Food Transportation Carbon Emissions Tools – User Guide

Food transportation is an important, yet often overlooked, source of carbon emissions. As businesses try to reduce their footprint, the travel routes and sources of their products must be taken into consideration.

The expression "food miles" is often used to describe the costs of product transportation. However, the distance travelled is only one of the factors that contribute to the total production of GHG (greenhouse gas). The mode of transportation, fuel type, storage requirements, and many other characteristics of the transportation are also important considerations when determining the most efficient traveling route or source.

Three tools have been designed to model the routes possible from an origin to a destination. These are in the associated MS Excel file entitled Tools.coded.xlsm. The user can enter the load mass, modes of travel, and distances travelled to estimate resulting carbon emissions.

Methodology

This set of tools uses very simple formulas and data to roughly estimate GHG emissions. To provide a simple and straightforward interface, only the three primary factors of emissions – the type of transportation, length of travel, and mass of cargo – are taken into consideration.

The measurement of distance varies by tool. The Tool 1 just requires a distance input from the user. However, Tool 2 and 3 both rely on entered locations to determine distance. A Google API is then used to determine coordinates. These are entered into a Haversine formula to determine the "as the crow flies" distance.

The type of transportation determines the emissions rating used for calculating the GHG emissions. There are four primary categories, which are broken down by distance travelled or cargo mass (depending on the category) to form 13 subcategories. These subcategories are then linked to ratings of carbon emissions per tonne-kilometer.

The rating, determined by the user-selected primary category and usage range, must be multiplied by the distance and cargo mass to estimate the total carbon emissions.

Emissions			Usage range
Small cargo train	35.28	($g\ CO_{2e}$)/(tonne*km)	Cargo mass < 90 t
Medium cargo train	22.95	($g\ CO_{2e}$)/(tonne*km)	90 t ≤ Cargo Mass < 110 t
Large cargo train	17.85	($g\ CO_{2e}$)/(tonne*km)	110 t ≤ Cargo mass < 120 t
Regional freight aircraft	1798	($g\ CO_{2e}$)/(tonne*km)	Distance travelled ≤ 2300 km
Continental freight aircraft	869.3	($g\ CO_{2e}$)/(tonne*km)	2300 km < Distance travelled ≤ 6600 km
Intercontinental freight aircraft	632.4	($g\ CO_{2e}$)/(tonne*km)	6600 km ≤ Distance travelled
Rigid truck	176.8	($g\ CO_{2e}$)/(tonne*km)	Cargo mass < 7.5 t
Large rigid ruck	129.5	($g\ CO_{2e}$)/(tonne*km)	7.5 t ≤ Cargo Mass < 20 t
Truck and trailer	82.52	($g\ CO_{2e}$)/(tonne*km)	20 t ≤ Cargo Mass < 34 t
Large truck and trailer	71.58	($g\ CO_{2e}$)/(tonne*km)	34 t ≤ Cargo Mass < 60 t
Inland/Coastal cargo ship	21.06	($g\ CO_{2e}$)/(tonne*km)	Distance travelled ≤ 2000 km
Regional cargo ship	15.732	($g\ CO_{2e}$)/(tonne*km)	2000 km < Distance travelled ≤ 4000 km
Ocean cargo ship	12.41	($g\ CO_{2e}$)/(tonne*km)	4000 km ≤ Distance travelled

Comparisons

Export Estimations:

The Export Estimations tab is a tool designed to provide insight on the export habits of twenty-two regions of the world. The user may experiment with the tool to find a likely region of origin for certain food categories.

Tool 1:

Tool 1 is a simple tool created to return CO_{2eq} estimates to users wishing to model a transportation scenario.

This tool is best used if the user knows:

- The length of the trip
- The mass of the cargo to be transported
- The ratios of different modes of travel to be utilized on the trip

Tool 2:

Tool 2 is slightly more complex and requires more error and fact checking from the user. This tool may help the user model and compare several different travel scenarios and enter in many checkpoints to change the mass and mode of transportation of the products.

In order to use Tool 2, the user should know:

- The route to be taken
- The mass of the cargo to be transported
- The modes of transportation between checkpoints

A map of the entered checkpoint locations will also be located at the bottom of the page to help visualize the entered locations.

Tool 3:

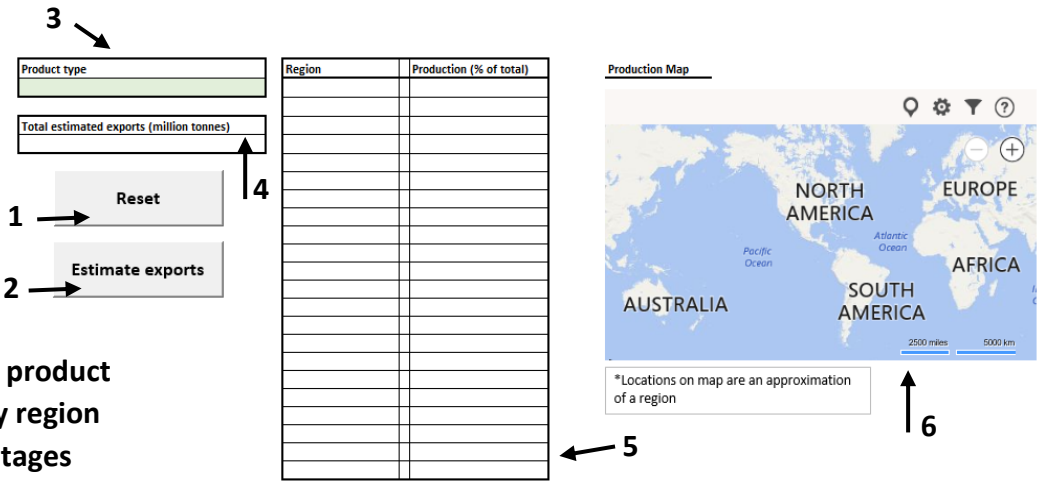
Tool 3 requires less user effort, but is the most complex of the tools. This tool, like Tool 2, requires some error checking from the user, but provides a way for the user to test several different simple scenarios for the transportation of goods. This tool is most useful when no direct, single-mode route is possible (most likely for routes that involve transporting goods from an origin to a port, then between two ports, and finally from the 2nd port to the destination).

In order to use Tool 3, the user must know:

- The origin and destination of the items
- The mass of the cargo
- The modes of travel used in the route.

Instructions

Export Estimations:



***Green fields require user selection from drop-down list**

1 – Reset button

2 – Solve button

3 – Selected food type

4 – Estimated total exports of product

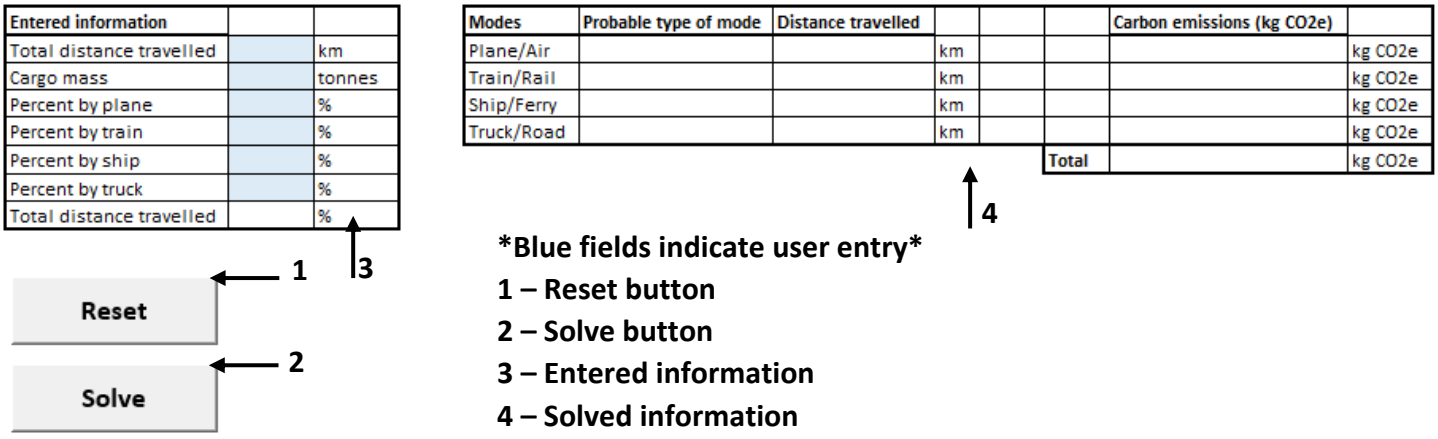
5 – Production percentages by region

6 – Map of production percentages

For the Export Estimations tab, the user must only select a desired product type. The total exports (in million tonnes) will be displayed below and the regional export percentages will be to the right. The production map will show spots for each region (scaled to reflect the percentages of exports for each region).

*The countries that show when hovering the cursor over or clicking the spots on the map are only selected to estimate the region. The export percentages reflect the entire region, not a specific country.

Tool 1:



Blue fields indicate user entry

1 – Reset button

2 – Solve button

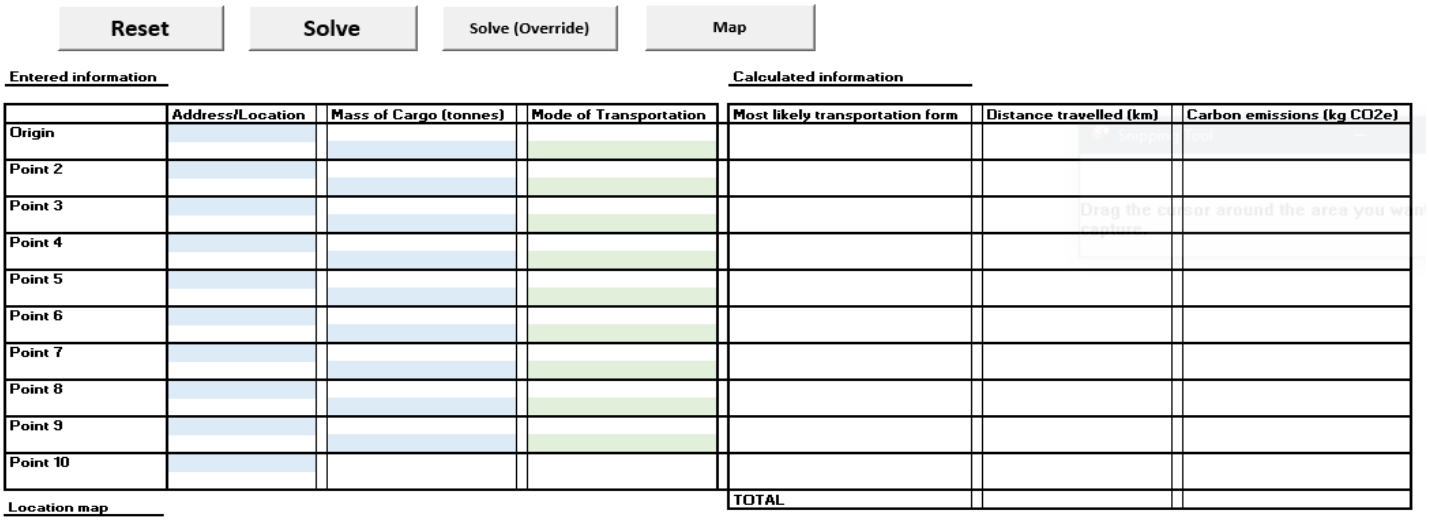
3 – Entered information

4 – Solved information

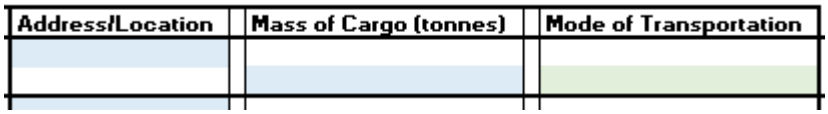
For Tool 1, the user must enter the specified data into the shaded fields and click the “solve” button. The calculated information will then appear in the columns of the chart to the right. The type of mode, distance travelled, and carbon emissions are located directly to the right of their respective modes. The sum of the emissions is located in the last row.

To clear the fields, the user should click the “Reset” button.

Tool 2:



1 – Reset button
2 – Solve button
3 – Override solve button (remove locational error checking)
4 – Map button
5 – Entered information chart
6 – Calculated information chart
7 – Map of entered locations



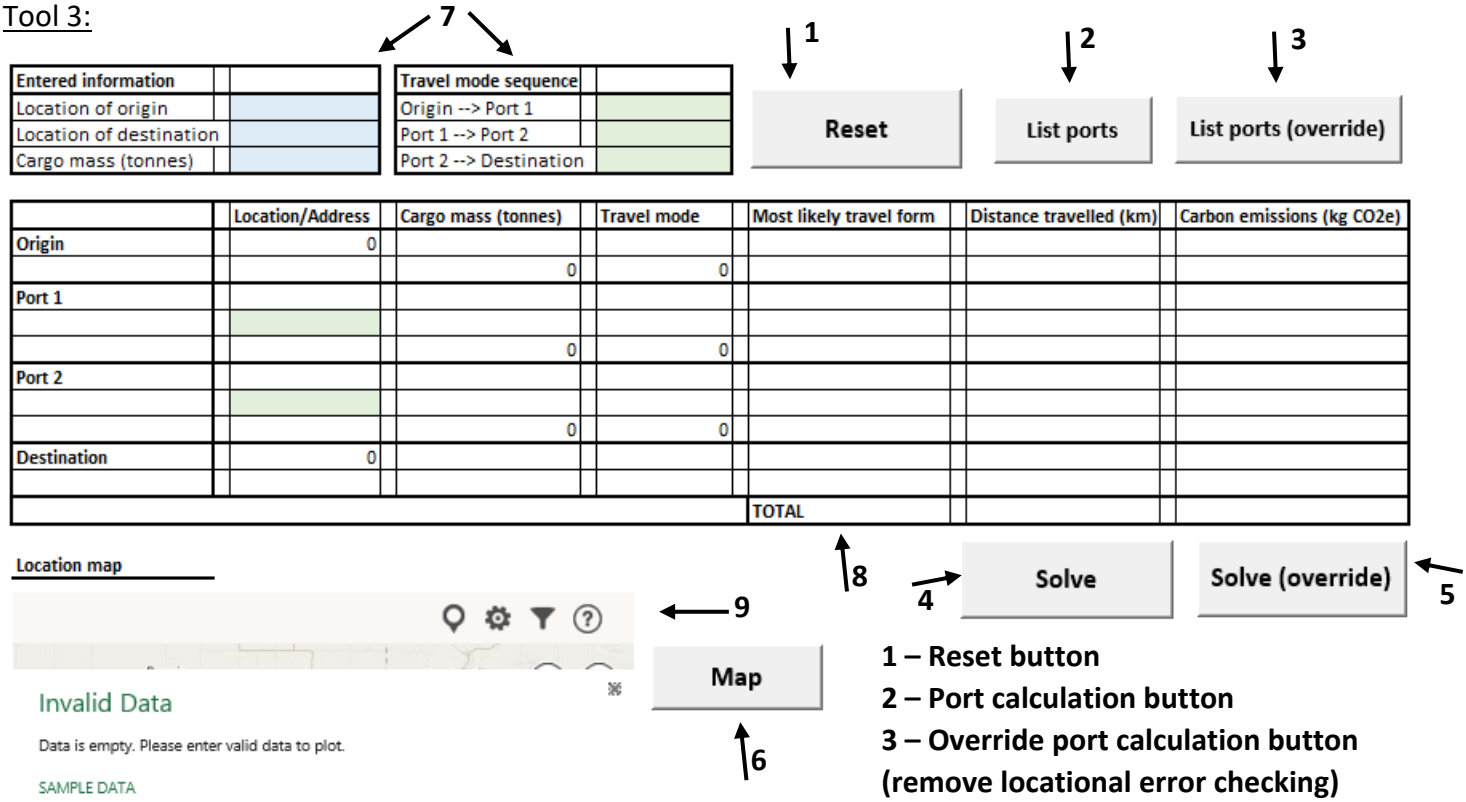
Blue fields indicate user entry
Green fields indicate user selection from drop-down list

For Tool 2, the user must enter the location of each point. Then, the user should enter the mass and select the mode between each point. Not all ten points need to be used. The calculated information will then appear in the columns of the chart to the right. The sum of the emissions is in the last row. The mapping button will show the entered locations on the map at the bottom of the page

*If the calculated information is not appearing, the program may have found an error with the means of travel. This can be corrected by using the override button.

To clear the fields, the user should click the “Reset” button.

Tool 3:



1 – Reset button
2 – Port calculation button
3 – Override port calculation button (remove locational error checking)
4 – Solve button
5 – Override solve button (remove locational error checking)
6 – Map button
7 – Entered information charts
8 – Calculated information chart
9 – Map of entered locations

Blue fields indicate user entry
Green fields indicate user selection from drop-down list

Tool 2 is most helpful in modeling routes that require international or overseas travel. The user should first enter the origin and destination locations and the cargo mass in the entered information chart. Then, the user should enter the travel modes between each point into the chart on the top right. The first and third modes are for the travel from the origin to the 1st port and from the 2nd port to the destination. These are intended to model ground travel to a major international port, so the user should select Truck/Road or Train/Rail. The 2nd mode of travel is intended for international port-to-port travel, so the user should select Ship/Ferry or Plane/Air.

After these fields are filled/selected, the user should click the "list" button. This will give a list of accessible ports in the green field below. The user should then select the desired ports from the dropdown lists in the greed fields of the "Calculated information chart." Then the user must click the solve button to display the calculated information. The mapping button shows all locations on the map at the bottom of the page

*If the calculated information is not appearing, the program may have found an error with the means of travel. This can be corrected by using the solve override button.

*The port override buttons will result in more ports displayed. These ports are still accessible by land, but less likely to be used. The user must click the solve override if overriding the ports to prevent distance errors.

To clear the fields, the user should click the "Reset" button.

Uncertainties

This tool is intended to be used for approximate estimates. The emissions ratings for the modes of travel are published averages. More about this can be found at the Network for Transport Measures. The distances are all calculated "as the crow flies." This means that actual transportation paths will add distance (and additional emissions) due to indirect routing paths.

The tool will not prevent user error. Although Tools 2 and 3 are programmed to prevent Train/Rail and Truck/Road travel across oceans, this feature does not always catch every error. There are also no features in place to prevent Ship/Ferry travel across land (to allow for river routes). The maps on the tools are provided to help visualize any errors that may occur due to the geography of the regions.

Troubleshooting

- A "mismatch" error occurs: This occurs when the error-checking features detect a flaw in the user inputs. Check plausibility of the route carefully. The user may instead utilize the "override" buttons to continue the calculation.
- The mapping features will not work: Close and reopen the file.
- Some of the calculated cells are blank: Make sure all necessary fields are filled out. If problem persists, try selecting the intended button again.
- Tool 3 port lists are empty: Make sure the dropdown lists are scrolled up as far as possible. If the list is completely blank, make sure that all user-input boxes in the top sections of the tool are filled in and try again.

Sources

Distances. (2017). Retrieved February 11, 2017, from https://sea-distances.org/

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Medium-haul Delays. (2015). Retrieved February 10, 2017, from https://www.caa.co.uk/Passengers/Resolving-travel-problems/Delays-cancellations/Delays/Medium-haul-delays/

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