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RESEARCH BRIEF

DECEMBER 2022

KEY POINTS FOR DECISION MAKERS

- **Reducing the cost of basic farming equipment is the most effective way to lower seaweed production costs.** Despite innovators' focus on reducing labor and transportation costs, our results suggest low production costs depend on lowering costs of seeded line and basic farm equipment like boats, buoys, and anchors.

- **Although seaweed farming could potentially deliver gigaton-scale carbon removals, it would require very large ocean areas and likely cost more than other approaches.** Even when we assume very low production costs and that only the most productive areas are farmed, average costs to remove 1 GtCO_2 are close to \$500/tCO_2—more than double cost targets for alternatives like direct air capture.

- **The biggest climate benefits of seaweed farming may be displacing conventional agricultural products.** The benefits are boosted by avoiding non-CO_2 agricultural emissions, but it is not clear that there are markets for enormous quantities of seaweed products.

Growing giant kelp (*Macrocystis pyrifera*) Credit: Phil Cola

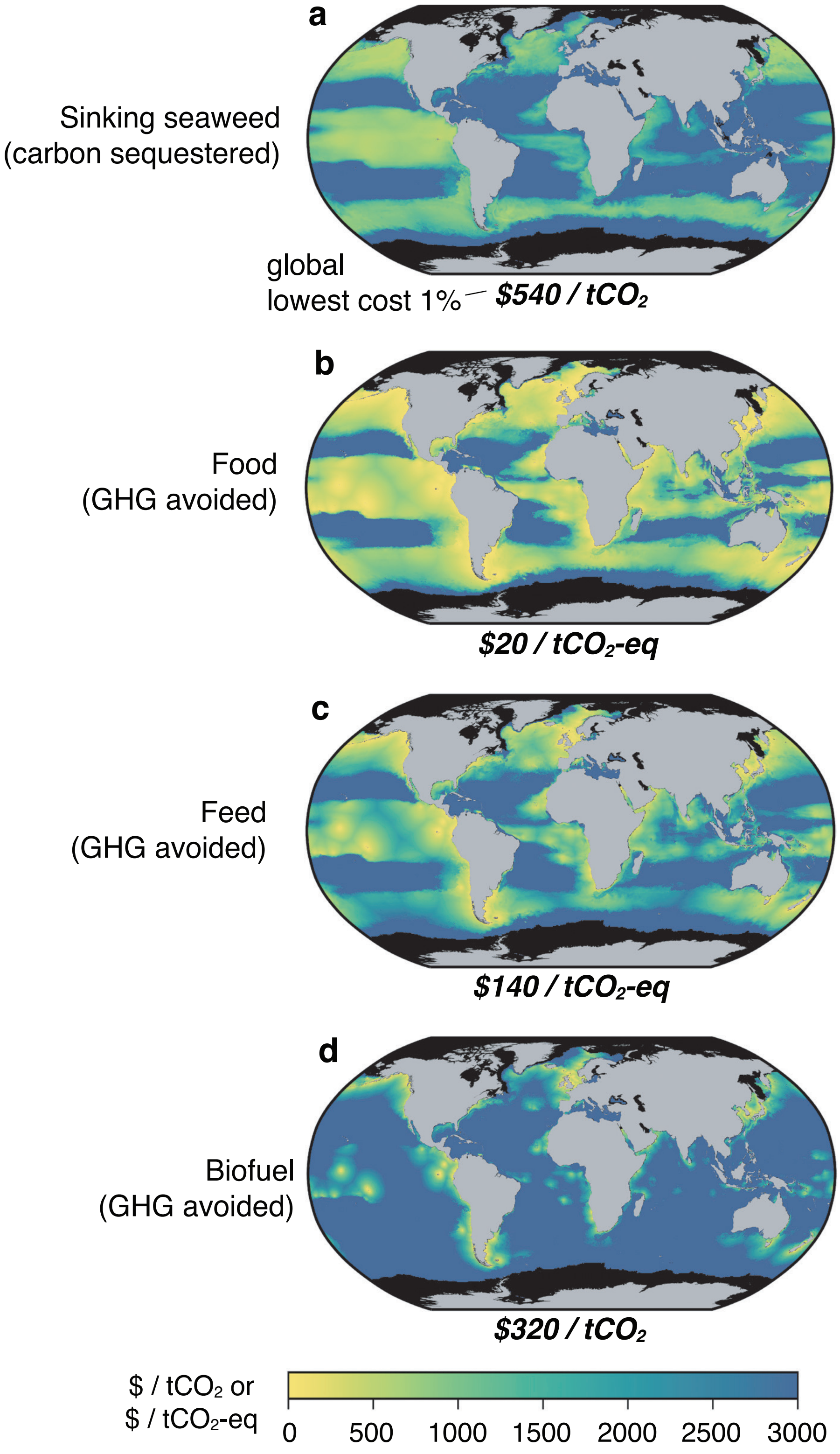
Climate benefits of farming seaweed could be large but depend on highly uncertain yields and competition with phytoplankton.

Net-zero greenhouse gas emissions targets are driving interest in opportunities for biomass-based negative emissions and bioenergy, including from marine sources such as seaweed. In a new paper, we couple seaweed growth and technoeconomic models to estimate the costs of global seaweed production and related climate benefits.

Under our most optimistic assumptions and best locations, we find that farming and sinking seaweed could sequester carbon at an average cost of \$540/tCO_2, whereas avoiding emissions by using seaweed for products might cost as little as \$20/tCO_2-eq (see **Fig**). However, these costs reflect ultra-low farming costs, high seaweed yields, assume that nearly all carbon in seaweed is removed from the atmosphere (i.e., that competition between phytoplankton and seaweed is negligible) and that seaweed products can displace products with substantial related non-CO_2 GHG emissions.

Moreover, our results show that gigaton-scale climate benefits from seaweed would require farming very large areas of ocean (>90,000 km^2, an area roughly the size of Maine), and a >30-fold increase in the area currently farmed.

In short, substantial seaweed-based climate benefits may be feasible, but targeted research and demonstrations are needed to reduce large economic and biophysical uncertainties.



Net cost of potential seaweed climate benefits. The costs of using farmed seaweed to sequester carbon or avoid GHG emissions vary due to differences in production, transportation, and processing costs as well as the market value of seaweed products and the magnitude of avoided emissions related to displaced non-seaweed products. Maps show costs under optimistic assumptions (i.e. the 5th percentile costs of our Monte Carlo analysis with access to all ambient nutrients). In each case, costs in 1% of areas with lowest costs ranges from \$20/ tCO_2-eq avoided when seaweed is used for food (**b**) up to \$540/tCO_2 sequestered by sinking seaweed (**a**).

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and web tool: **carbonplan.org/research/seaweed-farming**