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Wooden Buildings as Carbon Storages – Mitigation or Oration?

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Objective

To define (and indicatively quantify) the mechanisms by which timber construction contributes to and interacts with the CO_2 content in the atmosphere.

What's the point?

To clarify the causal dependences between timber construction and climate effects: what matters less, what matters more, and what's the sum?

Wood-eyed approach…

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Sustainable development

- The greatest challenge of the humankind is to preserve the planet to the coming generations – limited resources are distributed to a growing number of consumers.

Constantly growing potential for sustainable solutions, timber construction undoubtedly being among those

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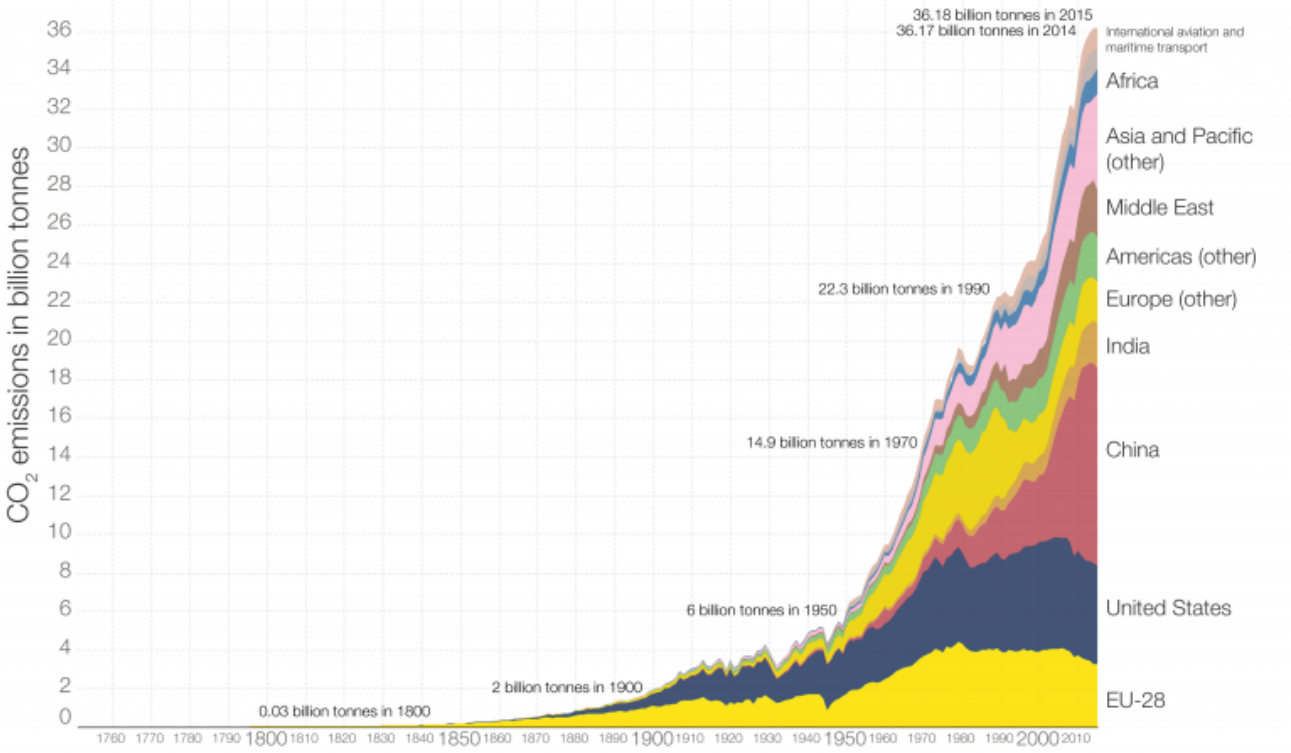
SDG13: Climate action…

Global CO_2 emissions by world region, 1751 to 2015

Annual carbon dioxide emissions in billion tonnes (Gt).

Our World in Data



Data source: Carbon Dioxide Information Analysis Center (CDIAC); aggregation by world region by Our World In Data.
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.

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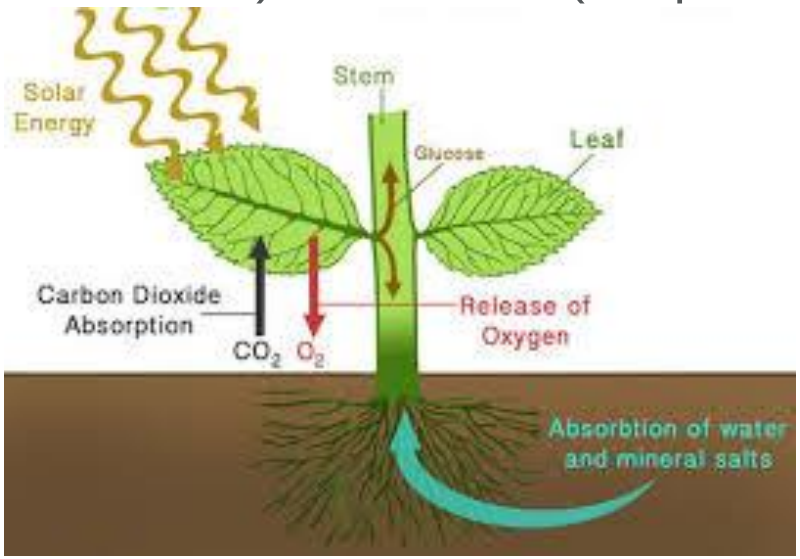
Carbon and wood

- Chloroplast in trees turns 0.8 t of atmospheric CO_2 and soil water into carbon hydrates, from which the cambium makes 1 m^3 of lignocellulosic compounds, cell walls. Side product: 0.7 t of O_2.
- All wood-based products, even tissue paper, have kept carbon molecules away from atmosphere for years (tropical or sub-tropical conditions) or decades (temperate or boreal conditions).



Source: quora.com

Carbon storage: material or product that stores carbon molecules a long period of time before releasing it back to the atmosphere. Old forest is a big but unstable carbon storage.

Carbon sink: a carbon storage that increases. Old forest is a small carbon sink or a carbon source, whereas a growing forest is a big sink.

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Ways to control atmospheric CO_2 content

1. Reduction of human CO_2 emissions (now 35,000,000,000 t/a)
   - Has been tried for some time, seemingly difficult (see: slide 4).
2. Increasing the sequestration and producing long-life storages
   - Sequestration is fairly simple and affordable (afforestation, re-forestation, growth optimizing forest management), but often referred to as a too slow process.
     - Good signs: ”greening” of China, India, and many African areas, tree planting campaigns throughout the world.

Unfortunately, CO_2 emissions still increase, and they increase faster than sequestration does, thus, point 1) needs more serious efforts.

HAZARD FACTORS (eruptions, wildfire, storms, insect outbtreaks,…) may turn human GHG limiting actions ”irrelevant” in a matter of minutes.

Effects of timber construction on CO_2 control

Three mechanisms:

Physical C stored in buildings annually

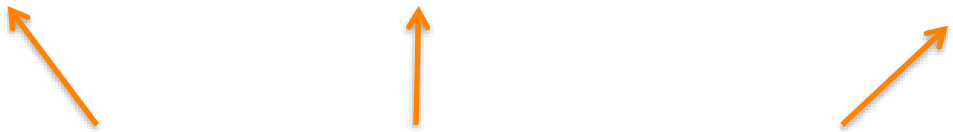
Mass, volume, CO_2 eqv.

Material and energy substitution effects

Displacement factors DF

Implications on forest management and subsequent C storage and sink

Forest inventory



Which is/are powerful in CO_2 control?

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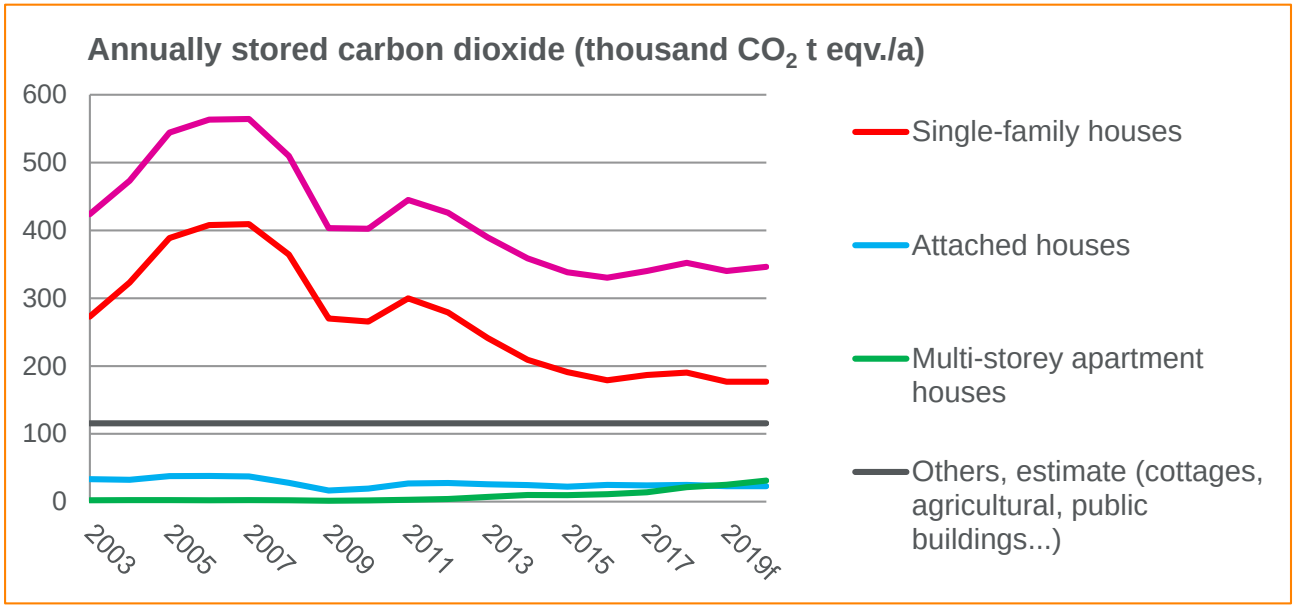
Building sink effect BSE

A measure that relates the C stored in buildings with the CO_2 emissions by human activities per year (or other time).

- BSE=1 means that one per cent of the annual human caused CO_2 emissions in a particular area is stored in new buildings as long-lifecycle structures (C storages) in the same area. Area may be, e.g., a country or the world.
- BSE illustrates the effect of timber structures as CO_2 emission compensators in a climate discourse relevant scale.

Wood products and human emission, FIN

- Long lifecycle C storage increment caused by new wooden buildings was 340,000 CO_2 t eqv. (440,000 m^3) in Finland in 2017, covering 14% of the domestic use of wood products.
  - 0.6% of Finland's annual emissions of 56,000,000 t => BSE=0.6



Sources: Statistics Finland, Heräjärvi 2019

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Wood products and human emissions, World

Wood product manufacturing (~ 0.5 billion m^3/a) stores 0.4 billion t of CO_2 from atmosphere (for longer or shorter time) => ~ 1% of the human emissions per a.

Theoretical CO_2 emission compensation potential in timber structures per annum?

Share of long-term C storages in buildings from the global wood product production of 0.5 billion m^3/a, %	Mill. m^3	BSE
10	**50**	**0.1**
20	**100**	**0.2**
90	**450**	**1.0**

Now we are around here...

Wood products as physical C storages only are low-impact tools in CO_2 control

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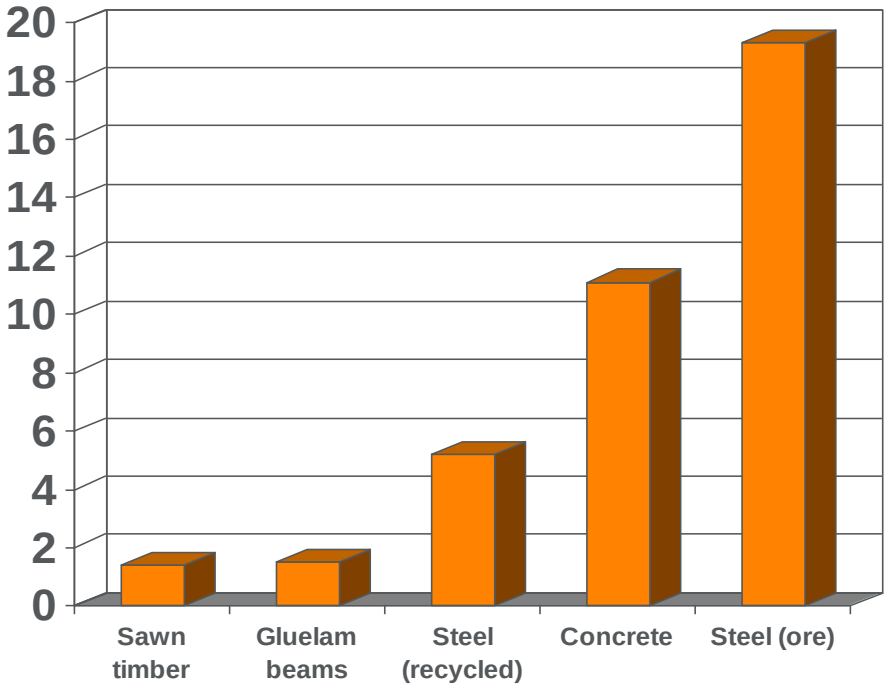
Substitution effects

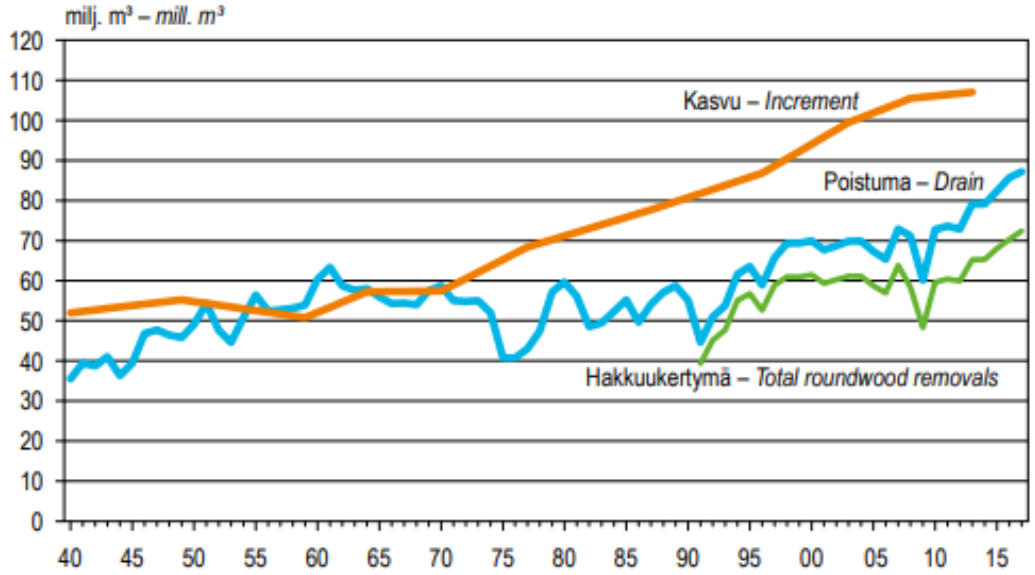


Source: Swedish Forest Industries Federation, 2003

Cement production is a global climate problem, but unfortunately wood products cannot substitute concrete: Global production of wood products is ~5% from the annual volume of concrete production.

Carbon storage and sink in Finnish forests

- Renewable resources can be both grown and utilised simultaneously.
- The volume of wood (= C storage) in and the CO_2 sink of Finnish forests has increased by 40% during the past 50 years as a result of forest management and markets for roundwood (= industrial buyers).



Lähde: Luonnonvarakeskus
Source: Natural Resources Institute Finland

A rational owner takes care of her/his property (and its growth) as long as the property is expected to have a reasonable market value.

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Timber construction and climate effects, Case Finland

- The meaningful climate effects of timber construction are realised via active forest management, which is predominantly motivated by well functioning saw log markets.
  - 70% of wood products, produced from sawlogs, are used in construction value chains (only little part of which ends up in long-term C storages).
  - 70% of stumpage income for Finnish forest owners comes from sawlogs.

=> Sawing, and practically whole forestry, depend economically on construction activity.

So where is wood C?

Storage size

- The amount of C stored in living trees and organic soil biomass is comparable to the entire CO_2 volume in the atmosphere.
- C storage of World forests estimated as ~800 billion t.
- C storage of existing wood products is 7-10 billion t.

Annually

- Globally, forests and soil sequester ~4 billion t of C.
- Globally, long-life wood products sequester 0.05-0.1 billion t of C.
- The volume of C loss (decay, burning) is challenging to estimate.
- In Finland, growth of forests sequester 50% from our annual CO_2 emissions of 56 mill. t.

Conclusions

- Both physical C storages in buildings and material and energy substitution are fairly low-impact tools in CO_2 control, yet useful in material comparisons.
- Real climate effects come via active forest management, which has been mostly enabled by construction markets.
  - The causality between timber construction and growth of forest resources and C sink is complex and difficult to quantify. But it's there, and it's far greater than the role of physical wood product C storages or substitution effects.
- Unlike in the recent public discussion or calculation systems, all three additive mechanisms should be understood and taken into account to get a holistic view.
- Timber construction is good, much better than thought today.

Kiitos!

Please, find more information:

Heräjärvi, H. 2019. Wooden buildings as carbon storages – Mitigation or oration? Wood Material Science and Engineering 14(5): 291-297.

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