Transportation Simulation Model for selected Concentrated Animal Feeding Facility (CAFFs) within the Maumee Watershed, Ohio

(Keywords: CAFOs, nutrient management, Maumee Watershed, Lake Erie)

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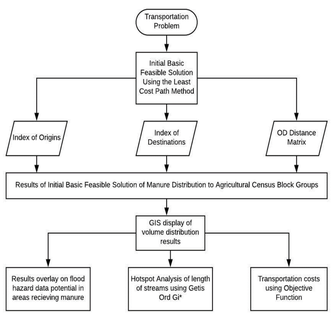
With funding provided by

Purpose

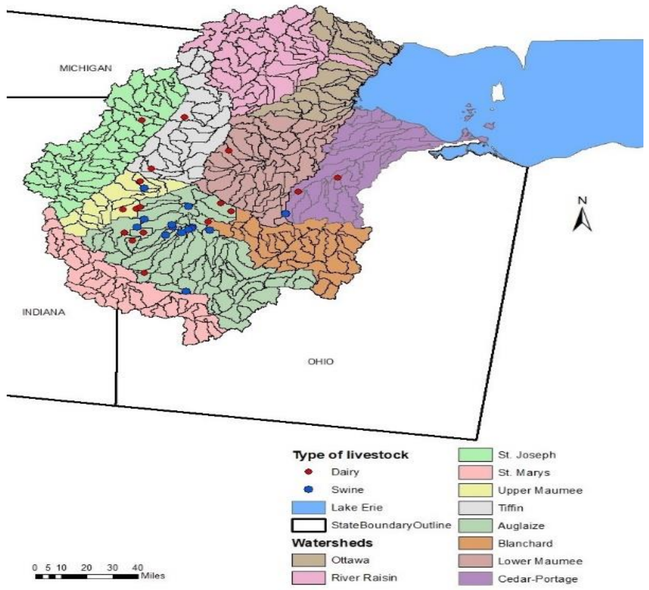
The goal of this study was to identify areas that were prone to nutrient transport from land application of manure-based on environmental conditions including length of streams and flood hazard potential in those areas. Additionally, the study aimed at developing an economic utility for producers in transporting manure in the Maumee Watershed in Northwest Ohio targeted at reducing the potential environmental impacts that may arise from over application.

What Did We Do?

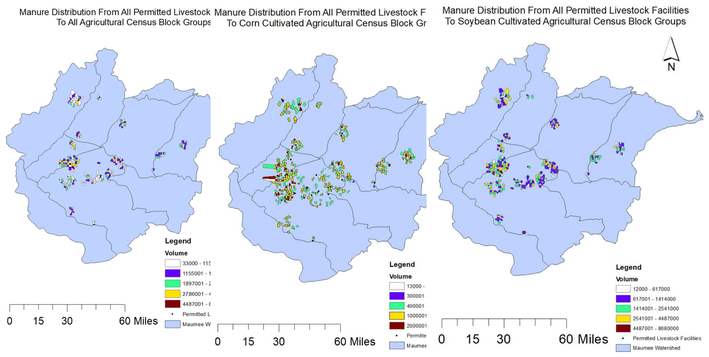
The initial basic feasible solution of the Hitchcock transportation model (Derigs, U. 1988. The Hitchcock Transportation Problem. In: Programming in Networks and Graphs. Lecture Notes in Economics and Mathematical Systems, vol 300. Springer, Berlin, Heidelberg.)was used to simulate the distribution of manure from 31 dairy and swine concentrated animal feeding facilities to agricultural census block groups (soybeans and corn) in the Maumee Watershed within NW Ohio. The model considered the supply and demand capacity of nearby livestock operations (origin) and agricultural census block groups (destinations) respectively. The second objective was to identify areas that were prone to nutrient transport as determined from the model results based on environmental conditions related to floodplain and length of streams dataset using the Getis-Ord GI* statistic. Finally, using the objective function of the transportation problem, the transportation costs associated with hauling manure from the source to the destinations were was calculated.



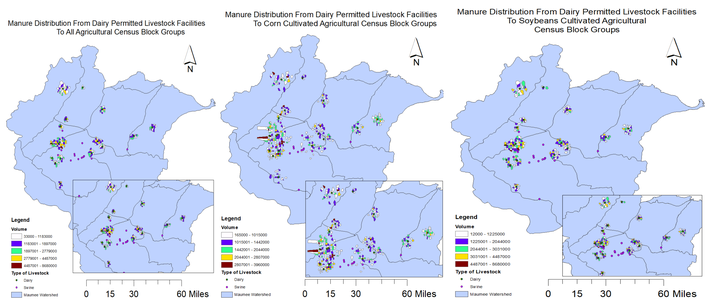
Permitted livestock farms in Northwestern part of the Maumee River Basin



Results & Findings – Allocate by source



Results & Findings – Allocate by material (Dairy manure)



What Have We Learned?

The distribution of manure showed an unbalanced transportation problem such that available farmland that could receive manure exceeded the supply of the livestock operations. The findings suggest there is adequate agricultural land for manure distribution in the watershed. Additionally, areas indicating clustering in the distribution of manure were further examined to determine the potential for nutrient transport off the land and into nearby water bodies based on the environmental conditions used. Approximately 98% of receiving agricultural census block groups fell in the EC-1 classification, which indicates a very low potential for environmental conditions to influence nutrient movement off farmland receiving manure from the 31 CAFFs (define acronym) studied. Approximately 2% and 1% of total acres receiving manure had a moderate to high potential for flooding respectively and were found in Upper Maumee and St. Joseph sub-basins. The identified sub-basins are recommended target areas for best management practices in reducing nutrient runoff. In using the Getis-Ord GI* statistic in ArcMap, Auglaize, Upper Maumee, Lower Maumee, and Cedar-Portage sub-basins were identified as critical areas of concern with high total acres showing high clustering of stream length.

Crop Type	Manure Type	Demand Capacity	Supply Capacity
Corn	Dairy	5 billion gallons	400.8 million gallons
	Swine	3.47 billion gallons	200.7 million gallons
Soybean	Dairy	1.14 billion gallons	400.8 million gallons
	Swine	8 billion gallons	200.7 million gallons

Future Plans

The transportation problem is a type of linear programming problem where goods and services are transported from one set of sources to one set of destination points to minimize transportation costs. There are two phases to the transportation problem – finding the initial basic feasible solution while the second phase involves optimizing the initial basic feasible solution. This study focused on finding the initial basic feasible solution for manure distribution and application in the Maumee River Watershed. Future research could include optimization of the initial basic feasible solution per the transportation problem process to test the robustness of the results from the first phase.

Secondly, the transportation model coded for this dissertation was based on the manure supply of permitted livestock facilities engaged in only swine and dairy production. The model could be refined to include the supply of all livestock operations in the watershed in addition to all destination agricultural lands. With transportation costs being a major overhead cost for producers, the model can also be calibrated based on minimal travel time as an economic utility for producers and farmers.

Furthermore, given the costs involved in the construction of manure storage facilities and the regulations surrounding manure application as identified in Ohio State Bill 1, locations for 'manure- sheds' can be identified for manure storage during off seasons for application. A GIS optimal model can be developed to determine the minimum cost and distance efficient for the location of the proposed 'manure-sheds' where both small and medium facilities with limited storage facilities can transport their manure to a centralized location for storage, while also serving as the point of distribution and utilization for farmers.

Acknowledgements

Ohio Sea Grant

Ohio Department of Higher Education
Ohio Pork Council
Ohio Livestock Association