The potential for local croplands to meet US food demand

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ABSTRACT: Local food systems may facilitate agroecological practices that conserve nutrient, energy, and water resources. However, little is known about the potential for local food systems to scale beyond niche markets and meet a substantial fraction of total food demand. Here we estimate the upper potential for all existing US croplands to meet total US food demand through local food networks. Our spatially explicit approach simulates the years 1850 through 2000 and accounts for a wide range of diets, food waste, population distributions, cropland areas, and crop yields. Our results demonstrate an unexpectedly large current potential for meeting as much as 90% of the national food demand locally. These results provide a spatially explicit foundation for exploring the many dimensions of agroecosystem sustainability.

METHODS: Our foodshed analysis consisted of three steps:
(1) estimating the per-capita food demand,
(2) creating maps of the number of people that could be fed based on the amount of cropland present in each map grid cell, and
(3) selecting which cells should be allocated to which cities in order to maximize the percentage of the total US population that can be fed with locally produced food.

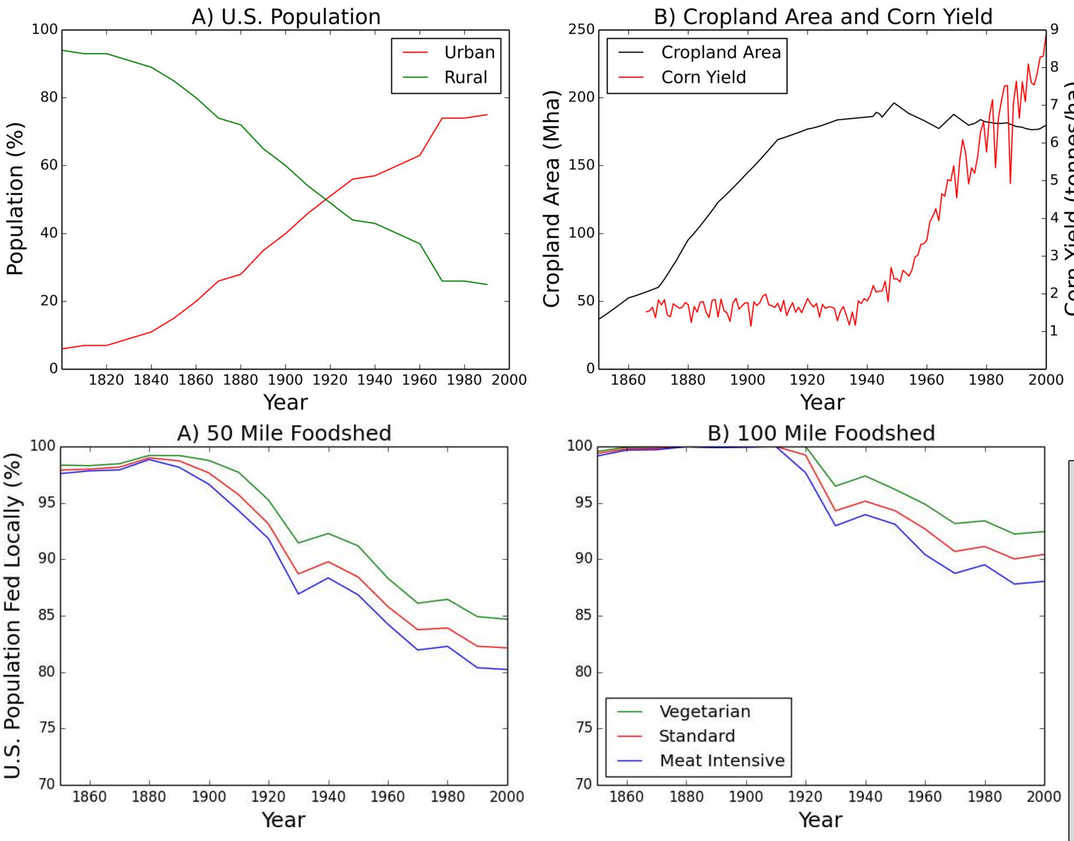

Figure 1. Historical US demographic trends, agronomic trends, and fraction of the population that can be fed by local food. Trends are for the years 1850 to 2000 in the US, including (a) population and (b) cropland area and corn yields. Percentage of the population that could theoretically be fed within a local foodshed in the conterminous US for Vegetarian, standard (ie typical US diet), and meat-intensive diets for (c) a 50-mile foodshed radius and (d) a 100-mile foodshed radius.

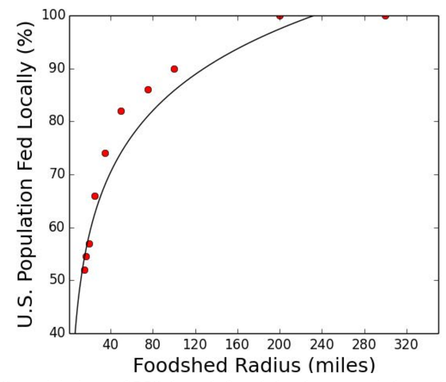

Figure 2. Sensitivity of US local foodshed potential to changes in maximum foodshed radius. Simulations are based on the assumption of a US standard diet for the year 2000. Points are individual simulations and the line is fit to data.

RESULTS and CONCLUSIONS:

- Nearly all US population centers could be fed within 100 mi. from 1850 to 1900
- In the year 2000, ~82% of US population centers could be fed within 50 mi. and 90% within 100 mi.
- Dietary choices and food waste have modest impacts on the national local food potential
- The theoretical local food potential is large enough to suggest that local food systems can scale beyond niche markets
- Our results indicate that the current foodshed potential of most US cities is not limited by current agronomic capacity or demographics to any great extent
- The critical barriers to this transition will be social and economic.

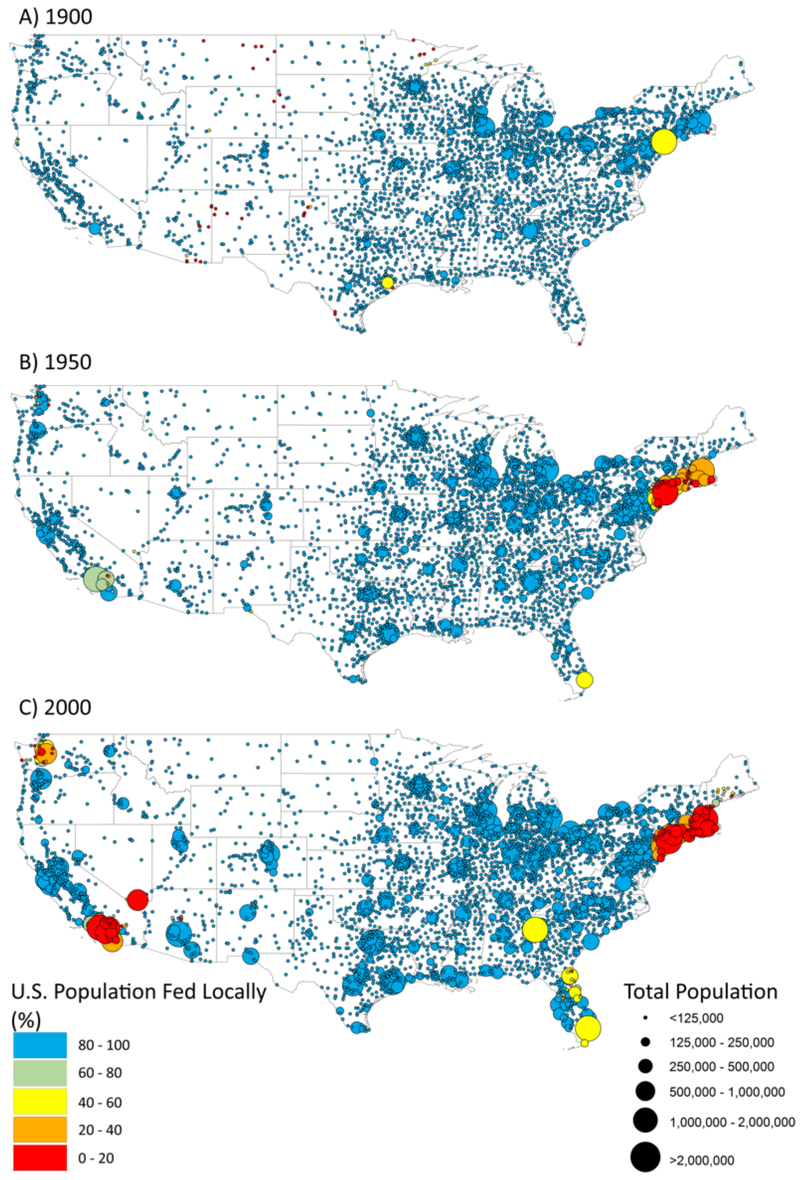

Figure 3. Percentage of the population that could theoretically be fed within a 50-mile foodshed by population center, based on a typical US diet in (a) 1900, (b) 1950, and (c) 2000

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Solar Photovoltaic Energy Generation on Aqueducts of California

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ABSTRACT: Passage of the California Global Warming Solutions Act of 2006 (AB 32) set the stage for a transition to a low-carbon economy. In addition to greenhouse gas action, drought in California is ushering in an era of unprecedented advances in water resource management. For example, Congressman Jared Huffman's pending assembly bill would expand investments to reduce evaporative losses in the Bureau of Reclamation water conveyances. Due to the simultaneous demand for greenhouse gas and water action, it is imperative that emerging solutions create synergies and avoid tradeoffs at the energy-water nexus. Photovoltaic structures constructed over aqueducts have been proposed as one novel solution to energy and water management. The objective of this study is to address knowledge gaps on the environmental and economic performance of these solar canals.

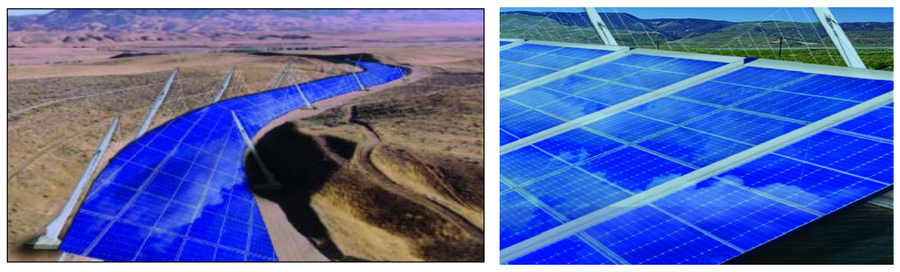

Figure 2. Renderings of a solar canals using tensioned cables

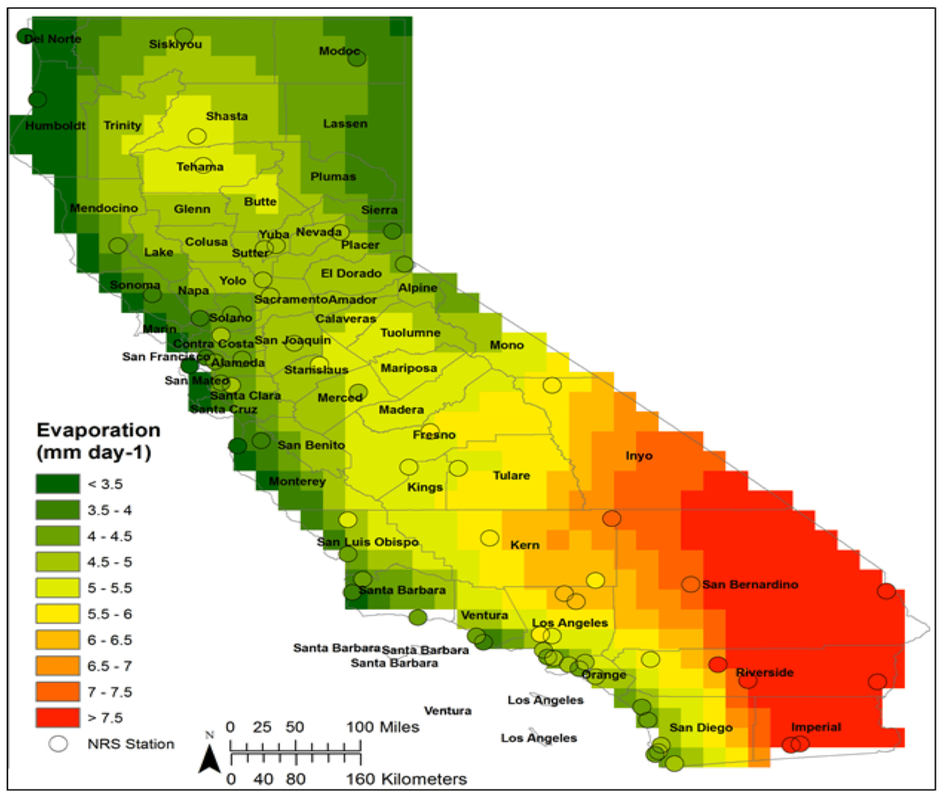

Figure 4. Annual mean evaporation estimates (mm day1) using the modified Penman equation at National Solar Radiation (NSR) weather stations indicated by circles overlaid onto a thin plat spline interpolated evaporation rate grid.

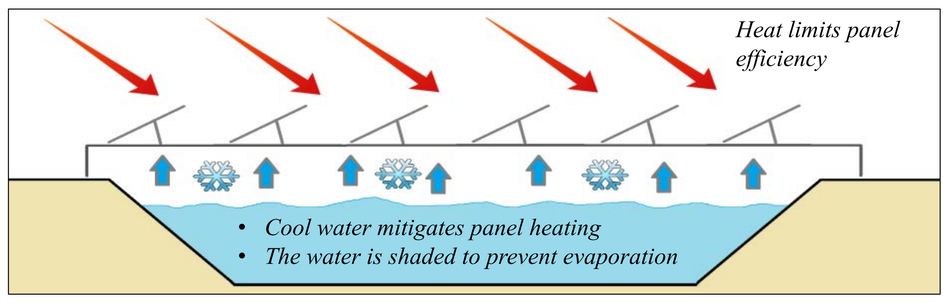

Figure 1. Schematic of a solar canal depicting the basic concepts behind the proposed benefits of increased photovoltaic efficiency and reduced evaporation.

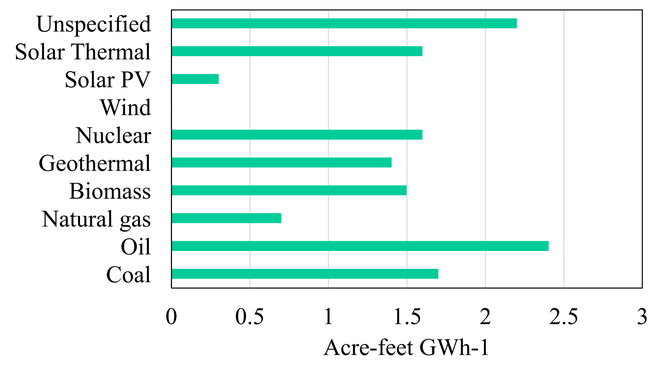

Figure 3. The water intensity of electricity production in California

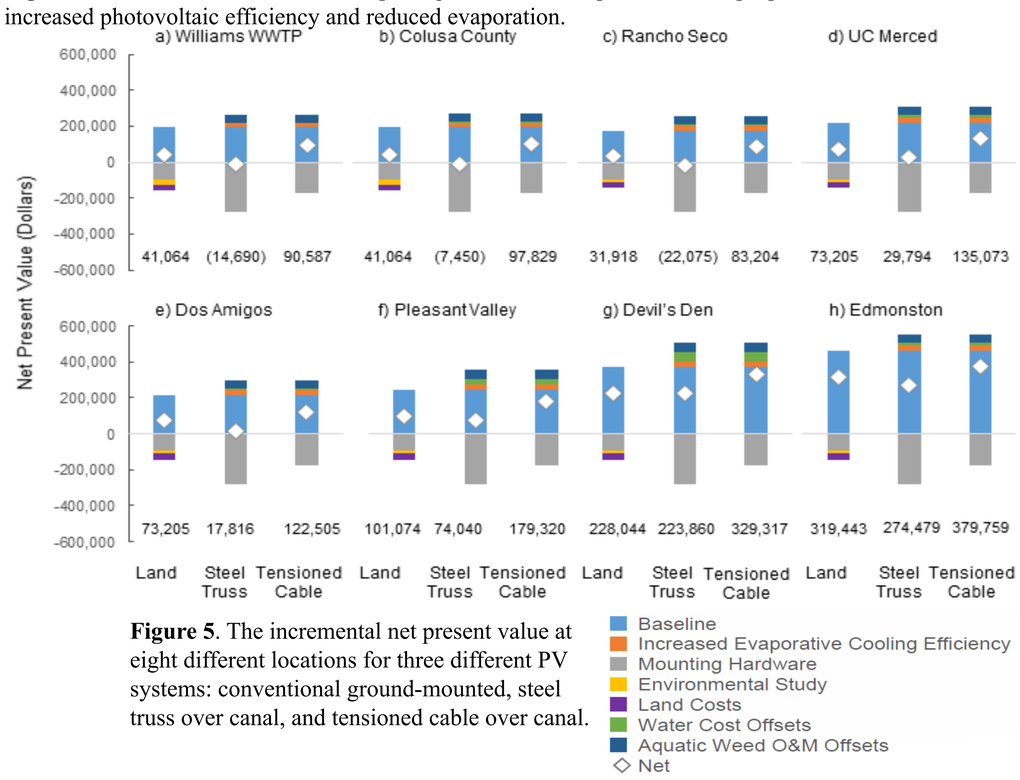

Figure 5. The incremental net present value at eight different locations for three different PV systems: conventional ground-mounted, steel truss over canal, and tensioned cable over canal.

RESULTS and CONCLUSIONS:

- Over 160,000 acre-feet of evaporation can be avoided every year by shading California canals
- Over 300,000 acre-feet of water can be saved by offsetting the current California energy mix by the amount of water that can be created from photovoltaics over California canals
- Pilot projects from previous studies suggest photovoltaic efficiency can increase up to 15% from evaporative cooling
- Tension cable solar canals are potentially more commercial than ground-based installations

METHODS: Evaporation rates were calculated using the Penman method, pan evaporation method and CIMIS data. Evaporative savings were calculated based on evaporation rates and previous shading experimentation. The water intensity of electricity production was compared to the potential for electricity generation from photovoltaics on California canals to estimate water savings from diverting the current energy mix to solar power.

We used the following metrics to evaluate the impact of the solar canals: 1) energy intensity, 2) greenhouse gas emissions intensity, 3) energy costs for water distribution, 4) water costs (including project capital costs), and 5) diesel generator populations. We used the information in our analysis to compare the financial feasibility of solar canals to a ground-mounted system considering a steel truss system and a tensioned cable system. The financial feasibility metrics include the installed cost ($/Watt direct current), the levelized cost ($/kWh), the net present value ($/MW) (Figure E.3), and the internal rate of return.

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