Abstract:

In 2008, the United States consumed over 8.5 billion gallons of bottled water, which equates to approximately 224.16x10^6 bottles per person.1 Growing concerns over climate change have popularized the idea of assessing an individual's carbon footprint. This project intends to calculate the carbon footprint of transporting bottled water from the source to grocery store locations in Eau Claire, Wisconsin. This task is accomplished by gathering bottling data, designing and creating a road network to calculate travel distances, and converting distances into a measure of carbon dioxide emissions using conversion factors. The information found in this investigation shows that the transportation of bottled water releases a substantial amount of carbon dioxide into the atmosphere.

Data:

The data used to begin the analysis were collected from bottled water bottles from grocery stores. To acquire bottling data, water brands were examined from the following stores: Walgreens, Gisydi’s County Market, and Festival Foods. At each of the stores, the city and zip code located on the label of each brand was recorded. On labels specifying a company name and city, internet search engines were used to find specific addresses. From the four stores, there were 14 different brands or addresses of domestic bottled water and 8 brands from overseas. In the case of the international brands, only city name was provided, therefore latitude and longitude coordinates were used. Tables 1 and 2 show the brands used in this analysis and the city of origin.

There are a few special cases for the brands that were chosen. First, Aquafina is on the list twice. This is because there were different code located on the label of each brand was recorded. On labels specifying a company name and city, internet search engines were used to find the geocode. 

The resulting values represent the CO₂ emissions that can be sequestered by carbon that can be sequestered by planting trees. The amount of CO₂ sequestered by trees is calculated using the following conversion factor: 20 metric tons CO₂ = 1 decision tree.

Methods:

All of the addresses and coordinates were geocoded to create point locations to be analyzed in the network. In order to simplify routing operations, a single destination point was created by finding the mean center of the four grocery store locations in Eau Claire. A transportation network was created using major roadways in the United States and Europe, and digitized shipping lanes. Figures 2, 3, and 4 show the sources used in the network. Distances from the source locations to Eau Claire were found by adding the point locations of the bottled water brands to the network. The distances were converted to CO₂ emissions by implementing the following criteria:

- Energy use from a truck is 3.5 MJ/mile (megajoule) per mile of travel.
- Energy use from a cargo ship is 0.37 MJ/mile per ton of cargo.
- There are 137.79 MJ of energy in one gallon of diesel fuel.2
- CO₂ emissions from a gallon of diesel = 2.778 grams x 0.99 x (44/12) = 10.084 grams = 0.1 kg/gallon = 22.2 pounds/gallon

Results:

The routes found on the network are illustrated in Figures 5 and 6. In these images, each “1” represents the starting point of the route for each brand, and the “2” indicates the Eau Claire location used as described in the method. All except one of the international brands are transported more than 10,000 km to reach the grocery stores in Eau Claire, Wisconsin, which in turn creates thousands of pounds of CO₂. Ten out of the fourteen domestic bottled water brands are shipped less than 1,000 km to grocery stores in Eau Claire, Wisconsin. The transportation distances and CO₂ emissions for each brand are presented in Table 3. The distances in kilometers were converted to an energy cost in MJ to use and the resulting values are illustrated in Figures 5 and 6. In Figures 5 and 6, the green lines illustrate the domestic routes and the red lines illustrate the international routes. The results show that the domestic routes are much more efficient than the international routes.

There are a number of unexplored avenues in regards to this research. Another matter to contemplate is the quality of the water. Nursery water is advertized as being better for young children than tap water. The source for this brand is the municipal supply in Atlanta, Georgia. Is the quality of water as advertized different than tap water? Future research inquiries include assessing the quality of the water.

Conclusion:

Buying bottled water has a potentially huge impact on the environment. The range of effect from brand to brand is vast with 3308 lbs. of carbon dioxide produced from transporting Jana to just 13 lbs. from Chippewa Spring Water. The emissions found in this study are produced only from the transportation of the water. Other sources of emissions include the production of plastic bottles and energy costs of treating the water.

Consumers need to consider the environmental impact of bottled water. If purchasing bottled water, be aware of where it is produced and choose a brand originating closer to home.

References: