private players. To move up the PPP maturity curve, Indian needs to institutionalize the policies and frameworks in the PPP space.

6. Unites States of America has instituted the **Tax Credit Mechanism**¹⁹, where consumers, home-builders, businesses, utilities, and even governments can itemize purchases on their federal income tax form, which will lower the total amount of tax they owe the government. This incentivizes the use of Fuel-efficient vehicles, Green-homes, use of Renewable energy and energy-efficient appliances.

Tax credit mechanism recommendation for India: Though India does not have the purchasing power capacity as that of the developing world, but it is the second fastest growing economy after China. It is the fourth largest market in the world, hence at some point in time in the future when the Indian consumers and taxpayers have attained a level of income and tax-deposits that can accommodate the Tax-credits; then it would be prudent to implement a similar mechanism that suits the Indian needs.

¹⁸ Source: http://ec.europa.eu/environment/air/transport/co2/co2_home.htm

¹⁹ Source: <http://www.energy.gov/taxbreaks.htm>



A New Urban Development Framework for Climate Change Adaptation in India

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Abstract:

India's urbanization has resulted in rising urban poverty, lack of basic living amenities for most and over burdening of public infrastructure. Climate change can significantly affect India's urban population due to their low adaptive capacity. Increasing adaptive capacities require an understanding of urban systems, which can be done best with systems dynamics modeling. The models can then be used to figure out the best leverage points in the system which can then be incorporated into a new framework for building adaptive capacity of urban citizens. Sustainable development must also be pursued simultaneously along with adaptive capacity building. In the end, features and characteristics of a sustainable system to increase urban adaptation to climate change have been described.

Key words: India, Urban, Cities, vulnerability, adaptation, climate change, sustainability, system dynamics



1. Introduction:

The mushrooming economic growth of India and rapid rise in living standards of its citizens has fueled unprecedented urbanization, which is set to continue. India's urbanization rate of 29% is low compared to China's 42%, but nevertheless the population has grown five times over the past fifty years and by 2030, nearly 40% of India's population will be urban (Indian Census, 2001). This burgeoning urban population of a few hundred million will be impacted greatly either directly or indirectly by climate change over the next few years. Our cities/urban centers are an important key to GHG mitigation. Indian urban centers account for 60% of India's GDP and rising. They are the biggest contributors to GHG emissions, generated from producing goods and services demanded by the, relatively well off, urban consumer.

Indian cities are cracking under pressures of a growing population, mostly driven by rural migration. The economic and social costs of not providing access to clean water; and environment costs of traffic congestion are very high. Some 300-400 families move into Mumbai every day and majority of them settle in illegal slums in low lying areas. The city needs at least a million houses for its poorer citizens ^{CITATION Mea99 \ 1033}. The city's services to provide water, sanitation, transport, power, buildings, etc are all overwhelmed. The situation only becomes more desperate during the rainy season, when parts of cities come to a near halt. The population in Indian cities is very vulnerable to climate change and improving adaptive capacities is the need of the hour.

2. Urban development issues:

Urban development; and climate change adaptation and vulnerability are intertwined issues. Unsustainable development drives climate change and sustainable development can reduce vulnerability to it and increase adaptive capacity. Creating a system for sustainable urban development requires a system dynamics approach to effectively understand current feedback loops, rules of the system, structure of information flow, etc that characterize an urban system. This might lead to counterintuitive leverage points¹. For example current rate of urbanization is undesirable because growth has costs as well as benefits, typically we don't count the costs- among which are poverty, pressure on public services, homelessness and so on- the whole list of issues which increase vulnerability! Vulnerability stunts

CITATION Mea99 \ 1033 "The World Goes to Town", 3 May 2007, *The Economist*.

¹ These are places in within a complex system (a corporation, a city, an economy, a living body, an ecosystem) where a small shift in one thing can produce big changes in everything (Meadows, 1999)



economic growth and is expensive ^{CITATION Mea99 \ 1033} . Without sustainable urban development, our vulnerability is exacerbated; our adaptive capacity to climate change is limited and their consequences on economy are severe.

Discussion of a few critical urban issues that are closely related to climate change:

- a. **Transportation:** The problems of congestion, safety and pollution in urban transportation are widely recognized. The GHG emissions of the transport sector are expected to soar with increasing economic well-being with even low-income people having choices to meet needs for personal mobility. Total NO_x emissions are projected to increase from 4 Mt in 2005 to 8.5 Mt in 2030 (International Energy Agency, 2007) further inflating the problem of urban smog and related respiratory diseases. When roads and railways seize up, or when ports and airports become overloaded, the cost to the economy is high. Bus transport accounts for 90% of public transport in India (Pucher *et al*, 2005), but their growth is highly constrained by government inefficiencies. The 11th five-year plan recognizes many of the problems like sharp declines in public transport share, rapid growth of personal vehicle fleets and fuel efficiency standards, but it lacks proposals to address these issues. There is a notable success story though. In 1998 the Supreme Court mandated the conversion of all public buses and municipal vehicles in Delhi to compressed natural gas (CNG), which has already led to a marked improvement in local air pollution.

- b. **Waste management:** Urban Indians produce over 1.5 lakh tons per day of waste which is growing exponentially. While India's urban population is expected to double by 2030 from 2001, in the same period OECD estimates per capita waste generated to grow six times considering the changing consumption patterns of urban India ^{CITATION Mea99 \ 1033} . Limited by a small budget marked for waste disposal; make city's Urban Local Bodies (ULBs) ill-equipped to operate an efficient waste collection, storage, treatment and disposal system. So currently 90% of urban waste generated is dumped on low lying land in environmentally unsound methods. With land being a scarce commodity this practice is both unsustainable and unsafe for human health

^{CITATION Mea99 \ 1033} For example cost of building-foundation damages in Mumbai due to sea level rise and floods is INR 15,01,725 crores(USD 300,345 million) (Kumar, Jawale, & Tandon, 2008).

^{CITATION Mea99 \ 1033} OECD environmental outlook 2030, pg 11 <http://bit.ly/Agfig>

- c. **Infrastructure:** Urban India has a massive deficit in providing basic public infrastructure to its citizens. India's per-capita investment has been lagging at 20 USD while minimum proposed spending is 62 USD (Chatterton & Puerto, 2005). Previous unplanned developments have led to over valuation of land, intractable slum settlements, poor quality water and sanitation services resulting in health issues. As per 2001 census report the slum population of India in cities and towns with a population of 50,000 and above was 42.6 million, which is 22.6 per cent of the urban population of the states/ Union Territories reporting slums. This could also roughly be the size of Spain or Columbia (United Nations Development Programme, 2009). The Central Public Health and Environmental Engineering Organization (CPHEEO) estimates the requirement for 100% coverage of safe water supply and sanitation services by 2021 at Rs1.73 trillion. There is some progress in energy efficiency standards for buildings though, Bureau of Energy Efficiency launched the National Building Code in 2007 for commercial and large residential buildings, with provisions for better building orientation, roof and wall insulation and the adoption of energy-efficient lighting and air-conditioning systems.
- d. **Electricity:** There is a wide gap between demand and supply of electricity in urban areas. Even parts of mega-cities like Mumbai or Delhi face power-cuts for a couple of hours during the peak demand months. The electricity demand per capita is 639 kWh in 2005. With GDP per capita expected to grow by 6.4% in 2010-2015, the potential for energy demand growth is enormous. Appliance ownership per household in India, even among the richest households, is much lower than the OECD average. Appliance ownership is expected to grow as incomes rise. For example, between 3 and 4 million refrigerators are sold in India annually at present: sales are expected to nearly triple by 2020 (Lawrence Berkeley National Laboratory, 2005). Rapid growth in appliance ownership and in the building stock puts more pressure on India's already weak electricity infrastructure. The energy demand in the commercial sector has been growing rapidly at 8.1% per annum (The Energy Research Institute, 2006). TERI's research shows that this demand is income inelastic implying that this electricity is crucial to carrying out operations. This further implies that commercial organizations will look for alternative methods to cope with chronic power shortages, most commonly using diesel generators.

3. Understanding Urban Vulnerabilities

Vulnerability is the degree to which a system will respond to a given change in climate including beneficial and harmful effects (IPCC Working Group II, 2001).

Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity [Summary for Policy Makers (IPCC Working Group II)].

The Intergovernmental Panel on Climate Change in their fourth assessment report says that Climate-change vulnerabilities of industry, settlement and society are mainly related to extreme weather events rather than to gradual climate change. And then adds that aside from major extreme events and thresholds, climate change is seldom the main factor in considering stresses on the sustainability of industry, settlements and society (Wilbanks *et al*, 2007).

Graphical explanation of vulnerability to climate change hazards (Lankao & Tribbia, 2009).

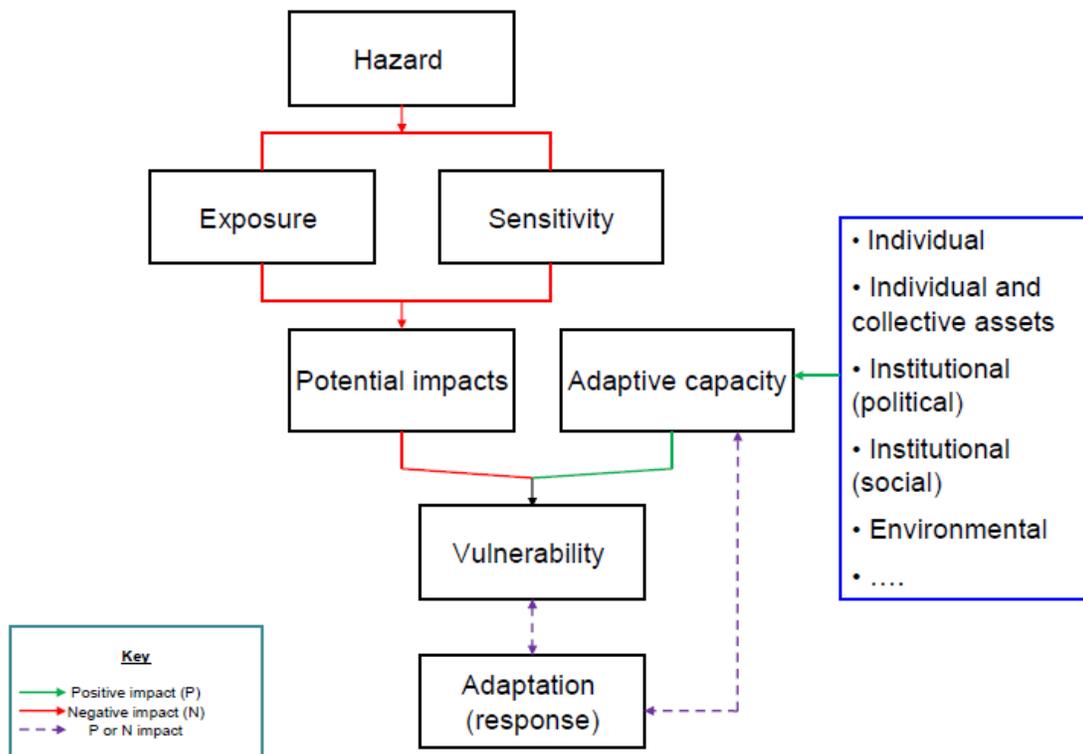


Figure 1

Definitions:

Exposure is the nature and degree to which a system experiences a stress or hazard. The characteristics of these hazards include their magnitude, frequency, duration and spatial extent (IPCC, 2007).

Sensitivity is the degree to which a system is modified or affected by perturbations.

Adaptive capacity is the ability of a system to evolve in order to accommodate hazards or, in the case of societies, introduce policy changes to expand the range of variability with which it can cope.

Indian cities are proportionally large drivers of economic growth and it is clear that current and new cities will continue to become larger part of the Indian GDP. These cities are at risk to climate related phenomena like floods, storms, landslides, heat waves, droughts, etc.. In addition the urban populations will be facing some major problems which have typically been associated with urban growth in developing nations like guaranteed access to water, electricity, health services and environmental degradation. Current urbanization trends imply major pressure points for growing and new Indian cities, including securing sufficient funds to provide social services and dealing with constraints of land availability, energy, water and environment.

Understanding and addressing the full complexity of vulnerability of Indian cities require diversity of local approaches. To rephrase, factors which influence vulnerability are often specific to the city and so the solutions will also need to be localized. For example Mumbai's risks from rise in sea levels are different in factors and magnitude from Chennai. Almost one fourth of Mumbai comprises low-lying areas and retracted land (below or at MSL) compared to a very low percentage in Chennai. Therefore low-income groups and poor residents living in vulnerable locations (accounting for nearly 50% of Mumbai's population) will be affected more. In addition as David Satterthwaite, et al say there is no sense in discussing vulnerability of urban populations to climate change and their responses to it separately from their current and often long-established vulnerability to climate variability that has not been induced by anthropogenic climate change. The key is to understand how urbanization systems exacerbate the risk to direct and indirect climate variability. Thus understanding vulnerability critically depends on the context.

1. Characteristics of Indian cities that exacerbate vulnerability:

- 1. The environment matters, but may be sacrificed for growth.** Surveys of mega-city stakeholders (GlobeScan; MRC McLean Hazel, 2007) show that environmental issues also feature prominently in the thinking of the infrastructure specialists: those in transport predict an emphasis on mass transit solutions, and those in the energy sector show a strong inclination for

solutions based on renewable. But if a choice has to be made between the environment and economic growth, it is the latter that often wins out.

2. **Lack of efficiency and capacity in local governments.** Indian cities have a mass of administrative bodies with overlapping and poorly defined responsibilities, and low capacity. Decentralization has come with challenges, as more functions are being devolved to local governments, there are the associated problems of capacity on many fronts – governance, financial management, project management skills to create urban infrastructure, and operational capacity to manage these assets.
3. **Financing challenges.** Development challenges in urban areas are often associated with financing constraints to build urban infrastructure and services, housing, and environmental protection. The level of financing required is beyond most urban areas capabilities and requires the participation of state and central governments.
4. **Climate change perspectives are not integrated into framework of urban development.** The need for a holistic approach to city governance, urban environmental planning and infrastructure development, is not expressed strongly in the national plan. Majority of the cities do not even have plans

4. A new framework for adaptation

Adaptation: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Adaptation is closely linked to urban development through the underlying forces that shape urban centers like economic growth, technological advancement, changing lifestyles, efficient governance. This is why highly modern cities in developed nations are less vulnerable than cities in India, which lack financial, institutional and infrastructural capacities to cope.

Just vulnerability depends critically on local context; adaptation to climate change requires local knowledge, local competence and local capacity within local governments (IIED, 2009).

5. Integrating adaptation and development

Climate change impacts can directly or indirectly hinder development and are a threat to the efficacy and sustainability of development work. For example, some Millennium Development Goal (MDG) targets can be affected directly by climate impacts. These include

addressing hunger caused by droughts and floods; providing access to water and sanitation; and preventing and treating malaria. Likewise, the capacity of a society to adapt to climate-related hazards is dictated by its access to technologies, financing, effective governance, institutions and other economic factors related to development. Progress towards the Millennium Development Goal targets, like reducing poverty, providing health services, improving urban sanitation and living conditions, will uplift lifestyles of the most vulnerable class and greatly improve their adaptive capacity.

6. A system dynamics approach to urban development and adaptation:

The system dynamics is a methodology used for framing, understanding, and discussing issues and problems in a complex system. It is based on two underlying beliefs: 1) the behavior (or time history) of a system is principally caused by the system structure, through changing the system structure can improve system behavior; 2) the concept that systems can be understood most clearly in terms of their common underlying flows rather than in terms of separate functions. It makes it possible to effectively understand and model current feedback loops, rules of the system, structure of information flow, etc that characterize an urban system. By identifying the materials and information flows (Roberts, 1978) in all systems, the system can be mathematically modeled to assess risk, sensitivity, exposure and adaptive capacities. These holistic views are suitable for analyzing issues of urban sustainable development.

Various studies and papers have utilized this tool for analyzing aspects of urban development. For example, simple feedback loops related to air pollution and its delayed effect on population is shown in Figure 2. Positive feedback promotes an activity, negative feedback decreases the activity.

Air pollution has a negative effect on urban economic growth in urban development, but also damages the health of residents and also their intention to live in cities. In the long term this will influence transport emission policies to be pursued.

Similarly shown below in Figure 3 is a representation of feedback loops that simulate air purification policies (Chen, Ho, & Jan, 2006). Two policies have been introduced for assessing air purification effects: 1. Green land preservation (forested or land with vegetation) 2. Public transport facilitation.

ects of policies.

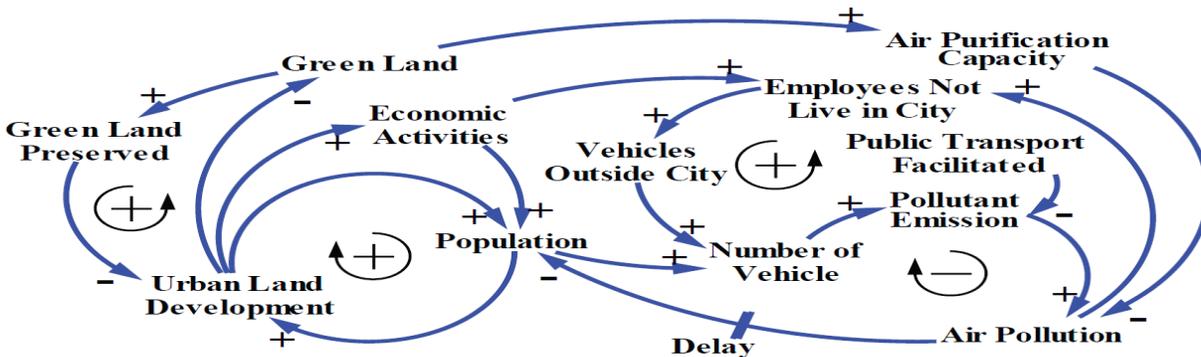


Figure 8. Feedback loops for simulating air purification policies in T

Figure 3

7. Leverage points in an adaptation system:

Leverage points are places in within a complex system (a corporation, a city, an economy, a living body, an ecosystem) where a small shift in one thing can produce big changes in everything (Meadows, 1999). Jay Forrester in his Urban Dynamics study showed that low-income housing is a leverage point. The less of it there is, the better off the city is-even the low-income citizens. That is because cheap housing without an effort at job creation severely disrupts a city's employment/housing ratio, thus increasing unemployed migrants, welfare costs and despair. Forrester used the word 'counterintuitive' to describe complex systems. Figuring out leverage points requires a lot of data and computer modeling, because there's no quick fix formula to discover a leverage point.

Figuring out leverage points in an urban environment requires an accurate modeling of the system without missing any of the interacting parameters. To increase adaptive capacity of our current urban systems, there are certain places where we can intervene for maximum effectiveness. This list has been taken from (Meadows, 1999) and is in increasing order of effectiveness.

1. **Constants, parameters, numbers (such as subsidies, taxes, standards)**
2. The size of buffers and other stabilizing stocks, relative to their flows
3. The structure of material stocks and flows (such as transport network, population age structures)
4. The length of delays, relative to the rate of system changes

5. The strength of negative feedback loops, relative to the effect they are trying to correct against
6. The gain around driving positive feedback loops
7. The structure of information flow (who does and does not have access to what kinds of information)
8. The rules of the system (such as incentives, punishment, constraints)
9. The power to add, change, evolve, or self-organize system structure
10. The goal of the system
11. The mindset or paradigm that the system — its goals, structure, rules, delays, parameters — arises out of
12. The power to transcend paradigms

8. **Features of an urban system for climate change adaption:**

A successful urban system that can integrate sustainability building long with climate change adaption will have the following features which create maximum potential for leverage.

- a. **Sustainability focused:** Integration of sustainability planning is a must for every adaptation step taken.
- b. **Territory specific:** Climate change hazards manifest themselves differently according to the location, example low lying coastal parts in Mumbai. Thus the adaptation system must be specified territorially.
- c. **Multiple stakeholder participation:** This ensures continual dialogue and regular feedback from different stakeholders. Also collection of knowledge from different stake holders will ensure updated understanding of the system.
- d. **Integrated approach:** Traditionally environmental risk focused on geophysical aspects, while social risks were considered in isolation. An integrated approach will result in higher effectiveness.
- e. **Transparency:** There should be transparency in all decisions and no hindrance in access to knowledge or data by the common man.

- f. **Action-oriented:** The system must continually evolve its rules or even goals according to updates in available data. Ensuring there is minimal delay between the feedback and action taken is necessary to reduce exposure to climate change variability.
- g. **Analytical vision:** Every single parameter in the urban system must be used in the model to determine risk potential and adaptive capacity. Also they must be treated with respect to their mutual interactions.
- h. **Benchmarks maintained:** Developing tools and metrics for climate change risk assessment for new projects is important to incorporate considerations of climate change throughout the project cycle and also to measure and compare effectiveness of different efforts.

9. Conclusion:

India's urbanization is inevitable and is rising at a steady pace. The infrastructure, services, local governments are under tremendous pressure from growing number of urban citizens. The vulnerability of these citizens has been exacerbated due to overwhelming of available infrastructure and services, which has led to growth in slum population and settlements in high risk areas of cities. The adaptive capacities of the cities are limited by constraints of finance, institutions, technologies and effective governance. Sustainable developments of urban areas will positively influence income and increase adaptive capacities and decrease vulnerability.

Urban vulnerability and adaptation are complex concepts which are highly context specific. Understanding them fully requires a system dynamics approach to create models which can be used to simulate risk, sensitivity, exposure and adaptive capacities. Leverage points must then be calculated in the system to figure out best places to intervene and create maximum impacts on adaptive capacity through minimum efforts.

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STRATEGIES FOR ADAPTATION TO CLIMATE CHANGE FOR POOR IN INDIAN CITIES

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Abstract

This paper sets out to assess the overall impacts of climate change on the livelihoods of the Indian urban poor. The paper is dealt in Seven Sections. The first section is the introduction to urbanization in India. The second section assesses the vulnerability of Indian cities to Climate Change. The third section gives an overview of the sectors that would have impact because of urbanization and climate change. The fourth section deals with the effects of natural disasters made by climate change on urban poor and the fifth section characterizes the risk for Indian urban poor of climate change. The sixth section gives a perspective of the key challenges for adaptation to climate from an urban perspective. The final section proposes some insight about the recommendations for Indian negotiators towards adaptation strategies for urban poor to climate change.

Key Words: Urbanisation, Climate Change, Livelihoods, Urban poor, Risk, Adaptation

BACKGROUND

Climate-related disasters have brought widespread misery and huge economic losses to India, adversely affecting public health, food security, agriculture, water resources and biodiversity. The world is now aware that various human induced activities like industrialization; agricultural practices; urbanization; animal domestication; etc. are responsible for generation of GHGs and realizes that these activities have disturbed the natural balance of gases in the atmosphere. The climate change is one of the extreme externality where the profits arising from the global human activities (production as well as for consumption) are privatized, while the GHG emissions having the severe long-term implications on global climate have been left to society to tackle.

It is also important to note that India has been identified one of the highly vulnerable country and it has to follow the path of adaptation for a sustainable development and growth of economy. India moving rapidly from a rural society to an individual one is faced with a crash development program to maintain and expand its economy. In a period of rapid national industrialisation and urban growth, climate change would be a setback for development at every stage. The most vulnerable and risk prone are the Poor in the urban growth centers as they are not prepared for the climate impacts.

...the impacts of climate change will worsen the existing problems of the country like Poverty, environmental degradation, and weaken political institutions. Climate change would aggravate the problems of poverty due to the increased problems like water stress and reduction in the availability of fresh water, threats to agriculture and food security, which might result in malnutrition and vector and water borne diseases in the poor. So the poor are the most vulnerable to the climate change effects

The paper specifically looks at the possible socio-economy impacts of the disasters caused by climate change on urban poor through some cases. There are about 1 billion people living in India today and it wouldn't take much to push Indian society into a climate induced crisis.

URBANISATION & POOR IN INDIA

According to the India-Urban Poverty Report 2009, the absolute number of people in urban cities and towns has gone up substantially. It is expected that urbanisation to also increase in the coming years. Although India is one of the least urbanized countries in the world, the absolute number is still increasing. The level of urbanization between 1951 and 2001 has increased only by 13%

Table 1 Pace of Urbanisation in India (Source: Compiled from various sources)

Year	Towns	Cities	Urban share(%)	Rural share(%)	Urban-Rural (%)
1901	1827		10.84	89.15	12.16
1911	1815	1	10.29	89.71	11.47
1921	1949	2	11.18	88.82	12.58
1931	2072	2	11.99	88.01	13.63
1941	2250	2	13.86	86.14	16.08
1951	2843	5	17.29	82.71	20.91
1961	2365	7	17.97	82.03	21.91
1971	2590	9	18.24	81.76	22.31
1981	3378	12	23.33	76.66	30.44
1991	3768	23	25.72	74.28	34.63
2001	NA	40	27.78	72.22	38.47

With over 575 million people, India will have 41 percent of its population living in cities and towns by 2030 from the present level of 286 million. But this success has been accompanied by poverty in urban areas urban poverty in India remains high, at over 25 percent. Over 80 million poor people live in the cities and towns of India. (Source: National Sample Survey Organisation's survey report). This is roughly equal to the population of Egypt. These scenarios had resulted in the massive increase in the squatters and the proliferation of slums in large and metro cities. As per the 2001 census, the total urban homeless population is 7, 78,599 people. The census report also reports slum population of India in cities and towns with a population of 50,000 and above was 42.6 million, which is 22.6 per cent of the urban population of the states/ Union Territories reporting slums. This could also roughly be the size of Spain or Columbia. 11.2 million of the total slum population of the country is in Maharashtra followed by Andhra Pradesh (5.2 million), and Uttar Pradesh (4.4 million). Although the slum population has increased, the number of slums is lower (National Sample Survey Organisation's 58th Round), which makes them more dense. There is higher concentration of slum population in the large urban centres (Census, 2001). With the different kinds of problems that the urban poor face like housing and shelter, water, sanitation, health, education, social security and livelihoods along with special needs of vulnerable groups like women, children and aged people, climate change would aggravate the problems. The urban poor also contribute to the climate change from the activities like use of fire wood as a major source for cooking, over dependence on reused vehicles and encroachment of various wetlands and other natural resource areas. According to several researchers, climate change impact is felt more by the urban poor. These urban poor are affected due to the reason that these urban poor living areas are overcrowded, often polluted and lack basic civic amenities like clean drinking water, sanitation and health facilities. Climate change has compounded the problems of these urban poor with the inadequate facilities which results in flooding, health risks, pollution, which complicate the adaptation capabilities of the urban poor.

In India Does Urbanisation worsen the effects of climate change?

In India, this year's floods are the worst in decades, claiming the lives of 1200 people, injuring thousands and forcing a staggering 20 million out of their homes. Why? Some point fingers at climate change - neglecting the fact that India's rapid urbanization might have contributed more to the recent flooding (*World Vision Asia Pacific, 2009*). According to the report of the UN Population Fund, by 2030, over 40 percent (about 600 million) of India's population will be living in urban and semi-urban areas compared to about 28 percent (about 336 million) now. Twenty years ago the Indian urban population stood at 23 percent (about 230 million), a climb of 5 percent or 106 million people in 20 years time. Over the years, the affluent urban population needed protection from floods; therefore, embankments were built to protect towns and cities. The flood waters that eclipsed villages situated along the big towns of Darbhanga in Bihar, Barabanki in Uttar Pradesh and Dibrugarh in Assam can be seen as a result of these embankments diverting the gushing water into the path of the villages.

The rate of migration from rural areas to urban areas in

India has witnessed the other side while the scenario shows decline on most of the regions of the world due to several problems like unemployment, economic poverty and food crisis, plus limited protection from natural disasters like these floods. Cities in drier regions like New Delhi will see a major impact of climate change, leading to poor water supply, sanitation problems, and higher precipitation. For example the recent (September, 2009) heavy rains in Delhi had made millions of poor vulnerable. The population of towns and cities in developing countries like India is expected to be doubled compared to that of developed world which might aggravate the problems of climate change.

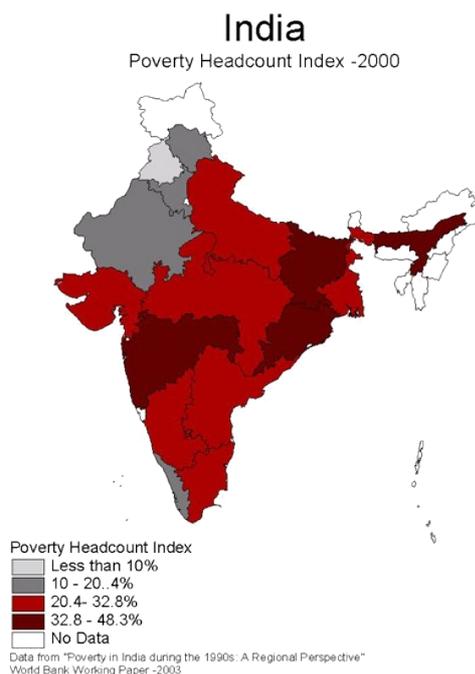


Fig 1 Poverty rate in India (www.povertyman.net)

FACTS ABOUT THE IMPACTS OF CLIMATE CHANGE ON INDIAN POOR

India's National Circumstances	2001
Population (Billion)	1.02
Urban Population (% of total population)	27.78
Population below poverty line	26
land area used for agriculture purposes (Million sqkms)	1.4
Share of agriculture in GDP for (1994-95)	26.4
Life expectancy rate at birth (years)	61.5

Figure 2 India's National Circumstances in 2001
(Compiled from various sources)

Climate Change is not only a major global environmental problem, but is also an issue of great concern to a developing country like India. As a result of ongoing climate change, the climate of India has become increasingly volatile over the past several decades; this trend is expected to continue. The impacts of climate change and the vulnerability of poor communities to climate change vary greatly, but generally, climate change is superimposed on existing vulnerabilities. With over 26% population living below the poverty line (*Census, 2001*), Indian poor are found to be one of the most vulnerable for climate change. The Poor would also

be getting affected due to the impact on agriculture. Natural disasters like droughts, floods, fires and earthquakes increase poverty and impose enormous human and economic costs, including loss of life, injuries, disabilities and displacement, as well as damage to agriculture, livestock, and infrastructure.

The destruction of assets can trap poor families into chronic poverty. Several cases of impacts caused by natural disasters which are triggered by Climate Change have had chronic effect on the underprivileged.

More scientists believe that the climate change will lead to more extreme weather patterns such as;

- **Heat Spells:** Extreme temperatures and heat spells have already become common over Northern India, often causing human fatalities. In 1998 alone, 650 deaths occurred in Orissa due to heat waves. (*Status of Environment Report of India, 2009*)
- **Storms/Cyclones:** India's 7,517 km coastline will be particularly hard-hit by storm surges and sea-level rise displacing millions, flooding low-lying areas, and damaging economic assets and infrastructure. The super-cyclone of 1999 wreaked havoc in Orissa, knocking decades off its development and claiming more than 30,000 human lives (*Status of Environment Report of India, 2009*)

The below facts shows some of the cases of impacts caused by Climate Change on Urban Poor;

- As stated in the Secretary General’s Report: *“The devastating impact of the Indian Ocean tsunami has reminded us all of the vulnerability of human life to natural disasters, and also of the disproportionate effect they have on poor people. Unless more determined efforts are made to address the loss of lives, livelihoods and infrastructure, disasters will become an increasingly serious obstacle to the achievement of the Millennium Development Goals.”* The Indian Ocean tsunami highlighted both the vulnerability of urban poor people to natural disasters.

- *‘The consumption level of a poor household drops by fifty per cent in the wake of droughts... The women are expected to take their meals only after others in the household have finished eating. More often than not... women are left with practically nothing to eat.’*- Bolangir, India

- In India, floods affected about 7 million hectares of land, including 3.3 million hectares of crops. About 3,000 people were killed and 36 million affected. 852,000 houses were partially or completely damaged, and 74,000 livestock were killed by the floods. (*Down to Earth, 2007*)

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...Disasters are defined by events that result in large numbers of people killed or injured, or in large economic losses. The conventional view is that they are caused by exceptional or unusual events, including “natural” disasters. The Centre for Research on the Epidemiology of Disasters (CRED), which holds the only publicly accessible global disaster database, defines disaster as “a situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance”.

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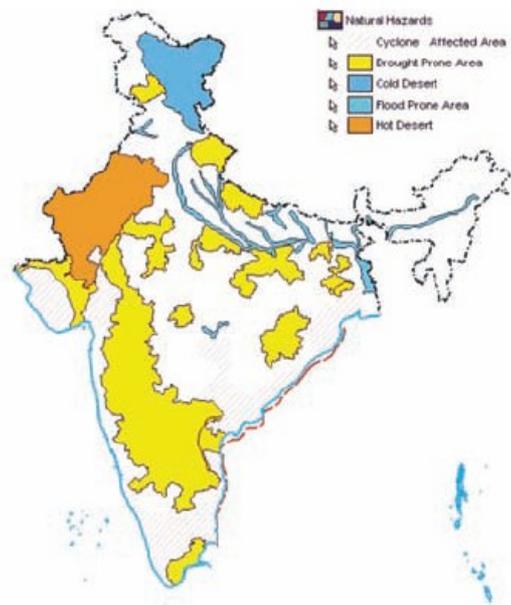


Figure 3 Natural Hazards
(Source: Status of Environment Atlas of India, 2007,

- Cyclone Aila struck with fury and around 27 people died and hundreds were left homeless in Darjeeling Hills. Landslides ripped homes, electricity connections snapped and roads were left in tatters. Two dams being built by the National Hydroelectric Power Corporation (NHPC), Stages III and IV of the Teesta Low Dam Project (TLDP) suffered huge damage. "Landslides take place in densely populated urban areas and the cause is largely anthropogenic." (*India Environmental Portal*)
- Ten people were killed when a portion of a rocky hill slid down on hutments in Mumbai. Another 22 who were injured are out of danger. This is the third time a landslide has occurred in this area in the last ten years. The slum dwellers said that they stayed there not out of choice but out of necessity. (*India Environmental Portal*)
- Even as the number of drought-hit districts has raised to 246 in 10 States, the Centre on Wednesday declared that rice production might decline by 10 million tonnes this kharif, following a shortfall of 5.7 million hectares in paddy sowing. Some shortfall is also expected in oilseeds and sugarcane output because of the decline in acreage. (*India Environmental Portal*)
- The Kosi flood of 2008-09 on August 18, 2008 highlights the manner in which natural disasters alter long term opportunities for the poor. (*Somanathan, 2008*)
- Ongoing sea level rises have submerged several low-lying islands in the Sunderbans, displacing thousands of people (*Roger, 2007*)

Natural Disasters (Cyclones, Status of Environment Report, India, 2009)	
<p>The spatial pattern of cyclone Incidences and the facts (1877 to 1990)</p> <ul style="list-style-type: none"> • 1,474 cyclones originated in the Bay of Bengal and the Arabian Sea during the period. • 964 cyclones crossed the Indian coastline. • Three districts of West Bengal (174 events). • Seven districts of Orissa (422 events). • Nine districts of Andhra Pradesh (203 events). • 15 districts of Tamil Nadu (100 events) <p>The Temporal Pattern of Cyclone Incidences</p> <ul style="list-style-type: none"> • Depressions have a distinct peak in the month of August. 	<ul style="list-style-type: none"> • Storms have two distinct peaks in June and October. • Seven storms have distinct peaks in May and November • The total number of tropical cyclones seasonally follows the path of the depression. <p>Average Based on Facts:</p> <ul style="list-style-type: none"> • 8.45 cyclones cross the Indian coastline per year. • 5.15 depressions cross the Indian coastline on an average per year storms occur on an average per year. • 1.35 severe storms occur on an average per year.

So the poor are the most vulnerable to the climate change effect always. According to the National Action Plan on Climate Change, there is no space for budget for adaptation programmes on Disaster Management. This would make the scenario worsen with no left space for recovery.

CLIMATE CHANGE IMPACTS ON POOR IN INDIA

Climate change would affect the poor especially the urban poor in many ways due to the impact on the other sectors which would have huge impact on the urban poor.

1. Food security and Poverty

India's food production is found to be most vulnerable and Threats to agriculture and food security, since agriculture is monsoon dependent and rain-fed agriculture dominates in many states. According to FAO, out of the total 832 million chronically hungry people in 2003-05, 65% live in only seven countries- India, China, Democratic Republic of the Congo, Bangladesh, Indonesia, Pakistan and

Ethiopia. India has an undernourished population of around 231 million (FAO, 2008). This effect on food production will have a direct effect on food prices which could have a direct impact on the

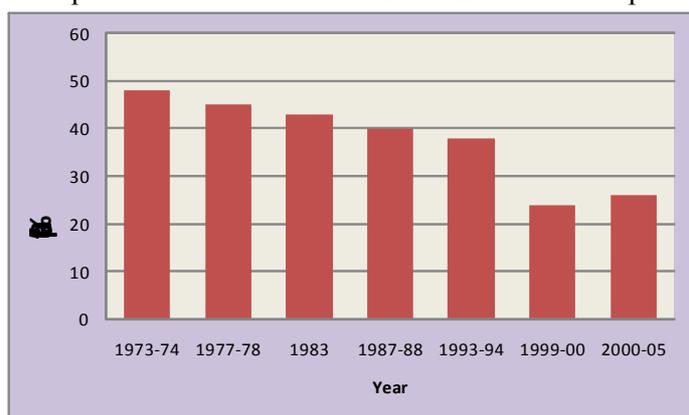


Figure 4 Percentage of Population below poverty line in Urban areas (Source: Status of Environment Report 2009, India)

country's economy. Income growth, climate change, high energy prices, globalization, and urbanization are converging to drive food prices higher, threatening livelihoods and nutrition of poor people in the developing countries, says a new report from the International Food Policy Research Institute (IFPRI). The percentage of below poverty line is found to be increasing from 2000 which shows that the impacts of climate change on food security have a direct impact on the poor (Figure 4). The

existence of food stocks above buffer requirements has not translated into availability and in 2001, a per capita availability of 151 kg per annum was lower than the level in the late 30s and around the average for the time period corresponding to World War II, which included the Bengal famine of 1943 (Patnaik, 2003). Further land degradation due to climate change affects the livelihoods of millions of people. Permanently degraded lands are growing at an annual rate of 6 Mha. Land degradation seriously undermines the livelihood opportunities, thus leading to poverty, migration and food insecurity. In India, erosion rates are reported to be in the range of 5 to 20 tonnes/hectare (upto 100 tonnes/hectare). Nearly 150 Mha are affected by water erosion and another 18 Mha are affected by wind erosion annually in India (Status of Environment Report 2009, India). The recent data shows that there was a decline in the share of agriculture's capital formation in GDP from 2.2% in late 1990s to 1.7% in 2004-05 (status of environment report 2009, India). Although there are several programmes for the poverty alleviation and hunger for the achievement of the goal 1 of the MDGs India's is on the top in the world's hunger chart (Table 2).

Table 2 MDG and the India's Plans for related targets (Source: Human Development Report, UNDP,2003 & Tenth Five-Year Plan, Planning commission, GoI)

Millennium development goals and global targets1	India's tenth Plan (2002–2007) and beyond
Goal 1: Eradicate extreme poverty and hunger.	
Target 1: Halve, between 1990 and 2015, the proportion of people whose income is less than \$1 a day.	Double the per capita income by 2012.
Target 2: Halve, between 1990 and 2015, the proportion of people who suffer from hunger.	Reduction of poverty ratio by 5 % by 2007 and by 15 % by 2012.
	Reduce the decadal population growth rate to 16.2% between 2001-2011 (from 21.3% during 1991-2001).

Changing rainfall patterns are likely to affect India's food security. Extreme events, such as droughts, torrential rains, flash floods, cyclones and forest fires could become more common. In the past fifty years, there have been around 15 major droughts, due to which the product. Floods are another major cause of food emergencies. Sharp seasonal differences in water availability can also increase food insecurity. In India, more than 70 per cent of annual rainfall occurs during the three months of the monsoon, when most of it floods out to sea. The change in the net sown area is surprisingly negative in the past five years in some states like Karnataka and Tamil Nadu, perhaps because prime agricultural land has been shifted for non-agricultural uses (status of environment report 2009, India). Thus Climate change over the long-term, in particular global warming, could affect agriculture in a

number of ways – the majority of which would threaten food security for the most vulnerable poor in India.

2. Rain fall, temperature, and water security

Potential impacts of global warming on water resources include enhanced evaporation, geographical changes in precipitation intensity, duration and frequency (together affecting the average run-off), soil moisture, and the frequency and severity of droughts and floods (*India's Initial National Communication to UNFCCC, 2004*). Analysis of the rainfall in the four mega-cities during the last 50 years shows that there is no significant trend in the annual rainfall, but the seasonality and intensity are changing. Increasing seasonality creates water shortage in non-rainy months. Depletion of groundwater level due to long gap in recharge invites salinity intrusion in the aquifers in coastal cities Mumbai, Chennai and Kolkata. Problem is more severe in Chennai where the monsoon rainfall is scanty. Solid wastes accumulate in channels and canals in non-rainy months. Mumbai experienced the worst flood in its history from the exceptionally heavy one day rainfall of 94.5cm on 26 July 2005.

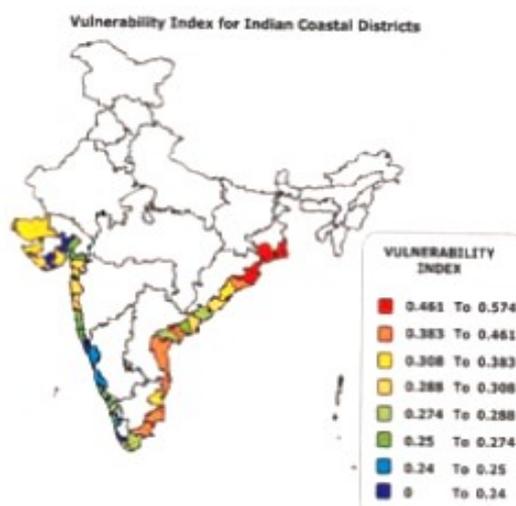


Figure 5 Vulnerability Index for Indian Coastal Districts (Status of Environment Report 2009, India) shelters. Area prone to malaria is likely to extend to Mumbai in near future (*Bhattacharya et al., 2006*). Extreme weather conditions like floods, droughts and natural calamities leads to psychiatric illnesses in poor people depending on climate sensitive sectors for livelihood (*Singh, 2008*). Millions of poor in all mega cities already face this situation.

According to IPCC (2004), by the year 2030, the Himalayan glaciers will shrink from 500,000 Km² to 100,000 Km², affecting north Indian rivers where 50% water is from snowmelt. Reduction in summer water flow in River Yamuna will make life more uncomfortable in Delhi that is already under water stress. This impact on water resources would affect all the sectors of the nation like domestic water pollution, Industrial water pollution and Agricultural water pollution. Waste management systems in India have not been able to keep pace with the huge volumes of organic and non-biodegradable wastes generated daily. As a consequence, garbage in most parts of India is unscientifically disposed and ultimately leads to

All the three coastal mega-cities – Mumbai, Chennai and Kolkata – are under threat from the sea level variations. Heat waves and cold waves have become common in the City of Delhi, killing dozens of people, most of them being poor without proper

Table 3 Coastal Districts vulnerable to cyclones (Source: India's Initial National Communication to UNFCCC, 2004)

Vulnerability	Districts
Highly vulnerable	Cuttack (now Jagatsinghpur and Kendrapara) in Orissa;
	Nellore in Andhra Pradesh;
	Thanjavur (now Nagapattinam) in Tamil Nadu;
	Junagadh (now Junagadh and Porbandar) in Gujarat.
Somewhat Vulnerable	North 24 Parganas in West Bengal;
	South 24 Parganas in West Bengal;
	Baleshwar (now Baleshwar and Bhadrak) in Orissa;
	Srikakulam in Andhra Pradesh;
	East Godavari in Andhra Pradesh;
	Guntur in Andhra Pradesh;
	Krishna in Andhra Pradesh;
	Chengalpattu (now Thiruvallur) in Tamil Nadu;
South Arcot (now Cuddalore) in Tamil Nadu; and Ramnathpuram in Tamil Nadu.	
Less Vulnerable	The rest of coastal districts

increase in the pollutant load of surface and groundwater courses. On the other hand, the large population of the poor in India do not have much choice but to live off the natural resource base and pollute the environment in the process. They deforest for food, fuel, fodder and fibre and pollute the water sources on which they depend, since they cannot afford access to sanitation services. Considerable investments will be required to install treatment systems in at least the 500 major cities and towns of the country. India with different climate regimes, characteristics of the water cycle variables differ from one region to the other and these are reflected in the water availability. Rather than total amount, rainfall seasonality and antecedent moisture conditions determine the water availability and even slight rise in temperature considerably reduces it. However, in India, when water availability is considered, population increase is a more serious issue compared to the effect of global warming on water resources (Nair, 2009). The national climate change policy released in 2008 does not provide any strong guidelines for the implementation of adaptation strategies for the cities. The coastal zone regulation act prohibits development activities in the coastal zone within 200 meters of the High Tide Line and restricts such activities between 200 and 500 metres. However, it is difficult to strictly implement the regulation in the coastal cities because of population pressure.

3. Environmental and technical issues

Extremes in climate add to the water crisis and further deteriorate the urban environment affecting the poor. Most of the existing water supply schemes in the cities were designed and installed decades earlier and are now highly inadequate to meet the increasing demands. Cities are also not well-planned to accommodate the current population. Untreated domestic wastes deteriorate both surface and groundwater resources. Cities still lack an adequate water treatment mechanism. Improper design of drainages and their poor maintenance in Mumbai and Kolkata cause urban flooding when the rainfall intensity is high, and the logged water infiltrates into groundwater (Nair, 2009). According to Central Public Health Engineering Organisation (CPHEEO) under the Ministry of Urban Development, nearly 90% of urban population has access to potable water supply. Climate change is a threat to the energy security that has large impact on cities. Frequent power failure and low and unsteady voltage affect pumping of water. Water is available for only on few hours in a day in most parts of the cities. India's electricity requirement is expected to double in about 5 years from now, adding to the crisis in cities (Subramaniam, 2007). According to the Mercers Survey (2007), the four mega cities of India are at the least bottom ranks with New Delhi 148, Mumbai 151, Bangalore 153, and Chennai 159 respectively. The more affluent cities, such as Delhi and Mumbai, with almost 10 per cent of the country's urban population, do not have access to housing, clean drinking water, adequate sanitation facilities, and transport facilities. About one-third of Mumbai's population consist of slum dwellers. World Bank statistics suggest that on average, urban Indians receive only four hours of water supply per day. About 15 per cent of urbanites in India do not have access to safe drinking water, while almost 50 per cent are not covered by sanitation facilities. In Delhi, only about 2 per cent of the entire sewerage system comprises trunk sewers, most of which were laid 40-60 years ago and have outlived their useful life. Already, a city like Mumbai is the 4th most populous city in the world of over 5 million people living in the slums who are found to be most vulnerable to climate change. So with the increased effects of climate change would have an adverse effect on the underprivileged of these cities.

Thus Climate change threatens the livelihoods of the urban poor in India. When disasters strike, most of the urban poor are unable to travel to work, losing money for food and other basic needs and

exacerbating their poverty. Floods and other problems related to increased precipitation are expected to worsen the poverty situation in Indian cities. Problems related to housing, increasing food prices, access to utilities such as water and electricity will leave the urban poor in Indian cities worse off (Nair, 2009).

PROJECTED IMPACTS OF CLIMATE CHANGE ON INDIAN URBAN POOR

According to census of India, only about 30% of India's population lived in urban areas in 2006, but on absolute numbers the urban population exceeds that of Japan (*Census of India, 2006*). It is said over the next 40 years, India's urban population will grow from 300 million to 700 million (*Hughes, 2006*). By 2025, an estimated 70 Indian cities are expected to have a population exceeding one million. Three mega-urban regions: Mumbai–Pune (50 million), the national capital region of Delhi (more than 30 million) and Kolkata (20 million) will be among the largest urban concentrations in the world (Dyson, 2004). By 2020, Mumbai will be the second largest city in the world, closely followed by Delhi, and Dhaka. With Karachi and Kolkata – five of the world's 11 megacities will then be in South Asia (*The World Bank, 2008*). In Mumbai, more than half the population are crowded into about 2,000 densely populated slums that are at risk from flooding and where settlements lack basic protective infrastructure. These figures and challenges show that India will have an importance on climate vulnerability.

Table 3 Projected Urbanisation in India (Population Division of Dept. of Economic & Social Affairs of UN, 2006, <http://esa.un.org/undp>)

Year	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Percentage	29	30	32	33	35	38	41	45	50	55

There are several studies showing that India especially the urban poor are mostly vulnerable to the climate change effects. Some of the studies show that;

- Increased landslides and flooding are projected to have an impact upon states such as Assam (*Das Gupta, 2007*)
- The Indira Gandhi Institute of Development Research has reported that climate-related factors could cause India's GDP to decline by up to 9%; contributing to this would be shifting growing seasons for major crops such as rice, production of which could fall by 40%
- Around seven million people are projected to be displaced due to, among other factors, submersion of parts of Mumbai and Chennai, if global temperatures were to rise by a mere 2 °C (3.6 °F) (*Wikipedia, 2007*)

CLIMATE CHANGE RISK EXPOSURE

The IPCC fourth assessment of 2007 states that “*Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies*”.

"Where extreme weather events become more intense and/or more frequent, the economic and social costs of those events will increase, and these increases will be substantial in the areas most directly affected. Climate change impacts spread from directly impacted areas and sectors to other areas and sectors through extensive and complex linkages." (Agrawala, et al 2007)

Sector-wise impact estimations in developing countries while being important may require significant resources and may not provide ground-level practical suggestions on adaptation process. Motivation for impact assessment partly comes for ‘justifying’ climate change mitigation policies. However it may be argued that such motivation has outlived its purpose. Vulnerability assessment helps in

understanding the adaptation process. Emphasis on vulnerability marks a shift away from traditional assessments, which limit analysis to the stressors (e.g., climate change) and the corresponding impacts, towards an examination of the system being stressed and its ability to respond. By focusing on the mechanism that facilitates or constrain a system's ability to cope, adapt or recover from various disturbing forces, vulnerability assessments help in not only identifying 'who', but also 'why'. Such information is critical in prioritizing limited resources for 'most vulnerable' and also for designing 'most effective' vulnerability-reducing interventions.

Vulnerability characterization:

Three primitives must be identified for characterizing vulnerability appropriately:

- The entity that is vulnerable - e.g., rice farmers
- The stimulus causing vulnerability – e.g., pressures such as climate change and globalization
- The (welfare) criteria with reference to which the entity's vulnerability is defined and on which preference order can be specified – e.g., break-even farm level yield level or minimum consumption level (poverty criteria)

Poverty has been identified as one of the greatest barriers to developing adaptive capacity. The poor, usually, have low adaptive capacity due to their limited access to information, technology and other capital assets, making them highly vulnerable to climate change. Poverty also constrains adaptation in other sectors. Poverty, along with infrastructural limitations and other socio-economic factors, could also limit efforts for sustainable development in India. Adaptive capacity in countries like India where there is a high incidence of poverty will likely remain limited. Indian cities with high population densities and less adaptation or mitigation measures are highly vulnerable to climate change risks. The cities like Mumbai where nearly half of the population lives in "slums" where there is basic infrastructure are highly vulnerable to the climate impacts. The following section provides some insight about the climate risk for Indian cities.

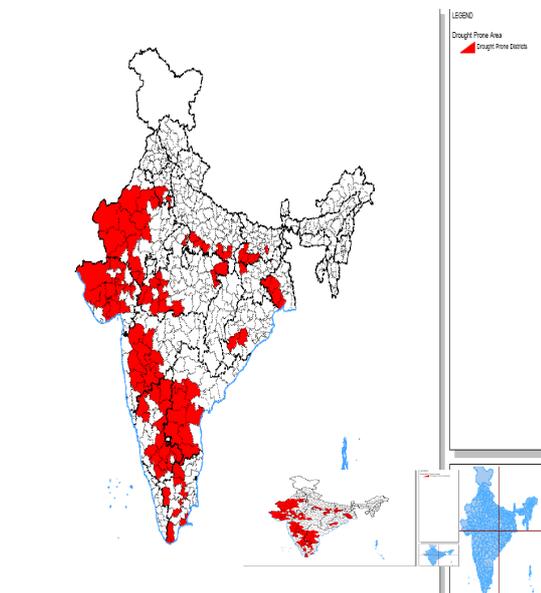


Figure 6 Drought prone areas in India (Source: Environment atlas of India)

Climate change has the potential risks in cities in three ways: from the sea (higher sea levels and storm surges); from rainfall – for instance by heavier rainfall or rainfall that is more prolonged than in the past; and from changes that increase river flows – or instance through increased glacial melt. The main impacts of climate change on urban areas, at least in the next few decades, are likely to be increased levels of risk from existing hazards. For poorer groups, some of the impacts are very direct – for instance, more frequent and more hazardous floods. Some are less direct – for instance, reduced availabilities of fresh water supplies for whole cities that reduce supplies available to poorer groups (or that increase prices). Some are indirect – for instance, as the impacts of climate change-related weather events increase food prices or damage poorer households' asset bases or disrupt their incomes (*Satterthwaite, 2007*). In general, in any urban area, the people most at risk from climate change are those who are:

- least able to avoid the direct or indirect impacts (e.g. by having good quality homes and drainage systems that prevent flooding, by moving to places with less risk or by changing jobs if climate-change threatens their livelihoods);
- likely to be most affected (for instance infants and older groups who are less able to cope with heat waves);
- least able to cope with the illness, injury, premature death or loss of income, livelihood or assets caused by climate change impacts.

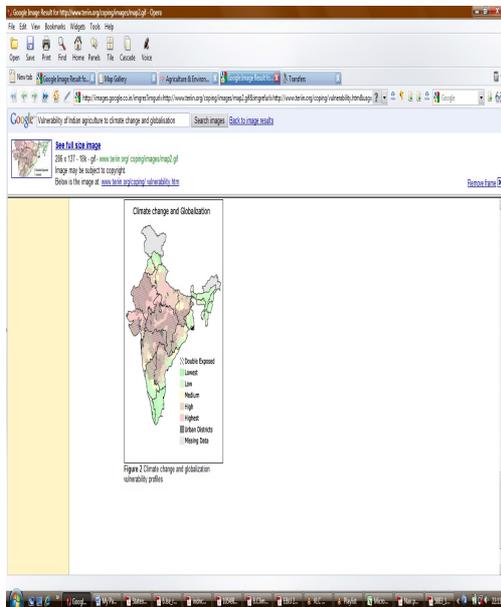


Figure 7 Climate Change and Urbanisation vulnerability profile (Source: www.teriin.org)

Poorer groups get hit hardest by this combination of greater exposure to hazards (e.g., a high proportion living in makeshift housing on unsafe sites), lack of hazard-removing infrastructure and less capacity to cope (e.g., lack of assets and insurance), less adaptive capacity, less state provision to help them cope, and less legal protection or protection from insurance. Low-income groups also have far less scope to move to less dangerous sites; indeed, the more dangerous sites are often the only sites where lower-income groups can find housing they can afford or can build their own homes (*Satterthwaite, 2007*). So there is a need for risk assessment of the impact of climate change on the urban poor. A significant number of urban areas currently face similar challenges to fulfilling the demand of the populations in those cities.

The risk assessment of the Urban poor helps in bridging the gap between the information gaps between the urban areas and climate sectors in order to improve our capacity to cope the impacts of climate change on the poor specifically. For the risk assessment of the poor to climate change, a risk assessment needs to be devised to provide a framework for considerations which are to be worked out in a schematic and systematic manner (Figure 9). This involves some of the factors like:

- Climate change and the criticalities (attributes) to the vulnerable poor (impact of climate change such as some degree of loss to the poor) need to be worked out and quantified.
- Threats to the urban poor need to be characterized (indicators).

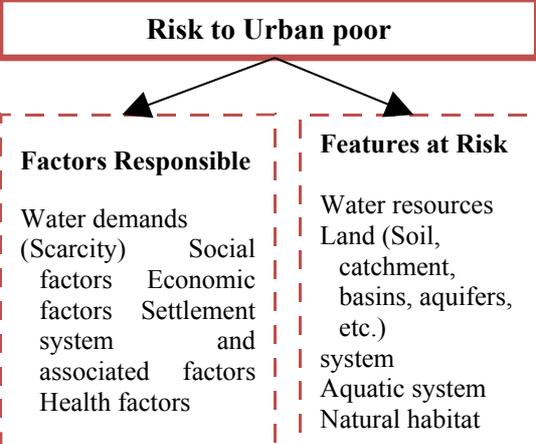


Figure 8 Relationship between Risk and Urban Poor

- The vulnerabilities of the poor to climate change are interrelated and need to be finally worked out and analysed.

The following framework gives some brief about the risk assessment of the poor to climate change.

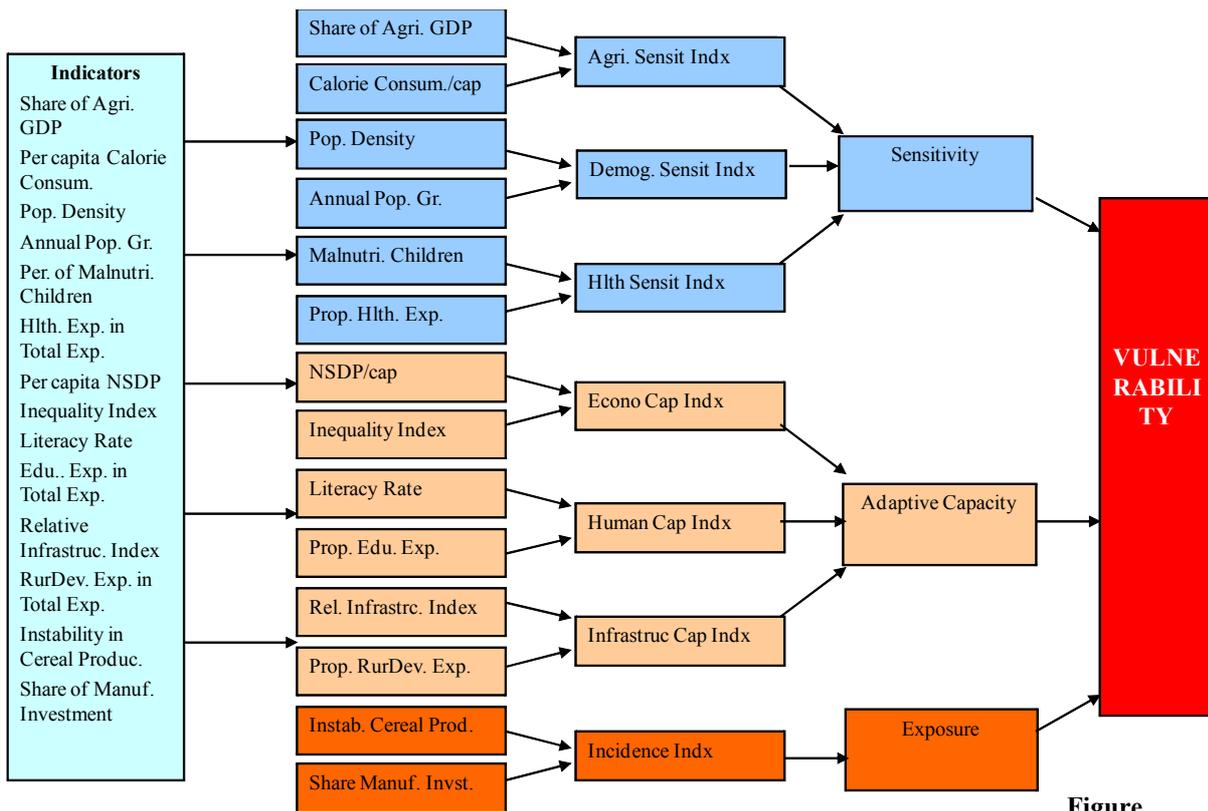


Figure 1

Framework for Vulnerability Analysis

This framework entails the further steps for the analysis of the risks of climate change to the poor which involve.

- Vulnerabilities of the poor need to be worked out.
- Risk factors to the poor also need to be worked out.
- Resultant risks have to be assessed and ranked.
- Possible mitigation options to reduce vulnerabilities (and thus risks) need to be identified, and appropriate options need to be selected and implemented to achieve an acceptable level of risk.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

...We believe that the challenges of climate change and its adaptation are even more daunting for the impoverished regions of India. These poor regions not only lack the resources to adapt, but they also do not have adequate capacity in science and technology to successfully address the challenges of the future

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

From the above analysis, it shows that the framework would be helpful in understanding the following issues relating to:

- Criticalities of the phenomenon of climate change.
- Threats to the poor.
- Associated vulnerabilities.

Thus the risk involved with climate change and the urban poor have to be properly analyzed for implementation of the adaptation programmes in the cities.

KEY CHALLENGES FROM AN URBAN PERSPECTIVE TO ADAPTATION TO CLIMATE CHANGE

The future of hundreds of millions of people in urban areas in India will be affected by the different impacts of the rapid urbanization and climate change. Providing basic necessities such as reliable water, food and energy, providing clean and healthy urban environment, maintaining public health, and finding shelter to the millions of poor becomes complicated under a changing climate, especially the climate extremes.

Situation is worse in the four megacities – Mumbai, Kolkata, Chennai and New Delhi – and the number of million plus large cities of India. Most difficult issue is the timely supply of reliable water and the disposal of urban waste water. The net addition of urban population during 1991-2001 has been 6 million, with a percentage decadal growth of 31.2% (*Census, 2001*). The percentage of urban population to the total population stands at 27.85 and has been an increase on 2.1% in the proportion of urban population during 1991 – 2001. There were 4378 cities and towns in India as on 2001 (*Census, 2001*). Indians make up 16.7 % of the world’s population with an annual growth rate close to 2%. In big states such as Tamil Nadu and Maharashtra, now almost half of the population lives in urban centres (*Census, 2001*) About 10.5 % of the national population lives in the million plus 35 cities . Mumbai with a population of more than 16 million is now the world’s fourth-largest urban area followed by Kolkata. Studies (*citymayors.com, 2008*) indicate that by the year 2020, 12 out of the 100 largest cities in the World will be in India, Mumbai being second in the list (Table 2).

Table 4 Indian Cities among the 100 largest cities in 2020

Rank	City	Average annual growth 2006 to 2020, in %	Population in 2020 (millions)
2	Mumbai	2.32	25.97
3	Delhi	3.48	25.83
11	Calcutta	1.74	18.54
28	Bangalore	2.79	9.92
32	Chennai	1.68	8.88
35	Hyderabad	2.21	8.61
39	Ahmedabad	2.73	7.78
41	Surat	4.99	7.72
43	Pune	3.46	7.53
78	Jaipur	3.6	4.79
86	Kanpur	2.53	4.44
100	Lucknow	2.72	3.89

Source: [www.city mayors.com](http://www.citymayors.com)

These figures give a daunting scenario of the impact of the climate change on the urban poor in India. Since the climate change impacts will undermine the country’s efforts to achieve the goals of sustainable development, adaptation is needed. Although a major percentage of about 59% of the relative expenditure have been spent of programmes on adaptation for poverty alleviation and livelihood preservation, the urban poor are still found to be highly vulnerable to the climate change impacts (Table 5) . This is critical particularly because climate is already changing and countries like India do not have the adaptive capacity to respond or be prepared to face the climate change impacts on cities, settlements and on livelihoods. The adaptive capacity and the capability of systems to actively and adequately respond are largely influenced by wealth, availability of technology, appropriate decision-making capabilities, human capital, social capital, risk spreading (e.g. insurance),

ability to manage information, and the perceived attribution of the source of stress (*UN-Habitat, 2008*). Climate change will bring new challenges, which would have great impact on the natural and built environments and aggravates existing environmental, social and economic problems in the Indian cities. Clearly these changes will affect different aspects of spatial planning and the built environment, including external building fabric, structural integrity, internal environments, service infrastructure, open spaces, human comfort and the way people use indoor and outdoor space. Coupled with the challenges of rapid urbanization, climate change impacts will undermine country's efforts to achieve the goals of sustainable development.

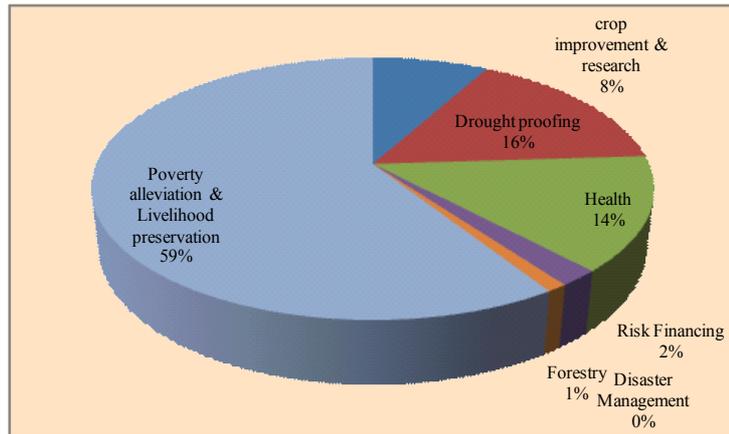


Figure 10 Relative expenditures on major adaptation programmes in India (Source: State of Environment Report 2009, India)

Coupled with the challenges of rapid urbanization, climate change impacts will undermine country's efforts to achieve the goals of sustainable development.

Despite national decentralization programmes and the inclusion of good governance principles in national policies and strategies, India does not appositely consider local governments as important partners in the articulation of action plans (Example: National Action Plan on Climate Change where there is no policy for the programmes at local level). Meanwhile, the effects of climate change are mainly experienced at the local level with many households and livelihoods affected. Institutional design and structure can heighten or diminish society's exposure to climate risks, yet, a clear imbalance still exists between demands and the existing administrative and financial capacities in the context of decentralization (*UN-Habitat, 2008*). Climate change perspectives are not fully integrated within the broader framework of sustainable housing and urban development and the much needed holistic approach to participatory governance, urban environmental planning and management is not well articulated in the national plans of most developing countries. Local authorities are therefore in need of further support regarding capacity building, specified tools, and technical expertise, so that they can develop adaptation actions and strategies for reducing the severity of many of the impacts.

ADAPTATION STRATEGIES FOR POLICY MAKERS

Adaptation to Climate Change for Urban poor in India had always been a hard touched task. Creating safe cities on the head of climate change has been a challenge for the urban planners. India is always in fast run of creating world class cities .To make the dream into real, India's flagship programme JnNURM envisages Rs 1,00,000/- crore to rebuild the cities and particular emphasises on providing basic services to the urban poor. But it could not take into consideration the aspects of adaptation to climate change. Even the most acclaimed India's National Action Plan on Climate Change (NAPCC) have no space for these urban areas or the cities which are growing with ever increasing urban poor in these cities. The plan also has no consideration of adaptation strategies for climate change which makes the plan a backlog. There has been huge investment in large scale infrastructure projects because of the increase of the population from small and medium towns which further makes the basis for augmented need of energy and power in large urban areas and metro cities. This increase in population leads to social instability and social issues which also give less emphasis in the social planning of the cities towards the adaptation to climate change.

- In order to arrive to a solution for adaptation strategies, old world knowledge i.e. the traditional knowledge needs to be integrated with the upcoming modern technology based solutions.
- Compare the experience of case studies in addressing climate change and assess the implications of these findings for urban sustainability and global environmental governance.
- Create knowledge base with both top down and bottom up approach by taking the local community responses and integrating them with policy recommendations
- One of the underlying solutions is to mobilise communities in sensitising about their individual health affected by climate change/global warming.
- Convergence of different agencies who are working in parallel way in order to arrive to the common solution.
- Best (good) practices need not to be talked in sporadic way. It can be replicated when contextualised and customised properly. We can also gain insights from the worst (bad) practices.
- While developing/building capacity of community for their livelihood enhancement/security it should be ensured that it is ecologically sound.
 - Ex: Orissa (Bamboo-handicraft)
 - Bricks-Loss of top soil.
- Also for effective adaptation strategies, the following questions need to be considered
 - Who is responsible?
 - Who is effected?
 - Who should act?
 - What is to be done?

Also a framework methodology has to be considered for future adaptation strategies.

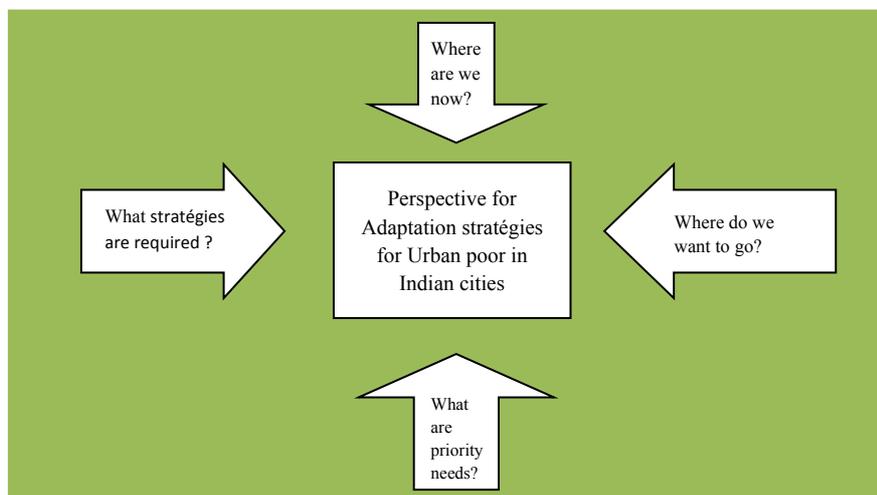


Figure 2 Framework for Considering adaptation strategies

Since the Indian Government is of low efficiency and reliability, private sector participation becomes necessary for the success of development projects. Government should have a control over them. But, in a country like India with millions below poverty line, one cannot ignore the realities in society (Nair, 2009).

With the current rate of urbanization, both the local and national governments have to struggle to provide basic necessities. There should be a strict control in urban migration and the spreading of slums. This can be done by provide facilities in satellite cities and shifting industries to out of the city

limits wherever possible. For rehabilitation in slums, it is better to provide free accommodation rather than giving permanent ownership, to avoid the renting and selling of houses. India urgently needs a comprehensive and appropriate urban policy. In climate change adaptation strategies, special care is to be given for the urban sector. A joint effort of the governments, civil society and the private sector and an impartial political interest with a national vision only can save the urban centres of India from the challenges associated with climate change and population impact.

CONCLUSIONS & SUMMARY

The Urban governments must analyse the existing situation and carry out research for the effective implementation of the adaptation strategies. The local governments especially the municipal governments and community based organisations should work out strategies that can be implemented effectively at the grass root level. The local authorities have to be strengthened by training and have to integrate climate change concerns in local and city wide planning and budgeting for cost-effective policy responses.

The success of the urban adaptation depends mainly on the good governance and inclusive development with appropriate funding mechanism in place. A pro-poor adaptation strategy can help in identifying the issues relating to the poor and the challenges of climate change of the urban poor.

Setting up and supporting networks of national and local government associations, nongovernmental bodies, universities, the private sector, and UN organizations addressing climate change can help in localisation and implementation national adaptation strategies

Good cases and practices have to be studied and replicated through integrated mechanism for creating climate resilient cities at the local level. The local communities and their best practices can be analysed and should be involved in the urban planning process. Special provisions have to be created for the gender, disabled and youth.

So integrated city and urban planning and creating local networks with involvement of the local governments can help in formulating successful adaptation strategies for climate change to help the urban poor adapt to climate change.

In a sum, the following aspects have to be considered in details while creating adaptation strategies toward the urban poor:

- Improving resilience to climate change at the local level
- Reducing the impacts of climate change to the urban poor
- Implementation of mitigation, and adaptation policies, strategies and actions
- Accessing available knowledge and resources on climate change adaptation
- Integrating climate change in education and local knowledge

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Gender & Climate Change- The Indian Context

Article by Rebecca David, Indian Youth Climate Network (IYCN)

“Women are the most vulnerable and the best poised to curb the effect of climate change” (WEDO 2007).

Lakhs of women across rural India traverse miles every day for the collection of basic necessities such as fuel and firewood. With water resources depleting, groundwater being scantily available, erratic rainfalls, rivers and streams running dry before the usual time periods, the problem has become all the more grave. Today, livelihoods dependent on natural resources which were freely available earlier are threatened. Tuvalu notes that the increased time spent on securing water and fuel is directly related to the decreasing rates of girls’ enrolment in school and literacy rates¹.

Gender - refers to the social roles and relations between women and men. This includes the different responsibilities of women and men in a given culture or location.

Gender roles -of women and men are socially constructed, unlike the sex of men or women, which is biologically determined, and such roles can change over time and vary according to geographic location and social context.

Gender equality means “equal enjoyment by women and men of socially-valued goods, opportunities, resources and rewards. Where gender inequality exists, it is generally women who are excluded or disadvantaged in relation to decision-making and access to economic and social resources. (...) [A] critical aspect of promoting gender equality is the empowerment of women, (but) (...) (t)he achievement of gender equality implies changes for both men and women (because) (t)he lives of men are just as strongly influenced by gender as those of women.”

The impacts of climate change affect different groups in different ways- several social groups and gendered groups are affected differently. The poor (of which 70% are women) will be disproportionately affected. It is important to understand how men and women may be affected differently by climate change considering their roles and responsibilities in the society. These vulnerable groups especially women will be faced with problems such as food insecurity, loss of livelihood, hardships due to environmental degradation which also lead to displacement and a whole host of potentially devastating economic and social

¹ Gender, Climate Change & Human Security – Lessons from Bangladesh, Ghana and Senegal. Prepared for ELIAMEP (May 2008)

consequences. It is the poor women who are vulnerable and will bear the adaptation burden despite their insignificant contribution to GHG emissions. Women are also powerful agents of change by playing a key role in energy consumption, deforestation, burning of vegetation, population growth and economic growth.

Why women in the Indian Sub-continent are specifically vulnerable?:

'Where women face social and economic disadvantages, women die exponentially more often than men from natural disasters (Neumayer & Pluemper 2007). In the 2004 Tsunami, 70 - 80% of all deaths were women. Of the 140,000 who died from the 1991 cyclone disasters in Bangladesh, 90% were women (IUCN 2004, a). These disparities in disaster mortality rates link directly to social and economic factors. In many societies, boys and men are more likely to hear warning signals in public spaces where they work, receive preferential treatment in rescue efforts, and have priority access to food aid (Nuemayer & Pluemper 2007). In Sri Lanka, more boys learn to swim and climb trees, which helped them survive the 2004 Tsunami (Oxfam 2005). The conclusion is that it is the socially constructed gender-specific vulnerability of women built into everyday socio-economic patterns that leads to the relatively higher female disaster mortality rates compared to those of men. Societies which have inherently treated women as the second sex (like in India) show trends of the inequalities for women being compounded. For example, the 1991 cyclone in Bangladesh killed 138,000 people, many of whom were women older than 40 years (Bern et al., 1993). Where women are more calorie-deficient than men, women have more problems recovering from the negative effects that flooding (or other natural disasters) has on their health (Cannon, 2002). During or after disasters, such as long periods of drought, more girls drop out of school to reduce household expenses by saving on school fees, or to assist in the household with tasks such as fetching water, or as a result of pregnancy and early marriage (Eldridge, 2002). A study in Western India (Rajasthan) (conducted by NGO URMUL) showed that girl-children are married off early in times of drought usually to older men, in the area there is also the common practice of marrying of a group of sisters from one family to a group of brothers in a good year as a mechanism to reduce any financial burdens during the expected drought periods. When poor women lose their livelihoods, they slip deeper into poverty and the inequality and marginalization they suffer from because of their gender, increases. Therefore, climate change presents a very specific threat to their security. Drought, deforestation and erratic rainfall cause women to work harder to secure (natural) resources and livelihoods.

Climate change is predicted to reduce crop yields and food production in some regions, particularly the tropics. Women are responsible for 70–80 percent of household food production in sub-Saharan Africa and 65 percent in Asia. They achieve this despite unequal access to land, information, and inputs such as improved seeds and fertilizer. Traditional food sources may become more unpredictable and scarce as the climate changes.

Women bear a disproportionate burden of climate change consequences...

Gender Equality in Environmental & Human Security:

The Millennium Declaration (Millennium Summit, 2000) commits signatories to promote equality between sexes and the empowerment of women as effective means to combat poverty, hunger and diseases, and promote a truly sustainable development. The Millennium Development

Decreased food security: With changes in climate, traditional food sources become more unpredictable and scarce. This exposes women to loss of harvests, often their sole sources of food and income.

Impact on livelihoods: Women are more dependent for their livelihood on natural resources that are threatened by climate change. For instance, climate change causes a rise in the sea level, affecting the fishing community (both men and women) not only in terms of fish-catch but also with regard to water scarcity, as seawater gets into fresh water. Besides, when the land is inundated, infrastructure (roads and houses) are damaged. Large scale migration from inundated areas is expected and much of the burden of migration falls on women.

Water resources shortage and access: Climate change may exacerbate existing shortages of water. Women are largely responsible for water collection in their communities and are therefore are more affected when the quantity of water and/or its accessibility changes.

Increased burden of care giving: As primary caregivers, women may see their responsibilities increase as family members suffer increased illness due to exposure to vector borne diseases such as malaria, water borne diseases such as cholera and increase in heart stress mortality.

Source: http://data.undp.org.in/Gndr_CC.pdf

Goals if seen as a collective are of particular interest to gender equality in environmental and human security through their parallel goals of poverty eradication (MDG1), gender equality and women’s empowerment (MDG3) and environmental sustainability (MDG7). Together these establish a platform of fundamental interrelated values on gender, poverty, and environment.² However, in practice, these goals are often still operationalized separately. In India the assorted ministries of Women & Child Welfare, Health, and Environment & Forests who are directly answerable for the MDGs have poor co-ordination both within themselves and with other departments who must also be involved in achieving these goals. Due to the vulnerabilities and impacts of climate change today we are in danger of being pushed further back from achieving these goals if we do not take immediate action.

² Gender, Climate Change & Human Security – Lessons from Bangladesh, Ghana and Senegal. Prepared for ELIAMEP (May 2008)

"The world has less than a decade to change course. No issue merits more urgent attention-or more immediate action." (HDR 2007)

Quote taken from Kevin Watkins et al.

Each year in India nearly 30 million women experience pregnancy of which nearly 136,000 mothers and 1 million newborn children die in childbirth or immediately after.³ More than half of all women in the country are anaemic (anaemia is a key indicator of malnutrition)⁴ and girls in India are 50% more likely to die than boys.⁵ Malnutrition in pregnant women increases the risk of adverse pregnancy outcomes increasing the risk of mortality, morbidity and low birth weight. NFHS (2006) data shows the child under-nutrition rate as being 46%. The impacts of climate change in the form of droughts, flash floods, tsunamis and the like only make the situation more grave. As a result of the recent drought like situations in more than 246 districts⁶ in the country many poor families were not able to produce their annual supply of food grains and were forced into more poverty and nutritional deprivation. Today, India ranks 66th among 88 countries in the Global Hunger Index (2008). FAO estimates show that almost 300 million people living in absolute poverty are in India. In other words, nearly half of the world's poor, who would not get two square meals a day, are in India.

Disaster prone areas are also beds of poor hygiene and sanitation with many people succumbing to diseases due to that alone, these challenges put an extra burden on women adding to the double burden of productive and reproductive labor (Patt et al., 2007). The impacts of poor water and sanitation in India provide for shocking statistics: more than 1,000 children die every year due to diarrhoea diseases and nearly 40 million people a year are affected by water and sanitation related diseases.⁷ Women and children bear the greatest burden as they are primarily responsible for collecting water, maintaining community water sources, feeding livestock, treating and storing water and taking care of the sick and elderly. Depletion of natural resources and decreasing agricultural productivity may place additional burdens on women's health and reduce time for decision-making processes and income-generating activities, worsening gender equality and women's empowerment (MDG3)..." (UNDP-2, 2007:1).

Gender issues in Environmental Agreements:

The UN Framework Convention on Climate Change (UNFCCC), does not recognize the gender aspects of climate change and omits the issues of gender equality and women's participation entirely. Also, its Kyoto Protocol, that outlines reductions in greenhouse

³ Ministry of Health & Family Welfare, GOI 2003c.

⁴ National Family Health Survey (NFHS) 3. Government of India (GOI), 2005

⁵ Submission by HAQ: Centre for Child Rights, New Delhi to the Committee on the Rights of the Child for the Day of General Discussion on 'Resources for the Rights of the Child Responsibility of States' 21 September 2007

⁶ Relief Web. India: Drought - Bulletin no.1, 01 Sep 2009

⁷ Central Bureau of Health Intelligence, Ministry of Health & Family Welfare 1988-89



gases until 2012, fails in integrating a gender perspective in its operationalization and mechanisms, such as the Clean Development Mechanism. The current inter-governmental negotiations under the UNFCCC are evolving around the key areas: mitigation, adaptation, technology and finance. At the 2007 United Nations Climate Change Conference (COP13) in Bali, negotiations began for the post-Kyoto regime (2012 and beyond). Women’s caucuses since the Conference of Parties (COP-11) meeting in Montreal (2005) have strongly lobbied for a gender approach in all these critical areas. At the last COP13 in Bali, the Gendercc - Women for Climate Justice network of women’s organizations and individuals, as well as the Global Gender and Climate Change Alliance of UN organizations, IUCN and WEDO along with other international organizations were established. (ELIAMEP Report, 2008).

Although the UNFCCC itself fails to incorporate gender equality as a cross-cutting issue, gender equality is a guiding principle in NAPA design and it was advised to include gender expertise in National Adaptation Programmes of Action (NAPA) teams. Many of the national reports submitted by signatory nations to the UNFCCC Secretariat emphasize the vulnerability of women and the importance of gender equality—albeit in broad terms. Most countries include some reference to the MDGs or national commitments to empowering women, but few detail how urgently women are affected by climate change, much less how they might be identified as powerful actors and agents for change. (ELIAMEP Report, 2008). The Indian submission to the UNFCCC does not anywhere mention women’s issues (with regard to climate change) or involvement in previous or oncoming projects. Relevant Indian Developmental Goals such as Reduction in gender gaps in literacy and wage rates by at least 50% points by 2007, Reduction in MMR to 2 per 1000 live births (2007) and to 1 per 1000 live births by 2012 need to look at achieving these goals given the vulnerabilities of climate change. Recent efforts at engendering the budget also need to address the same in light of the impacts of climate change on women in the country.

The Way Forward:

“Women are often perceived primarily as victims and not as positive agents of change. However, women can be key agents of adaptation and mitigation to climate change. Their responsibilities in households, communities and as stewards of natural resources position them well to develop strategies for adapting to changing environmental realities”. (WEDO, 2007). They also have a strong body of knowledge and expertise that can be used in climate change mitigation. Women have also been known to use resources more judiciously and even engage in conservation and protection of natural resources.

Building Resilient Institutions around Natural Resources:

India has a rich history of protecting its natural resources and doing so in innovative ways. However, it can be seen that most traditional institutions organized around the protection of NRs- fisher communities, forest protection committees etc have all been very male centred. The process has only worsened with modernization and the

Women’s strong role in preservation is remembered by “chipko movement” in the Seventies, where women hugged the trees to prevent them being cut by timber companies. Their participation in Joint Forest Management (JFM) is well known. Rawat (1996) in GEO Year Book (2004) reports in 1974, state government and contractors diverted the men of Reni Village to a fictional compensation payment site, while labourers disembarked from trucks to start logging operations. Under the leadership of Gaura Devi, a 50 year old illiterate woman, women left their homes to hug the trees and prevent them from being cut. A four day standoff ended in victory for village women.

centralization of governance. One tribal woman in a forested hilly region in Rajasthan, India claimed: *“The modern panchayati raj systems have marginalised the women in the community even more. In our communities we would sit face to face and talk to the men. However, today since in the Panchayat meetings many higher officials and high caste people come and there are very few women at gram sabhas, we are forced into silence and playing a secondary role.”* Even though there have been reservations for women in the Panchayati Raj Institutions (PRIs) and other governance forums there is much more to be done to empower women and increase their participation at various levels. Women have typically always had a strong role to play in institutions organized around natural resources and common lands. This system needs to be encouraged more by the government, through incentives, reservations and capacity building of both men and women groups to enable this. In a CARE project in Bangladesh, women tended to prioritize adaptation strategies that could be implemented close to home, such as homestead gardening and duck rearing. In the project, which recruited female field officers, women comprised 58% of total project participants (Patt et al., 2007). Women’s specific knowledge of maintaining biodiversity, through the conservation and domestication of wild edible plant seeds and food crop breeding, is key to adapting to climate change more effectively.

Micro-finance Solutions: India has one of the largest Self Help Group (SHG) networks in the world. SHG’s typically offer financial solutions to many women in the country. The Indian Government too has been promoting these groups across the country as a means to tackle ubiquitous poverty. A SHG begins as a thrift and credit association of poor women with similar social and existential contexts. Pooling their tiny savings, women meet their need for small loans to mitigate dire emergencies. These groups act as safety nets in case of disasters. SHGs and some micro-enterprises activity into which most

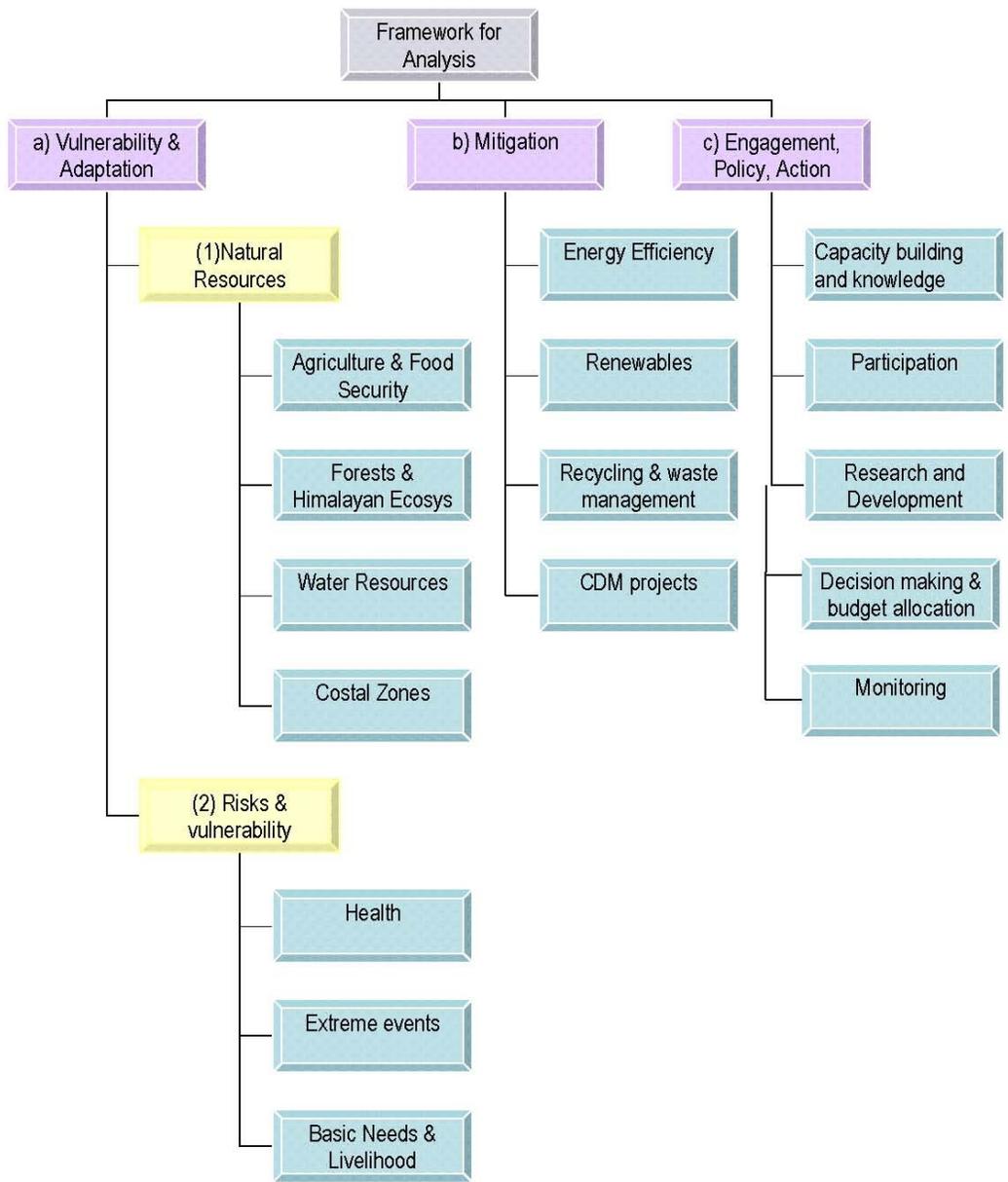
groups get into help in diversifying earning potential for poor women thus increasing risk taking capacities.⁸ SHGs act as a good fallback mechanism in dire times.

Promoting Cleaner Fuels: Women's active involvement in agriculture, and their dependence on biomass energy, makes them key stakeholders in effective environmental management. (Denton 2001). The need to diversify energy resources and introduce alternative fuels for household use constitutes an essential part of adaptation strategies. Thus promoting cleaner-burning fuel for household use, which will help to reduce air pollution and harmful emissions, and will benefit women by cutting their annual cooking costs by 25 percent would be a good strategy. In India biogas plants have gained much popularity in the rural areas. Biogas plants convert human and animal waste to clean gas for cooking, lighting and heating thus replacing fuelwood which would have been used for these purposes otherwise. The slurry from the biogas plants are used to fertilize fruit and vegetable crops. Smokeless chulhas (Energy-efficient stoves) are also popularly used by women in India after being promoted by NGOs.

More solutions:

- Supporting vulnerability-reduction measures that target women's needs;
- Gender debates need to be mainstreamed into the Governments approach to climate change.
- Making use of technologies that are accessible, beneficial, and acceptable to both male and female stakeholders;
- Facilitating extension studies, particularly for women, to improve the accessibility and use of new technology;
- Supporting the provision of tools, including vulnerability assessments, that build on local and indigenous knowledge, held by women and men, of measures to adapt to, or mitigate the impacts of, climate change; and
- Integrating gender analysis and gender equality indicators into programs and projects to identify where specific vulnerabilities to climate change lie, and where opportunities for mitigating and adapting to climate change can be found.

⁸ Learning's from the work of NGO- PRADAN, one of the pioneers of the SHG movement in India.





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