CVF | CLIMATE VULNERABLE FORUM

Paris Goals NDC Alignment

Traffic Light Assessment

A Groundbreaking Report Commissioned by the Climate Vulnerable Forum

AROHA geneva

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EXPLAINER*

CVF Research Inquiry into Countries' Current Climate Targets' (NDC) Paris Agreement Alignment

Background

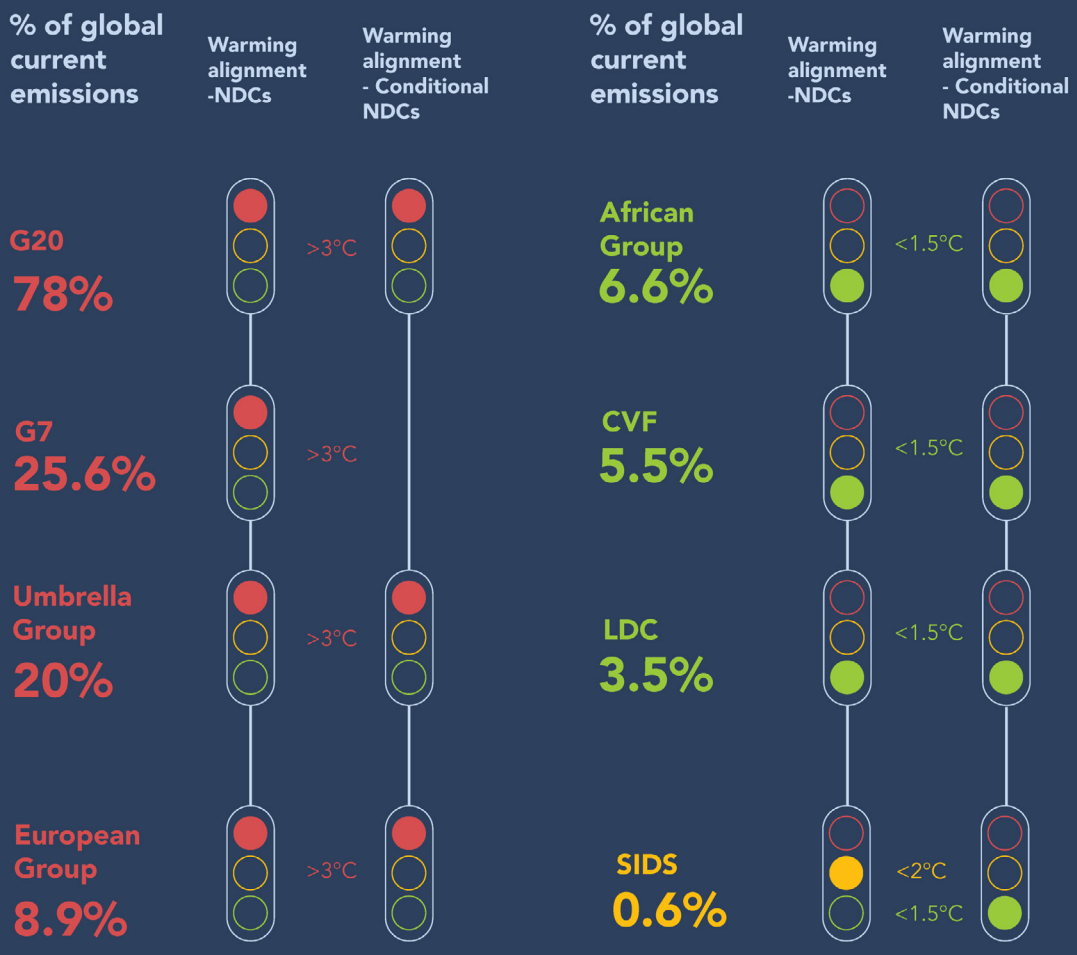
The Climate Vulnerable Forum (CVF), comprised of 58 developing nations particularly vulnerable to the adverse effects of climate change, has advocated since its inception for limiting global warming to 1.5°C or below. Since the adoption of the CVF Vision in 2016, the year the Paris Agreement was signed, with its Virtual Summit in 2018, the Madrid Ambition Drive for Survival in 2019, and, finally, the Midnight Survival Initiative for the Climate in 2020, the CVF consistently advocated the need for all countries to upgrade their earlier 2015 Paris Agreement climate targets for the years 2025 or 2030 in order to ensure the 1.5°C goal of the Agreement could be safeguarded. Nearly all CVF members also upgraded their own nationally determined contributions (NDCs) during the period from 2020 through the United Nations Conference of the Parties (COP26) in Glasgow last year. Owing to a prevailing shortfall between the collective level of ambition of all NDCs and requirements for limiting warming to 1.5°C, COP26 requested "Parties to revisit and strengthen the 2030 targets in their NDCs as necessary to align with the Paris Agreement temperature goal by the end of 2022, taking into account different national circumstances."

CVF

*CVF Secretariat: Matthew McKinnon, Selamawit Desta Wubet

Traffic Light Assessment Paris Temperature Goal Alignment of 2030 NDCs

*What is the warming signal of the current Paris emissions targets?**



* Per an emissions envelope over the period 1990-2100

CVF Commissioned Research

The COP26 outcome implies that all countries should align their NDCs with the Paris Agreement temperature goal of "well below 2°C" and "pursue efforts to limit the temperature increase to 1.5°C". Last month, the United Nations Framework Convention on Climate Change (UNFCCC) secretariat released its 2022 NDC Synthesis Report, which updated the review of all NDCs' contributions to keeping global heating aligned with the Paris temperature goal by 2030. The report considered 24 new NDCs that were submitted after COP26. It showed that countries' current commitments will in fact still increase global emissions by 10.6% by 2030, compared to 2010 levels. Whereas the UN's Intergovernmental Panel on Climate Change's (IPCCs) 2018 report indicated that CO2 emissions needed to be cut 45% by 2030, compared to 2010 levels (or be cut by 43% versus 2019 levels, per the 2021-22 IPCC 6th Assessment reports (AR6). The CVF member states, anxious to continue to promote global compliance with the Paris Agreement and its temperature goal, have been seeking answers as to the alignment of their own and of other countries' NDCs. This led the CVF to commission this present research effort, initial results of which are presented in this paper. Providing answers requires not just looking at emissions levels of different countries. In accordance with the UNFCCC and Paris Agreement, these instruments' implementation should reflect equity and responsibilities that are both shared by all yet also different, for example, because of variations in actual capabilities and national circumstances.

NDC Alignment Research Project

It is towards the promotion of dialogue and understanding that the CVF chose to request for an independent research inquiry project into the alignment of all countries' NDCs with the Paris Agreement temperature goal, inclusive of equity and capability considerations. The CVF secretariat was mandated to provide inputs to the work, with this present paper being the first contribution, while a more comprehensive report and online tool is planned for 2023, further supported by a peer-reviewed journal submission, and which will present individual national NDC assessment information for all Paris Agreement parties. That future publication will notably benefit from more in-depth internal – and external – exchanges made possible by this first contribution paper, including a scientific review process. The CVF secretariat aimed to provide guidance based on over a decade of forum member deliberations on climate policy issues, especially equity considerations, in order to identify key parameters and concepts that could guide an assessment of NDCs' alignment, or not, with the Paris Agreement temperature goal that might be considered broadly consistent with CVF views. Part of the remit of this research project was to develop an assessment framework enabling a "Traffic Light" appraisal of any countries' NDC for alignment (coloured green - being compatible on average with pursuing limiting warming to 1.5°C), near alignment (orange - i.e. below 2°C but not "well below" 2°C nor 1.5°C compatible) and non-alignment (red - implying a contribution to warming beyond 2°C) with the Paris temperature goal.

CVF Parameters for Evaluating NDC Alignment

In order to contribute to discussion and debate on the adequacy of any national climate change mitigation efforts under the Paris Agreement, this paper aims to transparently document key concepts of relevance to the CVF's appreciation of such concerns. Within this context, the following three chief equity parameters have, in particular, been proposed to guide this present papers' assessment of all countries NDCs for alignment with the Paris temperature goal:

1. Responsibility - the issue of evenly distributing emissions' responsibilities to all countries, whereby everyone has an equal right and responsibility to ensuring a safe climate. This parameter manifests as conferring "common" or shared responsibility to not exceed a given global carbon budget* (or, inversely: access rights to this budget) needed to keep within the Paris Agreement temperature goal, implying here country emission allocations are by population scale relative to one another.

2. Interval - the interval or time period over which any countries' per person responsibility for emissions should prevail. The CVF members have generally viewed responsibility to have a historical quality. The text of the UN Framework Convention on climate change (UNFCCC) itself called on developed countries to "lead", noting that "the largest share of historical and current [prior to 1992] global emissions of greenhouse gases has originated in developed countries". The CVF's broader research project is, for now, thereby exploring timeframes to 2100 and commencing in 1990, when the first IPCC report and first UN General Assembly resolution on climate change were adopted, as well as 1950. In this respect, emissions since 1990, the emissions reference year contained within the UNFCCC itself and to which all its parties hold emission responsibilities, are considered "observed", whereas emissions prior to 1990 (since 1950) are considered "historical."

3. Capability - the ability of any country to respond to climate change, especially as conditioned by available capacities and resources, which may be measured in a variety of ways, including economic (such as using Gross Domestic Product, GDP) or in human

development terms (such using the UNDP Human Development Index). The mandate provided to experts responsible for the present paper was to resolve the foregoing parameters - and not other - factors in a framework and approach that enabled comparable evaluation of countries' present national climate action pledges (NDCs) with the Paris temperature goal.

Data on developing countries' unconditional and conditional NDCs have been requested in order to contribute and enable discussion, bearing in mind that unconditional NDCs represent what a government is promising to deliver independently, whereas conditional NDCs depend on various forms of international cooperation and support, such as finance, technology, and capacity building.

*Where "carbon budget" is a catchphrase to mean the total amount of greenhouse gas emissions (GHGs) that can be released for a given temperature target, such as limiting global warming to 1.5°C.

An immediate ambition assessment framework for nearing climate targets

Yann Robiou du Pont

Reviewers:
Michiel Schaeffer, Saleemul Huq*.

*Chair of the Expert Advisory Group of the Climate Vulnerable Forum

Key findings

- Equitable emissions trajectories that start at current emissions level inherently reward climate inaction after every successive update. Their use for ambition assessment of 2030 pledges increasingly benefits unfairly high emitters and displaces the burden for near-term climate action away from major emitters who are overwhelmingly the countries most responsible for climate pollution, and also those the most capable to take action.

- Based on parameterisation provided by the CVF secretariat, this paper suggests a quantification of equitable emissions allocation with immediate effect (no transition period) and accounting for observed (since 1990) and historical responsibility (here counted since 1950), and capability.

- Current emissions levels are far from levels that can be considered equitable (or "fair share") for countries from the G7, a group of European countries and the Umbrella Group, which in aggregate have emissions proportionally the most above equitable levels.

- Countries from the 46 Least Developed Countries (LDCs), the 54 African Group countries and 58 CVF countries have – in the aggregate – emissions proportionally the most *below* equitable levels.

- Based on the methodology developed here, the 2030 emissions targets in current NDCs hardly correct this unfair situation. The 2030 NDC targets of European countries, the G20, G7 and Umbrella Group, in aggregate, do not align with their fair share of a 3°C warmer world, let alone with the Paris temperature goal. Altogether these countries represent over 80% of global emissions and their significant misalignment with the Paris Agreement emissions goals jeopardises its realisation.

- A large number of countries have NDC targets well within their share of limiting warming to 1.5°C per corresponding IPCC scenarios in 2030, including in the aggregate the LDC, African Group and CVF countries.

Introduction

The global stocktake under the UNFCCC will review in 2023 the global ambition of the 2030 countries' pledges towards achieving the goals of the Paris Agreement. At the national level, recent literature suggested frameworks to review the ambition of emissions pledges against various quantifications of equitable burden sharing to limit global warming to 1.5°C or well below 2°C – each constituent parts of the Paris Agreement temperature goal. However, all these approaches rely on allocations of emissions rights following a continuous trajectory starting at today's emissions levels. Such a modelling choice favours countries with unfairly high emissions in the near term and this will perpetuate beyond 2030.

Here we quantify discontinuous emissions allocations (starting directly at equitable emissions levels rather than current levels) accounting for countries' historical responsibilities and capabilities, in line with the equity principle of the Paris Agreement. Looking at a paramaterisation accounting for emissions since 1990 selected by the CVF group of 58 countries, we find disparities between emissions allocation for 2030 and emission levels derived from current NDCs. These range from allowances 3 times the levels implied by NDCs for LDCs in aggregate, to allocations 91% below NDC levels for G7 countries. Accounting for the latest unconditional NDCs (cut-off date of October 2022), the African Group, CVF, and LDCs have targets in line with their fair shares of the global effort towards limiting warming to 1.5°C, while G7, G20, and the Umbrella group have targets that in aggregate fall short of even 3°C aligned targets. SIDS have unconditional NDCs aligned in aggregate with their fair share of a below 2°C warmer world.

Approach rationale

Recent literature quantifying equitable distribution of the global mitigation effort needed to achieve the Paris Agreement goal agrees on the insufficiency of ambition of mostly NDCs from the wealthiest countries and some emerging economies[1–6]. Despite divergence on the modelling choices of equity concepts[7,8], this literature is based on a "continuous" allocation of emissions trajectory starting at current emissions levels. Successive updates of such literature delays future equitable allocation by "accepting" the lack of progress in emissions reductions to date, and thereby favourably biases the ambition assessment of inequitable NDCs. In this context, "continuous" refers to these trajectories starting at current emissions levels, rather than equitable ones, to achieve equitable outcomes over the century. Effort-sharing formula can be designed to directly achieve such continuity (equal cumulative per capita approach in ref.[4]). Alternatively, a transition period can ensure continuity[4,9], or the equity formula can drive the change in emissions allocations (effort to deviate from business as usual) instead of emissions levels directly[5]. All continuous approaches have by definition an influence of current emissions levels on near term emissions allocations, which can be described as a "grandfathering" bias[2], and which implies equating the start point of forward emissions contraction efforts to the current emissions level for every country. Some existing studies seek to compensate for this early influence through later allocations, possibly accounting for historical emissions to ensure an equity-based emissions budget. However, a near term influence by current emissions level may affect the ambition assessment of NDCs in 2030, only 7 years from now. For example, any equity based continuous emissions allocation starting in 2029 would find a business as usual pledge for 2030 (or contemporary policy trajectories) to be close to the fair allocation, starting only a year earlier, at contemporary levels. The ambition assessment of the current literature based on continuous allocations are getting increasingly influenced by current emissions as we near 2030. Continuous allocations are higher in the near-term for countries emitting more than what would otherwise be their fair share, that is mostly the wealthiest countries.

One of the motivations for quantifying continuous allocation is the need for emissions trajectories that countries can implement domestically. For example, it is unlikely to be

considered politically, socially or economically realistic for any country to halve its emissions domestically from one year to the next. Instead, countries can achieve their equitable emissions allocation through a combination of domestic effort and international cooperation[10]. Countries can therefore contribute to an equitable share of the global mitigation effort beyond what is globally cost-efficient to do within their borders. The international support needed to achieve this combination can be determined by equity-based models and socio-economic models jointly. The recent IPCC sixth assessment report calls for research "extending equity frameworks to quantify equitable international support, as the difference between equity-based national emissions scenarios and national domestic emissions scenarios"[8]. International cooperation, possibly through bilateral agreements, financial support or trading of mitigation outcomes, is now facilitated with the adoption of Article 6 under the Paris Agreement at COP26. Article 6 of the Paris Agreement can facilitate the implementation of globally cost-optimal transition scenarios such as through equitable emissions targets. It allows countries to mitigate emissions beyond their borders while contributing to meeting their fair allocation of emissions at lower costs, that is more efficiently. Through international cooperation and supporting mitigation globally, countries can reduce emissions to a fraction of their domestic emissions and even follow emissions allocations that are discontinuous such as the approach evaluated here. Such mechanisms offer a solution to both ensure an equitable distribution of the mitigation effort (through equitable trajectories suggesting a fair distribution of mitigation costs) and enable the domestic implementation of mitigation measures in line with the pursued global cost-optimal scenario (that suggests a geographic implementation of mitigation measures without indicating how each country is funding this effort). Energy-economic models providing these global scenarios assume that financial capital, mostly owned by the global north, is available when and where needed to fund mitigation options, mostly located in the global south where mitigation is cheaper.

While the cost-optimal scenarios do not require equitable funding, funding costs may not be bearable for certain developing regions, and contradict the principle of "common but differentiated responsibilities and respective capabilities" (CBDR-RC) of the UNFCCC and Paris Agreement. While continuous emissions trajectories may look "realistic" at first sight, the implication would be that present-day levels of domestic emissions are acceptable from an equity perspective. Given the immediate need for global mitigation investments towards net-zero emissions, including in developing countries, and the scientific evidence of present-day impacts, damages and disasters from anthropogenic climate change to date, the need for climate finance to support efforts in developing countries is urgent. The trading of mitigation outcomes to meet equitable emissions scenarios can deliver funding necessary for the implementation of mitigation measures in developing countries and make the remaining effort politically acceptable, though environmental and social safeguards should apply to ensure outcomes are not inconsistent with sustainable development.

The trajectories of domestic emissions can be informed by the cost-optimal scenarios, that can also be downscaled at the national level[11]. Beyond these globally cost-optimal scenarios,

countries have a great interest in doing a maximum domestically to reap the important co-benefits not accounted for in these scenarios and that can cover a substantial share of the mitigation costs[12].

Methods

Here we suggest a method to allocate equitable emissions trajectories that do not start at current emissions levels and in that respect immediately reflect principles of the UNFCCC and the Paris Agreement, notably CBDR-RC.

A recent paper[13] by Fyson et al. suggested an approach to allocate the negative emissions of global scenarios (including LULUCF emissions) on the basis of various equity concepts based on capability or historical responsibility. This paper alone cannot be used as a source for a metric to inform economy-wide emissions targets, nor assess the ambition of NDCs, as it "assume[d] that positive emissions follow least-cost pathways (that is, no equity principle is applied to gross emissions)"[13].

Building upon this paper, we suggest an extension of this approach to derive an allocation of economy-wide emissions to countries where global positive and negative emissions are allocated based on responsibility and capability, respectively. Looking at the global emissions scenarios, the positive emissions refer here to the actual (gross) emissions projected in the model (e.g. fossil fuels, agriculture). The negative emissions here refer to emissions captured through Carbon Capture and Storage and Direct Air Capture.

The approach derived here extends te capability-driven allocation of global negative emissions with observed and historical (following the naming considerations laid out in the explainer section of this document) responsibility-driven allocation of global positive emissions to ensure equal cumulative per capita emissions over the period 1990-2100 (and 1950-2100). In this approach, the capability of countries does not affect the total net emissions budget by 2100, only how it is used over time (its dynamic use).

The capability driven allocation of growing global negative emissions (under the most ambitious global pathways) requires greater negative emissions from richer countries, mostly occurring after 2030. Achieving future negative emissions requires technology (excluding LULUCF) yet to be developed and applied at scale, which do not provide the important (co-)benefits of positive emissions reductions (e.g. energy security, energy access, health co-benefits). Since the responsibility-driven allocation of global positive emissions ensures a given total emissions budget outcome for each country, the capability-driven allocation of global negative emissions provides richer countries with higher near-term emissions allocations. Many of these richer countries have negative emissions budgets in 2020 when calculated under an equal cumulative per capita emissions and could otherwise have immediate negative emissions allocations.

An alternative parameterisation of this approach uses Human Development Index instead of GDP to better reflect the development of a country and its potential need for development, supported by a view of development that is not purely economic, with the HDI spanning multiple development indicators wherein GDP is but one factor. A country with higher HDI will be allocated a great effort as a share of negative emissions. Comparing two countries with equal population with equal GDP, the country with higher HDI (that may result from better governance or potentially ill acquired wealth) will have greater effort to provide. The influence of the capability criteria will influence the distribution of emissions allocations over time, but not the overall emissions budget of a country until 2100.

Practically, the first step in our approach calculates the distribution of negative emissions (excluding LULUCF) of the global scenario proportionally to countries GDP projection at every point in time (and thus indirectly based on their populations). Unlike Fyson et al. 2020, the current approach does not filter out countries below the global mean of GDP per capita, all countries contribute proportionally to their resources or HDI and population. In the second step, the positive emissions of the global scenario are then allocated to ensure equal cumulative per capita emissions, and thereby equalise historical responsibility (in terms of emissions since 1950 or 1990) by 2100. To this end, the remaining climate budget (positive or negative) for the period 1990 (or 1950)[11] until 2100 of each country is calculated accounting for the negative emissions already allocated.

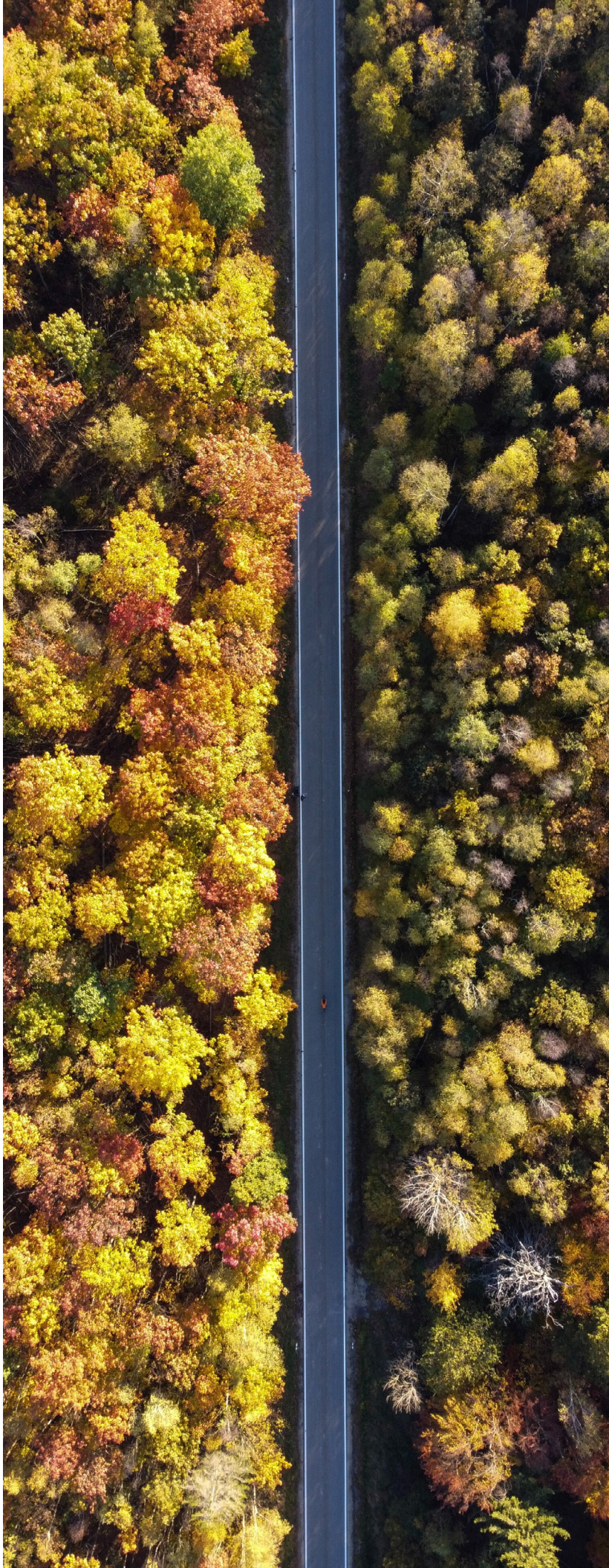
Note that we discount observed and historical emissions by 1.5% each year in the past to account for technological improvement[14]. Each country is then allocated at every point in time (2020 to 2100) a fraction of the positive emissions of the global scenario proportional to its budget remaining in 2020. As a result, the allocation in the first year of the analysis differs from current emissions in that year and it may require emissions trading and/or very rapid scaling up of mitigation efforts to reconcile (cumulative) actual emissions with (cumulative) allocations over the period to 2030. The use of HDI, an indicator that does not depend on the population of a country, instead of GDP requires accounting for the population of a country. Here, we simply multiply HDI by the population of the country and use this quantity instead of GDP. Each country is allocated at every point in time a share of the global negative emissions proportionally to its share of the sum of all countries' HDI (2020 value) times their population projection.

Paris Agreement alignment

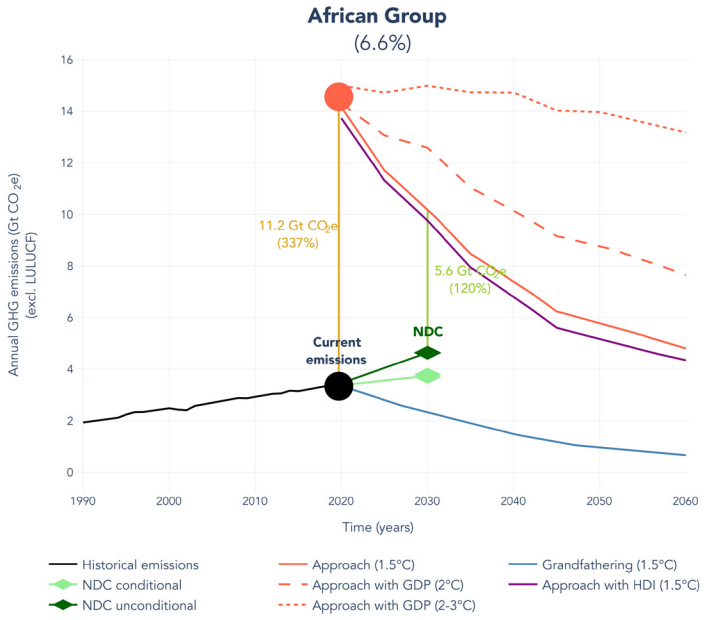
The reference to warming alignments reflects here the warming assessment of the global emissions scenarios, whose emissions are distributed by the equity approach described above. The reference to a 1.5°C alignment corresponds here to the distribution of emissions of the average of scenarios of the IPCC Categories C1 ('below 1.5°C with no or limited overshoot') averaged with the distribution of C2 ('below 1.5°C with high overshoot'). The below 2°C alignment follows a lenient definition based on emissions

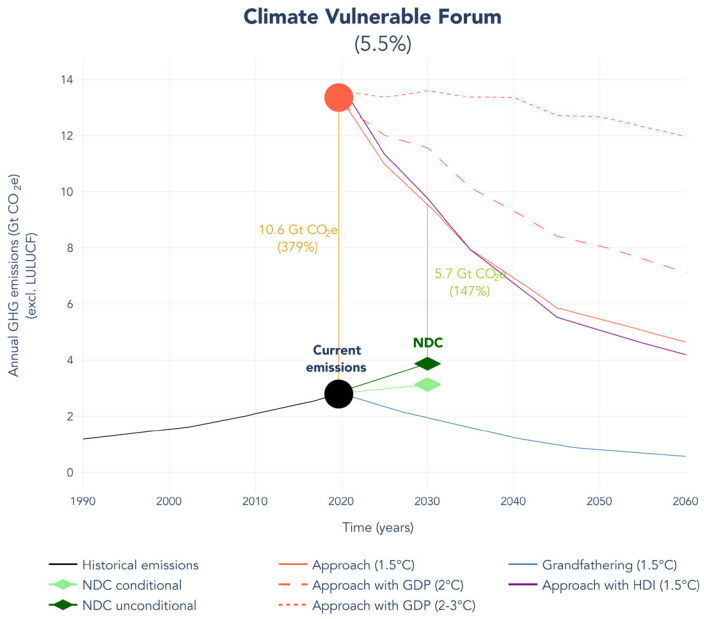
1 NB figures in this present report consider only the 1990 (not 1950) time interval

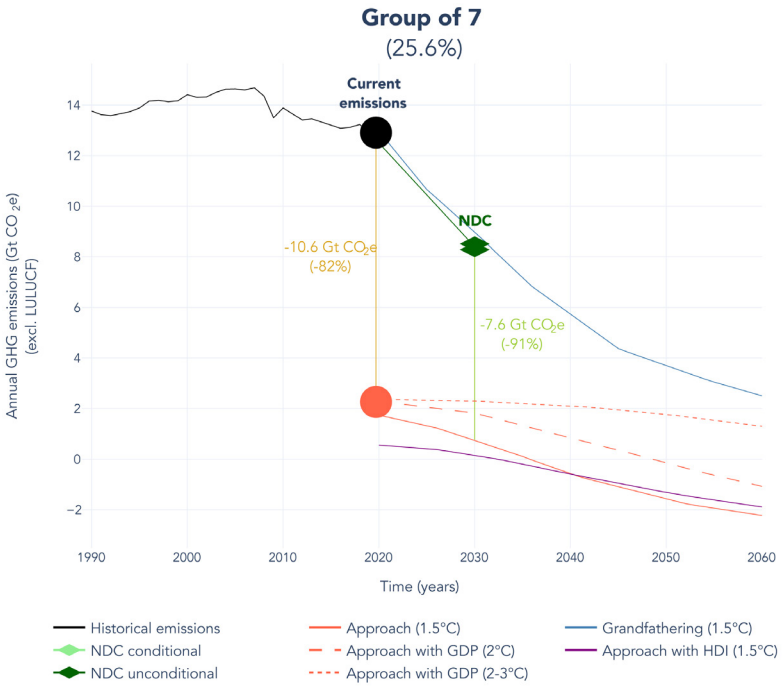
scenarios from the C3 ('likely below 2°C') and C4 ('below 2°C') categories and is therefore not consistent with the 'well below 2°C' threshold of the Paris Agreement. Otherwise considered are scenarios that fall outside 1.5/2°C, which includes the C5 ('below 2.5°C') and C6 ('below 3°C') scenarios. Avoiding any 1.5°C overshoot and ensuring a higher likelihood of achieving that warming threshold thereby implies smaller emissions allocations still than the ones presented in this report.

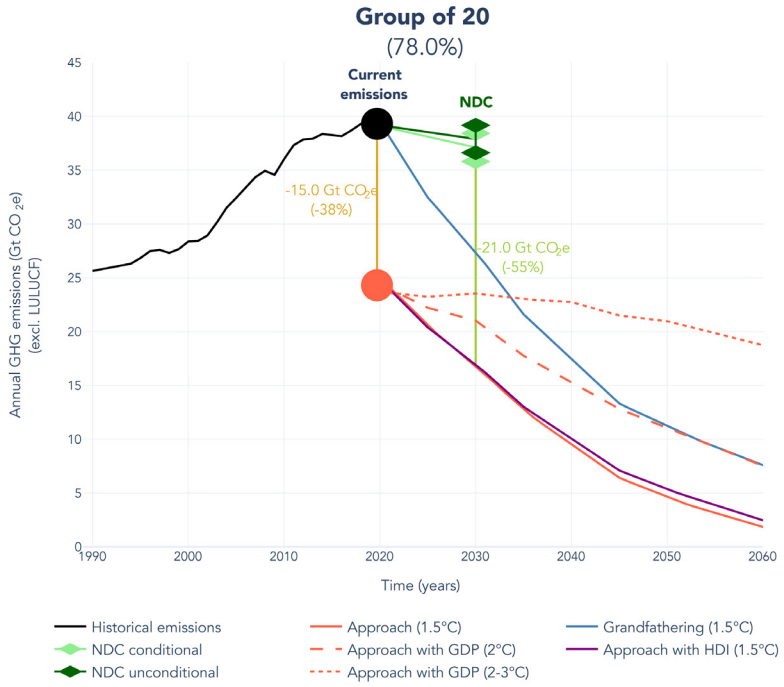


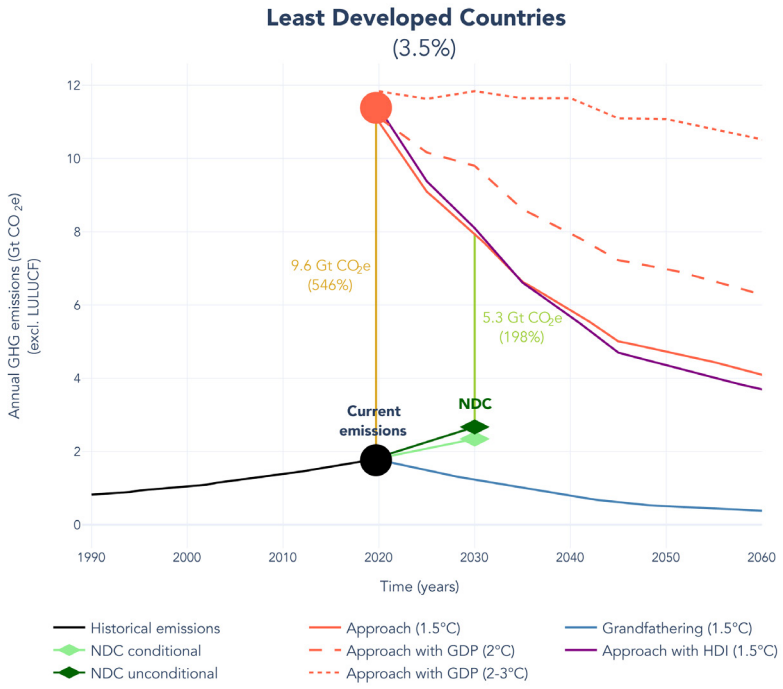
Results discussion

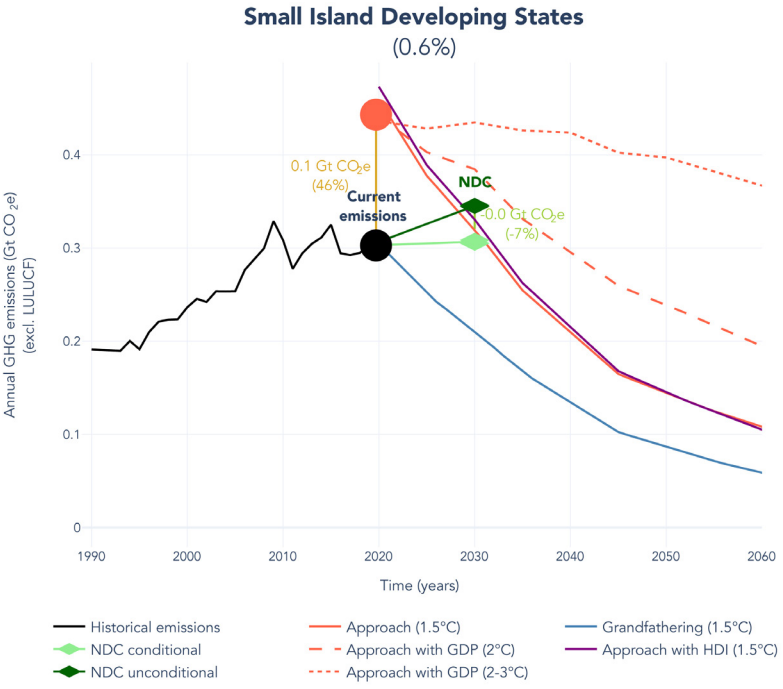


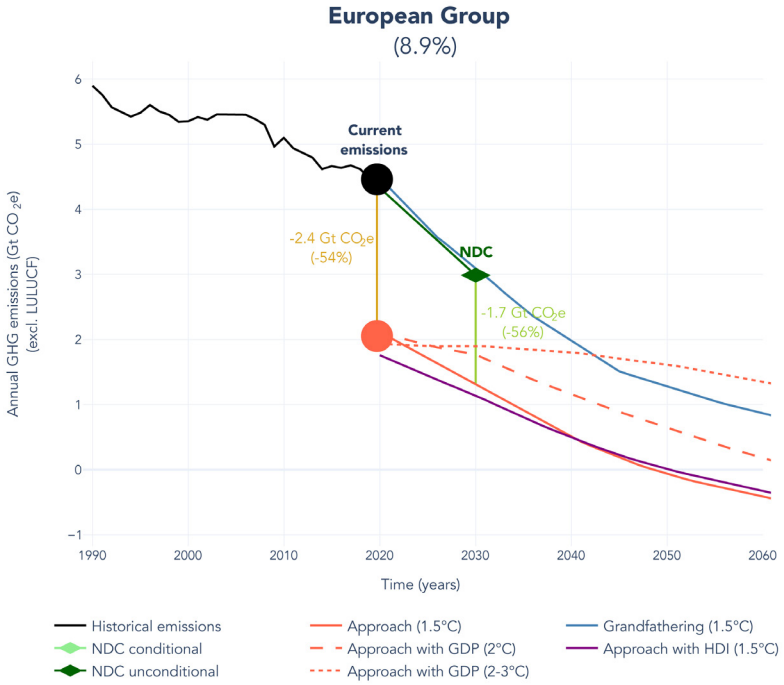



Group of 7
(25.6%)
Current emissions
NDC
-10.6 Gt CO2e
(-82%)
-7.6 Gt CO2e
(-91%)
Annual GHG emissions (Gt CO2e)
(excl. LULUCF)
Time (years)
Historical emissions
NDC conditional
NDC unconditional
Approach (1.5°C)
Approach with GDP (2°C)
Approach with GDP (2-3°C)
Grandfathering (1.5°C)
Approach with HDI (1.5°C)


Group of 20
(78.0%)
Current emissions
NDC
-15.0 Gt CO2e
(-38%)
-21.0 Gt CO2e
(-55%)
Annual GHG emissions (Gt CO2e)
(excl. LULUCF)
Time (years)
Historical emissions
NDC conditional
NDC unconditional
Approach (1.5°C)
Approach with GDP (2°C)
Approach with GDP (2-3°C)
Grandfathering (1.5°C)
Approach with HDI (1.5°C)


Least Developed Countries
(3.5%)
Annual GHG emissions (Gt CO 2e) (excl. LULUCF)
12
10
8
6
4
2
0
9.6 Gt CO2e (546%)
5.3 Gt CO2e (198%)
Current emissions
NDC
1990
2000
2010
2020
2030
2040
2050
2060
Time (years)
Historical emissions
NDC conditional
NDC unconditional
Approach (1.5°C)
Approach with GDP (2°C)
Approach with GDP (2-3°C)
Grandfathering (1.5°C)
Approach with HDI (1.5°C)


Small Island Developing States
(0.6%)
Annual GHG emissions (Gt CO 2e) (excl. LULUCF)
0.4
0.3
0.2
0.1
0
0.1 Gt CO2e (46%)
Current emissions
NDC
-0.0 Gt CO2e (-7%)
1990
2000
2010
2020
2030
2040
2050
2060
Time (years)
Historical emissions
NDC conditional
NDC unconditional
Approach (1.5°C)
Approach with GDP (2°C)
Approach with GDP (2-3°C)
Grandfathering (1.5°C)
Approach with HDI (1.5°C)


European Group
(8.9%)
Current emissions
NDC
-2.4 Gt CO2e (-54%)
-1.7 Gt CO2e (-56%)
Annual GHG emissions (Gt CO2e) (excl. LULUCF)
Time (years)
Historical emissions
NDC conditional
NDC unconditional
Approach (1.5°C)
Approach with GDP (2°C)
Approach with GDP (2-3°C)
Grandfathering (1.5°C)
Approach with HDI (1.5°C)

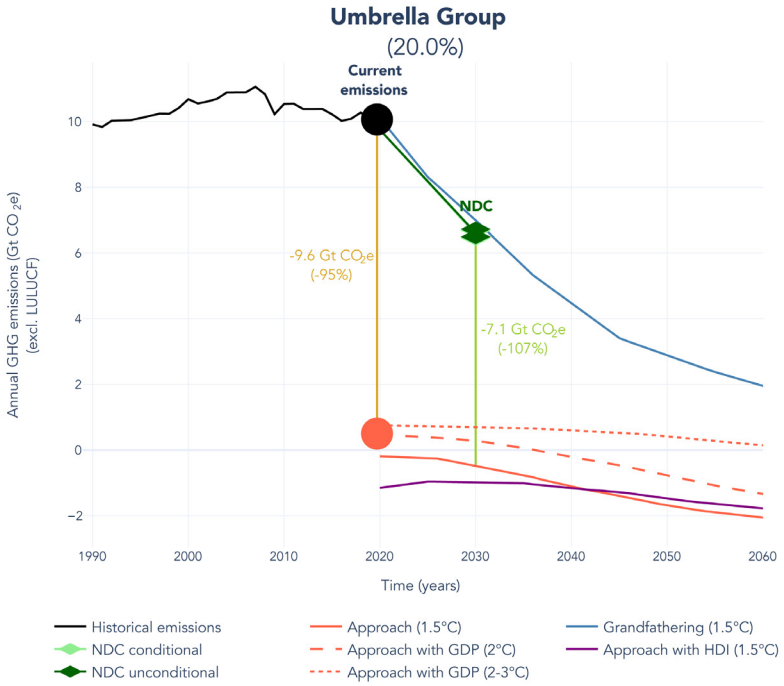

Umbrella Group
(20.0%)
Current emissions
NDC
-9.6 Gt CO2e (-95%)
-7.1 Gt CO2e (-107%)
Annual GHG emissions (Gt CO2e) (excl. LULUCF)
Time (years)
Historical emissions
NDC conditional
NDC unconditional
Approach (1.5°C)
Approach with GDP (2°C)
Approach with GDP (2-3°C)
Grandfathering (1.5°C)
Approach with HDI (1.5°C)

Figure 1 | Emissions allocations for selected country groups under the equity approach applied to the average of scenarios with a 1.5°C goal with possible overshoot (solid orange line), to the average scenarios consistent with a below 2°C threshold without overshoot (dashed orange line) and to the average of scenarios consistent with a warming up to 3°C (dotted orange line). The same equity approach using HDI instead of GDP is applied to the average of scenarios with a 1.5°C goal (purple line). A "grandfathering" allocation for the average of scenarios with a 1.5°C goal is shown for comparison (blue line). Emissions allocations are compared to unconditional NDCs (dark green) and with current emissions (green and yellow vertical lines). Conditional pledges are shown in light green. The bracketed number below the country group name indicates its share of global emissions in 2019.

The allocation of emissions here is dominated by the requirement to achieve equal cumulative per capita emissions by 2100 and the difference in observed per capita cumulated emissions across country groups for the time interval of 1990 to 2020 (the last three decades since, and immediately prior to, the UNFCCC coming into force). By 2030, the difference across country groups is greater than the difference of allocations for a given country-group under global emissions scenarios associated with the range of global-mean temperature limits (towards 1.5°C to below 3°C). The influence of the capability criteria is limited in 2030 given the overriding effect of the accounting of observed emissions. As a result, the NDCs of all country groups in Figure 1 are consistent with the fair shares of all of the global scenarios reflecting the various global-warming levels, or none, except for SIDS. The NDCs of CVF and LDCs are much more ambitious than their 1.5°C fair allocation, while the NDCs of the G7, G20 and the EU are much less ambitious than their fair shares of even a 3°C scenario. The NDCs of SIDS align with the fair share of the below 2°C scenario, but are very near to, yet slightly higher than their fair share of the 1.5°C scenario. The NDCs of countries from the G7 and the Umbrella group align, in aggregate, with a "grandfathering" approach which is not considered as an equitable effort-sharing principle[8,9]. This approach simply enshrines the current unfair share of countries' emissions as all countries decrease emissions at the same rate, irrespective of their per capita emissions levels[1].

Accounting for countries' observed and historical emissions to distribute future emissions allocation proportionally to their remaining budgets leads to allocations very different from today's emissions levels. Meeting such emissions allocations would require important international cooperation, possibly with the use of Article 6 and international support, and/or much more rapid scaling up of mitigation than implied by current NDCs. The G20 and G7 as a group would be net providers of finance to purchase mitigation outcomes, while LDC and CVF countries would be net receivers to achieve the fair emissions allocations quantified here. The unconditional NDCs of SIDS are collectively almost aligned with their 1.5°C fair share.

1 The grandfathering approach is logically less stringent than equitable approaches for most developed countries, and less stringent for developing countries, see ref 4.

Table 1 | Results for the equity approach accounting for observed emissions since 1990.

Country Group	Current per capita (tCO_2e/p)	% of global current emissions	2030 fair 1.5°C allocation using GDP (in % change to 2019)	2030 fair 2°C allocation using GDP (in % change to 2019)	Warming alignment -NDCs	Warming alignment - Conditional NDCs	2030 fair 1.5°C allocation using HDI (in % change to 2019)	2030 fair 2°C allocation using HDI (in % change to 2019)
G20	8.1	78	-57	-47	>3°C	>3°C	-57	-46
G7	12.8	25.6	-94	-86	>3°C		-99	-90
Umbrella Group	16.7	20	-94	-97	>3°C	>3°C	-110	-102
European Group	8.5	8.9	-70	-60	>3°C	>3°C	-74	-64
African Group	2.5	6.6	206	277	<1.5°C	<1.5°C	193	264
CVF	2.1	5.5	243	315	<1.5°C	<1.5°C	250	320
LDC	1.7	3.5	352	456	<1.5°C	<1.5°C	360	462
SIDS	4.6	0.6	6	27	<2°C	<1.5°C	9	30
World	6.5	100	-30	-14				

Table 2 | Results for the equity approach accounting for historical emissions since 1950.

Country Group	Current per capita (tCO_2e/p)	% of global current emissions	2030 fair 1.5°C allocation using GDP (in % change to 2019)	2030 fair 2°C allocation using GDP (in % change to 2019)	Warming alignment -NDCs	Warming alignment - Conditional NDCs	2030 fair 1.5°C allocation using HDI (in % change to 2019)	2030 fair 2°C allocation using HDI (in % change to 2019)
G20	8.1	78	-61	-50	>3°C	>3°C	-60	-65
G7	12.8	25.6	-131	-120	>3°C		-136	-125
Umbrella Group	16.7	20	-142	-132	>3°C	>3°C	-147	-136
European Group	8.5	8.9	-111	-97	>3°C	>3°C	-115	-101
African Group	2.5	6.6	230	299	<1.5°C	<1.5°C	217	286
CVF	2.1	5.5	289	357	<1.5°C	<1.5°C	296	362
LDC	1.7	3.5	405	505	<1.5°C	<1.5°C	413	511
SIDS	4.6	0.6	22	42	<1.5°C	<1.5°C	26	45
World	6.5	100	-30	-14				

In addition to results for the parameterisation for observed emissions since 1990 (Table 1), Table 2 presents allocation results when accounting for historical emissions since 1950, when global emissions began a steep rise. The 1.5% annual discount rate of past emissions implies a discount of 65% of emissions in 1950 and 35% in 1990. The additional historical responsibility, even discounted, results in more stringent emissions levels in 2030 for high historical emitters: European group, Umbrella Group, G7 and G20, in aggregate. The important differences in per capita observed and historical responsibility across countries, combined with the absence of NDCs going beyond grandfathering, results in ambition assessments either 1.5°C aligned, or not even below 3°C. When accounting for historical emissions since 1950, SIDS countries have aggregated NDCs aligned with 1.5°C. While accounting for historical emissions since 1950 strongly impacts emissions allocations in 2030, it has a minor effect on the ambition assessment of NDCs showing the importance of differences in per capita emissions since 1990 already.

Data sources

The global emissions scenarios whose emissions are allocated to countries are the average of ensembles of scenarios of the categories C1 to C6 from the IPCC AR6 database[15] (accessible here). The GDP data (in purchasing power parity) is taken from the Social Socioeconomic Pathways[16] associated with the global emissions scenarios (available here), specifically assuming the SSP2 scenario, describing a middle of the road between adaptation and mitigation challenges. Historical emissions data is from the Potsdam Real-time Integrated Model for the probabilistic Assessment of emission Paths (PRIMAP)[17,18]. The population data is from the UN population prospects 2022 (available here). The HDI data (for 2020 only as projections are not available) is from the UN Development Programme (available here). The quantification of NDCs is taken from a recent publication[19], updated in October 2022.

Missing data: historical emissions data and NDC quantifications are missing for Bermuda and Cayman Islands. Additionally, GDP data is missing for Cayman Islands, Cook Islands and Niue. Cayman Islands and Niue represent 0.04% of SIDS emissions in 2019. GDP data is also missing for Liechtenstein that represents 0.004% of the 2019 emissions of the European group. This missing data is not expected to have a significant impact on the results.

Country groups memberships:

● **CVF/V20 (58 countries).** Afghanistan, Bangladesh, Barbados, Benin, Bhutan, Burkina Faso, Cambodia, Chad, Colombia, Comoros, Costa Rica, Côte d'Ivoire, Democratic Republique of Congo, Dominican Republic, Eswatini, Ethiopia, Fiji, Ghana, Grenada, Guatemala, Guinea, Guyana, Haiti, Honduras, Kenya, Kiribati, Kyrgyzstan, Lebanon, Liberia, Madagascar, Malawi, Maldives, Marshall Islands, Mongolia, Morocco, Nepal, Nicaragua, Niger, Palau, Palestinian Territory, Papua New Guinea, Philippines, Rwanda, Saint Lucia, Samoa, Senegal, South Sudan, Sri Lanka, Sudan, United Republic of Tanzania, The Gambia, Timor-Leste, Tunisia, Tuvalu, Uganda, Vanuatu, Vietnam, Yemen.

● **European group (this is not a formal negotiating group, it refers to a group of countries aggregated for the purpose of this paper):** all of the 27 European Union countries, Andorra, Iceland, Liechtenstein, Monaco, Norway, San Marino, Switzerland, the United Kingdom.

● **G20 (20 countries including the EU 27 members):** Argentina, Australia, Brazil, Canada, China, European Union (and all its members), Germany, India, Indonesia, Italy, Japan, Mexico, Russian Federation, Saudi Arabia, South Africa, South Korea, Turkiye, United Kingdom, United States of America.

● **G7:** Canada, European Union (all of its member states), France, Germany, Italy, Japan, United Kingdom, United States of America.

● **LDC Group (46 countries):** Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Yemen, Zambia.

● **SIDS (39 countries not including "Associate Members"):** Antigua and Barbuda, Guyana, Saint Lucia, Bahamas, Haiti, Saint Vincent and the Grenadines, Barbados, Jamaica, Samoa, Belize, Kiribati, Sao Tome and Principe, Cabo Verde, Maldives, Singapore, Comoros, Marshall Islands, Seychelles, Cook Islands, Mauritius, Solomon Islands, Cuba, Micronesia (Federated States of), Suriname, Dominica, Nauru, Timor-Leste, Dominican Republic, Niue, Tonga, Fiji, Palau, Trinidad and Tobago, Grenada, Papua New Guinea, Tuvalu, Guinea-Bissau, Saint Kitts and Nevis, Vanuatu.

- **African Group (54 countries):** Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Togo, Tunisia, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

- **Umbrella Group:** Australia, Canada, Iceland, Israel, Japan, New Zealand, Kazakhstan, Norway, Ukraine, United States.

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