Climate Impacts of/on Timber Construction

Galina Churkina
Potsdam Institute for Climate Impact Research
Germany
Climate Impacts of Timber Construction
Forests → Timber → Manufacturing Facility → Wood Products → Bio-Fuel → City
Climate Change Manifestation

Global surface temperature relative to 1951-1980 average temperatures

Source: climate.nasa.gov
11 Gt C per year
CO$_2$ uptake

3.8 Gt C per year

2.5 Gt C per year
11 Gt C per year =

3.8

4.6

2.5
Globally, forests are a carbon sink:

2001 - 2010
Old growth forests: 0.66-0.96 PgC per yr
Regrowing forest stands: 1.03-1.96 PgC per yr

Pugh et al., PNAS, 2019
Forests release other greenhouse gases, e.g., N$_2$O, CH$_4$

... but their role in removal is negligibly small
Forests release and uptake water
VOC + NO\textsubscript{x} = O\textsubscript{3}

Figure from Churkina et al 2015, Environ Sci Policy
Forests modify land surface albedo
LMDz – general circulation model

ORCHIDEE-CAN – land surface model including forest management

CO₂, H₂O, Heat → CO₂

Forests

Wood Products

Bio-Fuel

Carbon Pool

Naudts et al. 2016, Science
What are the effects of 250 years of forest management in Europe?

Naudts et al. 2016, Science
What are the effects of 250 years of forest management in Europe?

Afforestation: +196,000 km$^2$

1750 - 2010

Naudts et al. 2016, Science
What are the effects of 250 years of forest management in Europe?

1750

- Unmanaged: 37%
- High stand: 36%
- Coppice: 27%

2010

- Unmanaged: 14%
- High stand: 72%
- Coppice: 14%

Naudts et al. 2016, Science
What are the effects of 250 years of forest management in Europe?

- **1750**
  - Conifers: 30%
  - Broadleaves: 70%

- **2010**
  - Conifers: 57%
  - Broadleaves: 43%
What are the effects of 250 years of forest management in Europe?

- 250 years of afforestation and forest management did not cool European climate
  - Increase in summer temperatures of atmospheric boundary layer (0.12 deg C)
  - Increase in radiative imbalance of the atmosphere (0.12 W per m²)
- Accumulated carbon debt of 3.1 Gt C despite afforestation
- Need to account for all processes, not one is clearly more important.

Naudts et al. 2016, Science
How powerful could the transition to urban timber buildings be in mitigating climate change?

2,300,000 new urban residents

Churkina et al. 2020, Nature Sustainability
How powerful could the transition to urban timber buildings be in mitigating climate change?

Churkina et al. 2020, Nature Sustainability
How powerful could the transition to urban timber buildings be in mitigating climate change?

- Reduce the CO₂ emissions from material manufacturing and construction by half
- Store 0.01–0.68 Gt C per year in cities and create an urban carbon pool of up to 20 GtC over 30 years
Sperrstrasse, Basel, Switzerland

Thermal Image of Sperrstrasse at night

Pictures credit: J. Voogt
Climate Impacts on Timber Construction
Forest disturbances

North America (2005-2008)
Droughts 1.2 million ha
Beetle outbreaks 6-7 million ha per yr

Klein and Hartmann, Science, 2018
Tree migration


Fei et al. 2017, Science Advance
Manufacturing Facility

Salvaged Timber

Wood Products

Bio-Fuel

Biochar

Tree Clippings

Used Wood

City

Forests (soft and hardwood)
There will be manifold impacts of timber construction on climate as the industry scales up.

Adapt forests to changing climate – monitor & sustainably manage the forest carbon pump.

Adapt product manufacturing to changing climate – diversify inputs and outputs.