

Forested landscapes in the Anthropocene

The flow of Chinese forests both highly local and global

M.K. Lau (Ph.D.)

- Ecological studies are now embedded in the anthropocene
- Interconnected world
- Global environmental change
- Complex systems at global scales

Overview

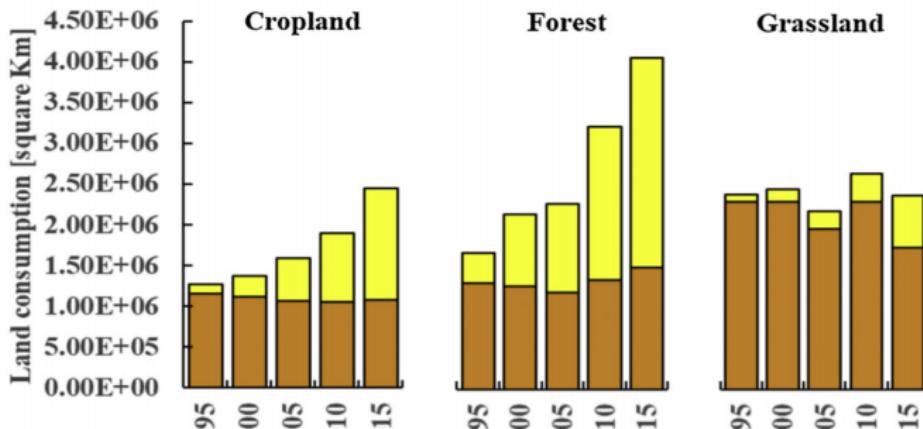
Background: Anthropocene

- Humans = dominant global impact -> Anthropocene
- Indirect effects and The far reach of the city
- Complex systems = many players and indirect effects matter

A little money moves a lot of forest.

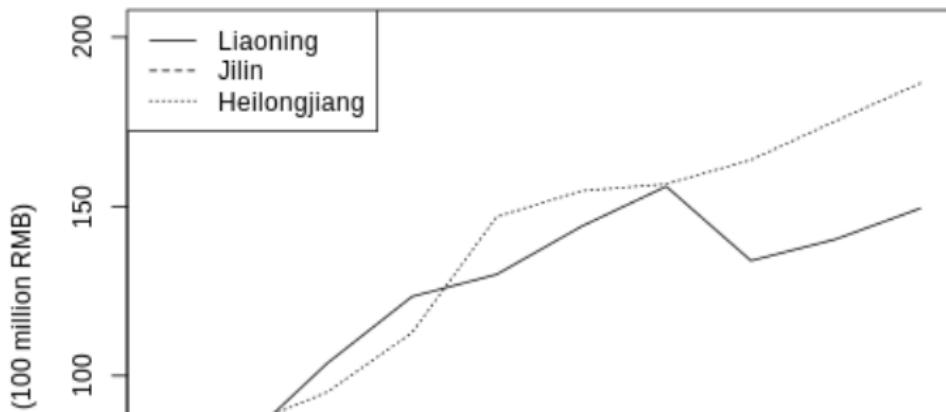
- Tian et al. 2019 showed that China consumes an equivalent amount of domestic cropland as forest land, on the order of 10^6 km^2 .
- Looking at the domestic landuse productivity data for China, forests have the lowest monetary productivity.
- Thus, per unit monetary output a relatively larger amount of forest land is used.

Land Use Policy 89 (2019) 104194

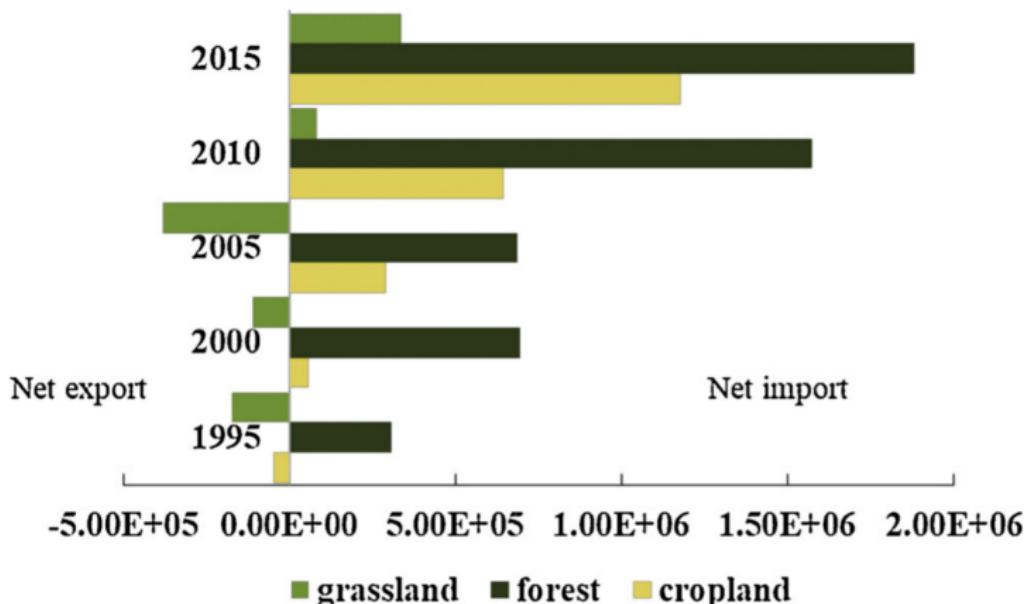


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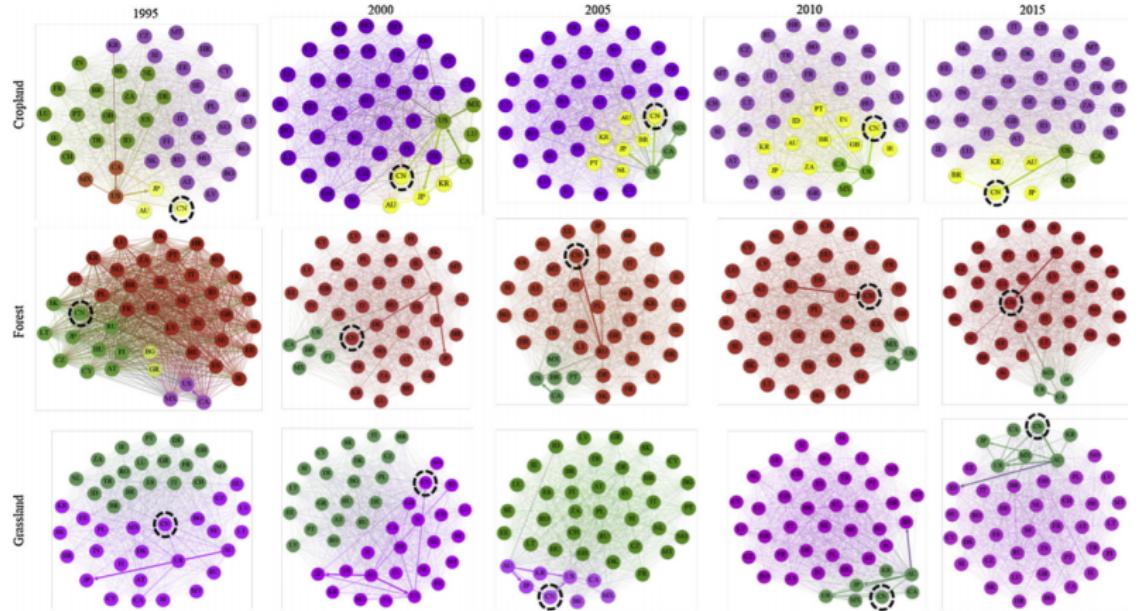
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Global Landuse Trade and China



Global Landuse Trade and China



Background: Economy == Ecology

- Economic trade data is a window into human impacts

Background: Input-Output Models

The Review of Economic Statistics

VOLUME XVIII

AUGUST, 1936

NUMBER 3

QUANTITATIVE INPUT AND OUTPUT RELATIONS IN THE ECONOMIC SYSTEM OF THE UNITED STATES

INTRODUCTION

The statistical study presented in the following pages may be best defined as an attempt to construct, on the basis of available statistical materials, a *Tableau Economique* of the United States for the year 1919.¹

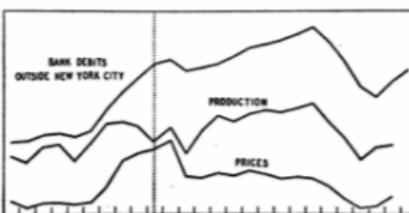
One hundred and fifty years ago, when Quesnay first published his famous schema, his contemporaries and disciples acclaimed it as the greatest "invention" since Newton's laws. The idea of general interdependence existing among the various parts of the economic system has become by now the very foundation of economic analysis. And yet, when it comes to the practical application of this theoretical tool, modern economists must rely exactly as Quesnay did upon fictitious numerical examples. What would be the present state of the theory and policy of international trade if, instead of actual balances of foreign trade, the economist had to base his analysis upon assumed numerical set-ups, supplemented by scattered items of actual statistical information? This is the situation in which the student of economics finds himself at present when he faces a problem of national production, consumption, and distribution. Despite the remarkable increase in the volume of primary statistical data, the proverbial boxes of theoretical assumptions remain in this respect as empty as

The publication of this preliminary survey is prompted by the conviction that the inevitable path of any empirical research is that of trial and error.

Governmental publications constitute the main source of primary statistical information used in this study. Additional data were gathered from trade publications, and in some instances the results of special investigations have been utilized. In many cases, use was made of the work of the National Bureau of Economic Research on national income.

At the time that this study was initiated (1932), the publication of the detailed results of the 1929 Census was still far from complete. As a result, the Census of 1919 had to be used. It is because of this fact that the entire investigation is based on 1919 data.

CHART I.—SERIES INDICATIVE OF BUSINESS CONDITIONS



Background: Input-Output Models

- How do we quantify and manage systems?
- Input-Output Analysis provides a modeling framework
- Direct consumption
- Trade occurs among sectors == Indirect consumption
- IO and MRIO models
- A new equation for a new era in science $E = F(I-A)^{-1}$

Background: Input-Output Models



Figure 2: exiobase3.jpg

Background: Environmental Extension

- Allows for indirect/consumption based accounting

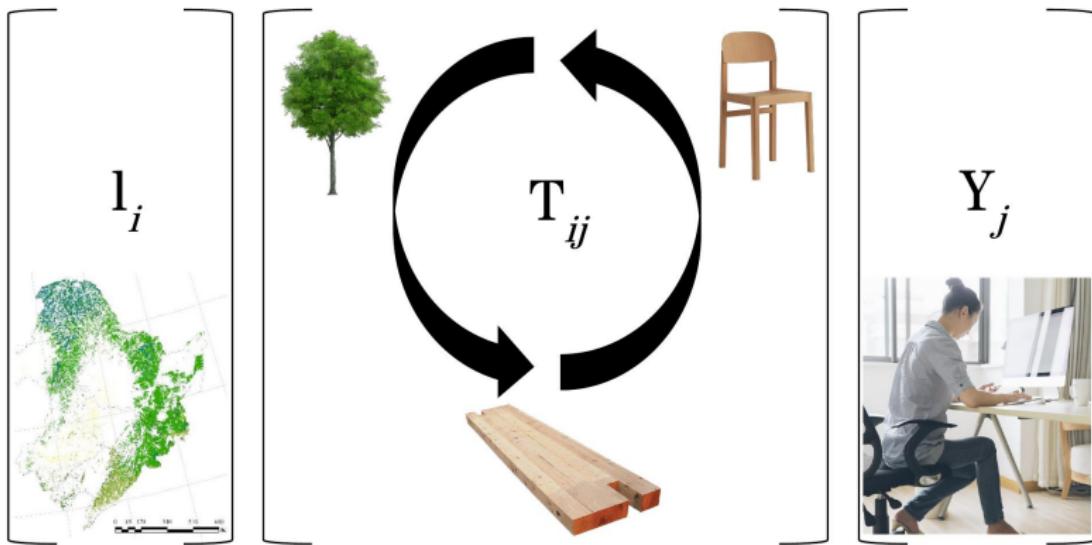
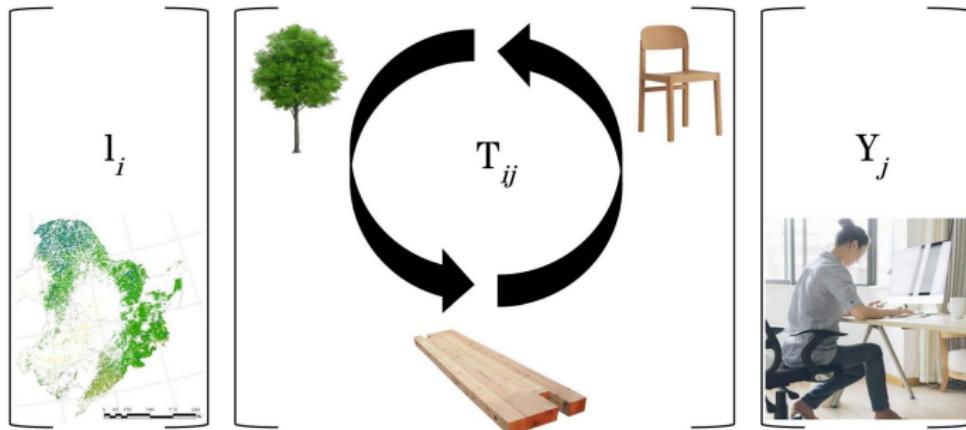


Figure 3: lemrio.jpeg

Background: Environmental Extension



$$L_j = l_i \cdot T_{ij} \cdot Y_j$$

Land area used by
region j

Total area used for
one monetary unit
for a sector

Input from one sector
used for one unit output
of a sector

Final consumption (not used to
create additional products)

Figure 4: lemrio_equation.jpeg

wos_mrio_time.jpg

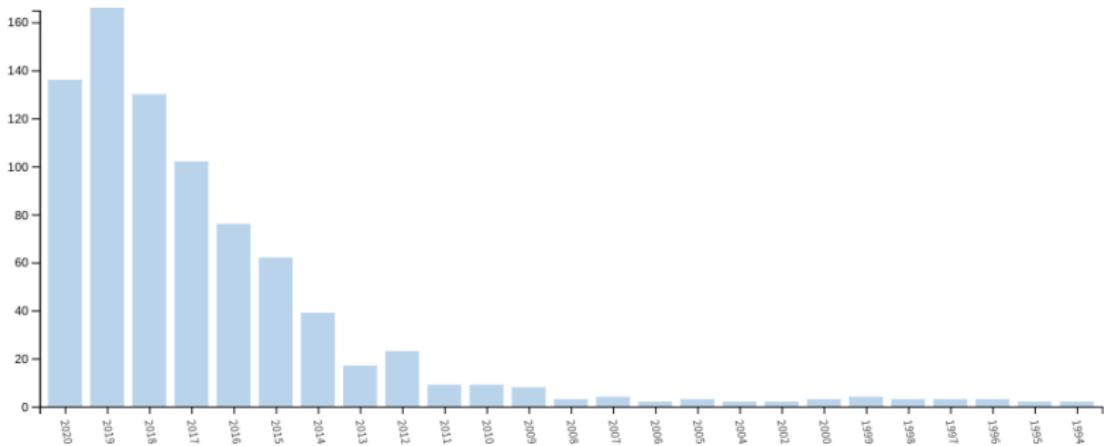


Figure 5: wos_mrio_time.jpg

wos_mrio_auth.jpg



Figure 6: wos_mrio_auth.jpg

wos_mrio_funding.jp



Figure 7: wos_mrio_funding.jpg



Figure 8: wos_mrio_field.jpg

wos_mrio_region.jpg



Figure 9: wos_mrio_region.jpg

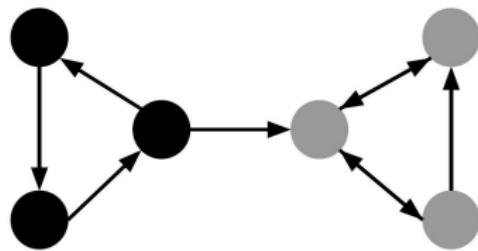
Background: Networks are Everywhere



Figure 10: resourcetrade_network.jpeg

Background: Networks are Everywhere

A



B

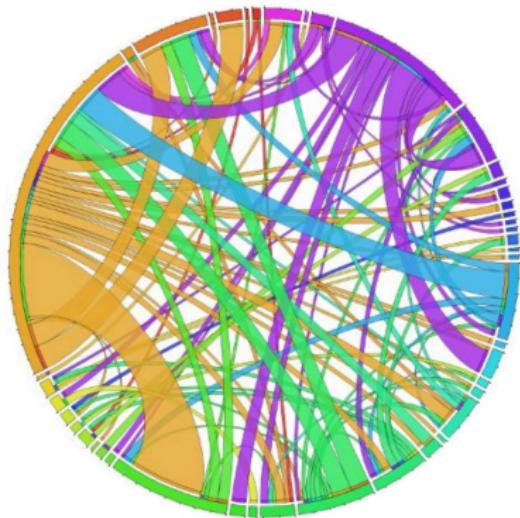


Figure 11: example_network.jpeg

Background: Ecological Network Analysis

- Ecological network theory provides predictions and metrics (Lau 2017)
- Systems theory provides strategies for interventions
- ENA <- Odums, MacArthur, Ulanowicz, Patten,
- SNA -> ecological networks (Watts and Strogatz, etc.)
- Structure linked to function (Donella Meadows)

Which metric?

Why information metrics?

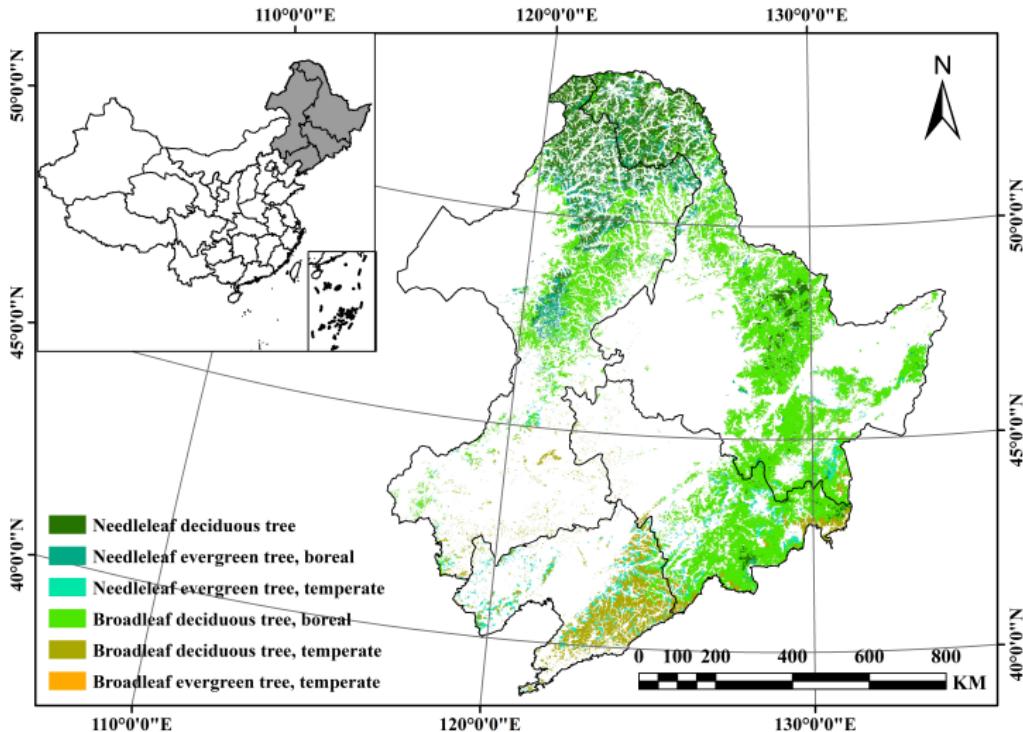
Research: Why Chinese Forests?

- Work = Forest Land Embodied in Trade

A Brief History of Forest Time in China

- China is big and diverse
- Long history of human habitation in China
- Historically, two primary regions of forestry
- Forest conservation impacts harvest
- Flows within China and among countries globally important

Research: Why Chinese Forests?



Research: Why Chinese Forests?

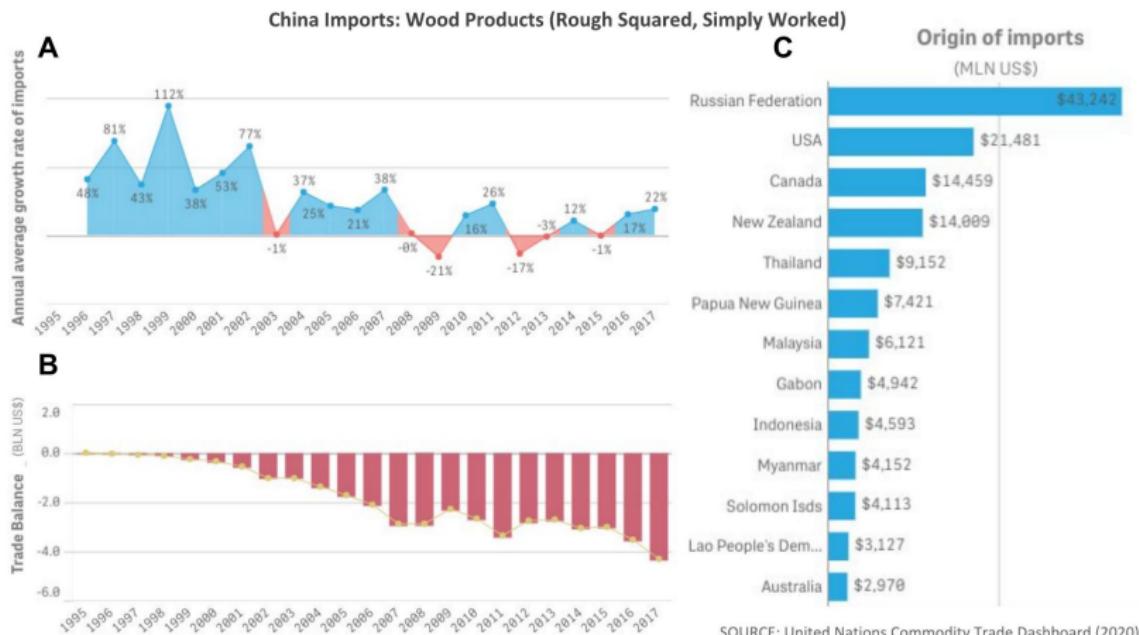


Figure 13: comtrade_china_imports_wood.jpeg

Methods: Model MRIO_{China}

Table 1

The structure of the ecological MRIO account.

		Intermediate use		Final demand				
		Region 1	...	Region m	Region 1	...	Region m	
Output					Region 1	...	Region m	
					Rest of final demand (capital goods)	...	Rest of final demand (capital goods)	
Input		Sector 1		Sector 1		Government consumption		
		Sector n		Sector n		Non-profit institutions consumption		
			Household consumption		
		Sector 1		Sector 1		...		
Intermediate input	Sector 1							
	...							
Region 1	Sector n							
	...							
Region m	Sector 1							
	...							
Primary inputs		p_j^s						
Exogenous environmental inputs		u_j^s						

Methods: Model MRIO_{China}

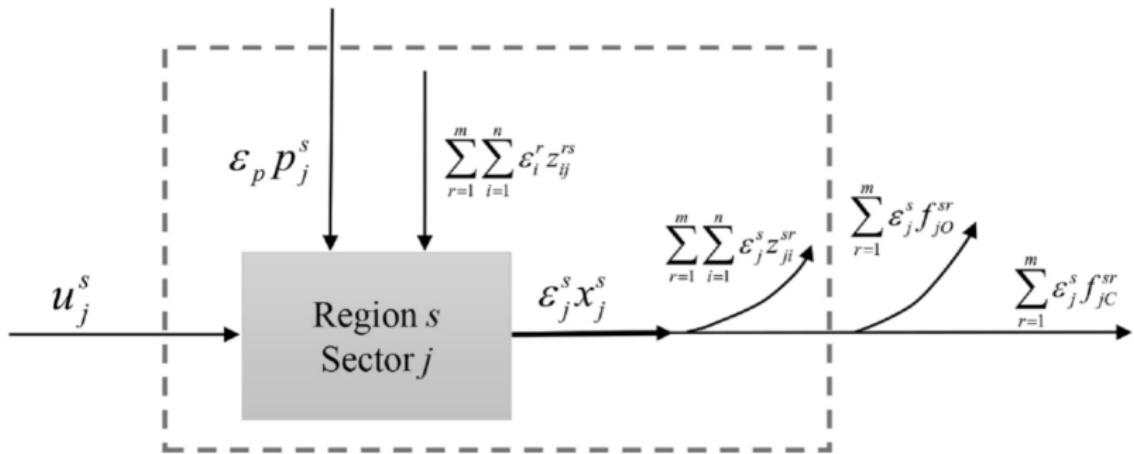
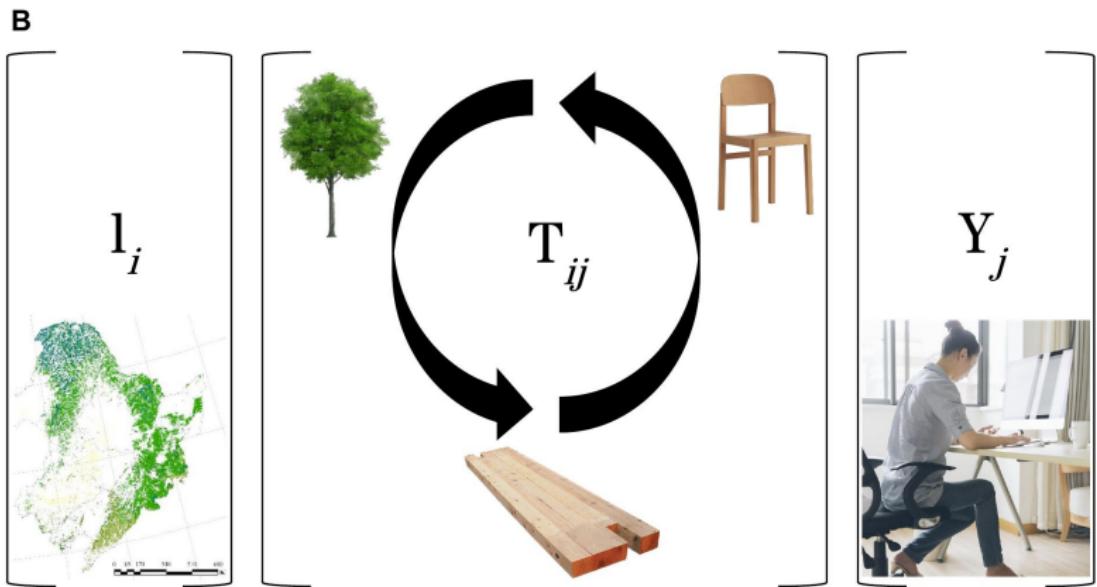


Fig. 2. Resource use flows for Sector j in Region s within the world economy.

Methods: Environmentally Extended Model

MRIOD_{China}



Methods: Model Source

NEED TO ADD FIGURE WITH DATA FLOWS

Maybe check the Mi 2018 supp mat



Figure 14: exiobase3.jpg

Main Focus of Research

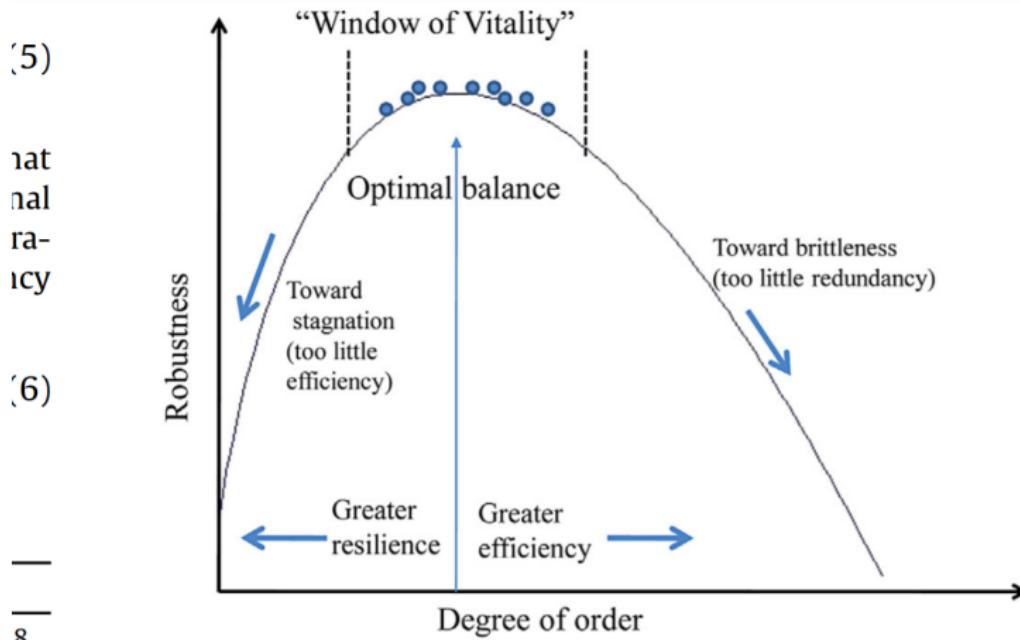
- ① What research has been done on forest or forest landscape embodied networks?
- ② What is the network structure? How can we characterize it?
- ③ What can we say about the potential system dynamics based on network structure?

Research: Network Analysis

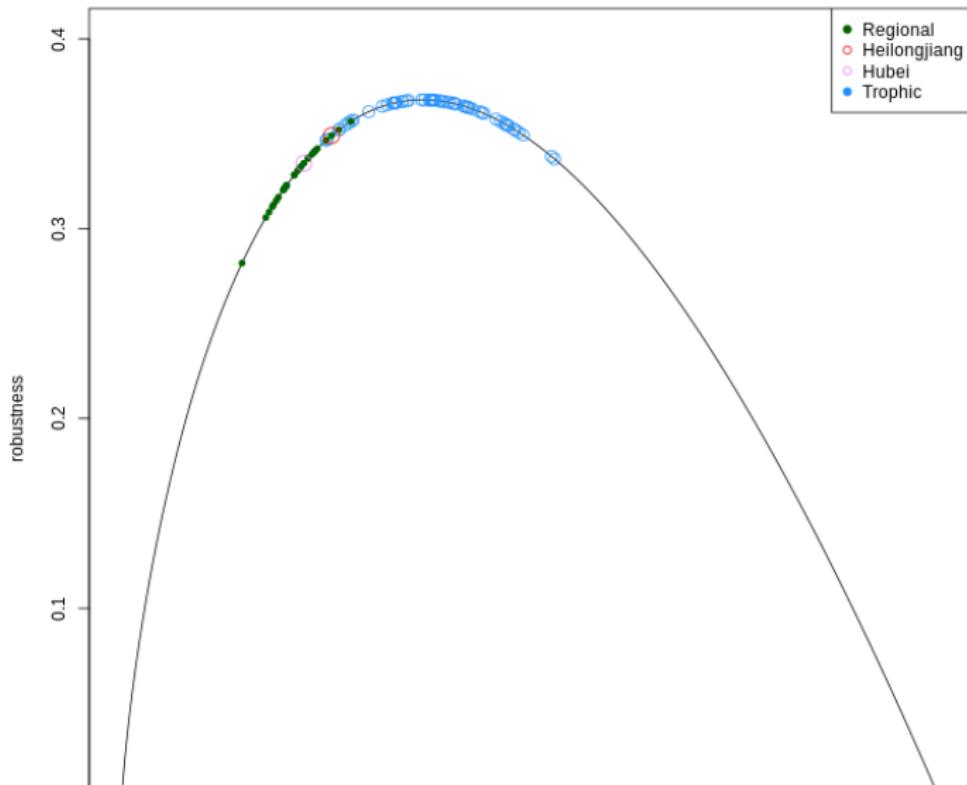
- LEMRIO global (Tian 2019)
- LEMRIO local (Chen 2019)
- Your LE-MRIO China
- Your ENA analysis
 - Small world
 - Modularity
 - Centrality
 - Control
 - Resilience

Research: Structural Analysis

- Analysis = Structure = Robustness



Forest Landscape Networks are More Efficient but Less Robust



Caveats

- Limitations of MRIO
- Potential impacts of storage lags and buffers

Future: Next up, climate change variability

- Next up = Climate change impacts and global scale

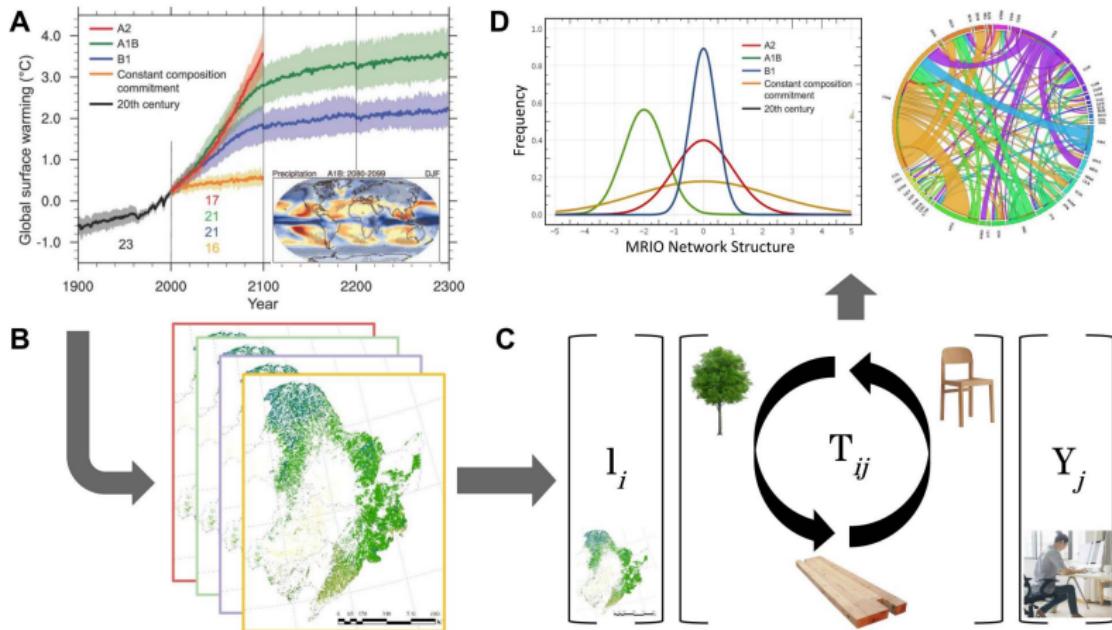


Figure 15: lemrio_climate_change.jpeg

Future: Next up, climate change variability

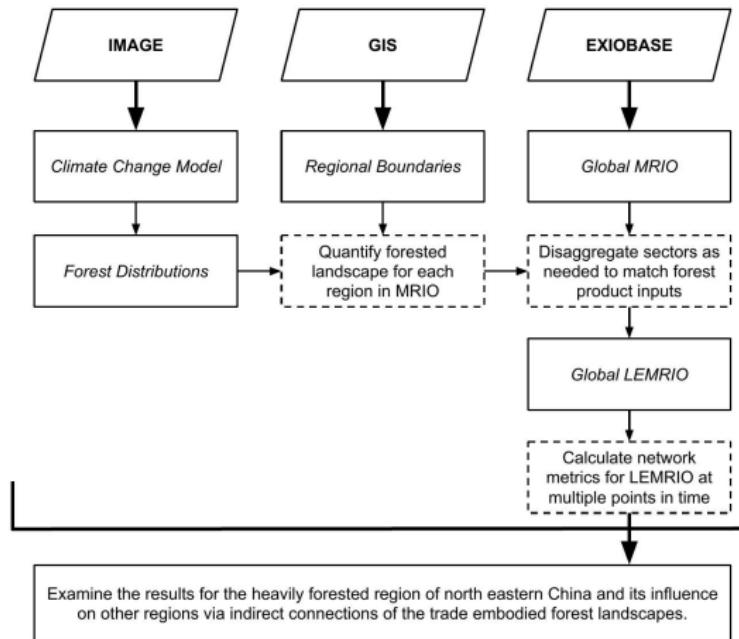
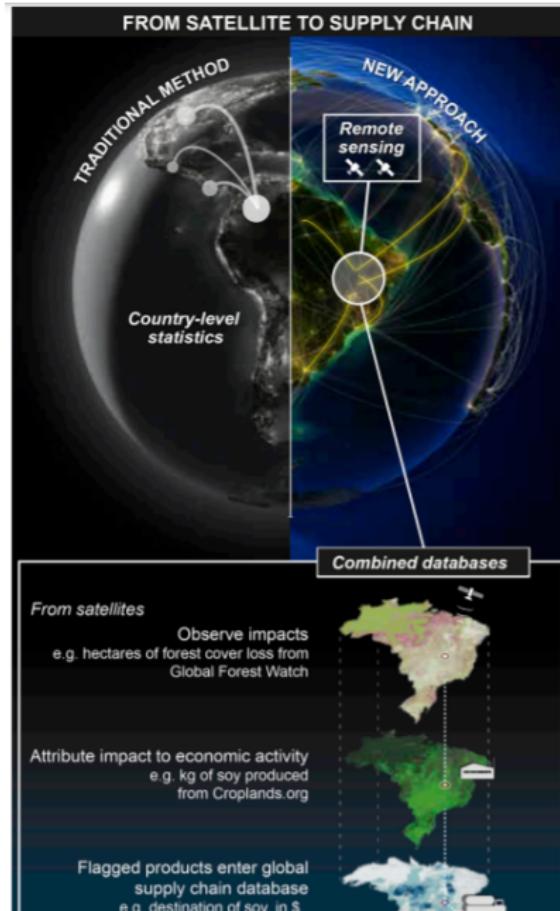


Figure 16: lemrio_climate_workflow.jpeg

Future Work: Remote Sensing Trade Models



This talk was made via Rmarkdown