

CLIMATE POLICY

Fairness considerations in global mitigation investments

Current mitigation finance flows are inadequate and unfair

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Despite overwhelming evidence that the world needs to make rapid and substantial investments in climate mitigation in this decade to meet the ambitious goals of the Paris Agreement (1–3), political and financial barriers continue to hinder mitigation efforts (2). Global mitigation investment pathways modeled in the sixth assessment report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) reach global climate goals in a cost-effective manner. These are agnostic about who should finance these and how to fairly allocate costs and benefits of mitigation efforts. We apply equity considerations to global cost-effective mitigation investment needs and derive “fair-share” regional contributions, which describe the direction and magnitude of interregional financial flows that align with each consideration. We find that flows from North America and Europe to other regions would have to increase substantially relative to present levels to meet the Paris Agreement goals under most equity considerations.

Progress on the alignment of financial flows with low greenhouse gas (GHG) emissions pathways remains slow (3). In 2019 and 2020, annual global climate finance flows were about USD (2015) 630 billion (with more than 90% for mitigation), but growth has slowed recently. The IPCC’s AR6 stresses that these flows must increase globally by a factor between three and six to meet average annual needs until 2030 to avoid the most dangerous impacts of climate change. Adequate capital and liquidity for this is globally available, as

is evident from the USD 2.4 trillion world energy investment in 2022 estimated by the International Energy Agency. The IPCC report also states that “accelerated financial international cooperation is a critical enabler of a low-greenhouse gas and just transition.” In particular, adequate international support for near-term investment is essential to ensure that national policies are put in place to attract the required finance in this decade.

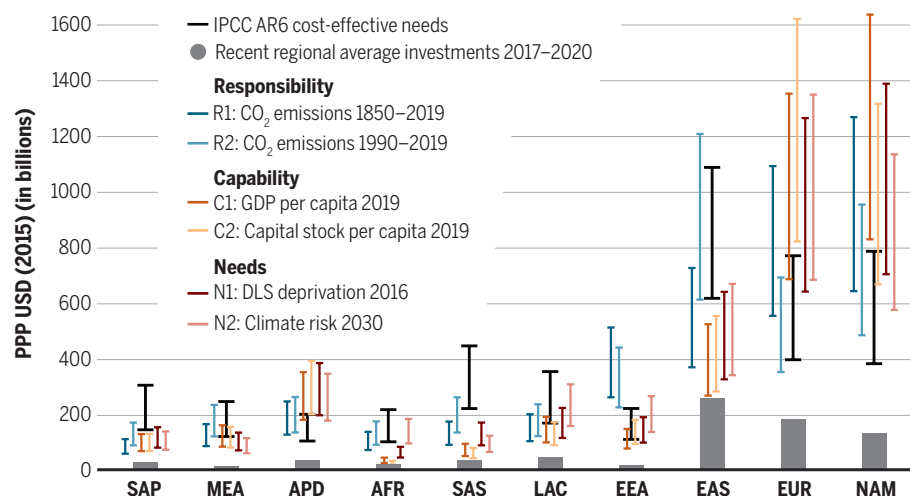
Global mitigation investment needs in the IPCC’s AR6 are based on pathways generated by integrated assessment models (IAMs). Several recent critiques of IAMs engage with the history, assumptions, limitations, and normative positioning of such exercises (4). Although several studies propose fair global carbon budget-sharing schemes, few focus on equity considerations in the financing of mitigation

investments, and these largely disregard near-term investment flows (5). We build on literature that argues that cost-effective mitigation investments require recognition of differentiated responsibilities, capabilities, and needs to yield an equitable outcome and be realized (6).

Consistent with suggestions in previous literature, we find that distributive justice considerations in global climate mitigation will require substantial interregional finance flows (7). Although mitigation activities involve costs that are distinct from investments, our work focuses specifically on modeled estimates of regional mitigation investment needs. This work provides a pathway to address the retrospective and prospective perspectives on climate equity in the literature: first, that wealthier high-emitting countries have historically benefited from fossil energy at the cost of poorer low-emitting countries (8), and second, that for cost-effective mitigation pathways to be fair, national and international redistributive measures are likely necessary (9). The magnitude and direction of interregional flows that we derive can also serve as input for policy and climate negotiations in the short term to ratchet up mitigation ambition, signal to the international private financial sector the magnitude of the required increase of interregional finance, and guide industrial pathways and value chain development toward a just and sustainable energy transition.

Regional needs and fair-share contributions

Annual regional cost-effective investment needs from 2020 to 2030 aligned with the well-below 2°C and 1.5°C compatible targets are shown (black, spanning the range from IPCC AR6). Recent regional average annual investments are shown for 2017 to 2020 (gray bars). Ranges of fair-share regional contributions to investment needs are shown using distinct considerations of equity (colors).

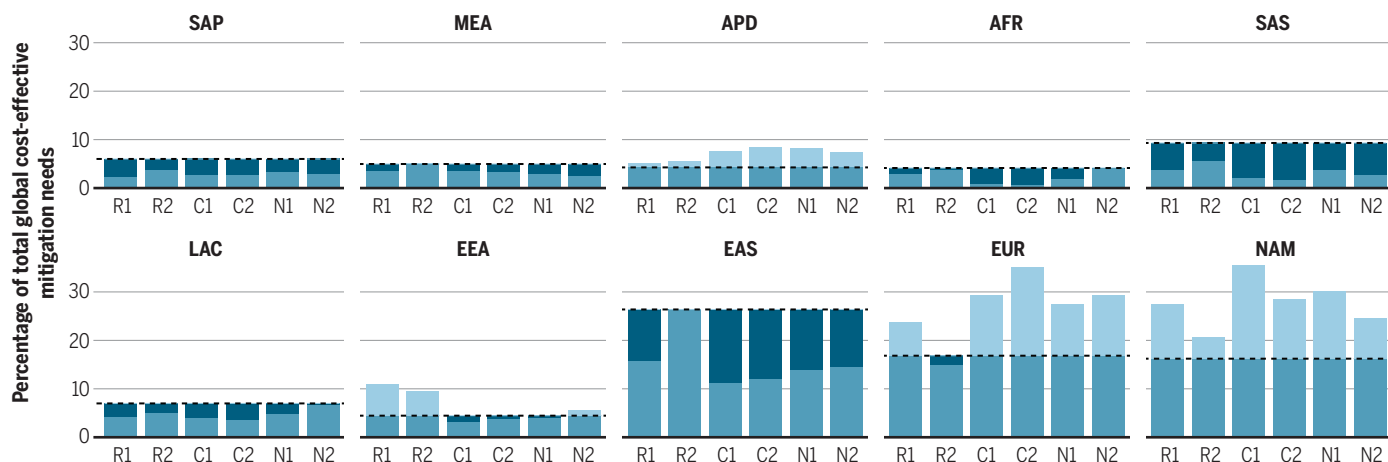


Regions are defined as follows: SAP, Southeast Asia and developing Pacific; MEA, Middle East; APD, Asia-Pacific developed; AFR, Africa; SAS, southern Asia; LAC, Latin America and Caribbean; EEA, Eastern Europe and west-central Asia; EAS, Eastern Asia; EUR, Europe; NAM, North America. DLS, decent living standards; GDP, gross domestic product; IPCC AR6, Intergovernmental Panel on Climate Change sixth assessment report; PPP, purchasing power parity

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Gaps between needs and fair-share contributions

Regional lower-bound cost-effective mitigation investment needs (dashed lines) and fair-share contributions under distinct considerations of equity (Rs, Cs, and Ns, where R is responsibility, C is capability, and N is needs) are shown as shares of total lower-bound global mitigation investment needs (see fig. S2 for upper-bound shares and fig. S3 for flows as share of regional gross domestic product). Some within-region needs can be met by fair-share contributions from countries in the region (●). Some regions' fair-share contributions exceed their needs and can help meet needs in other regions (●). Some regions' needs exceed their fair-share contributions, leaving gaps to be met by contributions from other regions (●).



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EQUITY CONSIDERATIONS AND INDICATORS

We begin with the range of cost-effective regional mitigation investment needs in the decade 2020–2030 to achieve targets compatible with well below 2°C and 1.5°C warming, as provided in the IPCC AR6 (3). Regions are made up of countries and territories collected into broad geographical groups following the IPCC country grouping (see table S1). Regional mitigation investment needs [defined in supplementary materials (SM) section 2 and table S2], include low-carbon energy resource extraction, conversion, power generation, transmission, and storage, as well as economy-wide energy efficiency improvements (3).

Our subsequent consideration of equity is consistent with principles emerging in the climate equity literature that correspond to considerations of responsibility, capability, and needs, which in turn underlie the notion of “Common but Differentiated Responsibility and Respective Capabilities (CBDR-RC) in light of national circumstances” enshrined in the Paris Agreement (6). We apply these equity considerations to allocate “fair-share” regional contributions to annual, cost-effective, global climate mitigation investment needs in the decade 2020–2030 in proportion to the indicators we select for each (see tables S4 and S5).

We draw on the literature in selecting established indicators for regional responsibility and capability and introduce two new indicators that describe regional needs, which have not previously been

operationalized in the IAM literature. We measure responsibility (R) as historical cumulative emissions shares. Given divergent views on when countries should be held accountable for their emissions, we implement two periods, one from 1850, accounting for postindustrial contributions, and the other since 1990, the year of the first IPCC assessment report. We consider only emissions of the dominant long-lived climate forcer, carbon dioxide (CO₂), from fossil fuel and industry, because other GHG emissions have not yet been thoroughly explored in the climate equity literature.

For capability (C), we use per capita gross domestic product (GDP) (C-1) and per capita capital stock (C-2), an alternative wealth indicator that reflects the extent of physical fixed assets and infrastructure in an economy. Under the consideration of needs (N), we use the average degree of deprivation across distinct dimensions of human well-being encompassed by the decent living standards (10) (N-1) and the modeled share of regional population facing multisector climate risk in the year 2030 (11) (N-2). We propose these needs indicators because they are not composites of the others used (such as per capita GDP) and capture both retrospective and prospective aspects of climate equity in terms of achieved human well-being and future vulnerability to climate effects. (See SM for a complete description of the methods used to transform each indicator into a corresponding regional fair-share contribution.)

GLOBAL SCALE FINANCE FLOWS

The IPCC AR6 reported large investment gaps between the recent average investment levels (2017–2020) and cost-effective investment needs over the decade 2020–2030. For most regions, it reported that recent investments were about three to four times lower in magnitude than the cost-effective needs (see the figure). However, in some regions, the gaps are much wider. We find that these gaps shift dramatically when principles of equity are considered to derive fair-share contributions, requiring large interregional financial flows (see the figure). Our estimated range of interregional flows to meet fair-share regional contributions is between purchasing power parity (PPP) USD (2015) 248 billion and PPP USD (2015) 1581 billion annually during 2020–2030 (see fig. S1).

The magnitude of interregional financial flows required is lowest (i.e., closest to cost-effective needs) when considering responsibility for historical cumulative CO₂ emissions since 1990 (R-2) and highest when considering the capabilities of regions (C-1 and C-2). With the exception of R-2, fair-share contributions under any equity consideration would be far higher than cost-effective needs in North America and Europe and lower in Africa, South and Southeast Asia, and Latin America. That is, regional cost-effective investment needs in low- and middle-income countries (LMICs) are higher than their fair-share contributions under most equity considerations (see the figure). Accounting for cumula-

tive CO₂ emissions since 1990 favors North America and Europe over other regions that experienced much of their industrial growth in recent decades. By contrast, we see that capability- and needs-based allocations (C- and N-) require substantial [PPP USD (2015) 657 billion to PPP USD (2015) 1.581 trillion] mitigation finance flows to regions dominated by LMICs to bridge the gap between regional cost-effective investment needs and fair-share contributions. As a practical matter, and given differing notions of fairness, policy-makers may want to combine and weight equity considerations to find consensus on representing fair efforts in international negotiations. The adoption of more ambitious pledges in LMICs may depend on such consensus to guide stronger commitments to international financial flows. To aid this, we have developed a tool that allows for selection and weighting of equity considerations and corresponding indicators (<https://data.ece.iiasa.ac.at/fairmitigation/>).

IMPLICATIONS OF FAIRNESS

Globally, climate mitigation investment gaps must be bridged to meet the agreed temperature goals of the Paris Agreement. How to finance global cost-effective climate mitigation investment needs across regions is still debated. We show that near-term interregional financial flows consistent with respecting equity principles enshrined in the Paris Agreement are substantial. Our proposal helps derive both the magnitude and directions of interregional flows that are necessary to incorporate selected considerations of equity, providing a way to integrate principles of equity into established approaches for developing global cost-effective mitigation scenarios. Importantly, our results indicate that interregional flows must be scaled up no matter which combination of our selected equity considerations and indicators we consider.

This work is consistent with other recent efforts to consider equity more explicitly in modeled mitigation pathways through alternative methods, such as applying specific social welfare functions, projecting degrowth in the Global North or more convergent growth futures, and explicitly accounting for regional populations in poverty to safeguard and exclude them from mitigation efforts in the near term. In reflecting on recent critiques of the AR6 IPCC mitigation pathways, we show here that cost-effective mitigation pathways are consistent with CBDR-RC as enshrined in the Paris Agreement when eq-

uity considerations guide the allocation of necessary financial flows. Future modeling efforts that explicitly represent the finance sector and specific economic instruments can also help derive fair interregional flows endogenously.

Our proposal and accompanying tool to derive fair-share near-term regional contributions to global mitigation investment needs does not yet address the much-

“...we find that distributive justice considerations in global climate mitigation will require substantial interregional finance flows.”

needed investments to meet both regional climate adaptation needs and loss and damages, which are a priority for most LMICs (12). Moreover, we recognize that the current target of USD 100 billion per year promised by developed nations for climate action in developing nations under the Paris Agreement has been problematic. Among the key complexities of this target is that it serves, at times, two distinct purposes: both to redistribute resources from developed to developing nations and to mobilize the scale of finance needed to achieve the Paris Agreement targets (13). It also does not clearly differentiate between adaptation and mitigation needs.

Although our work exploring the magnitude and direction of interregional financial flows that must be mobilized under different considerations of equity can inform negotiations, agreement around new targets for mitigation and adaptation cost support as well as international redistribution will clearly need to deal with these issues. What is clear from our results is that even when considering responsibility for historical cumulative CO₂ emissions since 1990 (R-2), which is an indicator most favorable to regions of the Global North, the magnitude of annual interregional flows just for mitigation action alone must increase substantially to PPP USD (2015) 250 billion to PPP USD (2015) 570 billion in the near term.

Several caveats apply to our proposal. There are other justice considerations and intraregional distributional concerns that we do not consider, such as claims for committed climate impacts or how local benefits and returns can be fairly distributed. Interregional financial flows, as implied by our paper, can be mobilized through a number of different instruments, and each may have its own implications in terms of political feasibility and economic effectiveness. This is particularly important because regional investment risk profiles differ, which

may also hinder financial flows. Finally, we do not address the wider issue of the distribution of macroeconomic costs and benefits resulting from the investments, which may change over time and require adaptive frameworks to motivate ambitious global mitigation strategies. A recent proposal toward fair-efforts metrics suggests one approach to account for true costs of mitigation technologies and nonmonetary benefits that may help advance this understanding (14).

Clear institutional and regulatory frameworks are needed to mobilize the magnitude of finance that is required to achieve globally agreed upon climate targets. Agreement on how to redirect international and domestic finance toward urgent near-term mitigation investments and climate adaptation efforts will be critical. Continued neglect of differentiated responsibilities, capabilities, and needs in the regional allocation of mitigation investment contributions risks lose-lose outcomes. Interregional cooperation will be necessary to move past this gridlock. Our work describes one pathway toward finding consensus by embedding distinct considerations of distributive justice in the derivation of “fair” regional contributions to globally cost-effective mitigation investment needs. This can inform estimates of the support required to bridge interregional financing gaps. Progress here will serve as a clear signal to governments, industry, and nongovernment actors and will be crucial for building the necessary momentum in regions where finance is scarce. ■

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SUPPLEMENTARY MATERIALS

science.org/doi/10.1126/science.adf0067

Published online 17 November 2022

10.1126/science.adf0067

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Science, 378 (6624), • DOI: 10.1126/science.adf0067

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