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Connecting Scenarios and Impacts Research: Needs and Capabilities

Report from Impacts Session Week 1

KATE CALVIN

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Outline

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- Connecting IAV science/information needs to scenarios

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Background on the Session

General idea

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Our goal in this Snowmass session:

Link together the various communities that do impacts research and look for synergies and opportunities to help each other improve research

- Participants have different goals:
  - Understand climate effects on a particular sector or technology
  - Build emulators of climate impacts that are scenario independent
  - Assess impacts along a particular scenario pathway

Science Questions

- How do we communicate our results, particularly in the event of significant uncertainty?
- How do we translate information across communities (e.g., from impacts models to integrated assessment models to social cost of carbon models)?
- How do we address catastrophic impacts and extreme events?
- What is the right scale for impacts assessment? And, how do we link across scales?
- How do we develop models that are useful for adaptation decisions?

Agenda

- User Needs:
  - IPCC, NCA, SCC, Risky Business, DOE, City of Boston
- Process & Empirical Modeling of Impacts:
  - Energy, Water, Agriculture, Sea Level Rise, Extreme Events, City Infrastructure
- Model-Based Impacts Assessments:
  - Single Sector: Energy, Water, Agriculture
  - Multi-Sector: PRIMA (USA sub-national), CIRA (USA), PESETA (EU), ISI-MIP (Global), SCC (Global)
- Future Directions in IAMs:
  - GCAM, IGSM, MERGE, IMAGE
- Re-Visiting our Science Questions

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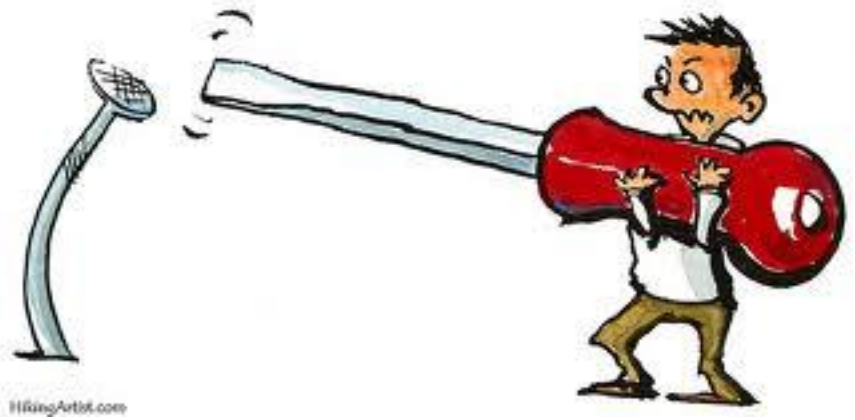
Lessons Learned and Future Directions

Overarching issues…

- What are the questions being asked?

- What is the appropriate tool?



What do users want to know?

- The IPCC and the NCA both try to assess impacts in various sectors and regions.
- The Social Cost of Carbon (SCC) quantifies the marginal damage associated with increasing emissions by a small amount.
- Risky Business quantified climate risk for the business community.
- The Department of Energy wants to quantify energy-water-land interactions under a changing climate.
- The City of Boston is focusing on “climate preparedness.”

Where are the IAMs going?

- The future directions of the integrated assessment models reflect the questions the users are asking.
  - Some IAMs are focused on energy-water-land interactions.
  - Some IAMs are focused on quantifying impacts and adaptation in various sectors.
  - Some IAMs are focused on quantifying aggregate damages for use in either benefit-cost analysis or in the computation of the social cost of carbon.

What are the challenges in quantifying impacts?

- Data availability:
  - Limited sectoral scope (e.g., energy supply literature is weak)
  - Limited geographical scope (mostly country/regional studies of developed countries)
  - Limited range of observations forces extrapolations out-of-sample
  - Some impacts not well-captured in either process or empirical studies (e.g., effects of pests and disease on crops)
  - Data isn't always provided for variables that IAMs need

- Resolution: averaging across space and time could average out the impacts (e.g., hydropower potential)
  - Almost all impacts assessments require a translation from highly resolved climate data to coarser-resolution IAM inputs, but these steps aren't well documented.
  - IAMs (and climate models) may not have sufficient resolution to really capture extreme events and catastrophic impacts

How do we communicate our results?

- Involve communications/stakeholders from the beginning.
- For Risky Business, it wasn't about "climate change" it was about mainstream risk assessment.
  - Separating the public face from the academic side was really important so they could say the academic work was really separate.
  - They spent 1/3 of their budget on communications.
- The City of Boston doesn't talk about "adaptation", but instead about "preparedness"
- From Senator Bingaman: The most important thing is that the scientific community speaks with credibility when it speaks, even if that includes uncertainty. Giving a slanted view of the science to influence policy is a mistake.

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Connecting IAV science/information needs to scenarios

Linkages between impacts and scenarios

- Improving understanding of scenario developers of how scenarios are used for impacts research, including
  - Sensitivity of different types of models to variation
  - Questions scenarios are used to address
  - This has implications for how many scenarios, of what type, and with what separation are required
- Encouraging more information exchange on the types of uncertainties of greatest concern/interest to users of IAV results and to IAV modelers/researchers
- Broader communication on more technical aspects of scenario use in IAV research (e.g., required data resolution, probabilistic information requested, variables needed, etc.)

Types of scenarios used

- Some assessments used a high and a low emissions scenario:
  - NCA used A2 and B1 from SRES/CMIP3
  - PRIMA uses A2 and B1 in their first paper, but are moving to RCP8.5 and RCP4.5
  - PESETA uses A1B from SRES and “E1”, a 2°C scenario
- The ISI-MIP project used the RCPs for climate information, and in some sectors “used” the SSPs as socioeconomic drivers for their models.
- The Social Cost of Carbon used multiple emissions baselines plus perturbed emissions.
  - Emissions baselines are from four IAMs [IMAGE, MERGE, MESSAGE, MiniCAM] EMF22 reference scenarios. They also included a fifth baseline that was the average of those four IAMs EMF22 550 CO2e scenario.
- Most assessments re-named the scenarios they used:
  - NCA labeled them “lower emissions” and “higher emissions”

Climate data used

- Some studies used climate data directly from CMIP archives. Other studies used downscaled climate data (either statistically or dynamically).

- Selection of which climate models to use from CMIP archives was somewhat arbitrary. For example, ISI-MIP used the first 5 GCMs to submit data to the CMIP5 archive.

- Some studies wanted scenarios that weren't available in the CMIP archives and thus used other means of generating.
  - The Social Cost of Carbon used the climate component of the three IAMs used to generate the necessary information. They only really used global mean temperature rise.
  - The CIRA project used IGSM, plus pattern scaling, to generate the necessary climate data.

Uncertainty

- CIRA captured uncertainty by using pattern-scaled climate data and varying climate sensitivity in IGSM.
- PESETA and ISI-MIP capture uncertainty by using multiple GCMs.
- Risky Business wanted to assess both median climate and the 95% climate (1 in 20 chance of occurrence).
  - They used MAGICC6 in probabilistic mode to assign probabilities of various climate outcomes. All of the probabilities are due to uncertainty in climate sensitivity (and associated climate parameters).

What are the challenges with using climate data?

- Resolution of data:
  - Many studies wanted higher resolution data
  - Some found that they had to make trade-offs between temporal and spatial resolution.
  - Many relied on downscaling of some kind.
- Scenario availability:
  - Some studies wanted to quantify benefits of climate change mitigation or quantify damages associated with small increases in emissions.
  - These studies were forced to use non-CMIP climate data.
- Model selection:
  - Sometimes seemed arbitrary
  - Concern about using multi-model mean because it may average away extremes
- Confidence in projections
- Downloading data from ESG is difficult and time-consuming

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DISCUSSION