Modeling Organic Waste Management for Soil Carbon Sequestration in California

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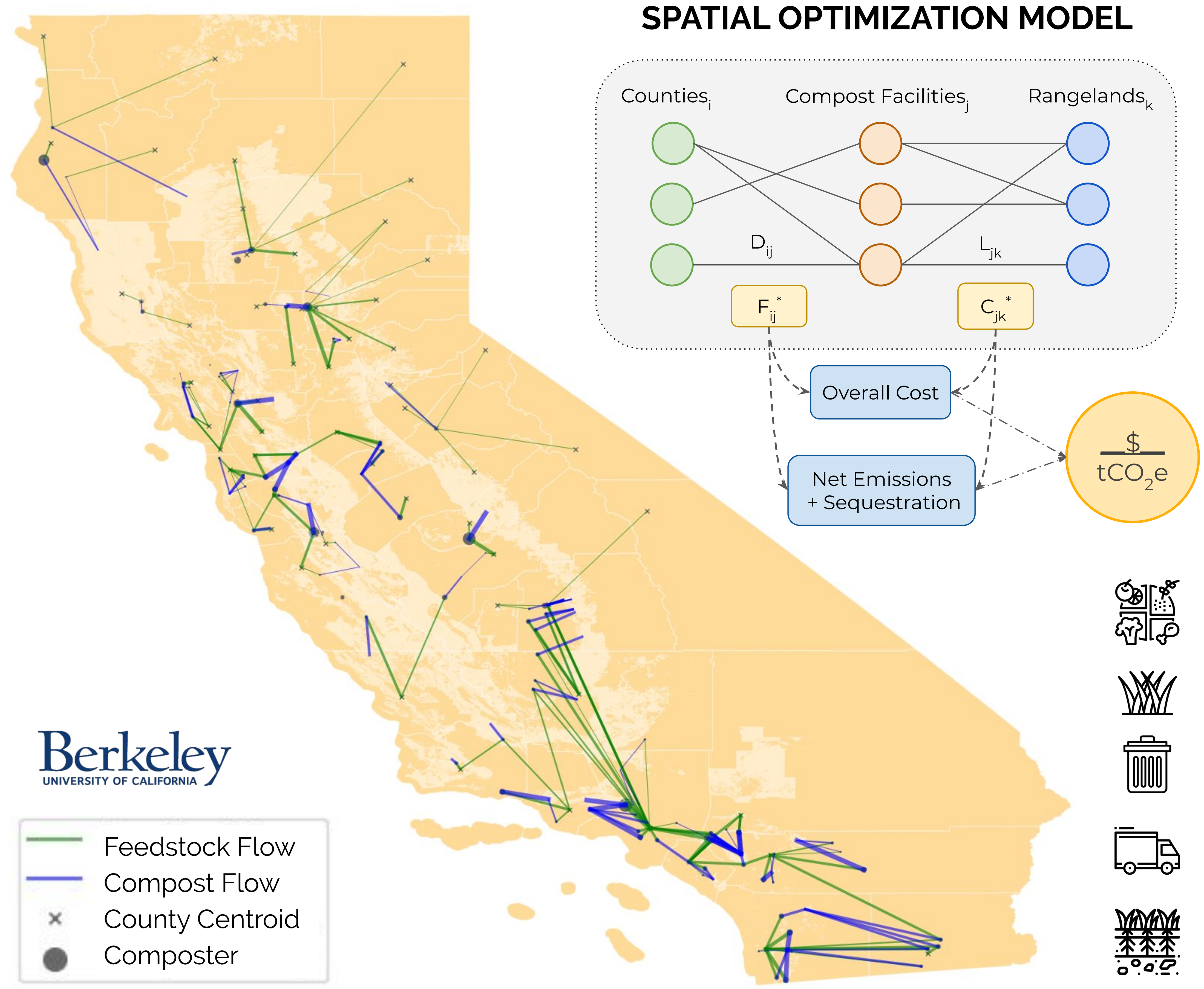
Composted municipal organic waste used as a soil amendment can both offset landfill greenhouse gas emissions and rebuild soil carbon in California's working lands



SPATIAL OPTIMIZATION MODEL

RESEARCH GOALS

>> This work combines spatial optimization and life-cycle assessment to consider the technical, economic, and institutional potential of actively managing the State's food scraps and green waste for climate change mitigation.

>> The goals of this research are to identify the cost and performance of re-imagining municipal organic waste streams as emissions sinks, rather than sources, and to assist decision-makers in developing strategies to manage waste and promote soil health.

METHODS

>> A linear programming model (illustrated to the left) was constructed to determine how best to distribute organic waste ('feedstock') and finished compost between nodes, s.t. capacity constraints.

>> The solved quantities (F_{ij}^* and C_{jk}^*) were used to calculate carbon sequestration, net emissions, and overall cost under a range of disposal scenarios.

Optimization Goal: Minimize CO_2e

Key Parameters: Haversine distances (D_{ij}, L_{jk}) between counties_i, compost facilities_j, & ranglands_k; emission factors for transportation; compost processing, application, & avoided emissions; and rangeland sequestration rate.

BACKGROUND

ORGANIC WASTE & GHG EMISSIONS

More than 30% of the food supply in the U.S. is never consumed[1] -- over half of this occurs at the household level and the vast majority ends up in landfills where energy and nutrients in food are broken down releasing methane (CH_4), a potent greenhouse gas[2]. In California this amounts to 6 million tonnes of food scraps landfilled every year. As a result, organic material is contributes over half of the state's anthropogenic methane (CH_4) emissions.[3]

CARBON SEQUESTRATION IN SOIL

In addition to preventing disposal emissions, amendments of composted organic material to rangelands can sequester new carbon at rates of 1 metric ton C/ha/y[3]. Compost-amended fields show improved forage production quantity and quality.[4] Organic matter in soil also reduces erosion, enhances nutrient retention, and increases water holding capacity.

DATA SOURCES

>> Organic Biomass - Breunig et al. 2017[5]

>> Compost Infrastructure - CalRecycle SWIS[6]

>> Grazed Grassland - California DOC 2016[7]

RESULTS

FROM SOURCE TO SINK: ~ $50/$tCO_2e$

>> The results of the model indicate a technical mitigation potential of ~8.5 MMT CO_2e, at a cost of $44 to $53 per ton CO_2e.

>> Sensitivity analyses suggest that some of the most influential parameters to this model are the cost of transportation (positively associated with abatement cost) and available composting capacity (negatively associated with abatement cost).

MATERIAL FLOW

>> The map above visualizes the modeled movement of feedstock (food scraps & yard waste) from counties to compost facilities (green) and finished compost from facilities to rangelands (blue), highlighting the large travel distances and volume of material in the south coast region of the State.

IMPACT & FUTURE WORK

>> Within current system constraints utilizing municipally generated feedstocks can yield considerable carbon sequestration benefits and present a cost-effective approach to climate change mitigation in the range of proposed federal sequestration credits[8].

>> This model is currently being revised to incorporate cultivated crop lands as a potential site of compost amendment and determine optimal siting locations for development of new composting infrastructure in California.

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