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Which countries avoid carbon-intensive development?

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ABSTRACT

This paper explores the underlying development outcomes and cumulative emissions trajectories of 20 middle-income countries from Eastern Europe, Latin America, North Africa and South Asia. First, well-being outcomes are assessed, defined in terms of access to education, democratic and legal rights, and the infrastructures that support physical health. Second, emissions trajectories are estimated to 2050, taking into account current trends in energy consumption and carbon intensity, a likely start-date for stringent climate policy arising from the Paris Agreement (2020), and maximum feasible rates of mitigation. Comparing these estimates to a per capita allocation from the global carbon budget associated with 2 °C, ten countries have low-carbon development trends that will not exceed their allocation. Of these, Costa Rica and Uruguay are achieving very high well-being outcomes, while many more are delivering good outcomes in at least two domains of human need. However, most are seriously deficient in terms of social well-being (education, democratic and legal rights). These results call into question the socio-economic convergence of developing countries with industrialised countries; but they also reaffirm the low-emissions cost of extending good infrastructure access and physical health outcomes to all, demonstrated by the existence of multiple countries that continue to avoid carbon-intensive development.

1. Introduction

Is human well-being compatible with climate change mitigation? Recent research would suggest so: at least a dozen countries have enabled strong health and poverty reduction outcomes, despite very low levels of energy consumption and greenhouse gas emissions (Lamb et al., 2014; Rao et al., 2014; Steinberger and Roberts, 2010; Steinberger et al., 2012). However, many nations in South Asia and Africa still remain below levels of per capita energy consumption necessary for meeting basic human needs (Lamb and Rao, 2015), including many of the aspirational 'Sustainable Development Goals' (SDGs). Reconciling much needed energy growth in these regions with the newly adopted Paris Agreement, which calls for global average temperatures to be held "well below 2 °C above pre-industrial levels" (UNFCCC, 2015), is a key challenge in the making of climate policy, particularly as many countries choose to deepen their commitment to carbon-intensive energy sources (Steckel et al., 2015). Yet surprisingly little is known about historical low-carbon pathways of development. Which countries enable high levels of access to household energy services, education, nutrition, health, and democratic rights, at levels of emissions far below the industrial average? This question is the focus of this paper.

Defining low climate impact is of course problematic, since all emissions must ultimately stabilise at zero (or be compensated by negative emissions) to avoid exceeding a temperature target. Similarly, 'high well-being' is an equally contentious phrase. In this paper, we elaborate on an early definition of low-carbon development called 'Goldemberg's Corner' (GC): a domain of relatively low per capita carbon emissions (0–3.5 t CO_2), but high levels of achievement in life expectancy (>70 years), comprising about two dozen countries across Eastern Europe, Latin America, North Africa and South Asia (Steinberger and Roberts, 2010). Our contribution is twofold: First, GC countries are examined for their ability to deliver a group of essential household energy and social services in addition to high life expectancy, defined from a human needs perspective, and building on recent literatures critiquing per capita GDP as a poor indicator of development and well-being (Stiglitz et al., 2009). Second, since it is the cumulative emissions that matter for climate impact (Meinshausen et al., 2009), this paper estimates emissions trends and peaking dates for GC countries,

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comparing these to an allocation from a 2 °C global carbon budget to assess the long-term sustainability of their current development pathways. In short, this paper identifies which countries are attaining objectively strong outcomes of human well-being, while continuing to demonstrate emissions trends that are compatible with a 2 °C framing of climate change. Accordingly, it argues that such countries may provide a rich source of climate-efficient development policy for those following in their wake, including very large potential emitters such as India, Nigeria and Bangladesh.

This work builds on old and new research investigating well-being in relation to energy consumption (Mazur and Rosa, 1974; Steinberger and Roberts, 2010), territorial emissions (Costa et al., 2011; Steinberger and Roberts, 2010) and consumption-based emissions (Lamb et al., 2014; Steinberger et al., 2012). It is related to research on the links between poverty and greenhouse-gas emissions (Lamb and Rao, 2015; Pachauri et al., 2013; Rao and Baer, 2012; Rao et al., 2014), a stream of work known as the "Carbon Intensity of Well-being" (Dietz et al., 2009; Jorgenson, 2014), and much theoretical and empirical work on the dimensions and determinants of human need (Doyal and Gough, 1991; Gough, 2015; Sen, 1990). Its closest counterpart is a study by Lamb et al. (2014), which investigated the underlying drivers of carbon emissions in Goldemberg's Corner, finding that countries in this domain of low-emissions and high well-being tend to be diverse in their climates, levels of trade, and population growth, but are constrained to low and middle incomes. O'Neill (2015) has also explored countries in the context of their resource consumption, carbon emissions and social performance; while a cumulative emissions framework has been used in Peters et al. (2015) to assess the ambition of mitigation pledges in major emitters.

A number of conceptual and empirical advances are made in this paper. To the author's knowledge, no previous studies have explored the well-being performance of countries from a cumulative emissions framework. In this task, this research builds on recently established consumption-based emissions inventories (Peters et al., 2011), an allocation method to model the persistent short-term emissions growth of countries (Raupach et al., 2014), and carbon emissions budgets of the latest IPCC synthesis report (IPCC, 2014). Furthermore, and in contrast to previous work, it follows a human needs based definition of well-being, moving beyond single-indicator approaches (such as GDP, life expectancy and the human development index) to suggest multiple indicators and thresholds of physical and social need that can be explicitly linked to the Sustainable Development Goals and must be universally enabled to achieve genuine well-being outcomes.

2. Materials and methods

2.1. Country selection

Previous work assessing high-level indicators of human well-being (life expectancy) and environmental impact (energy consumption, carbon emissions) has demonstrated a non-linear relationship: well-being increases with energy consumption (and thus emissions) up to a threshold of approximately 25–50 GJ/capita (~3.5 t CO_2/capita), where the relationship decouples (Lamb and Rao, 2015; Steinberger and Roberts, 2010). The countries that lie on the margin between 'enough' energy consumption and 'too much' are of course interesting and a likely starting point in the search for low-carbon development trends, as they may exhibit patterns of infrastructure and service delivery that are sufficient for enabling well-being, but come at a low cost to the climate. Thus the domain known as Goldemberg's Corner (below 3.5 t CO_2/capita and above 70 years life expectancy) provides a simple framing that reduces the scope of countries, allowing us to focus in more detail on their emissions trends and intermediate well-being outcomes. Importantly, emissions accounts in this paper are defined from a consumption perspective, correcting for transfers embodied in trade that may mask actual levels of carbon a country could be deemed responsible for (Hertwich and Peters, 2009; Peters et al., 2011), but also acknowledging the closer role consumption emissions have in enabling well-being outcomes (Steinberger et al., 2012). This framing and choice of data results in a total of 20 countries, comprising approximately 12% of global population, 7% of global energy consumption and 5% of global emissions.

2.2. Indicators of human well-being

This paper takes a needs-based approach to defining well-being, most clearly articulated in Doyal and Gough's (1991) *A Theory of Human Need*. In this view, well-being is defined as the avoidance of serious harm, which requires underlying conditions of physical health and personal autonomy (i.e. the ability to participate, and choose that form of participation in society). This is an objective approach, but one that recognises there are diverse social and cultural 'satisfiers' for each dimension of human need (Max-neef, 1991). The human needs approach is related to Sen's (1990) work on capabilities, but in contrast is able to elaborate on a specific list of well-being outcomes and the necessary preconditions for meeting them (see Gough, 2014 for a review). It has substantial advantages over preference satisfaction (i.e. income), which, among other well-known critiques, assumes rationality, fails to acknowledge market externalities, and reduces all needs to substitutable preferences (Stiglitz et al., 2009).

The human needs approach emphasises the non-substitutability of needs, and thus the requirement that multiple dimensions of well-being should be simultaneously analysed – and not aggregated into single indicators such as life expectancy or income (an approach also reflected in the Sustainable Development Goals). Thus even though the countries in Goldemberg's Corner have already attained high levels of life expectancy, it is still necessary to assess their achievements in intermediate need satisfaction, as well as the crucial social and political determinants of personal autonomy, before they can be judged in terms of overall well-being.

Moving from theory to practice, important constraints are data availability, data quality and policy relevance (Reinert, 2009). In this paper, three indicators are selected to represent basic conditions for satisfying physical health outcomes: access to improved sanitation facilities (flushed latrine, sceptic tank, pit latrine, or composting toilet), access to household electricity, and adequate nourishment (a ratio of dietary energy consumption to an intake adequacy rate for the respective population). All three indicators have clear pathways to improved physical health. Sanitation enables the avoidance of bacterial and parasitic infections; household electricity access reduces indoor air pollution and resulting respiratory diseases; while adequate nourishment is a precondition for human survival, while also strengthening resistance to illnesses (Karekezi et al., 2012; Pachauri and Spreng, 2004; Wilkinson et al., 2007). By describing the proportion of a population with access to these needs, these indicators capture distributional issues, but unfortunately provide little information on the quality (e.g. intermittency) and affordability of each given service – an important limitation of this study. Respectively, they closely correspond to the United Nations Sustainable Development Goal (SDG) 2.1 (eradicate hunger and ensure access to adequate nutrition), SDG 6.2 (achieve access to adequate and equitable sanitation), and SDG 7.1 (ensure access to energy services).

Personal autonomy is a more challenging concept to operationalize. Doyal and Gough (1991) recommend indicators of knowledge acquisition and literacy, but acknowledge the sparse

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