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Ethical aspects of life cycle assessments of diets

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ABSTRACT

Since the turn of the century a growing chorus of researchers has been espousing reduced meat and dairy intake as a partial strategy to transition towards a sustainable food system. Many of these studies have been predicated on a life-cycle assessment (LCA) methodology and though transparent in communicating their work within that framework, it has largely gone unmentioned that LCA involves a number of choices by the assessor and LCA methodology developers that are ultimately subjective. This study uses a consequential LCA of the average Danish diet in comparison to model vegetarian and vegan diets, leveraging the cultural perspectives afforded by the ReCiPe methodology, as starting point to explore the ways that subjectivity influences the LCA process and to test the robustness of the results against these different viewpoints. Mirroring earlier studies, we find vegetarian and vegan diets generally perform better environmentally compared to a standard Danish diet, but that there was minimal difference between the two no-meat options. Results were resilient to varying cultural perspectives applied in the model. LCA methodology, though loaded with value judgments, remains a dependable tool for assessing environmental dietary performance, but is less suited for estimating environmental pressures that are highly dependent on local conditions (e.g. chemical toxicity).

Introduction

At the global level, food production is estimated to be responsible for between 20% and 50% of anthropogenic environmental impacts (McLaren, 2010; Notarnicola et al., 2012; Roy et al., 2012). Irrespective of this pressure's true value, it is clear that global food consumption affects the performance of ecosystems negatively (locally and globally) through contributions to a variety of environmental issues including: climate change, water stress, toxic chemical release, air quality degradation, eutrophication of water bodies, soil erosion, and biodiversity losses (Cribb, 2010; Foley et al., 2011). Ecosystem damages aside, current intensive agricultural systems rely on non-renewable resources (fossil fuels, land, and minerals) that are being exhausted and inefficiently employed (IBID). A projected 33% population growth – from 7 billion today to 12 billion by 2100 (Gerland et al., 2014) – with concurrently increased global economic activity (Price Waterhouse Cooper, 2010) will challenge the global agriculture system to produce more food with less resources while minimizing environmental impacts synchronously. Recent trends have been discordant with these ambitions, showing reduced growth in yields per unit production factor (land, fertilizer, etc.) in a number of countries as well as increased gross, non-renewable resource consumption from 1985–2005 (Foley et al., 2011; Tilman and Clark, 2014).

Meat and dairy products are central to food-related impacts, having large environmental burdens including agricultural land degradation due to overgrazing, surface and groundwater contamination from uncontrolled waste management, biodiversity loss through the proliferation of grazing land (and land for feed production), and greenhouse gas (GHG) emissions related to livestock digestion (particularly ruminants) (Asner et al., 2004; Cribb, 2010; FAO, 2006; Modernel et al., 2013; Nijdam et al., 2012). Due to the inherent inefficiencies of producing biomass at higher trophic levels (McMichael et al., 2007; Pimentel and Pimentel, 2003), livestock production also requires calorific inputs amounting to 40% of global grain production (IBID; Foley et al., 2011). These feed requirements have environmental impacts embodied within their production, exacerbating the direct environmental disturbances of animal husbandry. Accounting for pastures and animal feed, livestock production is estimated to commandeer nearly one third of global, ice-free surface area (McMichael et al., 2007). These environmental pressures and land constraints are key issues if the predicted global animal product demand doubles from year 2000 levels by 2050 in response to population and

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economic drivers (FAO, 2006; Feeley and Machovina, 2014; McMichael et al., 2007; Tilman and Clark, 2014).

Technological improvements to livestock production can mitigate some environmental harm, but eco-efficiency gains have failed thus far to mitigate net environmental impacts. Conversely, tackling this challenge on the demand side by reducing meat and dairy consumption has been championed as a way to improve the environmental integrity of nourishing humanity (FAO, 2006; Foley et al., 2011; Tilman and Clark, 2014). This approach has been most salient in the United States Department of Agriculture's (USDA) 2015 dietary guidelines (2015). Indeed, environmental audits using life-cycle assessment (LCA) have shown that, low meat, vegetarian (no meat), and vegan (no meat or dairy) diets can have significant environmental benefits in comparison to prevailing dietary trends in wealthy countries (see Table 1). LCA estimates the resultant environmental impacts in a number of pertinent indicators from the supply chain (raw material extraction, processing, use, disposal, and related transport) required to deliver a product or service. These studies have shown univocally that vegetarian and vegan diets have reduced GHG emissions over standard omnivorous diets in a wealthy context. For other environmental impacts, LCA conclusions vary, showing that reduced animal product consumption reduces all accounted environmental impacts (Baroni et al., 2007), reduces particulate matter formation and land occupation (Saxe, 2014) or, conversely, exacerbates water consumption (Meier and Christen, 2013).

Though compelling, the veracity of environmental benefits from reducing meat consumption has shortcomings. The common application of single issue indicators, chiefly the GHG burdens, dominates relevant literature (Berners-Lee et al., 2012; Heller et al., 2013; Roy et al., 2012; Saxe et al., 2012; Wallén et al., 2004), running the risk that reduced meat diets may increase other environmental impacts (i.e. environmental burden shifting). Moreover, where expanded indicator sets covering more types of environmental pressures have been applied, paucities exist in illuminating the latent assumptions within the LCA framework and their potential consequences. Baroni et al. (2007) explored this theme with their analysis of the robustness of LCA results of dietary shifts to changes in assessor concern for different environmental impacts, both in terms of impact type and time-frame, finding that in general little change was seen with shifting assessor perspective. Aside from nascent investigation, there has been sparse discussion surrounding how the choice of indicators included in and LCA or the way that chemicals are modeled in the environment might affect dietary study results. Moreover, environmental efficacy has been ascribed to dietary choices even when the compared diets perform within the margins of error typically applied to LCA assessments. Herrmann et al. (2014) note that the margin of error can be significantly larger than the 10% uncertainty used in some of the reviewed studies. Lastly, with the exception of Saxe's work, studies have utilized attributional LCA models which are not representative of production systems at play with market forces (Plevin et al., 2014). Clearly, even within the LCA framework which strives for scientific objectivity, subjective values influence assessments, although this is only one aspect of the power of personal preferences in the discussion of the sustainability of diets.

Table 1
Previous environmental life cycle assessments of dietary habits.

Reference	Country	Impacts included				GHG reduction (% change relative to omnivorous diet)	Other comments
		Non-toxic	Toxic	H_2O use	Land use		
Heller and Keoleian (2014)	United States	X				Vegetarian: 33% Vegan: 53%	
Saxe (2014)	Denmark	X		X	X	New Nordic Diet: 30% w/reduced transport: 35% w/organics: 32%	– Land occupation reduction with reduced meat diet – Organic content of diet raised particulate matter and land occupation impacts
Scarborough et al. (2014)	United Kingdom	X				Medium meat: 21% Low meat: 35% Pescatarian: 46% Vegetarian: 47% Vegan: 60%	– Comprehensive diet survey used
van Dooren et al. (2014)	Netherlands	X			X	Vegetarian: 21% Vegan: 37%	
Meier and Christen (2013)	Germany	X		X	X	Vegetarian: 25% Vegan: 50%	– Water use inversely proportional to meat intake
Berners-Lee et al. (2012)	United Kingdom	X				Vegetarian: 22% Vegan: 36%	
Roy et al. (2012)	Japan	X				Not applicable	
Saxe et al. (2012)	Denmark	X				New Nordic Diet: 6% w/optimization: 27% Vegetarian: 27%	– Select local, organic and meat consumption performed equal to vegetarian
Macdiarmid et al. (2012)	United Kingdom	X				Reduced meat: 36%	– Unrealistic sustainable diet achieved 90% reduction in GHGs
Tukker et al. (2011)	Europe	X	X			Reduced red meat: 8% Mediterranean: 5%	
Baroni et al. (2007)	Italy	X	X	X	X	Vegetarian: 74% w/organic: 87% Vegan: 90% w/organic: 97%	– Ubiquitous superior performance across all impact categories with reduced meat
Wallén et al. (2004)	Sweden	X				Reduced meat: 5%	