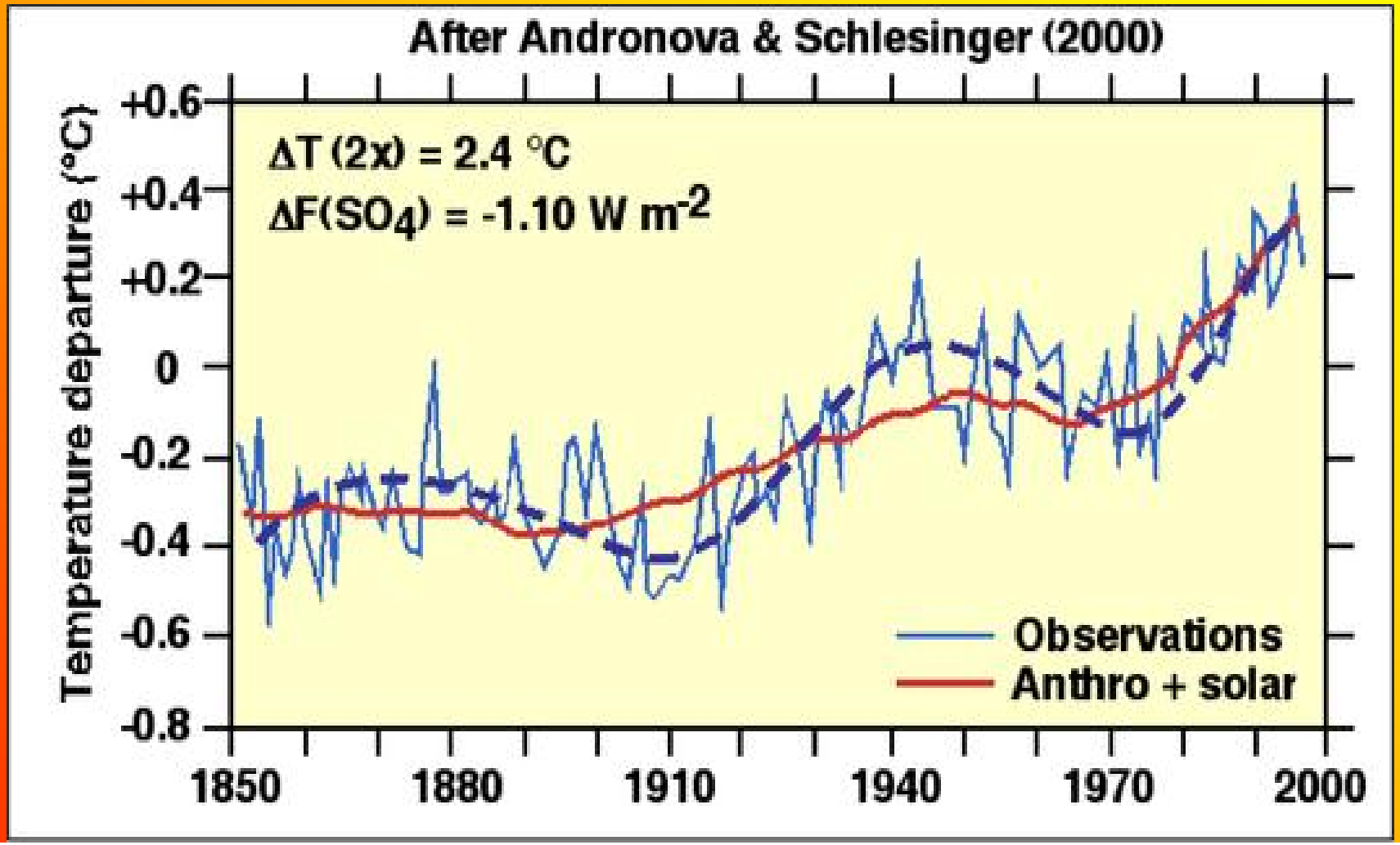
Climate Change

A Troika Presentation

The Science

- Cline represents atmospheric warming as a smoothly advancing curve. But:



Uneven progress

- Hot years, and hot decades, can produce catastrophic events
- Cool years, and comparatively cool decades, can produce illusion of normality
- Cyclical nature of phenomena have social and political implications

Uneven geographic vulnerabilities

- Change has severe *local* effects
- Warming severe in arctic regions: +6-10C at poles vs +2-3C at equator by 2100 (ciel.org)
- Drought severe in continental interiors
- Weather events severe in semi-tropics
- Flooding severe in low-lying coasts – *especially in heavily populated deltas.*
- Sea level rise approx 1m by 2100
- *Therefore: Plan for local catastrophes*

Economic issues

- Cline bases predictions on average global temp rise
- Represents “climate damage” as smoothly rising curve
- But economies and markets are volatile
- Markets delay, then over-react: hence panics
- Supply crises likely to trigger recession, depression

The economics of climate change

- Copenhagen provides summary of economic argument for mitigation of climate change
- Cline's DICE99CL model says investment in climate change mitigation yields marginal returns
- Current models have severe limitations which must be considered before decisions regarding prioritization should occur

Current economic models

- Based on slow steady economic growth with stable political systems
- Most projections cover only a few years and at most a few decades (Cline 2004)
- Forced to work with averages of phenomena that are (in reality) highly variable
  - Temperature projections, emissions, costs of abatement, and climate sensitivity (Cline 2004)

Current models

- Mathematical functions place significant emphasis on inputs
- Minor variations of inputs frequently result in significant changes in model outcomes
  - Cline designates pessimistic, moderate, and optimistic temperature inputs that vary by a total of only 1.2 C^{o} over 100 years
- Traditionally have avoided catastrophic events in analysis and have simply thrown them on the top of CBA data as added incentive to act on existing data (Cline 2004)

Current models

- Fail to account for asymmetry in timing of costs and benefits of action
- Improperly account for lifespan benefits of carbon abatement
  - Discount rates indicate we'd be better off simply investing resources allocated for CO_2. However, if successful, these investments last 10-15 years vs. CO_2 abatement which extends multiple centuries
- Are skewed towards costs of mitigation rather than benefits of abatement. (Cline 2004)
- Finally, they do not reflect the difficulty of performing CBA under disaster conditions

Complications of disaster CBA

- Supply and demand responses behave differently under chaotic conditions
  - Outside aid and sympathy alter supply and demand conditions
  - Actors may value reinvestment at a short-term cost rather than disturb established supply chains, example: Toyota
- Variable effects on capital stocks greatly impact recovery rates
- Available reinvestment and ability to implement new technology also impacts recovery rates

Okuyama 2003

Additional disaster complications

- Multiple factors affect the extent of economic damages
  - Location, vulnerability of population, infrastructure, preparedness etc.
- Populations are increasingly concentrated in high risk areas (Rasmussen 2004)
- Economic valuations of human life are often based on a person's lifetime economic contributions
  - Is this a valid measure when it is the marginalized that are most directly impacted by the effects of climate change?

Disasters create irrational economic behavior

- Insurance premiums and deductibles of coastal properties are skyrocketing due to costs of hurricane Katrina (Treaster NYT 2006)
  - Premiums rise $35,000 to $430,000
  - Deductibles rise $5000 to $125,000
  - Billions in equity lost thru impact on housing prices
  - Lost equity = lost collateral for rebuilding
- Stock market crashes in general all reflect irrational consumer and financial institution behavior

Economic bottom line

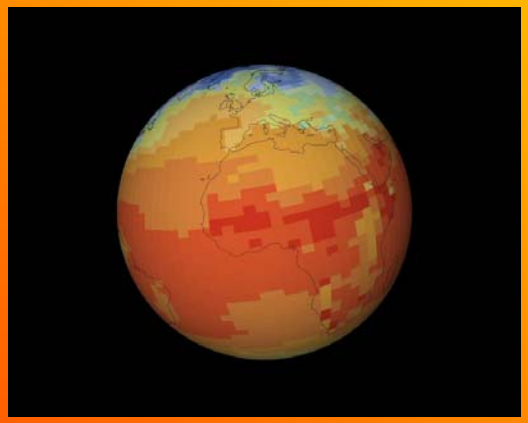
- Due to high variability in the economic impacts of disasters, the potential costs of climate change could be significantly greater than what is reflected by existing economic models
- The dramatic limitations of our existing models must be accounted for before valid prioritization of climate change policies can occur

Impact on Copenhagen issues

CLIMATE CHANGE

Warmer air and sea

More variable weather



Rising sea levels

More floods and droughts

COPENHAGEN CONSENSUS

Communicable diseases

Sanitation/clean water

Malnutrition

Migration

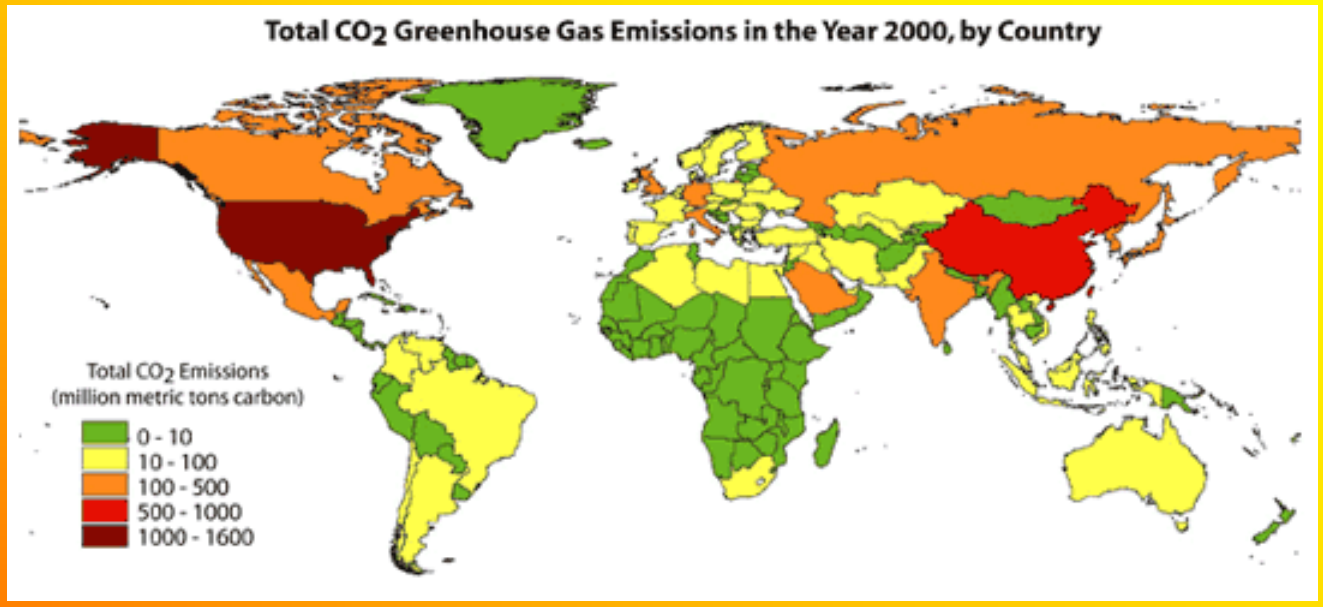
Conflicts

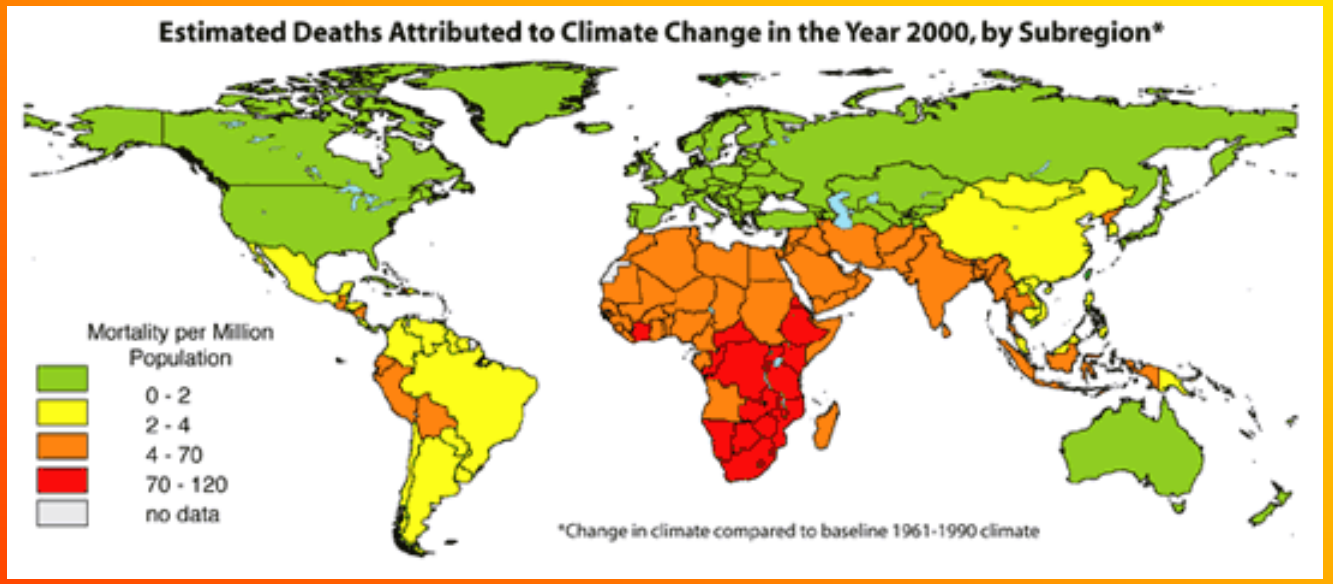
WHO: Currently 5 million illnesses/150,000 deaths per year due to climate change

Photo credit: http://www.nag.co.uk/Market/articles/prcpdn.asp

Photo credit: http://www.copenhagenconsensus.com/Default.aspx?ID=158

Impact on Copenhagen issues- Distribution of emissions vs. impacts

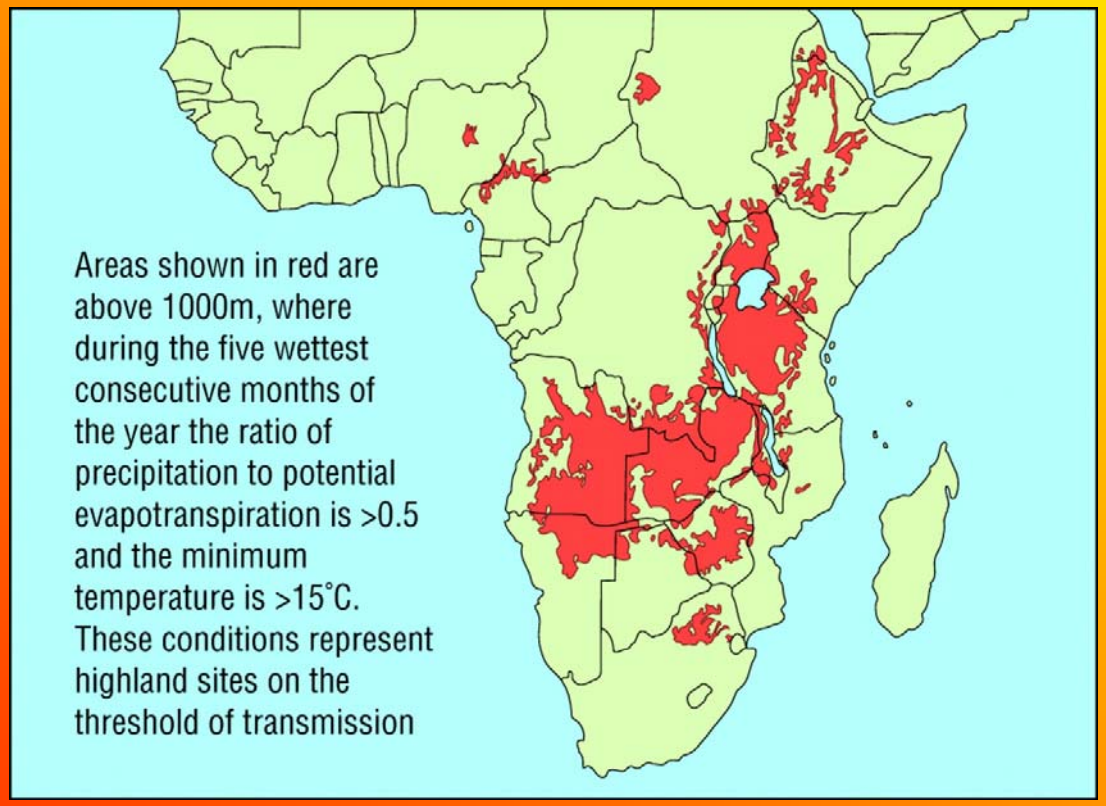




Maps: The Center for Sustainability and the Global Environment.

Impact on Copenhagen issues

- **<u>Communicable diseases</u>**
  - Malaria, cholera, dengue fever



Source: Patz J, Lindsay S, in: *Curr Opin Microbiol* 1999;2:445-51

Impact on Copenhagen issues

- **<u>Sanitation and access to clean water</u>**
  - Flooding of rivers and coastal areas
  - Disruption of infrastructure
  - Pollution
  - Change freshwater ecology
  - Communicable diseases

  Example: 1997-98 El Nino event in Lima, Peru

  5 deg C Temp increase = >2x increase in diarrhea cases

  (Jonathan A. Patz, in Nature Vol 438|17 Nov 05)

  - Drought

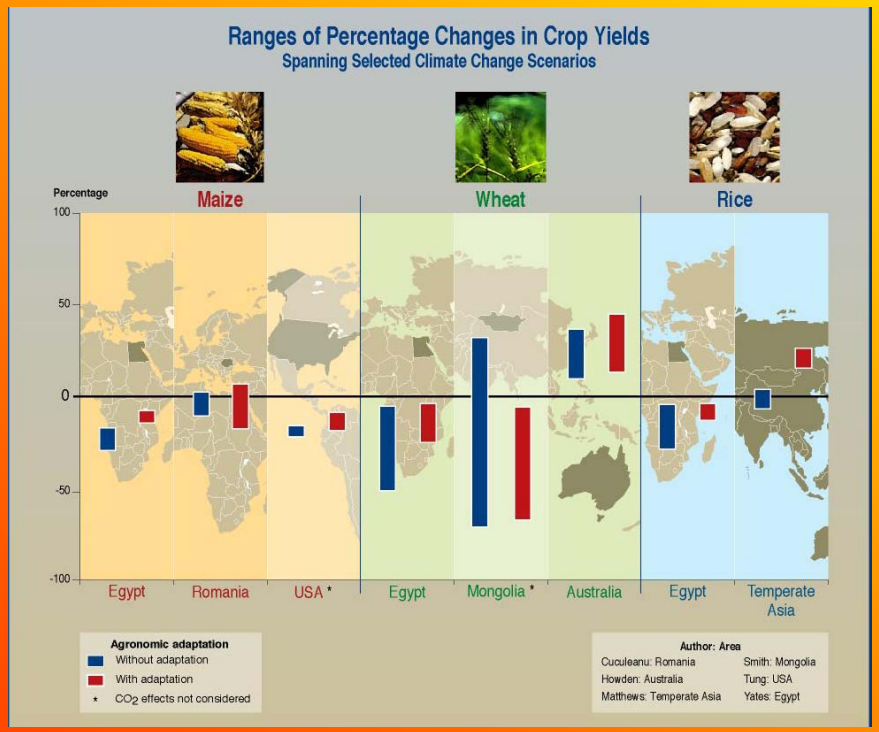
Source: Patz J, in: BMJ 2002;325:1094-1098 (9 November)

Photo credit: Marla Smith-Nilson, WaterPartners International

Impact on Copenhagen issues

- **Malnutrition**

- Drought
- Flooding
- Variable precipitation
- Warmer climate



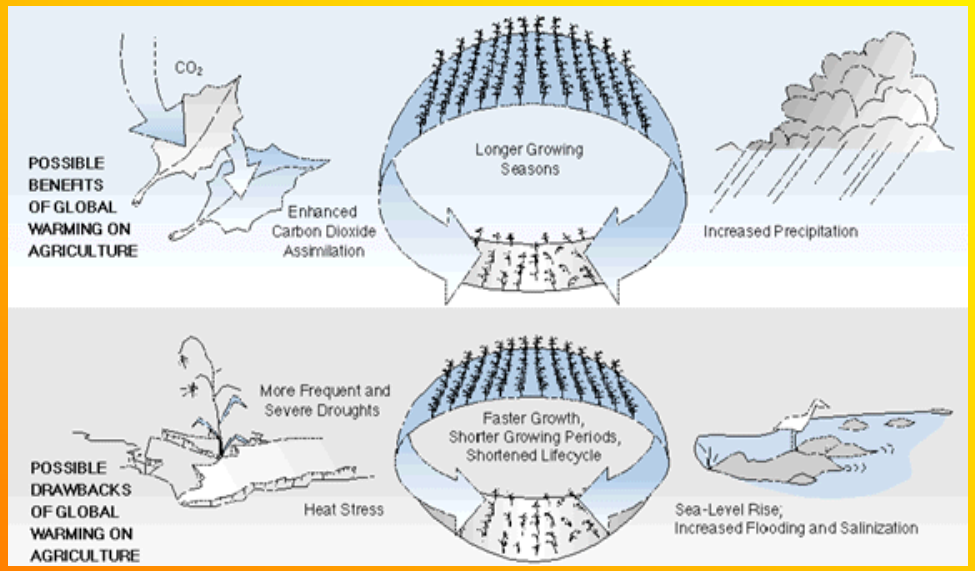


Figure-IPCC (http://www.ipcc.ch/present/graphics/2001wg2/ppt/08.01.ppt)

Figure-U.S. Global Change Research Information Office

Impact on Copenhagen issues

- **Migration**

- Sea level increases
  - * 13 of 20 megacities at sea level
  - * Islands, low lying deltas, coral atolls
- More frequent floods and droughts
- Changing weather patterns

  (increased frequency/intensity of extreme weather events)

"150 million environmental refugees will exist in the year 2050, due mainly to the effects of coastal flooding, shoreline erosion and agricultural disruption."

(Intergovernmental Panel on Climate Change (IPCC)

Photo credit: From: http://www.cdc.gov/nceh/ierh/Gallery/Zaire%201Lg.jpg.

Source: Patz J, in: BMJ 2002;325:1094-1098 (9 November)

Impact on Copenhagen issues

- **<u>Conflicts and arms proliferation</u>**
  - Wars for control of resources (fresh water, arable land, coast and marine resources, energy)
  - Mass migration across borders
  - Civil war
  - Political & religious conflicts

Source: “Policy Brief: The United Nations and Environmental Security”
http://www.wilsoncenter.org/topics/pubs/ecspr10_unf-purbus.pdf

Photo credit: BBC news

Case study: Bangladesh

Vulnerability

- Population density
- Economy
- Geomorphology

Digital Elevation Model of Bangladesh

Legend :

- International Boundary
- River
- Railway
- Roads

Elevation in meter (PWD)

N

Elevation in meter (PWD)

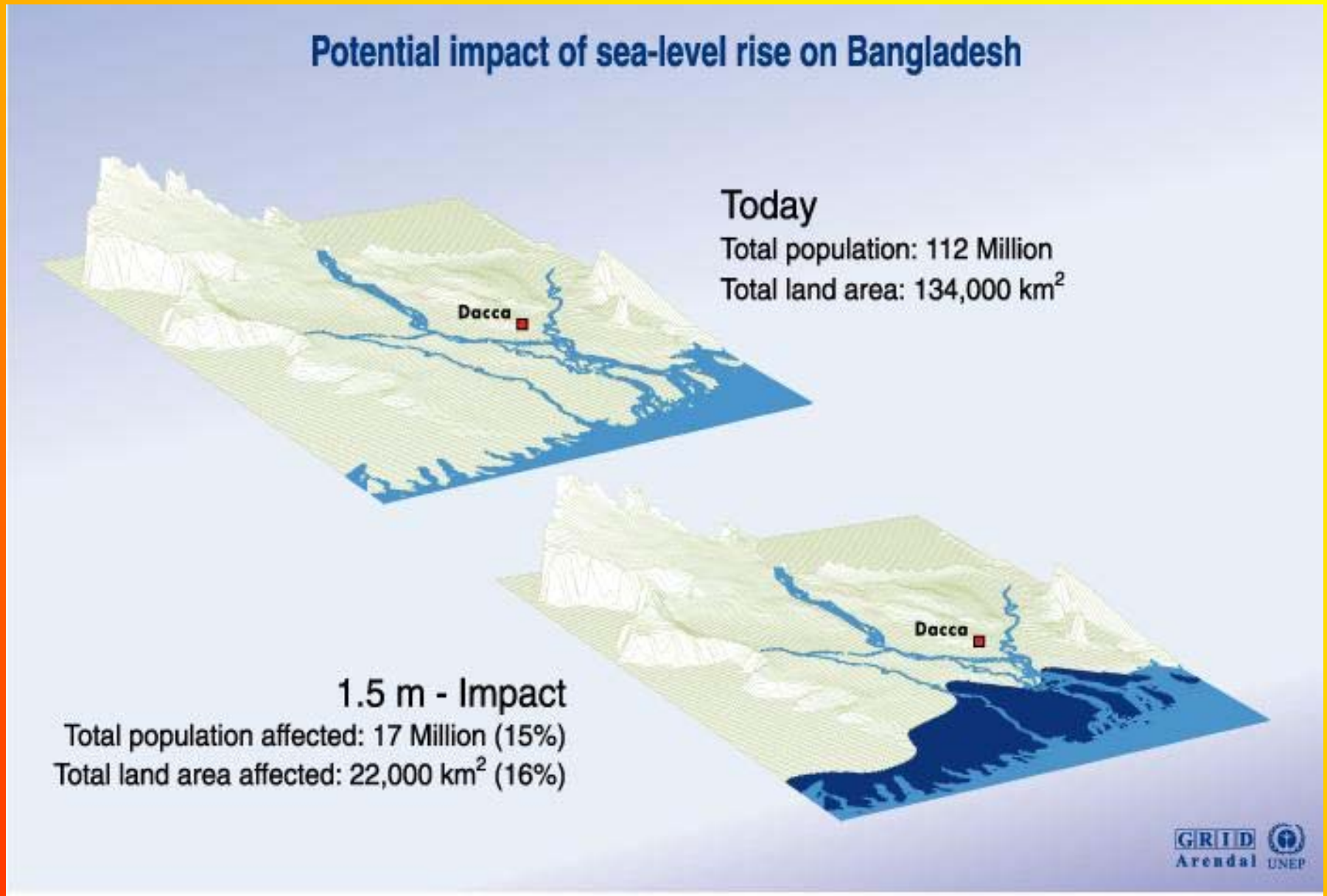
< 1 m	5 - 6 m	10 - 12 m	40 - 50 m	90 - 100 m
1 - 2 m	6 - 7 m	12 - 15 m	50 - 60 m	> 100 m
2 - 3 m	7 - 8 m	15 - 20 m	60 - 70 m	No Data
3 - 4 m	8 - 9 m	20 - 30 m	70 - 80 m	
4 - 5 m	9 - 10 m	30 - 40 m	80 - 90 m	

Climate change effects: sea level rise

- ¼ of pop lives in coastal areas, and a majority depends on the coast in some way
- Coastal erosion
  - Potential to lose additional 1879 ha of land for a 0.3m increase in sea level

Sea Level Rise (m)	Land that will be lost (km^2)	Percent of total land (%)
0.1	2,500	2
0.3	8,000	5
1.0	14,000	10

1989 model:


Potential impact of sea-level rise on Bangladesh
Today
Total population: 112 Million
Total land area: 134,000 km²
Dacca
Dacca
1.5 m - Impact
Total population affected: 17 Million (15%)
Total land area affected: 22,000 km² (16%)
GRID Arendal
UNEP
Source : UNEP/GRID Geneva; University of Dacca; JRO Munich; The World Bank; World Resources Institute, Washington D.C.

Climate change effects: natural disasters

- Increase in storm intensity and frequency
  - Cyclones, surges, and floods

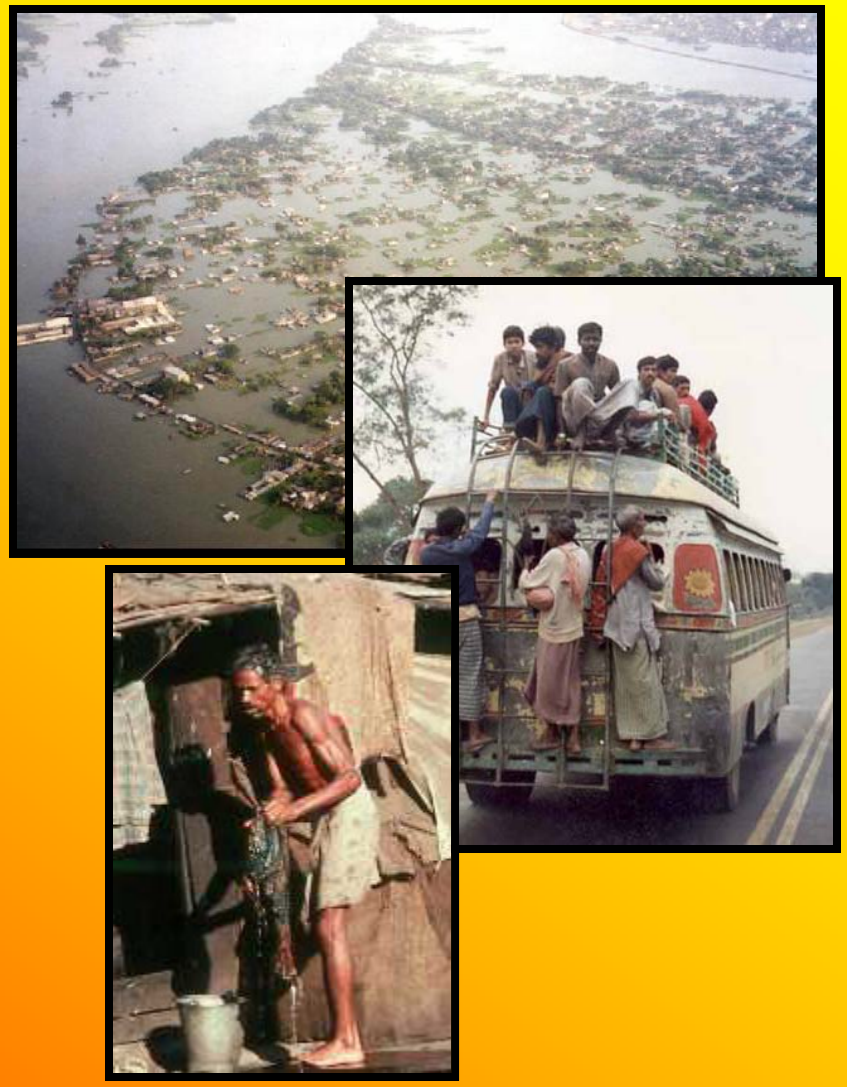
Sea Temp Increase (°C)	Cyclone Intensity Increase (%)	Storm Surge Height Increase (%)	Inland Surge Penetration Increase (%)
1	4		
2	10	21	13
4	22	47	31

Effects: natural disasters

- **Drought and floods**
  - More precipitation in the summer, increased evaporation in the winter
- **Backwater Effect**
  - Retardation of river discharge because of the water level of the Bay of Bengal
  - Increases inland flooding
- **Salinity Intrusion**
  - Groundwater, coastal water, and soil will become more saline
    - Affects agriculture, fisheries, and drinking water

Implications

- Migration
  - “Climate refugees”
  - Migration inland to already densely populated areas
- Conflicts
  - 85% Muslim vs Hindu & Buddhist neighbors
- Malnutrition and hunger
  - Reduction in agriculture
- Sanitation and access to clean water
- Communicable disease
  - Mosquito breeding grounds increased
- Loss of biodiversity-rich Sundarbans



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Summary

In thinking about how to allocate funds, consider these conditions:

- Climate will change
- Economic models aren't adequate
- Plan for local disruption
- Plan for synergies across Copenhagen issues