Integrating participatory mapping & advanced analytics to enable healthier food environments in Bangkok

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BACKGROUND: The food environment is a confluence of personal and external dimensions influencing consumers' food choices, including access and convenience to obtain or purchase, ability to afford, and desirability of healthy and unhealthy foods; and availability, prices, and marketing characteristics of foods and their vendors. Epidemiologic studies implicate diverse food environment dimensions as determinants of diet quality and nutrition, but the time-relevance and utility of this evidence for enabling nutrition-sensitive food environments remains limited given challenges inherent in operationalizing such a heterogeneous and spatiotemporally-dynamic exposure.

Artificial intelligence (AI) is increasingly important in augmenting food environment mapping and spatial analyses via integration with conventional software and recent advances in specialized cloud-based platforms. Integrating AI in collection and analysis of spatiotemporal food environment data – particularly data that are openly available, restricted by limited access controls, or are proprietary but allow measures of open access – can enable powerful and accurate understanding of how food environment dimensions are patterned across space, time, and populations, and otherwise unachievable insights into drivers of food choice and other highly multifaceted phenomena.

OBJECTIVE: This study is integrating participatory mapping and community engagement with AI and advanced geospatial analytics of open data to interpret and inform healthier food environments in inner Bangkok, focusing on areas surrounding Phayathai Campus, Mahidol University, as a starting point for methods testing and validation.

METHODS: **(1)** We are compiling objective and subjective ground-based data on key characteristics of food outlets and consumer-food outlet interactions collected using a SurveyCTO-based food environment mapping instrument as part of a large-scale student-led "mapathon".

(2) Ground-based measurements are compiled with open data on food outlets, aquired via cloud-based platforms and processed using deep and machine learning (DL/ML) tools, Google Maps Platform analytics, and Geographic Information Systems (GIS) software to develop, refine, and validate an integrated software framework for geospatial prediction of multifaceted metrics describing food environment-related risks.

(3) Spatiotemporal patterns and densities of these predictions are presented across inner Bangkok in the form of a user-friendly map that periodically harvests and re-analyzes updated ground- and cloud-based data to enhance expansiveness and performance of predictions.

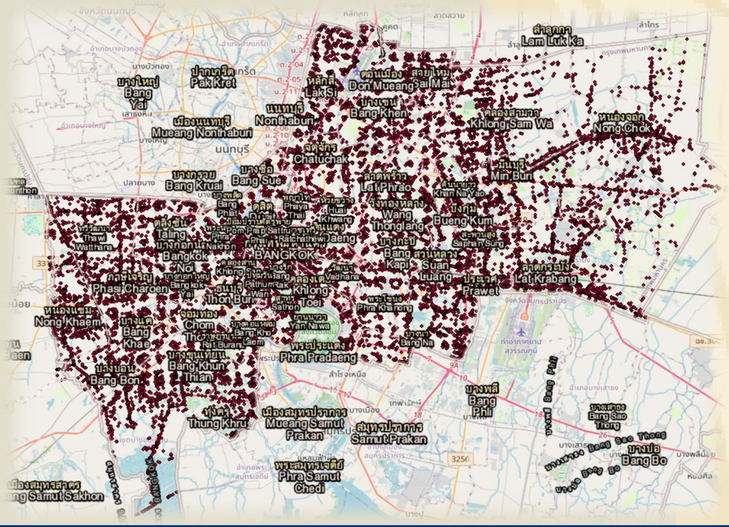
Open data sources & spatial analytics

ArcGIS · Google Distance Matrix API · Google Places API · Tripadvisor · OpenStreetMap · Google My Business

Attributes of open (cloud) data

- Coordinates, opening & usage hours
- Outlet types, service features, & keywords
- User reviews (text) & rating categories
- Images of establishments, menus, & foods
- Usual price range (numeric or categorical)

Scope of open data on food outlets



Integrated Software Framework:

Periodic Update

Periodically acquires and expands the pools of ground- and cloud-based data, automatically matches outlets at individual and neighborhood levels, iteratively updates accuracy and expansiveness of cloud-based predictions, and stores historical cross-sections of spatial predictions, enabling visualization and analysis of how food environment-related risks (contextualized by other key geospatial socioeconomic, demographic, and civic infrastructural layers) evolved and interact with one another over time.

Key Data Processing, Compilation, & Analysis Steps

Key tools & analytical methods for data processing

- **DL/ML methods:** Food & menu image recognition, automated matching of foods with food groups, sentiment analysis of user reviews, automated matching of ground- & cloud-based food outlets.
- **Nutrition tools:** Adapted Global Diet Quality Score-menu metrics.
- **Spatiotemporal analysis:** GIS- & Google Distance-Matrix API-augmented analysis of consumer-food outlet accessibility.

Database of partly-matched cloud- & ground-based metrics

Multidimensional metrics pertaining to quality, accessibility, price, affordability, desirability, and marketing profiles of healthy and unhealthy foods available and typically consumed at each food outlet.

Spatiotemporal validation, analysis, & visualization

Quantify accuracy and precision of area-based predictions (patterning and density of multidimensional food environment metrics over time and space for different demographic strata) and statistics based on analysis of individual food outlets, and map them to a user interface.

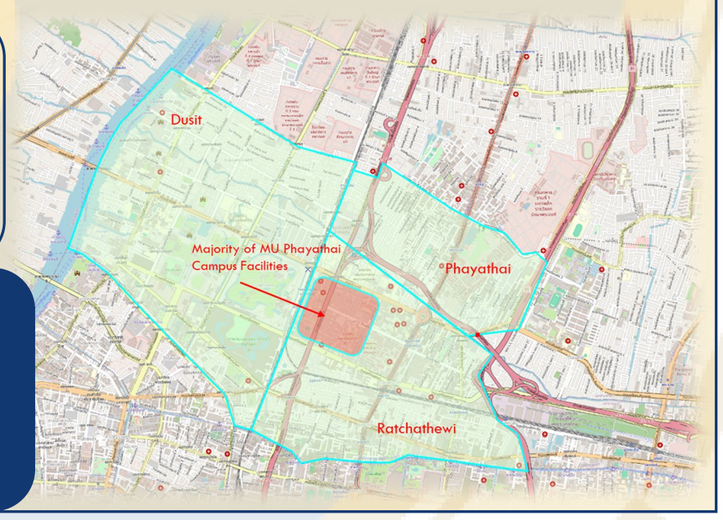
Ground-based data collection

SurveyCTO

Attributes of ground-based data

- Objective and subjective outlet characteristics related to diverse food environment dimensions
- Key aspects of consumer-outlet interactions
- Image and text recognition of menus and foods available and consumed (and their prices)

Scope of participatory "mapathon"



NEXT STEPS: Cloud-based metrics are derived from large volumes of open data, rendering them cost-effective for mapping food environment risks at neighborhood-levels over long periods. Ground-based metrics (against which cloud metrics are validated) do not rely on predictive methods for derivation, providing inherently truer representations of consumer-outlet interactions and the constructs upon which food environment dimensions are based. Thus, both categories of metrics hold value for understanding food environment risks.

Our next goal is to understand how spatiotemporal variation in food environment interactions – operationalized as a suite of metrics derived from ground-based participatory monitoring and cloud-based prediction – influence nutrition (particularly noncommunicable disease risk) of urban consumers. **To achieve this, we propose to establish a long-term cohort study in the Bangkok population that integrates these metrics with diverse measures of diet, nutrition status, and contextualizing socioeconomic, lifestyle, & behavioral factors.**

Based on this cohort, we will establish a typology of consumer-outlet interactions, conduct qualitative implementation research and longitudinal analyses to understand what factors drive these interactions, and analyze how changes in food environment interaction patterns are implicated in nutrition outcomes. Using this evidence-base, we will project how population dietary, nutrition, and disease profiles of inner Bangkok change under potential future food environment scenarios, and inform policies to anticipate and mitigate future risks.