India and the challenge of climate change

Devising a scientific response strategy

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Chairman IPCC and Director-General TERI
Outline

- The reality of climate change and vulnerability of our region
- Reducing uncertainties in precipitation projections and implications for water resources
- Using climate science to develop local adaptation and mitigation strategies
- Transboundary impacts and regional cooperation on adaptation
- Bridging the gap between science and action
The reality of climate change and vulnerability of our region
2011 was the warmest La Nina year

Source: WMO Statement on the Status of the Global Climate 2011
Number of disasters and extent of damages (in 2009 billion USD) during 2000 to 2008

Source: IPCC SREX Fig 4.7
Projected increase in extreme temperature and rainfall events in South Asia

Will the frequency of the hottest day in the last 20 years of the 20th century increase?  
Will the frequency of the wettest day in the last 20 years of the 20th century increase?

<table>
<thead>
<tr>
<th>Return period (years)</th>
<th>2046–65</th>
<th>2081–00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios</td>
<td>B1</td>
<td>A1B</td>
</tr>
</tbody>
</table>

Source: IPCC SREX Figs SPM.4A and 4B
Vulnerability of coastal zones
Asian megadeltas especially are key societal hotspots of coastal vulnerability

Source: IPCC AR4 WG2 ch.6 Figure 6.6
Average physical exposure to floods in 1970 and 2030 (in thousands of people per year; assuming constant hazard)

Source: IPCC SREX Fig 4.2
Average physical exposure to tropical cyclones in 1970 and 2030 (in thousands of people per year; assuming constant hazard)

Source: IPCC SREX Fig 4.1
Reducing uncertainties in precipitation projections and implications for water resources
Monsoon 2012: Large parts of India had deficit rainfall – other parts had floods

Source: http://www.imd.gov.in/section/nhac/dynamic/Monsoon_frame.htm (18 July 2012)
Change in average annual runoff: 2050s A2

HadCM3 (A2a)  ECHAM4/OPYC

CGCM2  CSIRO MkII

GFDL_R30  CCSR/NIES2

% change compared to 1961-1990
-30 to -20  -10 to 0  0 to 10  10 to 20  20 to 30
-30  -20  -10  0  10  20  30

Change less than one standard deviation shown in grey

Source: IPCC AR4
Chapter 3.4.1
There is a range of projections for rainfall, but the costs of adaptation are high for both wet and dry scenarios in South Asia.

<table>
<thead>
<tr>
<th></th>
<th>Annual adaptation cost for South Asia (in 2005 US$) under A2 scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet scenario</td>
<td>US$ 17.1 billion</td>
</tr>
<tr>
<td>Dry scenario</td>
<td>US$ 14.6 billion</td>
</tr>
</tbody>
</table>

Source: World Bank (2010), cited in IPCC SREX Table 4.5
Understanding the monsoon

- Climate models still have considerable difficulty in simulating the South Asian monsoon (Tumer and Annamalai review in Nature Climate Change June 2012)
- Understanding the monsoon is the first step to robust projections of monsoon precipitation in a climate change scenario
- Key role of National Monsoon Mission
Using climate science to develop local adaptation and mitigation strategies
Inundation map for West Bengal
by linking PRECIS regional climate model outputs to ADvanced CIRCulation storm surge model (2070s-2100s)

Source: TERI
SLR increase + Storm surge scenario over West Bengal for 2071-2100 under A2

Red – topography over 10m height which is not inundated

Source: TERI
Rooting local adaptation in climate science

- Build low-cost climate-resilient habitats
- Climate-proof coastal infrastructure
- Devise coping strategies for coastal communities and occupations
But adaptation alone is not expected to cope with all the projected effects of climate change.

- Adaptation is necessary to address impacts resulting from the warming which is already unavoidable due to past emissions.
- Neither adaptation nor mitigation alone can avoid all climate change impacts; however, they can complement each other and together can significantly reduce the risks of climate change.

Source: IPCC AR4
### Characteristics of Stabilization Scenarios

**Post-TAR stabilization scenarios**

<table>
<thead>
<tr>
<th>Stabilization level (ppm CO2-eq)</th>
<th>Global mean temp. increase (ºC)</th>
<th>Year CO2 needs to peak</th>
<th>Global sea level rise above pre-industrial from thermal expansion (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>445 – 490</td>
<td>2.0 – 2.4</td>
<td>2000-2015</td>
<td>0.4 – 1.4</td>
</tr>
<tr>
<td>490 – 535</td>
<td>2.4 – 2.8</td>
<td>2000-2020</td>
<td>0.5 – 1.7</td>
</tr>
<tr>
<td>535 – 590</td>
<td>2.8 – 3.2</td>
<td>2010-2030</td>
<td>0.6 – 1.9</td>
</tr>
<tr>
<td>590 – 710</td>
<td>3.2 – 4.0</td>
<td>2020-2060</td>
<td>0.6 – 2.4</td>
</tr>
</tbody>
</table>

Source: IPCC AR4
Impacts of mitigation on GDP growth

GDP without mitigation

GDP with stringent mitigation

Cost of mitigation in 2030: max 3% of global GDP

Mitigation would postpone GDP growth of one year at most over the medium term

Source: IPCC AR4
Providing clean energy for development in a water-scarce world

Source: IPCC SRREN Fig 9.14
Water-energy nexus and climate change

- Renewable energy technologies for irrigation pumping, desalination for drinking water, and waste water treatment
- Energy policies and agricultural policies that rationalise water use
- Business models to make vulnerable communities more resilient (e.g., ICTs for disease surveillance, cold storage for horticulture)
Co-benefits of mitigation

- Common drivers lie behind mitigation policies and policies addressing economic development, poverty, health, employment, energy security, and local environmental protection.
- Linking policies provide the opportunity for no-regrets policies reducing greenhouse gases mitigation costs.
- CO₂ mitigation potential for 2010 without net cost in India: between 13 and 23% of business as usual scenario.

Source: IPCC AR4
Mitigation co-benefits in India

- It has been estimated that half a million people die each year in India from indoor air pollution. Increasing access to modern energy services can alleviate air-quality problems as well as decrease GHG emissions.

- 6 developing countries including India have avoided approximately 300 million tons a year of carbon emissions over the past 30 years through development policies.

- Bioenergy production in India shows major socioeconomic benefits.

- Co-benefits of mitigation in the forestry sector include employment, income generation, biodiversity and watershed conservation, renewable energy supply and poverty alleviation (Joint Forest Management Programme in India)

Source: IPCC AR4
Transboundary impacts and regional cooperation on adaptation
Transboundary impacts and shared challenges:

- Exacerbated water stress
- Impact of temperature rise on food security
- Higher risk of vector borne diseases
- Glacier melt and river flooding, GLOFs, landslides
- Coastal inundation and salinity due to sea level rise
- Migration

Source: Google Maps
Holistic approach to earth science research for climate change adaptation

- Wealth of historical data
  - Meteorological data since 1875
  - Tide gauge records since 1877
  - Glacier monitoring since 1906

- Technological advances
  - Ocean observation network
  - Doppler weather radars

- India should lead regional collaboration on climate modelling, disaster management systems, and adaptation to transboundary impacts
  - Himalayan region
  - Coastal and marine impacts
Bridging the gap between science and action
Comparison of the impacts of recent extreme cyclones indicates the importance of disaster preparedness efforts, experience, and governance.

## Comparison of Extreme Cyclones

<table>
<thead>
<tr>
<th>Cyclone Event</th>
<th>Year</th>
<th>Storm Surge (m)</th>
<th>Maximum Wind Speed (km h⁻¹)</th>
<th>Category (Saffir-Simpson)</th>
<th>Number of Affected People (approximate in millions)</th>
<th>Mortality (approximate)</th>
<th>Damages (US$ billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhola</td>
<td>1970</td>
<td>6 - 9</td>
<td>223</td>
<td>3</td>
<td>1</td>
<td>300,000 - 500,000</td>
<td>Unknown</td>
</tr>
<tr>
<td>Gorky</td>
<td>1991</td>
<td>6 - 7.5</td>
<td>260</td>
<td>4</td>
<td>15.4</td>
<td>138,000</td>
<td>1.8</td>
</tr>
<tr>
<td>Sidr</td>
<td>2007</td>
<td>5 - 6</td>
<td>245</td>
<td>4</td>
<td>8 - 10</td>
<td>4,200</td>
<td>2.3</td>
</tr>
<tr>
<td>Nargis</td>
<td>2008</td>
<td>~ 4</td>
<td>235</td>
<td>4</td>
<td>2 - 8</td>
<td>138,000</td>
<td>4.0</td>
</tr>
<tr>
<td>Stan¹</td>
<td>2005</td>
<td>Negligible</td>
<td>130</td>
<td>1</td>
<td>3 - 8</td>
<td>1,726</td>
<td>3.9</td>
</tr>
<tr>
<td>Wilma</td>
<td>2005</td>
<td>12.8</td>
<td>295</td>
<td>5</td>
<td>10⁰</td>
<td>62 (8 in Mexico)</td>
<td>29 (7.5 in Mexico)</td>
</tr>
</tbody>
</table>

Notes:

¹ Most of damage and mortality caused by landslides and river flooding.

² Affecting Jamaica, Bahamas, Haiti, Cayman Islands, Belize, Honduras, El Salvador, Nicaragua, Honduras, Yucatán Peninsula (Mexico), and Florida (USA).

Source: IPCC SREX Table 9.2
### Earth science for building resilience

- Early warning systems
- Flood forecasting
- Weather advisories to enhance adaptive capacity of farmers
- Higher density of weather stations for weather-indexed insurance
- Educating the next generation of scientists and the next generation of citizens
Key mitigation policies and instruments

- The pace, cost and extent of our response to climate change will depend critically on the cost, performance, and availability of technologies.
- The move towards a low-carbon development pathway requires the adoption of adequate measures:
  - Effective carbon-price signal
  - Regulations, standards, taxes and charges
  - Changes in lifestyle

Source: IPCC AR4
Be the change you want to see in the world
Thank you