The Economics of Climate Change
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Second IG Patel lecture
New Delhi
26 October 2007
The economics of climate change

- Impacts, Risks, Costs: Global
- Possible Impacts on India
- Planning for Adaptation
- Mitigation Policy
- Global Deal
Impacts, Risks, Costs: Global
Why science implies this externality is different

- Global
- Long-term; irreversibilities
- Uncertainty
- Scale
Key messages

• The costs of strong and urgent action to avoid serious impacts from climate change are substantially less than the damages thereby avoided

• Even with strong action to reduce greenhouse gas emissions adaptation must be a crucial part of development strategy

• Policy requires urgent and international action, pricing for damages from greenhouse gases, supporting technology development and combating deforestation
### Projected impacts of climate change

<table>
<thead>
<tr>
<th>Global temperature change (relative to pre-industrial)</th>
<th>0°C</th>
<th>1°C</th>
<th>2°C</th>
<th>3°C</th>
<th>4°C</th>
<th>5°C</th>
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<tbody>
<tr>
<td><strong>Food</strong></td>
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<td>Falling crop yields in many areas, particularly developing regions</td>
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<td>Possible rising yields in some high latitude regions</td>
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<td>Falling yields in many developed regions</td>
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<td><strong>Water</strong></td>
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<td>Small mountain glaciers disappear – water supplies threatened in several areas</td>
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<td>Significant decreases in water availability in many areas, including Mediterranean and Southern Africa</td>
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<td>Sea level rise threatens major cities</td>
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<td><strong>Ecosystems</strong></td>
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<td>Extensive Damage to Coral Reefs</td>
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<tr>
<td>Rising number of species face extinction</td>
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<td><strong>Extreme Weather Events</strong></td>
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<td>Rising intensity of storms, forest fires, droughts, flooding and heat waves</td>
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<td><strong>Risk of Abrupt and Major Irreversible Changes</strong></td>
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<td>Increasing risk of dangerous feedbacks and abrupt, large-scale shifts in the climate system</td>
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Stabilisation and eventual change in temperature

Eventual temperature change (relative to pre-industrial)

<table>
<thead>
<tr>
<th>CO₂e Level</th>
<th>Eventual Change (%)</th>
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<tbody>
<tr>
<td>400 ppm</td>
<td>5%</td>
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<tr>
<td>450 ppm</td>
<td>95%</td>
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<tr>
<td>550 ppm</td>
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<td>650 ppm</td>
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<td>750 ppm</td>
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0°C 1°C 2°C 3°C 4°C 5°C
Aggregate estimates of impacts

Sensitivity of total cost of climate change to damage function exponent and consumption elasticity of social marginal utility in baseline-climate scenario (mean BGE loss, 5-95% confidence interval).

<table>
<thead>
<tr>
<th>Damage function exponent</th>
<th>Consumption elasticity of social marginal utility ($\eta$)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>10.4 (2.2-22.8)</td>
</tr>
<tr>
<td>2.5</td>
<td>16.5 (3.2-37.8)</td>
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<tr>
<td>3</td>
<td>33.3 (4.5-73.0)</td>
</tr>
</tbody>
</table>

- Models should not be taken too literally
- Assumptions on discounting, risk aversion and equity affect the results
- Review central case was top left hand corner: high weight on future, conservative on risks. Plausible case for centreing the argument further down the diagonal. Note: intra generational distribution, changing relative price of environmental goods, irreversibilities, all omitted and introduction would increase damage estimates
Delaying mitigation is dangerous and costly

Stabilising below 450ppm CO$_2$e would require emissions to peak by 2010 with 6-10% p.a. decline thereafter.

If emissions peak in 2020, we can stabilise below 550ppm CO$_2$e if we achieve annual declines of 1 – 2.5% afterwards. A 10 year delay almost doubles the annual rate of decline required.
Reducing emissions requires action across many sectors

**ENERGY EMISSIONS**
- Power (24%)
- Transport (14%)
- Buildings (8%)

**NON-ENERGY EMISSIONS**
- Industry (14%)
- Other energy related (5%)
- Waste (3%)
- Agriculture (14%)
- Land use (18%)

Total emissions in 2000: 42 GtCO₂e.
Cost estimates

• Review examined results from bottom-up & top-down studies: concluded that world could stabilise below 550ppm CO$_2$e for around 1% of global GDP

• Subsequent analyses Edenhofer/IPCC top down have indicated lower figures

• So too have bottom-up IEA and McKinsey

• Options for mitigation: McKinsey analysis examines approach of chapter 10 of Review in more detail
McKinsey bottom-up approach

- ~27 GtCO₂e below 40 EUR/ton (-46% vs. BAU)
- ~7 Gt of negative and zero cost opportunities
- Fragmentation of opportunities
Possible impacts on India
Intense monsoons, glaciers’ recession, flooding and water scarcity

- Number of extreme rainfall events likely to increase
- Rapid retreat of Himalayan glaciers and snow
- Severity of droughts and floods likely to increase; torrents in rainy season, dry rivers in dry season
- Water scarcity in the long run caused by reduced inflows in river system
Rate of Glacier Retreat in the Himalaya

Figure 2: Rapid retreat of greater Himalayan glaciers in comparison to the global average (Dyurgerov and Meier 2005)
Relative Vulnerability for Floods

Average annual deaths, 1980 - 2000

Average population exposed to floods, 1980 - 2000

Increase in Population and Agricultural Water Use in Asia

PROGNOSIS

Population and agriculture water use

- Population (million)
- Agriculture water use (Km³/year)

Water use: S Asia
Pop: S Asia
Water use: SE Asia
Pop: SE Asia

Planning for Adaptation
Adaptation and development

• Development key to adaptation: enhances resilience and increases capacity
• Adaptation to current climate variability reduces costs of natural disasters
• Adaptation requires economy-wide planning and regional co-operation
  – Leadership and co-ordination is essential: key role for Heads of Government, Finance and Economic Ministries
• How well is India prepared for the change in climate? For example record floods this year
Responsibilities for adaptation

- Central role for individuals, firms, and civil society in responding to climate change
- Measures for strengthening adaptation include
  - Ensuring access to high-quality information
  - Increasing the resilience of livelihoods and infrastructure
  - Improving governance
  - Integrating climate change impacts in issues in all national, sub-national and sectoral planning processes and macro-economic projections.
  - Encouraging a core ministry with a broad mandate, such as finance, economics or planning, to be fully involved in mainstreaming adaptation
- Local study of impacts and possible responses is crucial
International support for adaptation

• Development in context of climate change will be much more costly: likely to be scores of billions of dollars p.a.
• Rich countries are main source of climate problem: responsibility to help finance consensus
• Essential to meet commitments made to double aid flows by 2010
• UNFCCC process and funds essential to support capacity-building and prioritisation
• Given necessary scale additional ODA flows will be a bigger source of funding for adaptation and development
Global opportunities for adaptation

International action also has a key role in supporting global public goods for adaptation:

- Forecasting climate and weather
- Disaster response
- More resilient crop varieties
- Technologies for water conservation and irrigation
- New methods to combat land degradation
- Prevention and treatment of malaria and other water- and vector- borne diseases
Mitigation Policy
# Carbon dioxide emission projections

<table>
<thead>
<tr>
<th>Country</th>
<th>2002</th>
<th>2025</th>
<th>Avg. Annual Growth</th>
<th>Total Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>24,410</td>
<td>38,791</td>
<td>2.00%</td>
<td>58.90%</td>
</tr>
<tr>
<td>Annex I</td>
<td>14,169</td>
<td>18,258</td>
<td>1.10%</td>
<td>28.90%</td>
</tr>
<tr>
<td>non-Annex I</td>
<td>10,241</td>
<td>20,533</td>
<td>3.10%</td>
<td>100.50%</td>
</tr>
<tr>
<td>United States of America</td>
<td>5,752</td>
<td>7,980</td>
<td>1.40%</td>
<td>38.70%</td>
</tr>
<tr>
<td>Western Europe</td>
<td>3,550</td>
<td>3,953</td>
<td>0.50%</td>
<td>11.40%</td>
</tr>
<tr>
<td>China</td>
<td>3,323</td>
<td>8,134</td>
<td>4.00%</td>
<td>144.80%</td>
</tr>
<tr>
<td>India</td>
<td>1,026</td>
<td>1,993</td>
<td>2.90%</td>
<td>94.30%</td>
</tr>
<tr>
<td>Brazil</td>
<td>341</td>
<td>678</td>
<td>3.00%</td>
<td>98.90%</td>
</tr>
</tbody>
</table>

Source: Climate Analysis Indicators Tool (CAIT) Version 4.0.
(Washington, DC: World Resources Institute, 2007).
The CO2 emissions map

Note: Map reflects the relative emissions from fossil fuel consumption in 20th century.
Target flows

• Current 40-45 GtCO2e p.a. Current stocks around 430ppm; pre-industrial stocks 280ppm

• Heiligendamm 2007 pledge to halve global emissions by 2050 – consistent with stabilisation of CO₂e below 500ppm

• The United States and the EU countries combined accounted for over half of cumulative global emissions from 1900 to 2005

• 50% reduction by 2050 requires per capita global GHG emissions of 2-3T/capita (20-25 Gt divided by 9 billion population)

• Currently US ~ 20+, Europe ~10+, China ~4, India ~1 T/capita
The GHG ‘reservoir’

• Long-term stabilisation at 550ppm CO$_2$e implies that only a further 120ppm CO$_2$e can be ‘allocated’ for emission, given that we start at 430ppm

• Developing country can largely claim this 120ppm given their low emissions in the past. Note that rich countries largely responsible for increase from 280ppm to 430ppm

• Equity requires a discussion of the appropriate use of this reservoir given past history

• Thus convergence of flows does not fully capture the equity story, from emissions perspective

• Equity issues arise also in adaptation, given responsibilities for past increases
Mitigation policy instruments

- Pricing the externality - carbon pricing via tax or trading, or implicitly through regulation
- Bringing forward lower carbon technology - research, development and deployment
- Overcoming information barriers and transaction costs – regulation, standards
- Promoting a shared understanding of responsible behaviour across all societies – beyond sticks and carrots
Growth, change and opportunity

• Strong mitigation costs around 1% p.a. worldwide
• Strong mitigation is fully consistent with the aspirations for growth and development in poor and rich countries. Business as usual is not.
• Costs will not be evenly distributed:
  • Competitiveness impacts can be reduced by acting together.
  • New markets will be created. Investment in low-carbon electricity sources could be over $500bn a year by 2050.
• Mitigation policy can also be designed to support other objectives:
  • energy - air quality, energy security and energy access
  • forestry - watershed protection, biodiversity, rural livelihoods
Global deal
Key elements of a global deal: I

**Targets and Trade**

- Rich countries to take on **strong individual targets**, creating demand side for reductions

- Rich country reductions and trading schemes designed to be **open to trade with other countries**, including developing countries

- **Supply side from developing countries** simplified to allow much bigger markets for emissions reductions, **through sectoral or technological benchmarking**
Key elements of a global deal: II

**Funding Issues**

- Strong initiatives, with public funding, on *deforestation* to prepare for inclusion in trading
- Demonstration and sharing of *technologies*
- Rich countries to deliver on Monterrey and Gleneagles commitments on *ODA* in context of extra costs of development arising from climate change

Combination of the above can, with appropriate market institutions, help overcome the inequities of climate change and provide *incentives for developing countries to play strong role* in global deal, eventually *taking on their own targets.*
India: starting point for policy

- India is very vulnerable to climate change
- India will be central to discussion of a global deal
- India’s contribution to past emissions is low & India has very small current emissions per capita
- India has strong and important objectives in growth and poverty reduction
- Note Stern Review has no policy recommendations for India
India: possible policy

- Support global target: Heiligendamm: 50% by 2050
- Insist on strong responsibilities for rich countries: at least 75% reductions by 2050
- Promote GHG trading to generate financial flow
- Encourage rapid technological advance with sharing of technologies at reasonable cost
- Work towards targets which take into account history of flows, standard of living and development aspirations, as flows and technologies are established
- Pursue urgently intensive study of challenges of adaptation