



USING COMPUTABLE GENERAL EQUILIBRIUM MODELS TO ASSESS THE LINKS BETWEEN ECONOMIC ACTIVITY AND CLIMATE CHANGE

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The computable general equilibrium (CGE) framework

- **Multi-sectoral CGE models describe how households and firms interact with each other on different markets**
 - Households maximize utility subject to an income constraint
 - Firms maximize profits subject to a production function constraint
 - Prices adjust to balance demand and supply on all markets
- **Main features of general equilibrium models**
 - They provide a description of the entire economy, plus bilateral trade flows in multi-regional models
 - All economic activities are linked (input-output tables)
 - Micro-economic foundation for description of entire economy
 - Representative firms by sector/region and households by region (more advanced models can go beyond this)

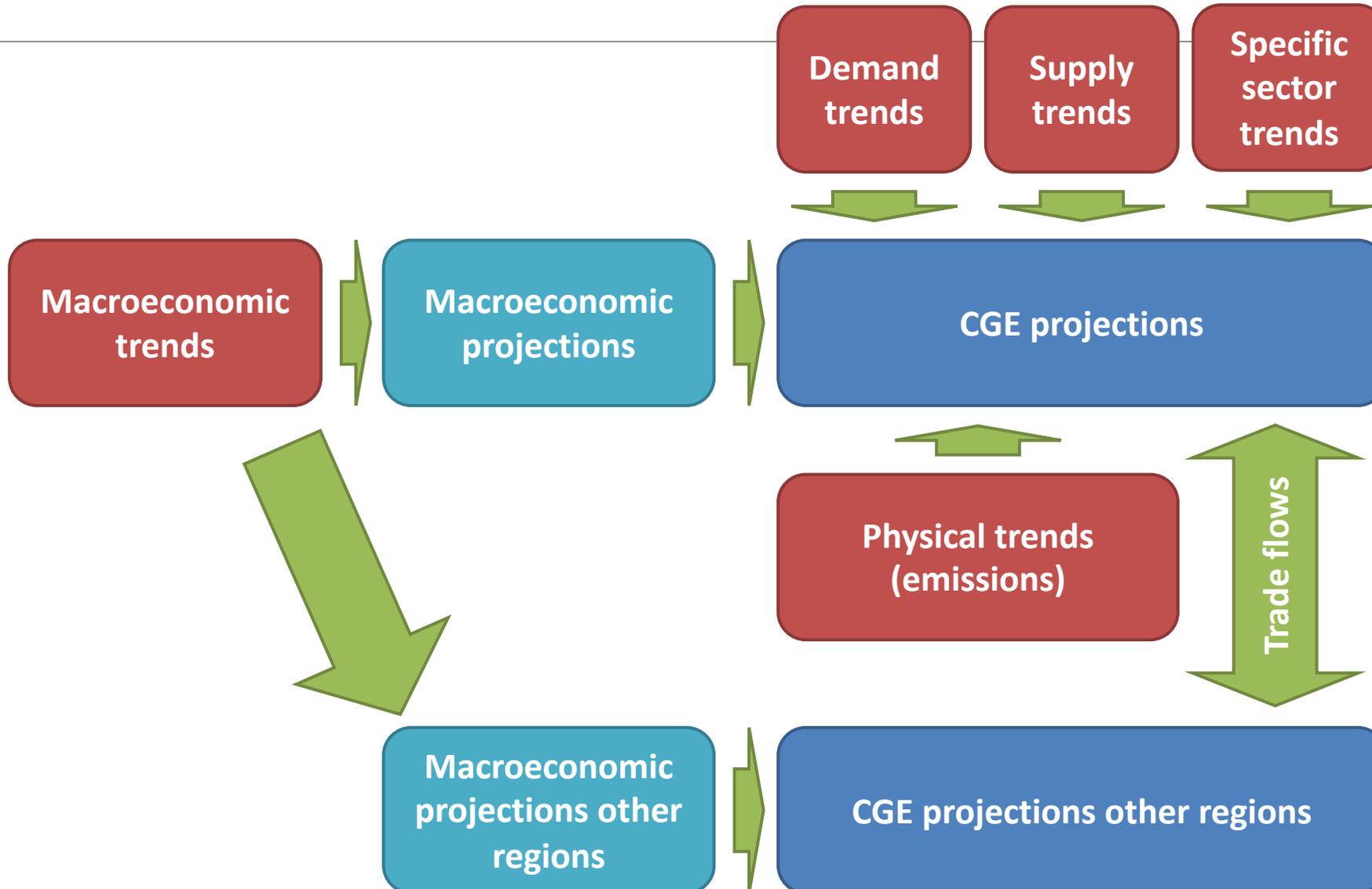


Choosing the modelling framework

- **There are many different modelling frameworks**
 - Choose the one that is most suitable for the research question (dynamic vs static, global vs regional, macroeconomic versus multisectoral...)
 - A model that tries to capture everything will explain nothing
- **Advantages of dynamic, multi-sectoral, multi-regional general equilibrium models**
 - Inclusiveness (global dimension), overall consistency, microeconomic foundation, suited to model structural trends and investigate structural effects of policies, ...
- **Limitations of typical (but not the most advanced) models**
 - Relatively high level of aggregation, limited description of short-term adjustment costs, little account of market imperfections, single representative agent...



Typical structure of a CGE modelling assessment





Key choices in CGE modelling

1. Model features

- Specification of production function, household behaviour, international trade
- Prices adjust freely to ensure equilibrium on all markets, but can consider e.g. wage rigidities, risk premia for capital flows across countries
- Details of representation of economic processes that lead to GHG emissions, including those not linked to combustion of fossil fuels

2. Model closure

- Government budget and spending
- Trade balances and exchange rates
- Savings and investment



Key elements in calibrating CGE baselines for climate change analysis

1. **Base year data**

- Social Accounting Matrices, additional indicators, ...

2. **Trends in exogenous drivers**

- Population, demographics, ...
- Factor productivity, cost structures, consumer preferences, ...

3. **Energy sector specification**

- Capture key trends and mechanisms, building on sectoral analysis

4. **Expectations**

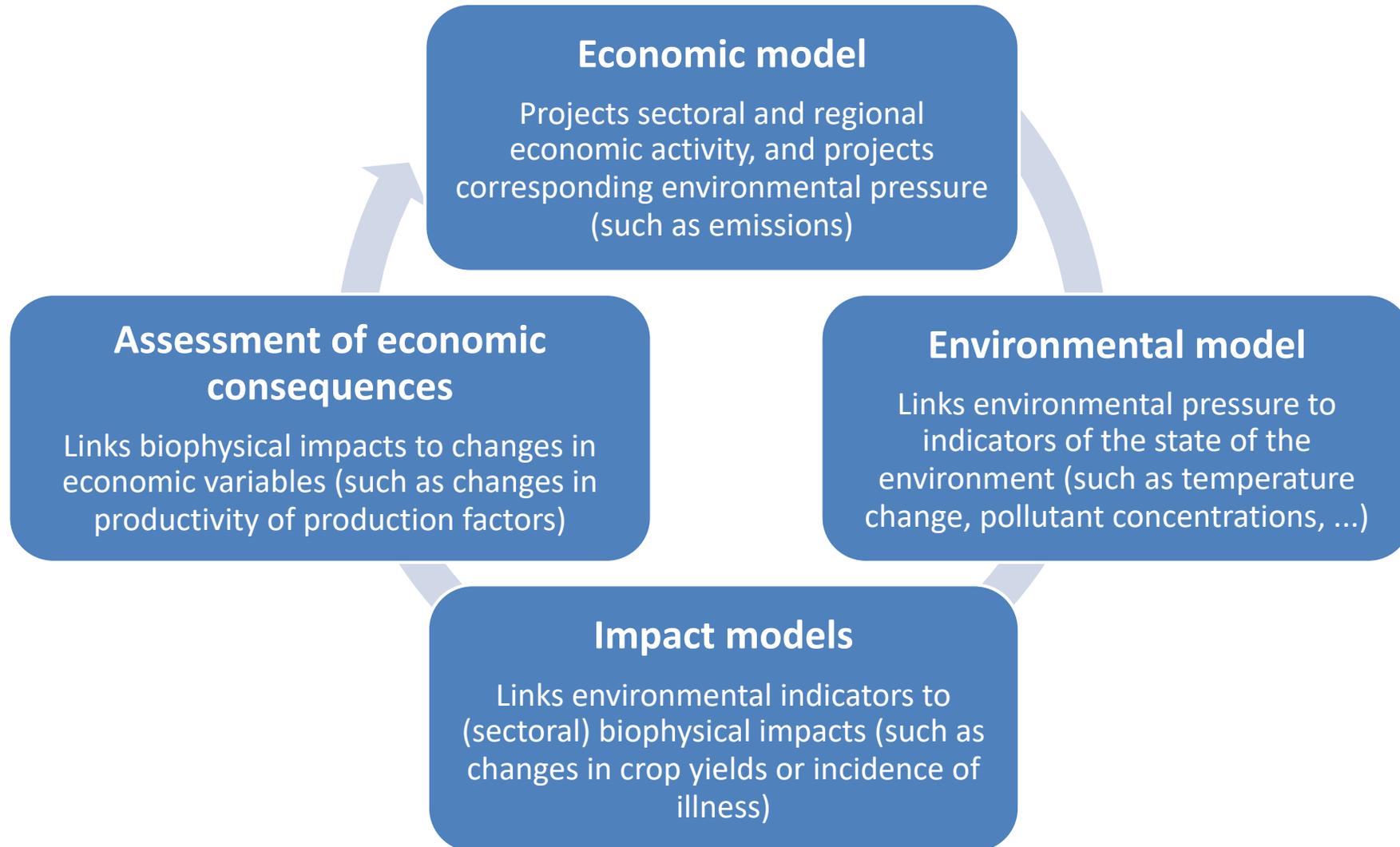
- Savings and investment decisions, foresight, ...

5. **Policies**

- Current policies, policy developments outside domain, ...



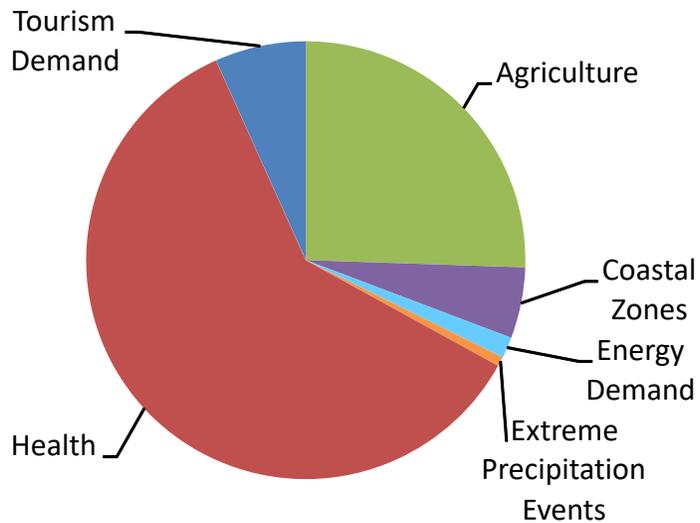
Sectoral framework is also essential for assessing feedbacks from climate on the economy



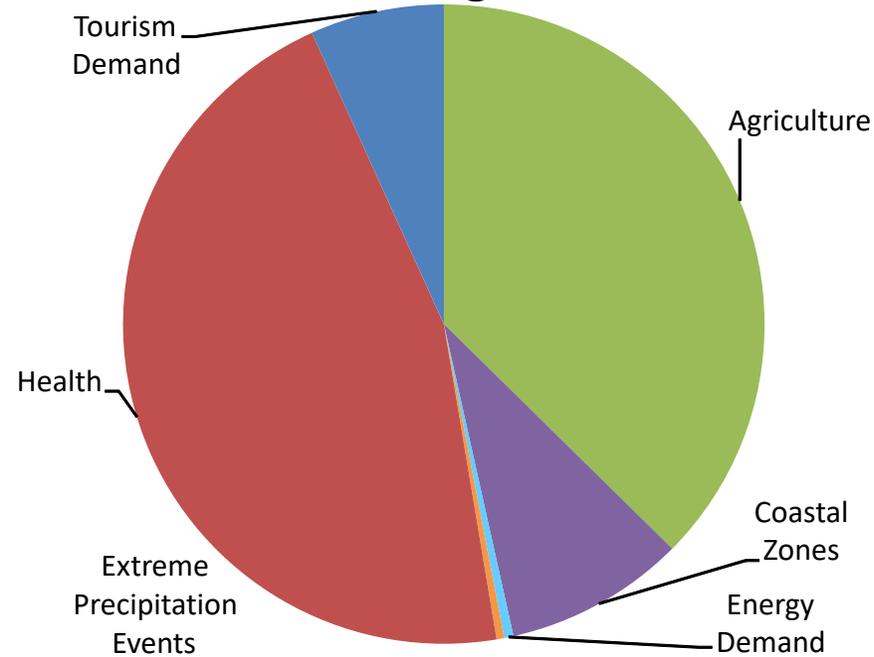


Example of global importance of different impacts

Global damages 2035



Global damages 2060



Global GDP loss:

2035: 0.3-1.0%

2060: 1.0-3.3%

Source: OECD (2016), The Economic Consequences of Climate Change

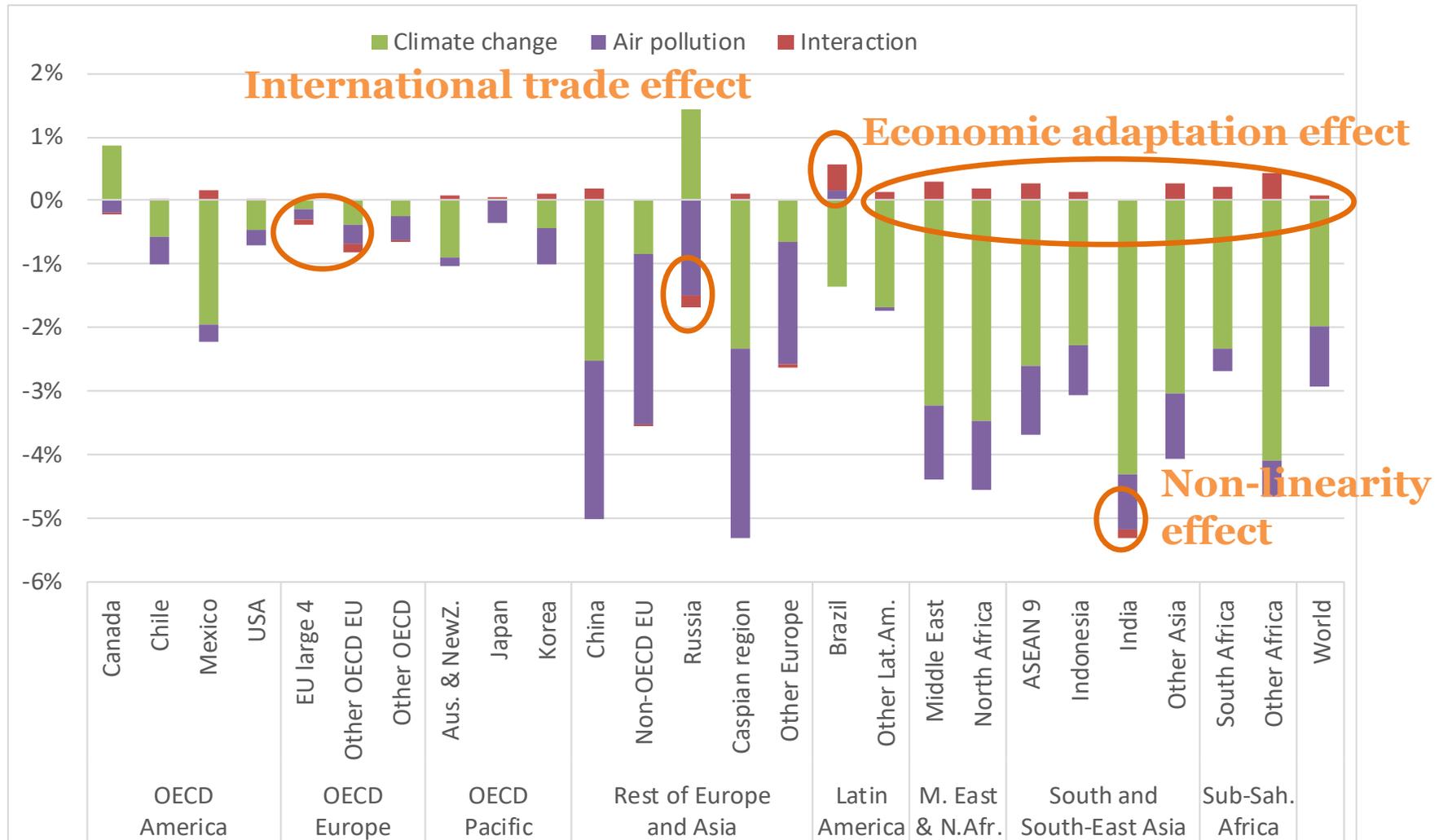


Incorporating feedbacks into a general equilibrium model

- **Make use of the details of the CGE model where possible**
 - sectoral disaggregation
 - explicit production function – e.g. health impacts can link to labour productivity
 - captures both direct and indirect effects (effects on the rest of the economy)
- **Subtract environmental feedbacks directly from economic growth where needed**
 - Relatively easy to highlight large uncertainties
 - avoids false sense of accuracy when arbitrarily assigning to specific sectors
 - Some feedbacks such as premature deaths cannot be approximated through their impact on economic markets (such as labour supply)



Economic interactions between climate change and air pollution damages



(percentage change wrt no-feedback baseline, 2060)



Be careful what you count





Backup slides



Scope of Climate Science, Impacts, and Damages Included in the Updated SC-GHG Estimates

Impacts and Associated Damages	
Human Health and Well-being	Buildings, transportation, and infrastructure
Heat and cold related mortality	Sea level rise
Mortality/morbidity from extreme weather events (e.g., storms, wildfire, flooding), and sea level rise	Intensity or frequency of coastal storms
Mortality/morbidity from climate mediated changes in the formation of criteria air pollutants (e.g., ozone, PM2.5)	Extreme weather inland (e.g., storms, wildfire, flooding)
Infectious diseases	Environmental conditions (e.g., melting permafrost, air temperature and moisture)
Other morbidity (e.g., malnutrition, allergies)	Food production
Displacement and migration	Agriculture/Crop production
Labor	Animal and livestock health and productivity
Labor supply (i.e., hours worked)	Fisheries and aquaculture production
Labor productivity (i.e., output per hour worked)	Forestry- Timber, pulp, and paper production
Energy	Tourism, recreation, aesthetics
Energy consumption (e.g., heating, cooling)	Visitation, locations, opportunities (e.g., recreational fishing, skiing, scuba diving, scenic views)
Energy production and provision (e.g., hydroelectric, thermal power generation)	Ecosystem services
Water	Availability and quality of natural capital used in production of marketable goods
Water consumption (residential, industrial, commercial)	Biodiversity and wildlife habitat (e.g., aquatic environments, breeding grounds)
Provision of safe drinking water	Other provisioning and regulating services (e.g., water filtration, wildfire and flood mitigation, medicinal resources, pest control, pollination)
Water storage and distribution	Cultural services
Land	Crime (property, violent)
Coastal land loss from sea level rise	National Security
Trade and logistics	Military base impacts
Supply chain disruption (e.g., from extreme weather)	Military mission impacts from international civil conflict
Supply chain transitions (e.g., altering trade routes)	International development, humanitarian assistance