Life cycle assessment of conventional concrete and green concrete with wood waste biochar

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BACKGROUND

Global agricultural expansion and industrial activities such as municipal wastewater treatment, sawmills, and the pulp and paper industry generate hundreds of millions of tones of biomass waste annually. Much of this waste is still left to decompose or openly burned, resulting in significant greenhouse gas emissions. Pyrolysis offers a more sustainable treatment pathway, producing syngas, bio-oil, and biochar (30–40% yield). Biochar has recently been explored as a partial cement substitute in concrete. This is relevant because cement production emits around 0.8 t CO_2 per tone of cement, making the construction sector a major contributor to CO_2 global emissions. Using biochar in concrete may reduce both cement-related emissions and biomass-waste impacts.

OBJECTIVE

Assessment of environmental benefits of partially replacing cement with wood waste biochar in concrete using a comparative life cycle assessment (LCA).

RESEARCH METHODS

1. 5 vol.% of cement was replaced with wood waste biochar.
2. A life cycle assessment (LCA) was conducted using the ReCiPe 2016 impact assessment method (SimaPro software).

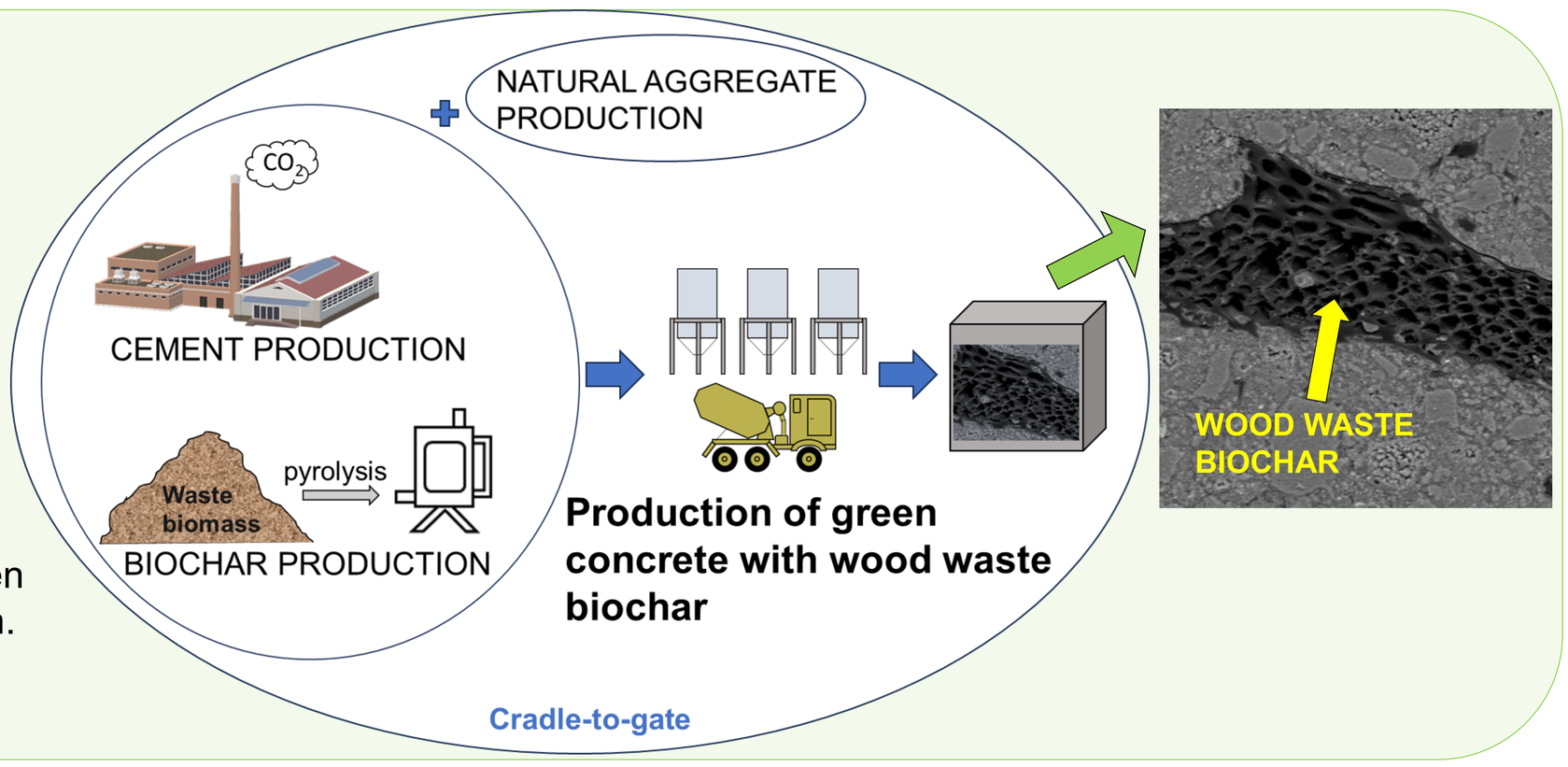

Figure 1: Life cycle assessment of green concrete production.

RESULTS

- Wood waste biochar reduced the global warming potential and decreased mineral resource scarcity.
- Wood waste preprocessing, especially drying, substantially increased electricity consumption.
- Electricity consumption due to preprocessing of wood waste elevated impacts in several categories, including terrestrial acidification, freshwater eutrophication, and fossil resource depletion.

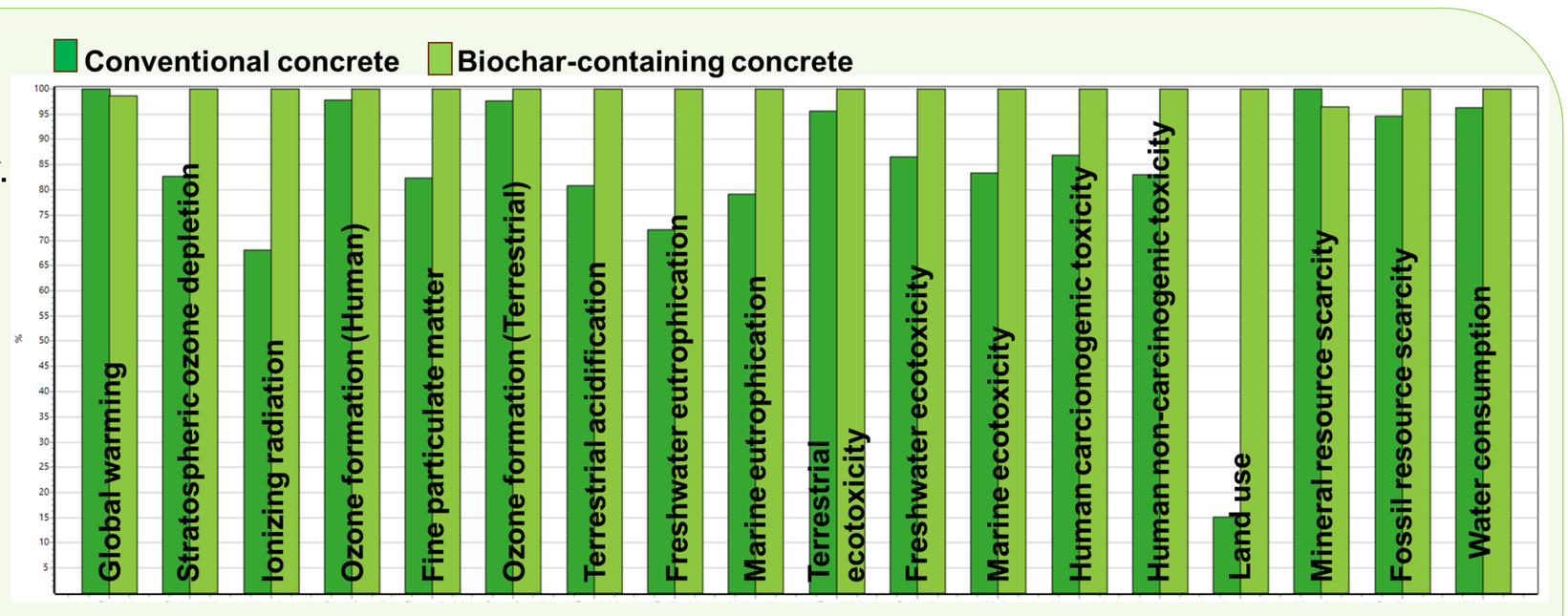

Figure 2: Comparison of life cycle assessment results of conventional and green concrete production.

CONCLUSIONS

→ **Energy demand in biomass waste preprocessing emerged as a key hotspot in the LCA.**
→ **Biochar reduces the carbon footprint of concrete when used as a partial cement replacement.**
→ **Enhancing the sustainability of biochar production will strengthen the environmental benefits of biochar-containing concrete.**

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