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Digital footprints as a tool to evaluate the spatiotemporal environmental impacts of grocery shopping across Great Britain

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Introduction & Background

Climate change represents one of the most pressing challenges of our time. Within this context, the food sector is a critical domain for intervention, accounting for approximately one-third of global greenhouse gas emissions. While consumers increasingly express concern about environmental issues, they often lack access to transparent, actionable information about the environmental footprint of their food choices.

Objectives & Approach

This study integrates environmental impact data of grocery products with digital footprint data from a major UK retailer to analyse sustainable food purchasing patterns. Through advanced text processing techniques including natural language processing (NLP) algorithms and machine learning classification models, we established comprehensive product mappings across retailers using product name similarity matching and category classification. Environmental impact scores were calculated based on life cycle assessment (LCA) data encompassing carbon footprint, water usage, and land use metrics, weighted by product-specific environmental intensity factors. These scores were merged with transactional shopping data for over 4 million loyalty card holders covering the period from July 2019 to December 2021. The analysis examines spatio-temporal variations in food-related environmental impacts across British neighbourhoods, at the Lower and Middle Super Output Area levels, incorporating area-level socioeconomic status (SES) data, such as the 2019 Indices of Deprivation, to explore demographic patterns in consumption behaviours and their associated environmental impact.

Relevance to Digital Footprints

Analysis of grocery transactions by loyalty card members demonstrates the ability of digital footprint data to be an effective method for visualising variations in the environmental footprint of food purchases at the local level and highlighting seasonal variations in environmental impacts.

Results

Mapping the normalised results shows wide divergences of environmental impact across neighbourhoods and seasons. Areas with above-average levels of animal-based products have higher environmental footprints, with a notable correlation between higher socio-economic status areas and increased consumption of environmentally intensive products per pound spent. Despite red meat having a significantly higher impact than other foods, it is often foods with lower environmental impact, like dairy products, that are responsible for much of the environmental footprint due to their higher levels of overall consumption. Seasonal analysis reveals distinct patterns: environmental impacts peak during winter months (December-February), potentially due to increased consumption of imported produce and processed foods, while summer months show reduced impacts likely coinciding with greater consumption of locally-sourced fresh produce.

Conclusions & Implications

The development of cross-retailer product datasets through text-based matching and machine learning techniques enables broader application of retailer-specific environmental impact data. This methodology mitigates single-source bias and enhances the generalizability of research findings. Our spatiotemporal analysis reveals that environmental footprints are primarily driven by consumption volume, with significant seasonal variations observed at the neighbourhood level and notable socio-economic disparities in consumption patterns of high-impact animal-based foods like red meat and dairy products.

Keywords

food, sustainability, spatiotemporal analysis, data integration