Cut the Bull from off your Plate:
Here is how much Water US Beef *actually* uses

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ABSTRACT

Using data from reliable sources, such as the USDA, the state of California's Department of Water Resources, and previous studies (Asem-Hiablie et al. 2018), I was able to calculate, using simple linear 'back-of-the-envelope' style algebra, the total amount of water used in a single life cycle of the entire US beef industry. I, then, calculated how much water is needed to, not only, end the horrific cycle of worsening annual droughts in California, but also reset the state's natural water cycles to a steady-state equilibrium. I found that we can reset said equilibrium nearly six times with just the water used by US beef. As shown by the EAT-Lancet Commission Summary Report (2019), transforming current global food production practices into a predominantly plant-focused food production system will not only guarantee saving natural resources but also ensure complete global human nutrition for a planet of ten billion inhabitants or more.

KEYWORDS

Water use; animal-sourced foods; US beef; plant-based global Food Regime.

INTRODUCTION

Within the past century, Humanity, through exploiting its 'freshly pressed' industrial infrastructure, has effectively burned, destroyed, cleaned up, and restored natural habitats globally in hopes of improving global life conditions for man and beast alike. Among the myriad of quotidian destructive activities led by Humanity, none have either deteriorated, depleted, abused, or drained natural resources with little to no concern for potential future apocalyptic consequences on global natural systems as has the global livestock industry (Steinfeld et al. 2006). Steinfeld et al. (2006) also established global cattle ranching to be the largest source of environmental degradation of all animal sectors, globally. Furthermore, according to the UN Food and Agriculture Organization (UNFAO), the U.S is the world's largest producer of cattle-sourced foods.

Since 2012 to today, California has been suffering the harshest and longest drought period in over a millennium (Freeman et al. 2015).

Life Cycle Assessments (LCA's) are a normalized scientific tool used by researchers to perform complete comprehensive analyses of the environmental impacts of a particular industrial activity, specifically how many resources are needed and used and how many emissions are created to complete the whole production process. A 2018 LCA of the US beef cattle ranching industry (US beef) (Asem-Hiablie et al. 2018) found that US beef caused the most damage through its water use practices. Defining their functional unit as a kilogram of red meat harvested from a single steer's carcass (dressed weight) and liters of water equivalents as the unit of their response variable to normalize amounts of water affected by the production chain, they analyzed every step of the US beef making process from "cradle-to-grave" and concluded that to produce one kilogram of US beef, a rancher effectively needed 5,126 L of water equivalents.

Using simple "back-of-the-envelope" linear algebra and reliable data from various sources, such as the one above, I calculated the total amount of water being used over just one life cycle of the US beef production chain, to afterwards equate this astronomical amount of water to how much water would theoretically be needed to end California's decade-long cycles of extreme summer drought periods, where thousands die and lose their livelihoods (Krannich et al.1995).

In this study, I ask: How much water does US beef effectively use to raise the entire US beef produced in just one full life cycle? To answer this question, I ask the following sub-

questions: (i) How much water is used per animal? (ii) How much water does California need to end its worsening drought cycle? (iii) Can California's drought situation realistically be resolved?

METHODS & RESULTS

To accurately calculate the total water consumed by US beef, I started with the results calculated in Asem-Hiablie et al. (2018) of 5,126 liters of water used for every kg of US beef dressed weight. From here, I found the average dressed weight harvested per each steer to be:

- According to the USDA National Agricultural Statistics Service (USDA-NASS)'s census, the 2021 monthly average dressed weight of US beef cattle measured was of:
    - (923+911+900+897+890+883+890+899+911+920+922+928)/12 = 906.17 lbs or ~ 411.0 kg.
- multiplying this weight by water use per kg gives us the total water used per steer in the industry, during only a single generation of steers, such that:
    - 411.0 * 5,126 = 2,106,786 L [H2Oeq]/US steer.
- Next, I needed to find how many steers are raised by US beef. In 2021, the USDA-NASS recorded a headcount total of 93.6 million steers raised in 2021, such that:
- The total amount of water used by the entire US beef industry, in 2021, was of:
    - 2,106.786 * 93.6 * 10^6

= 2.0 * 10^14 L

In the words of the resources manager for the California Department of Water Resources: " […] Using something called the USGS Basin Characterization Model, we're anticipating it would take 140% of average precipitation to get to average state runoff":

- What is then California's total volume of annual precipitation: The California Department of Water Resources says the state's annual precipitation is 22.9 inches, or 0.58 meters on average, and its area, of 423,967 square kilometers. I thus calculated the volume of California precipitation to be:

- Volume precipitation of California = area of California * 0.58, such that:

    - 423,967 km^2 * 0.58 m

= <u>245,900,860 m^3</u>

We need 140% of this volume to reset California's natural water cycles to a steady-state equilibrium, such that:

- 1.40 * 245,900,860,000

<u>= 344,261,204,000 L</u>

    - Therefore, CA needs nearly 350 billion liters of water for its statewide water cycle to return to its natural steady-state equilibrium.

- How many times then, with the amount of water used by US beef, in 2021, can we potentially help California out of the horrific annual drought it has been dreading for the past decade?

    - $\frac{200,000,000,000,000}{344,261,204,000} = \sim 5.81$ or **<u>~6 times</u>**.

DISCUSSION AND IMPLICATIONS

In a world where Humanity no longer consumes animal-sourced foods, the need for water and other resources will no longer be and the resources would have never been extracted from local ecosystems. More specifically, California has been dreading its worsening yearly summer-long extreme drought periods (Swain, D. L. 2015). The country can then restore local watersheds to help California with its water crisis (Richter et al. 2003). As I have calculated above, the water used for US beef equates to nearly 6 times the amount needed to help California out of its tragic summer drought cycle.

Discussion

Subsequentially, I can also answer the questions I had underlined in my introduction:

- a single animal necessitates 2,106,786 liters of water, typically taken from local water reserves and watersheds, once irrigated water reserves are empty (Steinfeld et al. 2006; Swain et al. 2015).

- US beef used a lump total of over 2.0 *10^14 liters of water to produce only one life cycle of the entire US beef production, in 2021.

- To end its record-breaking worsening drought cycle and reset its natural steady-state water cycles, California needs nearly 350 billion liters of water.

- With merely all of the water used by US beef, California can reset its water cycles to a natural steady-state equilibrium nearly six times.

Additionally, although the study (Pimentel & Pimentel, 2003) had found that, with current agricultural practices, no human diet (neither meat-based nor ovolactovegetarian) was sustainable in terms of the amounts of resources (water, land, and fossil fuels) used for production, the more plant-based the food production system is, the more sustainable it becomes. They concluded that

because producing livestock for food requires first producing crops for the livestock's feed, simply redirecting our resources to producing more plant-focused foods is much more sustainably sound than the world's current practices. They had also concluded that such a plant-focused food production system would also ensure complete nutritional requirements for all of Humanity, devoid of any kinds of deficiencies.

Additionally, Jalava et al. (2014) found that: "To further this claim that appropriate dietary modifications can be sufficient in providing an optimal solution to the global water scarcity crisis." The dietary modifications they refer to are to simply eliminate the need for animal-sourced foods and transition to a predominantly plant-based global food regime.

Further, completely removing animal-sourced foods from our global food regime could also suggest the prevention of any extreme natural climate disruption, in the first place (EAT-Lancet Commission, 2019). The EAT-Lancet was a global think tank initiative involving 137 scientists, ranging from politicians to nutritionists; psychologists to sustainability experts; ecosystem experts to medical doctors, who collaborated on establishing the sustainably ideal food system to be able to feed a projected world population of ten billion, or eventually more. They also concluded that the more plant-based the foods, the more sustainable their production: "a dietary pattern higher in plant foods such as vegetables, fruits, whole grains, legumes, nuts, seeds, and lower in animal-based foods is more health-promoting and associated with a lesser environmental impact than is the current average US diet." My study merely focused on US beef production. However, if another project were to, instead, consider the other sectors of the US livestock production, an exponentially larger amount of input resources and wildlife ecosystems would then be saved, as Humanity converts its global food regime to more and more plant-based food sources, not only saving water sources (Brauman et al. 2020).

Implications

Knowing that with only a fraction of the water used by US beef can we hypothetically help California to end its horrific cycle of extreme yearly droughts, How many more essential uses can we be reallocating these gargantuan quantities of natural resources to? For instance, considering the immense surfaces of land that have been converted from several hundred-million-year-old rainforests to grazeland for cattle, along with the wildlife in these forests, the planet's natural

cycles of resources, food, and Life can be restored with the adequate efforts from Humanity; in other words, by converting global animal-sourced food supplies to predominantly plant-based sources, Humanity can ensure enough food to be produced for several billion more inhabitants (EAT-Lancet report, 2019). Although my study does not go over the financial aspects of transforming our global food system; from the health benefits alone, switching to a plant-centered global food regime will save up to thirty trillion USD (EAT-Lancet report, 2019). This begs asking the following: How much more money, Life and natural resources could the World be saving from using significantly smaller amounts of resources and emitting vitally less pollution?

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