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The inequality-emissions link and what it means for the 1.5ºC goal

Methodological Note
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1. Introduction

The climate change problem is also a problem of inequality, and both must be tackled together to create a sustainable future. Our 2020 carbon inequality analysis estimated that the richest 10% of the global population are responsible for 46% of the emissions growth between 1990 and 2015, and consumed more than a quarter of the world's remaining 1.5°C carbon budget during the same time period (Kartha et al., 2020). Our study further found that even under moderately progressive scenarios of socio-economic development, consumption of the higher-consuming countries and populations alone would still exceed the levels required to keep global warming to 1.5°C this century, leaving little space for the world's poorest households to increase emissions to improve their standards of living (Kartha et al., 2020). This suggests that more substantive, transformative changes will be needed to enable more equitable development going forward. Despite the richest countries and individuals contributing the most to causing climate change, climate impacts will disproportionately affect the poorest and most marginalized communities (IPCC et al., 2018), further deepening inequalities.

Policy-makers are continually making decisions that implicitly determine how the remaining carbon budget is distributed among and within countries. One such set of decisions is embodied in the most recent emissions reductions pledges (or Nationally Determined Contributions, known as NDCs) made by countries under the Paris Agreement ahead of COP26 in Glasgow. The goal of this analysis was to understand the distribution of global consumption emissions in 2030 in light of the emissions reductions anticipated as a result of countries implementing their NDCs. The results and several policy recommendations are provided in a briefing note issued by the Institute for European Environmental Policy and Oxfam (IEEP and Oxfam international, 2021). The underlying analysis and methodological approach are described in this report.

2. Our methodological approach

In our previous work (Kartha et al., 2020), we estimated the global distribution of emissions across different population groups as a function of income distribution and national consumption-based emissions. We conducted this analysis both historically, during the 1990-2015 period, and projected into the future to explore different emissions and income distribution scenarios.

This analysis builds on this previous research and uses much of the same approach as Kartha et al. (2020), with some additional calculations, as noted in this document. In general, our methodological approach consists of the following three steps:

- For 2015, we estimate consumption emissions by income group for 113 countries as found in Kartha et al. (2020).

- For 2030, we first estimate territorial emissions for each country under the assumption that they fulfil the emission reduction pledges outlined in their NDCs. We then estimate national consumption-based emissions by adjusting for trade among countries and emissions embodied in traded products.

- We estimate the consumption emissions distribution within countries as in the previous analysis by apportioning national consumption emissions across populations based on income. We applied a country-specific emissions floor, below which we assume per capita emissions do not fall regardless of income, and a global emissions ceiling above which we assume per capita emissions do not rise. Between the floor and ceiling, we assume that emissions rise in relation to income within a given country.

Additional methodological details for each step are provided in sub-sections below.

2.1 Starting data for 2015

We start with the 2015 consumption emissions by income group for 113 countries as found in the previous analysis, which drew on income distribution datasets from the World Inequality Database (or, secondarily, the World Income Inequality Database), and historical national consumption-based emissions data from the Global Carbon Atlas (for countries amounting to roughly three-quarters of global emissions, or, secondarily, territorial emissions from the Global Carbon Budget). Then, the national consumption emissions were allocated to population groups within each country as a function of income. A full description of the methodology can be found in Appendix 1 of Kartha et al. (2020).

2.2 Estimating 2030 national consumption emissions

NDC emissions

We estimate national emissions in 2030 under the assumption that countries fulfil the emission reduction pledges in their NDCs, submitted as of 1 October 2021. We assume for the purpose of this analysis that NDCs are complied with fully, and that each country achieves its pledges wholly by reducing emissions within its own geographical boundary.[1] The specific policies and measures to achieve the NDCs are not available for consideration in this study, nor are other social and economic policies that might affect the distribution of income or of consumption, but it is possible that those could have a greater effect on carbon inequality than the aggregate national effects modelled here.

National (territorial) carbon dioxide (CO_2) emissions for 2030 are estimated based on greenhouse gas (GHG) emissions estimates for unconditional NDCs compiled by the Climate Action Tracker (Climate Analytics & NewClimate Institute, 2021).[2] EU's emissions target was allocated among the 27 EU countries in proportion to their 2015 emissions share.[3] In total, NDC data was compiled for 63 countries (including EU countries), 51 of

1 We make this assumption notwithstanding the unresolved Article 6 negotiations relating to emissions trading, and with the knowledge that many countries do not have policies in place consistent with meeting their NDC.
2 As of 1 October 2021
3 This approximation is made in advance of announcements on EU burden-sharing arrangements.

which were in the dataset developed for Kartha et al. (2020) and used for this analysis. Since our analysis focusses on CO_2, the NDC data was converted from CO_2e to CO_2 using the CO_2 share of emissions in 2018 from the CAIT Climate Data Explorer (World Resources Institute, 2021). We also make the simplifying assumption that CO_2 emissions are reduced at the rate implied by the national economy-wide NDC.

We converted 2030 territorial emissions to consumption-based emissions per country by adjusting for net emissions from trade. We assume trade patterns remain unchanged from the 2015 base year (from the Global Carbon Atlas updated from Peters et al. 2011 and Peters et al. 2012). The emissions from trade for countries that are net importers of emissions (according to the Global Carbon Atlas) are adjusted to reflect the average global emissions reduction associated with all NDCs, while emissions from trade for net exporters of emissions are adjusted to reflect the emission reduction corresponding to the country's own NDC.

Dealing with missing emissions data

For comparing and verifying our emissions projections with IPCC estimates, we calculated a global estimate for 2030. As described in the previous section, for 51 countries (comprising about 80% of global emissions in 2015), we have the territorial emissions in 2030 from the NDCs, as calculated using the process described above. For an additional 62 countries (comprising about 8% of global emissions in 2015) without 2030 NDCs from Climate Action Tracker, we simply adopted the projections of our previous analysis (e.g. population, GDP and income projections as in Shared Socioeconomic Pathway 2, known as SSP2), emissions downscaled from Representative Concentration Pathway 1.9, which is ambitious, but arguably consistent with the intended Paris temperature goals). Residual emissions from countries not in the 113-country dataset (comprising about 12% of global emissions in 2015) were calculated under the assumption that they maintained the same proportion of global emissions as in 2015.

2.3 Allocating consumption emissions to income percentiles

We allocated consumption emissions to populations within each country using a functional relationship between income and emissions per Kartha et al. (2020). We use a country-specific emissions floor assuming a minimum level of household emissions compared to the national median. For the country-specific minimum emissions floor, we chose emissions at an income equal to 30% of the median income. The European Union's risk-of-poverty threshold is 60% of the median income. As actual minimum emissions are likely well below that of a household at risk of poverty, in the absence of better data, we conservatively assume a factor of one-half of that threshold or 30% of the median income.

We then apply an emissions ceiling assuming a maximum level of household emissions. In the historical emissions calculations made in Kartha et al. (2020), we assumed a ceiling of 300 tons of CO_2 per capita (tCO_2/capita) anchored to estimates of very high-income carbon footprints in the literature (Ummel, 2014; Chancel & Piketty, 2015; Otto et al., 2019; Gössling, 2019). In the absence of projected estimates of the consumption patterns of the top 0.1% in 2030, we adjusted the emissions ceiling upward at a rate that reflects a decline in emission intensity at a rate similar to other income groups, i.e., from 300 tons of CO_2 per capita (tCO_2/capita) in 2015 to 567 tCO_2/capita in 2030.

Between the floor and ceiling, we assume that emissions rise in relation to income, based on studies that relate emissions to consumption categories according to household consumption surveys (including for example Ummel, 2014; Hubacek et al., 2017; Dorband et al., 2019; Oswald et al., 2020; Ivanova & Wood, 2020). Given the floor and ceiling, our effective income elasticity for this analysis was 0.82, which is at the low end of emissions and income elasticity estimates among those in other studies, suggesting that our results yield a conservative estimate of the magnitude of carbon inequality. This is comparable to the average elasticity of 0.86 found by Oswald et al. (2020) for the elasticity of household energy consumption footprints across 86 countries. Note that most estimates of the latter apply to emissions associated with household consumption demands, whereas our analysis applies to investments and government expenditure as well. While the elasticities of household consumption emissions in high-income countries is typically lower, the emissions associated with other investments are heavily skewed towards high-income populations. More details of our elasticity estimates can be found in Appendix 1 of Kartha et al. (2020).

We obtained population and GDP in 2030 based on projections made by the Organisation for Economic Co-operation and Development (Dellink et al., 2017). Our income projections for 2030 are in accordance with the SSP2, where trends in international inequality are assumed to stay the same as in the historical period (Moss et al., 2010; O'Neill et al., 2017). For the projected income distribution data in 2030, we drew on the scenarios of Rao et al. (2019) for projections of the intra-national income inequality between 2015 and 2030. We then estimated national income distributions by fitting cumulative income and population data (Lorenz curves) to the Jantzen-Volpert distribution. A detailed outline of this procedure can be found in Appendix 1 of Kartha et al. (2020).

3. Results

A summary of the main findings is provided in the following table:

Table 1. Carbon Inequality in 2015 vs 2030.

	2015 Emissions					2030 Emissions				
Income Groups	**%**	**Absolute ($GtCO_2$)**	**Per capita (tCO_2/cap)**	**Minimum income per capita (1,000s USD)***	**Average income per capita (1,000s USD)***	**%**	**Absolute ($GtCO_2$)**	**Per capita (tCO_2/cap)**	**Minimum income per capita (1,000s USD)***	**Average Income per capita (1,000s USD)***
top 0.1%	4%	1.6	217	402	1,048	5%	1.9	226	624	1,763
top 1%	15%	5.4	74	109	256	16%	5.6	70	172	426
top 10%	49%	17.2	23	38	75	48%	16.9	21	56	118
middle 40%	44%	15.7	5.3	5.6	15	43%	15.2	4.8	9.8	25
bottom 50%	7%	2.5	0.69		2	10%	3.5	0.88		4
Total	**100%**	**35.5**	**4.8**			**100%**	**35.5*** **	**4.5**		
1.5°C goal**		18.0	2.3				18.0	2.3		

*Units in 2011 purchasing power parity USD

**The UNEP *Emissions Gap Report 2021* (UNEP, 2021) notes a median estimate of 18 GtCO2 to limit warming to 1.5 C. To estimate average per capita emissions, we assume a 2030 global population of 7.9 billion, in line with SSP2.

***The net effect of the NDCs is that global emissions in 2030 are roughly equal to 2015 emissions.

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