Climate Equality: a planet for the 99%

Methodology Note

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CHAPTER 1

1.1. Overview of the Stockholm Environment Institute's approach to calculating emissions by income group

Oxfam and the Stockholm Environment Institute's (SEI) approach to estimating how global carbon emissions can be attributed to individuals based on their consumption builds on previous work by Oxfam and the SEI.[1,2,3] Other researchers, including Lucas Chancel and Thomas Piketty, have made similar findings.[4,5]

The approach used in this report follows the methodology outlined in Oxfam and the SEI's 2020 report *The Carbon Inequality Era*, with some changes to the data sources.[6] For the 2020 report, multiple data sources were relied upon to address data gaps in emissions, income distribution and income data. However, in this analysis, it was found that the preferred datasets now provide better coverage, enabling a streamlined approach and less dependence on multiple sources for most variables.

We start with national consumption emissions data for 196 countries from 1990 to 2019 from the Global Carbon Atlas,[7] which covers nearly 99% of global emissions. This reflects both the carbon emissions produced in a country and those the net emissions embedded in import trade while excluding those embedded in exports. Emissions measured are for carbon dioxide (CO_2) and exclude non-CO_2 emissions and emissions from land use, land-use change and forestry (LULUCF) due to limited data.

We allocate national consumption emissions to individuals within each country based on a functional relationship between income and emissions, drawing on the most recent income-distribution data from the World Inequality Database (WID).[8] Based on numerous studies at national, regional and global levels, we assume that emissions rise in proportion to income, above a minimum emissions floor and to a maximum emissions ceiling.[9] These estimates of the consumption emissions of individuals in each country are then sorted into a global distribution according to income.

National income data (i.e. gross domestic product (GDP)) is obtained from Penn World Tables (PWT),[10] and gap-filled with data from the World Bank's World Development Indicators (WDI).[11] The data is expressed in 2017 US dollars (USD) purchasing power parity (PPP), which adjusts for differences in purchasing power between different countries and regions. Population numbers for the SEI estimates are also from PWT and WDI up to 2019.

1.2. Carbon budgets, or how much carbon is left to be burned while staying within the limits of a 1.5°C temperature rise

To calculate how much remaining carbon there is that can be burned, we did the following.

First, we selected the scenario of how much carbon we can emit that would give a 67% chance of meeting the 1.5°C target, based on the Intergovernmental Panel on Climate Change's (IPCC) *Sixth Assessment Report*, Working Group 1 estimate, updated with the latest scenario information from Working Group 3. This gives us a budget of 300 Gt CO_2 starting in 2020, as reported by Forster et al. (2023).[12]

The carbon budget available in 1990 was calculated by adding cumulative emissions from 1990 to 2019 to the 300 Gt CO_2 budget.

According to SEI data (Table 1), the total cumulative emissions between 1990 and 2019 were 857 Gt CO_2.[13]

Adding 300 to 857 gives us a total of 1,157 Gt CO_2 of carbon budget available in 1990. This allows to estimate what proportion has already been used.

The historical emissions analysis by the SEI by income group is described in Table 1.

Table 1: CO_2 emissions by income group: 1990, 2015 and 2019

	1990		2015		2019		2015 to 2019	1990 to 2019	1990 to 2019
	Total	**Share**	**Total**	**Share**	**Total**	**Share**	**Absolute year variation**	**Absolute year variation**	**Cumulative**
Unit	***Gt CO_2***	***%***	***Gt CO_2***	***%***	***Gt CO_2***	***%***	***Gt CO_2***	***Gt CO_2***	***Gt CO_2***
Bottom 50%	1.52	6.7	2.65	7.5	2.85	7.7	0.19	1.3	59.3
Middle 40%	9.18	40.3	14.87	41.8	15.78	42.5	0.91	6.6	338.1
Top 10%	12.07	53.0	18.06	50.8	18.49	49.8	0.43	6.4	459.6
Top 1%	3.36	14.7	5.76	16.2	5.91	15.9	0.16	2.6	141.4
Top 0.1%	0.79	3.5	1.60	4.5	1.67	4.5	0.07	0.9	38.8
Total	22.77		35.58		37.11		1.53	14.3	857.0

Source: Stockholm Environment Institute/Oxfam (2023).

a. **By 2020, three-quarters of the remaining carbon budget that was available in 1990 had been used up. At the current pace, the last quarter will be used up by 2028.**

   Or alternative wording

   By 2020, three-quarters of the carbon that could still be burned while keeping the global temperature increase to a maximum 1.5°C had been used up. At the current pace, the last quarter will be used up by 2028.

The carbon budget available in 1990 was 1,157 Gt CO_2 and the remaining carbon budget in 2020 was 300 Gt CO_2 (see calculations above).

So (1157 − 300)/1157 = 0.74, meaning that 74% of the carbon budget had been used up by 2020.

The latest data point, 2019, gives us an annual emission rate of 37.1 Gt CO_2.

The carbon budget starting in 2020 is 300 Gt CO_2 (see explanations above).

So 300/37.1 = 8.1 years starting in 2020, meaning the remaining budget will be used up by 2028.

b. Between 1990 and 2019, the richest 1% depleted 12% of the world's carbon budget, and the richest 10% depleted 40%. In the same period, the bottom 50% by income used just 5%.

Or alternative wording

Between 1990 and 2019, the richest 1% depleted 12% of the world's carbon that can be burned to stay within safe limits (keeping the global temperature increase to a maximum of 1.5°C), and the richest 10% were responsible for using up 40% of the world's carbon that can be burned to stay within safe limits. In the same period, the bottom 50% by income used just 5% of the carbon that can be burned while staying within safe limits.

The cumulative emissions by income group and the percentage share of this carbon budget use are shown in Table 2.

The share of carbon budget is calculated by subtracting 2019 from 1990 cumulative emissions (Table 1) and dividing them by 1,157 Gt CO_2 (the carbon budget available in 1990; see above).

Table 2: Cumulative emissions and carbon budget use per income group, 1990 to 2019

	Cumulative emissions (1990 to 2019), in Gt CO_2	**Carbon budget use as a % of world's carbon budget for the period 1990 to 2019 (1,157 Gt CO_2)**
Bottom 50%	59	5
Middle 40%	338	29
Top 10%	460	40
Top 1%	141	12

Source: Stockholm Environment Institute/Oxfam (2023).

c. Since 1990, the richest 1% have used up twice as much of the carbon budget than the poorest half of the world combined.

Or alternative wording

Since 1990, the richest 1% have used up twice as much of the carbon that can be burned while staying within safe limits than the poorest half of the world combined.

The absolute variation in yearly emissions between 1990 and 2019 of the richest 1% is 2.6 Gt CO_2 (Table 1).

For the bottom 50%, it is 1.3 Gt CO_2 (Table 1).

2.6/1.3 = 2 times more.

d. **At current rates, the overconsumption of the richest 1% alone will deplete all our remaining carbon budget by 2070.**

In 2019 (the most recent data point), the richest 1% emitted 5.9 Gt CO_2 (Table 2).

The carbon budget starting in 2020 is 300 Gt CO_2 (see above).

300/5.9 = 50.8 years, meaning the budget will be depleted by just the top 1% by the end 2070.

1.3. Inequality of emissions

Summarized data of emissions by income percentile at the global level for 2019 is shown in Table 3.[14]

The total global emissions are 37.1 Gt CO_2.

Table 3: Population, income and CO_2 emissions per income group, 2019

	Also described in the report as	Population (thousand people)	Estimated threshold income (USD PPP)	Average income (USD PPP)	Total emissions (Gt CO_2)	Share of emissions (%)
Bottom 50%	Poorest 50%	3,900,000	0	2,000	2.8	7.7
Middle 40%		3,100,000	5,000	16,000	15.8	42.5
Top 10%	Rich	770,000	41,000	90,000	18.5	49.8
Top 1%	Super-rich	77,000	140,000	310,000	5.9	15.9
Top 0.1%	Super-rich	7,700	500,000	1,200,000	1.7	4.5
Top 0.01%	Ultra-rich millionaires and above	770	1,800,000	4,700,000	0.2	0.7

Source: Stockholm Environment Institute/Oxfam (2023).

a. **In 2019, the richest 1% were responsible for 16% of global carbon emissions, which is the same as the emissions of the poorest 66% of humanity (five billion people).**

According to SEI data in 2019, the richest 1% emitted 5,912 Gt CO_2, 15.9% of global emissions (Table 1).

The total carbon emissions of the bottom 66% were 5,912 Gt CO_2 in 2019 (Table 4).[15]

Table 4: Emissions of the top 1% and bottom 66%, 2019

	Population (thousand people)	Total carbon emissions (Gt CO_2)	Share of emissions (%)
Top 1%	77,000	5.91	15.9
Bottom 66%	5,110,000	5.91	15.9
Total	7,740,000	37.1	100

Source: Stockholm Environment Institute/Oxfam (2023).

b. In 2019, the world's richest 0.1% emitted 1.7 Gt CO_2, 4.5% of global emissions. This is more carbon emissions than 38% of the world combined (2.9 billion people).

According to SEI data in 2019, the richest 0.1% emitted 1.67 Gt CO_2, 4.5% of global emissions (Table 1).

The bottom 38% of the population emitted 1.66 Gt CO_2 (Table 5).[16]

Table 5: Emissions of the top 0.1% and bottom 38%, 2019

	Population (thousand people)	Total carbon emissions (Gt CO_2)	Share of emissions (%)
Top 0.1%	77,000	1.67	4.5
Bottom 38%	2,900,00	1.66	4.5
Total	7,740,000	37.1	100

Source: Stockholm Environment Institute/Oxfam (2023).

c. In 2019, the richest 10% were responsible for 50% of global emissions.

According to SEI data, the richest 10% emitted 18.5 Gt CO_2 in 2019, which is 49.8% of the total global carbon emissions of that year (Table 1). The data is summarized in Table 6.

Table 6: Emissions of the top 10%, 2019

	Population (thousand people)	Total carbon emissions (Gt CO_2)	Share of emis-sions (%)
Top 10%	774.3	18.5	49.8

Source: Stockholm Environment Institute/Oxfam (2023).

1.4. Growth in share of emissions

a. Since the 1990s, the richest 1% have burned through more than twice as much carbon as the bottom half of humanity.

According to SEI data,[17] the share of cumulative emissions of the bottom 50% between 1990 and 2019 was 7%, whereas the top 1% was 16% (Table 7).

Table 7: Cumulative CO_2 emissions per income group, 1990 to 2019

	1990	2015	2019	Share of cumulative CO_2 emissions (1990 to 2019)
Unit	*Gt CO_2*	*Gt CO_2*	*Gt CO_2*	*%*
Bottom 50%	1.52	49.67	60.78	7
Middle 40%	9.18	286.06	347.29	39
Top 10%	12.07	398.40	471.70	54
Top 1%	3.36	121.47	144.75	16
Top 0.1%	0.79	33.02	39.62	5
Total	22.77	734.13	879.77	100

Source: Stockholm Environment Institute/Oxfam (2023).

1.5. Emissions outpacing green energy

a. In 2019, the emissions of the top 1% were almost five times higher than the emissions saving from all the wind turbines installed that year, when compared to coal.

According to SEI data, the top 1% emissions in 2019 were 5.91 Gt CO_2 (Table 2).

According to the International Renewable Energy Agency 621,270 MW of new wind capacity was installed in 2019.[18]

An average onshore wind turbine with a capacity of 2.5–3 MW can produce more than 6m kWh in a year.[19]

If we take this at 3 MW, this means that new additional wind turbines created 1,242,540,000,000 kWh of energy that year.

According to the National Renewable Energy Laboratory, wind power produces 13 grams CO_2/kWh while coal produces 1001 g CO_2/kWh,[20] meaning there is 988g of saved CO_2 per kWh for wind compared to coal.

If we multiply 1,242,540,000,000 by 988, we get 123 trillion grams of CO_2 or 1.23 Gt CO_2 saved by new wind turbines.

If we divide the 5.91 Gt CO_2 emissions of the top 1% in 2019 (Table 2) by 1.23 (Gt CO_2 savings of wind turbines), we get 4.8 times.

b. Annual global 1% emissions cancel out carbon savings for almost a million onshore wind turbines, when compared to coal.

The annual emissions of the 1% in 2019 was 5.91 Gt CO_2 (Table 2).

Converted to grams of CO_2, and divided by the savings of wind power compared to coal (following the steps above in 1.4a), gives 5.97 trillion KWh of wind power needed to offset the emissions of the top 1%.

Dividing that by 6,000,000 (the annual KWh energy generation capacity of an onshore wind turbine)[21] gives 995,277 wind turbines needed to offset the top 1% emissions.

1.6. The geography of carbon inequality

The geographical spread of CO2 emissions is highly unequal.

Table 8. Population and CO2 emission share of various country groupings, 2019

Region or country grouping	Population (billions)[22]	Share of global population (%)	Emissions share (%)
Africa	1.32	17	3.9
High-income countries	1.22	16	40.4
Lower-middle-income countries	3.33	43	16.7
Low-income countries	0.662	9	0.4
Upper-middle-income countries	2.5	33	41.7
World	7.76	100	100

Source: Our world in data, the Word Development indicators of the World Bank, SEI, Oxfam, 2023

a. **Over 60% of the top 10% of emissions come from high income countries.**

According to SEI data,[23] high-income countries contribute to 30.2% of all consumption-based CO_2 emissions that come from the global top 10%.

Globally, the top 10% emit 49.8% of CO_2 emissions (Table 1).

30.2/49.8 = 0.61

Hence, 61% of the top 10% emissions come from high-income countries.

b. **In 2019, high-income countries were responsible for over 40% of global consumption-based CO_2 emissions, while the contribution of low-income countries is a negligible 0.4%.**

We use the World Bank 2023 country grouping,[24] which includes low-income, lower-middle-income, upper-middle-income and high-income countries (Table 8).

According to SEI data,[25] high-income countries were responsible for 40.7% of global consumption-based CO_2 emissions in 2019 (Table 8).

Meanwhile, low-income countries were responsible for 0.4% of global consumption-based CO_2 emissions in 2019 (Table 8).

c. **Africa's current consumption-based emissions are less than 4%,**

despite the continent being home to 17% of the world's population.

According to SEI data,[26] African consumption-based emissions in 2019 represented 3.9% of global carbon emissions (Table 8).

d. One-third of the carbon emissions of the richest 1% today are associated with the consumption of people in the USA, with the next biggest contributions coming from people living in China and the Gulf countries.

Table 9 shows how certain countries are home to large shares of the 2019 carbon emissions of the richest 1%.

The total emissions of the richest 1% represent 15.9% of global emissions in 2019 (Table 1).

Table 9: Geography of emissions from individuals belonging to the global richest 1%, 2019

Share of emissions from individuals belonging to the global richest 1%	Share of the total emissions of the global top 1%	Country/country grouping
4.7%	29%	USA
1.6%	10%	China
1.5%	9%	Gulf countries (Saudi Arabia, United Arab Emirates, Kuwait, Qatar, Oman, Bahrain)

Source: Stockholm Environment Institute/Oxfam (2023).

e. Over 40% of the carbon emissions of the richest 10% (22% of global emissions) today are associated with the consumption of individuals in North America, the EU and the UK, and around a fifth (10% of global emissions) with the consumption of individuals in China and India.

Table 10 outlines where, according to SEI data,[27] the carbon emissions of the richest 10% in 2019 came from.

The total emissions of the global richest 10% represent 49.8% (Table 1) of global emissions.

Table 10: Geography of emissions from individuals belonging to the global richest 10%, 2019

Country	Share of emissions from individuals belonging to the global richest 10% living in different countries	Share of the total emissions of the global top 10%
EU27	6.6%	13%
USA	13.3%	27%
Canada	1.1%	2%
UK	1.0%	2%
China	7.7%	15%

India	1.9%	4%

Source: Stockholm Environment Institute/Oxfam (2023).

1.7. Annual carbon footprint

a. The sustainable emissions level for 2030 per capita.

According to the United Nations Environment Programme (UNEP) *Emissions Gap Report* in 2022,[28] the median estimate of the emissions level in 2030 consistent with limiting global heating to 1.5°C is 33 Gt CO_2e (range: 26–34), which is approximately 24 Gt CO_2 (based on the 2019 share of CO_2 emissions in greenhouse gas emissions (71.4%)).[29] According to the UN, the global population is estimated to reach 8.5 billion in 2030. Dividing the 1.5°C compatible 2030 emissions level equally with 8.5 billion gives an estimate of 2.8t CO_2 per capita.

Note that this threshold does not account for fair shares that countries are entitled to given historical inequalities. For a more refined reflection of the fair share threshold, see Oxfam's recent discussion paper *Are G20 Countries Doing Their Fair Share of Global Climate Mitigation?.*[30]

b. Estimating 2030 footprints.

To estimate per capita consumption carbon emissions in 2030, the SEI used national territorial emissions estimates based on unconditional Nationally Determined Contributions (NDCs) from the Climate Action Tracker.[31] The emissions target of the EU was distributed among its 27 member countries in accordance with their respective 2019 emissions shares. CO_2 equivalents (CO_2e) were converted into CO_2 based on the 2019 CO_2/CO_2e to ratio for each country from the Climate Watch Climate Data Explorer.[32] Territorial emissions in 2030 were converted into consumption emissions estimates (assuming no change in overall trade patterns) by adjusting emissions of the countries that are net importers of emissions by the global average emissions reductions between 2019 to 2030, and modifying net exporters of emissions by the proposed national emissions reduction in their NDCs. These national consumption emissions estimates in 2030 were allocated to individuals within each country and their respective income group, assuming little change in national income distributions by 2030, which is consistent with the Shared Socioeconomic Pathway 2 (SSP2),[33] before being sorted into a single global distribution by income. Calculations were scaled to 2030 income and population levels and gap-filled for countries without 2030 Climate Action Tracker estimates using the representative concentration pathway (RCP) scenario from the SEI's non-NDC scenario calculations for SSP2. RCP 1.9 is used, which is a pathway that limits global warming to below 1.5°C, the aspirational goal of the Paris Agreement.

More information on the method, sensitivities and limitations are available in Ghosh et al.'s (2021) *Methodological Note*.[34]

The projections using RCP 1.9 lead to the results described in Table 11.[35]

Table 11: Per capita carbon footprint per year per income group, 2030

Income group	Population (thousand people)	Per capita carbon footprint per year, in 2030 (tonnes CO_2 per person per year)
Top 0.1%	8,650	182.3
Top 1%	86,500	63.2
Top 10%	865,000	19.2
Middle 40%	3,450,000	4.3
Bottom 50%	4,310,000	0.6
Level to be in line with 1.5°C		2.8

Source: Stockholm Environment Institute/Oxfam (2023).

c. **On average, the richest 10% emitted 24 tonnes of CO_2 per year in 2019, which is 8.5 times the amount needed to stay below the 1.5°C of global warming. Even when current promised reductions are taken into account (taken from NDCs), the emissions of the 10% will still be seven times more than the sustainable level.**

According to SEI data, in 2019, the total emissions of the top 10% were 18.5 $GtCO_2$ (Table 1).

18.5 gigatonnes equals 18.5bn tonnes CO_2.

The top 10% were 0.7743 billion people in 2019.

18.5/0.774 = 23.9 tonnes CO_2 per person in 2019.

23.9/2.8 (the per capita emissions consistent with a 1.5°C of global warming, described above) = 8.5 times

SEI data finds that, if national promises to reduce carbon are met, the per capita emissions of the 10% are set to be 19.2 tonnes in 2030 (Table 11).

9.2/2.8 = 6.9 times

d. **On average, the richest 1% emitted almost 77 tonnes of CO_2 per person in 2019, which is 27 times the amount needed to stay below the 1.5°C increase. Even when current promised reductions are considered (taken from NDCs), the emissions of the 1% will still be more than 22 times the sustainable level.**

According to SEI data, in 2019, the total emissions of the top 1% were 5.9 Gt CO_2 (Table 1).

5.9 gigatonnes = 5.9bn tonnes CO_2.

The top 1% of the global population was 77 million people in 2019 (Table 4).

5.9/0.077 = 76.6 tonnes CO_2 per person in 2019.

76.6/2.8 (the per capita emissions consistent with 1.5°C of global warming described above) = 27.4 times.

SEI data finds that, if national promises to reduce carbon are met, per capita emissions of the 1% are set to be 63.2 tonnes in 2030 (Table 11).

63.2/2.8 = 22.6 times.

e. By 2030, the poorest half of the world will still be using just one-fifth of the carbon they are entitled to while staying below the safe limit of 1.5°C.

According to SEI data, in 2019, the total emissions of the bottom 50% were 2.8 Gt CO_2 (Table 1).

2.8 gigatonnes = 2.8bn tonnes CO_2.

Fifty percent of the global population was 3.871 billion people in 2019 (Table 4).

2.8/3.900 = 0.72 tonnes CO_2 per person in 2019.

0.72/2.8 = 0.26 times

SEI data finds that, if national promises to decrease emissions are met, per capita emissions of the bottom 50% are set to be 0.6 tonnes in 2030 (Table 11).

0.6/2.8 = 0.21 times

CHAPTER 2

2.1. Heat-related excess deaths

The calculations below use a concept called the mortality cost of carbon, which assesses excess deaths due to temperature changes caused by climate change. It is one of the metrics used to calculate the social cost of carbon (SC-CO_2).[36] The SC-CO_2 measures the monetized value of the damages to society caused by an incremental metric ton of CO_2 emissions, including also changes in agricultural productivity, damages caused by sea level rise, mortality and decline in human health and labour productivity. The SC-CO_2 is widely used, for instance, by the United States Environmental Protection Agency (US EPA) to evaluate the impact of mitigation policies. The concept is used to calculate the cost–benefit analysis required when agencies propose environmental rules.

We choose to use the mortality cost of carbon, which shows the impact on human lives of excess heat. The mortality cost of carbon is used to calculate the SC-CO_2.

The estimated mortality cost of carbon per metric ton of 2020 emissions is 2.26 × 10 – 4 (0.000226).[37]

The deaths calculated span the period 2020 to 2100, rising to a peak at around ten years, or 2030. This is based on the fact that CO2 emissions reach their maximum warming potential around 10 years after being emitted[38]

a. **The emissions of the top 1% in 2019 are enough to cause 1.3 million excess deaths due to heat between 2020 and 2100**

Emissions of the 1% in 2019 was 5.9 Gt CO_2 (Table 1).

5.9 billion multiplied by 0.000226 is 1,333,400 deaths.

The calculations are summarized in Table 12.

Deaths will occur between 2020 and 2100, with the peak of impact being in 2030.

b. Cumulative emissions of the 1% (2015 to 2019) are enough to cause 5.2 million deaths due to excess heat between 2020 and 2100

The cumulative emissions of the top 1% from 2015 to 2019 is 23.3 Gt CO_2 (Table 2).

23.3bn tonnes CO_2 divided by 0.000226 is 5,198,000 deaths.

The calculations are summarized in Table 12.

Deaths will occur between 2020 and 2100, with the peak of impact being in 2030.

Table 12: Mortality cost of carbon calculations

Mortality cost of carbon	0.000226 deaths per metric ton of CO_2 emissions
Total carbon emissions of top 1% in 2019 (Table 2)	5.9 Gt CO_2
Cumulative emissions of the top 1% between 2015 and 2019 (Table 2)	23.3 Gt CO_2
Deaths caused by emissions of the 1% in 2019 between 2020-2100	1,333,400
Deaths caused by cumulative emissions of the top 1% from 2015 to 2019 between 2020-2100	5,198,000

Source: Own calculations based on Bressler (2021)[39]/Stockholm Environment Institute/Oxfam (2023).

2.2. Impact of emissions on crop yields

The calculations in this section are based on the following research. First, that the median estimate of the Transient Climate Response to Cumulative CO_2 Emissions (TCRE) is 0.44°C per thousand Gt CO_2 emitted.[40] This means that temperature will increase by 0.44°C for every thousand gigatonnes of CO_2 emitted.

Based on this median TCRE estimate, emissions attributed to income deciles using the SEI data are converted to warming (Table 13).

Table 13: Carbon emissions per income group and associated warming

	Carbon emissions (Gt CO_2)	**Warming (°C) (Emissions multiplied by**

		TCRE = 0.44)
Total 2019		
Bottom 50%	2.8	0.001
Middle 40%	15.8	0.007
Top 10%	18.5	0.008
Top 1%	5.9	0.003
Top 0.1%	1.7	0.001
Cumulative 1990 to 2019		
Bottom 50%	59.3	0.026
Middle 40%	338.1	0.149
Top 10%	459.6	0.202
Top 1%	141.3	0.062
Top 0.1%	38.8	0.017

Source: Stockholm Environment Institute/Oxfam (2023).

The results from this are then used to estimate the impact on crop yields attributable to the emissions of income groups. We use the average of two global meta-analyses of crop yield sensitivity to mean warming (i.e. yield change per degree of increased mean global temperature), Zhao et al. (2017)[41] and Wang et al. (2020),[42] to calculate this.

Table 14 shows how sensitive different crops are to warming, and Table 15 shows global crop yields and harvests based on averages between 2003 and 2007.

Table 14: Estimated crop yield reduction (crop sensitivity) to a 1°C increase in global average temperature

Crop	**Estimated yield reduction (%)**
Maize	7.3
Wheat	4.5
Rice	4.4
Soybean	6.9

Source: Oxfam, based on averages between Zhao et al. (2017)[43] and Wang et al. (2020).[44]

Table 15: Global crop yields and harvests based on averages between 2003 and 2007

Parameters	**Estimate** (average between 2003 and 2007)	**Units**
Maize yield	4.8	Tonnes/hectare
Wheat yield	2.8	Tonnes/hectare
Rice yield	4.1	Tonnes/hectare
Soy yield	2.3	Tonnes/hectare
Maize harvested area	149,566,402	Hectare
Wheat harvested area	214,556,146.8	Hectare
Rice harvested area	152,992,905	Hectare
Soy harvested area	90,665,273.6	Hectare

Source: UN FAOSTAT (2023).[45]

Our analysis assumes that global mean yield sensitivities apply uniformly and linearly to the global harvested area, that warming is linear over the aggregation period of 1990 to 2019, and that CO_2 fertilization and adaptation effects are negligible over the period.

a. **The emissions of the top 10% between 1990 and 2019 is equivalent to wiping out the entire 2021 harvests of Brazilian corn, EU wheat, Indian rice, and Argentinian soybean.**

AND

b. **The emissions of the top 1% over 1990 and 2019 is equivalent to wiping out the 2021 harvests of EU corn, US wheat, Bangladeshi rice, and Chinese soybean.**

The impact of the cumulative 1990 to 2019 emissions on crop production is shown in the Table 16. This is calculated by first multiplying the warming effect of the emissions (Table 13) by the crops sensitivity to warming (see Table 14) and then multiplying by 30 years for the 1990 to 2019 emissions period. We apply the mean 1990 to 2019 warming effect (here estimated as half the 2019 cumulative warming, assuming linear increments of warming over the period), rather than the full 2019 total warming.

We look at the warming caused by emissions of different income groups, which accumulates from 1990 to 2019. Since we are counting from 1990, this warming is 0 by definition in 1990, and increments up to the values outlined in Table 13. So, crops were not exposed to the full cumulative 2019 warming amount throughout the 1990 to 2019 period. Dividing by two accounts for this, assuming that cumulative emissions are evenly spread across the time period. For example, if the top 10% caused 0.202°C warming by 2019, but 0°C by definition in 1990, then (with the linear warming assumption above) the average warming experienced by crops across 1990 to 2019 is

$(0+0.202)/2 = 0.202/2$.

Functionally, dividing by two here just takes the average of warming over 1990 to 2019.

To compare against country and region production, we looked at the FAO crops and livestock productions database[46] and matched the emissions to the country that had the closest production value (Table 17).

Table 16: Cumulative production impact, 1990 to 2019

	Maize (tonnes)	Wheat (tonnes)	Rice (tonnes)	Soybean (tonnes)
Bottom 50%	20,342,819	17,191,983	17,707,014	5,965,508
Middle 40%	116,066,665	98,089,459	101,027,985	34,036,413
Top 10%	157,782,146	133,343,758	137,338,418	46,269,429
Top 1%	48,536,470	41,018,806	42,247,632	14,233,263
Top 0.1%	3,329,593	11,265,013	11,602,486	3,908,887

Source: Oxfam, based on averages between Zhao et al. (2017)[47] and Wang et al. (2020).[48]

Table 17: Crop production per country, for different crops, 2021

Country	Crop	Production quantity (tonnes)
Argentina	Soybeans	46,217,911
Bangladesh	Rice	56,944,554
Brazil	Maize (corn)	88,461,943
China	Soybeans	16,404,194
India	Rice	195,425,000
USA	Wheat	44,790,360
EU (27)	Maize (corn)	72,987,920
EU (27)	Wheat	138,079,330

Source: UN FAOSTAT (2023).[49]

c. Between 1990 and 2019, the impacts of warming attributable to the top 10% on wheat and rice (combined) led to harvest losses that could have provided enough calories to feed 86 million people per year.

AND

d. Between 1990 and 2019, the impacts of warming attributable to the top 1% on wheat and rice (combined) led to harvest losses that could have provided enough calories to feed 26 million people per year.

Person equivalents of production impacts are estimated by converting production impacts (Table 19) to caloric equivalents using UN FAO average caloric contents (Table 18) and assuming a 2,000 kcal per day base requirement.

The daily caloric need for a person depends on many factors including gender, age, activity and weather. The UK National Health Service (NHS) recommends 2000 kcal per day for a woman and 2500 for a man.[50] The *Dietary Guidelines for Americans* also use 2000 kcal as a reference value for a healthy adult diet.[51]

These numbers are illustrative, as consuming rice and wheat alone would not provide the complete nutrition required to sustain a healthy diet.

Table 18: Caloric content of wheat and rice

Parameters	Estimate	Unit
Wheat caloric content	3,340	kcal/kg
Rice caloric content	3,600	kcal/kg

Source: UN FAOSTAT Food Composition Tables Annex I.[52]

Table 19: Crop production losses, caloric and person equivalent

	Annual production loss (average 2003 to 2007)		Annual caloric equivalent (average 2003 to 2007)		Person-equivalent		
	Wheat (tonnes /year)	Rice (tonnes /year)	Wheat (kcal/year)	Rice (kcal/year)	Wheat (persons/year)	Rice (persons/year)	Total for both crops (persons/year)
Top 10%	8,889,584	9,155,895	29,691,210,163,646	32,961,220,413,287	40,672,891	45,152,357	85,825,247
Top 1%	2,734,587	2,816,509	9,133,520,886,448	10,139,431,617,246	12,511,672	13,889,632	26,401,305

Source: Own calculations, Oxfam (2023).

2.3. Disaster mortality rates by levels of inequality

a. **The death toll from floods is seven times higher in the most unequal countries compared to more equal countries.**

This is based on research from Lindersson et al. (2023),[53] who analysed income inequality and flood disasters in 67 middle- and high-income countries between 1990 and 2018 across 573 major flood disasters.

The data from Figure 4 of the research divides countries into three groups by their Gini coefficient levels; we calculated the average fatalities per flood disaster and divided the average of the most unequal third by the most equal third of countries, which equals seven.

The results are presented in Table 20.

Table 20: Fatalities due to flood disasters, 1990–2018

Countries	Number of countries	Fatalities (number of deaths)	Number of flood disasters	Average fatality per flood disaster
Low inequality countries *(Gini coefficient 24.1–34)*	33	808	197	4
Medium inequality countries (Gini coefficient 34–42.5)	23	2796	186	15
High inequality	24	5369	190	28

countries (Gini coefficient 42.5–63.5)				

Source: Own calculations based on Lindersson et al. (2023)[54] and Oxfam (2023).

CHAPTER 3

3.1 Wealth, income and windfall taxes

a. **A wealth tax of 2% on the world's millionaires, 3% on those with wealth above $50m and 5% on the worlds billionaires would generate $1.726tn.**

This calculation is based on high-quality wealth data for 2022 produced by Wealth X,[55] a private company producing wealth data for different markets such as research, market analysis and charity. Wealth X produces high-quality data covering 66 countries, which corresponds to 98% of the world's GDP. The Wealth X database contains around 150,000 dossiers on ultra-high net worth individuals (people with more than $30m in net wealth). This individual data is combined with public information from various countries concerning GDP, the value of the stock market, levels of taxation, levels of income, savings, etc. The information is then modelled into a Lorenz curve that shows the distribution of wealth over the population (Lorenz curves are most commonly associated with the Gini coefficient).

Valuation of shares is based on stock market value, and for unlisted companies (privately owned by persons or families, etc.) the valuation is based on comparing with comparable companies (for example, stock market companies with a clear market value).

Data on billionaires are taken from the Forbes billionaire list[56] May 2023 to supplement the Wealth X information.

The model of taxation applied in our analysis is a three-step taxation, where all net wealth below $5m is not taxed. From $5m up to $50m, net wealth is taxed with 2%, and from $50m up to $1bn, net wealth is taxed with 3%. Finally, net wealth from $1bn and above will be taxed with 5%. This means that, in our calculation, we make three different tax bases, one for the 2% tax, one for the 3% tax, and one for the 5% tax, where 2% is the broadest tax base covering most rich individuals and 5% is the smallest tax base covering only the few dollar-billionaires. The reason behind the three tax bases is to make sure people are not taxed two or three times on the same money but only pay progressively on their wealth as it grows above the thresholds. This is laid out in table 21.

Table 21: Distribution of global wealth for those owning more than $5m, 2022

Wealth thresh-olds 2022	Total wealth (billion USD)	Population	Average wealth (million USD)	Total revenue (billion USD)
+ $5m	82,600	4,051,000	20.4	675.0
+ $50m	38,900	205,500	189.0	567.0
+$1,000m	12,200	2,500	4,900	485.0

Source: Wealth X.

b. An income tax of 60% on the top 1% of earners would generate $6.4tn.

A tax rate of 60% on the top 1% has been put forward by Oxfam in its latest inequality report *Survival of the Richest*.[57] In order to calculate a revenue, we have used the following approach.

The data is taken from WID[58] extracted in July 2023. Here you can access the income of every percentile in the world income distribution. The concept of income is expressed as pre-tax income in 2022 USD PPP constant terms. The data refers to the year 2019 and the population considers just the adults. In the World Income Database, it is possible to find both the average income for every percentile and the income thresholds for every percentile; that is, how much income you need to have to be in each percentile. In this case, we are interested in top 1%. That is the 100th percentile.

For 2019, we find that the average top 1% pre-tax income is $485,067 PPP. The threshold is $199,523 PPP. We use the adult world population from the WID, which is 5.155 billion people in 2019. One percent of this is 51.5 million people.

Calculating the total income of the top 1% is the average income multiplied by 51.5 million people. This results in a total income for the top 1% of $25,003bn PPP.

The tax must only be levied on incomes over the threshold to be in the top 1%. To calculate this tax base, we use the income threshold, and define that everything below the threshold is not subject to the tax rate of 60%. We multiply the threshold income of $199,523 PPP per capita by 51.5 million people and end up with $10,285bn PPP. This is subtracted from the $25,003bn PPP.

We now have a tax base of $14,719bn PPP. We must assume that the top 1% already pays tax on this income. What we need here is not the marginal tax rates, but the effective tax; that is, what is actually being paid. Here we make the conservative assumption that 30% of this is already effectively paid in taxes.

This is a conservative assumption for the following reasons. The *Survival of the Richest* report shows that the global average marginal tax rate is actually 31% and we know that marginal tax rates are generally much higher than the effective tax rate.[59] We also have to keep in mind that the top 1% group is typically receiving large shares of their income from capital gains. The *Survival of the Richest* report shows that the global average on capital gains tax is even lower, at 18%. Finally, the richest 1% are much more likely to dodge tax, as showed by Alstadsæter, Johannesen and Zucman (2019).[60]

If we assume then that the top 1% is already paying 30% of their income in tax, this takes out a further $4.416bn PPP from the tax revenue, leaving us with $8.831bn PPP. To this we apply a tax rate of 60%. This results in a revenue of $4.416bn PPP.

To express this in a normal USD (2019) instead of PPP, we divide this revenue with the conversion rate from PPP to market USD as we were informed after inquiry with the WID. The conversion rate given by the WID is 0.69, meaning that the revenue is $6.399bn. This is laid out in Table 22.

Table 22: Income tax of 60% calculation summary, 2019

Total accumulated income of the top 1%	$25,003bn PPP
Deductible income (based on the threshold to be in top 1% income group)	$10,285bn PPP
Remaining income above top 1% threshold to be taxed	$14,719bn PPP
Tax already paid (at effective tax rate of 30%)	$4,416bn PPP
Remaining income to be taxed at 60%	$8,831bn PPP
Tax revenue at 60%	$4,416bn PPP
Tax revenue in USD 2019	$6,399

Source: Own calculations using data from World Inequality Lab and Oxfam (2023).

c. A windfall tax on the windfall profits of megacorporations could raise up to $941bn.

Of the world's biggest corporations, 722 together raked in over $1tn in windfall profits each year for the last two years. Of these, 45 energy corporations made on average $237bn a year in windfall profits. Oxfam and Action Aid analysis shows that a tax of 50–90% on the windfall profits of these megacorporations could have generated up to $941bn.[61]

We define windfall profit as when the 2021 to 2022 average profit is 10% above the 2017 to 2020 average. Calculating the windfall profit for both 2021 and 2022 is done relative to the years before inflation and corporate profits took off in 2021. The analysis is based on the Forbes *Global 2000*[62] list of the 2,000 largest public companies. The methodology that Forbes uses to compile the list is available here. Of the 2,000 companies, 1,094 have been present on the Forbes list every year since the fiscal year 2017. Eliminating the companies that made a loss in 2021 and 2022 reduced the number of companies from 1,094 to 976. Of those companies, 722 (74%) made a windfall profit. Where a company made an average loss in 2017 to 2020, this was treated as zero, thus contributing to making the estimated size of windfall profits conservative. Categorizing Forbes' *Global 2000* companies according to the industrial sector, we calculated windfall profits for individual sectors. All numbers are nominal, i.e. not adjusted for inflation.

Windfall tax revenue is calculated as a tax rate of between 50% and 90% of the windfall profits; that is, for both 2021 and 2022, only profits 10% above the 2017 to 2020 average profits are included in the tax base for windfall profits. The tax revenue concerns the companies' global profits and cannot be presumed to be allotted to the headquarters country of any of the respective companies. As most multinational corporations do not currently provide a country-by-country breakdown of their profits, it is not possible to present country-level revenue estimates.

3.2. Emissions of politicians

a. **The salaries alone for US senators, European commissioners, UK cabinet ministers Australian MPs puts them in the top 1% of global emitters.**

Table 23 gives the estimated emissions based on the salaries of different policy makers in different countries and regions.

Based on the income threshold reported in the SEI data (Table 3), we assigned the decision makers to the matching global income group.

Table 23: Decision makers' income and global income group, 2019

Position	2019 salary	Conversion rate	2019 salary in USD	Global Income group
European commissioner	€278,427[63]	0.893	311,788	Top 1%
US senator	US$174,000[64]	N/A	174,000	Top 1%
UK cabinet minister	Cabinet minister + Member of Parliament (MP) salaries = £150,558[65]	0.784	192,038	Top 1%
Australian MP	A$221,250[66]	1.439	146,803	Top 1%

Source: Own calculations, Stockholm Environment Institute, Oxfam (2023).

CHAPTER 4

4.1. Delivering prosperity for all while increasing emissions

To make this calculation, we have used income data from the WID[67] extracted in July 2023. Here you can access the income of every percentile in the world income distribution. The concept of income is expressed as pre-tax income in 2022 USD PPP constant terms. Pre-tax income is used because post-tax income is not available for enough countries. The data year refers to 2019 and the population refers to equal-splits adults. This dataset also provides the average income for every percentile. Multiplied by the adult population in each percentile, this sums to the accumulated percentile's total income.

This is matched with the average elasticity of 0.82 that the SEI method leads to.[68] The elasticity means that, for every 1% of income growth, emissions grow by 0.82%.

Based on this, we take the emissions of the top 1% from SEI data as our starting point. We calculate the percentage change in income, apply the elasticity of 0.82% for emissions and calculate downwards through the distribution. We have to put the two lowest income percentiles as zero, since their incomes are negative, and negative emissions are not possible. We now have the average per capita emissions for the whole distribution and, again, by multiplying with the number of adults in the percentile, we have the total emissions. Total emissions will differ slightly from the SEI results, since they apply both ceilings and floors on emissions on their national estimates.

It should be noted that other distributional statistics in the report are based on SEI income data (see section 1.1). For this calculation, WID income data were more suitable because the global results are estimated directly on the global income distribution, while the SEI computes its distributions of emissions and income by putting together national results, making the income and emissions series less smooth. Since we are dependent on emissions and income following each other closely without small leaps between percentiles, we have chosen WID data for this calculation.

When changing the incomes and emissions, we raised all the bottom incomes to \$25 a day (or \$9,125 PPP pre-tax a year). That is percentile 48 (\$9,286 PPP pre-tax).

a. **A global redistribution of income could raise everyone to a level of \$25 a day or above (the World Bank proposed prosperity line),[69] while reducing global emissions by 10% (roughly the equivalent of the total emissions of the European Union), and still leave the global richest 10% with an average income of around \$47,000 PPP pre-tax.**

We first calculated what it would take to increase all the incomes in the world to at least \$25 a day.

In the absence of any mitigating action, this will lead to an increase in carbon emissions of around 4.4bn tonnes, as with higher incomes more carbon will be consumed by the bottom 50% (using the elasticity of 0.82 described above.)

To mitigate this, we modelled a reduction in the the emissions of the richest.

In scenario one, *Prosperity for all with no net increase in emissions,* everyone is living on \$25 and above, which will increase carbon emissions, and if we reduce the emissions of the richest by the equivalent amount (4.4bn tonnes) then the incomes of the top 10% would fall to \$75,000 PPP pre-tax per capita.

In scenario two, *Prosperity for all while cutting emissions*, we go further and reduce the overall level of emissions by approximately 10% by reducing the emissions of more of the richest people. In this scenario, the pre-tax income per capita for the top 10% would be \$47,000 PPP .

Taking such an action would reduce the global Palma ratio (the ratio between the incomes of the top 10% and the bottom 40%) from the current 10.7 to 1.3.

Both scenarios focus on two objectives:

1 not increasing and preferably reducing emissions; and

2 lifting everyone on Earth above the level of $25 a day.

These two scenarios are laid out in Table 24.

Table 24: Palma ratios and reductions for the two scenarios

	Income share	Average income (USD PPP)	Palma ratio	Reductions in CO_2 emissions
Current situation				
Top 10%	52.5%	132,230	10.7	n/a
Bottom 40%	4.9%	3,104		
Scenario 1: Prosperity for all with no net increase in emissions				
Top 10%	34.1	75,174	2.0	−0.4%/−134,514,947 tonnes
Bottom 40%	16.8	9,286		
Scenario 2: Prosperity for all while cutting emissions				
Top 10%	24.6	47,232	1.3	−9.7%/−3,241,144,984 tonnes
Bottom 40%	19.4	9,286		

Source: Own calculations based on World Inequality Database (WID), Stockholm Environment Institute, Oxfam (2023).

Palma ratios are calculated by dividing the share of the top 10% total incomes with the bottom 40% total incomes. Average incomes are the top 10% and bottom 40% total incomes divided by the respective number of adults in the top 10% and bottom 40%.

The income share is the share for the top 10% and bottom 40% out of total global income.

The reductions are comparable to the emissions of large parts of Europe or even the whole EU27.

The reductions under scenario two, *Prosperity for all while cutting emissions*, are 3.2 Gt CO_2, roughly equivalent to the emissions of the whole EU27.

This is laid out in Table 25 below.

Table 25: Cuts in carbon under scenario two, 'Prosperity for all while cutting emissions'

	Total emissions (tonnes CO_2)
EU27 (total emissions 2019)	3,507,400,000
Emissions savings under scenario two, 'Prosperity for all while cutting emissions'	3,241,000,000

Source: Own calculations based on Stockholm Environment Institute and Oxfam (2023).

b. A tax of 60% on the income of the top 1% would reduce global emissions by 700m tonnes, more than the total emissions of the UK.

Following the same approach as above, in our estimate of 60% tax on the income of the top 1% and the income/emissions scenarios, we find that the 60% tax would reduce the incomes of the top 1% by 17.7%, equivalent to $4,416bn PPP out of a total of $25,003bn PPP.

This enables us to model the extent of carbon emissions that would be reduced if the incomes of the top 1% were reduced by this much using the elasticity of 0.82 from the SEI[70] (see above).

This means that the tax on the top 1% would result in a reduction of 695m tons rounded, or 2.1% of global emissions, more than the 2019 emissions of the UK (534m tonnes rounded based on the SEI's estimates).[71]

The extent to which these tax revenues are subsequently invested in carbon-intensive activities will dictate the overall amount of carbon saved.

It is plausible that these revenues, if invested in carbon-intensive activities, could lead to a net increase in carbon. Equally, if these revenues were used in large part to fund the transition away from fossil fuels to green energy, then the overall savings in carbon could be significantly higher.

4.2. Poverty reduction and inequality

a. **If current levels of inequality remain unchanged, raising everyone on Earth to the minimum of $25 a day (the prosperity line proposed by the World Bank)[72] would require all incomes, including those of the richest, to grow by 50 times.**

The data is sourced from the World Inequality Database[73] for the year 2021.

In line with World Bank analysis,[74] we assign an income of $0.5 a day to the poorest 1%.

We calculate by how much the incomes of the poorest 1% would need to grow to reach $25 a day.

This gives us a figure of 50 times. To calculate the factor by which the income of the poorest needs to grow to end poverty at $25 a day, we divide $25 by $0.5, i.e. 25/0.5 = 50.

We then calculate from the WID what share of total global income is earned by the bottom 1%.

If we assume that inequality remains unchanged, and the share of global income of the poorest 1% remains the same, then this means that total global income would have to rise by 50 times too.

Since the income share of the poorest percentile (0.00726%) remains unchanged in the total global income (but their incomes increase by 50 times to $25 a day), all being equal, the total global incomes would also need to grow by 50 times to $6,482tn (from $130tn as of 2021).

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