Assessing Potential Environmental Justice Implications of Environmental Pressures from the Global Food System

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OBJECTIVES
The main objective of this capstone project is to explore spatial patterns connecting human welfare indicators with one or more of four environmental pressures resulting from global food systems: land and ocean disturbance, CO2 emissions, water consumption, and excess nutrients. Until recently, maps of individual environmental pressures from specific food sectors existed, but aggregate maps of all foods and all key environmental pressures from these foods were lacking. The comprehensive data from the NCEAS Environmental Impact and Sustainability of Global Food Systems working group provides a spatially explicit assessment of cumulative pressures from food production that account for essentially all reported global foods.

We know from past work on environmental justice that the consequences of environmental impacts from human activities are often felt most by underserved or marginalized communities (8). Missing from this body of research is an examination of potential implications to human health and well-being from the environmental pressures of global food systems, despite the large environmental footprint of food production. This gap in understanding has persisted largely due to previous unavailability of spatially-mapped, comprehensive global food systems environmental pressure data that would allow one to compare where (locally) food is creating environmental pressures and where different groups of people are living.

This proposed project leverages newly available data that allow, for the first time, assessment of the potential social justice implications from food's environmental footprint. By analyzing human health and well-being indicators through the lens of global food systems pressures, we can gain insights into where and how to transform global food systems to address environmental justice.

SIGNIFICANCE

Currently, food production uses around 50% of habitable land and 4% of sea area, accounts for about 70% of global freshwater withdrawal, and is responsible for 26% of all anthropogenic greenhouse gas (GHG) emissions (4). All of these environmental pressures have potential implications for human health and well being, with human communities closest to the source of pressures likely suffering the greatest consequences. GHG emissions in particular can also have regional consequences; there are several mechanisms by which climate change can affect human health, including disease, natural disasters, and resource insecurity (7). Indeed, such effects on human-well being by environmental stressors have been documented in several studies (6).

Despite these important potential implications of food's environmental footprint, we currently know little about the impact on human health and well-being. These gaps likely contribute to food production policies that fail to protect the interests of both people and nature (4). By using newly available global datasets on food's environmental footprint, coupled with widely available data on human communities, we can begin to examine such patterns. For this capstone project, we propose that MEDS students explore possible relationships at the scale of countries to address global dynamics of food systems and human welfare.

BACKGROUND

Previous studies about the impact and sustainability of food systems have focused on singular food systems or singular impacts. Such focus is valuable for understanding the specifics of a particular food or pressure, but inhibits systemic comparisons across broader food categories (e.g., fish vs. meat) and multiple pressures, and thus limits informed decision-making for food system programs and policy.

The NCEAS Environmental Impact and Sustainability of Global Food Systems working group has synthesized science and data to map at high resolution the individual and cumulative environmental pressures of all major food systems globally (99% of all food produced). Their work maps four of the major stressors from global food systems: land and ocean disturbance, CO2 emissions, water consumption, and excess nutrients. Food types include crops, livestock, marine aquaculture, marine fisheries, and freshwater fisheries. It is the group's vision that this data can inform policy and decision making to promote sustainable, equitable food systems (1). Comparing human welfare patterns relative to environmental stressors from food at the country level will add substantial value to this research initiative by exploring these relationships at a global scale.

EQUITY

Industrial development, including the growth and development of the global agriculture sector, has had profound effects on the health of the planet and its resources as well as the health and wellbeing of human populations. Local and regional trends in water scarcity, for example, are often the result of high usage in industrial processes (5). Similarly, N and P, both nutrient

emissions from crops examined as environmental stressors in the NCEAS dataset, have adverse human health effects (6). This project seeks to systematically examine such effects through the lens of all four environmental stressors.

One of the principles of environmental justice is that all communities have equal access to clean water, air and land (4). In order to feed a growing global population that already suffers major inequities, global food policy and programs need to address the ways specific food systems across regions exacerbate and perpetuate environmental inequities. By exploring patterns between major stressors of global food systems and human welfare indicators, this project can help surface where and how the environmental footprint of global food production is related to inequities in human health and well being, and thus support future research that will inform equitable and sustainable food system policy implementation.

DATA

- **NCEAS Dataset**: This dataset includes the amount of each environmental pressure for each food type in each country. Questions about the data from the Capstone Committee can be directed to Dr. Ben Halpern.
- Possible human welfare datasets:
    - **FAOSTAT Macro Indicators**
    - **FAOSTAT Suite of Food Security Indicators**
    - These dataset suggestions are not exhaustive.

POSSIBLE APPROACHES

1) ***Data selection***: Examine and select datasets describing human welfare data at the country level to be considered in spatial relationship with environmental pressures.
2) ***Data cleaning***: Harmonize the human welfare data to compare to the environmental footprint data
3) ***Data analysis***: Using R, apply simple pairwise regressions in which each country is a point, plotting the environmental pressure variables against human welfare variables. The correlation values between food systems and welfare indicators will be the main value for NCEAS scientists in future exploration of these patterns.
4) ***Data visualization***: Develop data visualizations to help NCEAS scientists examine patterns for future directions and communicate their results.
5) ***Work flow:*** Manage project approaches using a Github repository and Bren server, Taylor, in a way that is reproducible and scalable.

DELIVERABLES

In addition to the final Design & Implementation Plan, Technical Documentation and two oral presentations provided by the capstone group, as required by the Bren School of Environmental Science and Management, the final deliverables for the client will include outputs and code for:

- *A pairwise regression analysis and workflow*
    - This work will compare different combinations of national environmental pressures from food systems and national human welfare indicators.
    - Exploration and evaluation of human welfare indicators.
- *Data visualization*
    - This work will help tell a story about the patterns observed between national environment pressures from food systems and human welfare indicators.

SUPPORTING MATERIALS

Citations

(1) NCEAS Dataset
(2) Mohai, P., Pellow, D. & Roberts, J. T. Environmental Justice | Annual Review of Environment and Resources. *Annual Review of Environment and Resources* **34**, 405–430 (2009).
(3) Clark, M. A. *et al.* Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets. *Science* **370**, 705–708 (2020).
(4) Kuempel, C. D. *et al.* Integrating Life Cycle and Impact Assessments to Map Food's Cumulative Environmental Footprint. *One Earth* **3**, 65–78 (2020).
(5) Chowdhary, P., Bharagava, R. N., Mishra, S. & Khan, N. Role of Industries in Water Scarcity and Its Adverse Effects on Environment and Human Health. in *Environmental Concerns and Sustainable Development: Volume 1: Air, Water and Energy Resources* (eds. Shukla, V. & Kumar, N.) 235–256 (Springer, 2020). doi:10.1007/978-981-13-5889-0_12.
(6) Nieder, R., Benbi, D. K. & Reichl, F. X. Reactive Water-Soluble Forms of Nitrogen and Phosphorus and Their Impacts on Environment and Human Health | SpringerLink. https://link.springer.com/chapter/10.1007/978-94-024-1222-2_5 (2018).
(7) A. Haines, R.S. Kovats, D. Campbell-Lendrum, C. Corvalan, Climate change and human health: Impacts, vulnerability and public health, Public Health, Volume 120, Issue 7, 2006, Pages 585-596, ISSN 0033-3506, https://doi.org/10.1016/j.puhe.2006.01.002. (https://www.sciencedirect.com/science/article/pii/S0033350606000059)
(8) James K. Boyce, Inequality as a cause of environmental degradation, Ecological Economics, Volume 11, Issue 3, 1994

Budget/Justification

It is not anticipated that the proposed project would require additional funding beyond the $50 contributed by the Bren School.

Letter of Client Support

See attached.