Comparative Analysis of Urban Food Systems for Tailored Interventions

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This brief is adapted from the following peer-reviewed journal article: Boyer, D. Sarkar, J. & A. Ramaswami. (2019). Diets, Food Miles, and Environmental Sustainability of Urban Food Systems: Analysis of Nine Indian Cities. *Earth's Future*, 7, 911-922.

Study Intent and Research Question

How do food systems and their sustainability impacts vary across cities? Do the same food system interventions make sense in all contexts, and how can cities analyze their own local systems to design food action plans? This study examines the environmental impacts—greenhouse gas (GHG) emissions, land use, and water consumption—of urban food systems in nine Indian cities, while also looking at variation across nutrition, equity, supply chain risk, food-miles traveled, and disaggregation of impacts to production locations, including both local production and production locations far from urban centers where food is consumed. The study considers community-wide food flows, including those linked to residential, commercial, and industrial uses, connecting those flows to upstream agricultural production and location-specific environmental impacts.

Key Background Information

Urban food systems affect multiple outcomes, spanning environmental (water, land, greenhouse gas emissions), health/nutrition, and supply chain risks. It is possible to evaluate food systems for their impact on each of these outcomes, both locally and non-locally (Boyer & Ramaswami, 2017; UNEP, 2016).

A community-wide approach to food systems acknowledges that food systems supply residential, commercial, and industrial users. However, most food system analyses overlook non-residential food consumption by visitors and local food processing industries.

Most cities draw on food supply chains that extend great distances, but little is known about specific supply chains for individual cities, making it difficult to design policy interventions that link consumption with production.

Linking food consumption to the location where that food is produced is necessary to capture variation in environmental impacts, as well as potential risks from resource constraints at specific locations of production.

Globally, studies show that food supply accounts for 70–85% of freshwater use (Gleick, 2003); 12% and 25% of ice-free land allocated to production and pasture grazing, respectively (Ramankutty et al., 2008); and 19–29% of human-caused GHG emissions (Vermeulen et al., 2012).

Risks to food supply can include transportation disruption, energy failure, climate variation, and water scarcity in areas of agricultural production.

This study looked at nine Indian cities representing a range of diets, resource use, and potential supply risk: Delhi, Chandigarh, Rajkot, Ahmadabad, Surat, Chennai, Goa, Bangalore, and Pondicherry.

Key Findings

In some cities, i.e. Pondicherry and Goa, industrial food flows dominate, at respectively 53% and 61% of total flow by mass. In other cities, i.e. Delhi and Chandigarh, residential flows dominate, at 62% and 72% of total annual food demand. Commercial food demand constitutes less than 20% of total food demand across all four of the mentioned cities.

Average residential per capita food demand varies by city in terms of diet composition, quantity of food, and nutritional sufficiency. Further, the proportion of food consumed outside the home as a percentage of per capita demand also varies by city, contributing between 5% (Ahmadabad) and 27% (Pondicherry) of total intake.

The GHG emissions of per capita food demand across cities changes substantially when incorporating spatial variation of energy use for groundwater pumping for irrigation and on-farm use (second-order GHG impacts).

Analysis of city-specfic diets finds substantial differences in diet composition, particularly for distribution of grain consumption across geographic regions.

The average diets of the northern and western cities studied demand a greater quantity of wheat, a crop with particularly high irrigation requirements, in contrast to rice-based diets of southern cities.

The weighted average distance between the location of production and urban demand, or food-miles, varied from 200 to over 1,140 km/metric ton food across the nine cities.

Policy and Practice Implications

High variation across urban food systems within a single country suggests that the common approach of down-scaling national-level dietary data may not be sufficient for informing effective food system policy interventions for individual cities.

There is a need to collect and study spatially explicit dietary data to more accurately understand urban food systems.

Considering the high local reliance of all nine cities on local agricultural areas, controlling urban expansion into valuable agricultural areas near cities should be a policy concern for decision-makers charged with managing urban food supplies.

Availability of resources upon which agriculture is so dependent (e.g. land and water) at both distant and local production locations may be increasingly relevant to urban decision-makers as critical elements of urban food security.

Evaluating the environmental impact of dietary interventions requires considering both first and second order impacts . Dietary shifts can have dramatically different impacts, depending on where diet staples are cultivated and what secondary emissions are associated with them, such as energy for irrigation.

Supply chain data can be used to examine potential risk to city food supplies by linking urban demand with locations of production and spatially explicit resource scarcity. Further analysis is needed: How often do supply disruptions occur as a result of water scarcity in food-producing areas? How flexibly can city supply chains adapt to instances of scarcity?

The systems framework informs how certain actions perceived to be positive can actually have negative impacts when assessed across multiple considerations.

Further Reading & References

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The Sustainable Healthy Cities Network is a U.S. National Science Foundation-supported sustainability research network focused on the scientific advancement of integrated urban infrastructure solutions for environmentally sustainable, healthy, and livable cities. We are a network of scientists, industry leaders, and policy partners, com-mitted to building better cities through innovations in infrastructure design, technology and policy. Our network connects across nine research universities, major metropolitan cities in the U.S. and India, as well as infrastructure firms and policy groups to bridge research and education with concrete action in cities.