Saving the Environment one Pizza at a time[1]

Anusha Porwal

Food is one of the necessities for humans to survive. Others include clean water, shelter, sanitation, healthcare to name a few. To produce enough food, various resources are required, with land and water being the most critical. The entire process of producing, storing, and transporting food takes a significant toll on the environment. So, it's no wonder that we should be as sustainable as possible throughout this whole process, so we don't waste resources, and everyone has access to food.

Right now, the food production process is a large contributor to emissions produced and along with that, a lot of the food produced is wasted (for example there is not enough storage, or the previous production is still not used up and new quantities are produced) – and people are still hungry. The topic of this visualization is an overlap of 3 UN sustainability goals – Climate Change, Protecting Water resources and Zero Hunger.

The visualization shows how much greenhouse gas is emitted and how much water is used in producing certain foods in certain countries. Along with this it also shows how much of that food produced is eventually wasted. Based on this, a small conclusion analysis is made to show how much the emissions could have been cut down, if production is reduced to about just enough - so that almost zero food is wasted (this would still be considering whatever is exported, the needs of the people in that country, storage for the future, etc.). The same kind of analysis is also made for water use.

The hope is that this kind of visualization will be useful for policy and decision makers related to the agriculture sector and will help them see how much food is wasted each year and what the environmental impact of that is. We will know that these kinds of visualizations are useful and doing their job, when there is less food wasted, less pollution produced and load on the environment begins to reduce. It would help to drive research around sustainable agriculture and using less resources to still produce the same amount and quality of crop.

The data used for this project is majorly from ourworldindata.org. They have data on crop production, environmental impact of growing different crops, food wastage, and a lot more data. The data is present in different tables, which are easy to filter out by crop, country and year. For this project, multiple tables have been combined to get the data that was needed. The dataset was created in 2018 by Joseph Poore and Thomas Nemecek. It contains data for 40 products that are produced in 119 countries. This isn't all the food that's produced in the world, but data from about 38,700 farms.

Two important points about the dataset are as follows. The creators of the dataset have performed extra analysis to make the dataset slightly compact, which has resulted in it becoming easy to use.

[1] Temporary title idea. Explanation is present in the main text.

- The environmental impacts that this dataset measures (which are CO2 equivalent emissions, land and water consumption) are calculated from the lifecycle of these foods – data is combined from different stages of the product lifecycle to give a final number.

- The greenhouse gas emissions are calculated in CO2 equivalents. So, for every greenhouse gas, it is calculated that 1 gram of the gas causes the same harm to the environment as N grams of carbon dioxide. When the amounts of all greenhouse gases were found for different crops/products, their carbon equivalents were added together, so that there is a single metric for comparison, instead of different combination of gases for different products.

The exact tables that were used are as follows:

- Data on the amount of CO2eq generated to produce 1kg of different foods was available and information on how much land and water is used to produce certain quantities of food was also available [1].
- Data on how many tons of different crops and food items are produced by each country each year. [2]
- Data on how much food is wasted per year per country divided by different crops/food items. [3]

A lot of the data on food wastage per crop per country per year is not fully available. To deal with the missing data, some interpolation of numbers has been done. A combination of linear interpolation between 2 points, populating from the left and populating from the right has been performed.

As seen, there are a lot of factors at play and different datasets are being combined to create this visualization – data for about a hundred countries and about 40 crops over a span of about 70 years is available. To make the visualization manageable, debug-able and most of all interpretable, the data has been filtered out. Ideally the filtering would have been done based on crops that have the largest environmental impact, and then further filtering out countries that are some of the largest producers of those crops. And finally, it would be nice to see the data change over as long a time as possible – maybe 50 or 60 years. This approach couldn't be followed because of missing data points in different tables. So, the filtering was done to maximize the data availability, so that the least amount of interpolation would have to be performed.

After playing around with the data, and to make the visualization slightly more interesting, the crops selected are ingredients of a pizza that were found in the datasets - *Wheat, Tomatoes, Onions and Peppers*. Ingredients like cheese, salt, yeast, didn't have data available so they weren't added. *USA, India, and Egypt* were the most consistent countries in terms of data availability across all tables, so these were the 3 countries picked. It is important to pick the same crops in the selected countries so that the comparison between them for water use and emissions produced is a fair one and is also easy to interpret over time. The final filtering factor was time – data for a span of 40 years is used here, from *1979 to 2019*.

The final visualization is a 2-dimensional plot with water use on the y-axis and emissions produced on the x-axis. The countries are represented by circles, whose sizes are proportional to how many tons of food (of the 4 pizza ingredients) they produce each year. In the circle, there is also a pie chart that represents how much of that food is wasted – this is where the pizza comes into play. The amount of food being wasted is depicted as the size of the leftover pizza slice. An important point to note is that the ingredients are taken totally and not in a proportion that would

be counting the exact number of pizzas being wasted. It is necessary to note this point so that the meaning of the plot is not misunderstood.

Time is an important aspect of this plot, as trends over a period of a few years are visualized here. It is not explicitly seen as one of the axes but rather it is the 4th dimension of the plot. The changes in the statistics across the years are visible. It is an animated transition to show the progression of water use, emissions and food wastage over the years. This graph should be able to quickly show if some countries are improving or getting worse in the way they are utilizing their resources - A possible conclusion here is the identification of countries that are taking steps to improve itself based on the data available. Such a dynamic animated transition is helpful in getting a quick summary of the issue at hand rather than looking at the tables of data and trying to figure out the trends.

The interaction with the visualization is mainly viewing the dynamic plot. The users can pause the visualization video to observe the details in the plot for that given year.

The last part of the visualization is more of an analysis or a future-best-case-scenario plot, where one can see how much the emissions would decrease and how much water would be conserved if these countries only produced how much they needed and how much they are using.

Practicalities in creating the visualization:

The data was cleaned and processed using python Jupyter Notebooks. The data had to be cleaned and filtered, and different datasets had to be combined. The missing datapoints were interpolated manually in an excel sheet using simple excel functions.

The visualization was created using Excel enabled with VBA, as it was helpful to make charts on excel. The graph plot images for each year were generated using the created script. The graphs were then imported into a PowerPoint Presentation (with one image per slide) and exported as a video that pauses at each slide for a few seconds. This is what completes the task and makes it a dynamic plot.

Along with the plot, a timeline progression was also added to the visualization to get a sense of time. It is not a moveable slider – it is only there for representation purposes.

The codes and notebooks are available on a GitHub repository, which can be found here[2].

Limitations:

There were a couple of challenges that were faced in creating this visualization which are explained in this section. The plot that was created must be viewed with these limitations in mind, as the visualization is only as good as the data that's used to create it. If these limitations were solved (somehow), then the outcome would be a complete overview of the situation at hand.

- Incomplete data in various columns of different tables:
    - The crop loss data was not complete at all – out of all the (10) shortlisted countries and all the (7) shortlisted crop items, only 3 countries had some data, and even this data was incomplete. It was also really a struggle to find other data and

[2] GitHub Link: https://github.com/AnushaPorwal/SavingTheEnv1Pizza-aTime/

articles online that could have some statistics – as this wasn't giving consistent results, it wasn't pursued after a point. Crude interpolation techniques were used to complete the visualization.
    - The dataset for the food produced country-wise year-wise had gaps and missing datapoints of years before 1979 (which is why the plot starts there). Data after 2019 was also not completely available.
    - Not sure if the dataset is being updated annually.
- The data provided on emissions and water used, was data provided as of 2010 – it was not year-wise data. This doesn't help us in seeing improvements in technology over time. Year-wise data for this would have been way better.
- While thinking over the topic and working on it, I thought of a question, which I couldn't answer and so I decided to put it under this section. If a country imports something, and ends up wasting it, does someone count it? who counts it? Suppose India exports tomatoes to some country that doesn't produce tomatoes. For India it is counted as tomatoes used, because it's getting money to produce those tomatoes. But then suppose, the country that imported those tomatoes, imported too much and ends up wasting some amount. Technically additional tomatoes being produced by India are being wasted, but not properly considered.

Conclusion:

From the visualization, we could see different themes coming together to paint a picture of the need for sustainable agriculture and promoting the idea of zero food waste, emphasizing the need to progressing toward a better future.

From the plot of 2019, we could see that if the right amount of food was produced, about 134 MLs of water could have been conserved and about 70 tonnes of CO_2 wouldn't have been produced. Combined over all years, this would be a significant amount and the load on the environment would have been lesser.

The visualization sheds some light on the wastage of food and its impact on the environment, with the major takeaway being the importance of adopting more responsible practices on personal and global scales.

Data Links:

[1] https://ourworldindata.org/environmental-impacts-of-food?insight=there-are-also-large-differences-in-the-carbon-footprint-of-the-same-foods#all-charts

[2] https://ourworldindata.org/crop-yields?Metric=Actual+yield

[3] https://www.fao.org/platform-food-loss-waste/flw-data/en/

[4] https://ourworldindata.org/hunger-and-undernourishment?insight=the-world-has-made-significant-progress-against-hunger-but-this-has-slowed#key-insights

[5] https://www.fao.org/faostat/en/#data/FS