

# Energy Scenarios for Sustainable Development

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18 February 2002

Conference on Sustainability in Energy Production and Utilization in Brazil:  
The Next Twenty Years, Unicamps – S. Paulo, Brazil



## Sustainable Energy:

Energy that is produced and used in ways that simultaneously support human development over the long-term in *all* its social, economic, and environmental dimensions

# MAJOR CHALLENGES

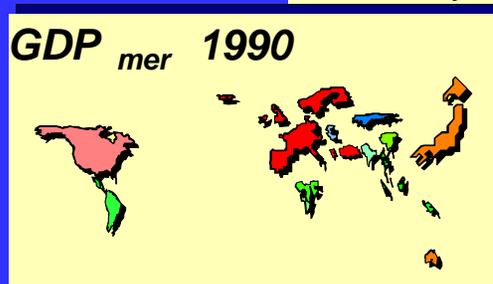
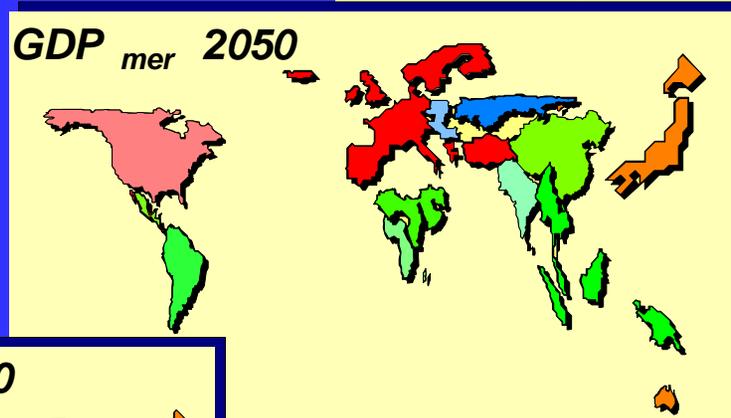
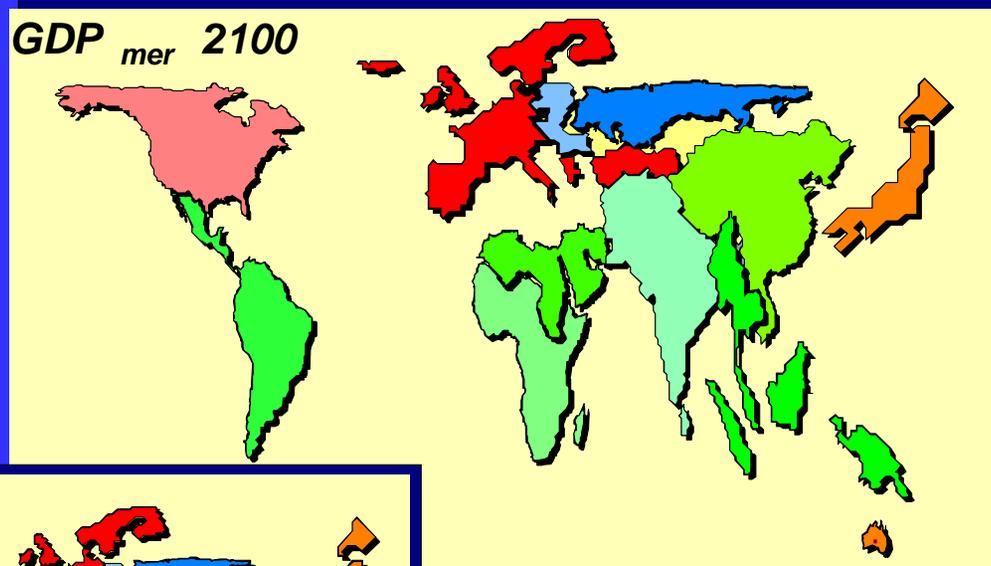
- 1.5 billion people < \$1 per day
- Technology diffusion > 20 years
- “Leapfrog rugs of the energy ladder”
- Financing energy transformations
- Achieving sustainable energy

# World Economic Map

Areas of Regions Proportional to 1990 GDP  
(mer)



**Area of Regions  
Proportional  
to 1990  $GDP_{mer}$**



## **WORLD ECONOMIC MAP**



Scenario development – thought experiments – is a useful tool in evaluating possible combinations of assumptions that may lead to sustainability

- The middle course B scenario
- Scenario A3
- The “ecologically” driven scenario C1



# Sustainable Development Indicators

World Energy Assessment

<http://www.undp.org/energy/activities/nea>

| Elements of sustainability            | 1990   | Scenario A3 | Scenario B | Scenario C1 |
|---------------------------------------|--------|-------------|------------|-------------|
| Eradicating poverty                   | Low    | Very High   | Medium     | Very High   |
| Reducing relative income gaps         | Low    | High        | Medium     | Very High   |
| Providing universal access to energy  | Low    | Very High   | High       | Very High   |
| Increasing affordability of energy    | Low    | High        | Medium     | Very High   |
| Reducing adverse health impacts       | Medium | Very High   | High       | Very High   |
| Reducing air pollution                | Medium | Very high   | High       | Very High   |
| Burden of long-lived radionuclides    | Low    | Very High   | Very high  | Low         |
| Limiting GHG emissions                | Low    | High        | Low        | Very High   |
| Diversifying primary energy sources   | Medium | Medium      | High       | Low         |
| Raising indigenous energy use         | Medium | High        | Low        | Very High   |
| Improving supply efficiency           | Medium | High        | Low        | High        |
| Increasing end-use efficiency         | Low    | High        | Medium     | Very High   |
| Accelerating technology diffusion     | Low    | Very High   | Medium     | High        |
| Freedom of international energy trade | Medium | Very High   | High       | Low         |



United Nations Development Programme

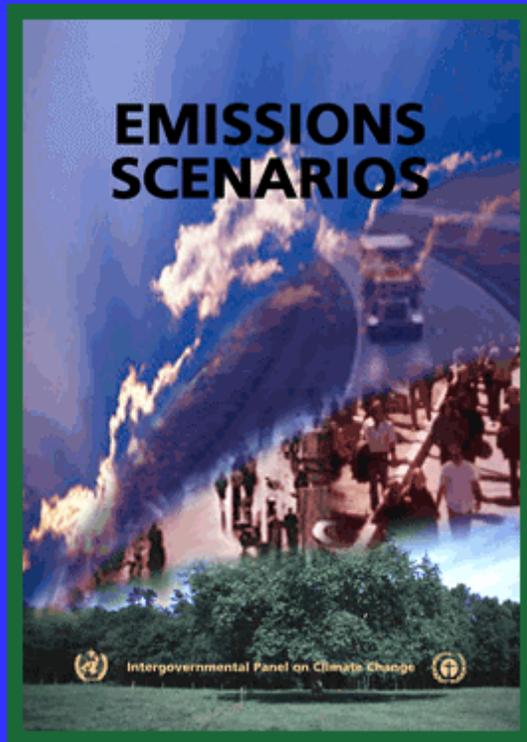


United Nations Department of Economic and Social Affairs



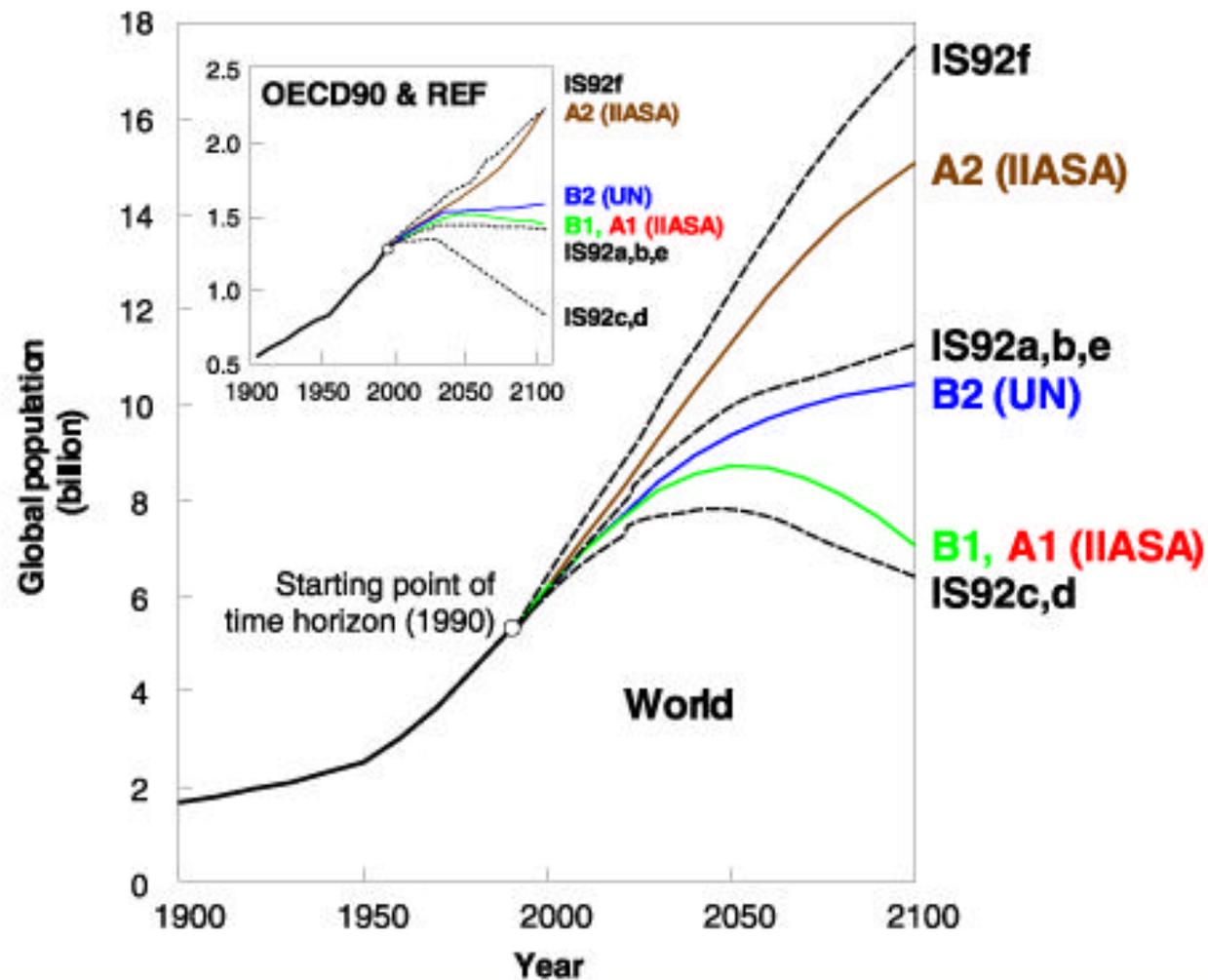
World Energy Council

# IPCC Special Report



- ## IPCC Emissions Scenarios
- Extensive literature review
  - Four narrative storylines
  - Six modeling frameworks
  - Forty emissions scenarios
  - Six illustrative scenarios

# GLOBAL POPULATION PROJECTIONS



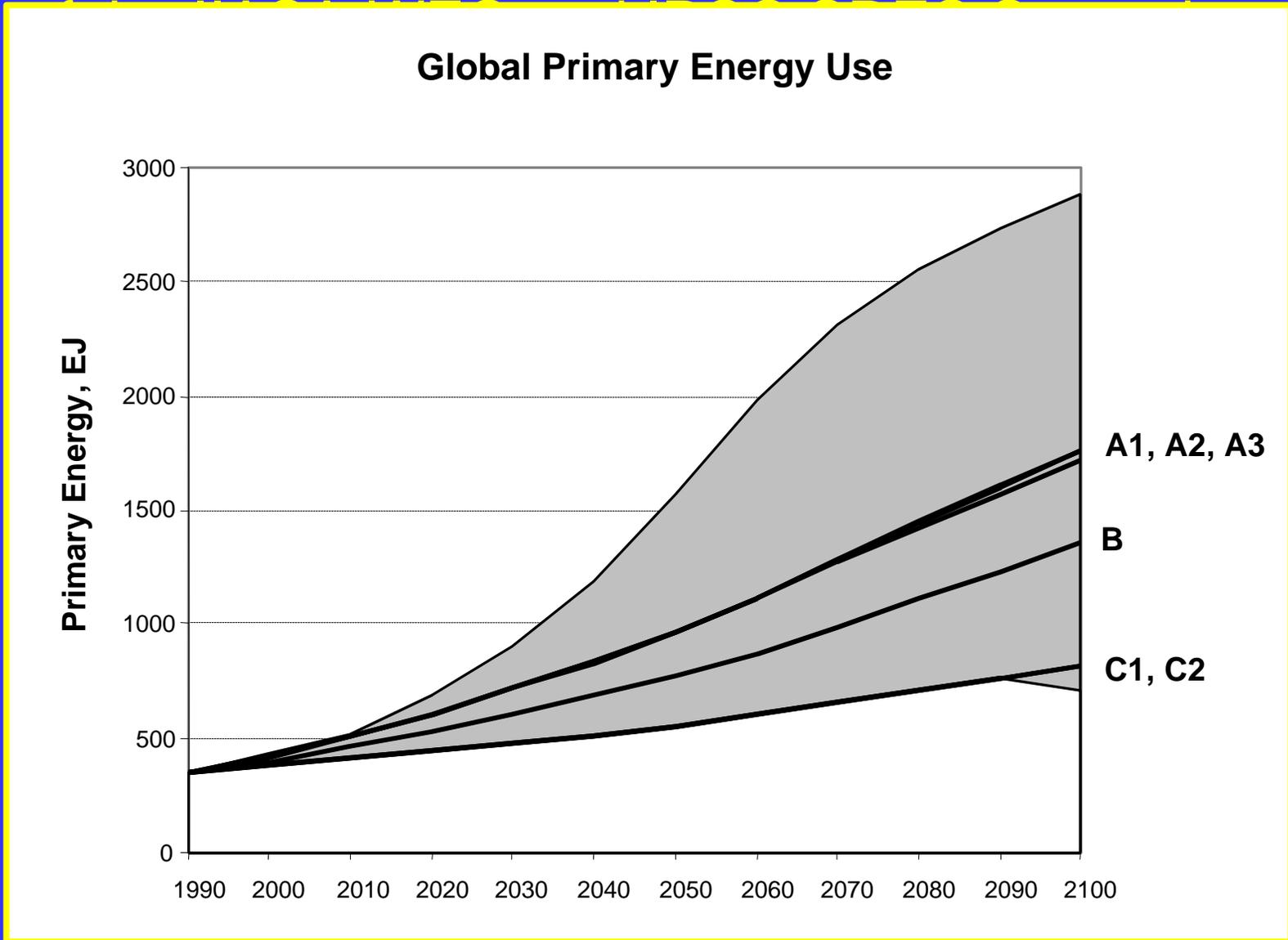
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SRES 2000

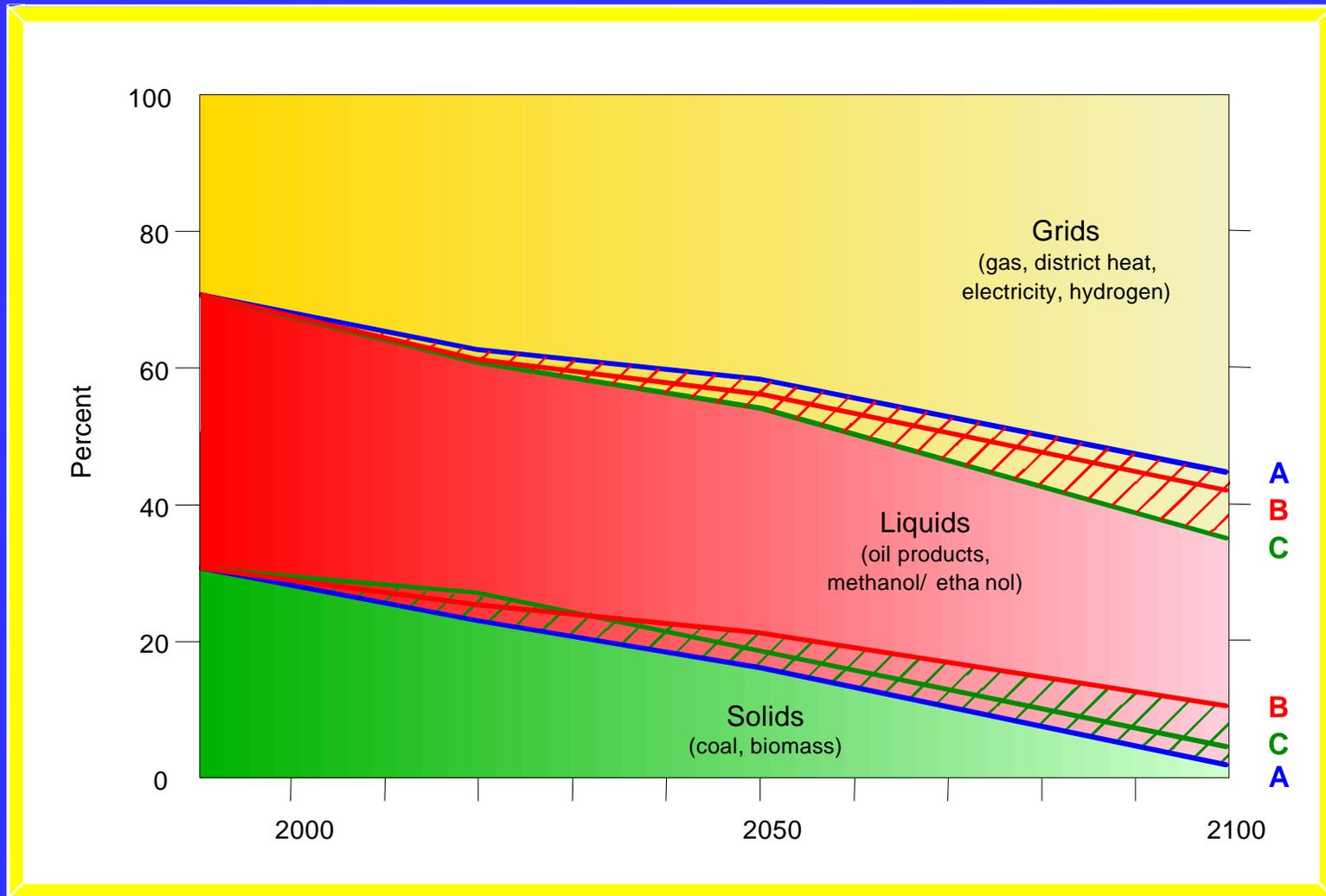


- Conventional oil and gas could last at least 50-100 years.
- Total fossil fuel resources will last at least several hundreds of years
- Renewable energy flows are some 1000 times current global energy use

# Global Primary Energy Requirements



# Global Final Energy by Form





# Technical Options for a more Sustainable Future

World Energy Assessment

<http://www.undp.org/seed/eap/activities/wea>

- **Improved Energy Efficiency** - especially at the point of end-use in buildings, electric appliances, vehicles, and production processes.
- **More Renewable Energy:** such as biomass, wind, solar, hydro, and geothermal
- **Advanced Energy Technologies:**
  - next generation fossil fuel technologies
  - nuclear technologies, if the issues associated with nuclear can be resolved.



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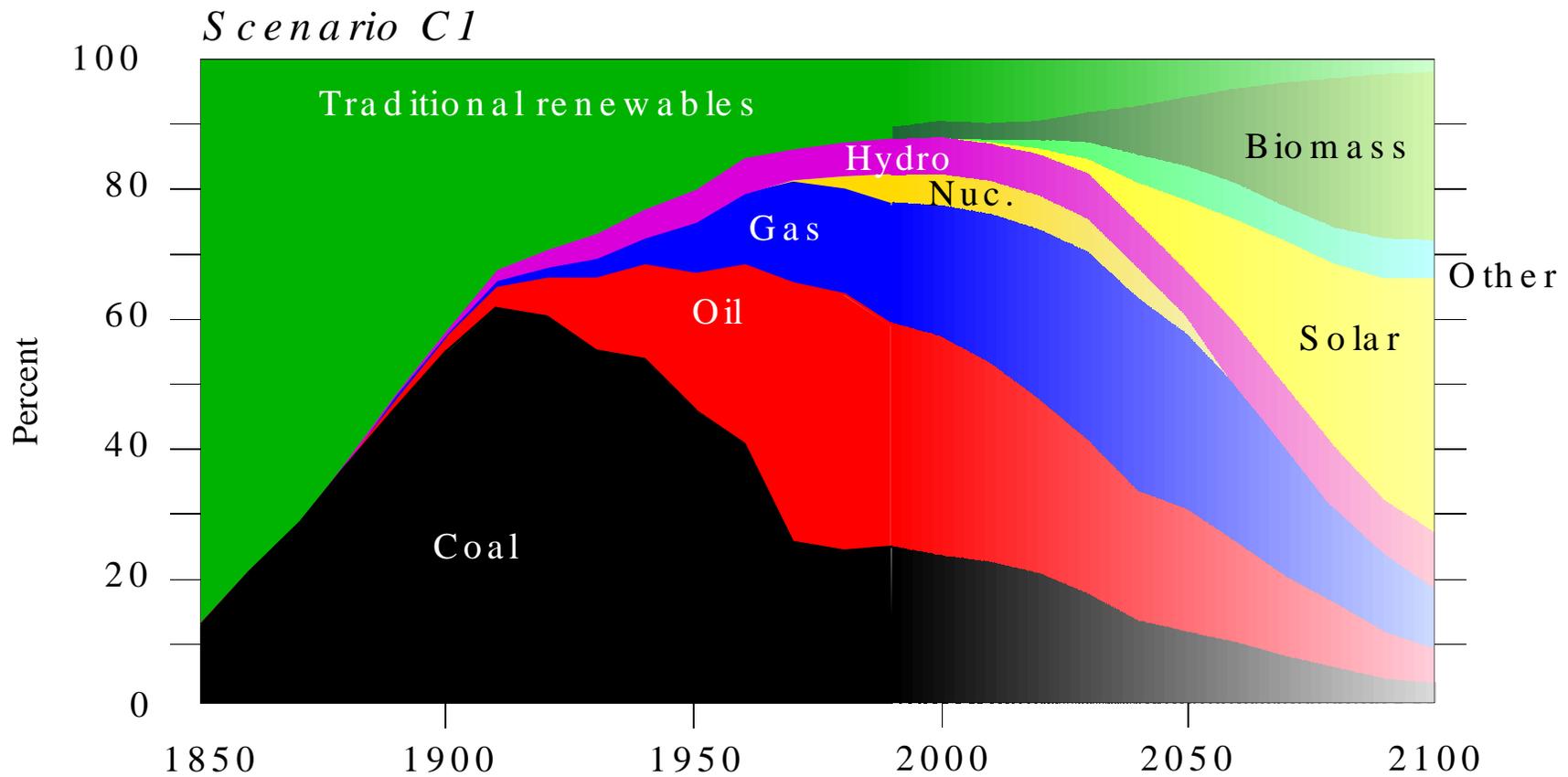
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# Illustrative Energy Supply Projection

World Energy Assessment

<http://www.undp.org/seed/eap/activities/wea>



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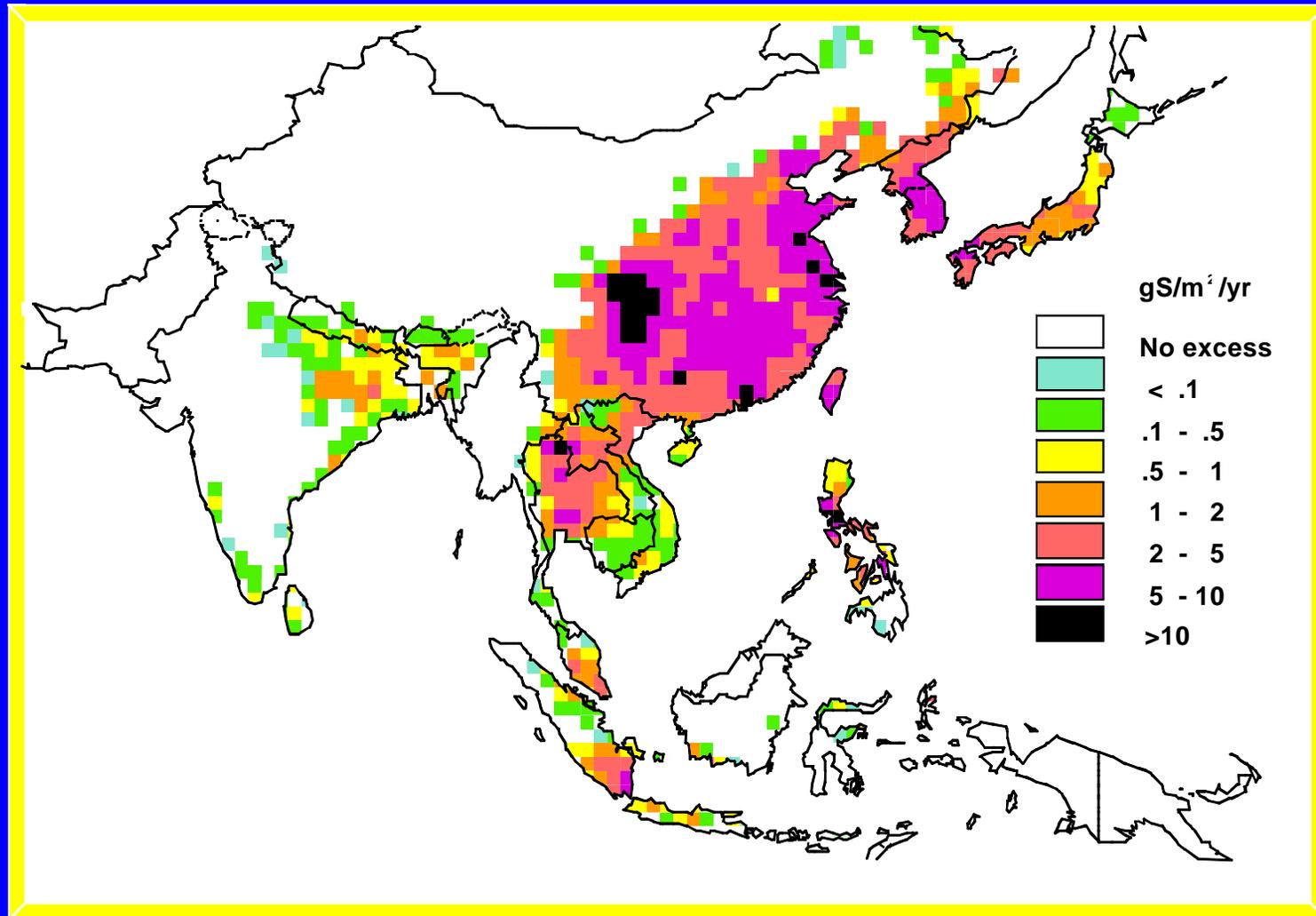


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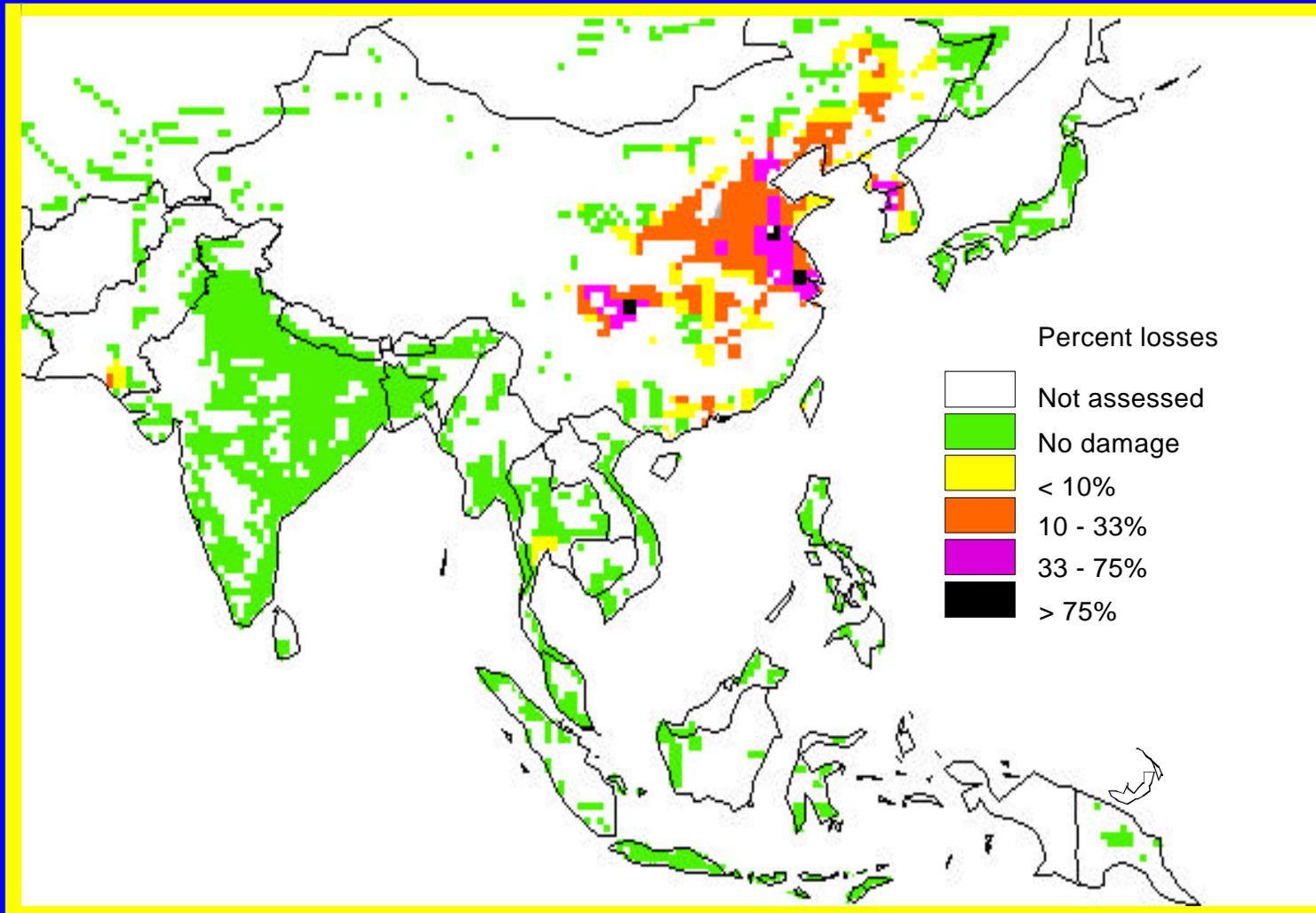


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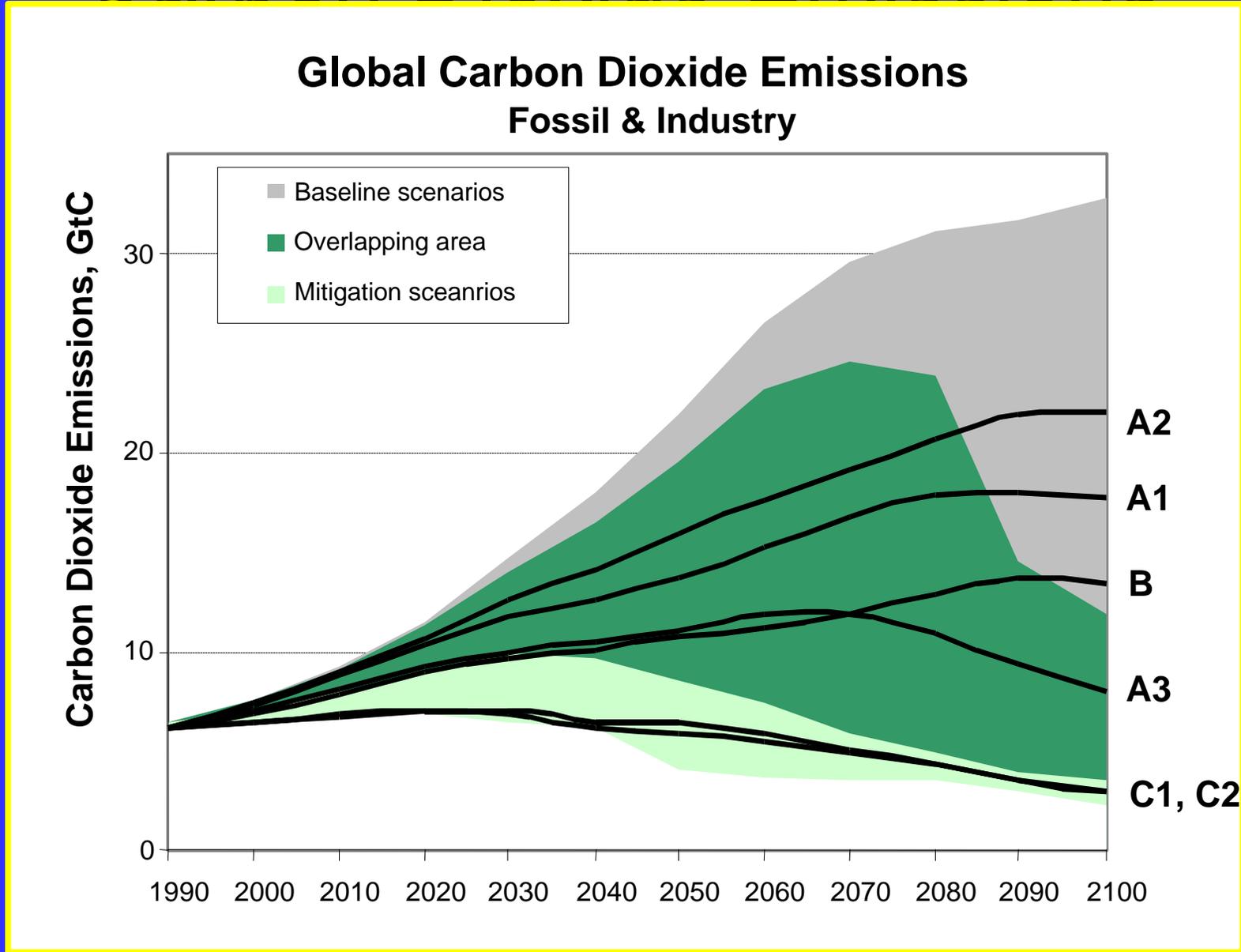
# Excess Sulfur Deposition for an Unabated Coal Scenario



# Acidification Impacts on Food Crops for an Unabated Coal Scenario



# Carbon Dioxide Emissions





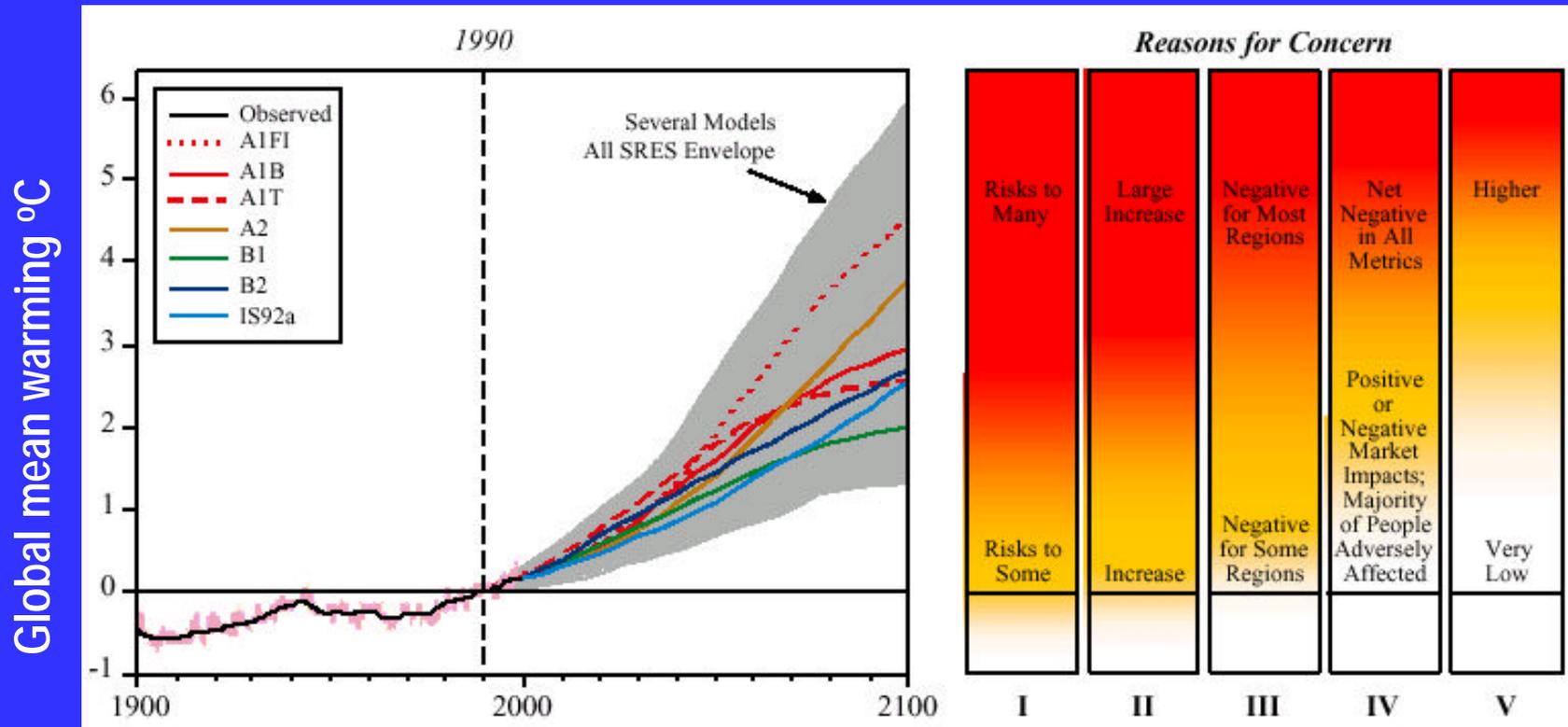
WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)



UNEP

# Comparing Reasons for Concern

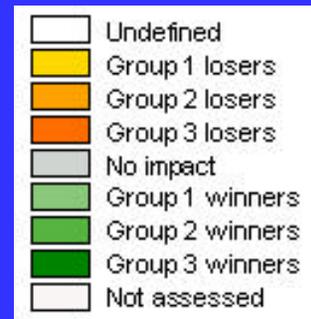
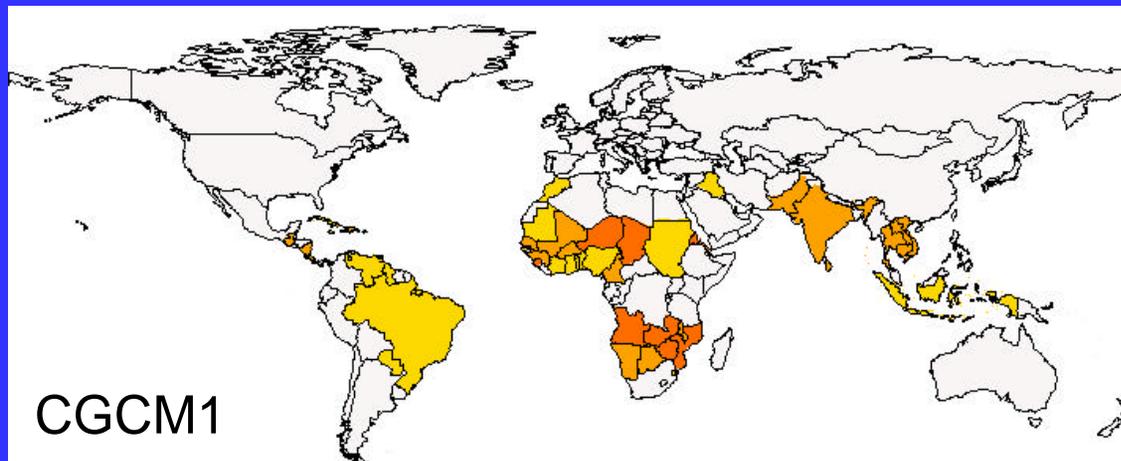
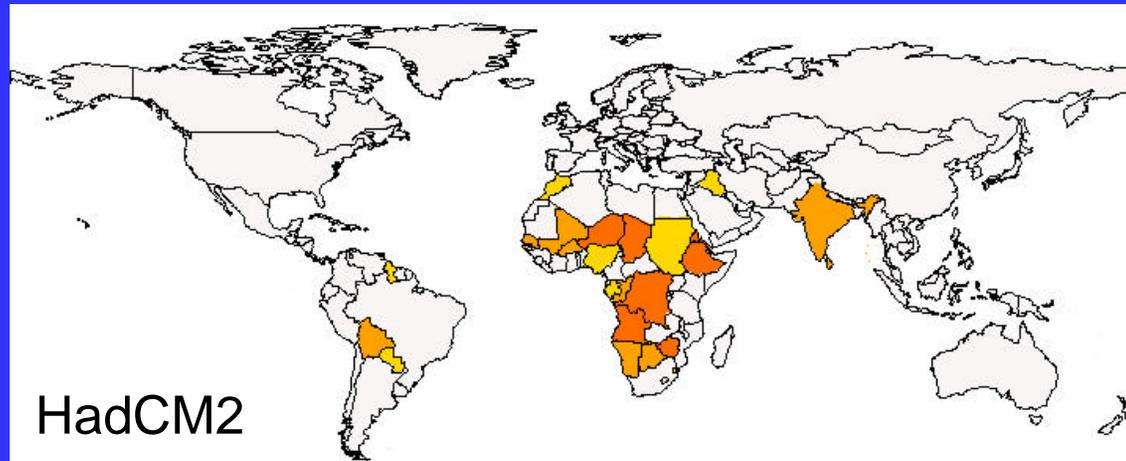
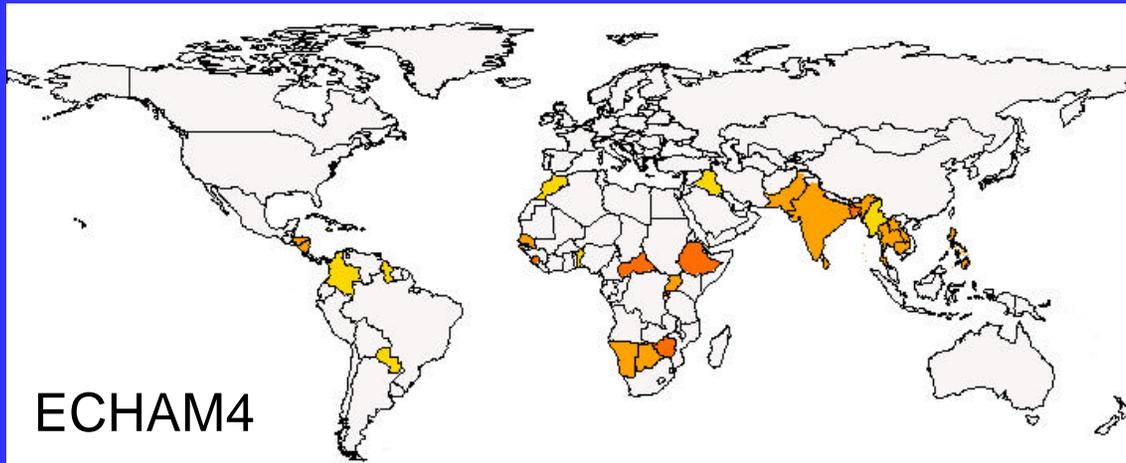


Year

- I Risks to Unique and Threatened Systems
- II Risks from Extreme Climate Events
- III Distribution of Impacts
- IV Aggregate Impacts
- V Risks from Future Large-Scale Discontinuities

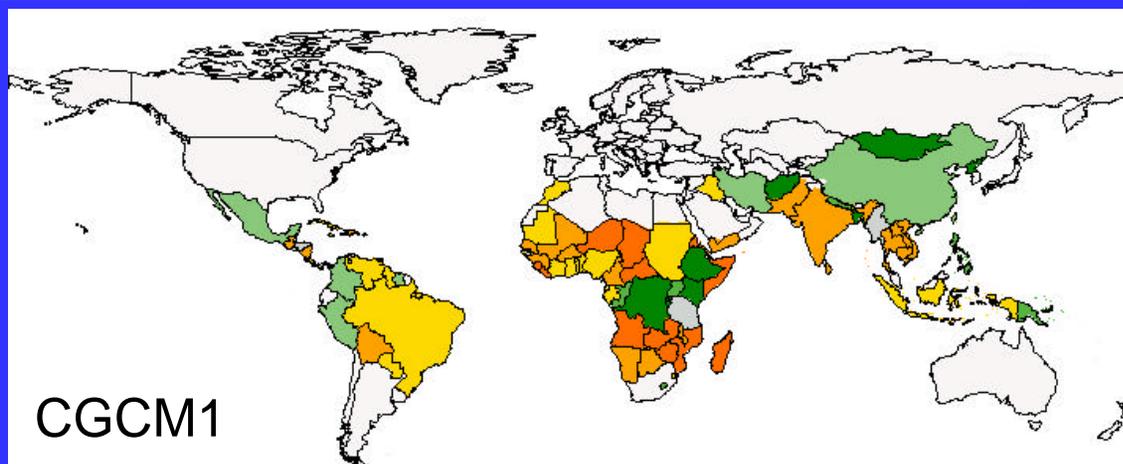
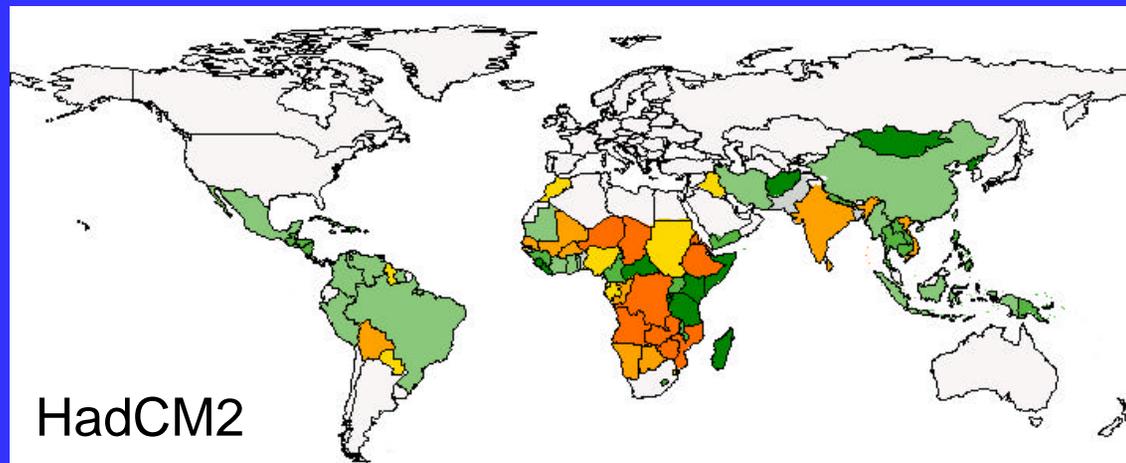
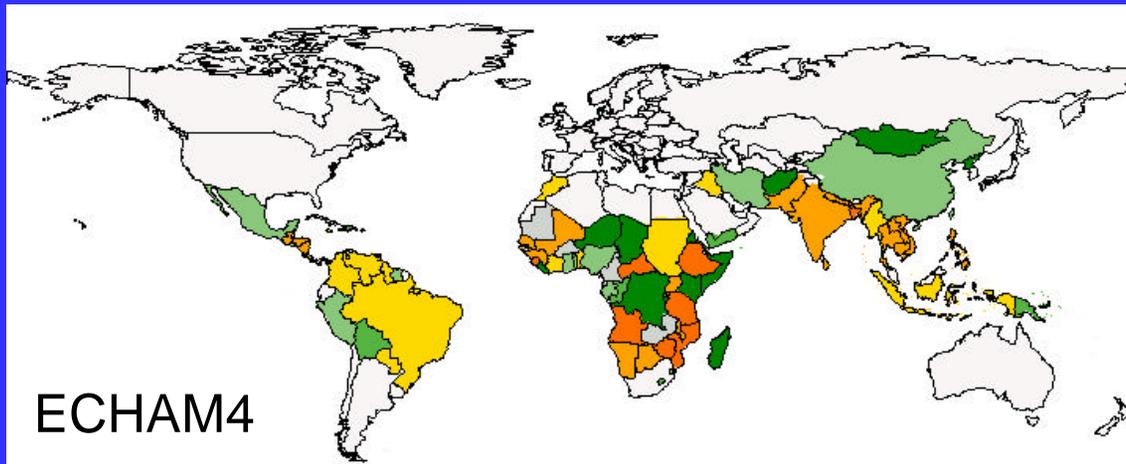
IPCC 2001

# Climate Change Impacts on Cereal Production Potential of Food Insecure Countries 2080s



Fischer *et al.*,  
IIASA, 2001

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Fischer *et al.*,  
IIASA, 2001



Issue: Mobilization of capital for energy supply investments

- Investment in energy supply projected at \$300-500 billion per year for the next 20 years, depending on path chosen
- Less than 10% of total overall investments



World Energy Assessment

## The Innovation Chain

<http://www.undp.org/seed/eap/activities/wea>

- Research and Development
- Demonstration projects
- Early deployment (cost buy-down)
- Widespread dissemination



United Nations Development Programme



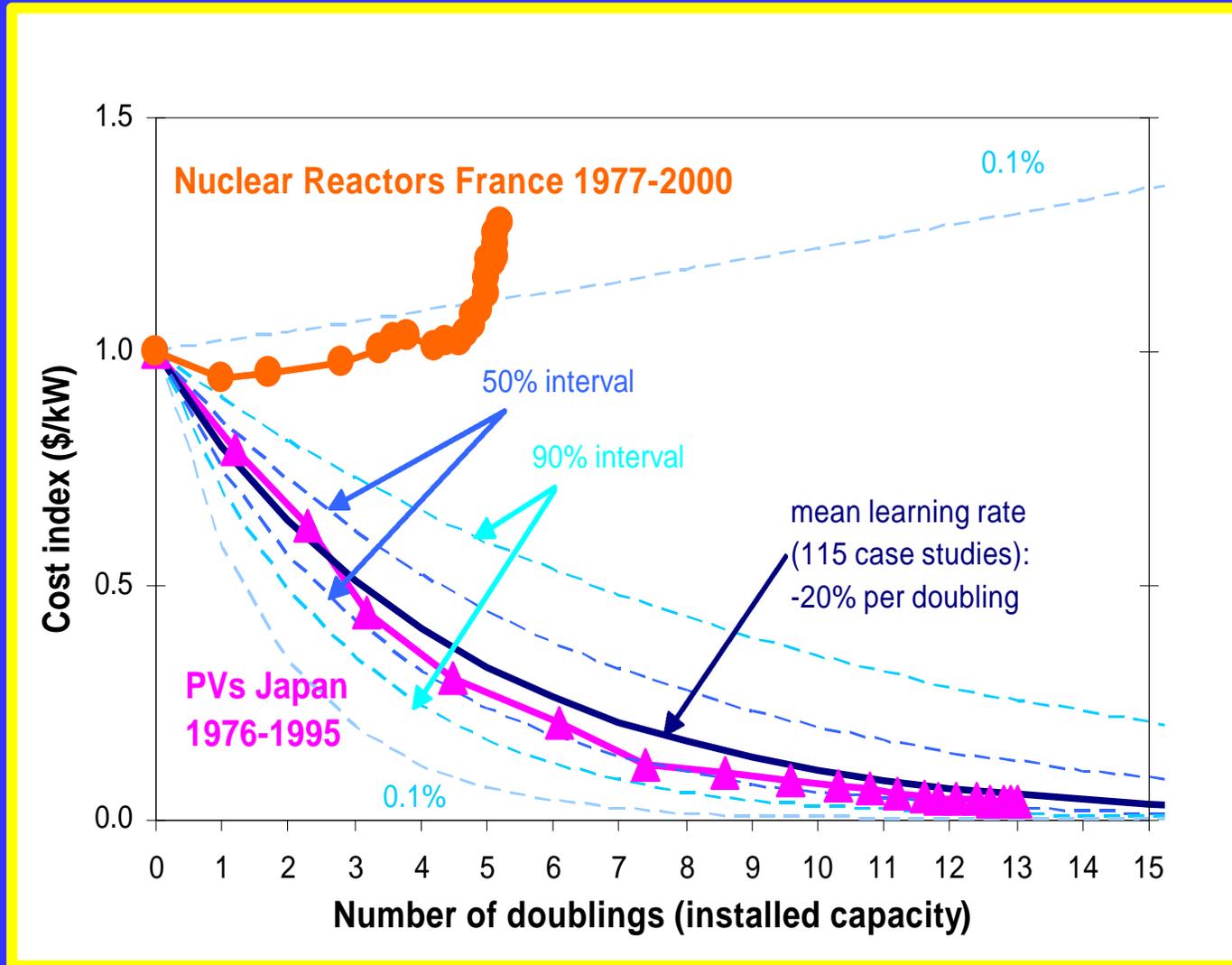
United Nations Department of Economic and Social Affairs



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# Technological Uncertainties

Learning rates (push) and market growth (pull)





- Policy support and institution building
- Education and training
- Investment-friendly environments that are socially and environmentally responsible
- Technological leap-frogging
- Consumer credits, micro-finance

<http://www.iiasa.ac.at/Research/TNT/index.html>

<http://www.undp.org/seed/eap/Projects/WEA.html>

<http://www.ipcc.ch/>

<http://www.sres.ciesin/>

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