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Relating climate compatible development and human livelihood

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Abstract

We explore the link between improvements in human development and greenhouse gas emission. We argue that a disaggregated view on human development is required to understand the potential for decoupling of development from greenhouse gas emissions. To do so, we relate 16 elements from the livelihood index to emissions. Improvements in livelihood are decoupled from emissions for 10 elements, while only 6 are related to significant emissions. We operate the proposed framework for the example of food consumption and related emissions and find a reduction potential of about 13% compared to the total emissions from this sector.

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Keywords: Livelihood; Allocation of CO_2 emissions; human development index (HDI); Climate Change; Fairness

Introduction

A political consensus has been achieved to limit the rise in global mean temperature to 2 degrees compared to the pre-industrial period [1]. Due to the absence of concrete strategies and the need to guarantee fairness among countries several allocation frameworks have been proposed. For example the WBGU budget approach [2] proposes equal cumulative per capita CO_2 emissions for a certain period for all people world wide. According to this suggestion, political agreement has to be reached about the duration (start and end) of the cumulation period, the population projections used to calculate country

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budgets, and the certainty with which to stay below the 2°C limit. Chakravarty et al. [3] propose to shift the discussion from inter-country to intra-country allocation based on the rationale that within country inequalities are as important as global ones. They assume a relationship between income and emissions based on unitary elasticity together with income distributions to calculate emission caps.

Other studies investigate the link between CO_2 emissions and development aspects. The core goal is to ultimately achieve a decoupling of development from increases in GHG emissions. This is a key step to manage a transition towards sustainable development. Steinberger et al. [4] in her analysis on the relation between emissions and development – measured as life expectancy and income – finds that long lifes are compatible with low emissions, while high income is always associated with high emissions. Further, given an optimal distribution of resources worldwide, carbon emission would suffice to ensure high developments levels [5]. Costa et al. [6] find exponentially increasing emissions with increasing human development index (HDI) from past and current data. They report large improvements in efficiency in the past, i.e. decreasing emissions over time associated with a certain level of HDI. Rao and Baer [7] developed a conceptual framework to quantify energy emission requirements for a set of basic consumption goods and some basic infrastructure development. They find decreasing energy intensities over time and with increasing average income.

Based on the observed connection between emissions and development, we may ask whether it is possible to find a limit to differentiate between indispensable emissions for development and those emissions that can be considered as optional. Such a limit is ultimately connected to appropriate levels of consumption and lifestyle. In this regard, a shift from a production to a consumption based emission assessment is necessary and under current discussion [4, 8, 9]. In other words, besides policies that (a) increase the efficiency of energy use and policies that (b) transform the energy system towards a 100% renewable basis we also need a discussion on policies that (c) address the absolute level of consumption and the underlying lifestyles. Note that policies affecting lifestyles are not new and have been used before, such as policies for the provision of cheap energy in the 1950 or state subsidies for housing.

The HDI has been proposed to find such a limit to differentiate between indispensable emissions for development and those emissions that can be considered as optional [6]. While the HDI is useful for such a distinction, it only gives a narrow view on development and omits several issues. Thus, a more disaggregated assessment including additional livelihood elements may be better suited to achieve more target oriented emission reductions that are compatible with development. While Rao and Baer [7] disaggregate their analysis to include nutrition, shelter, health care, education, transport, refrigeration, television and mobile phones, their framework is very consumption based and misses other livelihood elements. Thus, a disaggregated and comprehensive assessment is currently still missing.

The objective of this work is to (1) give a more in-depth understanding of the interplay between development and CO_2 emissions, and (2) to differentiate between indispensable emissions and optional emissions using a disaggregating livelihood-based accounting framework. We will (3) exemplify our accounting framework for food consumption and related emissions.

2. Relating emissions to human development

The relation between CO_2 emissions and development has been a topic of discussion in political discourses and scientific debate [10, 11]. The broad assumption that development depends on economic growth and this in turn leads to greater emissions has been detailed in regard to the heterogeneity of such relations between nations and the effect of carbon embodied in trade [8, 9]. Because the concept of human development is not limited to an economic logic, studies have investigated the dependencies between CO_2 emissions and more holistic indicators such as the Human development Index (HDI) [5, 6]. As Costa et al. [6] find, there is both, reasons for concern and good news, emerging from the investigated relations. The first, evidence for concern, is the existence of an exponential relationship between CO_2 emissions/cap and HDI (Fig. 1a). This implies two things. (i) Developing countries have increased their emissions fast in the early stages of their development and (ii) Developed countries maintained high CO_2 emissions even after development is fulfilled. The good news are the apparent gains in CO_2-HDI efficiency (Fig. 1b). An average decrease of CO_2 emissions for a fixed development standard between 1980 and 2006 was verified. Assuming that past the logistic relation between CO_2 and HDI will be maintained for the near future, i.e. 2050 (Fig. 2), further improvements in CO_2-HDI efficiency are foreseeable.

Once these relations are known one can devise the simple exercise of setting a minimum development standard for countries beyond which CO_2 emissions need to be reduced. This suggests that countries are allowed to emit until a certain HDI is achieved and must thereafter engage in CO_2 reductions proportional to the extrapolated HDI. For this purpose a minimum human development standard of 0.8 HDI as implied in the United Nation Human Development report 2008/2009 was taken. Under these constraints, between 20 to 30% of previously calculated CO_2 budgets limiting global warming to 2°C [12-14] would be required for development between 2000 and 2050.

One should point that the relations between CO_2 and development are only vaguely understood. It is assumed that there are no discernible decarbonizing trends of energy supply among world regions and that there are substantial obstacles to large scale implementation of renewable energy in the near future. In particular, setting appropriate development standards and the incorporation of more detailed human well being remain largely unanswered.

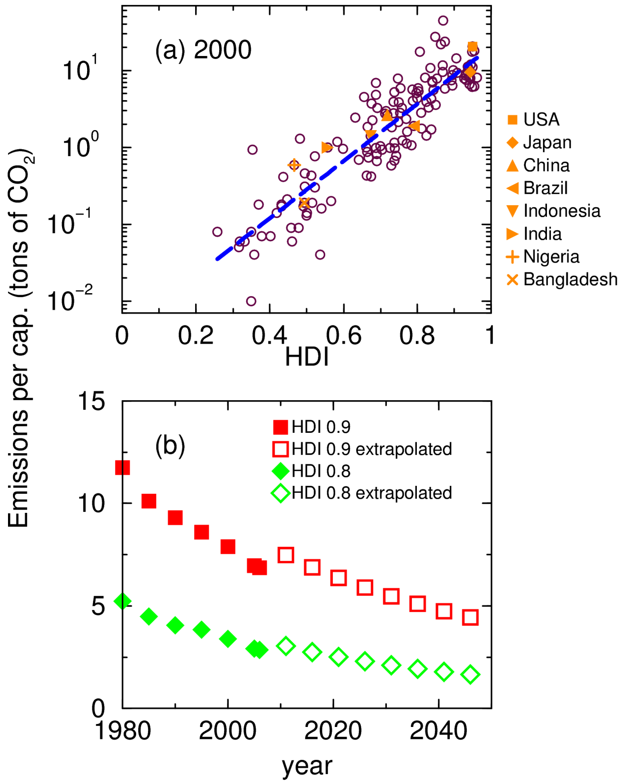

Figure 1: Correlations between CO_2 per capita emissions and HDI as well as gains of efficiency. Panel (a) shows the correlations between CO_2 per capita emissions and HDI in the year 2000 in semi-logarithmic scale. The dashed line represents a least squares thorough all values with correlation coefficient of ≃0.90. Panel (b) indicates the past evolution (solid symbols) and projection (open symbols, [6]) of CO_2 emissions per capita required to achieve a 0.8 (green) or 0.9 (red) values of HDI.

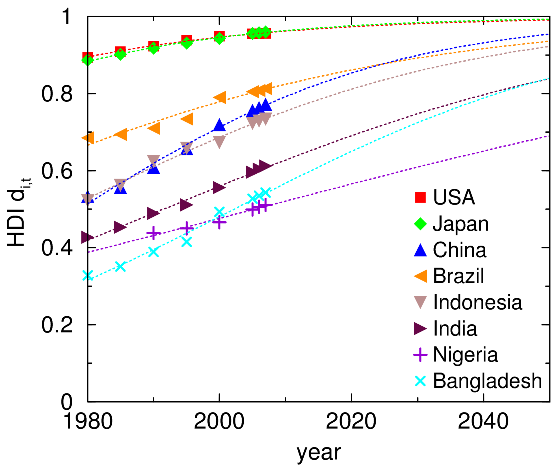

Figure 2: Human Development measurements and projections. The solid symbols denote observed HDI values for the same countries as in Fig.1(a). Country specific fits and extrapolations of HDI (until 2050) are depicted by the dashed lines. 1

3. Towards a more holistic measure of development: the livelihood index

In order to avoid negative tradeoffs between emission reductions and development, we need to decouple emissions from development as far as possible. The HDI has several benefits: its simplicity and transparency make it easy to interpret, while at the same time taking into account more dimensions than economic growth. Health, education and resources represent the very basic means necessary to be able to transform the given opportunities into the life one wants to lead [15]. At the same time, the HDI also has limitations. Dimensions of development are represented in three comprehensive components, reflecting "the freedoms which give us greater opportunities to achieve those things we value (opportunity freedoms)" [15]. Further important aspects, such as equity or human rights, are intentionally not included. Regarding the relationship of CO_2 emissions and development, a simple relationship between increasing HDI values and higher emissions is apparent (see Fig. 1).

Due to the reduced form of the HDI, an analysis of the causal relationships between development elements and their emissions-intensity is not possible. Many livelihood needs, however, may offer opportunities to decouple development from conventional material growth, if considered separately. Differentiating important elements of development further allows viewing these relationships in more detail and analyze causal relationships between development and increases in resource use and emissions.

Based on a review of basic needs and well-being, the recently developed livelihood index includes measures of development across key domains [16]. The index focuses on resources (tangible as well as intangible) which are required for adequate livelihood conditions. It distinguishes the three sub-domains subsistence, infrastructure and social structure and comprises a total of 16 elements (Fig. 3).

Limits of need fulfilment represent the transition from a situation of basic survival towards a situation of choice and good livelihood conditions, beyond which emissions may be regarded as optional. Similar to the aforementioned human development standard of 0.8 HDI, countries move gradually from the fairness domain towards a domain of responsibility. The framework allows to distinguish elements associated with the consumption of material resources and the emission of GHG from intangible elements, which advance development and livelihood without increasing emissions.

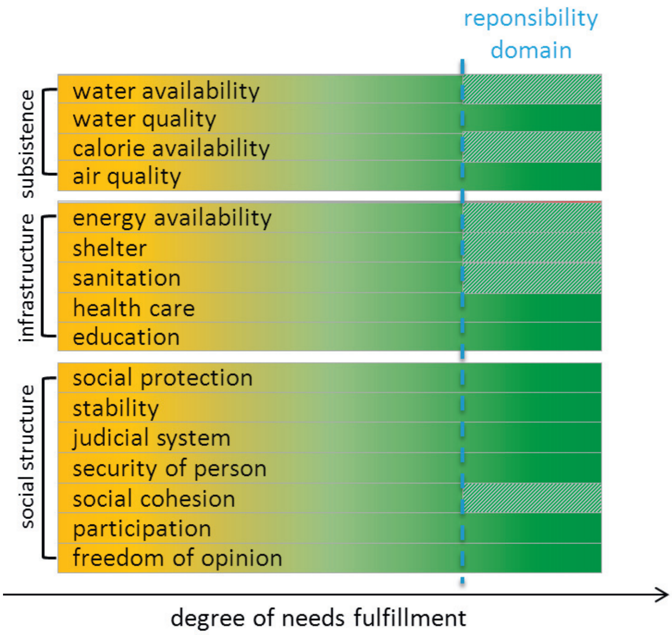

Figure 3: Livelihood index based on the dimensions "subsistence", "infrastructure" and "social structure". For each elements (e.g. calorie availability) a limit is shown beyond which good livelihood conditions exist and emissions may be regarded as optional (i.e. the responsibility domain). Only for elements indicated by the hatched areas, increases in the degree of needs fulfilment are closely connected to emissions – for the other elements increased fulfilment of needs generally does not cause increased emissions.

Development in all domains of livelihood should thus be allowed and encouraged, until fully adequate conditions have been achieved. For those elements, which are associated with emissions and material consumption (hatched responsibility domain in Fig. 3), emissions have to be limited once the domain of responsibility has been reached. For some elements of livelihood, further increases in consumption or availability may results in overconsumption, resulting in a decline of individual livelihood quality (e.g. overconsumption of food may lead to obesity and impairments of health) or affect societal sustainability (e.g. emerging water conflicts caused by overuse).

The emissions resulting from tangible elements can be broadly grouped according to the level at which they are best addressed. Some elements may encompass an individual element of choice (personal lifestyle), while others are mainly determined by public decisions. Developments in elements of public infrastructure, for example, are mainly influenced by decisions at a policy level. In comparison, food related choices - under the assumption that overall availability is not restricted - may encompass degrees of freedom and individual choices are possible regarding dietary patterns. Similarly, elements related to housing as well as mobility offer individual lifestyle choices. Table 1 presents the emission intensity and the potential for emission reduction of the various livelihood elements as a qualitative discussion.

The present categorization of elements has been developed for the purpose of outlining and operationalizing the livelihood index. Many elements are however highly interrelated. This is especially relevant for the element ’energy availability’: the fulfilment of other needs, e.g. education, may require energy to be fully functional. Here, we subsume the energy requirements of other elements under ’energy availability’, thus assuming that education does not cause emissions.

Table 1: relationship between livelihood dimensions (Fig. 3) and GHG- Emissions.

Dimension of livelihood	GHG Intensity	Reduction potential
Subsistence		
water availability, water quality	Energy requirements vary greatly depending on the water source [17].	Water, food and energy are interdependent and to some extent substitutable [17]. Thus, a detailed case study may reveal significant potential for emission reductions.
calorie availability	Agriculture is one of the main sources for anthropogenic methane and nitrous oxide [27].	A study by Pradhan et al. [19] shows that the effluent dietary patterns of mainly western societies produce the highest share of GHG emissions. Changes in dietary patterns (mainly reducing meat and rice consumption) may reduce non- CO_2 GHG gas emissions by 50% [20]. However, cultural background needs to be considered to avoid a reduction of livelihood conditions.
air quality	Good air quality in itself is not a major source of GHG emissions	Reduction of GHG emissions may lead to improved air quality as a side effect [21].
Infrastructure		
energy availability	Electricity and heat cause about a quarter of the overall GHG emissions world wide. Thus savings in these two livelihood dimensions has a large potential for GHG reductions	A decarbonization of the electricity sector appears feasible and affordable under appropriate policies while it may be more difficult for other sectors [22].
shelter		Heating needs may be reduced by 60 per cent by insulating buildings [23-24] to 83 per cent when insulating activities and technological shifts to CO_2 efficient technologies are combined [25].
sanitation	see water quality	
health care infrastructure	Aside a general demand for electricity and heating and cooling, GHG emissions from health care and education are negligible	Besides energy and heating/cooling there is only a minor reduction potential for these elements
education		
Social structure		
social structure	In general the livelihood dimensions related to social structure are not directly linked to GHG intensity	
social cohesion	The need for social cohesion is one of the causes for travelling [e.g. 26]. Transportation causes about 13% of the GHG emissions. [27, p.36]	Schaefer et al. [28] estimate reduction potential from transportation by technological innovation of up to about 40 percent. However they expect increasing travel demand to offset the efficiency gains.

4. The example of food production and consumption

The presented livelihood approach displays dimensions with potential for emission reduction without compromising livelihood conditions. We will exemplify this by a more detailed assessment of the dimension calorie availability. This dimension is especially relevant since it is undebatable a vital components for human health. More than 900 millions people are estimated to be undernourished in 2010 [29], while affluent diets with a high composition of animal products, vegetable oils and sugar-sweetener are at the same time common in developed countries (i.e. a daily uptake above 3000 kcal/cap/day [30]). In 2007 more than 80 countries worldwide [31] have exceeded the average dietary energy requirement for an adult with moderate physically active lifestyles [32] of 2800 kcal/cap/day.

Not only the consumption side, but also the production side of the food sector shows patterns of unsustainability with high inputs of fertilizers, pesticides, fossil energy for farm machinery. The food production and the associated supply chain is responsible for around 30% of total global energy demand (about 6% for food production and rest for supply chain and food preparation and processing FAO [33]) and about 14% of total global GHG emission [34]. Non-surprisingly, the Kyoto protocol also highlights a potential role of the agricultural sector for GHG mitigation [35].

We evaluate how the food sector could contribute to global sustainability by reducing emissions form food consumption. We assess the consumption patterns of 39 countries in the year 2005, which represent 73% of the total global population [36] and cause agricultural emissions of about 5.2 Gt CO_2 equivalent per year [37]. The GHG emission associated with food consumption patterns for countries are estimated with the methodology described by Pradhan et al. [19] based on data on food production [31], food consumption [31], agricultural GHG emission [37] and agricultural energy output/input ratio [38].

The average dietary energy requirements of 2800 kcal/cap/day and a consumption of animal products of 500 kcal/cap/day is considered as indispensable, while levels above are considered as optional consumption. 23 out of 39 countries have exceeded a total food consumption of 2800 kcal/cap/day and 17 have exceeded a consumption of 500 kcal/cap/day of animal products (Fig. 4). These are thus situated in the domain of responsibility and could engage in reduction activities without impairing livelihood. Thus, assuming a cut in food consumption down to 2800 kcal/cap/day and 500 kcal/cap/day of animal products for each of these countries results in reductions of annual emissions of 0.7 Gt CO_2 equivalent. This accounts for 13% of the total agricultural emission of the 39 countries. We achieved this by calculating the GHG emission intensity of crop production and animal production for the countries using the methodology described by Pradhan et al. [19].

Considerable reductions are also possible on the production side. This is especially apparent, when considering that total agricultural GHG emissions are highly variable among the analysed countries, ranging between 1 and 14 kg CO eq/cap/day depending on food consumption, emission intensities and fraction of animal product consumption.

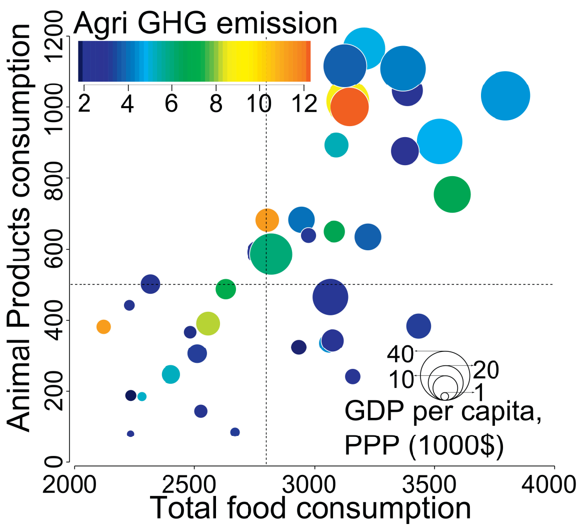

Figure 4: Average per capita animal product consumption versus total food consumption (kcal/cap/day). The size of the symbol is proportional to the average per capita GDP in PPP (constant 2005 international $) and the color of the circles represents per capita agricultural GHG emission (kg/cap/day). The dashed lines represent the average dietary energy requirement for an adult with moderate physically activity of 2800 kcal/day [32] and a level of 500 kcal/cap/day of animal products consumption.

5. Discussion

We have shown an exponential relationship between CO_2 emissions and development measured as HDI in existing data sets. Therefore, a widespread concern is that, emission reductions could imply a loss in welfare. However, the HDI has some limitations, especially since its aggregated form hinders analysing causal relationships between emissions and elements of development. Thus we suggest to use extended set of livelihood elements from three dimensions: subsistence, infrastructure and social structure. By disaggregating the elements of livelihood, it becomes clear, that most elements which improve livelihood conditions are linked to no or minor emissions (e.g. education). Thus, for these elements, livelihood can be improved without compromising sustainability. For the remaining domains, a distinction between indispensable emissions to sustain life and optional emissions due to lifestyle choices is possible. We suggest to base this differentiation on certain levels of consumption specific for the respective element. Emissions due to consumptions above such a level therefore offer a major potential for reductions. We have exemplified this concept for calorie availability, where emissions beyond the basic requirements of 2800 kcal/day per person are considered optional. Based on 39 countries, we have shown a considerable reduction potential of these optional emissions of 0.7 Gt CO_2 equivalents per year on the consumption side. This is a direct example of how optional emissions can be accounted for and underlines that it is feasible to decouple development from emissions.

The idea that optional emissions can be avoided without compromising livelihood conditions is consistent with findings from other studies [e.g. 5]. However, this is the first attempt of disaggregating the saving potential to the different elements that make up livelihood conditions. For some elements of livelihood, detailed studies exist, relating livelihood conditions to greenhouse gas emissions, as shown in Table 1. For the selected case of food consumption, the effect of reductions in excessive consumption regarding greenhouse gas emission has been stressed previously. Assuming a decades reduction in the demand for meat products by 25%, Popp et al. [20] find a decrease in 51% of the global non-CO2 emissions in 2055 compared to a baseline model with constant diets. Similarly, Eshel and Martin [39] show an emission reduction potential in the US of about 1.5 t CO_2 equivalents per person and year for vegetarian diets compared to the average diet.

We suggest that for dimensions related to emissions, increases in livelihood fulfilment of the respective dimensions should be allowed until adequate levels of development have been reached regardless of emissions (fairness domain). After a certain point of adequacy has been reached, the domain of responsibility is reached. We therefore propose to encourage emission reductions beyond this point to allow for sustainability. Such a distinction between a domain of fairness and a domain of responsibility is also included in the framework of Rao and Baer [7]. In line with the study by Chakravarty et al. [3], ideally such policies would target rather at intra-country emission-allocations than at inter-country policies on a global level. In any case, policies are in demand that distinguish between indispensable and optional emissions. In summary, our approach provides a novel way of looking at emissions from consumptions and helps in allocating these in a more equitable way.

The proposed disaggregated perspective on livelihood needs provides the opportunity to identify optional emissions, which are dispensable for human life. Our findings, as a conceptual guidance, can therefore be translated into policy advice, however, more research on the specific livelihood dimensions is necessary. We show, that it is possible to consider distributional aspects not only between, but also within countries. With our approach, we therefore contribute to the ongoing political discussion of allocating greenhouse gas emissions worldwide based on fairness principles.

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