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The impact of global dietary guidelines on climate change

Hannah Ritchie[a,*], David S. Reay[a], Peter Higgins[b]

[a] School of Geosciences, University of Edinburgh, High School Yards, Edinburgh, EH8 9XP, United Kingdom
[b] Moray House School of Education, University of Edinburgh, EH8 8AQ, Edinburgh, United Kingdom

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ABSTRACT

The global food system faces an ambitious challenge in meeting nutritional demands whilst reducing sector greenhouse gas emissions. These challenges exemplify dietary inequalities—an issue countries have committed to ending in accord with the Sustainable Development Goals (by 2030). Achieving this will require a convergence of global diets towards healthy, sustainable guidelines. Here we have assessed the implications of dietary guidelines (the World Health Organization, USA, Australian, Canadian, German Chinese and Indian recommendations) on global greenhouse gas emissions. Our results show a wide disparity in the emissions intensity of recommended healthy diets, ranging from 687 kg of carbon dioxide equivalents (CO_2e) capita^{-1} yr^{-1} for the guideline Indian diet to the 1579 kg CO_2e capita^{-1} yr^{-1} in the USA. Most of this variability is introduced in recommended dairy intake. Global convergence towards the recommended USA or Australian diet would result in increased greenhouse gas emissions relative to the average business-as-usual diet in 2050. The majority of current national guidelines are highly inconsistent with a 1.5 °C target, and incompatible with a 2 °C budget unless other sectors reach almost total decarbonisation by 2050. Effective decarbonisation will require a major shift in not only dietary preferences, but also a reframing of the recommendations which underpin this transition.

1. Introduction

The global food system is currently failing to meet basic nutritional needs (Haddad et al., 2016), and is placing increasing pressure on planetary boundaries and resources (Alexander et al., 2016; Foley et al., 2011). Agriculture and food production systems are estimated to contribute more than one-quarter of global greenhouse gas (GHG) emissions (Edenhofer et al., 2014; Tubiello et al., 2014)—a contribution which is projected to increase through population and economic pressures (Alexandratos and Bruinsma, 2012). United Nations (UN) projections of global population growth to 9.8 billion by 2050 (United Nations: Department of Social and Economic Affairs, 2017) will place increasing pressure on the intensification of agricultural systems. Economic growth is also expected to drive dietary change towards more GHG-intensive diets (Alexandratos and Bruinsma, 2012). Business-as-usual (BAU) pathways are not only expected to exceed global climate targets for 2 °C scenarios (Wellesley et al., 2015), but will also place unsustainable resource pressures on land (Alexander et al., 2016; Wirsenius et al., 2010), freshwater supplies (Mekonnen and Hoekstra, 2016), and marine resources.

Despite continued improvements in agricultural output (Foley et al., 2011), poor nutritional health remains a widespread, and in some cases, a growing issue (FAO et al., 2015). More than 800 million people are defined as undernourished, an estimated two billion suffer from micronutrient deficiencies, and 40% of adults globally are classified as overweight or obese (with increasing links to the incidence of non-communicable diseases—NCDs—such as cancer, stroke and heart disease) (FAO, 2017b). This ‘triple burden’ of malnutrition is reflective of the large dietary inequalities which exist both between and within countries.

To simultaneously meet the 2nd and 13th Sustainable Development Goals (SDGs), of ending malnutrition, and combating climate change (United Nations, 2016) (in addition to meeting the international climate change mitigation target of 2 °C (Wollenberg et al., 2016)), a convergence of global diets towards more healthy and sustainable patterns is of pressing importance. The average diet across most high-income countries (FAO) is well in excess of WHO recommendations for caloric, meat and sugar consumption, with increased risk of NCDs and obesity (WHO, 2015). Conversely, the typical diet across many low and middle-income nations (FAO) falls below quantity, quality and diversity requirements—increased intake of commodities such as meat, dairy, and fish are likely to improve health and social outcomes (FAO, 2011; Rivera et al., 2003; Zotor et al., 2015). Agricultural production is also likely to become increasingly important for countries in meeting their

* Corresponding author.
E-mail addresses: Hannah.Ritchie@ed.ac.uk (H. Ritchie), david.reay@ed.ac.uk (D.S. Reay), pete.higgins@ed.ac.uk (P. Higgins).

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climate change mitigation commitments (Elbehri et al., 2017; The World Bank, 2017)—a constructive means of defining and monitoring demand-side progress in the food sector will be essential for this. Convergence of national dietary patterns towards a healthy global recommended level may contribute to a significant reduction in the GHG emissions intensity and NCD risks of average high-income diets, and a healthy, sustainable improvement in low-income diets.

There are currently no internationally agreed guidelines for what a simultaneously nutritious and environmentally sustainable mainstream human diet constitutes. A number of studies have shown that a transition towards pescetarian, vegetarian or vegan diets would result in significant GHG savings relative to meat-intensive diets (Tilman and Clark, 2014; Springmann et al., 2016a; Van Dooren et al. 2014; Scarborough et al., 2014). While the incidence of vegetarianism has shown some increase in developed economies (Beverland, 2014), the adoption of more flexitarian or meat-reduction based dietary transitions have shown greater uptake and social acceptance (Dagevos and Voordouw, 2013; De Boer et al., 2014). Convergence guidelines which recommend a reduction rather than elimination approach to meat may therefore be more effective in increasing dietary transition rates. Convergence towards a moderate mixed diet—rather than wholly plant-based diets—may also be important in balancing environmental concerns with health outcomes in low-income nations (where dietary diversity is often poor, and high-quality alternative protein products are often unavailable or expensive). Relative to sustainability-focussed dietary advice, dietary health guidelines are better-established, with WHO global-level recommendations (WHO, 2015), and national-level nutritional plans in more than 100 countries (Fischer and Garnett, 2016). Despite international guidelines, significant variations in national recommendations remain (Fischer and Garnett, 2016).

Here, for the first time, we have attempted to assess the degree to which convergence of global average diets to a defined set of guideline levels could simultaneously achieve improved human health and significant reductions in GHG emissions from global agriculture. This analysis comprised several steps. First, all available country-level dietary guidelines (FAO, 2017a) were reviewed to assess their clarity in providing clear, quantitative recommendations for an average healthy diet. Next, a range of representative national dietary guidelines were assessed for their resultant per capita GHG emissions using commodity-specific GHG-intensities derived through life-cycle (LCA) meta-analyses (Tilman and Clark, 2014). National guidelines—including the USA, China, Germany, Australia, Canada and India—were compared relative to income-dependent dietary projections (Tilman and Clark, 2014) and WHO healthy diet guidelines (WHO, 2015). This analysis revealed wide disparity in the GHG-intensity of national recommended diets—with some showing a minimal reduction in GHG emissions relative to the average projected income-dependent diet in 2050. Global agricultural GHG emission pathways were then assessed based on the assumption that average diets converged on each of these global or national recommendations by 2050—such a convergence would allow for both nutritional and GHG mitigation targets to be addressed simultaneously.

Finally, we assessed the compatibility of current dietary trends with national and WHO guidelines, and the likelihood of their convergence in the near (2030, the end date of the SDGs) and longer (2050) term. Annual rates of change in food consumption were estimated for three exemplar countries which together cover a full range of dietary compositions—the USA, China and India—based on extrapolation from current FAO consumption figures for the period 2000–2013 (the latest full dataset available). (FAO). This provides some indication of the magnitude of change in dietary patterns necessary for these and similar nations to meet dietary guidelines relative to current trends.

A number of publications have assessed the GHG intensity of dietary choices, as well as the reduction potential of dietary changes. Several such studies have looked at the global comparison between business-as-usual (or income-dependent) projected diets towards 2030 and 2050 alongside the World Health Organization (WHO) healthy diet guidelines (Tilman and Clark, 2014; Springmann et al., 2016a). These studies attempt to address the diet-sustainability-health trilemma through GHG and health benefit quantification. Other analyses have looked more regionally or nationally at the potential mitigation impact of dietary change—either in terms of meat reduction, substitution, or adoption of Mediterranean, vegetarian or vegan diets (Berners-lee et al., 2012; Westhoek et al., 2014; Stehfest et al., 2013; Scarborough et al., 2014). It is well-established within the literature that an overall reduction in meat (particularly red meat) products is synonymous with GHG reduction and health benefits.

However, no analysis to date has attempted to quantify the suitability or impact of adoption of current national dietary guidelines with respect to climate mitigation, and the more recently established SDG targets. Fischer and Garnett (2016), of the UN FAO, to our knowledge have produced the only large-scale assessment of sustainability within national dietary guidelines. However, this work, does not attempt any quantification of impacts of guideline adoption and instead focuses on a qualitative assessment of which countries have made reference to sustainability within their recommendations.

Our work therefore attempts to provide the first comparison of national dietary guidelines in terms of GHG emissions. This was carried out through the adoption of similar methods utilised in global-level assessments of diet-environment-health links by Tilman and Clark (2014) and Springmann et al. (2016a,b), but applied within the context of national-level recommendations. Assessment of the relative impact of countries switching from their current average diet to nationally recommended intake across greenhouse gas, eutrophication and land use metrics has been previously assessed, with a focus on the impact of this transition rather than the comparison of national recommended diets or their compatibility with climate targets (Behrens et al., 2017).

2. Methods

National food-based dietary guidelines were reviewed based on those publicly available in FAO repositories. These cover 86 countries across all regions, with countries at all stages of development. A qualitative assessment of the suitability of national guidelines for sustainability has been previously published by the FAO (Fischer and Garnett, 2016). We attempt to build upon this work through a quantitative assessment of the compatibility of these guidelines with climate targets.

2.1. Quantifying emission footprints of recommended diets

The average diets of six national guidelines—India, China, Germany, Canada, Australia and the USA, in addition to the WHO healthy (WHO, 2015) and income-dependent 2050 diet (Tilman and Clark, 2014)—were quantified in terms of annual GHG emissions per capita based on commodity-specific life-cycle analysis (LCA) meta-analyses carried out by Tilman and Clark (2014). This meta-analysis reviewed 555 LCAs across 82 food items. These LCAs were sourced based on a criteria of complete 'cradle to farmgate' boundary scope, including emissions from pre-farm activities such as fertilizer, feed production and infrastructure construction. This footprint does not include post-farmgate activities such as transport, processing and consumer use. For reference, analysis suggests that this post-farmgate component of the overall footprint would approximately add a further 20% to total emissions (Weber and Matthews, 2008; Tilman and Clark, 2014). Due to the large uncertainties involved in calculating levels of land-use change (LUC), and the resultant GHG emissions, LUC has also not been included. This study therefore focuses only on emissions related to agricultural production.

Tilman and Clark (2014) derived their income-dependent 2050 diet based on eight economic groups – six groupings plus China and India independently (aggregated based on per capita gross domestic product; GDP); GDP-consumption relationships and modelled using the Gompertz 4p curve function. The income-dependent diet differs from