THE OHIO STATE UNIVERSITY

Downscaling sustainability theory and measurement to subnational regional scales

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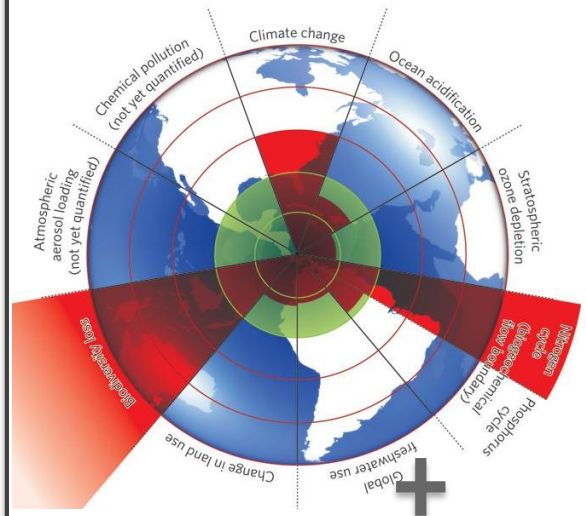
Contrasting frameworks for assessing sustainability:
How well do they downscale to regional scales?



Planetary boundaries:
Development that does not exceed biophysical limits

Strong sustainability (SS)

Value of **built capital**

Value of **Human capital**

Value of **Natural capital**

Inclusive wealth

Weak sustainability (SS)

Sustainable Development Goals:
Development that meets specific targets

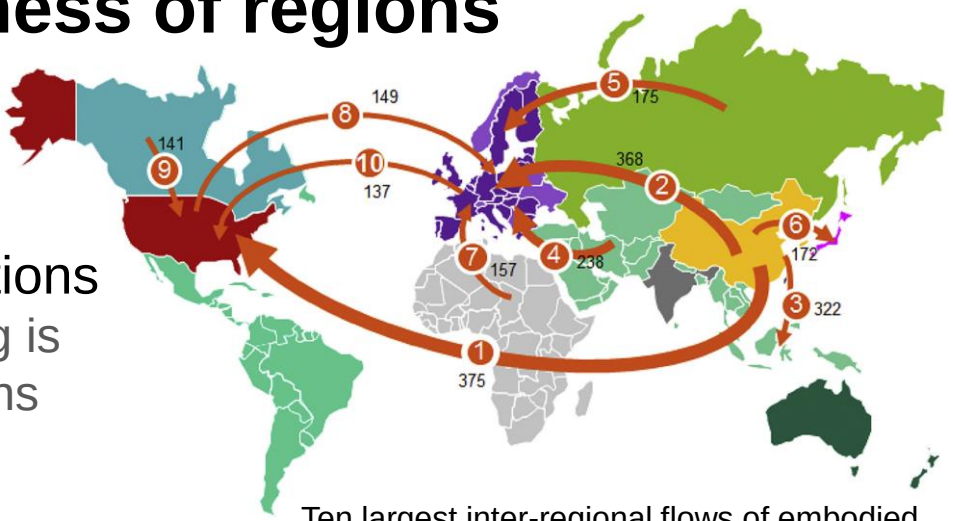
Sustainable development

Despite advantages of WS, there are significant challenges to downscaling WS theory to regions

- Regional scale requires accounting for trade or migration
  - Regions are open economies with flows of (1) financial capital, (2) goods, (3) people across space
- At a regional scale there is more likely to be limited substitution between natural and built capital
  - Underscores importance of trading and regional specialization
  - However, also important for region to maintain place-specific capital
- Distribution of wealth is very uneven across space
  - Regional sustainability requires explicit consideration of intra-generational equity

Towards WS theory and measurement for regions: **Accounting for the openness of regions**

- Trade has environmental implications
  - Consumption-based accounting is useful, but unclear what it means for regional sustainability



Ten largest inter-regional flows of embodied CO_2 emissions (Mt/y). Liu et al. 2014. *J Cleaner Production* 146: 20-28

- A region's sustainability is not independent of other regions nor of the nation/world
  - Nation = portfolio of regions, some growing others not
  - Regions with declining population may still be sustainable if they are contributing sufficient ***per capita*** increases in other capitals

Towards WS theory and measurement for regions: **Accounting for the openness of regions**

- Maintaining place-specific capitals is key to sustainability
  - Spatial equilibrium: people and firms migrate in response to differences in location-specific attributes
  - Focus on valuing capitals that generate place-specific attributes
  - Avoids problems that arise with intangible capital

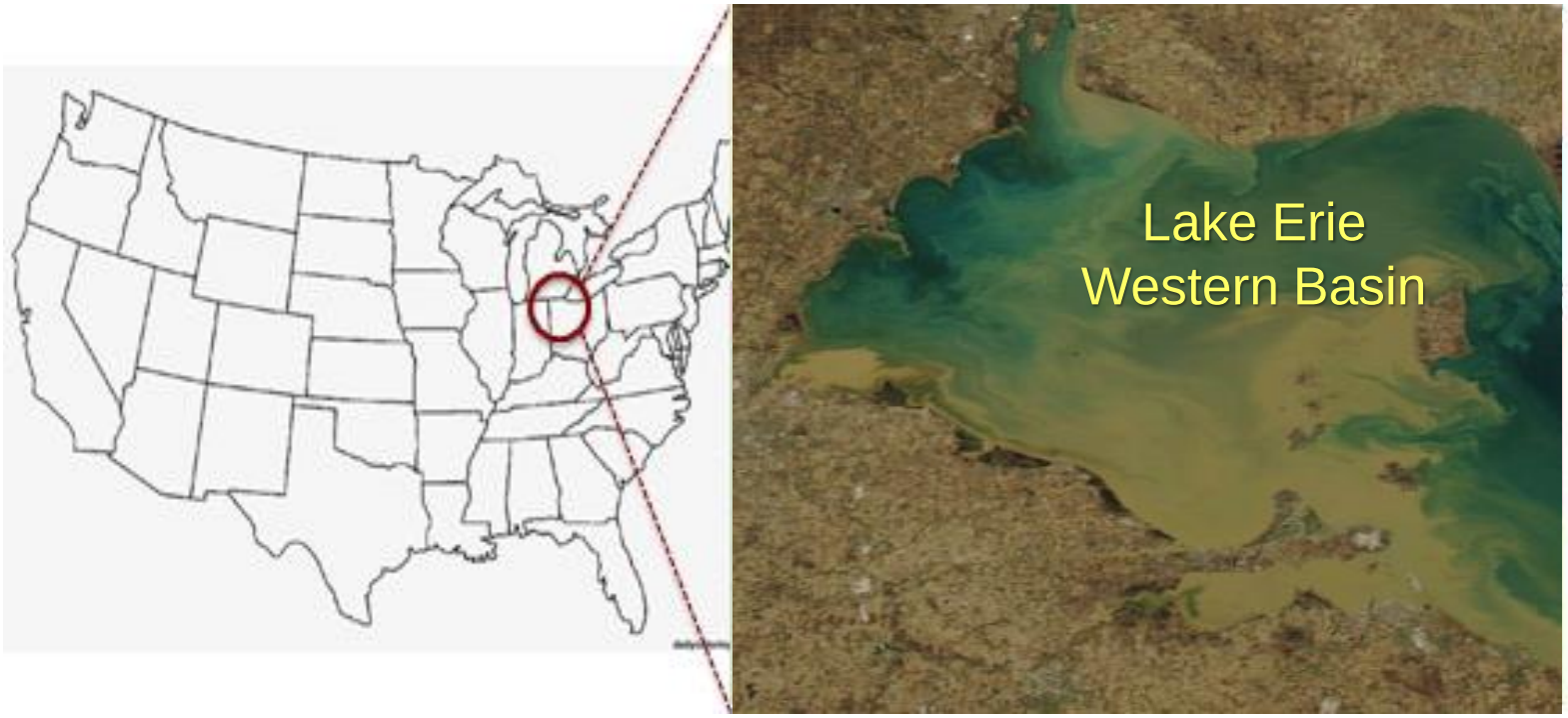
Place-specific attributes and capitals may include…

- Built capital
  - Transportation and other built infrastructure (water, energy)
  - Buildings (housing, commercial, industrial)
  - Built-up urban land area
  - Urban amenities (shopping, restaurants, cultural, etc.)
- Natural capitals that generate ecosystem services
  - Parks, conservation land, other areas w natural vegetation
  - Forests, agricultural land, other natural resource lands
  - Water areas, water quality
  - Climate and weather
  - Air quality
- Human capital
  - Place-bound universities, colleges, secondary schools
  - Educational attainment and job skills of regional labor force
- Health capital
  - Place-bound hospitals, health care facilities
  - Life expectancy, incidence of disabilities of regional population

Towards WS theory and measurement for regions: **Accounting for limited substitution within regions**

- SS constraints impose large costs, can greatly reduce welfare. Nonetheless a region may want to impose a SS constraint on natural capital if it is essential—what would make it essential?
  - It has reached a critical minimum level; is essential to welfare
  - No substitutes in region and trading isn't possible (or isn't sustainable)
- Uncertainty may justify SS constraint for a period of time
  - Uncertain timing of resource-saving technological innovation
  - Uncertain tipping point and high cost if surpassed
  - Uncertain protection
- **WS+** = Non-declining inclusive wealth + SS constraints as needed
- The larger the region, the more likely substitutes are available and the less need for SS constraints

Strong sustainability policy example: Reduce dissolved reactive and total phosphorus loadings to Lake Erie by 40%



Lake Erie water quality arguably meets the description of an essential capital stock that is at a critical minimum level; unique and highly valued in the region (and world); uncertain tipping points with high costs of surpassing

In sum: Measuring regional sustainability requires

- Accounting for embedded pollution or ecosystem degradation that are imported/exported to/from region
- Accounting for dependency of regional sustainability on other regions and nation
- A focus on place-specific regional capital stocks
- SS constraints for essential capital stocks under cases of high uncertainty
- Accounting for changes in the distribution of wealth across people and places within a region and across regions