

Methods and Tools for Freight Flow Disaggregation

March 4, 2020



D. Pallme, A. Kosanovic, TN-DOT
K. Pujats, M. Golias, S. Mishra, Univ. of Memphis

Contents



Brief project overview



Production/Attraction Methods



OD Disaggregation



GIS Tools

Background

TN DOT Ongoing Study (Began April 2019)

Objective

- Review freight disaggregation methods
- Develop in-house GIS tools

Team members:

- TNDOT: D. Pallme, A. Kosanovic
- UoM: M. Golias, S. Mishra, K. Pujats

Methods

How do we create disaggregate freight OD?

Approach 1: Productions/Attractions => OD Matrix

Approach 2: OD Disaggregation

Both consider relationship between:

- Commodity producing/consuming industries
- Socio-economic variables
- Some impedance function

Used Data Sources and Crosswalk Tables

Data Sources:

- Transearch
- InfoUSA
- Bureau of Economic Analysis (BEA) Input-Output (IO) Accounts Supply and Use tables
- Network Data (Zones, Links, Facilities)

Crosswalk Tables:

- BEA IO Account code to NAICS code crosswalk
- SCTG 2-digit to NAICS 3-digit crosswalk (see Anderson et al., 2013)

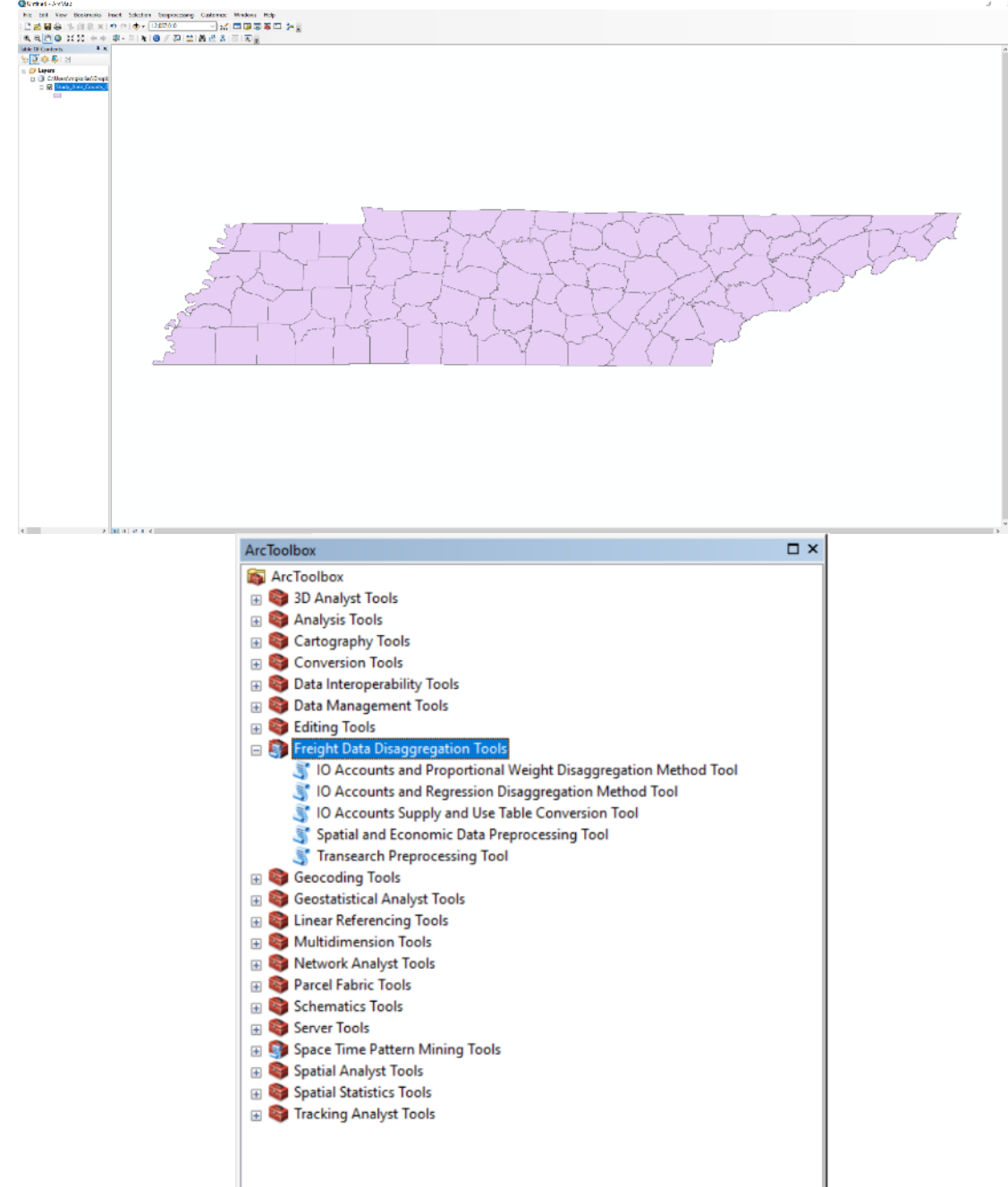
GIS Toolbox

Preprocessing tools:

1. Transearch: SCTG3=>SCTG2 (County level in TN)
2. IO Accounts Supply and Use: Industry shares (producing and using) by IOCode, NAICS
3. Spatial and economic data (InfoUSA): Aggregate and disaggregate values/shares for sq. ft., value of sales, employment

Disaggregation tools:

1. Trip productions/attractions disaggregation=> Create OD
2. Direct OD Disaggregation



Preprocessing Tools

Transearch Preprocessing Tool

Transearch Database
Study Area County Geographic File

☒ Production and Attraction Estimation (optional)
☒ Average Commodity Flow Length Estimation (optional)
☒ Split Data by Unique Field Attributes (optional)

Unique Field Attributes (optional)

☒ County
☒ SCTG_2D
☐ Equipment
☐ Trade_Type
☐ Mode

Select All Unselect All Add Value

☐ Select Data by County (optional)

Counties (optional)

Select All Unselect All Add Value

Output Folder

OK Cancel Environments... << Hide Help

IO Accounts Supply and Use Table Conversion Tool

IO Accounts Supply Table
IO Accounts Use Table
IO Accounts Industry Code to NAICS 3-digit Code Crosswalk Table

☒ Convert IO Accounts Supply and Use Tables to NAICS 3-digit Code (optional)
☐ Estimate IO Accounts Supply and Use Commodity Producing and Using Industry Shares (optional)
☒ Estimate IO Accounts Supply and Use Commodity Producing and Using Industry Shares with a Minimum (%) of Shares (optional)

Minimum (%) of Commodity Producing and Using Industry Share (optional)
10

Output Folder

OK Cancel Environments... << Hide Help

Spatial and Economic Data Preprocessing Tool

InfoUSA Database
Study Area County Geographic File
Disaggregate Zone Geographic File

Disaggregate Zone Spatial Identifier
TAZ

Economic Indicators
☒ Employment
☒ Sales
☒ Square_Footage

Select All Unselect All Add Value

☒ Estimate Zone Economic Indicator Shares at Disaggregate Level
☒ Estimate Zone Economic Indicator Values at (Dis)Aggregate Level
☐ Estimate Disaggregate and Transearch Zone Centroid Latitude and Longitude (optional)

Transearch Zone Geographic File (optional)

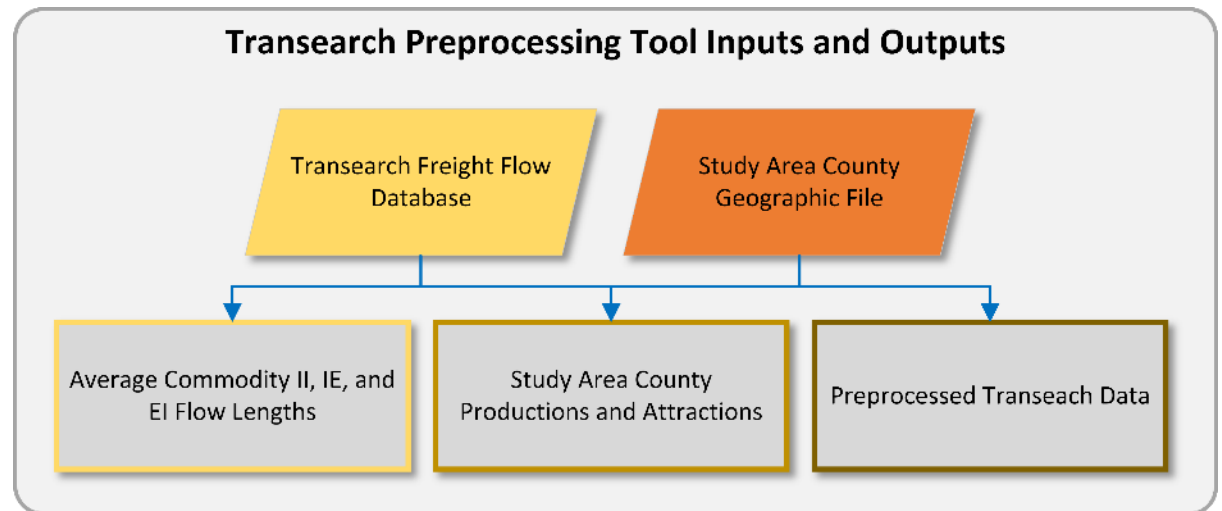
Output Folder

OK Cancel Environments... Show Help >>

Transearch Preprocessing Tool

The screenshot shows the 'Transearch Preprocessing Tool' dialog box. It has a title bar with a blue icon and the text 'Transearch Preprocessing Tool'. The main area contains several sections: 'Transearch Database' with a dropdown menu and a folder icon; 'Study Area County Geographic File' with a dropdown menu and a folder icon; three checked checkboxes for 'Production and Attraction Estimation (optional)', 'Average Commodity Flow Length Estimation (optional)', and 'Split Data by Unique Field Attributes (optional)'; a section titled 'Unique Field Attributes (optional)' with a list of checkboxes for 'County', 'SCTG_2D', 'Equipment', 'Trade_Type', and 'Mode'; 'Select All', 'Unselect All', and 'Add Value' buttons; a 'Select Data by County (optional)' checkbox; a 'Counties (optional)' section with a text box and the same three buttons; and an 'Output Folder' section with a text box and a folder icon. At the bottom are 'OK', 'Cancel', 'Environments...', and '<< Hide Help' buttons.

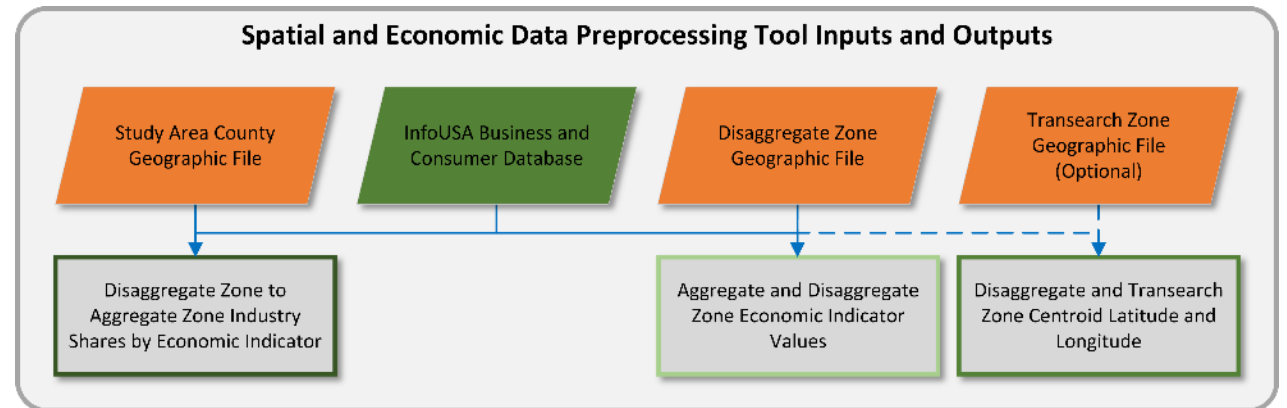
- From SCTG 3 to SCTG 2 digit code BY:
 - i. Equipment type
 - ii. Trade type
 - iii. Mode
- Average length (miles between ODs)
- Estimate Productions and Attractions (Aggregate Level)



Spatial and Economic Data Preprocessing Tool

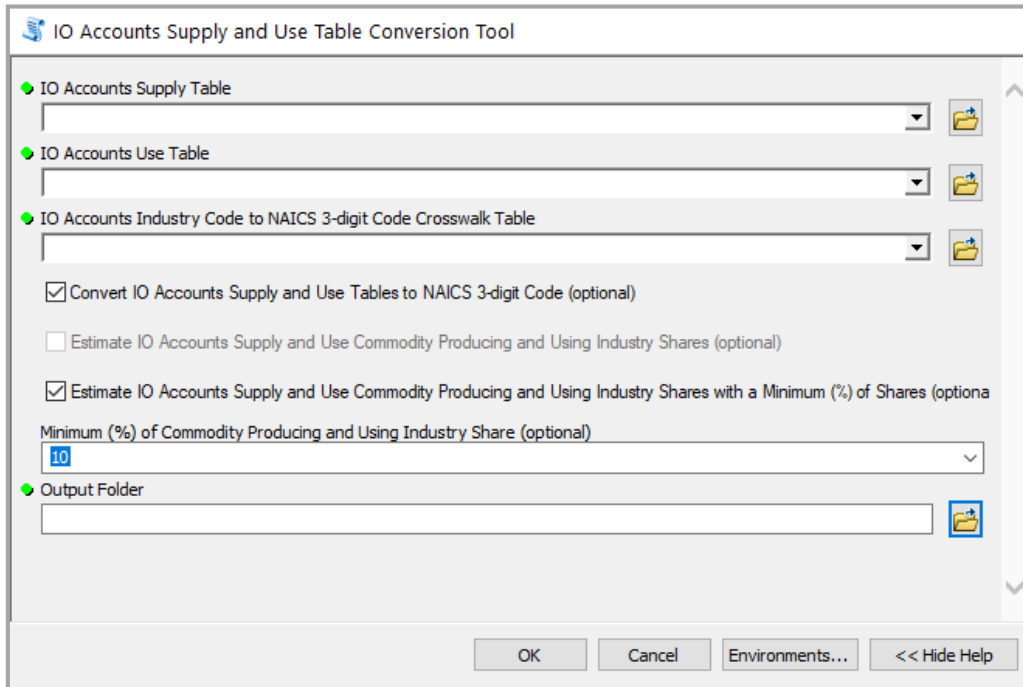
The screenshot shows the 'Spatial and Economic Data Preprocessing Tool' window. It features several input fields and checkboxes. At the top, there are three file selection fields: 'InfoUSA Database', 'Study Area County Geographic File', and 'Disaggregate Zone Geographic File', each with a folder icon. Below these is a 'Disaggregate Zone Spatial Identifier' dropdown menu set to 'TAZ'. A section titled 'Economic Indicators' contains three checked checkboxes: 'Employment', 'Sales', and 'Square_Footage'. Below this section are 'Select All', 'Unselect All', and 'Add Value' buttons. Further down, there are three checkboxes: 'Estimate Zone Economic Indicator Shares at Disaggregate Level' (checked), 'Estimate Zone Economic Indicator Values at (Dis)Aggregate Level' (checked), and 'Estimate Disaggregate and Transearch Zone Centroid Latitude and Longitude (optional)' (unchecked). Below these is a 'Transearch Zone Geographic File (optional)' field with a folder icon. At the bottom, there is an 'Output Folder' field with a folder icon. The window has standard 'OK', 'Cancel', 'Environments...', and 'Show Help >>' buttons at the bottom.

- Economic indicator shares and values at disaggregate level
- Centroid of disaggregate and Transearch zones (estimate travel times or length)



IO Accounts Supply and Use Table Conversion Tool

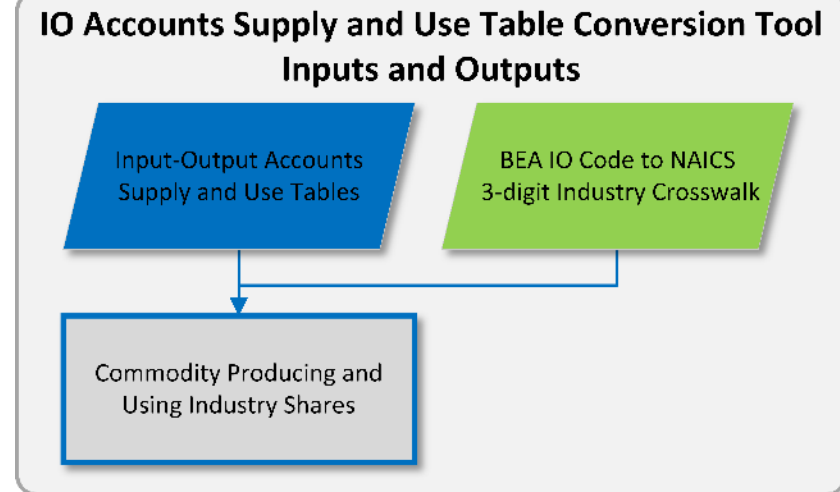
- Supply and Use Shares (any level of aggregation available)



The screenshot shows the 'IO Accounts Supply and Use Table Conversion Tool' dialog box. It contains the following fields and options:

- IO Accounts Supply Table:** A text field with a folder icon on the right.
- IO Accounts Use Table:** A text field with a folder icon on the right.
- IO Accounts Industry Code to NAICS 3-digit Code Crosswalk Table:** A text field with a folder icon on the right.
- ☒ **Convert IO Accounts Supply and Use Tables to NAICS 3-digit Code (optional)**
- ☐ **Estimate IO Accounts Supply and Use Commodity Producing and Using Industry Shares (optional)**
- ☒ **Estimate IO Accounts Supply and Use Commodity Producing and Using Industry Shares with a Minimum (%) of Shares (optional)**
- Minimum (%) of Commodity Producing and Using Industry Share (optional):** A text field containing the value '10'.
- Output Folder:** A text field with a folder icon on the right.

At the bottom of the dialog box are four buttons: **OK**, **Cancel**, **Environments...**, and **<< Hide Help**.



OD Estimation/Disaggregation

IO Accounts and Proportional Weight Disaggregation Method Tool

- Transearch Preprocessed Database
- Economic Indicator Spatial Share Table
- SCTG 2-digit to NAICS 3-digit Code Crosswalk Table
- IO Accounts Commodity-Producing Industry Share Table
- IO Accounts Commodity-Using Industry Share Table
- Freight Flow Tonnage Lower Bound
0.1
- Output Folder

OK Cancel Environments... << Hide Help

IO Accounts and Regression Disaggregation Method Tool

- Transearch Preprocessed Database
- Productions and Attractions
- Study Area County Geographic File
- SCTG 2-digit to NAICS 3-digit Code Crosswalk Table
- IO Accounts Commodity-Producing Industry Share Table
- IO Accounts Commodity-Using Industry Share Table
- Aggregate Zone Economic Indicator Value Tables
- Disaggregate Zone Economic Indicator Value Tables
- ☐ Distribution Using: Gravity Model (optional)
- Disaggregate and Transearch Zone Centroid Files (optional)
- Average Commodity Flow Travel Length Tables (optional)
- ☒ Distribution Using: Proportional Weighting (optional)
- ☐ Distribution Using: Iterative Proportional Fitting (optional)
- Gravity and/or Iterative Proportional Fitting Tolerance (%) (optional)
- Freight Flow Tonnage Lower Bound (optional)
0.1
- Output Folder

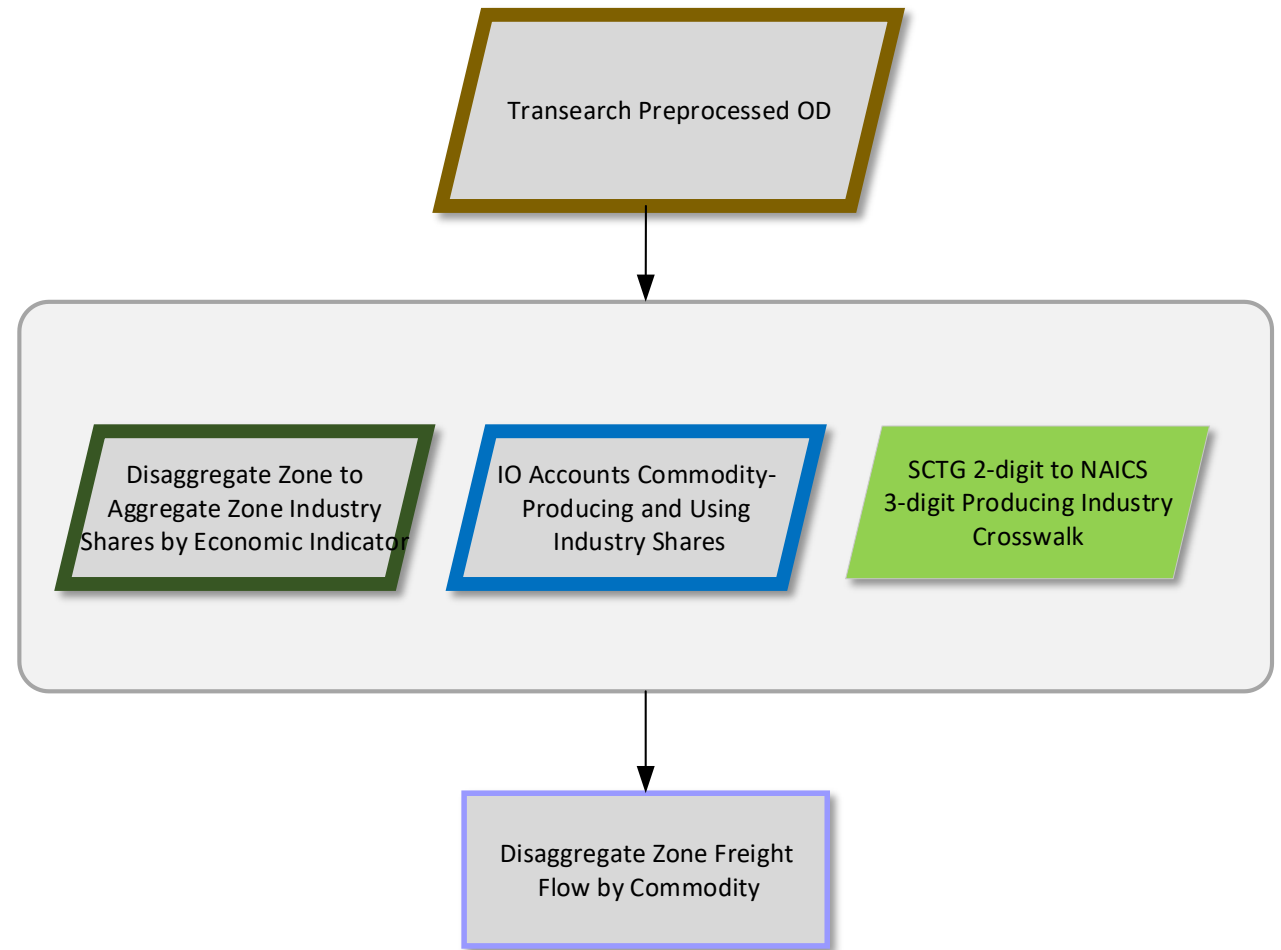
OK Cancel Environments... << Hide Help

Proportional Weight OD Disaggregation

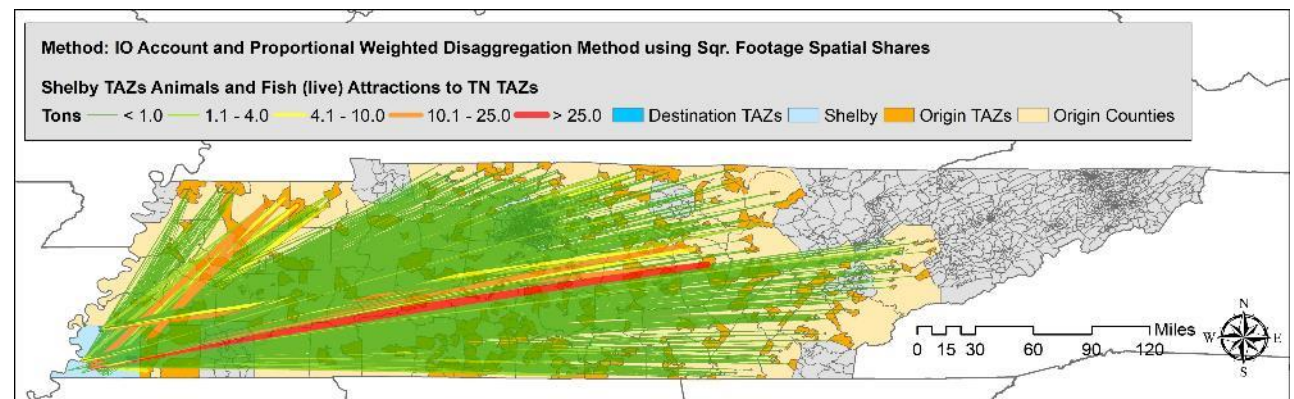
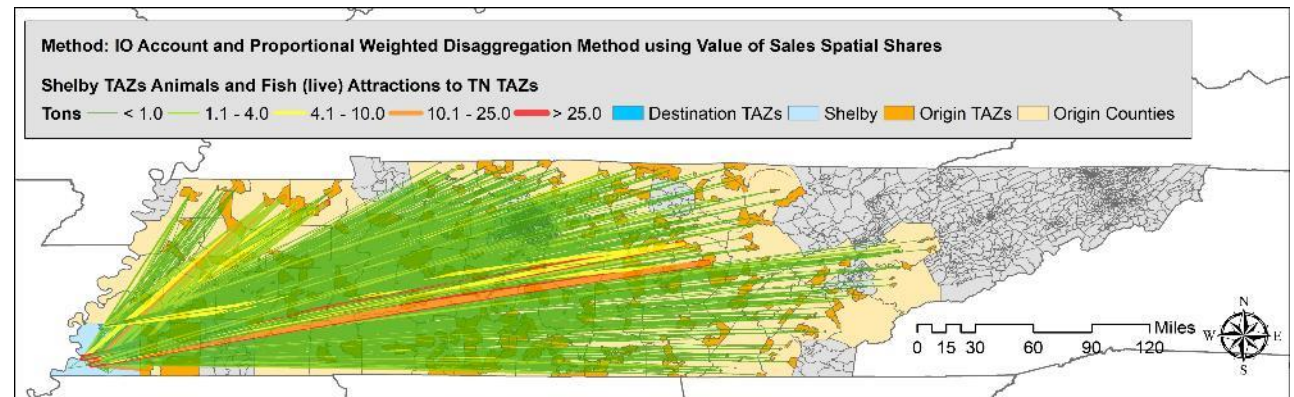
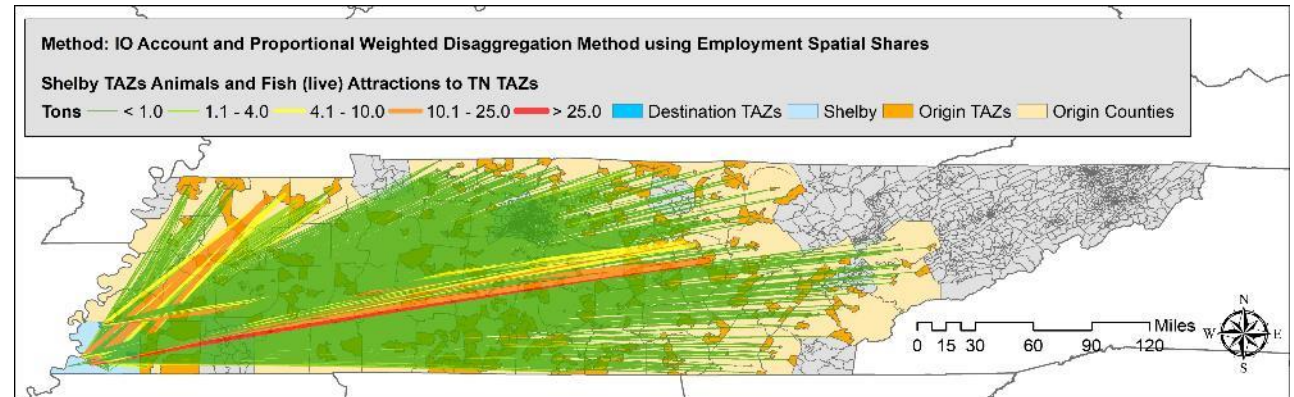
IO Accounts and Proportional Weight Disaggregation Method Tool

- Transearch Preprocessed Database
- Economic Indicator Spatial Share Table
- SCTG 2-digit to NAICS 3-digit Code Crosswalk Table
- IO Accounts Commodity-Producing Industry Share Table
- IO Accounts Commodity-Using Industry Share Table
- Freight Flow Tonnage Lower Bound
0.1
- Output Folder

OK Cancel Environments... << Hide Help



Proportional Weight OD Disaggregation Example Output



Regression Disaggregation Method Tool

IO Accounts and Regression Disaggregation Method Tool

- Transearch Preprocessed Database
- Productions and Attractions
- Study Area County Geographic File
- SCTG 2-digit to NAICS 3-digit Code Crosswalk Table
- IO Accounts Commodity-Producing Industry Share Table
- IO Accounts Commodity-Using Industry Share Table
- Aggregate Zone Economic Indicator Value Tables
- Disaggregate Zone Economic Indicator Value Tables

☐ Distribution Using: Gravity Model (optional)

Disaggregate and Transearch Zone Centroid Files (optional)

Average Commodity Flow Travel Length Tables (optional)

☒ Distribution Using: Proportional Weighting (optional)

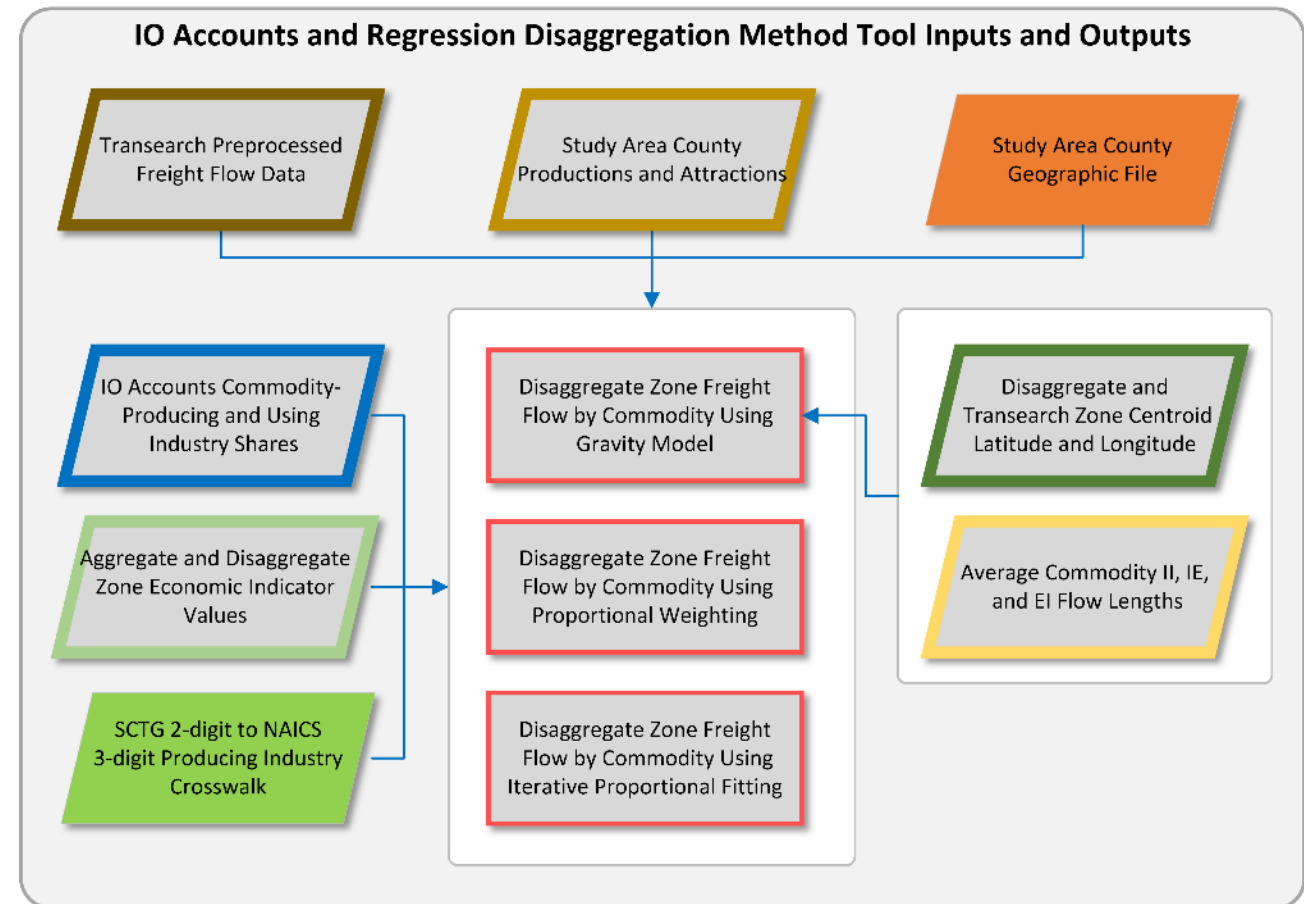
☐ Distribution Using: Iterative Proportional Fitting (optional)

Gravity and/or Iterative Proportional Fitting Tolerance (%) (optional)

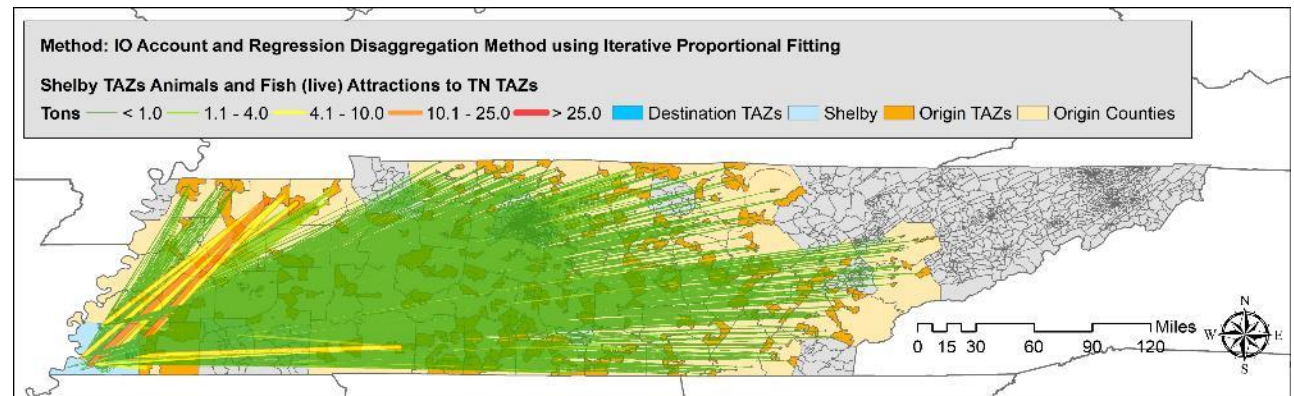
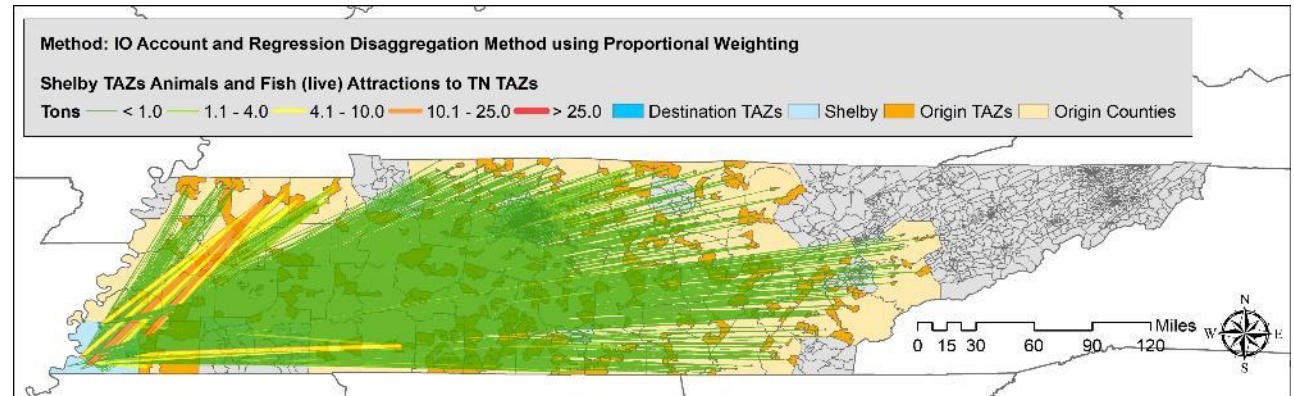
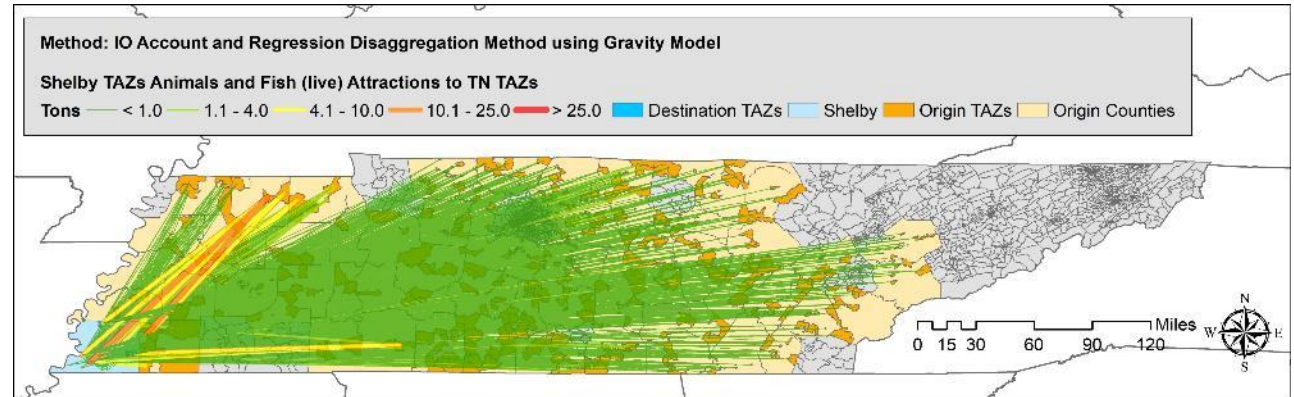
Freight Flow Tonnage Lower Bound (optional)

Output Folder

OK Cancel Environments... << Hide Help



Regression Method Tool Example Output



Next Steps

- Finalize GIS Tool Test
 - Tonnage to Truck Trip Conversion
 - Fix Bugs (if any)
- Validation/ Comparison of the two methods
- Finalize report by August 2020

Daniel Pallme:
daniel.pallme@tn.gov

Amy Kosanovic:
amy.kosanovic@tn.gov

Mihalis Golias:
mgkolias@memphis.edu

Methods and Tools for Freight Flow Disaggregation

March 4, 2020



D. Pallme, A. Kosanovic, TN-DOT
K. Pujats, M. Golias, S. Mishra, Univ. of Memphis