The Relationship between Climate Action and Poverty Reduction

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There is growing awareness that actions by policymakers and international organizations to reduce poverty, and those to mitigate and adapt to climate change, are inextricably linked and interwoven. This paper examines relevant academic and policy literature and evidence on this relationship and explores the potential for a new form of development that simultaneously mitigates climate change, manages its impacts, and improves the wellbeing of people in poverty. First, as a key foundation, it outlines the backdrop in basic moral philosophy, noting that climate action and poverty reduction can be motivated both by a core principle based on the right to development and by the conventional consequentialism that is standard in economics. Second, it reviews assessments of the current and potential future impacts of weakly managed climate change on the wellbeing of those in poverty, paying attention to unequal effects, including by gender. Third, it examines arguments and literature on the economic impacts of climate action and policies and how those affect the wellbeing of people in poverty, highlighting the importance of market failures, technological change, systemic dynamics of transition, and distributional effects of mitigation and adaptation. Finally, the paper surveys the current state of knowledge and understanding of how climate action and poverty reduction can be integrated in policy design, indicating where further research can contribute to a transition that succeeds in both objectives.

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Introduction

Climate change, poverty, and action to tackle each are closely interwoven. In this paper we argue that an effective response to these challenges requires the understanding and creation of a new form of development that simultaneously *mitigates* climate change, manages its *impacts*, and improves the *wellbeing of people in poverty*. Failure to tackle climate change will dramatically increase poverty across its many

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dimensions.[1] Well-designed measures to reduce emissions and adapt to climate change can drive a new form of sustainable, resilient, and inclusive development, especially in emerging markets and developing economies (EMDEs), which can offer avenues out of poverty for people both in the present and in the future.

This paper examines a range of relevant theoretical and empirical literature on the relationship between climate action and poverty reduction. While not an exhaustive survey, our examination indicates that the nature of the problems requires innovation beyond the standard models used for economic analysis, which poses a vitally important research agenda. It must address complex dynamics, distributional consequences, and systemic change. Yet the science is very clear about the necessary urgency of action. Therefore, the dilemma common to all policy making—that action and research are needed simultaneously—is particularly intense in this context.

Section 2 examines the ethical issues around linkages between climate change and poverty. It focuses on the standard utilitarian/welfarist approach in economics and on rights and justice. Both bring insights of importance, but both have intrinsic problems in any attempt to calibrate a values-driven "trade-off" between climate action and poverty reduction.

Section 3 examines the evidence on the impacts of climate change and demonstrates that delayed climate action will likely be profoundly damaging for efforts to reduce poverty in the future. Current impacts already indicate that poorer people suffer particularly severely from a changing climate. The distributional issues, including in relation to power and gender, are of real significance.

Section 4 appraises economic analyses of commonly articulated trade-offs between climate action and poverty reduction. It argues that trade-offs are not inevitable, by highlighting the deficiencies of much of the existing economics literature in recognizing the static and dynamic implications of a collection of key market failures. And it points to actions that can tackle any negative impacts on poor people. The systemic dynamics of the creation of a new approach to sustainable, resilient, and inclusive development will not be simple, but basic logic requires these transition dynamics to be center stage. We argue that such rapid systemic change cannot be shoe-horned into standard aggregate growth models which only recognize modest or marginal perturbations associated with climate impacts, and that attempts to do so have been misleading. However, economics does offer certain insights into these development challenges, and section 4 also examines a newer body of work reflecting the key vectors of systemic change and their distributional consequences (including geographical, intergenerational, and gender dimensions) relevant for the overall impact on poverty. In so doing, it highlights important areas for further research.

The science is clear on the necessary urgency of action, and the paper indicates some priorities for action and decisions now on climate and poverty which, we argue, are supported by current understanding. Section 5 emphasizes these priorities, but also indicates gaps that call for further work. Section 6 briefly summarizes.

Ethics, Values, Justice

Making policy in relation to climate and poverty reduction requires an understanding of what are just or moral actions and how to assess and weigh changes in current wellbeing, and in the wellbeing of people in the future. That requires consideration of ethical frameworks. This section first examines the dominant utilitarian or welfarist framework used in economic analysis,[2] including for analyses on climate, growth, and poverty, noting some key limitations of this approach. We also consider an important alternative view based on rights and justice, which has been prominent in discussions of climate policymaking. While not our main focus, we make references to other potentially relevant ethical approaches, although they have not featured as strongly in public discussion. Both the utilitarian/welfarist and rights/justice approaches encounter serious difficulties in assessing potential trade-offs between climate action and poverty reduction. That further underlines the importance of finding strategies that take account of both.

Utilitarian/Welfarist Approaches

Standard analyses of policies and choices in economics typically compare consequences on paths with and paths without some policy under consideration. This consequentialist approach usually takes the form of making value or welfare comparisons using social welfare functions (SWFs), sometimes in terms of sums of social utilities. Sen (1979) characterizes this approach as "welfarism," using "utilitarianism" in a narrower way as concerned with the sum of utilities (which, in some frameworks or with some authors, are seen as measurable). Utilitarianism and welfarism lie within the consequentialist approach. In the utilitarian/welfarist framework, risk is usually analyzed in terms of the mathematical expectations of the SWF. These standard approaches have characterized much of the economics of climate change. Having a single overall criterion can enable quantification of trade-offs between outcomes on different dimensions.

The standard approaches have, in large measure, served economics well in policy analysis, particularly where that analysis is of marginal change or small perturbations around some specified counterfactual. But they can run into difficulty and confusion as ethical frameworks when the potential consequences are extreme or, for many, potentially existential (Stern 2022; Stern et al. 2022a). For example, global warming of 3°C, 4°C, or 5°C could have potentially catastrophic outcomes involving mass destruction of lives and livelihoods, forced migration, and conflict. Indeed even warming of 2°C or 2.5°C could involve very heavy loss of life.[3] An expected utility framework is limited in how it can assess such outcomes in a way that is useful for decision-making. Placing an infinite value on loss-of-life leads to unbounded objective functions.[4] That would in general make it impossible to compare different

policies and thus the use of such objective functions would in many cases fail to give policy conclusions. However, specifying a finite valuation of a life, particularly where the potential scale of loss of life is so large, inevitably results in large sensitivity of "recommended" policies to that valuation under the standard approach; and relative valuations across different groups can themselves be extremely problematic.[5]

In theory and in policy regarding the changing climate, the possibility of catastrophic outcomes has motivated the idea of a "guard rail" which places some limits on the extent and severity of outcomes. While that approach could also be seen as consequentialist, the foundations of such an approach go beyond standard welfare economics, as discussed in Stern et al. (2022a). The guard rail approach has been adopted in public discussion of upper bounds for temperatures and is the science-based approach embodied in the United Nations Framework Convention on Climate Change (UNFCCC), the Paris Agreement of 2015 and the Glasgow Pact of 2021. Adopting guard rails imposes an absolute limit on welfare trade-offs.

Given the limitations of the standard approach, it is important to recognize the potential relevance of other ethical frameworks and values available for thinking about climate and poverty. Stern (2014a, 2014b, 2015) provides a closer examination and review of relevant literature on moral philosophy in relation to climate change (including contractarian, Aristotelian, and Kantian approaches); many non-Western philosophies also offer ethical frameworks with less individualistic foundations which can nevertheless motivate a concern for sustainable development and the protection of nature or natural capital (Schonfeld 2013; Spahn 2018). Here, we examine just one alternative approach, that of rights and justice, since it has been prominent in discussions of climate, inequality, and poverty.

Rights and Justice

Amongst ethical approaches to, and public discussion of, climate change, the idea of justice, or injustice, looms large. Sen (2009) provides an analytical framework for applying the concepts of common humanity and fundamental equality amongst human beings, which have a long heritage (e.g., Paine 1791; Wollstonecraft 1792). Sen argued that whilst "justice" is not always easily defined in ways that can guide thought and action, it *is* possible, in many circumstances, to define and identify "injustice." Injustice can be considered in terms of the denial of rights and entitlements. In the context of climate and poverty, the core relevant right is arguably the "right to development." Sen writes in terms of the right to pursue a life and outcomes that individuals "have reason to value" (2009, 231 and Chapter 11). The "right to development" has a long history in discussion of public action on development (e.g., UN General Assembly Resolution 41/128). In bringing attention to this approach, we must note that it may not be clear how to offer an ethical evaluation of damage to "rights" caused by public action.

For the analysis of poverty and climate change, the logic that begins with the "right to development" would first ask whether continued emissions of greenhouse gases (GHGs), are compatible with reduction in poverty, and second whether they are necessary for it. Since this perspective is grounded in rights held by all, a right to development held by some does not imply a right to harm others: indeed, as the then Prime Minister of Ethiopia, Meles Zenawi, argued on Africa Day at the UNFCCC COP17 in Durban, South Africa, "it is not justice to foul the planet because others have fouled it in the past" (2011).[6]

Importantly, GHG emissions create both *intra*generational and *inter*generational injustices. Climate change is causing especially deep damage now to the development prospects, or rights to development, in poorer countries and for poorer people as a consequence particularly of past actions and forms of growth in richer countries (Callahan and Mankin 2022) and the economic habits of the world's richest people (Kartha et al. 2020). Poor people suffer earliest and hardest despite having contributed least to causing the problem. It also damages the development prospects of those living in the future. These injustices relate not only to poverty, but also to characteristics that confer social power, including ethnicity and gender. Those in less powerful positions can be less able to defend against and adapt to the impacts and are often last to escape locations devastated by extreme weather events.

However, *action* on climate change may also be seen as having potentially unjust consequences if it results in some people's wellbeing being impaired by price or cost changes or by the dislocation caused—for example through job losses or limited energy access caused by the phase out of coal or oil sectors (McCauley and Heffron 2018). The policy challenge could then be to design protection for poorer groups against changing prices or to find ways to manage dislocation through the provision of new opportunities or support (Green and Gambhir 2020).

These two approaches to the problem—standard welfare and justice—frame the remaining sections of this paper. But they do have their limitations as each is problematic in this context in terms of providing a calibration for an ethical trade-off between climate action and poverty reduction. As in much of economic policy, it is important to take account of a range of ethical perspectives.

The Impacts of Climate Change on Poverty

The impacts of climate change are critical to understanding both the effect of climate action or inaction on poverty and how to adapt to those impacts that are already "locked in." Section 3.1 reviews the literature on past and current impacts as indicators for the future. However, historical experience carries only limited information and guidance on the challenges ahead, because the climate is already outside the limits of human experience and likely headed far outside that experience. Further, past trends do not capture the risks of non-linear changes and of crossing dangerous

tipping points, such as the melting of the West Antarctic ice sheet or the collapse of the Amazon ecosystem, which could push the Earth system into a completely different state. In section 3.2 we examine potential consequences of future impacts. One of the important rationales for early action on climate is the uncertainty around future impacts, which could be large, unstable, and irreversible, and around potential feedback loops that could accelerate climate change.

Current Impacts

Climate change amplifies the extreme events and major shocks that force people into poverty and keep them there. Because poor people are often more exposed, more vulnerable and lack the resources to cope and recover from these shocks ("adaptive capacity"), they suffer most from climate change (Birkmann et al. 2022). Likewise, evidence suggests that impacts are greatest for women and girls, as well as the youngest and oldest in the population. Several main channels through which climate change already affects poverty are explored below. These include impacts both from extreme events and "slow-onset" phenomena.

Costs of Physical Damage

Climate change is increasing the frequency and intensity of natural hazards in many parts of the world, and while most (88 percent) of economic losses due to weather, climate and water extremes from 1970 to 2020 have occurred in upper-middle and high-income countries due to their larger assets, low- and lower-middle income countries suffered a disproportionate 82 percent of all fatalities during the same period (WMO 2021). Hallegatte et al. (2017) conclude that natural disasters are already pushing upwards of 26 million people temporarily or permanently under the international extreme poverty line every year; this does not, of course, include the impact on those who are already below or who remain just above the poverty line.

Socioeconomic disparities shape both the severity of shocks on the affected population and the duration of the recovery (World Bank 2021). Poorer households do not have the same adaptive capacity as richer households (such as financial savings or insurance), so take longer to recover from a disaster and thereby face greater long-term impacts on their economic and physical wellbeing. Hallegatte and Rozenberg (2017) find that the poorest 40 percent of the population experience income losses from climate change that are 70 percent larger, relative to their wealth, than those of the average population. And within developed countries, poor people stand to lose more than wealthier people from natural disasters (Bleemer and van der Klaauw 2017).

Impacts Via Disruption to Agriculture

By disrupting agricultural production, climate volatility and extreme weather events are a significant threat both to rural communities, who depend on the agricultural

sector to survive and as a means through which to escape poverty, and to poor people in urban areas, due to cascading impacts on food prices (FAO et al. 2018). Climate change makes it more expensive and difficult for farmers to sustain livestock and crops as it exacerbates water scarcity, land degradation, and difficulties with weather and precipitation patterns. Human-induced land and water degradation combined with worsening climate impacts have already pushed many regional agricultural systems to breaking point (FAO 2021), slowing agricultural productivity growth around the world (Ortiz-Bobea et al. 2021; Trisos et al. 2022). The resulting crop and livestock losses not only affect agricultural incomes, but also cause high and volatile food prices, one of the most important channels (together with effects on health) of the impact of climate change on poverty (Jafino et al. 2020). Because people in poverty tend to spend more of their income on food, even a small increase in food prices can have large impacts on them (Hallegatte et al. 2017).

The disruption to agricultural systems from both extreme events and slow-onset phenomena also encourages migration (Falco et al. 2019) and exacerbates the risk of conflict (Wischnath and Buhaug 2014; Koren et al. 2021), both of which are driving forces of poverty. The intensification of drought by climate change increased armed conflict in West Asia and North Africa in the period 2011–2015, which in turn drove an outflow of asylum-seekers (Abel et al. 2019). In the Syrian Arab Republic, climate change exacerbated the 2007–2010 drought amidst growing water scarcity and poor water management, leading to widespread crop failures and mass migration from rural to urban areas, which contributed to the causes of civil war (Kelley et al. 2015). Even though the impacts of climate change on migration and conflict cannot be estimated without important uncertainties, they may come to dominate everything else, especially in regions already facing political turmoil and persistent violent conflicts, like the Sahel.

Impacts on Health

Climate change amplifies major health outcomes—including death from natural disasters, mental health issues, heat-related illnesses (such as cardiovascular, cerebrovascular, and respiratory conditions) and vector-borne diseases such as malaria—and puts pressure on healthcare systems and facilities (Watts et al. 2018; Romanello et al. 2021), with disadvantaged and vulnerable populations being the most severely affected.

Extreme heat and cold events led to around 1.7 million deaths globally in 2019, with the majority of heat-related deaths concentrated in South Asia, Africa, and the Middle East (Burkart et al. 2021). Changing environmental conditions are increasing the transmission risk of climate-sensitive infectious diseases (Romanello et al. 2021) and are aggravating over half of known pathogenic diseases that affect humans (Mora et al. 2022). Impaired crop yield and water scarcity resulting from

climate shifts also worsen malnutrition, with severe implications for health and child development (Alderman et al. 2006).

Health shocks are a well-documented driver of poverty (e.g., Moser 2008), because of the income loss from an inability to work and the costs of medical care for which poorer households are often uninsured. These shocks push an estimated 100 million people into poverty every year, with the impacts of climate change contributing to this trend (Hallegatte et al. 2015). Agricultural workers in EMDEs are among the most vulnerable: in 2020 they suffered almost half of the 295 billion potential work hours lost due to extreme heat (Romanello et al. 2021).

Furthermore, fossil fuel combustion adversely affects health by worsening air quality—again, disproportionately harming poor people. While estimates vary, a recent study of outdoor air pollution from fossil fuels suggest it contributed to around 9 million premature deaths in 2018, in the context of total global deaths of around 57 million a year (Vohra et al. 2021).[7] People in EMDEs tend to be more exposed to toxic air than those in advanced economies. Household air pollution due to poor ventilation and the use of polluting fuels for cooking and heating contributed to an estimated 2.3 million deaths in 2019 (about 4 percent of all global deaths), almost all in Sub-Saharan Africa, South and East Asia, and Oceania (Health Effects Institute 2020). Women are 40 percent more exposed than men to this type of pollution (Romanello et al. 2021).

Disproportionate Impacts on Women and Girls

Insufficient attention has been given to how climate change worsens the cycle of poverty for women and girls. A growing body of research shows that women and girls are more vulnerable than men to climate change impacts and are less able to cope and recover. Indeed, existing gender inequalities and unequal power dynamics amplify their vulnerability and limit their adaptation to climate-related impacts (Schipper et al. 2022). The bottom line is that natural disasters disproportionally affect women's life expectancy, unemployment, labor force re-entry, and relative losses of assets (Erman et al. 2021).[8]

An important reason for this effect is that unequal control over and access to resources—including land, water, food, credit, and technology—hampers women's ability to efficiently cope with and adapt to climate impacts (Eastin 2018). Although women represent 43 percent of the agricultural workforce, with significantly higher rates in agriculture-dependent countries in Asia and Africa, only 15 percent are agricultural landholders (OECD 2019). As such, they have limited access to credit for climate change adaptation practices, for example, to invest in climate-smart technologies to increase harvests, increase resilience, or invest in off-farm activities (Atela et al. 2018).[9]

Furthermore, climate change disproportionately affects women's health and well-being. In rural areas, where women are often the primary providers of food, water

and fuel, resource scarcity can force them to travel long distances, often through unsafe areas, reducing the time available to generate income and disrupting girls' education (see, for example, Yadav and Lal 2018).[10] More generally, competition over scarce resources can exacerbate gender-based violence as a means of control and reinforcement of unequal power dynamics. The devastating impacts of climate-induced disasters on communities (resource stress, loss of property and livelihoods, financial pressures, and post-traumatic stress disorder) have been shown to increase the incidence of domestic violence, child marriage, and sexual exploitation (Castañeda et al. 2020; Allen et al. 2021; van Daalen et al. 2022).

Future Impacts

The Earth has already warmed by around 1.2°C compared with the 1850–1900 average. If today's development patterns do not change, and without deep emissions reductions, global warming will far exceed the temperature goals of the 2015 Paris Agreement set at COP21: containing temperature rise to "well below 2°C," while pursuing efforts for an upper limit of 1.5°C (IPCC 2023). Many estimates place the median warming by 2100 between 2.5°C and 3°C under governments' current policies.

Every extra increment of warming will have increasingly devastating impacts on lives and livelihoods across the world, but poor and marginalized communities will suffer the most. Jafino et al. (2020) estimate that depending on the level of temperature increase, between 32 million and 132 million more people could be pushed into poverty as a result of climate change in 2030,[11] compared to a world with a stable climate. The impacts of climate change on poverty are extremely sensitive to different levels of warming (Byers et al. 2018). The number of people exposed to multiple climate risks could double between 1.5°C and 2°C of warming,[12] and almost double again at 3°C of warming, to half the global population, with 91–98 percent of the exposed and vulnerable population living in Asia and Africa (ibid).

Impacts on Livelihoods

Increases in global temperatures will both intensify and increase the frequency of many climate-related extreme events, as well as accelerate slow-onset impacts including sea level rise and desertification, thereby amplifying impacts on food and water systems. Poor populations are particularly vulnerable to slow-onset events due to their limited capacity to anticipate and adapt to these phenomena, for example, by migrating to safer areas (Benveniste et al. 2022). Agricultural and ecological droughts in drying regions that occurred once every 10 years on average in past centuries before industrialization,[13] as well as extreme temperature events that occurred once every 50 years, would occur more frequently with every increment of warming (IPCC 2021). Climate events such as droughts and extreme heat could also

coincide more often in the future, with more severe impacts in poor and rural areas (Yin et al. 2023), and exacerbate the damaging impacts on global crop yields (Lesk et al. 2021). As a result, the number of people exposed to lower crop yields would be 10 times higher under 2°C warming compared with 1.5°C, most of them living in South Asia and Sub-Saharan Africa; some 600 million people would be exposed to water stress (Roy et al. 2018). Marine fisheries would decline by more than 3 million metric tons per degree of warming (Cheung et al. 2016).

Impacts on Health

The impacts identified in section 3.1 are expected to accelerate with additional warming. The proportion of the global population exposed to severe heat at least once every five years is likely to increase from 14 percent at 1.5°C of warming to 37 percent at 2°C of warming (Dosio et al. 2018). For instance, at 2°C, Pakistan and India would likely experience similar conditions to their deadly 2015 heatwaves on an annual basis (Matthews et al. 2017).[14] Greater warming will extend the transmission seasons and geographical range of climate-sensitive food-borne, water-borne, and vector-borne diseases. For instance, dengue risk would increase in Asia, Europe, Central and South America, and Sub-Saharan Africa, potentially putting additional billions of people at risk by the end of the century (IPCC 2022a). At 2°C or higher levels of warming, the IPCC warns that "food security risks due to climate change would be more severe, leading to malnutrition and micro-nutrient deficiencies, concentrated in Sub-Saharan Africa, South Asia, Central and South America, and Small Islands" (ibid.). Morbidity (incidence or prevalence of a disease) would also increase, with consequences for poverty.

Projected Impacts, Thresholds, Tipping Points, and Irreversibility

A range of expected climate impacts under different temperature scenarios are summarized in Table 1. In all of them, poor people are shown to be the most vulnerable.

Although projections involve margins of uncertainty, especially many decades out, the scientific evidence makes clear that unmanaged climate change would render many regions uninhabitable and would radically change lives across the world for the worse, especially those of poor people. Some of the future impacts of climate change, such as sea level rise and more severe heatwaves, are already "locked in" and therefore unavoidable, even if GHG emissions are cut rapidly. The IPCC (2022a) stresses that "many ecosystems are near the hard limits of their natural adaptation capacity." That is, ecosystems are approaching the thresholds beyond which they cannot successfully adapt to avoid severe risks. Once these hard limits are reached, no additional adaptation actions can prevent irreversible loss and damage. People in

Table 1. Impacts under Different Levels of Warming

Impacts	1.5°C	2°C	4°C	Sources
Food systems	10-year agricultural and ecological droughts in drying regions will likely occur every 5 years (range 2–10)	10-year agricultural and ecological droughts in drying regions will likely occur every 4 years (range 1.7–7.7)	10-year agricultural and ecological droughts in drying regions will likely occur every 2.4 years (range 1.4–5.9)	IPCC (2021)
	32–36 million people exposed to lower yields	330–396 million people exposed to lower yields	Information unavailable	Roy et al. (2018)
Ecosystems	70–90% of coral reefs at risk from bleaching	99% of coral reefs at risk from bleaching	Information unavailable	Roy et al. (2018)
	49% (±9%) of glaciers will likely disappear	Information unavailable	89% (±7%) of glaciers will likely disappear	Rounce et al. (2023)
Water scarcity	496 (range 103–1,159) million people exposed and vulnerable to water stress	586 (range 115–1,347) million people exposed and vulnerable to water stress	Information unavailable	Roy et al. (2018)
Health	14% of global population exposed to severe heat at least once every 5 years	37% of global population exposed to severe heat at least once every 5 years	Information unavailable	Dosio et al. (2018)

Source: Authors' analysis based on review of selected literature.
Note: Included impacts are not exhaustive.

poverty will be especially affected given that they generally depend on ecosystems for their livelihood (Robinson 2016) and for protection against climate impacts.

Beyond 1.5°C of warming, multiple climate tipping points could be triggered (McKay et al. 2022). Every increment of warming increases the risk of passing major thresholds, which could generate dangerous feedback loops. Examples include the collapse of the Amazon and boreal rainforests, thawing of permafrost, destabilization of polar ice sheets, and large-scale die-offs of coral reefs.

Implications for Society and Humanity

Based on past experience, as the frequency and intensity of shocks increase, greater warming could trigger mutually reinforcing economic, social, and political instability, leading to cascading disruptions including impoverishment, food insecurity, migration and displacement, and civil and political conflict (see, for example, Kemp et al. 2022). For instance, as temperatures rise, the existing trends of rural–rural and rural–urban migration might accelerate suddenly and significantly, involving tens to hundreds of millions of people with climate-sensitive livelihoods in Africa, Asia, and Latin America. This could lead to large-scale ethnic or civic strife, as is already being witnessed, for example, between pastoralist and agricultural communities in Nigeria and the Sahel, and would put extreme pressure on urban areas, triggering conflicts (Birkmann et al. 2022). The increasing frequency and intensity of extreme precipitations associated with flooding, tropical cyclones, droughts, and sea level rise would also drive displacement (IPCC 2022a). Under a high emissions scenario leading to global temperatures increasing above 3°C by the end of the century, rising sea levels threaten land that is home to between 2.5 and 9 percent of the global population with annual coastal flooding by the year 2100 (Kulp and Strauss 2019; Kirezci et al. 2020; Rohmer et al. 2021). This would trigger large-scale humanitarian crises and is likely to be highly destabilizing for societies, in a way that most exposes people in poverty.

In summary, poorer people are affected more severely by the impacts of climate change. Already, the effects of climate change are materializing earlier than expected and at a greater scale and intensity than anticipated, most severely affecting EMDEs and poor communities.

The Impact of Climate Action on Poverty

In this section we examine how action on climate change might itself affect poverty, particularly in the shorter term. Broadly speaking, there are four interwoven arguments or mechanisms which could lead to climate action increasing poverty. Each has substance and raises important questions, yet in each case well-designed policy can combine effective climate action with poverty reduction. Without such policies, the effects could go the other way.

The first argument suggests that in an efficient world, introducing an additional criterion—here, the future state of the climate—must involve reduction on some other dimension. However, this position is not a sound basis for analyzing a world that has many important inefficiencies. Well-designed climate action can and should overcome market failures and crucial inefficiencies. Second, there is an argument that development needs energy and that energy needs fossil fuels and thus that development must involve increased GHG emissions. However, such historically observed relationships are not necessarily stable and it is clear that alternative pathways are possible in the future: for instance, low-carbon sources of energy are now cheaper than fossil fuels in many sectors and geographies. These two arguments are examined in section 4.1.

A third argument is that using resources for climate action will reduce those going to growth, and further that growth reduces poverty and increases resilience. However, well-designed climate action can also drive growth, as section 4.2 highlights. That section also reviews analysis and modelling of output, jobs, and resilience gains from climate action and discusses the challenges and limitations of some widely used models.

Fourth, climate action can involve a whole range of policies around pricing, technologies, and phasing out of fossil fuel extraction, which could, in principle, increase costs and reduce opportunities for poor people. Again, that directly raises the question of how policies can be designed to overcome such effects. These effects and associated policies are the subject of 4.3.

Absence of an Inevitable Trade-off Between Climate Action and Poverty Reduction

Inefficiency and Market Failure

The argument that pursuing sustainability may be at odds with improved wellbeing for those in poverty has precedent in the economics profession (Solow 1991; Beckerman 1992). There is an argument that if the existing equilibrium is efficient, relative to an existing set of criteria, then progress against a new criterion can be achieved only at some cost to other objectives. However, the world is characterized by multiple market failures and inefficiencies of direct and major relevance to the implications of climate action for poverty. Beyond the externality of GHG emissions, these include underinvestment in knowledge (including research and development (R&D)) as a public good, imperfect information, problems in coordinating networks, failures in capital markets, and failure of markets to value other benefits (such as nature or health) (Stern and Stiglitz 2023).

Despite the negative consequences of rising temperatures for multiple dimensions of poverty identified in section 3, a range of studies have questioned whether action to meet climate goals (usually focused on mitigation) is desirable from the perspective of the poorest individuals and households. For example, several studies using

Integrated Assessment Models (IAMs) suggest that the benefits of climate mitigation for poorer regions or countries are smaller than the economic costs, with net negative impacts on people's wellbeing (Akimoto et al. 2012; Hussein et al. 2013; Hasegawa et al. 2018; Campagnolo and Davide 2019; Fujimori et al. 2019). Climate policy measures affect the costs of production factors (particularly land and energy), feed back into higher prices, and reduce the relative income and consumption of poor households. However, it is important to note that studies relying on average national or regional household incomes (e.g., Hasegawa et al. 2018; Fujimori et al. 2020; Lomborg 2020) can overlook differentiated impacts between households of different income level *within* these broader geographic zones (Dennig et al. 2015). And, as we argue, these models have narrow and misleading assumptions in relation to climate impacts, growth, and market failures.

The suitability of IAMs to analyze the relationship between climate action and poverty is compromised because they typically omit crucial market failures from their description of the underlying economy (Stern et al. 2022a). Grant et al. (2020) highlight that baseline scenarios describing an efficient world with a total absence of climate mitigation are far removed from actual policy and do not address *which* climate policies and strategies would perform best under more realistic conditions of uncertainty, inefficiency, and structural change. Climate policy is frequently modelled as the global application of a carbon price (Hussein et al. 2013; Davies et al. 2014; Franks et al. 2018; Hasegawa et al. 2018; Campagnolo and Davide 2019; Dorband et al. 2019; Fujimori et al. 2019, 2020; Budolfson et al. 2021; Soergel et al. 2021). In a world without further market failures, fully pricing in the externality of GHG emissions would result in cost-efficient mitigation pathways. By contrast, comprehensive climate action that addresses the range of relevant market failures entails a suite of interventions across many additional policy spheres, including long-term public spending commitments; investment in natural capital, R&D and infrastructure; and education and training (IPCC 2023).

Evidence from the empirical literature reflects many available opportunities for resolving market failures across economic sectors. For example, evidence from Mexico, Indonesia, and Oman (Amann et al. 2021; Calì et al. 2022) shows that investment in R&D and the deployment of renewable energy can lead to productivity improvements in industry, contrary to some modelling approaches, which assume that increasing these flows will have an opportunity cost for other sectors (Campagnolo and Davide 2019). Resource-efficient design for buildings in cities and improving mass public transportation to tackle urban congestion can reduce costs to households and positively affect health by reducing pollution (Johansson et al. 2012; Kwan and Hashim 2016; Lovins 2018). R&D in food systems is currently underfunded in EMDEs (Nin-Pratt 2021), even though increased investments in R&D could have joint benefits for climate mitigation, adaptation, and poverty reduction (e.g., Boeckx et al. 2020;

Tesfaye et al. 2021) and could reduce hunger by 20–40 percent in these countries (IFPRI 2022).

Development, Energy, Income, and Emissions

The second argument that climate action necessarily implies a trade-off with poverty reduction is based on an understanding of development, energy, and emissions focused on historical relationships. For instance, several econometric studies show that GHG emissions and income are correlated at country level in international panel data (e.g., Masron and Subramaniam 2019; Koçak and Çelik 2022). Steckel et al. (2013) argue that lower levels of energy use under climate mitigation scenarios are below threshold levels of per-capita energy consumption identified in historical data, so that these scenarios are inconsistent with economic development. The assumptions behind these approaches are that reducing poverty requires growth and energy use, and that energy use entails emissions. Yet, as section 4.2 elaborates further, the expectation that fossil sources will continue to provide energy at lower cost than low-carbon alternatives (e.g., Jakob and Steckel 2014; Collins and Zheng 2015) is already starkly at odds with reality (IRENA 2022a).

An alternative lens on the problem is to consider the consequences for global emissions and climate goals of increasing the income of the poorest people under different assumptions. Wollburg et al. (2023) estimate the annual difference in emissions associated with growth rates high enough to raise income per capita above poverty lines in all relevant countries. They find that incremental emissions in 2050 associated with ending extreme poverty would represent 4.9 percent of 2019 global emissions (15.3 percent for surpassing the $3.65 per day lower-middle-income poverty line or 45.7 percent with the $6.85 upper-middle-income poverty line). Annual emission reductions needed to meet net zero emissions in 2050 rise by approximately four percent compared to a scenario with no poverty reduction (i.e., no growth in countries where extreme poverty is concentrated). Therefore, these authors argue that the need to eradicate extreme poverty cannot be used to justify limiting climate ambitions. Importantly, for comparing potential development pathways, the central poverty-reduction scenario assumes that countries' growth elasticity of poverty, energy-intensity, and carbon intensity match their historical averages. If instead all countries match the best historical performance—representing lower inequality, energy efficiency, and decarbonization, respectively—the emissions increase in 2050 becomes only 0.54 percent. Recognizing the rapidity of technical change for clean activities, often underestimated, would lead to still stronger conclusions. These findings corroborate those of Hubacek et al. (2017) and Bruckner et al. (2022), who conclude that climate mitigation is not in conflict with eradicating extreme poverty (albeit using a different method which raises the income and energy consumption of only the poorest households, rather than using growth

across the board to achieve the same effect). All three papers suggest that the greater challenge lies in decarbonizing while sustaining middle-income levels.

Perspectives that center on market failures and inefficiencies suggest that historical data make it appear more costly and polluting to improve living standards than is necessary. In this vein, Malerba (2020) finds that the "carbon intensity of poverty reduction" (CIPR) is non-linear with income, declining at low and increasing at higher incomes, and decreases if socioeconomic inequality is reduced. Improving the quality of national political and economic institutions, by strengthening the legal system, reducing corruption, and increasing bureaucratic capacity, nullifies the trade-off between growth and lower emissions in panel data (Kornek et al. 2017; Rizk and Slimane 2018; Koçak et al. 2019)—in other words, the same factors contribute to persistent poverty, low wellbeing, and high emissions. Energy efficiency and leapfrogging energy-intensive processes could also reduce inefficiencies and bring the per capita energy consumption required for economic development below the historical averages that Steckel et al. (2013) view as constraints on future pathways (Lovins 2018, 2020).

Some authors reach a similar conclusion—that alternative development pathways are possible and even desirable—focusing on the multidimensional nature of poverty, which studies on income and energy do not fully capture (Rao et al. 2017; Wollburg et al. 2023). Rao et al. (2014) investigate the relationship between national emissions and the population share meeting a minimum standard of living with respect to five material dimensions of basic needs: nourishment, water, sanitation, electricity, and non-slum urban housing. They find that countries with the highest share of people whose needs are met have a lower income and lower sectoral carbon emissions per capita on average than those in the middle group. However, emissions for the highest group span a wide range, implying "a diversity of emissions paths that countries have followed."

Market failures cannot be removed entirely but the above examples illustrate that commitment to action on climate can make decision-makers more willing to tackle those failures. That greater willingness would in general imply a move towards policies and actions that could reduce inefficiencies and obstacles to innovation and investment, and thus an improvement in economic performance and overall welfare.

Potential of Climate Action to Drive Growth and Development

Related to the two arguments considered in section 4.1, a third questions whether money spent on climate action now has an opportunity cost by not prioritizing increases in wellbeing for poor people. For instance, Dercon (2014a) argues that poor countries could use any window of opportunity before the most devastating impacts of climate change to boost growth and that this would, in any case, reduce the costs

of those impacts, since rapid socioeconomic development is one of the best ways of reducing the impacts of climate change on wellbeing (Hallegate and Rozenberg 2017).

On the other hand, Stern and Stiglitz (2023) identify several drivers of growth implied by climate action. These include resource efficiency; increasing returns to scale in key new technologies; stronger productivity of systems such as energy, transport, cities; rapid innovation from shared social priorities with direction and urgency; higher investment; reinforcing effects of international coordination; improved health (labor productivity and lower costs of care); and behavior change. Thus, climate action can drive growth.

This section describes aggregate models which estimate employment and output gains from investing in mitigation, adaptation, and biodiversity and nature-based solutions, and comments on the emerging literature on economic gains from adaptation. Both low-carbon and adaptation investments can be sources of greater wellbeing for poor people, by raising incomes and providing stable employment, building resilience to shocks, and through other co-benefits (such as improved health by reducing urban and industrial pollution). Finally, we also note the potential of technological change to drive even more rapid and dramatic changes in economic structures, which could only be captured in models and analytic approaches which incorporate endogenous growth.

Employment and Output Gains[15]

Several aggregate models estimate that a comprehensive policy package to tackle climate change could boost output and generate new job opportunities at the global level (OECD 2017; NCE 2018; IMF 2020). Other studies focusing on emerging markets or on specific countries reach similar conclusions (IFC 2021; World Bank 2022a). There is also some evidence to suggest that climate-friendly investments create more jobs per $1 million of investment than unsustainable investments (Jaeger et al. 2021). Many of these job opportunities can benefit poor people, provided they have the sufficient skills and human capital (which is explored further in section 4.3.3). Table 2 presents the findings on aggregate gains across several prominent studies.

However, the effects of climate action on employment and output vary across sectors, geographies, and over time. Several studies confirm that the low-carbon transition can contribute to a net increase of employment in the energy sector (Garcia-Casals et al. 2019; Malerba and Wiebe 2021; Pai et al. 2021; IRENA 2022b), but evidence of the labor impacts in other sectors is more limited (O'Callaghan et al. 2022). There are differences across regions and countries (Saget et al. 2020; IRENA and AfDB 2022); the ILO (2018) suggests that in the short to medium term, Africa and the Middle East may see net job losses, while the Americas, Asia, and Europe would see net job creation. The magnitude of impacts also depends on the stringency of mitigation. Malik et al. (2021) show that while in the near-term energy employment increases under a 1.5°C scenario, it decreases in the long run due to im-

Table 2. Some Estimates of the Output and Employment Benefits of Climate Action

Study	Countries	Sectoral coverage	Time period	Macroeconomic impacts	
				Jobs gains	Output gains
IFC (2021)	21 emerging markets	10 investment areas	2020–2030	**New (direct) jobs:** +213.4 million	*Information unavailable*
NCE (2018)	Global	All	2018–2030	**New jobs: +**65 million **Net effect**: +27 million	+1.7% ($26 trillion) by 2030
OECD (2017)	G20	All	2050	*Information unavailable*	**Without climate damages**: +2.8% **With climate damages**: +4.7%
IMF (2020)	Global	All	2021–2030	**New jobs**: +12 million p.a. for 2021/27	+0.7% p.a. on average until 2035
Pai et al. (2021)	Global	Energy	2020–2050	**Net effect from current level**: +8 million **Net effect from current policy scenario**: +5 million	*Information unavailable*
Garcia-Casals et al. (2019)	Global	Energy	2018–2050	**Net effect**: +0.14%	+1.5% in 2031 +1% in 2050

Table 2. Continued

Study	Countries	Sectoral coverage	Time period	Macroeconomic impacts	
				Jobs gains	Output gains
IRENA and AfDB (2022)	Africa	Energy	2021–2050	**Net effect: +**3.5%	+6.4%
IRENA (2021)	Global	Energy	2050	**Net effect from current policy scenario:** +0.55% (20.2 million jobs)	**Without climate damages:** +0.3% **With climate damages**: +3.9%
IRENA (2022b)	Global	Energy	2022–2030	**Net effect from current policy scenario: +**1.2–1.6% (43–57 million jobs)	+2.2–2.3% on average
Saget et al. (2020)	Latin America and the Caribbean	All	2020–2030	**New jobs:** +22.5 million **Net effect: +**15 million (+4%)	*Information unavailable*
Malerba and Wiebe (2021)	Global	Energy	2030	**Net effect:** +0.3%	*Information unavailable*
Malik et al. (2021)	Global	Energy	2025 & 2050	**Net effect (2020):** +838,500 **Net effect (2050):** -2.2 million	*Information unavailable*

Source: Authors' analysis based on review of selected literature.
Note: Included impacts are not exhaustive.

provements in labor productivity, although total jobs are still higher in this scenario than in a weak emissions reduction scenario. Whether the distribution of employment, income, and wellbeing will benefit the poorest depends on model structures, analytical approaches and, importantly, assumed social and political context.

Adaptation Gains

The impacts of climate change set out in section 3 could be, and have been, devastating for people in poverty. Integrating adaptation and resilience interventions to development strategies can help reduce some of these impacts (Castells-Quintana et al. 2016). Further, many of the required investments promote resilience while reducing emissions and fostering development. For example, there is increasing evidence that "nature-based solutions" to adaptation play an important role in improving the ability of people to sustain their livelihoods (Griscom et al. 2017; Mwangi and Evans 2018; Chausson et al. 2020; Seddon et al. 2020). Preserved and restored wetlands and forests not only act as carbon sinks but also reduce disruption to economic activity by absorbing storm surges, improving water systems, and reducing risk from floods and droughts, and they support local economies through improved soil quality, pollination, and habitat protection (Kapos et al. 2019; Powell et al. 2019; Tye et al. 2022).

The economic returns from adaptation efforts are potentially significant: the Global Commission on Adaptation (2019) estimates that a $1.8 trillion investment in strengthening early warning systems, making water resource management and new infrastructure resilient, improving dryland agriculture crop production, and protecting mangroves would deliver $7.1 trillion in returns over the next decade. Again, well-designed climate action can yield high returns and benefits for poor people.

Broader Challenges for Modelling: Multiple Market Failures and Endogenous Growth

There are limits to the insights into development pathways that can be gained from existing models where technological progress and growth are exogenous and extrapolated from past trends, and which therefore might understate the speed and extent of structural and technical change. Correspondingly, the costs of low-carbon technologies have fallen much faster than anticipated in much of modelling, including for renewable energy generation and lithium-ion batteries (SYSTEMIQ 2020, 2021; Ziegler and Trancik 2021; Clarke et al. 2022; Way et al. 2022). Other key technologies, such as for battery electric vehicles (BEVs), green ammonia, and green hydrogen, are expected to reach tipping points before 2030, which in turn will trigger their scaling-up to mass market (SYSTEMIQ 2023).[16] Improving data analytics and efficiency in production processes and supply chains and increased capabilities in

research and innovation associated with general purpose technologies (Andres et al. 2022) might also hasten positive tipping points (Sharpe and Lenton 2021; Chui et al. 2022).

Economic transformation of the kind required to successfully manage climate change can be understood in terms of *endogenous* growth, driven by the dynamics of discovery, innovation, and investment (Aghion et al. 2021; Akcigit and Van Reenen 2023). Technology creation and diffusion, in this view, is driven by frequent and purposeful policy intervention, in combination with entrepreneurship, with a focus on structural and institutional enabling conditions (Rodrik 2014; Grubb et al. 2021). How poor countries might pursue such a form of growth and what the consequences for poor people would be are two key framing questions for the remainder of this paper.

Strategic Choices Over Development and Vectors for Impacts on Poverty

For the relationship between climate action and poverty, it matters how the effects of new technologies and activities will be distributed by income, demographics, and across countries, and whether countries where poverty is concentrated have the necessary resources and capabilities to purposefully steer structural economic change (Barbier 2016). Therefore, modelling must be complemented by closer attention to the strategic choices countries face and the specificity of policy design in the context of country circumstances. Countries must face the challenges of navigating a nationally specific series of structural, micro, and macro effects to achieve both climate and development goals simultaneously. Many of these challenges are examined in detail in the World Bank's Country Climate and Development Reports (CCDRs) (World Bank 2022b). Such analyses suggest that perceived costs of climate action for poverty often stem from a failure to incorporate poverty concerns in policy design or to provide an accompanying set of social policies (Hallegatte et al. 2014; Dercon 2014b; Montmasson-Clair 2021). On the macroeconomic side, structural change will affect countries' fiscal and currency positions—crowding out, debt sustainability, and absorptive capacity are key (but varying) constraints. Domestic revenue mobilization and aid flows can assist public investment increases (Gurara et al. 2019), and are indeed relevant policy interventions for tackling poverty.

Here, we identify four significant "vectors" of climate action where context and decision-making matter for the impact on poverty: resource extraction (fossil fuels and transition minerals) and fossil-fuel phase-out; carbon pricing instruments (including fossil fuel subsidies); the creation and distribution of new green jobs; and the inclusivity and local effects of low-carbon technologies, adaptation measures, and land-use change. When considering impacts, the counterfactual and time horizon are important framing: what does the alternative to climate action look like, and how does wellbeing for people in poverty in either scenario evolve over time?

Resource Extraction and Fossil Fuel Phase-out

Phasing out the extraction and burning of coal, oil, and fossil gas for energy use has been presented as a challenge for developing countries that might otherwise plan to use these activities to increase energy access, generate employment, and raise fiscal revenue (e.g., Kalkuhl et al. 2019; Laan and Maino 2022). However, "locking in" fossil fuel assets, infrastructure, and value chains transfers *economic* risks (as well as increased physical climate risks) onto future populations in a matter of decades or even just a few years. Most existing fossil fuel reserves cannot be exploited if the world is to remain below 2°C (Welsby et al. 2021). Demand-side policies and investments in pursuit of this good, in low-carbon energy, will lead to declining fossil fuel prices (Boer et al. 2023). Pye et al. (2020) present evidence and modelling to show that even if an entitlement to provide future fossil fuel supply were redistributed primarily to lower-income countries—which faces large practical barriers—the benefits for those countries are limited by trade and energy system costs, falling prices, and negative side effects. Fossil fuel infrastructure often has strongly negative health impacts on poor people via air pollution, displacement, and destruction of natural ecosystems that provide sources of income (Saha and Carter 2022; Du et al. 2023; see also section 3 of this paper). By contrast, short-term profits often benefit foreign investors or, to the extent they flow to domestic interest groups, increase potential "resource curse" effects: clientelism and rent-seeking that depress growth (Lane and Tornel 1996; Saha and Carter 2022). However, some authors ask whether similar effects could occur in some countries due to the extraction of transition minerals or renewable energy exports, pointing to the importance of domestic political economy for ensuring that green investments support broad-based development (Månberger and Johansson 2019; Leonard et al. 2022).

A growing literature addresses how phasing out from existing fossil fuel value chains and development of new "green" supply chains must both be carefully managed to prevent disruption from structural change harming people in poverty (e.g., Muttitt and Khartha 2020). Time, again, is a factor: for example, Zhang et al. (2022) find that continued development of coal-fired power generation in China could result in up to 90 percent of workers in coal plants losing jobs between 2030 and 2040, who would struggle to find re-employment in a mature clean energy economy. Beginning the phase-out now creates less severe impacts on wellbeing than concentrating it in some future, compressed timeframe. However, some poor communities are also highly vulnerable to immediate phase-out, such as in Madhya Pradesh, India, where entire local economies are based around the coal industry, including both formal and informal sectors (Pai 2021). Informality in labor markets and land tenure, weak social safety nets, limited availability of social and economic data, and low state capacity all make "just transition" policies more challenging for governments to orchestrate in EMDEs (Atteridge et al. 2022). Contextual factors are also found to be pivotal for

how mineral extraction affects poverty, such as the scale of mining operations and nature of governance (Gamu et al. 2015; ETC 2023a). These considerations all point to a need for more granular transition planning that differentiates phase-out and transition strategies by regions within countries, and over time, to isolate the most concentrated impacts on poverty.

Carbon Pricing and Redistribution, Fossil Fuel Subsidies

Carbon price instruments can have a highly variable impact on wellbeing, poverty, and inequality, depending on effects through four channels: on consumption, income, health, and potential recycling of revenues (Shang 2023). Studies modelling the global application of a carbon tax often find that redistributing revenues can substantially alleviate, indeed reverse, the negative impact on low household incomes (Davies et al. 2014; Franks et al. 2018; Campagnolo and Davide 2019; Fujimori et al. 2020; Budolfson et al. 2021). Studies at the national level support this result, for instance in South Africa (Altieri et al. 2016), Brazil (Grottera et al. 2017), and Peru (Malerba et al. 2021). However, some studies find that the poorest countries are constrained by their available domestic resources and would face real difficulties in fully compensating all poor households, suggesting that international redistribution is also required to compensate the negative impacts of carbon pricing on households in poverty (Davies et al. 2014; Campagnolo and Davide 2019; Fujimori et al. 2020). Moreover, designing and implementing carbon pricing and redistributive policy instruments might be challenging for EMDEs with low state capacity and large informal sectors (Aleksandrova 2020). For example, in Latin America, even while compensation could be achieved for poor and vulnerable households with 30 percent of carbon pricing revenues on average (Vogt-Schilb et al. 2019), characteristics which drive exposure to carbon pricing vary widely across countries and even within income groups—consequently, existing cash transfer programs do not cover all of the poorest, most vulnerable households, calling for a bespoke approach to revenue recycling (Missbach et al. 2022).

In many countries, fossil fuel subsidies represent a more immediately accessible opportunity for carbon pricing reform. Although subsidies are widely considered to be regressive overall, their removal could still harm some of the poorest households by leading to higher prices—Damania et al. (2023) present recent evidence from a wide survey of countries. Corresponding to the literature on carbon taxes, a range of studies demonstrate positive effects on poverty reduction if fiscal savings from subsidy reform are transferred to households (e.g., Dennis 2016; Vandeninden et al. 2022; Klaiber et al. 2023), although it is important to note that impacts vary significantly by region *within* countries, again making it important to adopt a tailored approach (Rentschler 2016). Most impact studies are conducted *ex ante*, and the challenging political economy of reform has prevented a wider range of successful cases. Deeper understanding and in-country guidance is needed to embed subsidy

reform in a durable social contract—likely based on a package including social safety nets, improving wider government services, and engagement with the public (Couharde and Mouhoud 2020; Vidican Auktor and Lowe 2022).

Green Job Creation

Given climate action's broadly positive aggregate effects on output and employment shown in section 4.2, the potential to reduce poverty through job creation in the long term will also depend on the distribution of skills, access to the labor market, and the geographic distribution of jobs, other factors of production, and supply chains (Taheripour et al. 2021). Jobs are also not a guarantee of decent work: 6.4 percent of the world's working population lives in extreme poverty, with much higher figures in low-income countries where the working poverty rate reaches nearly 40 percent (ILO 2022). Several authors make the case for actively including job quality, regional effects, and gender in all climate policymaking to ensure a just transition and poverty reduction (e.g., Garcia-Casals et al. 2019; Saget et al. 2020; Malerba and Wiebe 2021). Effects on labor often differ by gender, and nuanced transitional impacts can be important for wellbeing: for example, technologies for mechanization in rice production or dairy intensification can lead to negative short-term impacts on women, even if there are long-term income gains from productivity (Kabir et al., forthcoming). Tailored communication, support (including training to take up technological shifts), and incentives for firms are key conditions to ensure women have full access to social and economic opportunities from mitigation and adaptation (Janikowska and Kulczycka 2021).

An important avenue for research into climate action and poverty is how EMDEs can develop the human capital necessary for economic diversification, mapping onto a global geography of opportunities in the production of low-carbon technologies. Noting the variable poverty-reduction potential of growth in different sectors, and that many lower-income countries have deindustrialized comparatively early in their economic development (Rodrik 2016), climate action may present opportunities for more durable income gains than current models. For instance, Behuria and Goodfellow (2019) highlight how even in a comparatively successful economy such as Rwanda, a mismatch between education policies and service-based growth can be observed, in stark contrast with successful East Asian development models in the 20th century. Global policies and standards for technology supply chains will be very significant for impacts on poverty—such as for lithium, which in Africa is mined in the Democratic Republic of Congo and recycled in Ghana (Otlhogile and Shirley 2023). However, it is worth noting explicitly that these issues would arise similarly in a pathway without climate action.

Social Inclusion and Local Effects

Mitigation and adaptation activities will have distributive and wellbeing impacts beyond the growth in aggregate income and employment associated with potential development pathways. An immediate question concerns access for the poorest countries and households. A survey of mitigation options presented by the IPCC (2022b) highlights that technology solutions in agriculture, forestry, and other land use are not yet at cost parity with reference (higher-carbon) options. Even solar technology, which in terms of up-front and operating costs is now almost universally cheaper than fossil alternatives, faces barriers to deployment because of geographic variability in the affordability of up-front costs (Szabó et al. 2021), particularly in relation to the availability and cost of finance. These near-term constraints have implications for good policy design to achieve both climate and poverty objectives. For example, carbon taxes on households' fuel consumption have been found to discourage people from switching to gas away from traditional solid fuels, with negative health impacts (Cameron et al. 2016; Greve and Lay 2023). By contrast, subsidies for roll-out of distributed renewable energy are found to have positive impacts on poverty reduction in lower-income countries (Lamb et al. 2020).

The potential for poverty reduction also depends on the extent to which local and national power structures and decision-making processes consider the needs and rights of vulnerable people and communities. For example, in some EMDEs, utility-scale wind and solar plants have been associated with private enclosure of communal land in contexts with weak regulation and limited representation for poor, rural, often indigenous groups (Lamb et al. 2020). Relatedly, Hussein et al. (2013) model international payments for forest protection (alongside a carbon price) and find that these could undermine food security and increase poverty—yet assumptions about land ownership are critical. The impact of nature-based solutions depends on who captures rents from new (lower-carbon) uses of land. Can land-grabs by large landowners be prevented, and can information and knowledge barriers to equal participation and fair governance be overcome (Barbier 2014)? Climate adaptation measures, if badly designed, can also introduce new risks for poorer communities while benefiting more politically and economically powerful actors (Mustafa and Wrathall 2011; Warner and Kuzdas 2016; Henrique and Tschakert 2021). Retrofitting adaptation onto existing development agendas risks maladaptation (Eriksen et al. 2021), yet ignoring existing processes of economic integration and development can trap people in locations or industries that are in economic decline (such as marginal land in urban areas that is prone to flooding) (Dercon 2014b).

All of these findings show the importance of designing programs and interventions with the participation of affected communities, wider reforms of governance and markets, and tools for assessing whether specific projects and investments are aligned with macro pathways for decarbonization and resilience. There are real op-

portunities in combining mitigation, adaptation, and development. There are many examples. However, taking advantage of these opportunities requires good policy. These issues present an important research agenda into the conditions and sequencing of structural economic change for both climate and poverty reduction objectives.

An Integrated Approach to Policy for Climate and Poverty Reduction Goals

It is clear from the range of the literature covered in section 4 that achieving development pathways which reduce poverty and manage climate change will require comprehensive policy approaches designed not only to drive the transition but also to enable the opportunities of the low-carbon transition to be widely shared and to support those who might be adversely affected. The appropriate policy mix will vary by country, according to economic and social structures, political cultures, and patterns of power and influence among national and local stakeholders (Rogge and Reichardt 2016; KCI 2022; IPCC 2023). Lessons on how to navigate these issues are emerging from the frontier of policy practice and related research; we discuss three such lessons in this section: the need for stepped-up broad-based investment, the importance of combining climate policies with investment in people and social protection, and the crucial role of international financial partnerships. With good policies and actions the evidence suggests that climate action and poverty reduction can be achieved together and indeed can be mutually supportive.

First, the literature highlights investments in all of physical, human, natural, and social capital as core elements of both climate action and poverty reduction. Increases in investment—including in education, health, access to justice and infrastructure such as energy, water, sanitation, and transportation—are necessary to achieve the SDGs under both "business-as-usual" scenarios and low-carbon transition scenarios (Bhattacharya et al. 2016; Gaspar et al. 2019; OECD 2017; Kharas and MacArthur 2019; Rozenberg and Fay 2019).

Assessments of the investment implications of climate action have focused particularly on the requirements for the energy transition, usually the largest of the incremental investment requirements. However, research indicates that meeting climate goals in EMDEs will also entail a scaling up of investment across sectors in order to transform the supply and demand of energy (IEA 2021; ETC 2022; IEA and IFC 2023), to promote sustainable agriculture, forestry, and land use practices (Deutz et al. 2020; UNEP 2021), and to adapt and cope with the loss and damage from adverse climate change impacts (Baarsch et al. 2015; Markandya and González-Equino 2019; Chapagain et al. 2020; UNEP 2022). Songwe et al. (2022) estimate that the required investments in these four areas (energy, nature, adaptation and resilience, loss and damage) would need to reach between $2–2.8 trillion by 2030 in EMDEs

other than China. Their analysis reveals that there are important complementarities between development and climate goals, and thus a large part of the investment requirements for climate action are already embodied in the investments required for development, such as the large-scale deployment of energy infrastructure. Simply put, climate objectives are nested within the SDGs and a poverty-focused climate agenda will need to take the SDGs into account and can drive progress towards them.

The breakdown of investment needs for EMDEs by income groups (Kharas and McArthur 2019; ETC 2023b) indicates that while aggregate spending for both development and climate action will be higher in middle income countries, spending relative to GDP will be substantially higher in low-income countries, thus highlighting the particular challenge that increasing investment poses for low-income countries. For example, the World Bank (2022b) identifies that incremental climate and development-related annual investment needs average 1.4 percent of GDP over 2022–2030 for all countries for which a CCDR has been prepared, and 8 percent of GDP in low-income countries to achieve growth and be on track to reduce emissions by 70 percent by 2050.

Second, measures to scale up investment in physical capital will need to be accompanied by investment in human capital and in places (or mobility) if the aim is to create opportunities for poor people. Active labor market policies can help incorporate people in poverty into the more formal economy and equip them with the necessary skills to benefit from new green job opportunities. These include, for example: education and training programs (Keese and Marcolin 2023); gender-sensitive policies including gender-sensitive training opportunities (Kwauk and Casey 2022) and greater investment in childcare to free up women to transition to formal employment (OECD 2021); and mobility support services to connect workers to emerging green sectors (Rigolini 2022). In addition to a substantial literature emphasizing the importance of social protection policies to help populations adapt to the impacts of climate change (Kuriakose et al. 2013; Schwan and Yu 2018; Tenzing 2020; Ulrichs et al. 2019; Aleksandrova and Costella 2021; Rana et al. 2022), policy initiatives and research now regularly highlight the importance of specific social protection programs and policies if people in poverty are to be protected and benefit from changes in local economic development (e.g., ILO 2023; Mukherjee et al. 2023).

Third, for many EMDEs, navigating the low-carbon transition effectively will require strong collaboration with advanced economies. Research underscores the importance of international financial support for countries with limited financial resources as they confront the economic challenges posed by global climate objectives and the effects of climate change (Lenferna 2018; Muttitt and Kartha 2020). This support would complement domestic resource mobilization. It would include a combination of expansion of support from international financial institutions

Table 3. Examples of Policy Initiatives to Tackle the Poverty and Distributional Impacts of Climate Action

Vectors of impacts of climate action on poverty	Organization, *Initiative*	Intended mechanism for intervention
Strategic choices	World Bank *Country Climate and Development reports (CCDRs)*	Helps countries prioritize the most impactful actions that can reduce GHG emissions and boost adaptation, while delivering on broader development goals. Identify main pathways to reduce GHG emissions and climate vulnerabilities, including the costs and challenges as well as benefits and opportunities from doing so.
	Asian Development Bank, *Community Resilience Partnership Program (CRPP)*	Aims to help countries and communities in Asia and the Pacific scale up investments in climate adaptation, especially investments at the community level, that explicitly target the nexus between climate change, poverty, and gender.
Resource extraction and phase-out of fossil fuels	Beyond Oil and Gas Alliance (BOGA)	Convenes national governments and stakeholders to commit to and collaborate on the managed phase-out of oil and gas production.
	UNDP and WWF, *The Alliance for Just Energy Transformation*	Helps advance inclusive community-centered dialogue with all relevant stakeholder groups (communities, civil society, policymakers, and private sector) to facilitate and to identify common ground to ensure the path to energy transition is socially just and sustainable.
Carbon pricing, fossil fuel subsidies, and redistribution	Coalition of Finance Ministers (CoFM), *Initiative on Carbon Pricing Measures*	Develops and builds capacity for fiscal and financial policy measures, including effective carbon price mechanisms with attention to distributional impacts and revenue use to support development objectives.
Distribution of changes in jobs	International Labour Organization, *Climate Action for Jobs Initiative*	Ensures that the need for decent jobs and social justice is taken into account in designing and implementing action on climate change.
	United Nations, *Global Accelerator on Jobs and Social Protection for Just Transitions*	Helps countries create 400 million decent jobs, including in the green, digital, and care economies, and to extend social protection coverage to the 4 billion people currently excluded.

Table 3. Continued

Vectors of impacts of climate action on poverty	Organization, *Initiative*	Intended mechanism for intervention
	World Bank, *Partnership for Economic Inclusion (PEI)*	Global partnership with a mission to support the adoption of government-led economic inclusion programs that promote access to labor markets. Economic inclusion programs provide a bundle of coordinated, multidimensional interventions that support extreme poor and vulnerable groups, with a special focus on women, to increase their incomes and assets.
Impact of and access to new technologies	Coalition for Sustainable Energy Access	Meets the energy needs of the world's population with clean energy through the strengthening of South–South cooperation in technology transfer and improving the understanding of roles of existing institutions and initiatives in the Global South.
	IEA *Global Commission on People-Centered Clean Energy Transitions*	Examines the social and economic impacts of the shift to cleaner energy technologies, including issues of affordability and access.
	Just Rural Transition	Supports governments to develop inclusive roadmaps for sustainable land-use and food system change.
Building effective international cooperation	Just Energy Transition Partnerships (JETPs)	Country-led partnerships to expand public and private finance to accelerate country-led energy transition in EMDEs.
	Blended Finance Taskforce	Helps mobilize large-scale capital for the UN Sustainable Development Goals (SDGs).

Source: Authors' analysis based on review of selected policy and institutional documentation.
Note: Included initiatives are not exhaustive.

and development banks, private sector finance, official development assistance, and other low-cost or grant finance (Bhattacharya et al. 2022; Songwe et al. 2022). However, successive analyses by official and independent sources have concluded that existing facilities and conditions, such as improved tax and transfer systems in EMDEs, financial market regulation and de-risking, and the efficient use of multilateral development bank (MDB) capital, are inadequate (UNEP 2015; Chenet et al. 2017; Clark et al. 2018; Yeo 2019; G20 2021; Bhattacharya and Stern 2021; Bhattacharya et al. 2022; G20 2022; Songwe et al. 2022; World Bank 2022b; Lankes and Robins 2023). There is a clear and shared conclusion that a major and urgent scale up of finance is required if the necessary investment is to be achieved.

Country ownership, including of building a platform for investment and policy-making, particularly in relation to the conditions for investment, is central to aligning international financial support with domestic priorities. Close involvement of the private sector in these platforms and in the implementation of policies is crucial. However, research suggests that, in practice, such ownership does not always create participation and equity since existing state processes can fail to respond to local needs of vulnerable populations (Omukuti 2020a, 2020b; Kuhl and Shinn 2022; Shawoo et al. 2022).

Technology is another area where the literature highlights mutual benefits from an international collaborative approach (Pigato et al. 2020). However, while there are interesting examples (such as digital applications that help with agricultural practices for small farmers), further research is required on larger-scale policy interventions that enable those in poverty to benefit from these technologies.

Table 3 summarizes some examples of the growing number of policy initiatives to enable climate action to be positive for people in poverty, categorised under the framework of strategic choices and the four vectors presented in section 4.3.

Conclusion: Policy, Collaboration, Research

The theory and evidence assembled in this paper shows that failure to tackle climate change would lead to severe consequences for people in poverty. Sustainable, resilient, and inclusive development requires investment and careful policy design to focus on all of mitigation, adaptation and resilience, loss and damage, and natural capital. We have argued that these activities and objectives are in many cases interwoven and mutually supporting, particularly through the necessary investments. However, the extent, pace, and nature of structural change involved in achieving climate goals and delivering this new form of development present a series of challenges in the creation of very different development pathways from those of the past, including around distributional impacts and impacts on poverty in the process of change.

Further research is needed to connect these various factors and understand how to drive rapid technical, behavioral, and systemic change that also reduces poverty.

This research should include analytic approaches and models that can account for unprecedented climatic conditions and impacts, with biophysical systems linked to economic ones that exhibit complexity, feedback loops, non-linearities, and endogenous change. However, macro-system models cannot capture every layer of nuance affecting people in poverty and are limited by the granularity of available data. Research is needed to identify and evaluate strategies and tools promoting climate action which are sensitive and responsive to the impacts of people in poverty, particularly in the context of limited state capacity which characterizes many EMDEs. Mainstreaming climate justice and the just transition into assessments of policies and mechanisms is another pillar of this agenda.

The physics points inexorably to urgency. Thus, research must take place simultaneously with action, and each should inform and improve the other. For example, clarifying how different combinations of policy and investment affect job creation and the distribution of value chains across sectors could inform better design of just transition partnerships between international funders and EMDEs in need of financial support. While understanding of challenges and responses can and should be greatly improved, our review of the science shows that taking weak or no climate action would be the worst options of all for seeking to end global poverty.

Conflict of Interest

All authors declare that they have no conflicts of interest to diclose.

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Data Availability Statement

Regarding data access, no new data were generated or analysed during this study.

Notes

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1. There are various ways to define and measure poverty. In this paper, we use different concepts based on the availability of data and studies, and the questions at hand, but overall we support and employ a multidimensional account. As highlighted by Atkinson et al. (2019), "The measurement of poverty is not a purely technical subject [. . .] the right answers depend on views that are politically influenced and, at heart, matters of moral judgement." Various approaches are used to measure poverty, including measures of income (the international poverty line of $2.15/day for extreme poverty; income thresholds relative to the national average are often set at 60 percent); measures of income combined with direct measures of consumption (e.g., the EU's "persons at risk of poverty and social exclusion" indicator); and multidimensional measures that take into account other dimensions of welfare beyond income, such as education, health, housing, and personal security (e.g., the Alkire-Foster measure).

2. For definitions, see 2.1 below and references therein.

3. Global heating here is measured in a now standard way as the difference in average global surface temperature from the second half of the 19th century.

4. Weitzman (2009) emphasized that the possibility of catastrophe could give, in standard approaches, expectations of the sum of utilities over time of minus infinity. The models then have very limited usefulness for policy guidance.

5. We recognize that valuing a life in this way can have some usefulness in a micro context, for example, in allocating resources to the prevention of accidents. But for a global strategic problem the difficulties can be overwhelming, for the reasons indicated.

6. Nicholas Stern was present on the relevant panel.

7. It is striking to see how limits on sources of industrial pollution, especially in urban areas, including steel and coal plants, reduced the number of premature deaths in China over the period 2012 to 2018, from 3.6 to 2.4 million due to a 43.7 percent reduction in $PM_{2.5}$ particulate matter deriving from fossil fuel combustion.

8. The literature shows that children and the elderly are also particularly vulnerable to climate change impacts, but our focus here is on women and girls.

9. See illustrative case study on Tanzania in Wangui and Smucker (2018).

10. See illustration of impact in Darfur in MSF (2005).

11. This estimate considers all the impacts of climate change on poverty (including health impacts and the impacts of climate change on labor productivity) projected for the year 2030, whereas the Hallegatte and Rozenberg (2017) estimate cited above only covers the effect of today's natural disasters on poverty.

12. Defined as the number of people in locations where two or more sectors surpass a tolerable level of risk (see Byers et al. (2018) for further details about the specific thresholds).

13. The IPCC defines drying regions as "the AR6 [Sixth Assessment Report] regions in which there is at least *medium confidence* in a projected increase in agricultural/ecological drought at the 2°C warming level compared to the 1850–1900 base period in CMIP6 [Coupled Model Intercomparison Projects 6]. These regions include W. North-America, C. North America, N. Central-America, S. Central-America, Caribbean, N. South-America, N.E. South-America, South-American-Monsoon, S.W. South-America, S. South-America, West & Central-Europe, Mediterranean, W. Southern-Africa, E. Southern-Africa, Madagascar, E. Australia, S. Australia (Caribbean is not included in the calculation of the figure because of the too small number of full land grid cells)" (IPCC 2021).

14. The author writes before the 2022 heatwaves that exceeded the intensity of 2015.

15. It should be noted that this section does not provide an exhaustive review of all the studies that have considered the future impacts of climate-driven growth, but rather it highlights a number of modelling approaches that have attempted to overcome some of the flaws highlighted in section 4.1.1).

16. Socio-economic tipping points exist when a set of conditions are reached that allow new technologies or practices to out-compete incumbents.

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