IAM as a coordinating mechanism to integrate impacts across sectors and regions

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Integrated Assessment Models (IAMs)

IAMs integrate human and natural Earth system climate science.

- IAMs capture interactions between complex and highly nonlinear systems. IAMs provide insights that would be otherwise unavailable from disciplinary research.
- IAMs provide physical science researchers with information about human systems such as GHG emissions, land use and land cover.

IAMs provide important, science-based decision support tools.
- IAMs support national, international, regional, and private-sector decisions.
Integrated Assessment Models (IAMs)
Climate change impacts in IAMs

► Methodology:
  ▪ Adjust climate-sensitive parameters/variables to reflect impacts

► In order to estimate the effect of climate change impacts on various systems, IAMs need some means of translating changes in climate into physical impacts. Several options exist, including:
  ▪ Using output from a climate model directly
  ▪ Using output from an intermediate, process model
  ▪ Developing response functions, either from process model output or from the empirical literature

► In many cases, including climate presents challenges such as:
  ▪ Translating across spatial, temporal, and process resolutions
  ▪ Bias correction
  ▪ Incomplete information
## Climate change impacts in IAMs

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<th>Implications</th>
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<td>Bioenergy</td>
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<td>Water</td>
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Impacts on Energy Demand: Climate change increases demand for cooling and decreases demand for heating. The net effect is small.

- Increased temperatures lead to a 70% increase in demand for cooling energy and a 30% decrease in demand for heating energy.
- Changes are unevenly distributed across space and time.
- Net effect on energy is small, as is effect on CO$_2$ emissions.
- Results are sensitive to a number of factors, including population, income, climate, etc.
- Source: IMAGE model, Isaac and van Vuuren (2009)

See also: Mima and Criqui (2009), Labriet et al. (2013), Zhou et al. (2013)
Impacts on Hydropower: Climate change increases hydropower production globally.

- Changes in precipitation in the future result in small increases in hydroelectricity production globally.
- Changes are unevenly distributed across space and time.
- The impact on total electricity production and on CO$_2$ emissions is small.
- Source: TIAM model, Labriet et al. (2013)

See also: Mimi and Criqui (2009)
Impacts on Thermal Power Production:
Climate change decreases thermal power production globally.

- Increases in temperature result in a decrease in thermal power efficiency and thus production.
- The impact on total electricity production is small, reducing global electricity generation by ~8% in 2100.
- Source: POLES model, Mimi and Criqui (2009)
Impacts on Agriculture: Climate change could increase or decrease the amount of cropland area needed.

- Changes in climate, CO$_2$, and ozone affect the productivity of crops and other land types.
- The effect on cropland area varies in both sign and magnitude, depending on climate model, crop model, IAM, CO$_2$ fertilization, and ozone effects.
- Source: AgMIP Global Economics Team, Nelson et al. (2014)

See also: Reilly et al. (2007), Kyle et al. (2013)

Note: Data is from Nelson et al. (2014), but figure has been redrawn.
Impacts on Water Supply: Water scarcity/stress will increase in the future in many parts of the world, but much of this increase is due to increases in demand.

- Changes in climate affect water supply, and changes in socioeconomics (e.g., GDP, population, technology, etc.) affect water demand.
- The effect on water scarcity varies regionally and is very sensitive to climate model selection.
- Source: AIM model, Hanasaki et al. (2013)

See also: Hejazi et al. (2014), Schlosser et al. (2014)
Integrating Impacts Sectors using an IAM

Energy Demand → Increases in electricity demand, decreases in natural gas demand

Hydropower → Changes in production of hydropower

Thermal Power → Decreases in thermal power production

Agriculture → Changes in productivity of land, bioenergy supply, crop production, carbon sequestration

Water Supply → Changes in water availability (globally and regionally)

?????
Integrating Impacts Sectors using an IAM

Pros:
- Models already exist
- Can look at interactions between sectors and regions
- Can look at interactions between mitigation and impacts/adaptation
- Can add *extra* effects (e.g., GE, etc.)
- Potential for consistency with climate model projections if integrated models (or iterative models) are used
- Others??

Human Systems
- Economy
- Security
- Food
- Managed Ecosystems
- Population
- Water
- Technology
- Health
- Infrastructure
- Transport
- Energy

Physical Earth Systems
- Atmospheric Chemistry
- Sea Ice
- Coastal Zones
- Carbon Cycle
- Earth System Models
- Oceans
- Hydrology
- Ecosystems
Integrating Impacts Sectors using an IAM

**Cons:**

- Relatively new area for many IAMs
- Can only integrate sectors that are present in an IAM
- Coarse spatial resolution
- Coarse temporal resolution
- Often need information from other models (e.g., physical IAV models)
- Others???

IAMs are often coarse resolution
Discussion