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Toward a More Sustainable, Local Food Production System—From a System Modeling Perspective

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Abstract
Localized food production and sourcing is drawing increasing attention due to environmental and health considerations. In this study, we used population, dietary and geographical information to map potential foodsheds with emphasis on minimizing total geographic distribution. We also developed innovative protocols, metrics and optimization methods to analyze the foodshed localization of geographic areas. We used data from Iowa to analyze and validate the optimization model. This study can also be extended to other regions outside of Iowa.

Keywords
Local food production, Sustainability, Population, Dietary, Geographical, Optimization

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FIELD NOTES: PEOPLE, PROGRAMS, & POLICIES

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Analyzing Sustainable. Localized Food Production Systems With a Systematic Optimization Model

Abstract

Localized food production and sourcing is drawing increasing attention due to environmental and health considerations. In this study, we used population, dietary and geographical information to map potential foodsheds with emphasis on minimizing total geographic distribution. We also developed innovative protocols, metrics and optimization methods to analyze the foodshed localization of geographic areas. We used data from Iowa to analyze and validate the optimization model. This study can also be extended to other regions outside of Iowa.

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Introductory Notes:

Dr. Guiping Hu (email: gphu@iastate.edu)
Dr. Hu is an assistant professor in the Industrial and Manufacturing Systems Engineering Department at Iowa State University. She received her B.S. in Management Science (2003) and B.E. in Automation (2004) at the University of Science and Technology of China, and her M.S. and Ph. D. in Industrial Engineering at the University of Pittsburgh in 2006 and in 2009.

Dr. Lizhi Wang (email: lzwang@iastate.edu)
Dr. Wang is an assistant professor of department of IMSE. He received his B.S. in Management Science (2003) and B.E. in Automation (2003) at the University of Science and Technology of China, and Ph. D. in Industrial Engineering at the University of Pittsburgh in 2007.

Dr. Susan Arendt (email: sarendt@mail.iastate.edu)
Dr. Arendt has been an assistant professor in the department of Apparel, Educational Studies and Hospitality Management for five years and holds a courtesy faculty appointment in the department of Food Science and Human Nutrition. Arendt holds a B.S. in Dietetics, an M.S. in Clinical Nutrition, and Ph.D. in Foodservice and Lodging Management. Arendt is also a registered dietitian.

Mr. Randy Boeckenstedt (email: rboecken@iastate.edu)
Mr. Boeckenstedt has been a Transportation Research Specialist at Iowa State University's Transportation Institute (formerly the Center for Transportation Research) since January of 2000. He has an MBA (1990) and undergraduate degree in Manufacturing Technology (1988), both from the University of Northern Iowa.

Acknowledgement:

Funds for this project have been provided by the Leopold Center for Sustainable Agriculture. Established by the 1987 Iowa Groundwater Protection Act, the Leopold Center supports the development of profitable farming systems that conserve natural resources. More information about the Leopold Center is available on the web at: www.leopold.iastate.edu, or by calling the Center at (515) 294-3711.

Project Objectives:

Agricultural and food distribution systems face tremendous challenges as food prices increase, world population grows and transportation costs rise. Local food production and distribution plays an essential role in the process of driving the agriculture systems in the direction of sustainable development.

In this project funded by Leopold Center for Sustainable Agriculture at Iowa State University, we engaged community partners and foodservice representatives to inform the design and data collection process. We developed a methodology to define the dietary requirements of a specific population center in the context of human health. We defined, identified and collected the data needed to achieve the objectives of the project. We developed a mathematical model to characterize the cost of transporting food from multiple producers to multiple client locations. Application software will be developed to incorporate solution/optimization techniques with emphasis on minimizing transportation costs among competing population centers.

Implementation Process:

This project adapted concepts from a study that identified foodsheds for New York State (hereinafter the Cornell Study) [1]. The Cornell Study combined Geographic Information Systems (GIS) and an optimization model to map potential foodsheds with emphasis on minimizing total transportation needs. This project follows the New York model in context, but will vary in technique. Compared to New York, Iowa's population is substantially less concentrated, while its production capacity is more distributed and "monocultural" in nature. Iowa has six times more cropland than New York, and less than one sixth of the population. Seventy-four percent of Iowa's land area is cropland, compared to 14% in New York [2]; corn (58%) and soybeans (36%) account for 94% of the land harvested in Iowa [2]. Unlike the Cornell Study, which is based on a single

representative diet to associate land capacity to food needs, this project will develop a more focused method to integrate USDA MyPyramid daily dietary recommendations, allowing for specific food group considerations, and serving size uniqueness within each food group. Our strategy will also more broadly estimate the potential of cropland and pastureland.

The results will be a set of methods and measures that can be applied to public domain data by a variety of states and audiences to analyze and define optimum foodshed distances for their respective communities. This includes accounting for competing demands between geopolitical jurisdictions (towns, counties, statewide) as well as accounting for the varying dietary needs of different age groups (school age consumers in a particular town, for example).

Outcomes:

A descriptive summary will be developed to illustrate how the model can be used and applied to define foodshed geographies for all cities and rural populations in Iowa. The same methodology can also be applied to other states. We will present, communicate, and initiate peer review and discussion of results with the intention of prompting derivative economic and environmental studies in Iowa. Journal and/or conference papers to leading organizations will be submitted for peer-review and discussion.

References

[1] Christian J. Peters, Nelson L. Bills, Arthur J Lembo, Jennifer L. Wilkins, and Gary W. Fick., 2008. "Mapping Potential Foodsheds in New York State: A Spatial Model for Evaluating the Capacity to Localize Food Production." Renewable Agriculture and Food Systems: 24(1): 72-84

2 USDA, 2009. 2007 Census of Agriculture.