

Far Flung Forest Landscapes in the Anthropocene

Structural analysis of China's embodied forest network

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forests

Biodiversity and Conservation in Forests

Edited by

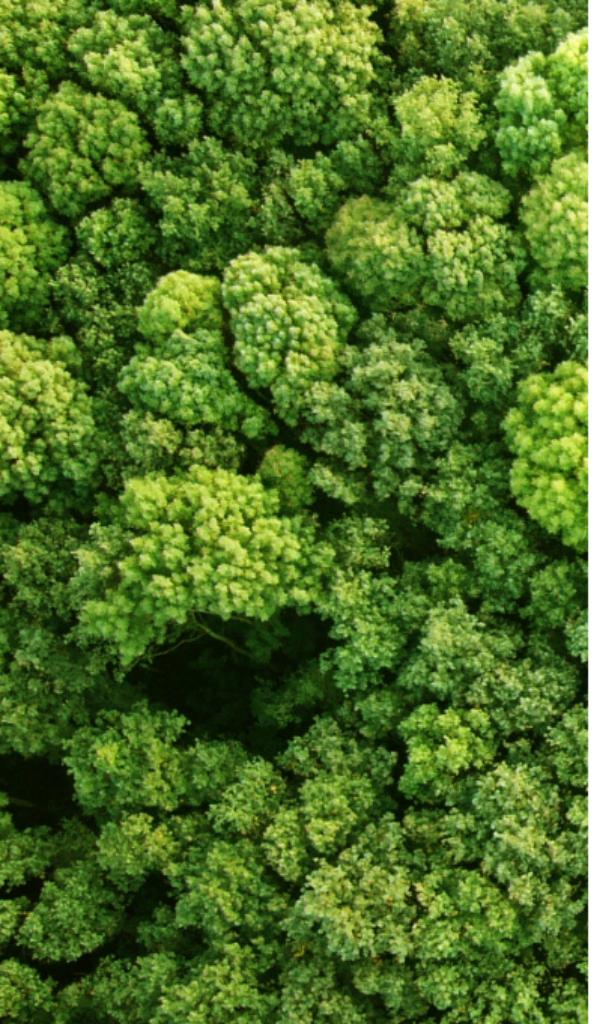
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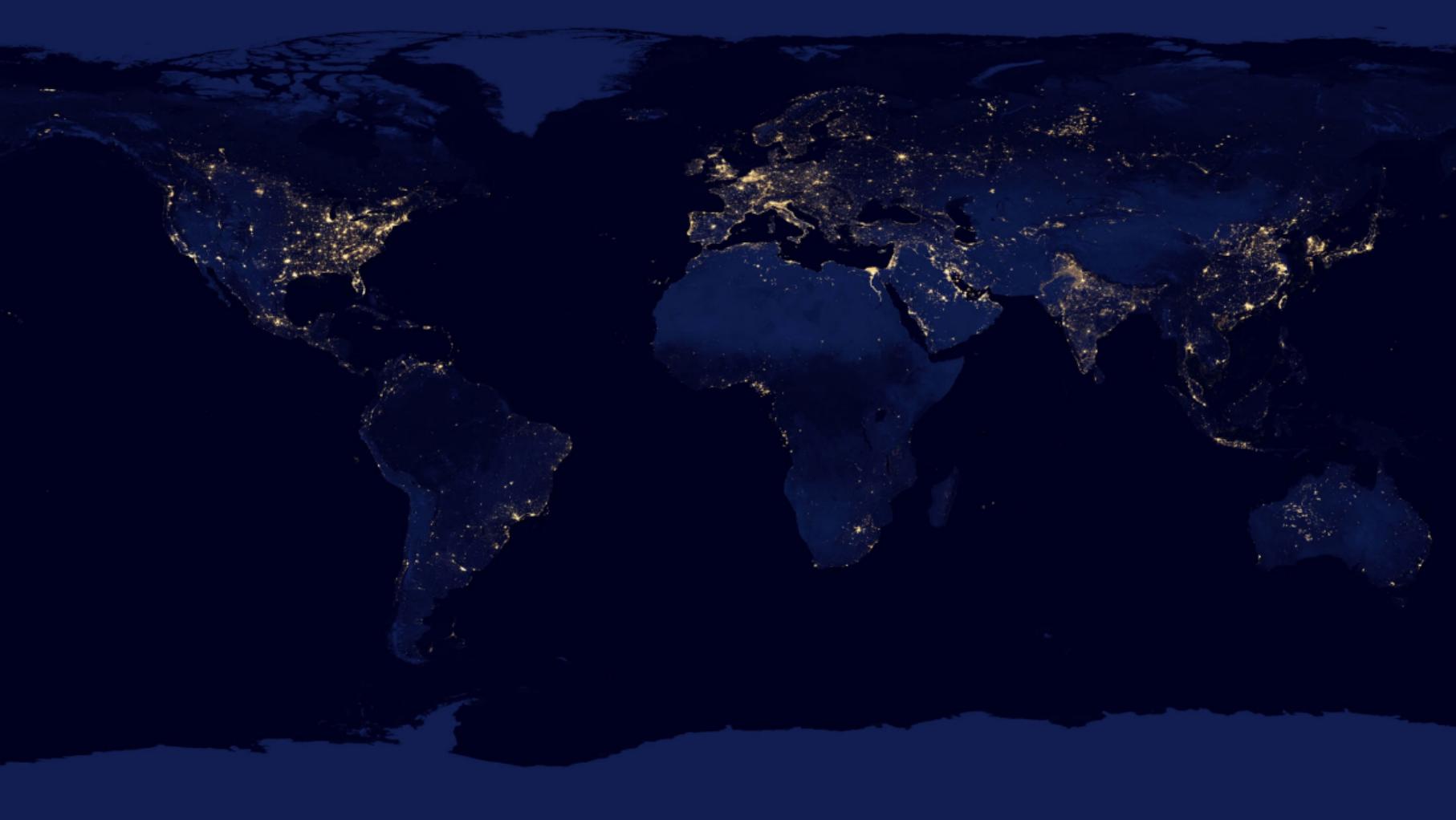
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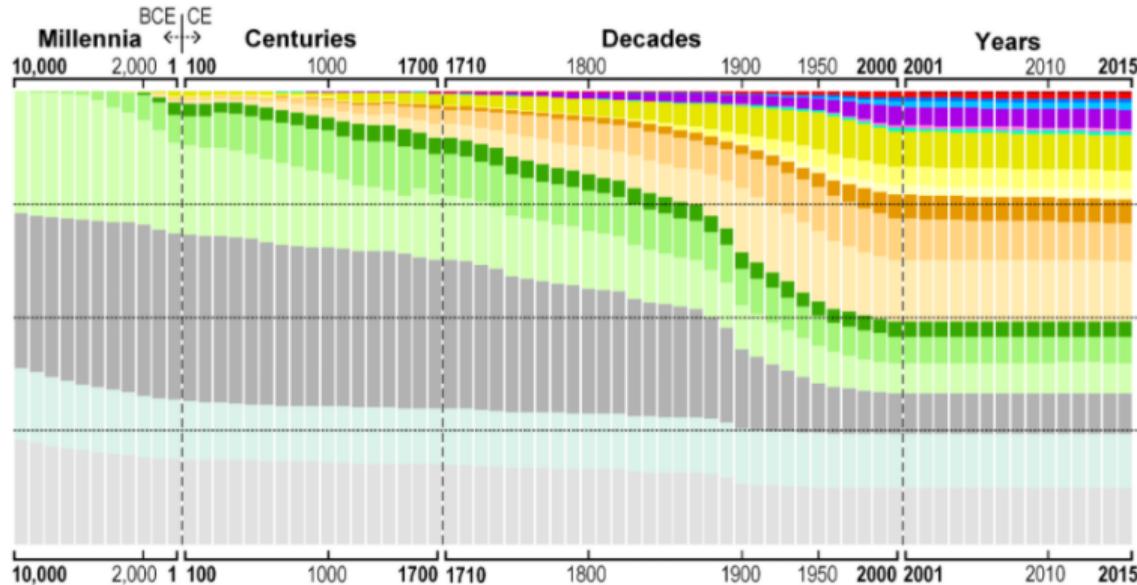






Anthropogenic biomes: 10,000 BCE to 2015 CE

Changes in anthrome classes as % global land area



Used

Dense Settlements

- Urban
- Mixed settlements

Villages

- Rice villages
- Irrigated villages
- Rainfed villages
- Pastoral villages

Croplands

- Residential irrigated croplands
- Residential rainfed croplands
- Populated croplands
- Remote croplands

Rangelands

- Residential rangelands
- Populated rangelands
- Remote rangelands

Seminatural

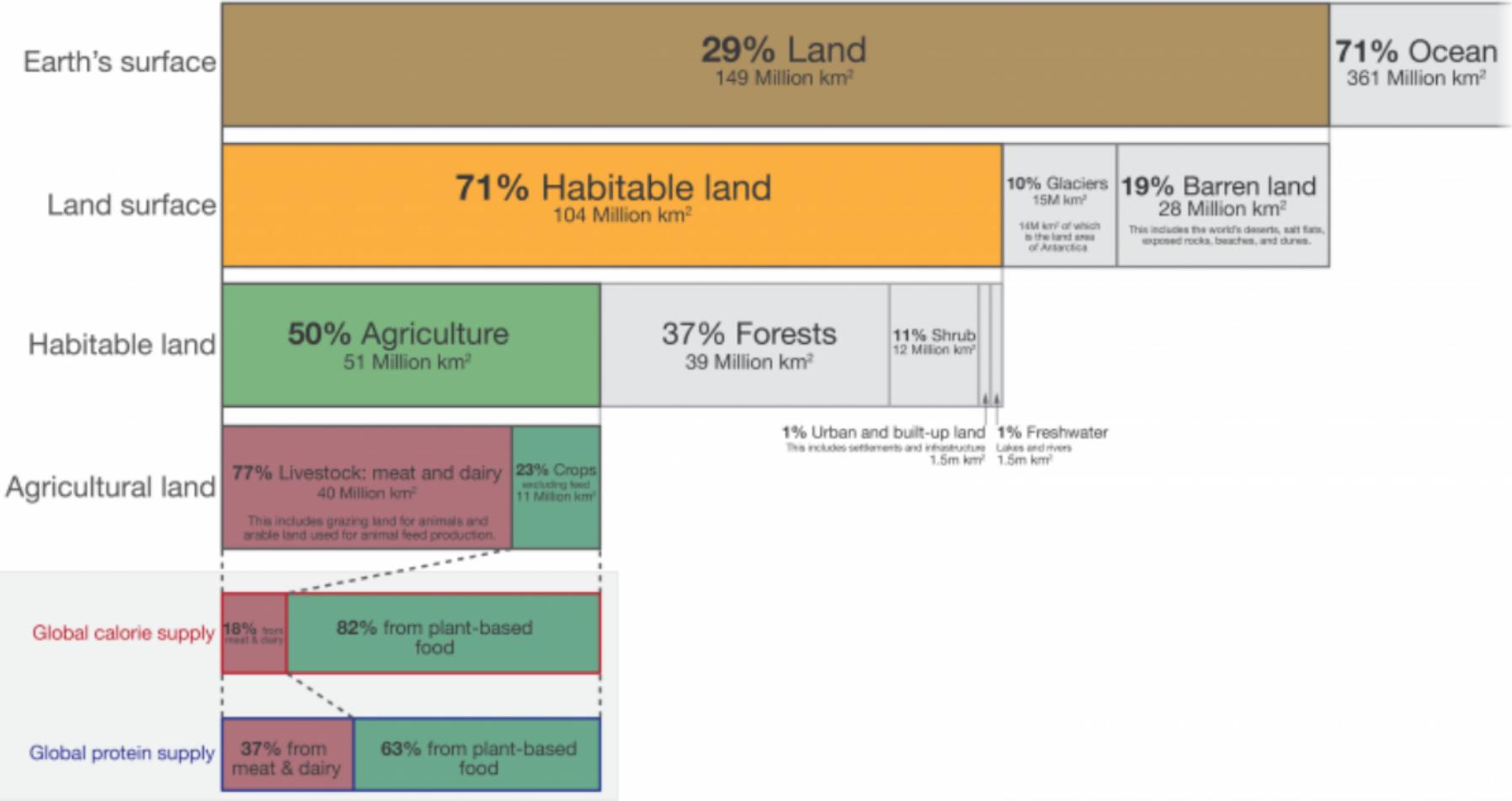
Seminatural

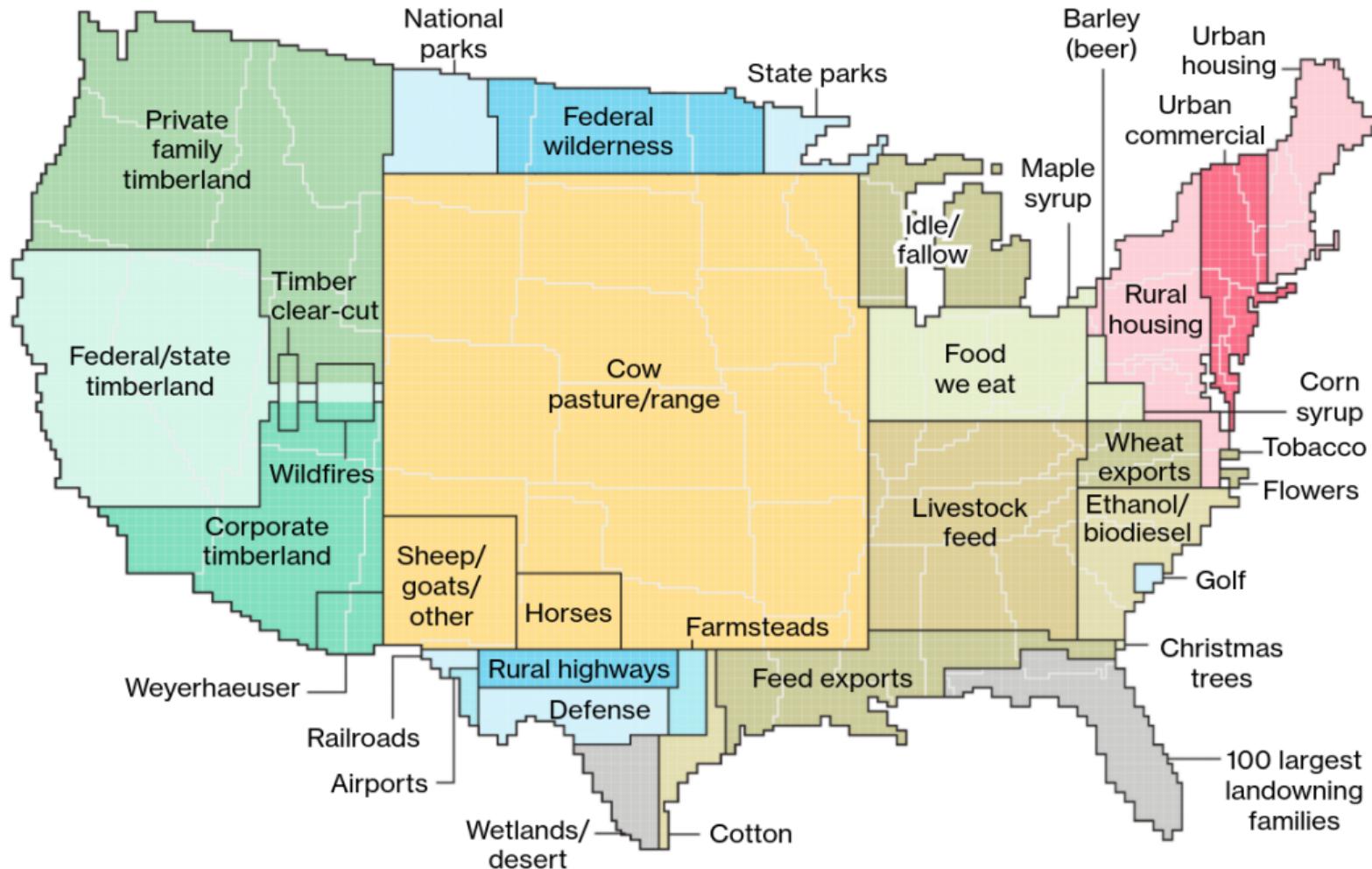
- Residential woodlands
- Populated woodlands
- Remote woodlands
- Inhabited treeless & barren lands

Wild

Wildlands

- Wild woodlands
- Wild treeless & barren lands
- Ice, uninhabited







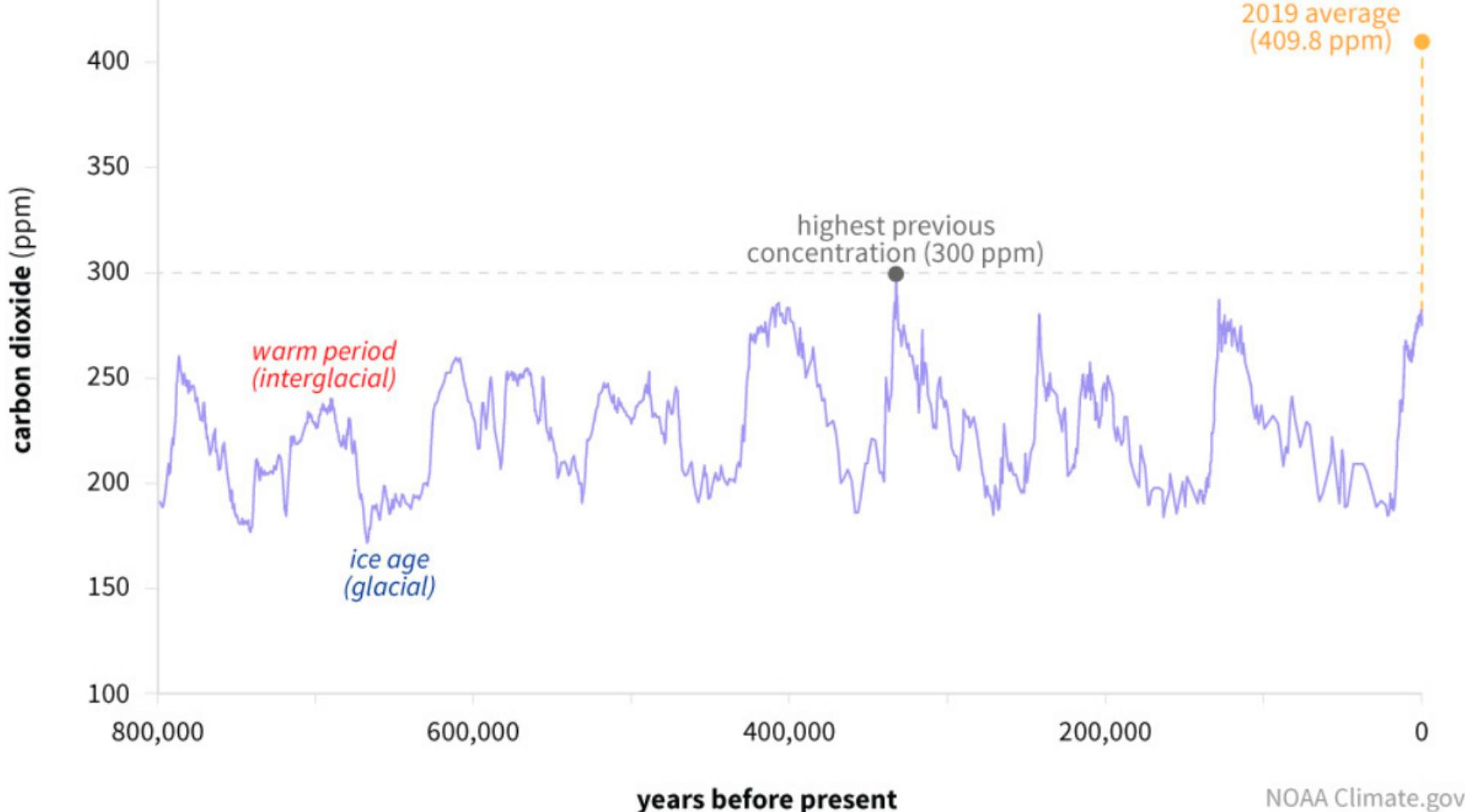


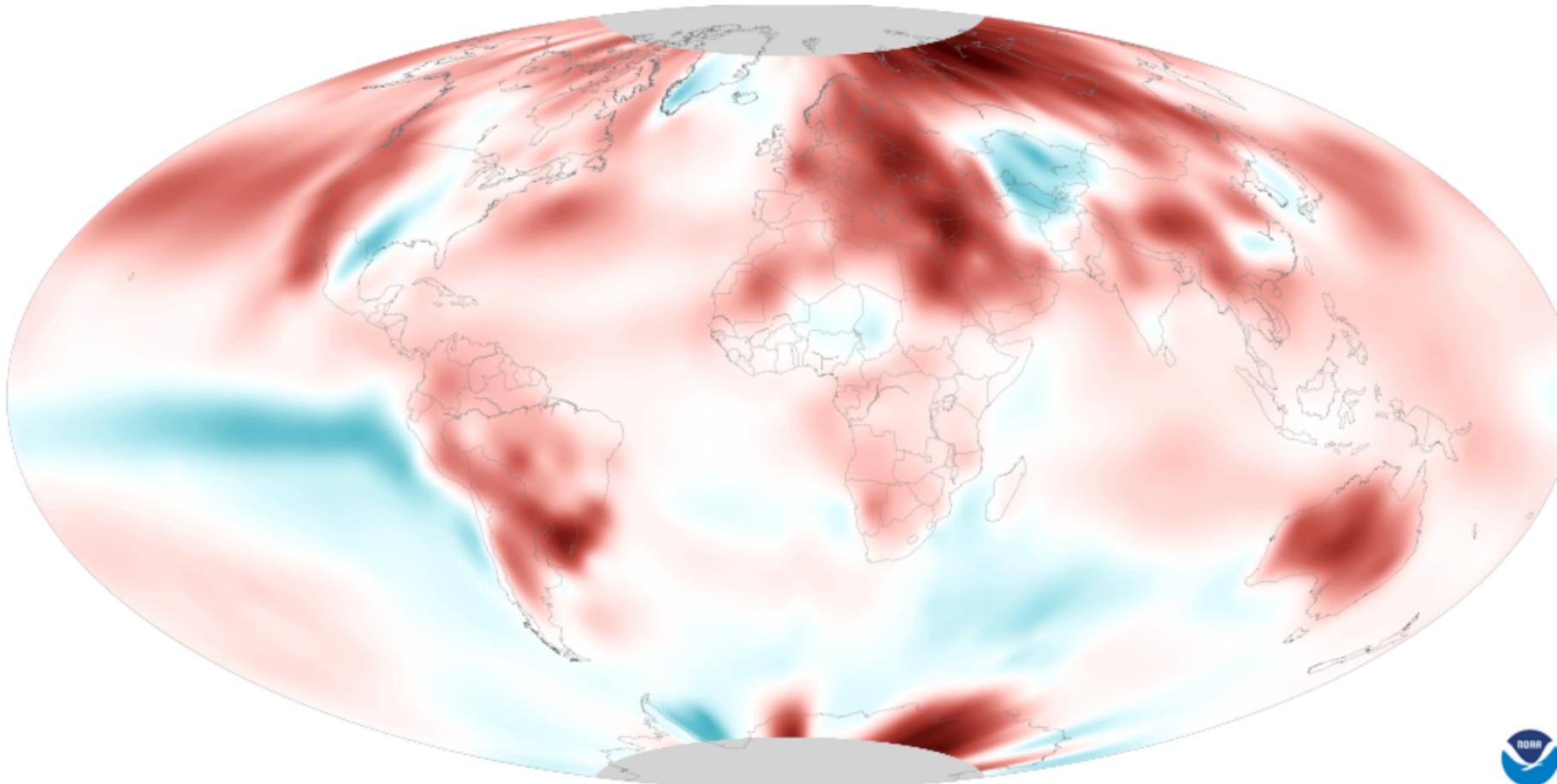




ECLIPSE Ice Drill







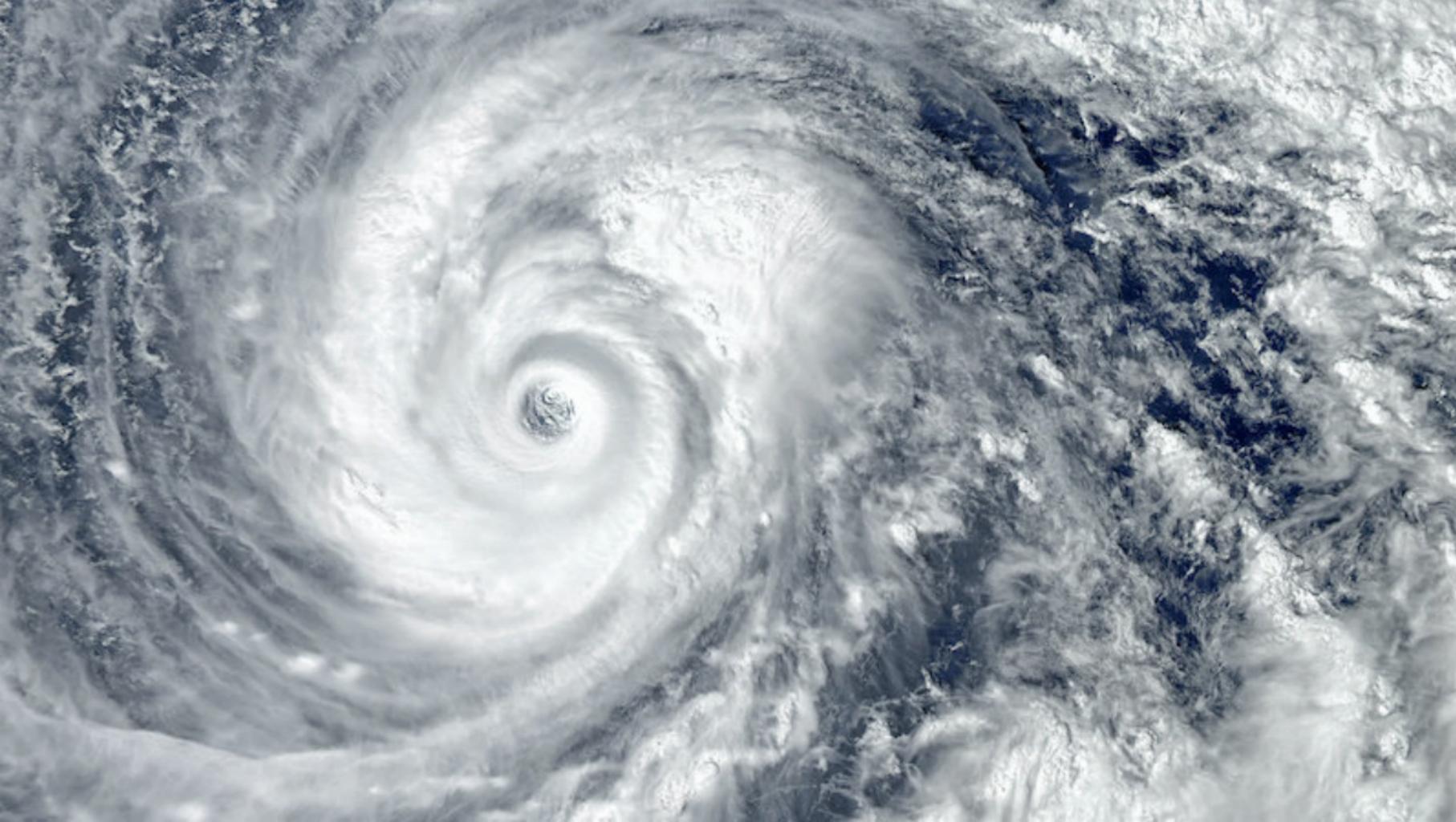
September 2020
Compared to 1981-2010

Difference from average temperature (°F)

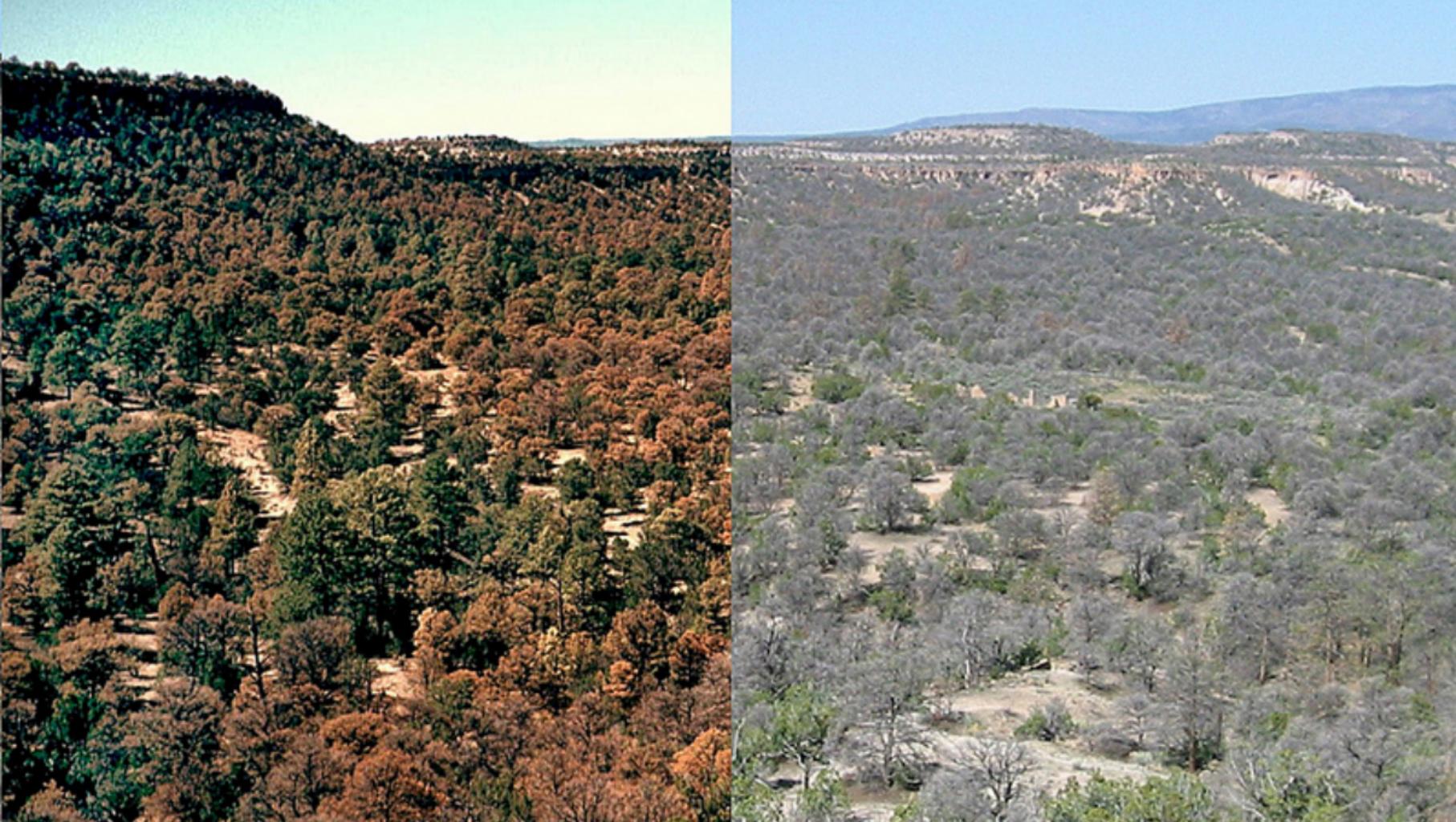
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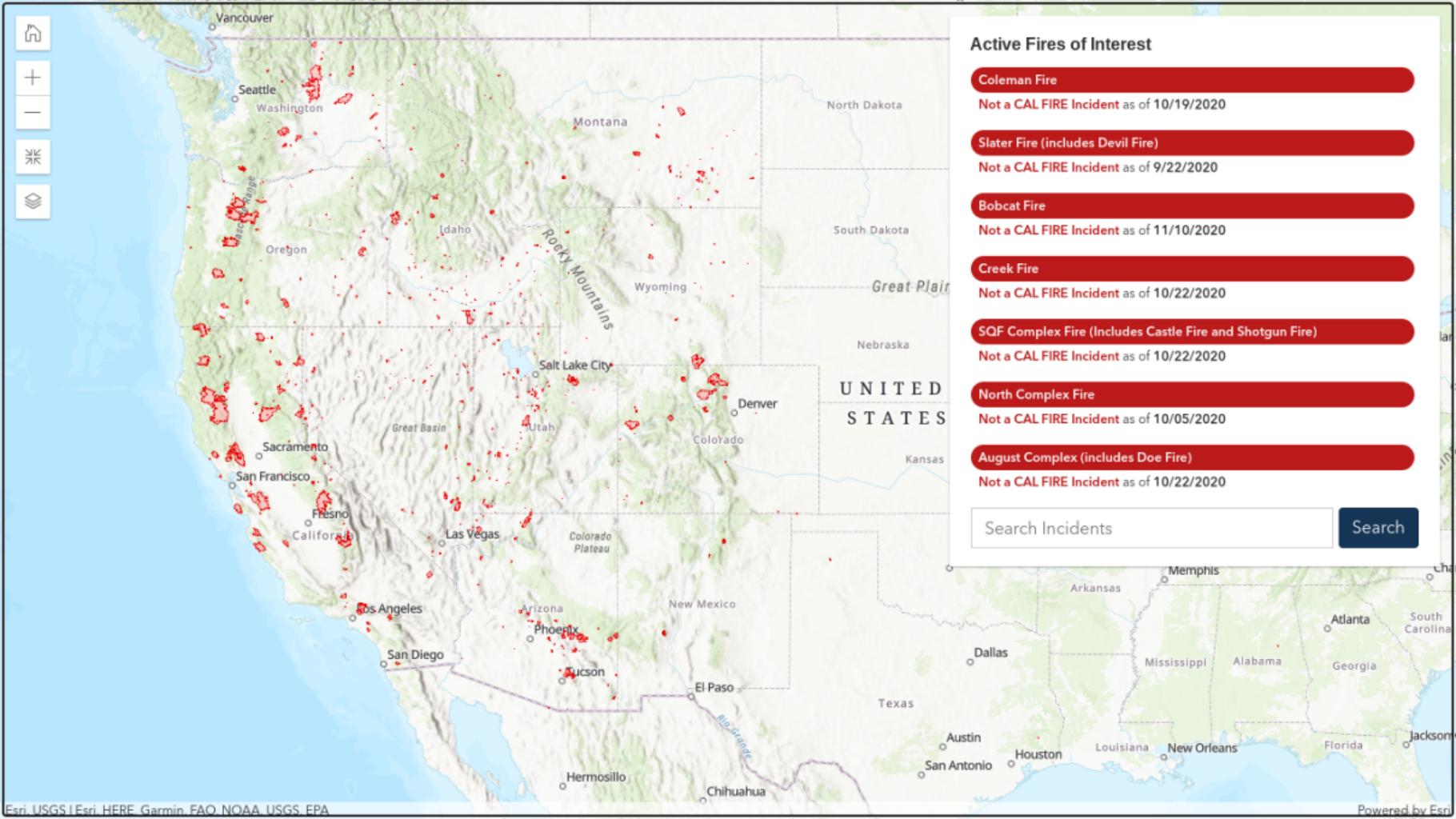


NOAA NN
Data: NC

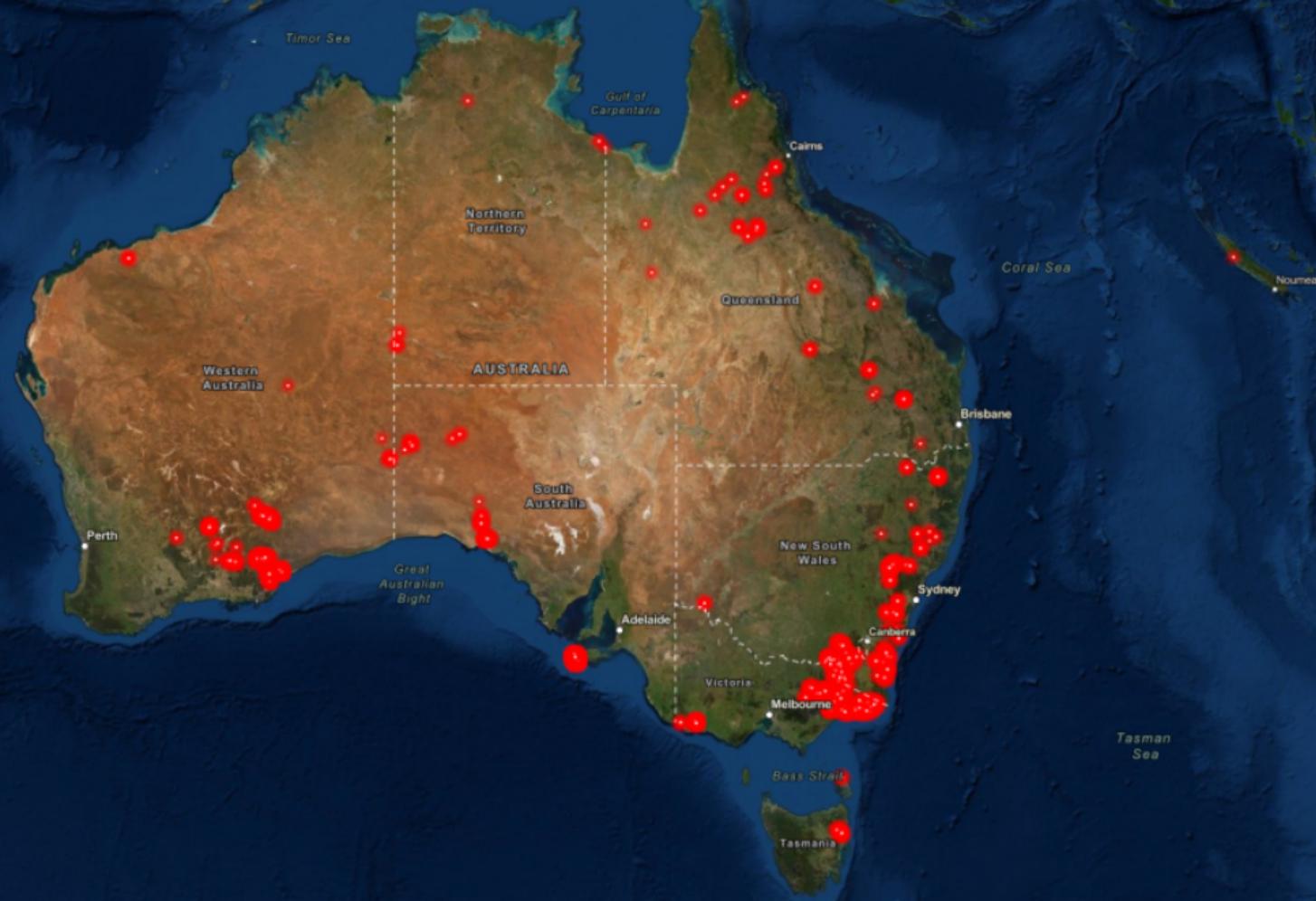












Forests in the Anthropocene

- Forests are changing from human impacts

Forests in the Anthropocene

- Forests are changing from human impacts
- Large direct and indirect effects of land-use

Forests in the Anthropocene

- Forests are changing from human impacts
- Large direct and indirect effects of land-use
- How do we address indirect and systems-level effects?

- ① Environmentally Extended Economic Models
- ② Global Trade Networks of Forest Landscapes
- ③ China's Domestic Forest Land Network Structure
- ④ Summary and Conclusions
- ⑤ Future Work

Economic Input-Output Models

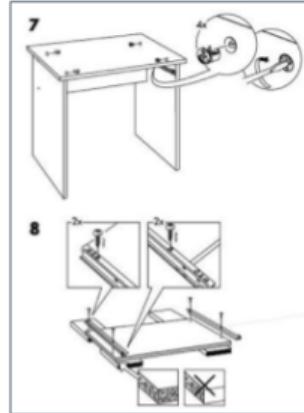


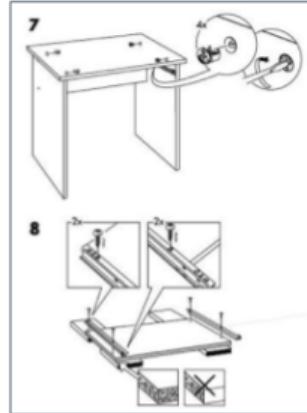


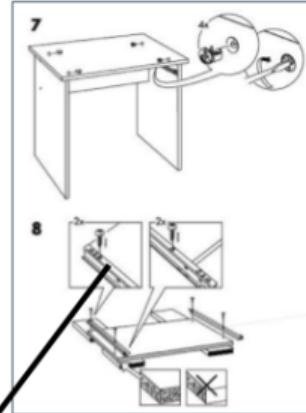












Economic Input-Output Modeling

$$X = (I - A)^{-1} Y$$

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- Indirect effects can, and usually are, greater than direct
- Has been influential in ecosystem network analysis

Environmental Extended Input-Output Models

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$$E = F(I - A)^{-1} Y$$

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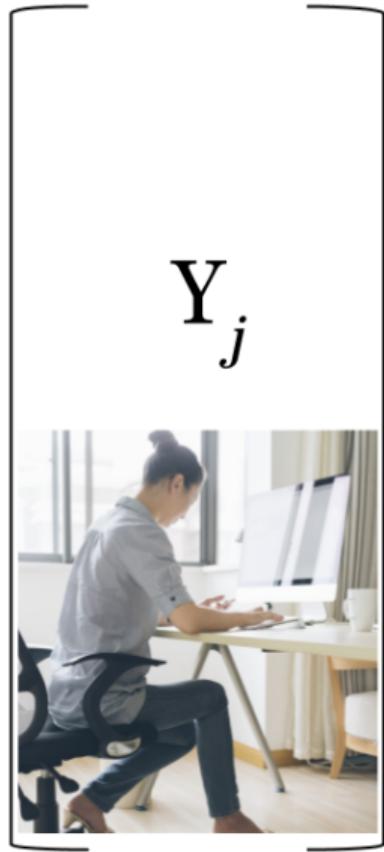
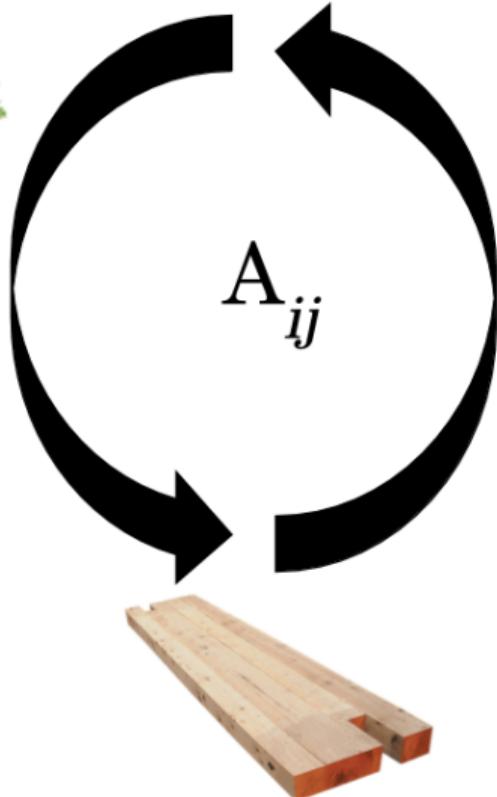
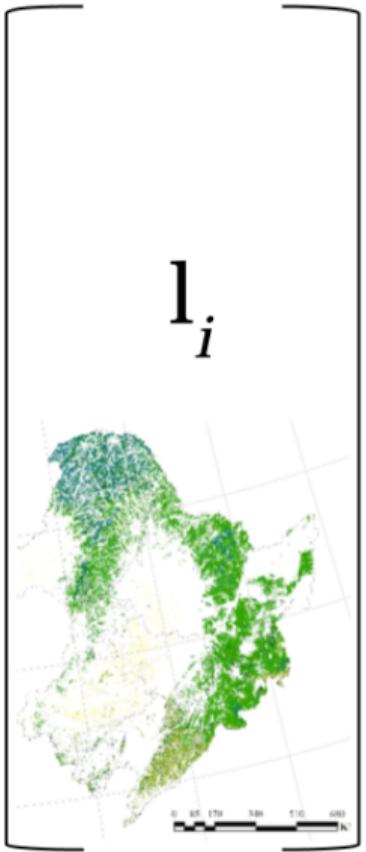
- Any environmental (or social) variable can be used

Environmental Extended Input-Output Models

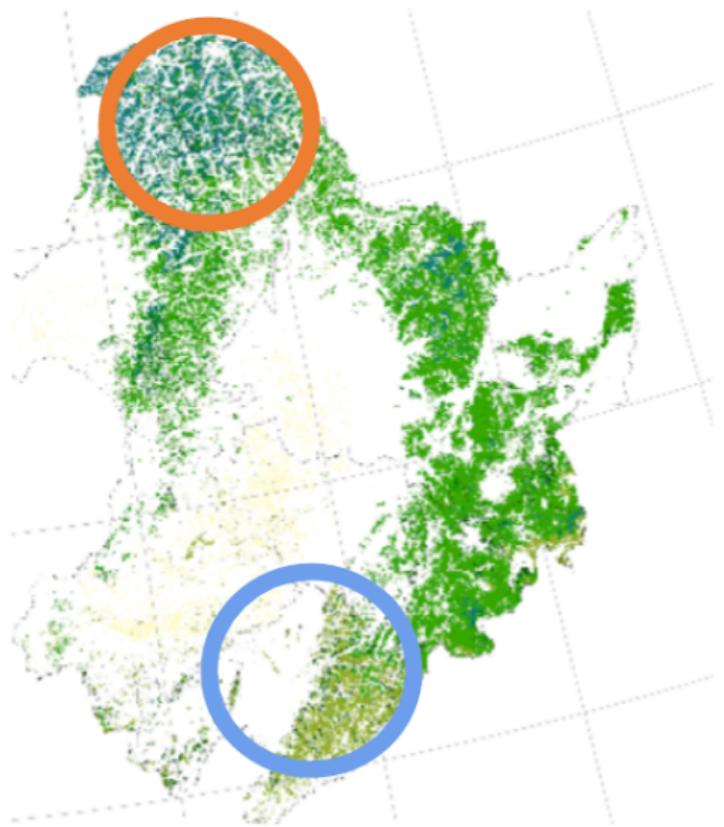
$$E = F(I - A)^{-1}Y$$

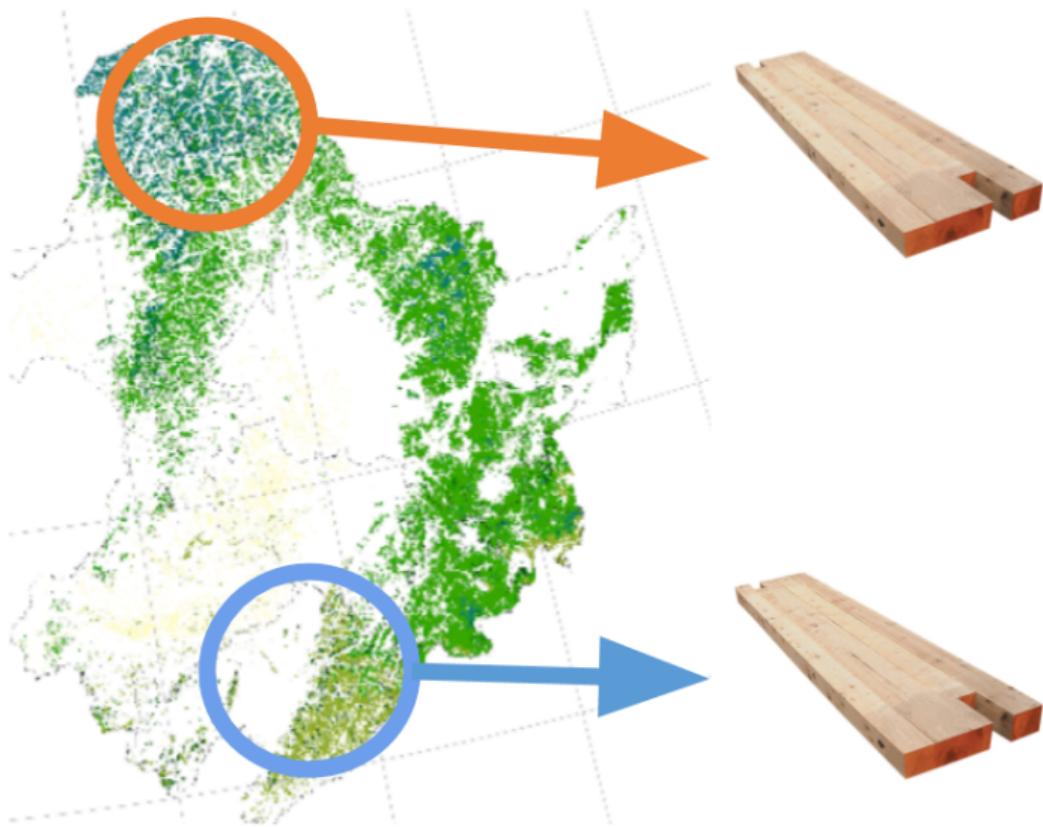
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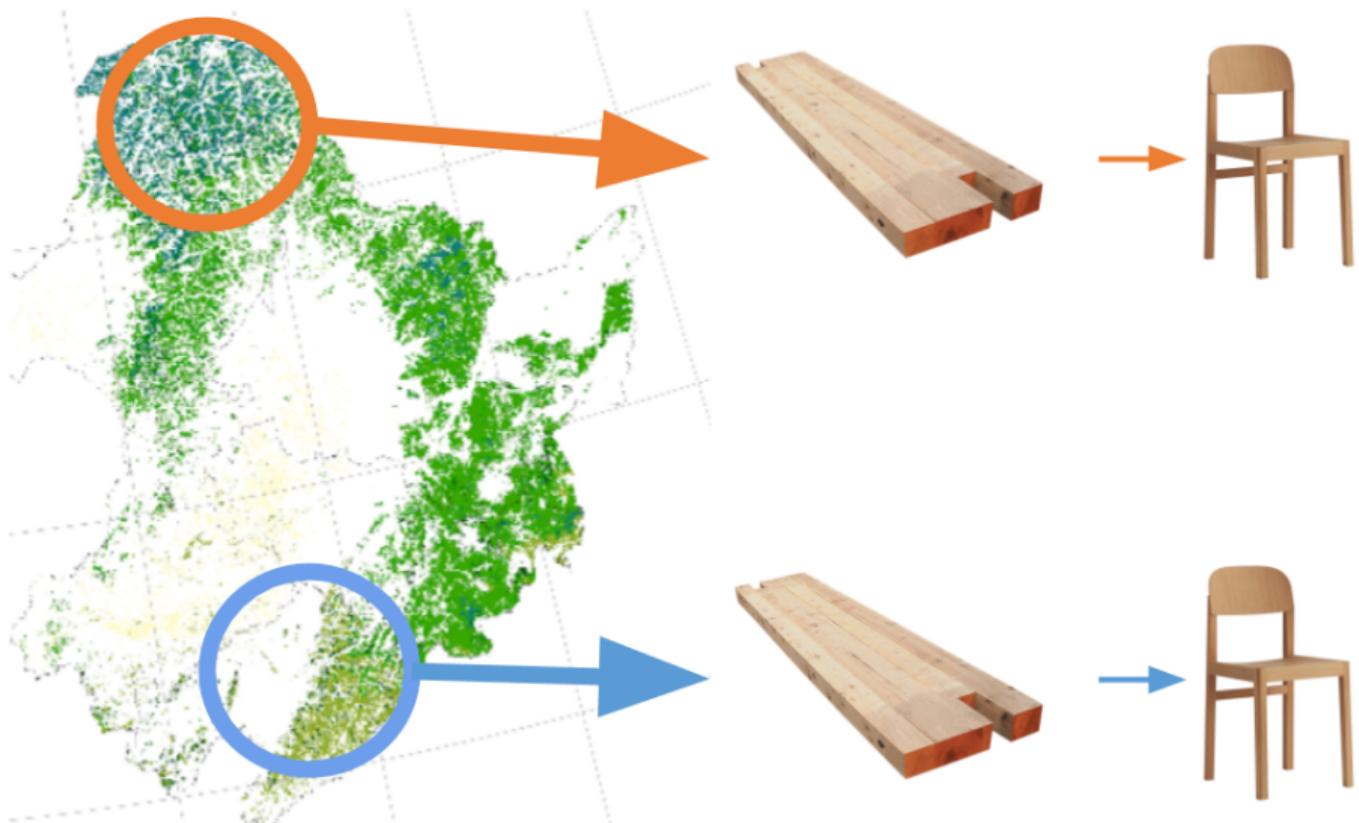
- Any environmental (or social) variable can be used
- **Required:** estimate of how much is used by each industrial sector

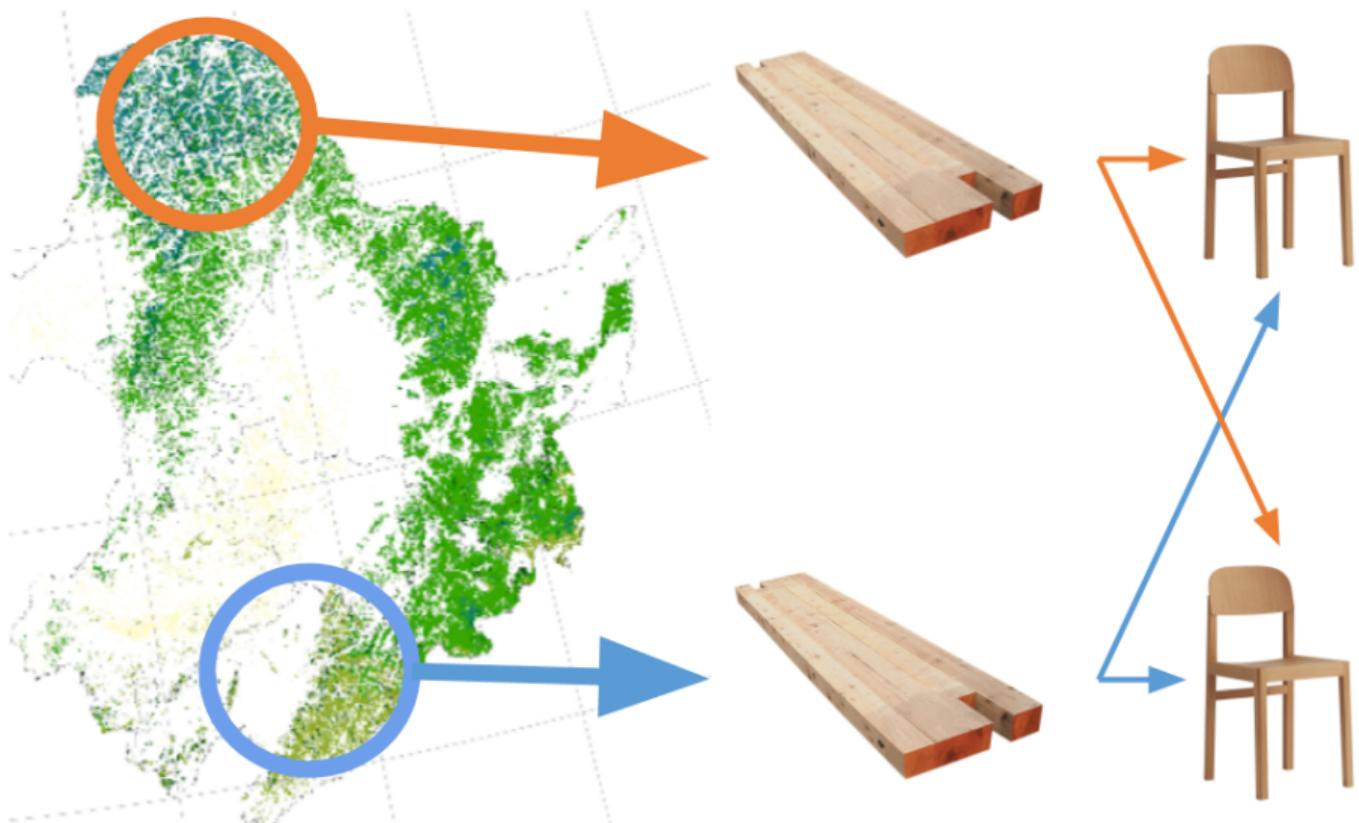


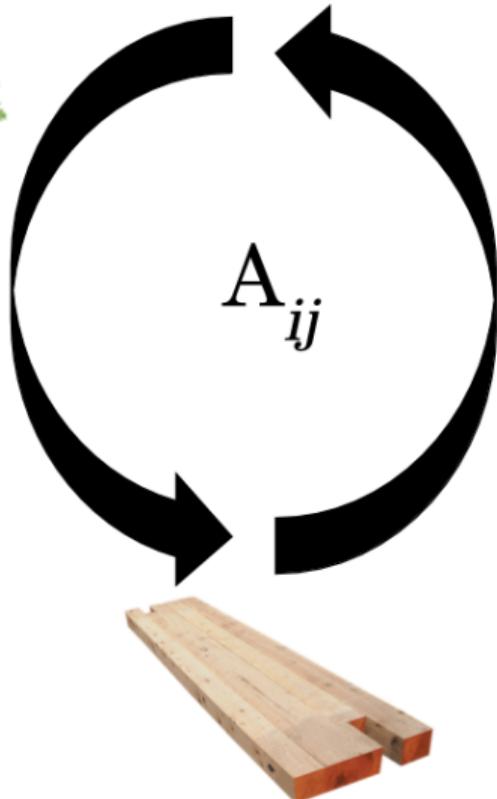
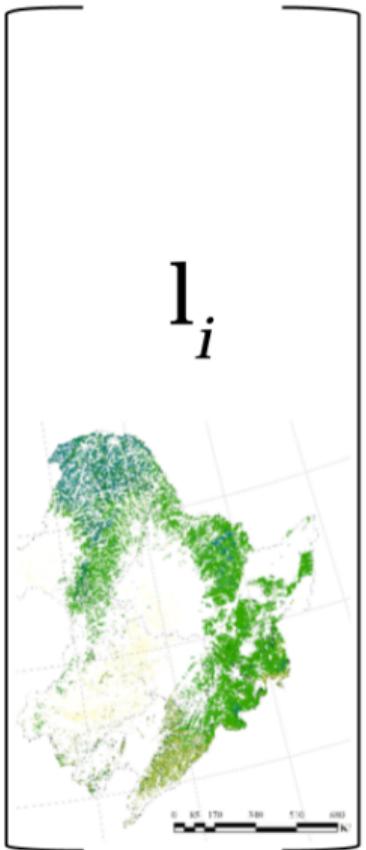
“Multi-Regional” = Spatial Context











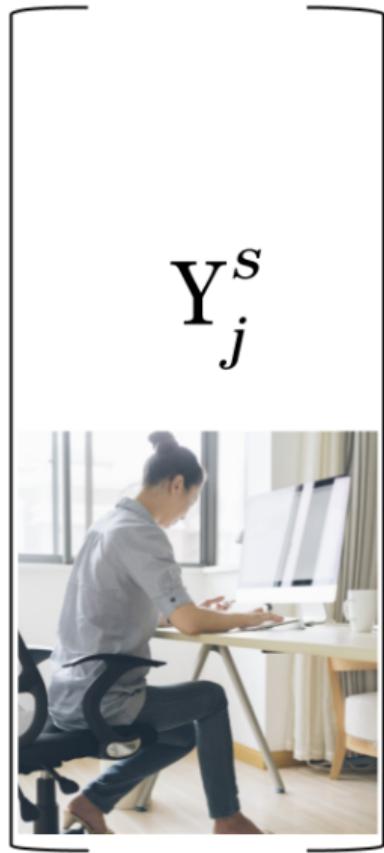
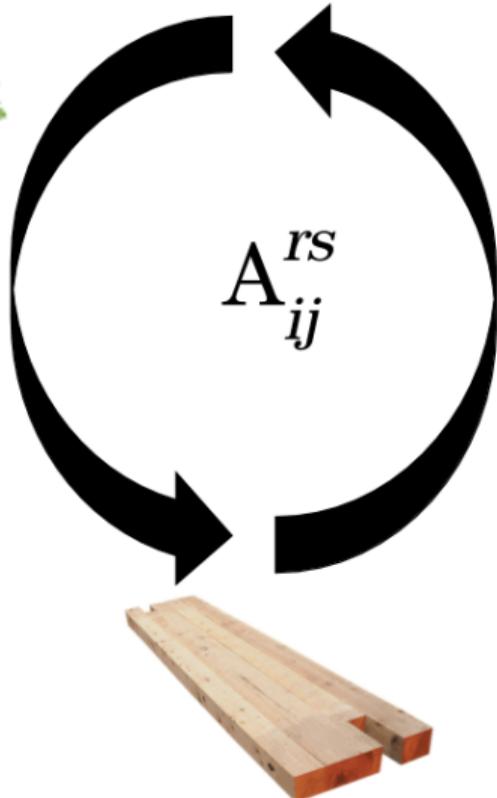


Table 1

The structure of the ecological MRIO account.

				Final demand		Region m		Rest of final demand (capital goods)	
				Region 1		...		Government consumption	
				Region 1		;		Non-profit institutions consumption	
				Region 1		Household consumption		Household consumption	
				Region 1		...		Rest of final demand (capital goods)	
Output		Intermediate use							
		Region 1		Region m					
		Sector 1		...		Sector n			
		Sector 1		...		Sector n			
		Sector 1		...		Sector n			
		Sector 1		...		Sector n			
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$$E_j^s = F_i^r (I - A_{ij}^{rs})^{-1} Y_j^s \quad (1)$$

A few EE-MRIO Applications

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- 17% of biodiversity is embodied in food exported to high income countries [1]
- Tropical forest loss in Brazil driven by conversion to soy exported primarily to China (48.6%) and the USA (72.3%) [3]

Global Embodied Landscape Trade Networks

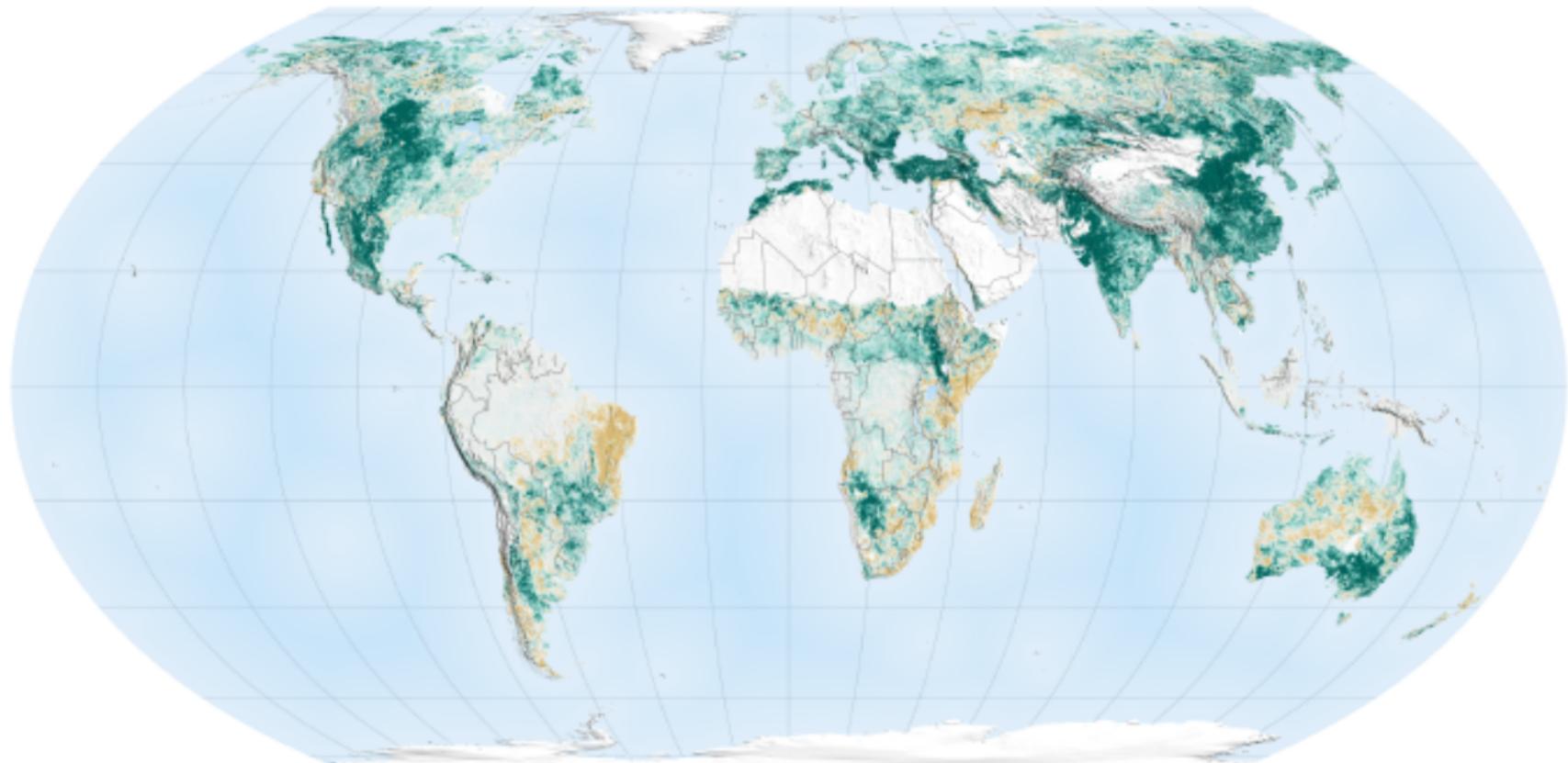
- What is the current state of forested landscapes

Global Embodied Landscape Trade Networks

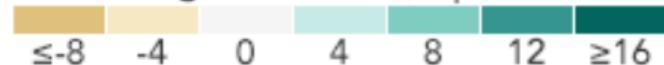
- What is the current state of forested landscapes
- How does this relate to current patterns of landscape trade?

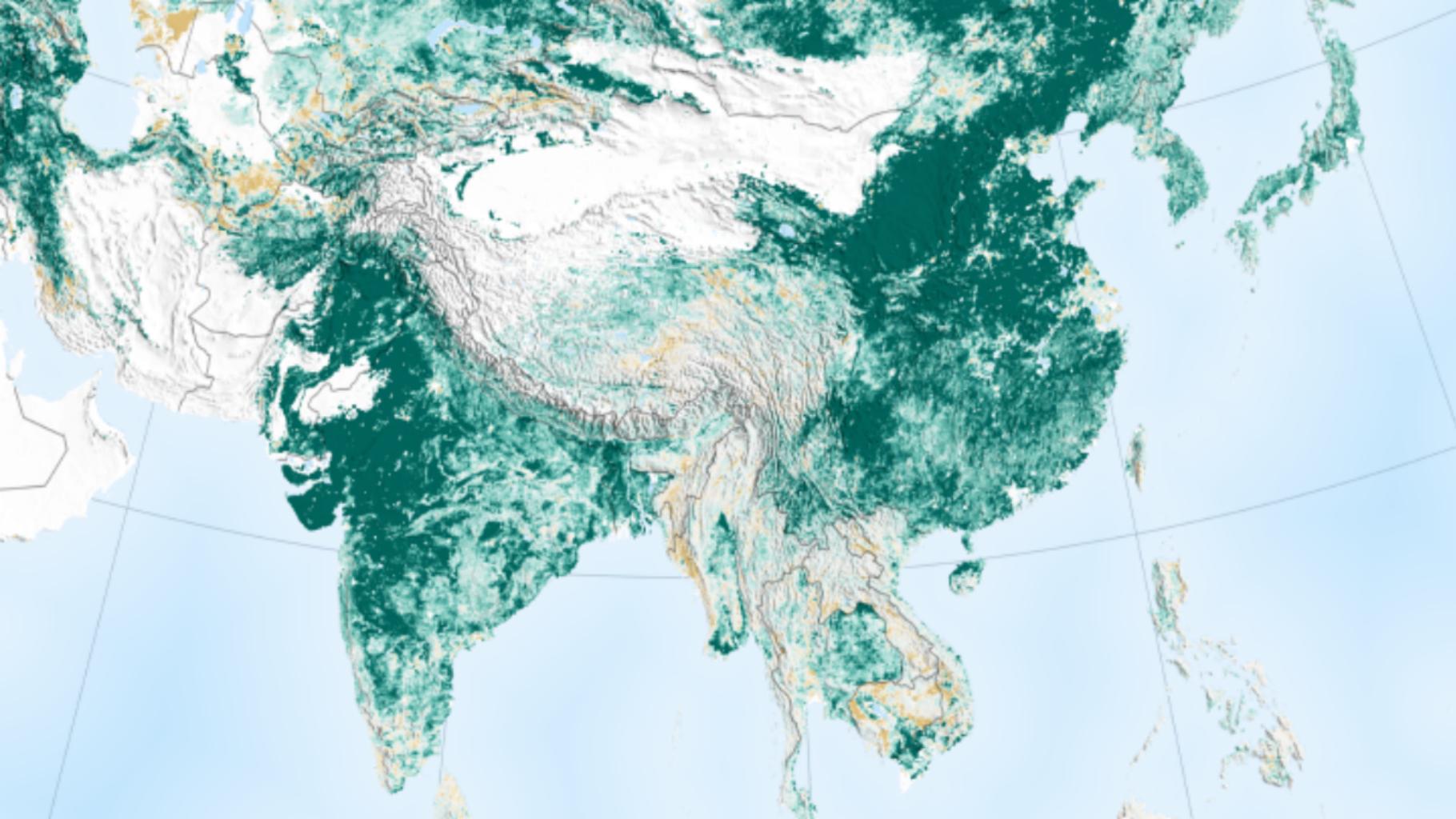
Global Embodied Landscape Trade Networks

- What is the current state of forested landscapes
- How does this relate to current patterns of landscape trade?
- What is the role of China, which is a globally dominant economic consumer and producer?



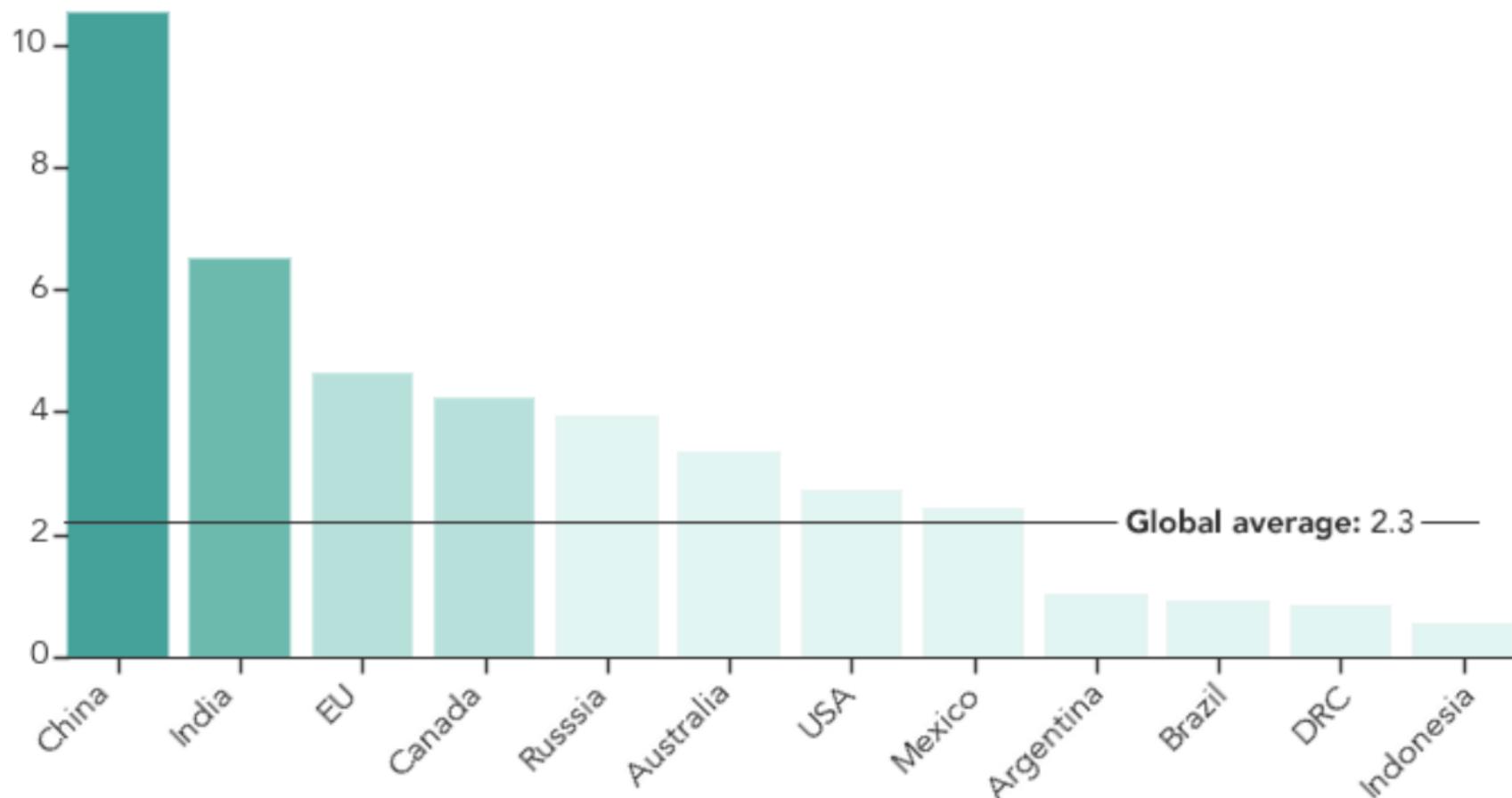
Trend in Annual Average Leaf Area (% per decade, 2000-2017)





China and India Lead in Greening Due to Human Activity

Change in Leaf Area (% per decade)



D

China Imports 2018: Wood (Lumber and Sawn)

Units

Value (US \$)

Weight



Share of global forestry products trade



Scale

5m t

10m t

20m t

Exporter

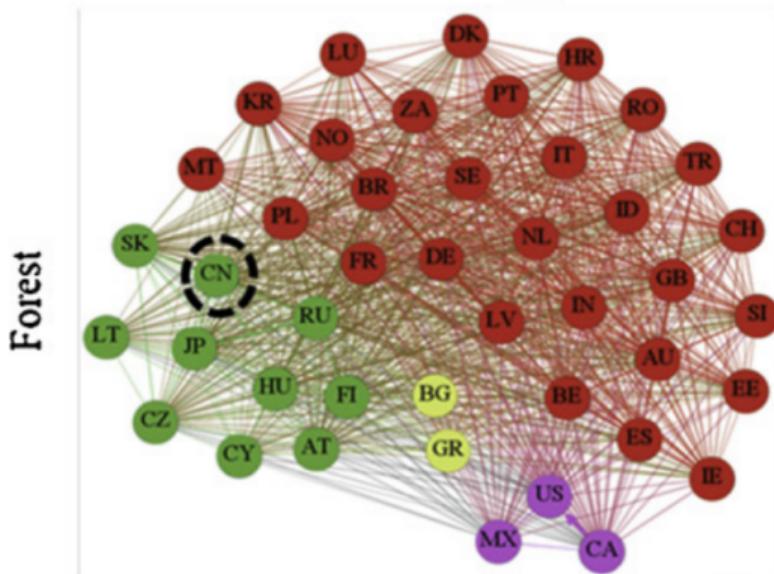
Importer

Free Zones

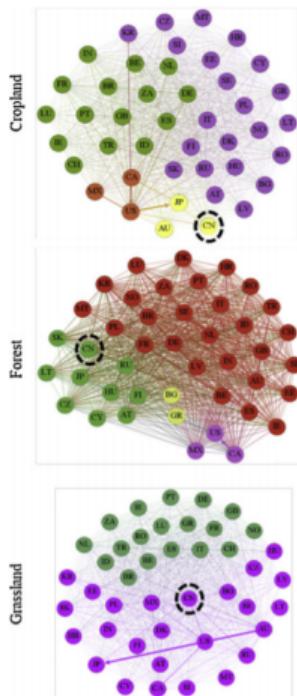


SOURCE: Chatham House Resource Trade Dashboard

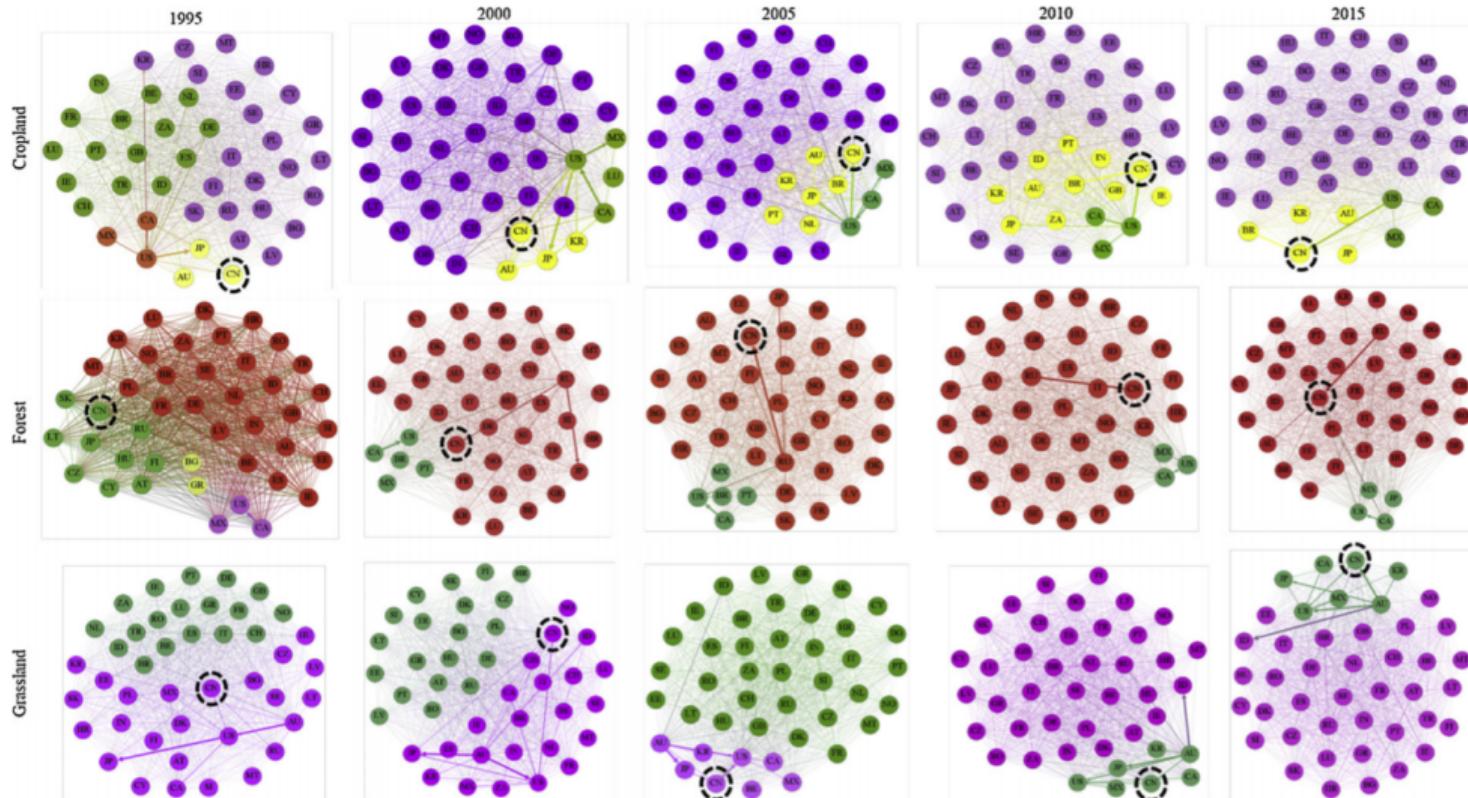
Global Embodied Landscape Trade Networks (Tian et al. 2019)



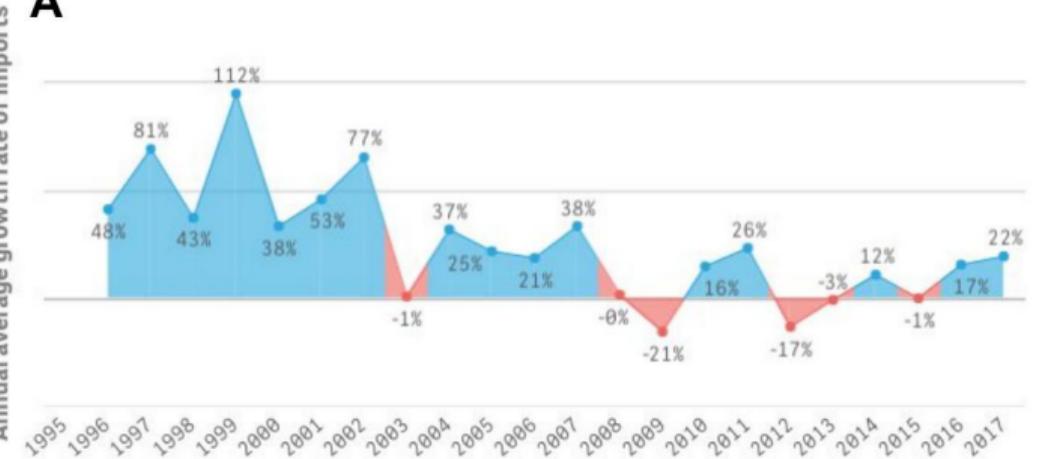
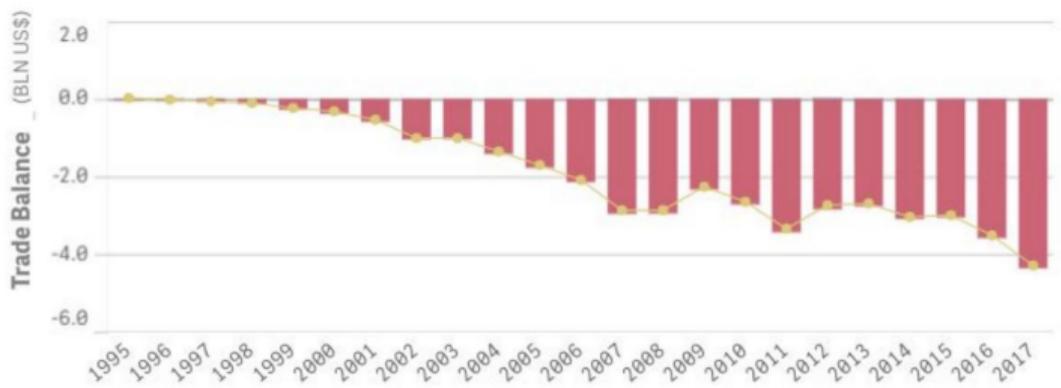
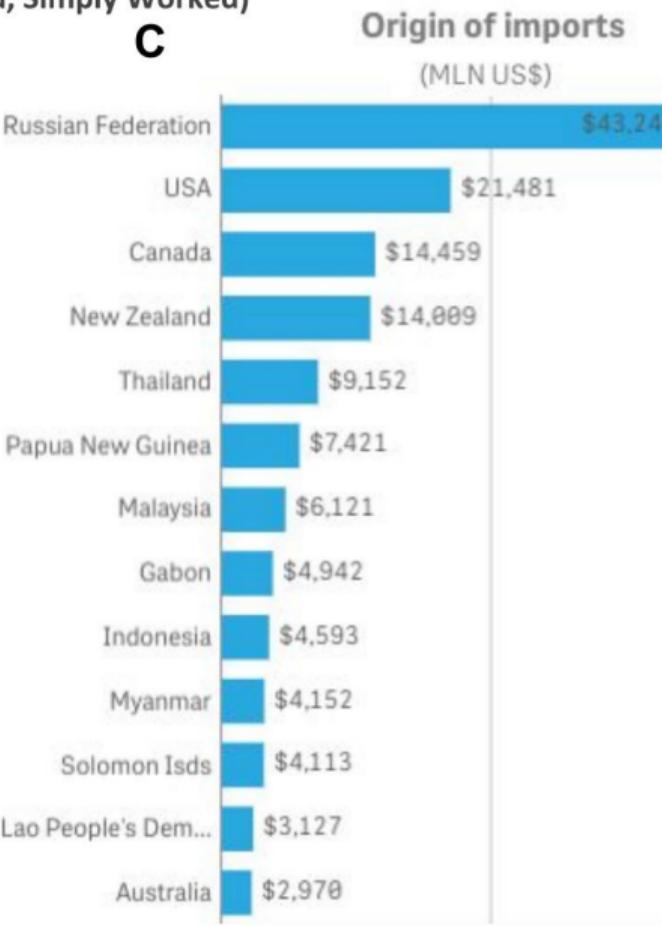
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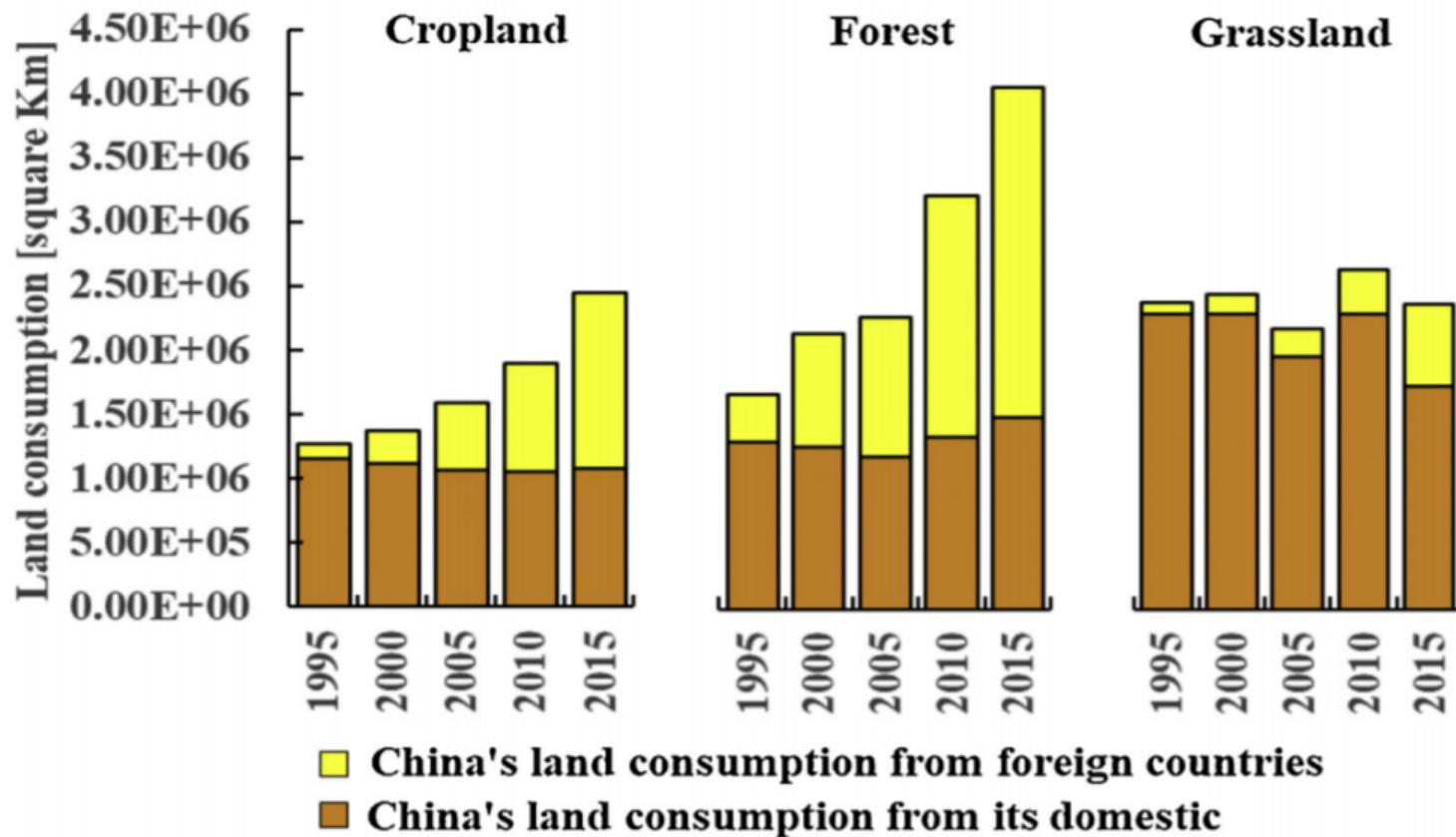
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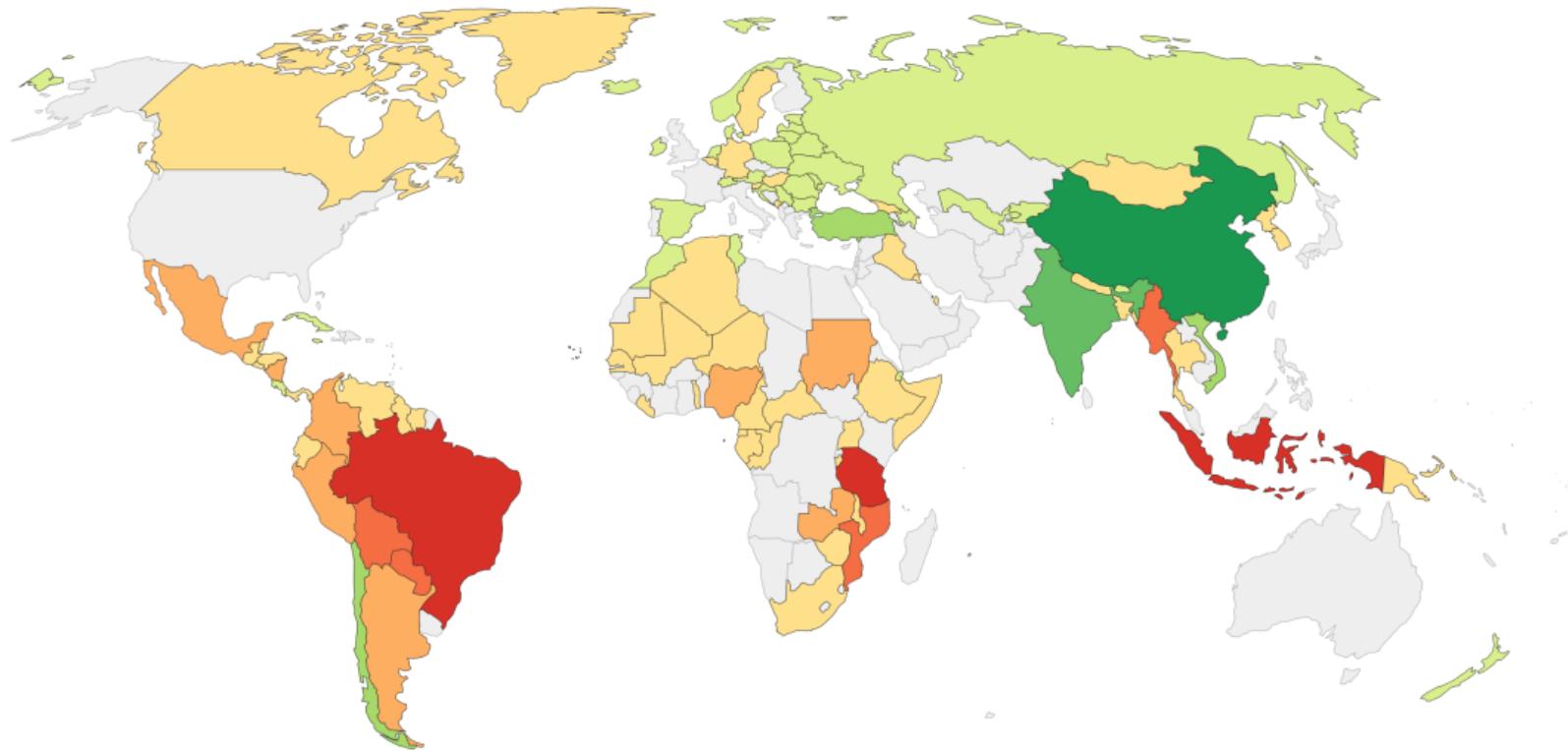


China Imports: Wood Products (Rough Squared, Simply Worked)

A**B****C**

SOURCE: United Nations Commodity Trade Dashboard (2020)





No data
-400,000 ha

-200,000 ha

-100,000 ha

0 ha

100,000 ha

200,000 ha

400,000 ha

>600,000 ha

Global Embodied Landscape Trade Networks

- The Earth is getting greener, due in large part to forests in China

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- This greening is in part the result of national forest policy driven shifts in forest use

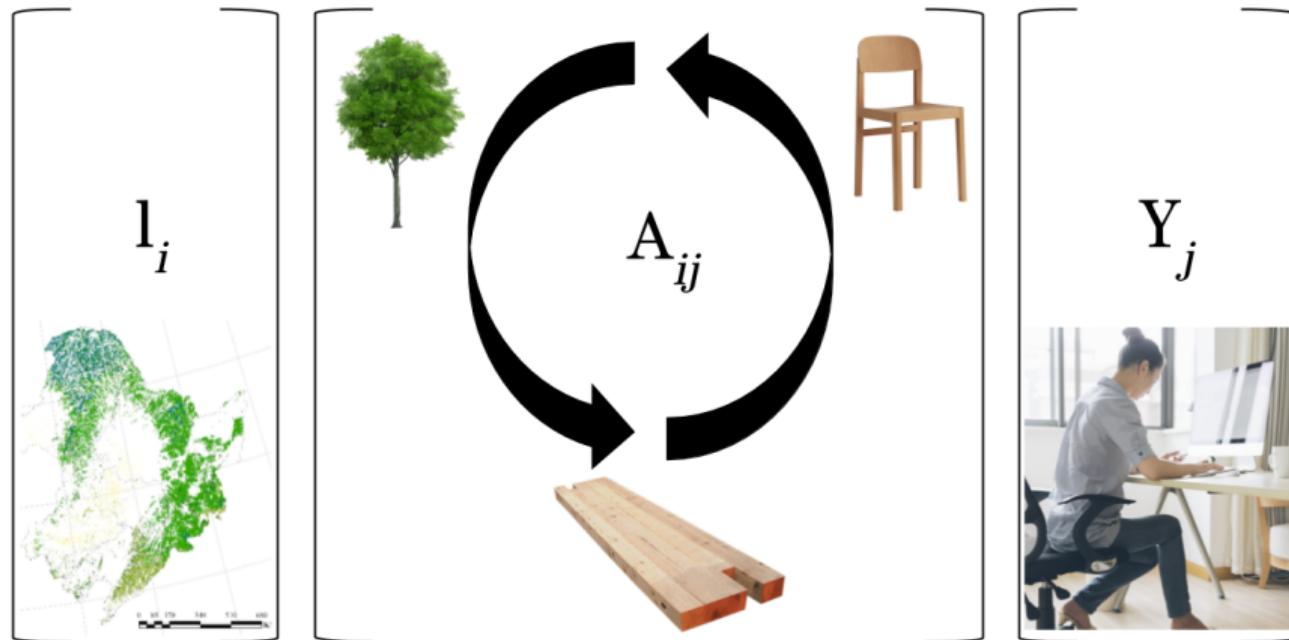
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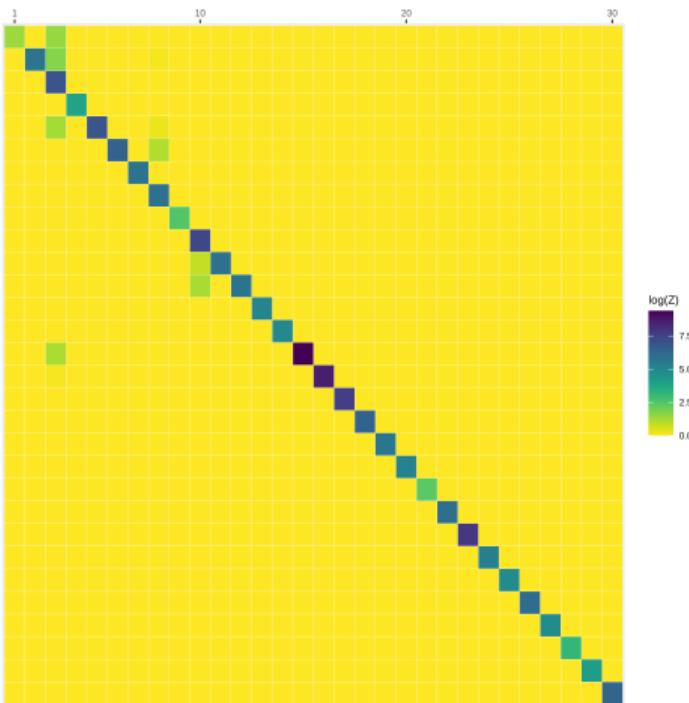
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- This greening is in part the result of national forest policy driven shifts in forest use
- These shifts have concomitantly resulted in expansion of imports and deforestation through global trade networks
- China is a dominant direct and indirect consumer of domestic and global forested lands

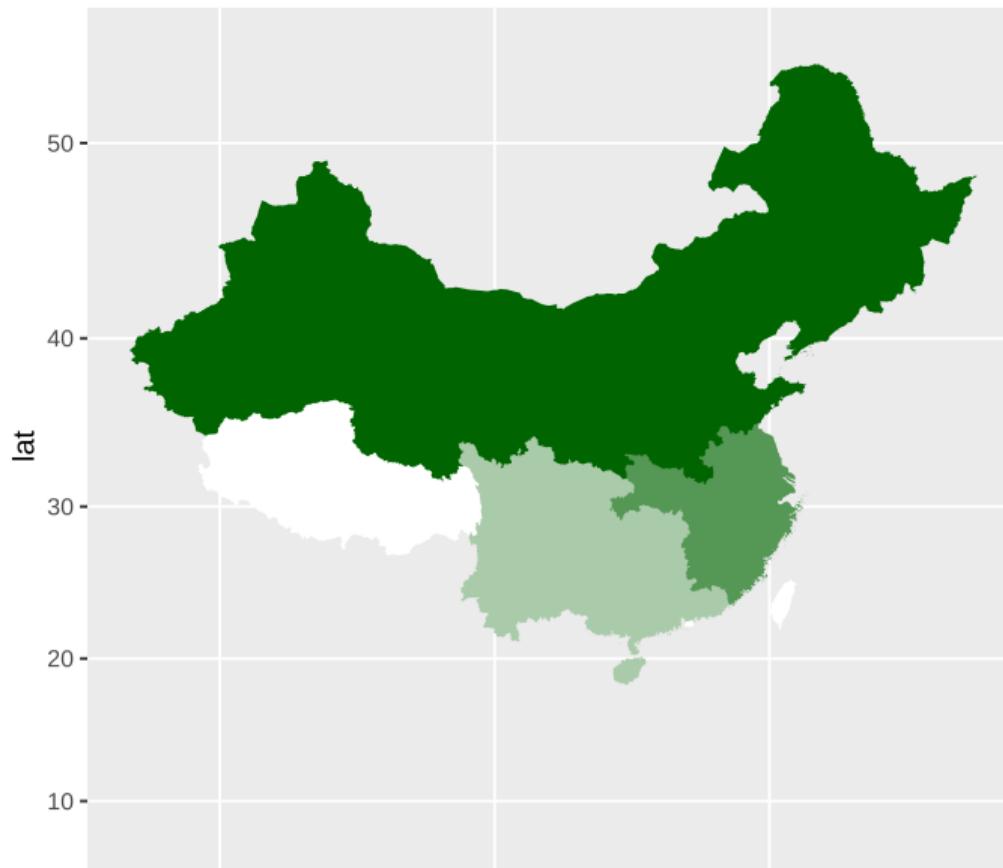
Network Structure of China's Domestic Forest Lands



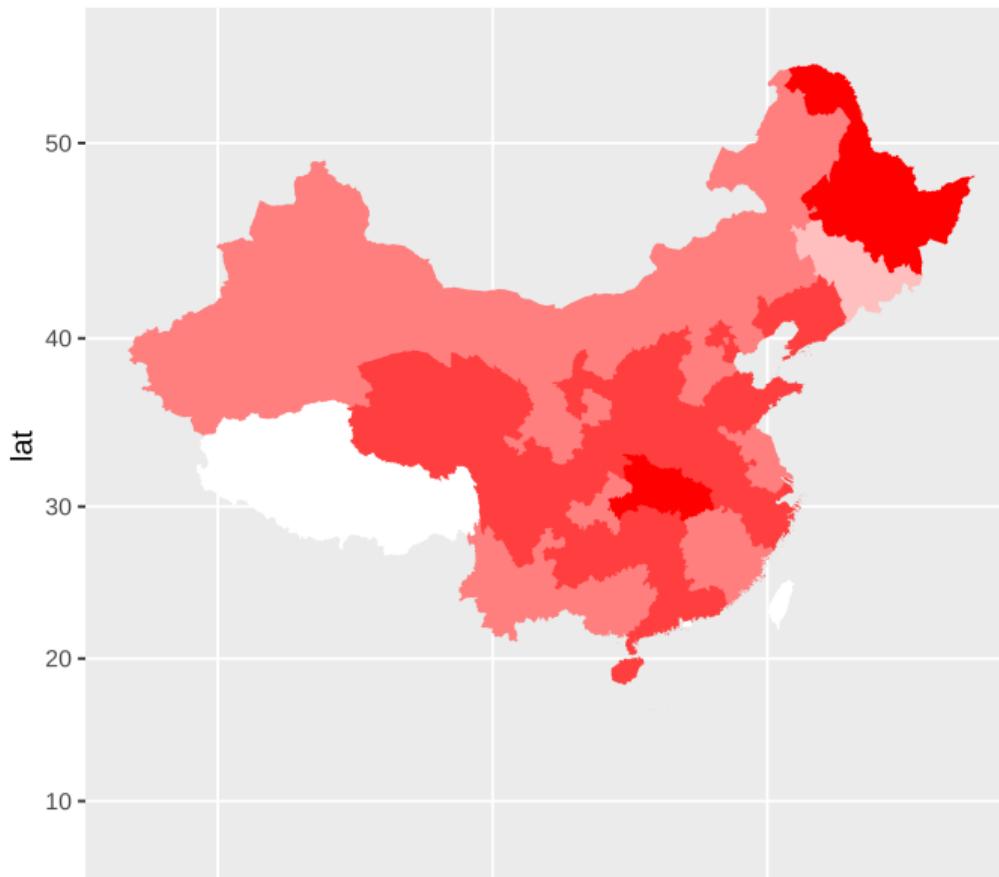
Network Structure: Highly Localized Direct Use



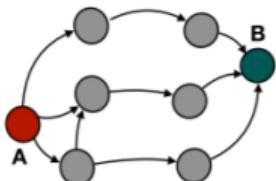
Network Structure: Three Modules



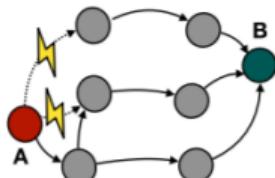
Network Structure: Dominated by Two Provinces



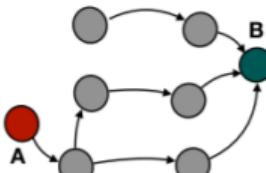
Network Structure to Dynamics



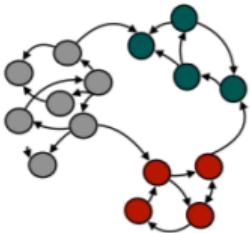
Redundant pathways between
A and B



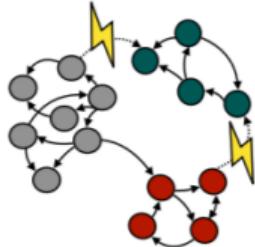
Shock in the system



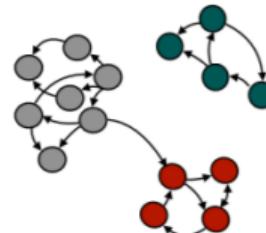
Perseverance of pathway
between A and B



Modular network

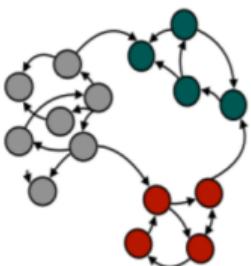


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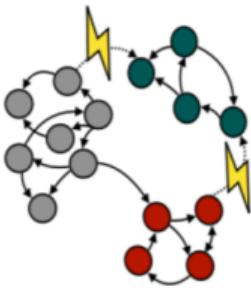


Network fragmentation

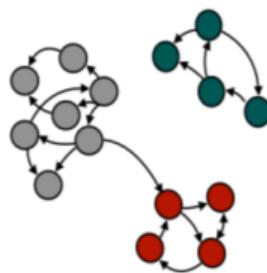
Network Structure to Dynamics



Modular network

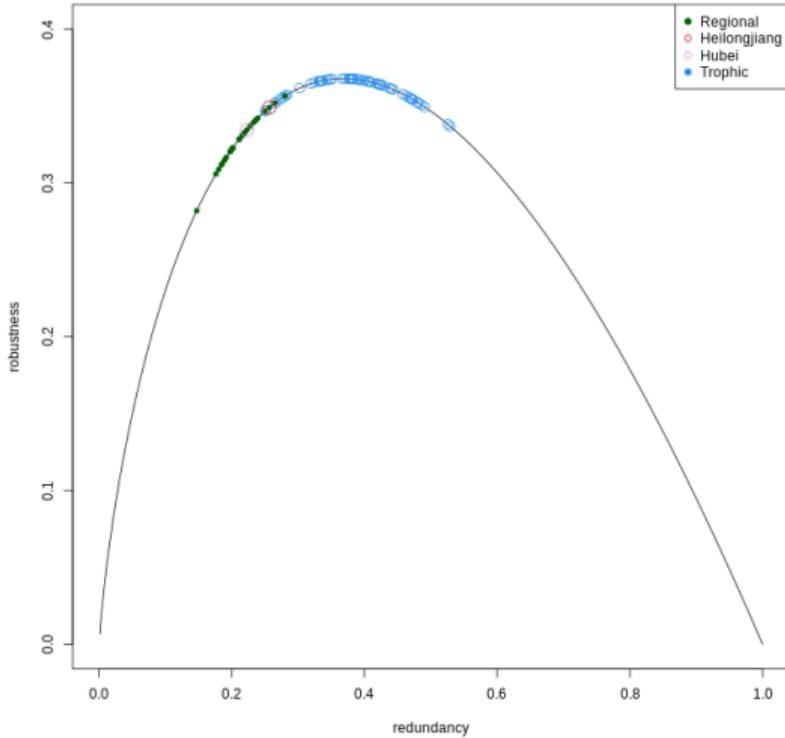


Shock in the system



Network fragmentation

Network Structure to Dynamics



Summary and Conclusions

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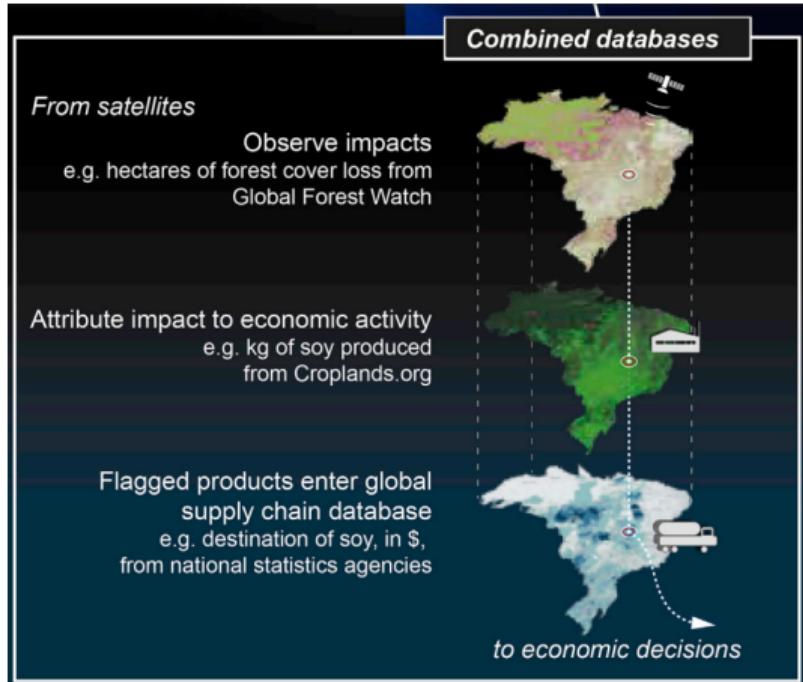
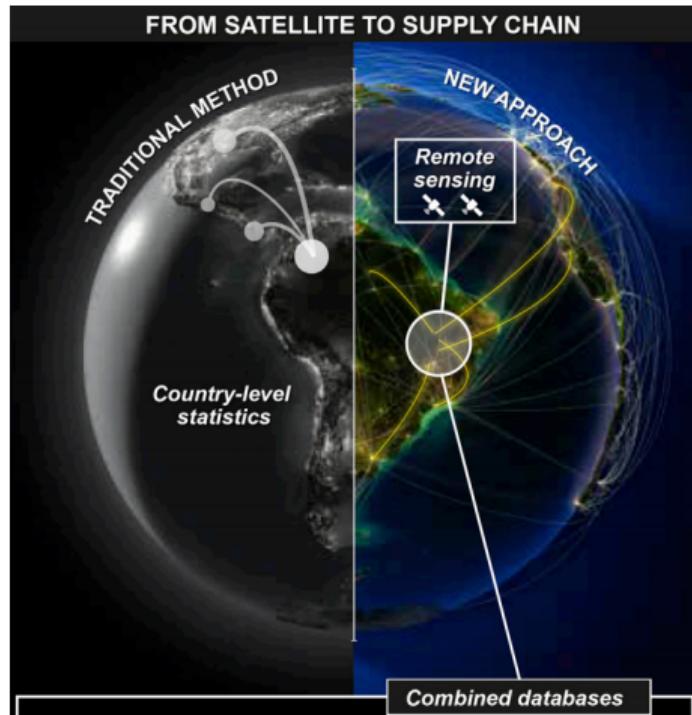
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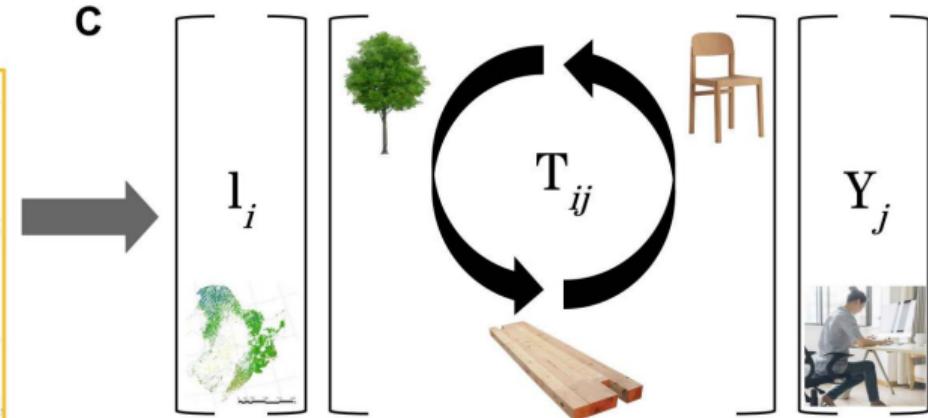
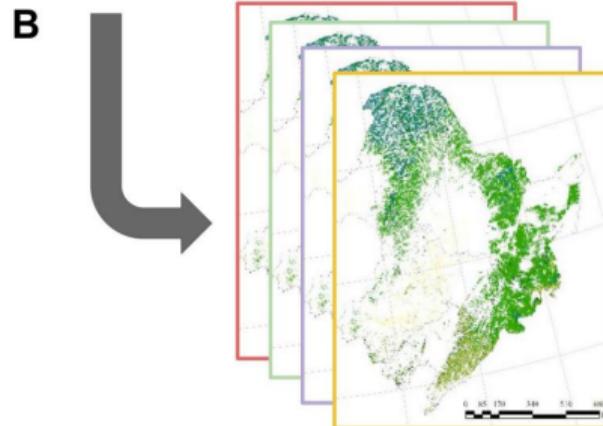
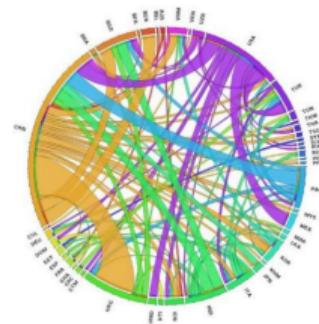
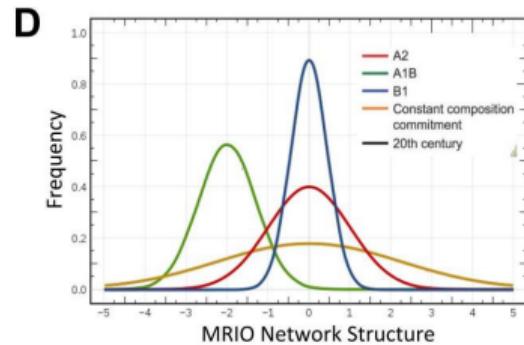
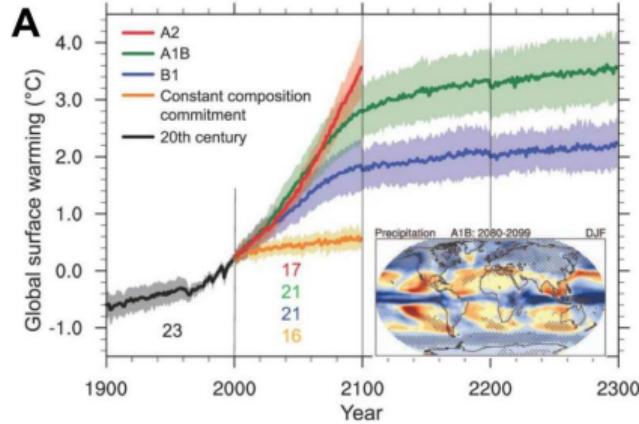
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- **Take-Home:** structural analysis of global and domestic networks provide a necessary insight into human impacts on Earth, suggesting the need/opportunity for international coordination in environmental issues.

Future Work: CAS Grant (2021-2023)



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Cool Projects to Check Out

- www.globalcanopy.org - Financial Sector Transparency
- www.fineprint.global - Product Sourcing Analysis
- trase.earth - Stakeholder and Investor Information

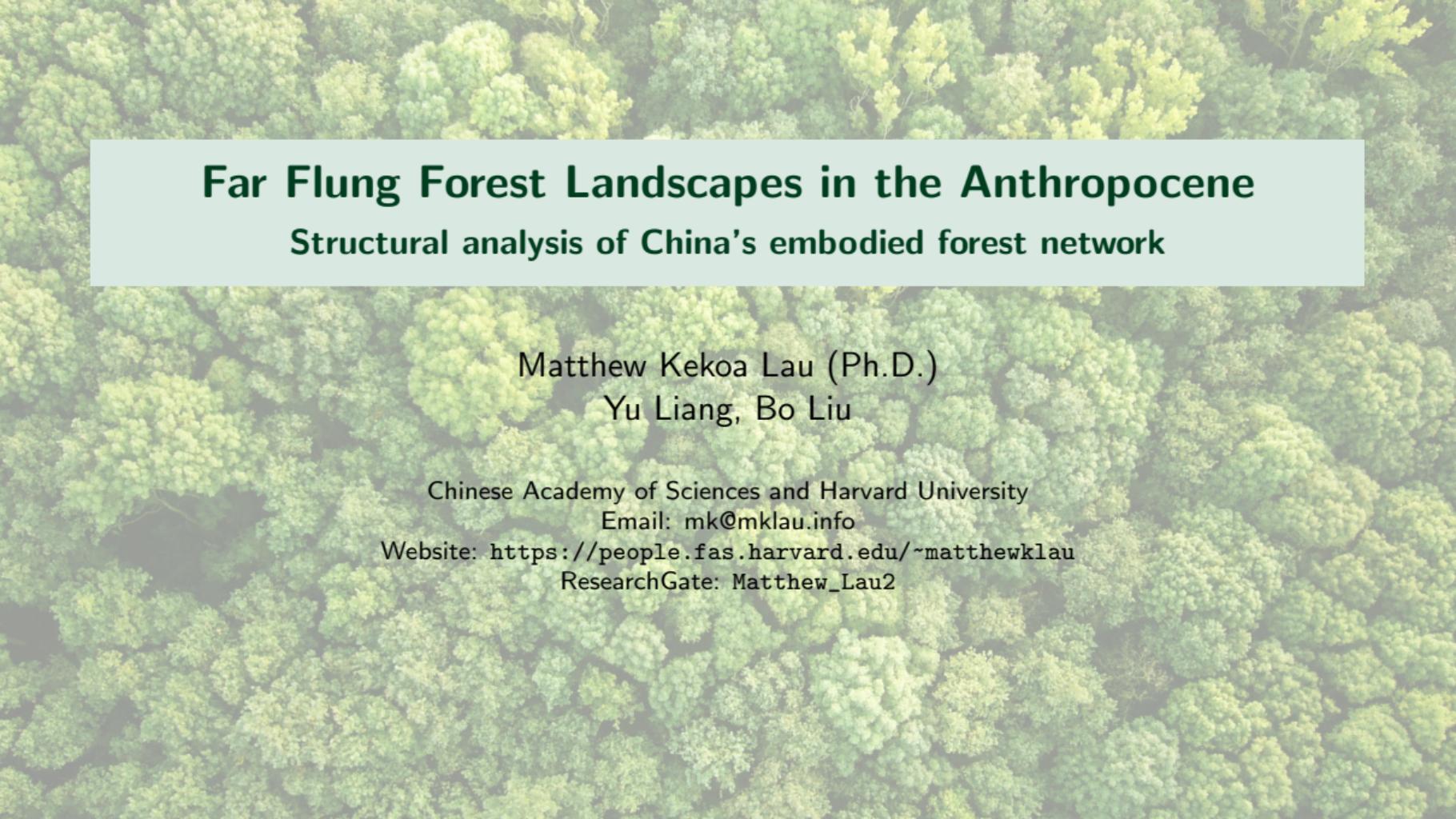
Acknowledgements





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Far Flung Forest Landscapes in the Anthropocene

Structural analysis of China's embodied forest network

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