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Human development in a climate-constrained world: What the past says about the future

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ABSTRACT

Energy consumption is necessary for the delivery of human development by supporting access to basic needs, services and infrastructure. Given prevailing technologies and the high degree of inertia in practical rates of decarbonisation, growth in energy consumption from rising global living standards may drive consequent greenhouse gas emissions (GHG). In this paper the 'development as usual' GHG emissions impact of achieving high levels of life expectancy, access to basic needs and continued economic growth are projected to the mid-century using historical elasticities of development and energy consumption in 3 regions – Africa, Centrally Planned Asia, and South Asia. The results suggest that long life expectancy and high levels of access to basic needs are achievable at lower levels of emissions than continued economic growth, but will consume a substantial share of the global budget associated with a 2 °C climate goal.

1. Introduction

A defining feature of industrial development since the 1950s has been a rapid increase in the extraction and consumption of energy (Krausmann et al., 2008). Energy use is a prerequisite for modern lifestyles (Mazur and Rosa, 1974), economic activity more broadly (Stern, 2011), as well as the underlying infrastructures that support human development (Rao et al., 2014). Energy production, along with land-use change and agriculture, in turn generates greenhouse gas (GHG), ultimately leading to climate change impacts. In a world of persistent poverty, with continued inequalities in health, education, nutrition and sanitation (UN, 2014), what will be the GHG emissions impact of raising all to an adequate standard of living? How do these 'development' emissions compare to the emissions budget available if we are to stabilise climate change at levels related to the 2 °C target? These questions are the focus of this paper.

There has been much elaboration in the literature on equity proposals and the 'fair burden-sharing' of emissions rights between industrial and developing nations (Baer, 2013; Baer et al., 2009), but very little research on the actual energy use *necessary* for development and likely arising emissions. This is a prescient issue in the context of on-going international negotiations, where it is now recognised that the participation of all major emitters, including key developing countries such as India and China, is required to break the climate impasse (Grasso and Roberts, 2014). Technology transfer offers one means to 'leapfrog' development to a less emissions-intensive pathway, but has unfortunately failed to manifest in time for low and middle income countries to avoid highly polluting infrastructures (Unruh and Carrillo-Hermosilla, 2006). Instead it appears that systems of energy production and consumption embody a high degree of inertia in their practical rates of decarbonisation (Anderson and Bows, 2011; Loftus et al., 2014; Raupach et al., 2014), with almost certain near term emissions growth in most developing countries (Davis and Socolow, 2014). Our approach thus focuses on extrapolating existing trends in energy growth, emissions and development, highlighting the level of policy ambition that will be necessary to meet the twin challenges of climate change and poverty alleviation.

The patterns by which greenhouse gas emissions facilitate human development have been the focus of much recent research (Costa et al., 2011; Dietz et al., 2009; Jorgenson, 2014; Lamb et al.,

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2014; Pretty, 2013; Rao and Baer, 2012; Steinberger et al., 2012, 2010). The central premise of this work is the need to measure development outcomes directly, rather than as a function of increasing per capita incomes. The resulting human development and energy or carbon relationship is noted for its non-linearity: increasing resource and energy consumption (and hence economic development) improve human well-being, but only up to a point (Mazur and Rosa, 1974; Rao et al., 2014). Diverse groups of countries have followed relatively efficient pathways of development (Steinberger and Roberts, 2010), achieving high well-being outcomes at moderate levels of energy consumption and emissions (Lamb et al., 2014). The relationship between human well-being and it's environmental impacts is also known to be temporally dynamic, becoming progressively more efficient over the past several decades (Steinberger and Roberts, 2010), with important regional differences (Jorgenson, 2014). Few studies have attempted to shape these factors into a quantity of emissions necessary for development: Costa et al. (2011) employed elasticities of the Human Development Index (HDI) and per capita CO_2 emissions to project the climate impact of reaching particular HDI thresholds; while Rao and Baer (2012) lay out a conceptual roadmap for assessing the energy requirements for specific development needs and activities in a bottom-up approach.

In this study we make a number of advances. First we design an indicator for 'basic needs', capturing a high level of detail on material living standards that is missing from previous studies. Pairing this indicator with average life expectancy and income, we generate historical elasticities of energy consumption using 20 years of data (1990–2010) in order to project energy growth scenarios to 2050 for three developing regions. This method allows us to compare the energy requirements of reaching thresholds in two dimensions of human development, as well as that of economic growth more generally. Finally, these are translated into GHG emissions scenarios via GHG intensities from the LIMITS integrated assessment study. By employing these intensities we are able to directly compare our own development based (no policy) allocation of emissions rights to widely employed least cost IAM mitigation scenarios, assessing the likely conflict that may arise between addressing climate change and poverty eradication.

2. Materials and methods

2.1. Human development

In acknowledging the narrow focus of gross domestic product (GDP) per capita (Stiglitz et al., 2009), alternative indicators of development must be theoretically sound, empirically quantifiable and policy relevant (Reinert, 2009). The literature to date linking well-being to environmental impact has been predominantly guided by Sen's 'Capabilities Approach', employing the human development index (Costa et al., 2011; Martínez and Ebenhack, 2008; Moran et al., 2008; Pasternak, 2000; Steinberger and Roberts, 2010) and its constituents, income, life expectancy and educational achievement (Dietz et al., 2009; Jorgenson, 2014; Lamb et al., 2014; Steinberger et al., 2012). In this paper we follow Doyal and Gough's (1991) theory of human need, wherein they define well-being as physical health and personal autonomy, i.e. the avoidance of serious harm, the ability to participate in society, and the freedom to choose that form of participation. In particular, and in contrast to previous literature, we operationalise cross-cultural 'intermediate' indicators, i.e. a set of preconditions for achieving human well-being. These 'basic needs' constitute a minimum baseline of access to material and infrastructural services, and is able to provide a defensible 'moral minimum' of energy and emissions requirements for development (Doyal and Gough, 1991; Rao and Baer, 2012; Reinert, 2009; Reusser et al., 2013). Such a baseline exists firmly within the policy space for intervention, and can be commonly established across all societies. To contrast our approach to previous conceptualizations of human development, we also conduct our analysis for life expectancy. Similarly, GDP per capita is included in order to compare the well-being approach to a purely economic perspective. Our analysis does not incorporate other components of basic well-being, such as physical, economic and childhood security, due to a lack of appropriate time-series international data. In addition, while there are clear links (as described below) between meeting basic needs and greenhouse gases, improvements in personal autonomy are likely to take the form of social and institutional developments, with less obvious impacts on GHG emissions.

We describe basic needs access as a composite of six factors related to food, shelter, basic health and hygiene, and education. We select suitable indicators based on available data. They include: (1) access to improved sanitation facilities (flushed latrine, ventilated improved pit latrine, pit latrine with a slab or a composting toilet); (2) access to household electricity; (3) access to an improved water source (piped household water, public tap, tube well/borehole, protected dug wells, protected springs, rainwater collection); (4) adequate nourishment (where average dietary energy consumption is above an energy intake adequacy rate for that population); (5) access to education (at least one year of primary school for all persons over 15 years of age); (6) a survival rate to 5 years of age. Factors (1–3) are sourced from the World Bank Development Indicators (2014), (4) from FAOSTAT (2014), (5) from Samir et al. (2010), (6) from the UN (2013) life tables. Life expectancy data is sourced from the UN (2013) and GDP per capita (expenditure side purchasing power parity) from Feenstra et al. (2014).

The composite basic needs indicator is calculated as an unweighted geometric mean of these six dimensions, scaled from 0% (no access) to 100%, where all persons in a country have access to basic needs (in fact it is possible get close to, but not reach full access, as there will never be a perfect 100% survival rate). A potential alternative methodology would simply take the minimum level of achievement across all six indicators, however this would lead to systemic bias as in the majority of cases sanitation is the poorest performing criteria of development. Following the Multidimensional Poverty Index we do not assign weights to the individual dimensions of basic needs, avoiding normative judgments of their relative importance, but also rendering them substitutable – an important drawback of our study (Decancq and Lugo, 2013). Follow-up work may assign weights to poorer performing dimensions (such as sanitation).

2.2. Climate impact via energy consumption

Human development is known to share strong links with energy consumption (Karekezi et al., 2012). For instance, access to electricity and clean cooking fuels in households has well documented benefits for women and children's health, education and livelihoods. More broadly, energy is a prerequisite for adequately functioning hospitals, schools, transportation and other productive activities that support basic human needs. We measure this energy use at the point of consumption, using the International Energy Agency (2014) indicator for 'final energy consumption'.

In defining climate impact, researchers have typically focused their attention on CO_2 emissions, from both territorial (Costa et al., 2011; Jorgenson, 2014; Steinberger and Roberts, 2010) and consumption-based approaches (Lamb et al., 2014; Steinberger et al., 2012), as well as ecological footprinting (Dietz et al., 2012, 2009, 2007). To our knowledge, only Rao et al. (2014) have explored overall GHG emissions and their implications for