The Dependence of Energy Sector Vulnerability Studies on Climate Scenarios

Prof. Roberto Schaeffer
Energy Planning Program, Graduate School of Engineering, Federal University of Rio de Janeiro
PPE/COPPE/UFRJ
roberto@ppe.ufrj.br

10 November 2011 - ICEM 2011

Introdução

- Human and natural systems can be affected by climate change
- Changes in climate conditions can affect the production and consumption of energy
  - Renewable
  - Non-renewable
- Renewable energy are essential to achieve a low emission economy and reduce the effects of climate change
- However, the flux of renewable energy is closely related to climate conditions, so renewable energy is most vulnerable to climate change

Climate Impacts and Energy Planning

- System operation and expansion are planned under uncertainties regarding
  - Fuel availability and prices, future demand, technological improvements, future costs, etc
  - Climate uncertainty: temperature, precipitation, river flows, wind speeds, etc
- Conventional energy planning assumes that climate variables are stationary

→ **Need to evaluate the impacts of climate change and adaptation measures**

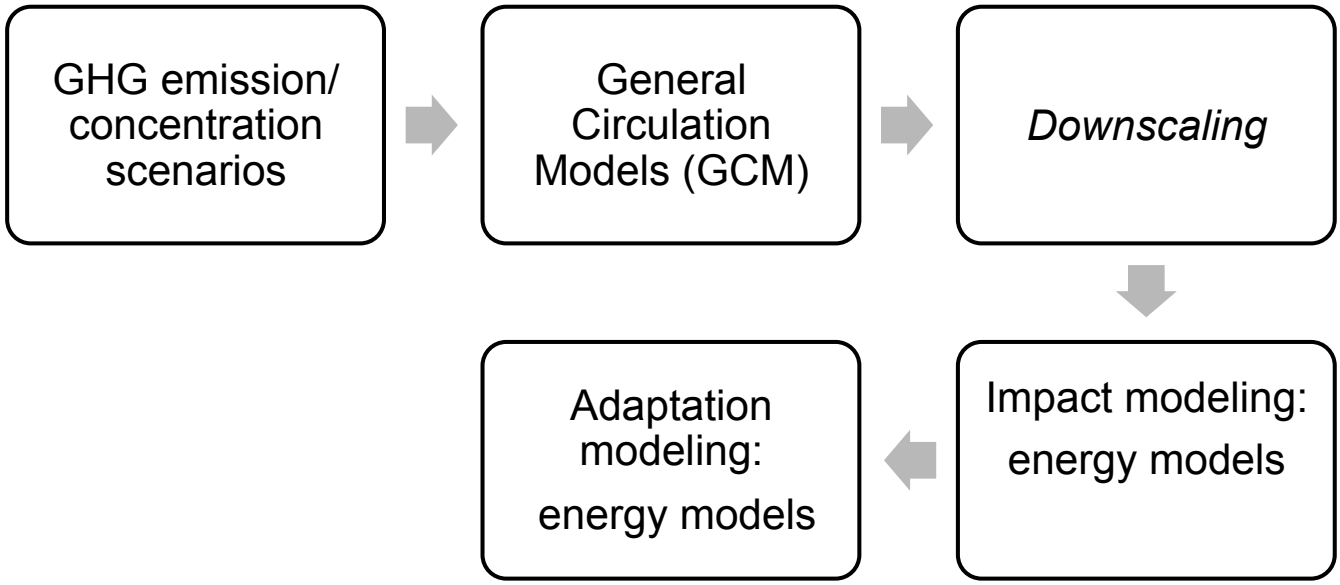
COPPE UFRJ Programa de Planejamento Energético

The Brazilian Energy System

- Highly dependent on renewable energy, especially hydropower
- Renewable energy accounted for 45% of total primary energy in 2010 (EPE, 2011)
  - Hydropower provided 85% of electricity supply
  - Sugarcane ethanol accounted for 15% of fuel consumption in the transport sector
  - Gross wind power generation potential estimated at 1.26TW, enough to provide 3000TWh/year (Dutra, 2007)

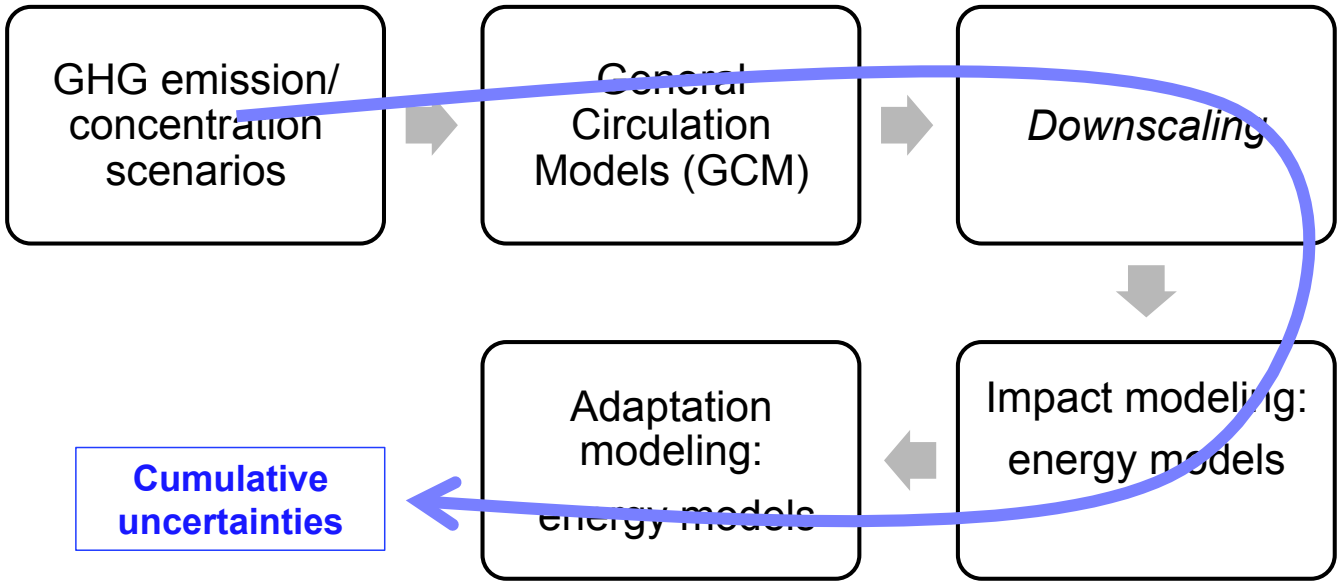
COPPE UFRJ Programa de Planejamento Energético

Methodological Procedure for Climate Change Impact Projections – Energy



COPPE UFRJ Programa de Planejamento Energético

Methodological Procedure for Climate Change Impact Projections – Energy



COPPE UFRJ Programa de Planejamento Energético

Climate Impact Assessments on Energy: Brazil

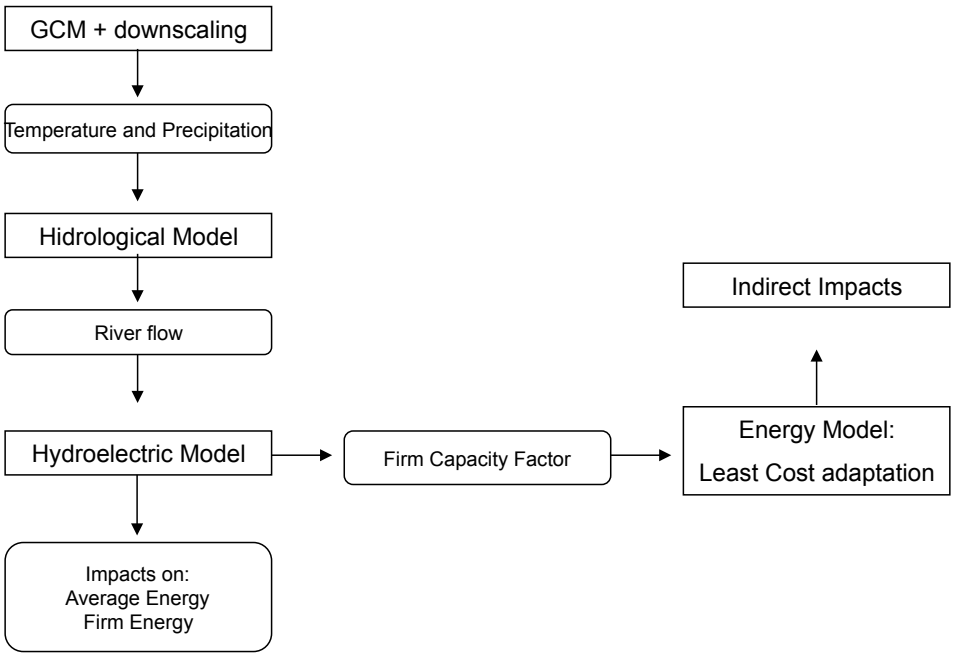
- Schaeffer et al (2008)
- Lucena et al (2009)
- Lucena et al (2010)

- Differences:
  - Emission Scenarios
  - GCM
  - Downscaling
  - Time-slices
  - Hydrological models
  - Energy models

→ To what extent these differences can lead to different directions and magnitudes of climate impacts on energy systems?

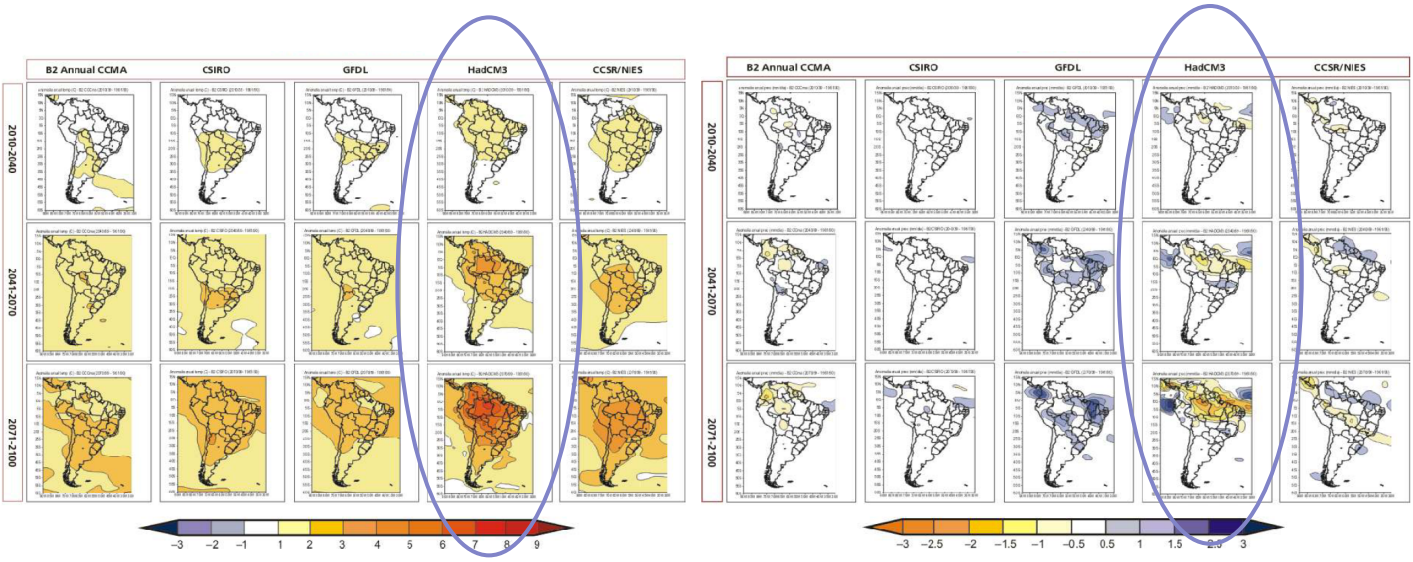
COPPE UFRJ Programa de Planejamento Energético

Methodology



COPPE UFRJ Programa de Planejamento Energético

Climate model uncertainty: Temperature (°C) and Precipitation (mm/day)



INPE (2007)

Results for Different Impact Assessments on Hydropower Production in Brazil

	Lucena et al. (2010)	Lucena et al. (2009)	SCHAEFFER et la. (2010)
Emission Scenarios	**A1b**	**A2 and B2**	**A2 and B2**
GCM	HadCM3	HadAM3P	HadAM3P
Downscaling	ETA	PRECIS	PRECIS
Time slices	2011-2040	2071-2100	2025-2100
Hydrological model	Water Balance	Statistical	Water Balance/statistical
Energy model	MSUI	SUISHI-O	SUISHI-O
Results	Average energy (+12 to +16%); Firm energy (+14 to +20%); Severe regional impacts (At. Leste and Parnaíba Basins)	Average energy (-0.7 to -2.0%); Severe regional impacts Northeast Region	Average Energy (- 1 to -3%); Firm Energy (-29 to -32%); Severe regional impacts Northeast Region
Adaptation	MAED-MESSAGE	-	MAED-MESSAGE
Results	Less installed capacity needed	-	More installed capacity needed

Results for Different Impact Assessments on Hydropower Production in Brazil

- Different studies using different modeling tools showed different results
- In the short-medium term (2040), Lucena et al. (2010) indicate that there will be no negative impacts on hydropower production
- In the long term, Schaeffer et al. (2008 & 2010) show negative impacts of different magnitudes
- Different impacts would lead to different adaptation strategies

COPPE UFRJ Programa de Planejamento Energético

Recomendations

- Improve the link between climate and energy models, so as to increase the number, and quality, of global climate scenarios and improve the knowledge about the many possible outcomes of climate change impacts
- This will only be possible if the two communities of meteorologists /climatologists and energy specialists begin to work close together

COPPE UFRJ Programa de Planejamento Energético