Chapter **5**

Climate change and inequalities in the Anthropocene

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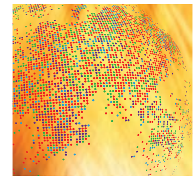


The climate is in crisis. The effects are already unspooling in the form of melting ice sheets and, as is likely, record heatwaves and superstorms. Without bold collective action, these will only worsen over time, joined by a suite of other calamities, from depressed crop yields to rising sea levels to potential conflict. As recognized in the Sustainable Development Goals and the Paris Climate Agreement, climate change is a global challenge.

But it will not affect everyone equally — not in the same way, not at the same time, not at the same magnitude. Poorer countries and poorer people will be hit earliest and hardest. Some countries could quite literally disappear. Of all climate change's disequalizing effects, perhaps none is greater than that on future generations, which will shoulder the burden of previous generations' fossil fuel-dependent development pathways.

Inequality runs the gamut of climate change, from emissions and impacts to resilience and policy. Climate change is a recipe for more inequality in a world that already has plenty. But climate change and inequality, and the interaction of the two, are choices, not inevitabilities. Even though the window for decisive and bold action on climate is shrinking, there is still time to make different choices.

This chapter suggests that by redressing inequalities, action on climate could also be made easier and faster. To see why, consider two of the multiple possible channels at play.[1] The first relates to how individual consumption decisions add up to total emissions (box 5.1).[2] The second, which is the focus of this chapter and likely more consequential, relates to how inequality interacts with technological change

BOX 5.1

Household income, inequality and greenhouse gas emissions

Higher household incomes are associated with higher emissions, but the impact of inequality on aggregate emissions depends on how quickly emissions increase as income rises.[1] There is a wide range of empirical estimates for this relationship, showing that, on balance, emissions increase more slowly than income in most developed and middle-income countries but at the same rate (or even a little faster) in lower income countries.[2]

Taking this channel alone into account would imply that income inequality should be associated with lower emissions in developed countries. To see how, consider the impact of transferring income from the rich to the poor in a developed country. Even though rich people emit more, given that the rate at which emissions increase is slower than the rate at which income does,[3] the increase in emissions by poor people would be higher than the corresponding decrease in consumption by rich people, leading to a net increase in emissions. And one would expect to see the opposite in developing countries, with reductions in inequality lowering emissions.[4] However, the scale of the impact of inequality through this channel tends to be small, certainly when compared with other determinants of changes in emissions, such as technological change and policies.[5]

Perhaps more important, the interplay of these consumption patterns within and across countries—although trending towards lower emissions overall—appears unlikely to substantially reduce global aggregate emissions.[6]

Notes

1. It also depends on how inequality interacts with rising income. For a comprehensive description of the different possibilities, see Ravallion, Heil and Jalan (2000). 2. See, for instance, Liddle (2015). For a detailed estimate for the Philippines, see Seriño and Klasen (2015). 3. When this relationship is measured in terms of how much a percentage change in income is reflected in a corresponding percentage change in emissions—in technical terms, an elasticity—this implies an elasticity of less than 1. 4. More precisely, this would happen if the elasticity were greater than 1. For some empirical support of the hypothesis of this differential impact of inequality in emissions in developed and developing countries, see Grunewald and others (2017). 5. To illustrate, Sager (2017) calculated consumption-based carbon emissions Engel curves (showing the relationship between household income and average carbon dioxide emissions) for the United States for several years between 1996 and 2009. In a scenario where income is redistributed to perfect equality (a dramatic and extreme case), average carbon dioxide emissions in 2009 would have increased 2.3 percent, from the actual 33.9 tonnes per household to 34.7 tonnes. In contrast, had there been no technological change and assuming the same consumption composition between 1996 and 2009, average emissions would have increased 70 percent, to 57.9 tonnes. 6. Caron and Fally 2018.

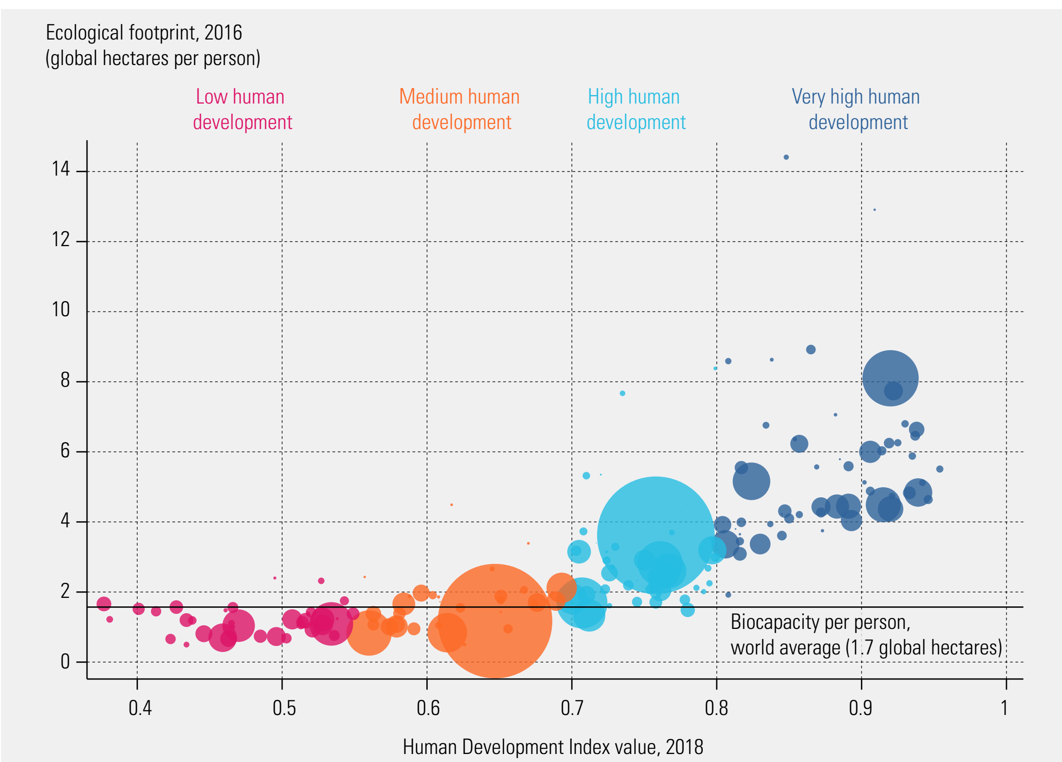
and policy formation. There is some evidence that high inequality hinders the diffusion of new environmentally friendly technology.[3] Inequality can influence the relative power of interests arguing for and against curbing emissions. Emissions would be expected to be higher when income is concentrated at the top and when the resulting concentration of economic power coincides with the interests of groups that oppose action on climate.[4] More generally, higher inequality tends to make collective action—key both within and across countries to curb climate change—more difficult.[5] Information is critical for collective action, but the ability of different interest groups to communicate tends to be lower when inequality is high,[6] with the concentration of income potentially leading to the suppression or propagation of information in order to serve a particular interest.[7] Other interacting mechanisms relate to how inequality shapes perceptions of fairness (with implications for compliance and enforcement).[8]

Higher inequality tends to make collective action—key both within and across countries to curb climate change—more difficult

Where emissions are being decoupled from economic growth—a hopeful sign that is directionally right but not yet at scale, despite accelerating over the past two decades—this is related to countries having "underlying policy frameworks more supportive of renewable energy and climate change mitigation efforts,"[9] which shows the feasibility of a break from unsustainable development models that have endured for centuries.[10] Still, countries with higher human development generally emit more carbon per person and have higher per capita ecological footprints (figure 5.1).[11] Richer countries and communities may put a premium on local concerns, such as water and air quality, but they tend not to experience locally the full extent of their impacts on the environment, which are driven more by their income than by "green" self-identities and associated behaviours.[12] Instead, they often shift a significant portion of the environmental impacts of their consumption preferences to less-visible countries and communities elsewhere, including to

FIGURE 5.1

Per capita ecological footprints increase with human development



Note: Covers 175 countries in the Global Ecological Footprint Network database (www.footprintnetwork.org/resources/data/; accessed 17 July 2018). As used here, the ecological footprint is a per capita measure of how much area of biologically productive land and water a country requires, domestically and abroad, to produce all the resources it consumes and to absorb the waste it generates. Each bubble represents a country, and the size of the bubble is proportional to the country's population.
Source: Cumming and von Cramon-Taubadel 2018.

those along global supply chains.[13] In the case of climate change, they also shift the impacts to future generations, which are even less visible.

Environmental burden shifting happens not just for greenhouse gas emissions but also across many environmental domains.[14] Thus, this chapter goes beyond climate to examine inequalities and burden shifting in other important areas, such as waste generation, meat consumption and water use. Environmental burden shifting is linked to gradients in economic and political power. Attempts to redress these power differences and how they manifest environmentally are likely to be ever more relevant as humanity enters what has been called the Anthropocene (box 5.2).

The 2007/2008 Human Development Report showed not only how climate change was an existential threat to future generations, exacerbating intergenerational economic inequality, but also that it would increase income inequality across and within countries.[15] Recent research has confirmed, and made more precise, how disequalizing climate change can be: Income inequality across countries may already be about 25 percent higher than it could have been without climate change.[16]

This chapter takes that analysis further, showing how climate change exacerbates inequalities in other dimensions of human development and how inequality is also relevant to building climate and disaster resilience. Some evidence suggests that "development on its own" may not offer protection from the negative impacts of climate change.[17] New, broadly shared approaches to resilience may needed. Echoing a central theme

Some evidence suggests that development on its own is unlikely to offer protection from the negative impacts of climate change

BOX 5.2

From Holocene to Anthropocene: Power—and who wields it—at the brink of a new era

The environment has a profound impact on people's capabilities and on their ability to convert capabilities into achievements—and thus on human development.[1] Conversely, human activity affects the natural world, shaping environmental processes and patterns at a global scale. Arguably, humankind today is not just witnessing but also causing the sixth mass species extinction in the Earth's history.[2] While the stratigraphy community has yet to formally declare a new epoch (meaning that humanity is still in the Holocene), the unfolding changes to the environment are so dramatic, and so heavily influenced by humans, that the expression Anthropocene has entered current use.[3]

The Anthropocene portends a worrying mix of power, fragility and uncertainty. The end of the last glacial period and the beginning of the Holocene more than 10,000 years ago ushered in a stable climate regime—a climatic cradle for humans—with conditions favourable for permanent agriculture and the dawn of civilizations. Rising populations, wealth and technological know-how have translated into greater, seemingly unbridled power, including over the environment. Yet fragilities have always been evident. Crops are susceptible to pests and bad weather. Infectious diseases have sprung from (and through) domesticated animals and elsewhere.[4] The interplay among humans, geography and the environment has been central to the way civilizations have come and gone.[5]

Fast forward to today, and the intertwining of power, fragility and uncertainty has not changed. The differences are in the scale and the stakes. Humans have far more power to affect the environment, including at the planetary level, but no greater control. The list of negative feedback from human activities ranges from introducing invasive species to the plastics epidemics in the oceans to fisheries stress and collapse to fossil fuel emissions and climate change.[6] These and other activities have not just destabilized ecosystems but have also transformed planetary biogeochemical processes.[7] Humanity is thought to have already breached at least four of nine planetary boundaries, the safe operating limits for different components of the Earth system seen as critical to maintaining a stable Holocene-like state.[8] Two of these—climate change and biosphere integrity—are considered core boundaries, meaning they have the potential on their own to push the Earth into a new state.[9] Humans have exceeded the safe operating space for both; the risk of crossing a critical threshold, destabilizing the Earth system and exiting the Holocene is no longer assuredly low.[10]

This is the Anthropocene: human power at scale, without illusions of control and without fully grasping or heeding the consequences. Through unmitigated greenhouse gas emissions and other actions, humans are pulling themselves out of the relative stability of the current geological epoch into the uncertainty of a new one. The Anthropocene is essentially a leap into the unknown. Making a choice for sustainable human development, based on a country's unique set of circumstances, is necessary. But it is not easy—and it is made all the more difficult when persistently high inequality, in its many forms, with its corrosive effects, implies that both people and planet lose. Choices rooted in inclusion and sustainability can turn the damaging historical relationship between development and ecological footprints on its head—breaking humanity free from old development approaches that simply will not work as it enters the brave new world of the Anthropocene.

Notes

1. Robeyns 2005. 2. Barnosky and others 2011; Ceballos, Ehrlich and Dirzo 2017; Ceballos, García and Ehrlich 2010; Ceballos and others 2015; Dirzo and others 2014; McCallum 2015; Pimm and others 2014; Wake and Vredenburg 2008. 3. Scott (2017) attributes to Paul Crutzen the introduction of the term and the proposal to date the start of this era to the late 18th century, coinciding with the invention of the steam engine, which unleashed the Industrial Revolution (even though Scott himself proposes the concept of a "thin Anthropocene," which could be dated as far back as the hominid use of fire). In May 2019 the 34-member Anthropocene Working Group voted to designate the Anthropocene as a new geological epoch. The panel plans to submit a formal proposal to the International Commission on Stratigraphy, which oversees the official geological time chart. 4. Dobson and Carper 1996; McNeill 1976; Morand, McIntyre and Baylis 2014; Wolfe, Dunavan and Diamond 2007. 5. Crosby 1986; Diamond 1997, 2005. 6. Choy and others 2019; Early 2016; Millennium Ecosystem Assessment 2005; Seebens and others 2015; US NOAA 2018. 7. Campbell and others 2017; Steffen and others 2015. 8. Steffen and others 2015. 9. Steffen and others 2015. 10. Steffen and others 2015.

of this Report, this chapter finds convergence in basic capabilities to cope with climate change and divergence in enhanced ones. Countries are converging—even though large disparities persist—in their preparedness to "normal" shocks, ones expected at a certain frequency and magnitude based on historical trends—a basic resilience capability. Climate change impacts, however, do not always conform to historical trends, with more "surprises" than in the past.[18] Shocks take on a new, unanticipated character. Building preparedness—which relies less on the experienced past and more on how science and technology, including advanced weather prediction systems, can help prepare for an uncertain future—is becoming an enhanced capability in which gaps are emerging. The challenge is to ensure that climate resilience does not become the reserve of only a select group of countries and communities that can most afford it, thereby further exacerbating the inequality impacts of the climate crisis.

The challenge is to ensure that climate resilience does not become the reserve of only a select group of countries and communities that can most afford it

The urgency for action to combat climate change, including by fully implementing the Paris Agreement under the United Nations Framework Convention on Climate Change, cannot be overemphasized. So why isn't more being done? True, there is renewed interest in many countries around the world in carbon pricing, but to take just a simple illustration, only 5 percent of emissions are covered by a carbon price high enough to achieve the goals of the Paris Agreement.[19] Some even argue that carbon pricing will not be enough and that instead of relying on market signals, more fundamental transformations of economies and societies will be needed.[20] The various mechanisms through which inequality influences technology diffusion and policies, reviewed briefly above, speak to the complex interplay between climate change and inequality and even how action on climate can be hamstrung, as in the case of the *Mouvement des gilets jaunes* (yellow vests movement), perhaps an instance when people felt as though they were being left behind.

Addressing inequality and the climate crisis together can move countries towards inclusive and sustainable human development. For instance, when carbon pricing is part of a broader set of social policy packages, it is possible to address inequality and climate together while facilitating the realization of people's human rights. Climate policy can create virtuous feedback loops in which emissions decline from direct effects (such as a carbon price) and from indirect effects (such as lower inequality, which may facilitate even bolder climate policies). This chapter, as well as chapter 7, tees up some of these key issues.

How climate change and inequalities in human development are intertwined

This section starts by expanding beyond inequalities in carbon emissions between countries to inequalities within them, adding to the more familiar story on how climate change will harm—and has already impacted—different dimensions of human development. Finally, it takes an illustrative look at climate resilience, framing it as an enhanced capability that risks divergence.

From inequality in emissions to inequality in impact: Two dimensions of climate injustice

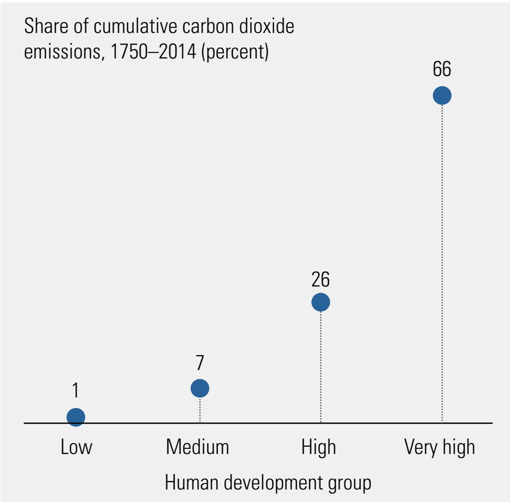
Carbon dioxide is not the most potent anthropogenic greenhouse gas, but it is the most widespread, driven overwhelmingly by fossil fuel combustion (87 percent of total carbon dioxide emissions over 2008–2017) for electricity, transportation and other uses.[21] It is widespread because carbon emissions are deeply embedded in current patterns of production and consumption, and powerful fossil fuel interests have generally tried to keep it that way.[22]

The richest countries account for the lion's share of cumulative carbon dioxide emissions (figure 5.2); they are still among the top polluters on a per capita basis and in terms of aggregate country emissions today.[23] These inequalities in cumulative emissions are central to the global conversation on climate, particularly for climate justice, burden sharing and differentiated responsibilities.[24]

The same pattern of inequality plays out within countries, with households at the top of the income distribution responsible for more carbon emissions per person than those at the bottom. While there is no direct way of allocating emissions to individuals, estimates

FIGURE 5.2

Today's developed countries are responsible for the vast majority of cumulative carbon dioxide emissions



Source: Human Development Report Office calculations based on Ritchie and Roser (2018).

based on plausible approximations suggest that global carbon dioxide equivalent emissions are highly concentrated: The top 10 percent of emitters account for 45 percent of global emissions, while the bottom 50 percent account for 13 percent. The top 10 percent of emitters live on all continents, a third of them in emerging economies (figure 5.3).[25]

Inequality in global carbon dioxide equivalent emissions between individuals has decreased, but within-country inequality is steadily rising and approaching the share of between-country inequality in the global dispersion of carbon dioxide equivalent emissions (figure 5.4). In 1998 a third of inequality in global carbon dioxide equivalent emissions was due to within-country inequality; by 2013 half was.

Turning from emissions to impact, unmitigated climate change drives inequalities in human development through two main mechanisms: differential exposure and vulnerability.[26] Debate continues on the relative importance of each. This chapter takes the view that both matter. Differential exposure is real: Climate change will hit the tropics harder first, and many developing countries are in the tropics.[27] At the same time, developing countries and poor and vulnerable communities have fewer capacities to adapt to climate change and severe weather events than do their richer counterparts. Part of the reason climate change and disasters are disequalizing is that inequality exists in the first place; they run along, exploit and deepen existing social and economic fault lines. These fault lines were dramatically laid bare when Hurricane Katrina

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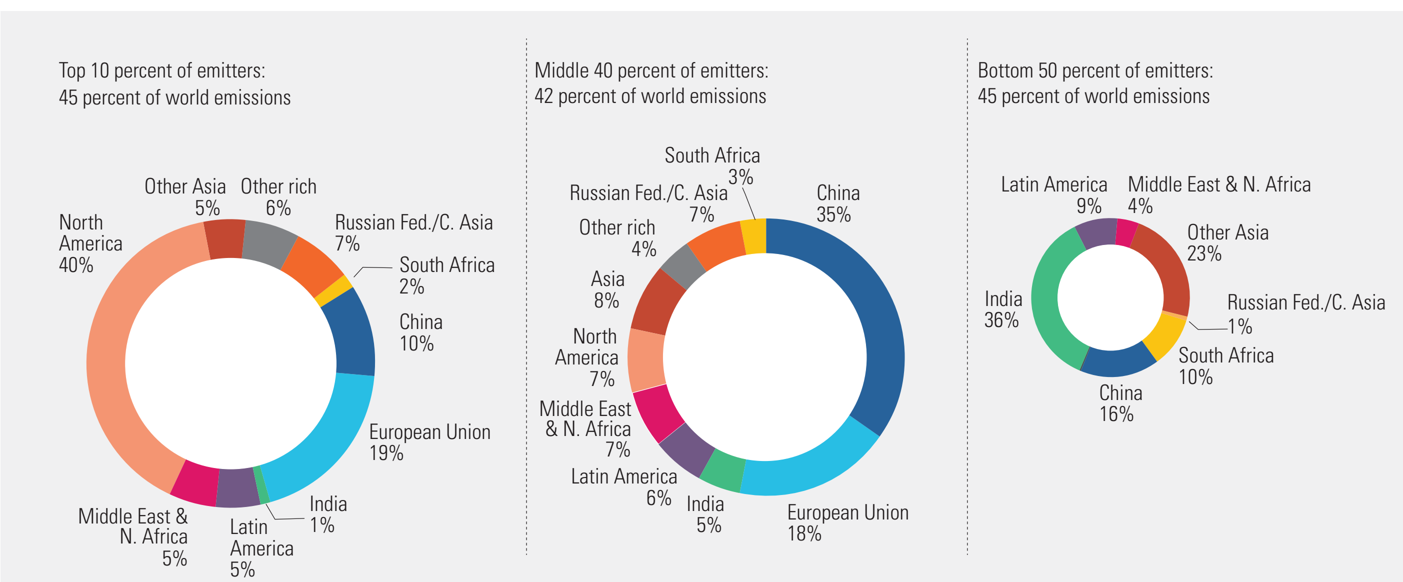
FIGURE 5.3

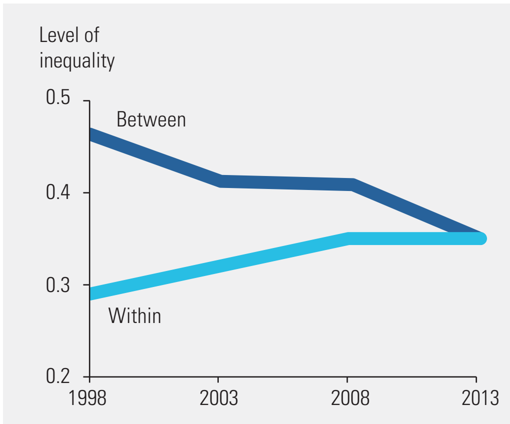
Of the top 10 percent of global emitters of carbon dioxide equivalent emissions, 40 percent are in North America, and 19 percent are in the European Union



Source: Chancel and Piketty 2015.

FIGURE 5.4

Within-country inequality in carbon dioxide equivalent emissions is now as important as between-country inequality in driving the global dispersion of carbon dioxide equivalent emissions



Note: In 2008 the within-country component of the Theil index, which measures dispersion in the distribution of a variable that can be perfectly decomposed into between-group and within-group components, was 0.35 and the between-country component was 0.40—that is, between-country inequality accounted for 53 percent of total inequality

Source: Chancel and Piketty 2015.

struck New Orleans in 2005. A more recent example is the tragic loss of life and devastation wrought by Hurricane Dorian in the Bahamas in 2019. Dorian was the strongest hurricane to strike the country since recordkeeping began in 1851.[28] The communities hardest hit included shantytowns populated mostly by poor Haitian immigrants, some of whom had fled the devastating 2010 earthquake in their home country.[29]

The global economic impacts of climate change have been modelled many times, producing a range of estimates, each with its own range of possible outcomes. From these estimates, two key points emerge: First, climate change will reduce global GDP, especially in the long run, and second, negative economic impacts are generally worse at higher temperature thresholds.[30] Moving beyond these general trends to more precise estimates is challenging. The exact magnitude of the economic effects of climate change is highly uncertain, and it varies by geography and many other variables. Nonlinearities complicate matters: Each additional unit of change in the climate is unlikely to yield the same incremental impact over time.[31] The complexities of the climate system make significant tipping points and thresholds possible—for example, the possibility for catastrophic events, whose impacts are generally not systematically captured in many models.[32] As Martin Weitzman once claimed, "All damage functions are made up—especially for extreme situations,"[33] yet many of the most widely used economic models of climate change rely on "smooth" damage functions that may not fully account for the possibility of catastrophic events.[34]

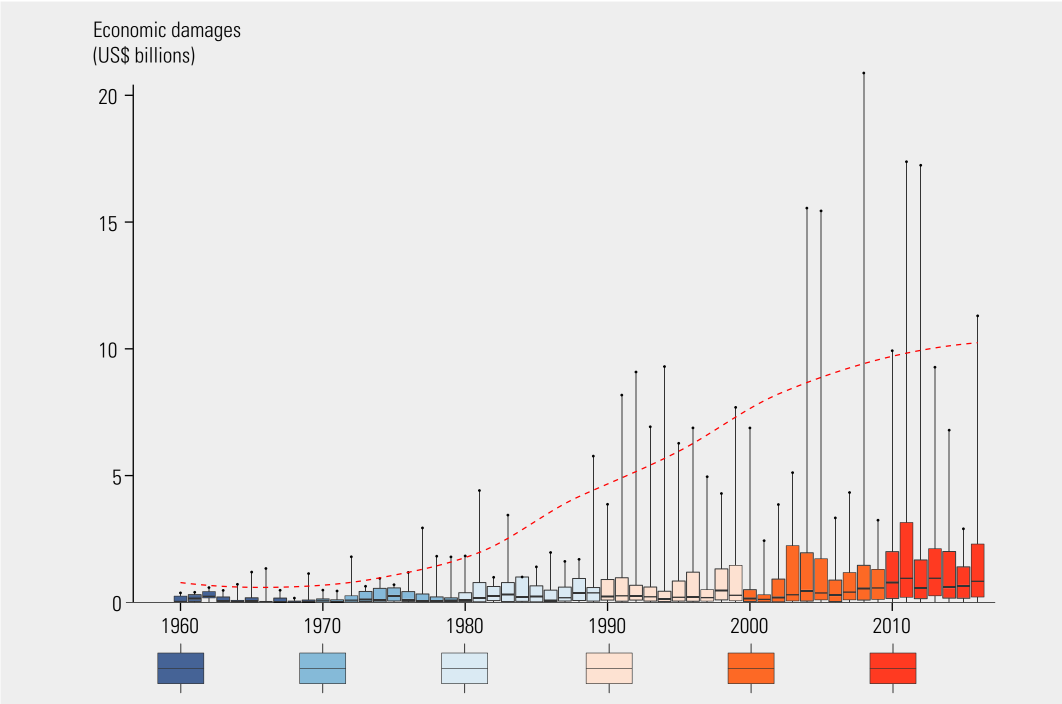
The complexities of the climate system make significant tipping points and thresholds possible

Over the past few years research has attempted to incorporate tipping points into integrated assessment models. The findings of such work have generally strengthened the case for a greater precautionary approach to the climate.[35] The bottom line is that estimates of economic effects of future climate change give some broad directional agreement, and while uncertainties abound, the costs of potential catastrophic events coupled with the pace at which the scientific evidence is accumulating on the scale of damages reinforce arguments for early and forceful action.[36] For example, there is strong evidence that the economic damages of extreme natural hazards have increased globally over the past several decades (figure 5.5). Some new modelling approaches that attempt to incorporate risk and uncertainty point to large costs associated with delays in taking forceful action on mitigation, with these costs compounding over time (a five-year delay implies a cost of $24 trillion, and a 10-year delay implies a cost of $100 trillion).[37]

The negative impacts of climate change extend to health and education. Between 2030 and 2050 climate change is expected to cause some 250,000 additional deaths a year from malnutrition, malaria, diarrhoea and heat stress.[38] Hundreds of millions more people could be exposed to deadly heat by 2050, and the geographic range for disease vectors—such as mosquito species that transmit malaria or dengue—will likely shift and could expand.[39] Lower agricultural yields due to temperature changes can affect food security, and food insecurity can worsen nutrition. Good nutrition is essential for healthy pregnancies and for early childhood survival and development, which can reduce inequalities in human development (chapter 2). It is also important for school attendance, performance and achievement.[40] Malnutrition, by contrast, complicates the course of other illnesses, such as tuberculosis and AIDS.

FIGURE 5.5

Economic damages from extreme natural hazards have been increasing



Note: Data are the yearly distribution of economic damages associated with 10,901 disasters that occurred worldwide between 1960 and 2015. Partial boxplots are coloured by decade. The lower hinge is the median, the middle line is the 75th percentile, the upper hinge is the 90th percentile and the upper whisker is the 99th percentiles. The red dashed line tracks the time progression of the 99th percentile.
Source: Coronese and others 2019.

By the end of the 21st century, unmitigated climate change could cause an additional 1.4 billion drought exposure events a year and 2 billion more extreme rainfall exposure events a year, inevitably increasing flood risk.[41] The impact of these shocks on livelihoods can impede human development, influencing factors ranging from the availability of food to the ability to pay for health care and schooling. Out-of-pocket health spending pushes almost 100 million people into extreme poverty each year.[42] Even where schooling is free, livelihood shocks can siphon children from school into income-generating activities. These interrelated, overlapping shocks, when combined, will also have consequences for mental health, which now appears in some countries' national health strategies for adapting to climate change.[43]

Climate change is likely to have already been a force for increasing income inequality between and within countries (see spotlight 5.1 at the end of the chapter), as noted in the opening of this chapter. Climate change is likewise driving inequality in other dimensions of human development. An analysis of the last 40 years further substantiates the general pattern: Temperature-related shocks hit poorer countries harder than richer countries.[44] In fact, even though some richer countries may have enjoyed small benefits on average from temperature increases, the evidence suggests that all countries will eventually be negatively affected by climate change.[45]

For health, the evidence from large-scale empirical studies on climate impacts shows:[46]

- In all regions the proportion of people vulnerable to heat exposure is rising. The elderly account for a significant portion of that vulnerability (see spotlight 5.2 at the end of the chapter). Heat stress, cardiovascular disease and renal disease are among the many causes of heat-related illness and death.[47] In 2017, 153 billion labour hours were lost because of heat, an increase of more than 62 billion hours since 2000.
- Global vectorial capacity[48] for the transmission of dengue fever virus continues to rise, reaching a record high in 2016. In other

Climate change is likely to have already been a force for increasing income inequality between and within countries. It is likewise driving inequality in other dimensions of human development words, conditions are becoming more favourable for transmission of dengue.

- In the highlands of Sub-Saharan Africa, malaria vectorial capacity has increased 27.6 percent since the 1950 baseline.
- In the Baltic region, changes in sea surface temperatures have steadily increased suitability for cholera outbreaks.

Since poor countries—and poor and vulnerable people within countries—are disproportionately burdened by these health conditions, climate change has already put pressure towards greater health inequalities, both within and between countries.[49]

In many developing countries exposure to floods, droughts and hurricanes in utero and during early life impair later education and cognitive outcomes. In Southeast Asia higher than average temperatures during the prenatal period and early life are associated with fewer years of schooling, perhaps because heat has a negative impact on education attainment where local climates are historically warm and wet.[50] In some developed countries there is also evidence that prenatal heat exposure increases the risk of maternal hospitalization and of hospital readmission in the first year of life for newborns, with differentiated impacts across segments of the population that tend to increase maternal health gaps.[51] These and other potential impacts of climate change on education outcomes have clear inequality implications, both within and across generations.

Climate change's biophysical and social dimensions are working in the same direction: towards worsening inequality

As noted above, climate impacts are often framed as the interaction of exposure and vulnerability.[52] Exposure can be driven by vulnerability, as vulnerable groups are driven to less secure, more disaster-prone locations, especially in urban areas.[53] Such vulnerability-driven exposure is widespread. The location or operation of polluting factories and expressways, waste management[54] and landfills, gazetted parks and conservation areas[55], and even airports[56] and other transportation hubs (and their expansion) in or near vulnerable communities rests on decisions that can take advantage of those communities' relative lack of power—either explicitly or implicitly. For example, cost-benefit analyses for policy decisions—analyses that purport to be objective, impartial or efficient—can, among other potential pitfalls, implicitly take advantage of vulnerable communities by misconstruing ability to pay for willingness to pay, thereby systematically undervaluing those communities' needs and desires.[57]

Consider the impact of climate change on crop yields. Without improved crop varieties, climate change will cause significant declines in average crop yields over the course of the 21st century in many regions. The largest declines will occur where food insecurity is already a threat.[58] Climate change–related inequality is partly a biophysical phenomenon of differential exposure. In regions where natural climate variability is lower—such as the tropics, where many developing countries are found—climate signals will emerge from the "noise" more quickly and easily in the tropics.[59] Recent modelling shows that poorer countries will generally experience weather-related changes before richer countries. Regional heat extremes, for example, are expected to change noticeably in Africa, large parts of India and most of South America after 1.5°C of warming, but mid-latitude regions will not see such changes until global temperatures increase by about 3°C.[60]

Climate-induced inequality is also a social phenomenon. Vulnerable people will suffer more because, for instance, with less irrigation, yields are more weather dependent. With fewer and less robust cereal market stabilization mechanisms, livelihoods can be volatile. With less income and wealth, poor people are less able to absorb spikes in food prices. With discriminatory laws, marginalized groups are burdened with compounding insecurities. Climate change is expected to exacerbate these and other vulnerabilities, its biophysical and social dimensions working in the same direction: towards worsening inequality.[61]

Recent modelling has started to capture the interaction between biophysical and social aspects through the spatial correlation of countries' cereal productivity and gains from trade. Climate change, instead of affecting countries' cereal yields uniquely or independently, will cause regional changes that affect countries' yields more similarly the closer countries are to one another. So, developing countries will take a direct hit from climate change as cereal yields decline and an additional hit when neighbouring countries also experience a decline. The decline in productivity across neighbouring trade networks reduces the gains from trade, which could worsen income inequality among countries by an additional 20 percent over the course of the 21st century.[62]

Feedback mechanisms have long been important in climate science, especially in terms of biophysical systems. Economic feedback mechanisms, such as knock-on trade effects, are coming increasingly into view. Another is the impact of climate-induced GDP declines on carbon emissions. Climate-driven decreases in GDP may in turn decrease energy use and carbon emissions over the course of the 21st century. In some scenarios fossil fuel emissions drop 13 percent, enough to offset positive carbon emission feedback mechanisms from natural systems.[63]

Here again recent empirical analysis complements income inequality projections. One study using longitudinal data from more than 11,000 districts in 37 countries suggests that since 2000, warming has made tropical countries at least 5 percent poorer than they otherwise would be.[64] The study also sheds light on the importance of exposure and vulnerability as mechanisms for climate-related inequalities: Disparities in the economic impacts of warming are driven more by differences in exposure than differences in underlying vulnerability. In other words the negative impacts of warming cut similarly across communities of all levels of development. Richer ones are not insulated from warming because they are rich, and poorer ones are not uniquely vulnerable because they are poor. Part of the challenge is that exposure to damaging temperatures is much more common in poor regions.

That study's findings, which imply a primacy of exposure, correspond to those of another recent study on climate's impacts on education across 29 countries, mostly in the tropics. It found that the level of education of the head of household did not buffer households from the long-term impacts of adverse climate events.[65] In fact, children from more educated households suffered greater education penalties, with hot temperatures having a levelling effect on education attainment. On the other hand, a recent study using global data spanning four decades found the opposite: that richer countries are more insulated than poorer countries from the effects of temperature increases.[66]

Thus, the debate continues around an unsettled, and unsettling, question: Might climate change overwhelm response capacities, as typically conceived, across many—perhaps all—levels of human development? For countries where climate change is an existential threat, the answer is a resounding yes. For others, if exposure ultimately matters much more than vulnerability, climate change may not be something that countries can necessarily grow or "develop" out of.

Countries have already started adopting tools, implementing policies and making investments that build resilience to climate change and other kinds of shocks, precisely because old ways of doing things are insufficient to the task.[67] They are charting different development paths that try to respond to the sobering, unfolding reality of climate change. Data and technology, ranging from satellite imagery to drought-tolerant seeds, are seen as important parts of forward-looking climate adaptation.[68] So are fiscal rules that help protect economies from unexpected climate shocks.[69] Plus, building resilience is a good economic investment. The Global Commission on Adaptation found that every $1 invested in adaptation could result in benefits worth $2–$10.[70]

So, empirical analyses that emphasize exposure-driven pathways need not undermine the rationale for resilience. On the contrary, such studies provide important historical lessons for why conscious efforts to build resilience matter—and matter urgently. From a forward-looking inequality perspective the challenge is to ensure that climate resilience is a broadly shared capability and a collective investment in human development rather than a capability that is the reserve of only a select group of countries and communities that can most afford it, thereby opening a new area of divergence in the face of a global climate crisis.

As some analysts have noted, some impacts of climate change may be smaller than the impacts of demographic change and economic growth.[71] Poverty projections at certain levels of warming similarly depend at least as much on development scenarios as on warming itself.[72] The 2011 Human Development Report probed the ways various environmental and inequality scenarios might affect human development across low, medium, high and very high human development countries.[73]

A world of greater inequality is one possible future, depending on the choices societies

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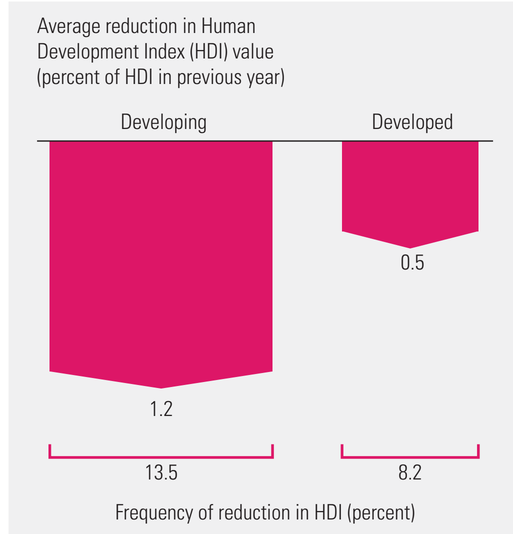
ultimately make. Although unmitigated climate change will continue to narrow those choices over time—and indeed some climate change is already baked in, owing to legacy emissions—much can still be changed. Carbon dioxide and other greenhouse gas emissions are the product of human choices mediated largely by biophysical processes as well as by economic and social systems.[74] Development paths that prioritize resilience and inclusion can be chosen, too. The disproportionate impacts on poor countries—and poor and vulnerable people within countries—largely reflect and are likely driven at least in part by structural inequalities. If such inequalities—across income, wealth, health, education and other elements of human development—are in no small part the result of social choices, as this Report argues, the course of climate change and the way it ultimately affects inequality have a lot of choice built in. There still is time to choose differently.

FIGURE 5.6

Human development crises are more frequent and deeper in developing countries



Source: Human Development Report Office calculations for countries with annual data for 1980–2017.

Differentiated paths in the ability to adapt to climate change: Convergence in basic, divergence in enhanced capabilities yet again?

The effects of shocks do not appear to be randomly distributed; instead, they seem to do more harm to the more vulnerable

This section considers asymmetries in capabilities relevant to withstanding disasters linked to natural hazards. The effects of shocks (linked not only to disasters but also to other causes ranging from conflict to terms-of-trade crises) do not appear to be randomly distributed across different groups; instead, they seem to do more harm to the more vulnerable. Over 1980–2017 developing countries recorded a higher frequency of crises in human development, measured as a yearly reduction in Human Development Index (HDI) value, than developed countries did, and the impact of these reductions was more severe. The average reduction in HDI value when facing a crisis was 0.5 percent for developed countries but 1.2 percent for developing countries (figure 5.6).

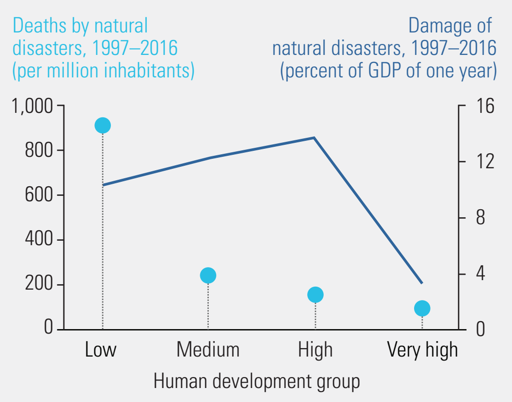
Low human development countries are more exposed to the human and economic losses from shocks from all sources. While some extreme negative shocks can have an equalizing effect within countries,[75] people in very high human development countries are better shielded from the costs because they have more options for responding to shocks, greater ability to move and more resources with which to recover. People in low human development countries are 10 times more likely than people in very high human development countries to die due to natural hazards leading to disasters. And the relative cost (as a percentage of GDP) of disasters is about four times lower in very high human development countries than in other countries (figure 5.7). These results are merely suggestive and should be seen in the context of broader trends in the global reduction in causalities linked to natural hazards and accelerating increases in the economic damages—with asymmetric impacts across climate regions depending on the nature of the hazard.[76]

Developing countries tend to have fewer resources to prevent and respond to disasters linked to natural hazards.[77] The support and enforcement of building codes, the construction and maintenance of basic infrastructure, and the development of contingency plans, among other investments, demand resources. And with poverty and deprivation much more prevalent in developing countries, people are more vulnerable.[78]

Within countries the effects of disasters vary with income. Poorer people are more likely to be affected by natural hazards. In 12 of 13 country studies from developing countries, the

FIGURE 5.7

The lower the level of human development, the more deadly the disasters



Note: Data are simple averages across human development groups. Country values are the sum of population or GDP over 20 years divided by the population or GDP in one representative year.
Source: Human Development Report Office calculations based on data from the Centre for Research on the Epidemiology of Disasters' Emergency Events Database (www.emdat.be/database; accessed 28 October 2019).

percentage of poor people affected by natural hazards was larger than that of nonpoor people.[79] In El Salvador and Honduras people in the lower quintiles of the income distribution were more likely to be affected by floods and landslides (figure 5.8).

There has been progress curbing the effects of recurring shocks behind disasters. Even though too many preventable casualties remain from events such as flooding, drought and earthquakes, total causalities per recorded event have declined. In the 1960s and 1970s there were twice as many deaths, despite a fraction of the number of recorded events, as over the past 20 years (figure 5.9). This reflects good work on disaster prevention, preparation and response.

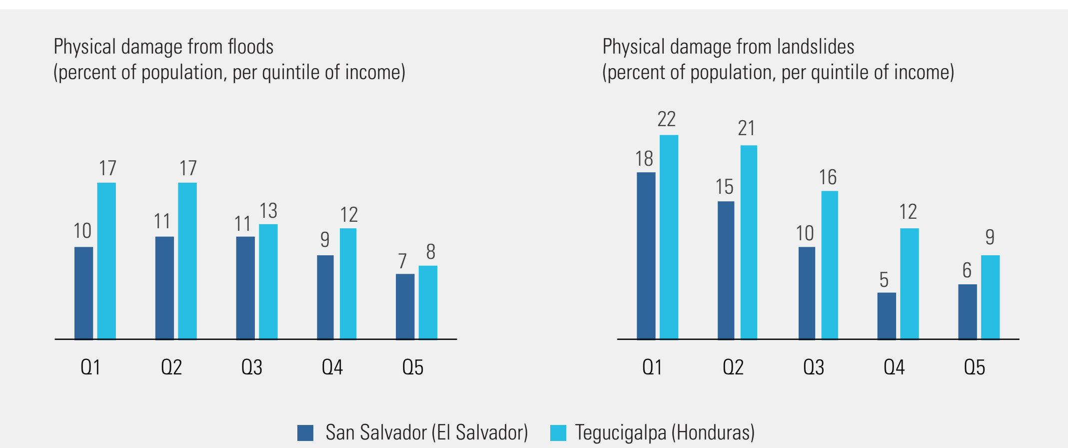
International instruments—including the Yokohama Strategy (1994) and the Hyogo Framework for Action (2005), leading to the 2015 Sendai Framework for Disaster and Risk Reduction—have mobilized stakeholders across the globe to invest in disaster risk reduction.[80] As a result, developing and developed countries are converging to lower vulnerability.[81]

But progress in reducing the absolute number of deaths appears to have plateaued since the 1990s—likely the result of two forces. One is further progress in adaptation, leading to convergence towards greater preparation to recurrent events. Second is the greater frequency and severity of shocks, possibly related to climate change—increasing the human cost in poorer areas, creating inequalities. The IPCC's 2014 Synthesis Report warned that "continued emission of greenhouse gases will cause further warming [...] increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems."[82] Climate change "risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development."[83] If disasters tend to hit disadvantaged people harder, climate change could make vicious cycles of low outcomes and low opportunities more persistent.[84]

If disasters tend to hit disadvantaged people harder, climate change could make vicious cycles of low outcomes and low opportunities more persistent

FIGURE 5.8

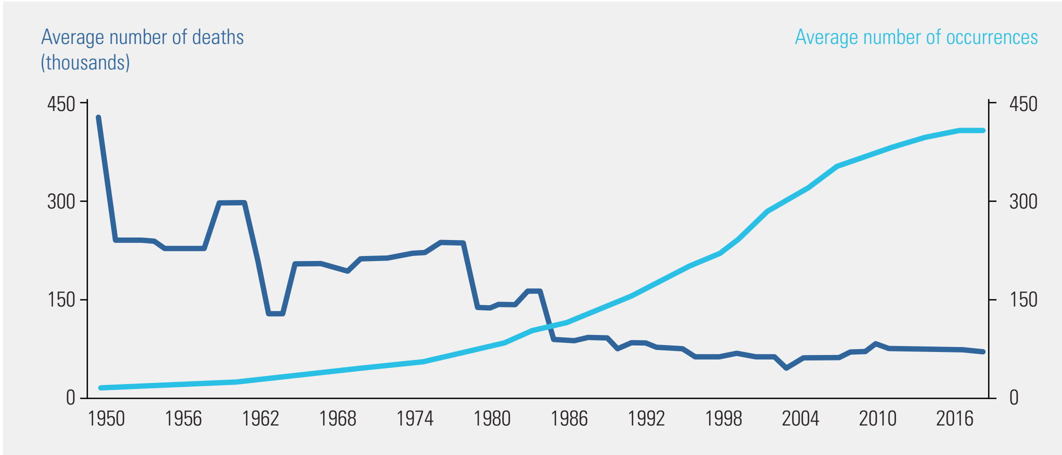
In El Salvador and Honduras people in the lower quintiles of the income distribution were more likely to be affected by floods and landslides



Source: Hallegatte and others (2017), based on Fay (2005).

FIGURE 5.9

Fewer deaths in the 2000s than in the 1960s and 1970s despite more occurrences of natural disasters



Note: Data are rolling 20-year averages.
Source: Centre for Research on the Epidemiology of Disasters' Emergency Events Database (www.emdat.be/database).

Shocks, including those related to climate change, can push people into poverty. In Senegal, households affected by a natural disaster were 25 percent more likely than others to fall into poverty during 2006–2011.[85] The impacts of natural disasters go beyond income. In Ethiopia, Kenya and Niger children born during droughts are more likely to suffer from malnutrition.[86] In Cameroon climate shocks reduce girls' chances of finishing primary school by 8.7 percentage points. In Mongolia, wildfires reduced the probability of completing secondary school by 14.4 percentage points.[87]

Climate change may also increase forced population displacements. In 2017 there were 18.8 million new internal displacements associated with disasters across 135 countries and territories, most caused by floods (8.6 million) and storms, including cyclones, hurricanes and typhoons (7.5 million). While countries at different incomes were affected, most displacements took place in developing countries,[88] where the risk of becoming homeless due to disasters is more than three times higher than in developed countries.

In sum, climate change impacts mediated by disasters differ across the globe, with shifts in both the nature of the events and their probability. This affects the ability to measure the effects and to formulate policies (box 5.3). Developed countries appear to have a broader set of resources and institutions that enable them to prepare for and respond better to surprise shocks, including climate-related ones.[89]

Environmental inequalities become a lens to understand and address other forms of inequality, and the distribution of power and decisionmaking more broadly

Environmental inequalities and injustices are pervasive—a global snapshot of waste, meat consumption and water use

Environmental inequalities and environmental injustices have much deeper roots than the current climate crisis.[90] The environmental justice movement has had strong links with other social justice movements.[91]

Ultimately, environmental inequalities—and environmental justice—are not just about the environment. They give expression to stigmatizing social norms and discriminatory laws and practices, which are manifestations of inequality in different dimensions, many taking shape as horizontal inequalities.[92] Environmental inequalities thus become a lens to understand and address other forms of inequality, and the distribution of power and decisionmaking more broadly.

Many environmental inequalities and injustices persist around the world. They are many, pervasive and persistent because differences in power (and how it is wielded) are as well. Environmental inequalities operate at many scales, reproducing and reinforcing familiar gradients, as seen in the preceding climate discussion and elsewhere in this Report. The rest

BOX 5.3

When history is no longer a good guide

When an event recurs, societies are likely to adapt through learning about four aspects:

- The nature of the shock.
- The probability of occurrence.
- The effects of the event on well-being.
- The actions to reduce damage.

Common knowledge accumulates over time, informed by historical conditions, with lessons learned about what works to reduce the negative effects of shocks. So when the events are uncertain but their effects are "known" from historical experience, coping mechanisms are easier to develop. The upshot: a substantial reduction in the negative effects of shocks.[1] This sort of adaptation occurs in all societies in different ways.

However, when events fall outside of the historical norm, there is significant unpredictability in the four aspects outlined above. And with climate change, it appears that communities around the world will confront more and more "surprises" (shocks outside of the historical experience).[2]

With climate change the basic structure of shocks does not disappear but evolves into a different process. Current policy frameworks may become incomplete. Some effects of climate change might take the form of "black swans," low-probability but high-impact events to which both public and private institutions are ill-prepared to respond. In other cases the effects are completely unknown and unpredictable: when events never experienced before are observed (such as new record temperatures). The ability to successfully adapt to climate change depends on resources for an enhanced system of preparation and response.[3]

Notes

1. See, for instance, Clarke and Dercon (2016). 2. For an example based on the climate impact on ocean temperature, see Pershing and others (2019); for the implications in terms of the need to develop a more prospective, as opposed to retrospective, ability to respond to surprise shocks, see Ottersen and Melbourne-Thomas (2019). 3. See, for instance, Farid and others (2016).

Source: Human Development Report Office.

of this chapter takes a look at a few of them, in the forms of waste, meat and water use.

Waste

Waste[93] comes from the flow of materials, often in the form of products, through society. More waste generally means more upstream extraction of raw materials, from mining to deforestation, with negative impacts on natural habitats. It also means more conversion of raw materials into products, which usually entails the intensive use of industrial energy (especially from fossil fuels), the consumption of water and the emission of pollutants across interconnected networks.

Waste management requires transportation and energy. It is a notable contributor to climate change. Nearly 5 percent of global greenhouse gas emissions are due to waste management (excluding transportation), driven mainly by food waste and improper management.[94] When burned openly, waste contributes to air pollution and health hazards; when deposited in landfills, it takes up space and can leach toxins into soil and groundwater.

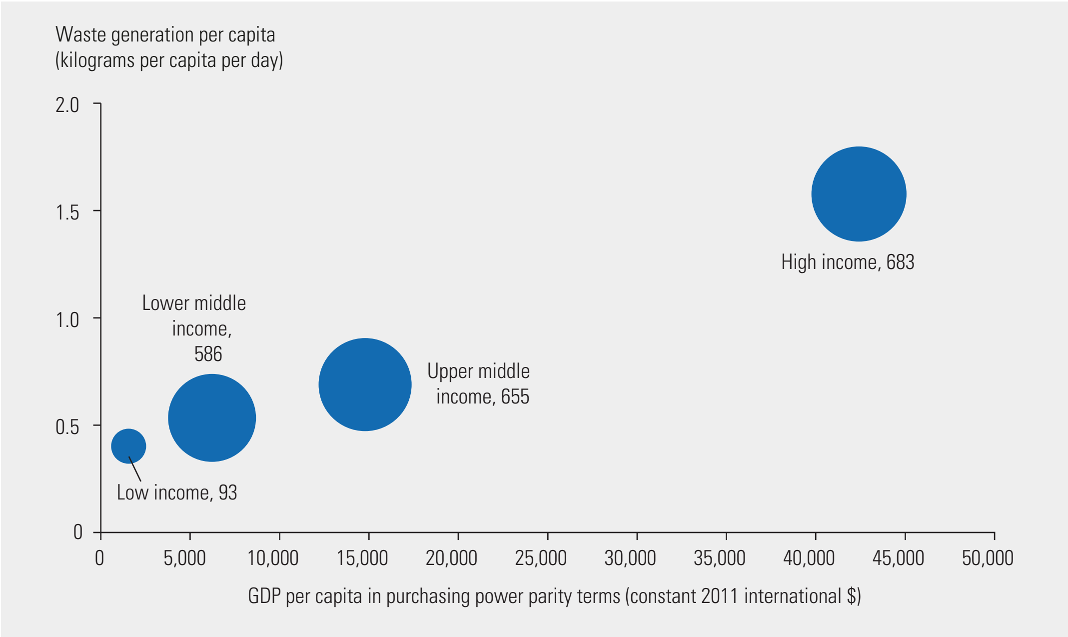
Waste also finds its way into waterways and oceans. More than 270,000 tonnes of plastic waste are in the world's oceans,[95] where gyres concentrate it in enormous garbage patches. Three have been identified so far: one in the North Pacific (the Great Pacific Garbage Patch), one in the South Pacific and one in the North Atlantic.[96] The Great Pacific Garbage Patch measures 1.6 million square kilometres (three times the size of France), and parts of it have upwards of 100 kilograms of plastic per square kilometre.[97] Plastics can circulate in oceans for years, degrading in sunlight into microplastics, forming a sort of peppery soup that birds and fish consume.[98] Marine microplastics are not confined to the sea surface; they have also been documented in the water column and animal communities of the deep sea.[99] The largest living space on earth, the deep sea, may also prove to be one of the largest reservoirs of microplastics, which have also been found in the atmosphere and remote mountains.[100]

In 2016 the world generated just over 2 billion metric tonnes of solid waste, or 0.74 kilogram per person per day, an average that varies widely by country (0.11–4.54 kilograms).[101] Under a business-as-usual scenario total waste is expected to grow to 3.4 billion metric tonnes by 2050—and to grow fastest in low-income countries, tripling by 2050. Richer countries produce more waste per capita and poorer countries less (figure 5.10).

More than 270,000 tonnes of plastic waste are in the world's oceans, where gyres concentrate it in enormous garbage patches

FIGURE 5.10

Richer countries generate more waste per capita



Source: Kaza and others 2018.

Rates of waste collection vary considerably between and within countries. Waste collection is nearly universal in high-income countries, with little disparity between urban and rural areas. At lower income levels waste collection rates decline steadily, and stark disparities between urban and rural areas open up. About 40 percent of global waste is disposed of in landfills, and one-third is openly dumped. The vast majority of waste in low-income countries is openly dumped, and open dumping steadily declines in favour of landfills, as country income increases. Incineration is used primarily among upper-middle and high-income countries. Industrial waste typically far exceeds municipal solid waste and shows a steep gradient by country income. Generally, recycling is a significant waste disposal method only in high-income countries.[102]

In addition to urban-rural divides, inequalities in waste are evident within countries.[103] Waste sites, polluting factories, and noisy airports and expressways are eyesores and health hazards that no community wants to be near. Their location in poorer communities thus reflects other forms of inequality.

Meat consumption

Livestock production is important for livelihoods and economies. It employs at least 1.3 billion people worldwide and supports the livelihoods of some 600 million poor households, mostly in developing countries,[104] where it accounts for 20 percent of total agricultural output. Animal-source foods are important components of healthy, nutritious diets, contributing especially to children's balanced growth and cognitive development. Among many other benefits, livestock can also help cushion households from negative impacts of shocks, such as droughts.[105]

Livestock is the world's largest agricultural user of land resources, with pasture and cropland dedicated to the production of feed accounting for almost 80 percent of all agricultural land (while providing only 37 percent of the world's protein and 18 percent of its calories—after including aquaculture).[106] About a fifth of available freshwater is directed to livestock production.[107] The intensity of resource use by livestock is closely tied, directly and indirectly, to energy inefficiencies in animal food production systems. Most plant matter that animals ingest, including

Livestock is the world's largest agricultural user of land resources, with pasture and cropland dedicated to the production of feed accounting for almost 80 percent of all agricultural land

feed, is used up by the animals themselves rather than stored as muscle or fat for consumption by people. The loss ratio varies but has been estimated to be as high as 90 percent,[108] making animals a highly inefficient source of calories for people. For each calorie, the production of animal foods requires much more land and resources than the production of an equivalent amount of plant-based foods.[109]

Up to 80 percent of greenhouse gas emissions generated by the global agricultural sector are from livestock production, which adds up to 7.1 gigatonnes of carbon dioxide equivalent per year—or 14.5 percent of global anthropogenic greenhouse gas emissions.[110] Emissions emanate from across the supply chain, with feed production, enteric fermentation, animal waste and land use changes among the most important sources at the farm level).[111] Cattle are responsible for about two-thirds of livestock-related carbon dioxide equivalent emissions, largely in the form of methane emissions, a greenhouse gas roughly 30 times more potent than carbon dioxide in trapping heat.[112]

Improving farm management is one way to reduce these and other environmental impacts. For many major agricultural products, greenhouse gas emissions vary widely across farms. Livestock is no exception. For beef the top 10 percent of emitters produce up to 12 times as much greenhouse gases per unit of protein as do the bottom 10 percent of emitters. The problem is concentrated at the top: The majority of emissions from beef herders come from the highest impact 25 percent of producers. One-size-fits-all approaches are unlikely to work, but significant opportunities exist to reduce variability among farms and mitigate the environmental impacts of beef, livestock and agricultural production generally. Reducing losses across the supply chain is another option, as is reducing demand for meat where possible and appropriate. For instance, on a per unit of protein basis, greenhouse gas emissions from the bottom 10 percent of beef producers still exceed those from peas by a factor of 36.[113]

The environmental benefits of dietary change exceed what producers can achieve on their own (box 5.4).[114] But the trend is in the opposite direction, owing mostly to population growth but also to other variables, such as urbanization and rising per capita incomes, that tend to increase demand for animal foods.[115] Between 2000 and 2014 the global production of meat rose 39 percent and milk 38 percent. The Food and Agriculture Organization of the United Nations estimates that by 2030 meat production will increase another 19 percent from that in 2015–2017, with developing countries accounting for almost all the increase (figure 5.11). Milk production is projected to grow 33 percent in the same period.[116] Even

Up to 80 percent of greenhouse gas emissions generated by the global agricultural sector are from livestock production, which adds up to 7.1 gigatonnes of carbon dioxide equivalent per year—or 14.5 percent of global anthropogenic greenhouse gas emissions

BOX 5.4

The impacts of a global dietary shift on sustainable human development

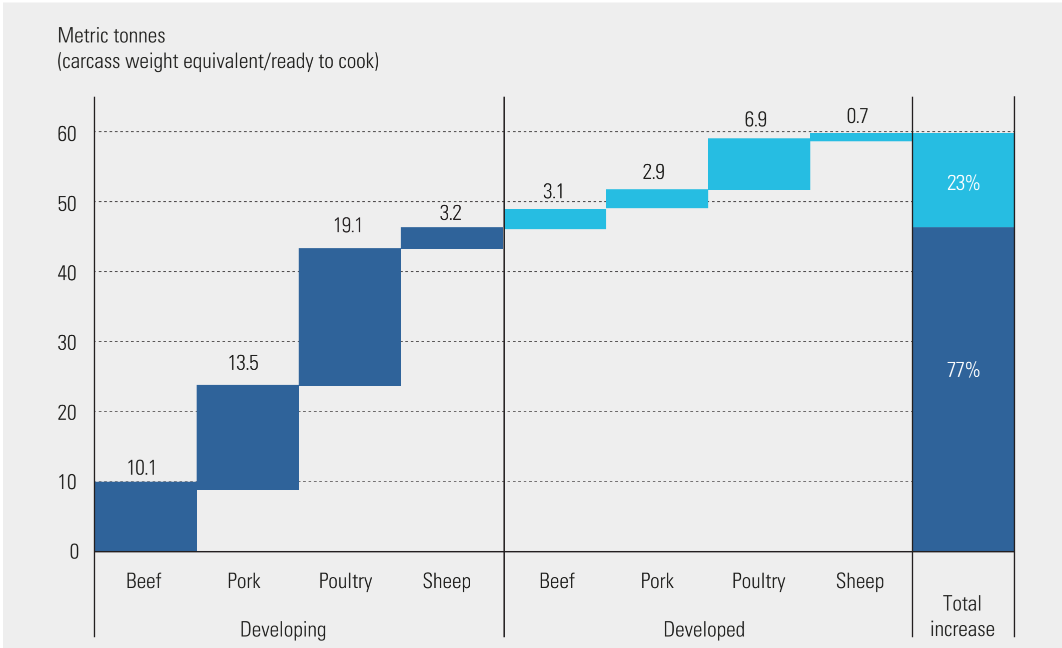
A global dietary shift favouring more plant-based foods and following guidelines for good nutrition would impact several dimensions of sustainable human development, both in aggregate and in distribution. The climate would also benefit. One estimate is that dietary changes could reduce growth in food-related greenhouse gas emissions by 29–70 percent by 2050.[1] On a per capita basis, food-related emissions could fall twice as much in richer countries as in poorer ones, narrowing the inequality in carbon dioxide equivalent emissions between them.[2] This would be driven primarily by reductions in red meat consumption, which also has health benefits[3] (though a series of recent systematic reviews have, with some controversy, called into question the degree to which reducing red and processed meat consumption improves key health indicators).[4] Numerous studies have estimated the impacts of nutritious, plant-based diets, including on overall mortality reduction.[5] The benefits, however, are not evenly shared. On a per capita basis, high- and middle-income countries might benefit more, owing to reduced red meat consumption and lower energy intakes.[6] A global shift to sustainable, nutritious, plant-based diets, therefore, could improve health overall globally while potentially worsening some kinds of health inequalities among countries.

Notes

1. Springmann and others 2016. 2. Springmann and others 2016. 3. Springmann and others 2016. 4. Han and others forthcoming; Vernooij and others forthcoming; Zeraatkar, Han and others forthcoming; Zeraatkar, Johnston and others forthcoming. See also Carroll and Doherty (2019) and Johnston and others (forthcoming). 5. Key and others 2009; Le and Sabaté and 2014; Orlich and others 2013; Springmann and others 2016; Tilman and Clark 2014. 6. Springmann and others 2016.

FIGURE 5.11

Developing countries will drive most of the rise in meat production to 2030



Source: FAO 2018.

though developing countries will drive future growth in meat production, the world's richer countries eat meat most intensively, and this is expected to continue well into the future.[117]

As incomes rise, food expenditures favour more nutrient-rich foods, such as animal foods (Bennett's Law).[118] This is explained partly by the nutritional benefits of meat and other animal products, especially for children in poorer households. There are clear inequalities in spending on meat across income quintiles, but as incomes increase, inequalities in meat consumption decline.[119]

Projections of meat consumption—and inequalities—do not account for wild cards such as technological breakthroughs that could greatly alter current trajectories and reduce environmental damages. An estimated 31 start-ups are working to become the first company to market synthetic animal protein.[120] Competition will also come from elsewhere, particularly novel vegan meat replacements[121] New areas of divergence could open up, since products are likely to be rolled out initially in rich countries. And if these foods offer additional benefits in reducing noncommunicable diseases, they could exacerbate health inequalities.

Global water withdrawal has nearly septupled over the last century, outpacing population growth by a factor of 1.7. Most of it is for agricultural use

Water use

Water and sanitation are essential for human development. They have also been recognized as human rights.[122] Despite the expansion of safely managed drinking water and sanitation services over the past two decades, significant gaps remain. As of 2017, 29 percent of people worldwide lacked access to safe drinking water. The gap is even higher for sanitation, at 55 percent.[123]

How much water humans use and in what ways have consequences for the environment and societies. Global water withdrawal has nearly septupled over the last century, outpacing population growth by a factor of 1.7.[124] Most of it is for agricultural use (69 percent), followed by industry (19 percent) and municipalities (12 percent).[125] Attempts have been made to establish a meaningful safe operating space for water use at the global level.[126] The conceptual underpinnings are also being revisited to consider subnational boundaries and to expand beyond consumptive use of blue water (freshwater in the form of rivers, lakes, groundwater and so on) to include green water (soil moisture that evaporates or transpires) and other elements of the dynamic, global hydrological cycle. Much analytical, management and policy work remains at the national level and at smaller spatial scales, such as the basin.[127]

It is at these spatial scales where water stress, scarcity and crises are manifest. By some estimates, as many as 4 billion people, about two-thirds of the global population, live under conditions of severe water scarcity for at least one month of the year.[128] Half a billion people face water scarcity year-round.[129] One-third of the world's 37 largest aquifer systems are considered stressed.[130] Globally, enough freshwater is available to meet annual demand, but spatial and temporal mismatches between water and supply drive water scarcity. The 2006 Human Development Report argues forcefully that limits on physical supply are not the central problem but rather that "the roots of the crisis in water can be traced to poverty, inequality and unequal power relationships, as well as flawed water management policies that exacerbate scarcity."[131]

Water footprints are one way to understand and measure human use of water. Every country has a national water footprint, the amount of water produced or consumed per capita. The footprint includes virtual water, which is the water used in the production of such goods as food or industrial products. Across countries, agriculture constitutes the single greatest component (92 percent) of the water consumption footprint, with cereals the largest subcomponent (27 percent), followed by meat (22 percent) and milk products (7 percent).[132] Because the national water footprint of consumption includes imported virtual water, some countries have water footprints much larger than might be expected based on national water resource endowments alone. The transboundary movement of virtual water is significant. Over 1996–2005 about one-fifth of the global water footprint was bound up in exported goods, with trade in crops the lion's share.[133]

Water footprints vary considerably across countries. The widest variation is for developing countries. Indeed, some of them have national water footprints of consumption on par, or exceeding, those in developed countries.[134] The high water footprints in some developing countries have been attributed more to lower efficiencies of water use in consumed products than to higher overall consumption of those products per se,[135] though the latter can be relevant as well.[136] This points to the enormous potential that remains for efficiency improvements.

Water access and consumption also vary greatly within countries. Consider access to safe drinking water and sanitation, where significant inequalities persist between and within countries. Gaps in coverage between rural and urban areas have long been important. Globally, over the past two decades the gaps have narrowed, falling from 47 percentage points to 32 for safely managed water services and from 14 percentage points to 5 for safely managed sanitation services. In many countries inequalities by wealth are significant. In some, basic water and sanitation coverage for the wealthiest quintile is at least twice that for the poorest quintile (figure 5.12). For water, wealth inequalities generally exceed urban-rural ones within the same country. While water and sanitation coverage has generally improved over the past two decades across most, but not all, countries, inequalities by wealth have shown no such general trend. In some countries inequalities have declined; in others they have increased.[137]

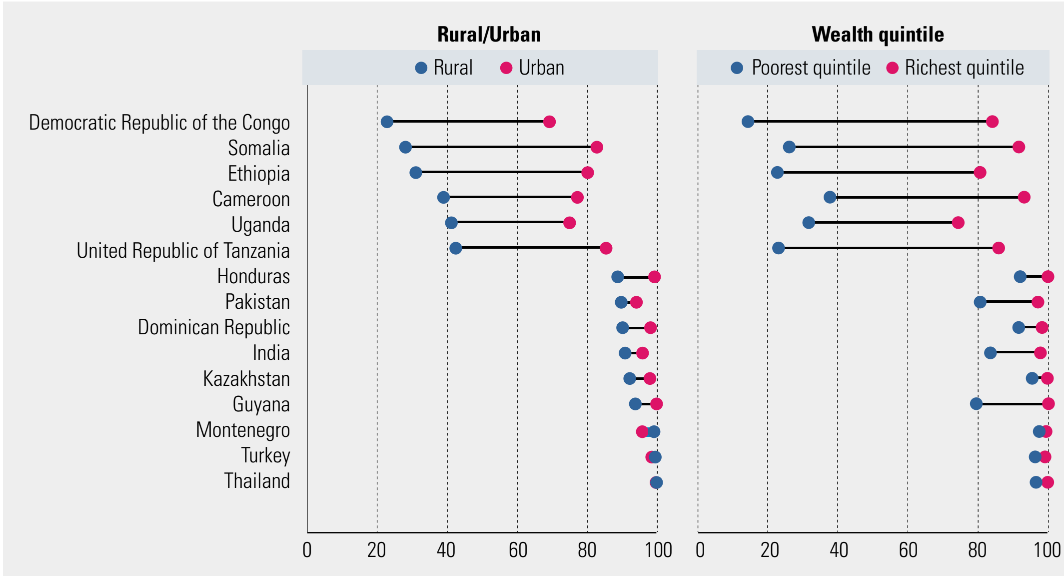
In many countries, basic water and sanitation coverage for the wealthiest quintile is at least twice that for the poorest quintile

As with urban-rural divides, national averages can mask differences and deprivations at lower levels. In South Africa the national Gini index for piped water is .36, but this varies considerably across the country's provinces, from .06 (least unequal) to .57 (most unequal).[138] Reducing inequality in water access and use cannot mean denying people their right to water, a right embedded in South Africa's constitution and affirmed by legislation that includes sanitation.[139] The human right to water and sanitation is also affirmed in the Sustainable Development Goals. The very realization of this right should go a long way in reducing inequalities.

Increasingly severe water-related crises around the world are driving what some have argued is a fundamental transition in freshwater resources and their management. Approaches that focus singularly on meeting water demand are giving way to more multifaceted ones that recognize various limits on supply, broader ecological and social values of water, and the costs and efficiency of human use. Nexus approaches are emerging that identify and respond to the way in which water is linked to other resources, such as energy, food and forests.[140]

FIGURE 5.12

In some countries basic water and sanitation coverage for the wealthiest quintile is at least twice that for the poorest quintile



Source: UNICEF and WHO 2019.

Economic production systems, demographic trends and climate change are all playing big parts in this shift. So is technology. Over the past two decades, for example, the spread of sophisticated precision irrigation technology has improved efficiency of water use in agriculture. Modern technologies are also transforming wastewater treatment and reuse, as well as the economic viability of seawater desalination. Remote sensing provides real-time data. Smart water meters and improved water pricing policies can both improve efficiency.[141] The response to and shaping of these new tools and trends—the extent to which inclusion is made a bedrock principle of a shift to freshwater sustainability—will play a big role in determining whether the human rights to water and sanitation are progressively realized, inequalities in access to both are reduced and a path of sustainable water use is embarked on.

Environmental inequalities are largely a choice, made by those with the power to choose. Remedying them is also a choice

A break from the past: Making new choices for people and planet

This chapter has shown that environmental inequalities are many and that they are inextricably linked with inequalities in human development. They reflect the way economic and political power—and the intersection of the two—is distributed and wielded, both across countries and within them. Often, these environmental inequalities and injustices are the legacy of entrenched gradients in power going back decades; for climate change, centuries. Countries and communities with greater power have, consciously or not, shifted some of the environmental consequences of their consumption onto poor and vulnerable people, onto marginalized groups, onto future generations. Environmental inequalities are largely a choice. Remedying them is also a choice, but doing so cannot come at the expense of achieving the full suite of people's human rights.

Technology has been central to the climate story. It has underpinned development trajectories that are directly linked to the climate crisis. Technology, in the form of renewables and energy efficiency, offers a glimpse that the future may break from the past—if the opportunity can be seized quickly enough and broadly shared.[142] If so, both people and planet win. The way people grapple with these and other technologies so that they encourage, rather than threaten, sustainable and inclusive human development is the subject of the following chapter on technology.

The uptake and broad diffusion of climate-protecting technologies old and new will be critical in charting new development paths for all countries. Historical development paths have exacted environmental and social tolls that are too great. They must change, and there are encouraging signs that they are. The SDGs, the Paris Agreement and renewed interest in and expansion of progressive carbon pricing offer promising paths forward. So do efforts thus far at building climate resilience. But much more on the policy front needs to be done urgently, with developed and developing countries working together, to avoid dangerous climate tipping points and to ensure that poor and vulnerable people are not left behind. Chapter 7, which takes a panoramic look at policy options across the Report, discusses some potential policies that help address climate change and inequality together in the hope that they help countries chart their paths for more sustainable, more inclusive human development.

Historical development paths have exacted environmental and social tolls that are too great. They must change, and there are encouraging signs that they are

Spotlight 5.1

Measuring climate change impacts: Beyond national averages

A recent study that moved beyond national averages to a more granular look at climate change impacts in 3,143 counties across the continental United States[1] could signal the future for climate change economic impact assessments—partly because some of the model's parameters were linked to real-world, observed data.

The study found significant spatial heterogeneity in agricultural yields and all-cause mortality. Projected economic impacts varied widely across counties, from median losses exceeding 20 percent of gross county product to median gains exceeding 10 percent. Negative economic impacts were concentrated in the South and Midwest, while the North and West showed smaller negative impacts—or even net gains.

Climate change will worsen inequality in the United States because the worst impacts are concentrated in regions that are already poorer on average

The study concluded that climate change will worsen inequality in the United States because the worst impacts are concentrated in regions that are already poorer on average. By the latter part of the 21st century, the poorest third of counties are projected to experience damages of 2–20 percent of county income. Effects in the richest third are projected to be less severe, ranging from damages of 6.7 percent of county income to benefits of 1.2 percent. Nationally, each 1°C increase in global mean surface temperature will cost 1.2 percent of GDP.

The study does not address one of the main coping mechanisms for climate change: migration. Migration would affect national impact estimates as well as the absolute costs and benefits for individual counties. In theory, migration could also dampen the impact on inequality, as those experiencing the most negative impacts move to areas less affected and with more opportunities. The United States has a long history of migration for economic opportunity, including in times of environmental and economic crisis (such as the Dust Bowl).[2] In practice today, however, some evidence suggests migration may not be a significant coping mechanism for poor people, thereby worsening inequality. Mobility in the United States has fallen in recent decades.[3]

While in middle-income countries warming has increased emigration to cities and other countries, in poorer countries warming has reduced the likelihood of emigration.[4] Although this does not mean that poorer people in rich countries are less likely to migrate in response to climate change, it does indicate that other variables—perhaps poverty-related ones at various levels—can interact with climate change to shape migration likelihood and overall coping capacity. It also suggests that migration as a coping mechanism for climate change is less common in poorer countries than in richer ones.

Granular analyses, adapted for differences in data availability and quality, could be useful in other contexts. They could also be linked to deprivation and vulnerability data so that climate exposure, impacts and vulnerabilities could be brought together, superimposed and integrated for policy-relevant analysis and visualization, perhaps using geographic information systems. Vulnerability hotspots could be identified—spatially and by population—for policy action, including through impact mitigation and resilience building. Granular analyses would also be key in developing place-specific adaptation pathways, which could advance climate change adaptation, structural inequality reduction and broader Sustainable Development Goal achievement by "identifying local, socially salient tipping points before they are crossed, based on what people value and tradeoffs that are acceptable to them."[5]

Notes

1 Hsiang and others 2017.
2 Hornbeck 2012.
3 Carr and Wiemers 2016.
4 Cattaneo and Peri 2016.
5 Roy and others 2019, p. 458.

Spotlight 5.2

Climate vulnerability

Much like economic feedback mechanisms, attention to structural inequalities and development deficits in the context of climate change is a fairly recent advance. In a literature review in four climate-change journals through 2012, 70 percent of published studies articulated climate change itself as the main source of vulnerability, while less than 5 percent engaged with the social roots of vulnerability.[1] The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report in 2014 helped redress this imbalance.[2]

How the variables of social (or structural) vulnerability aggregate at different levels—from individuals and households to towns and cities to districts and provinces to countries and regions—will shape the patterns of climate-related impacts across space and across populations in those spaces. Different patterns of inequality may emerge at different scales and depending on the kind of inequality being measured. The impact on inequalities at those different levels depends critically on whether more negative impacts are disproportionally borne by those on the lower ends of existing inequality distributions—that is, those already experiencing various forms of greater deprivation or development deficits. Given that structural inequalities exist in various forms and are inextricably linked to communities' and countries' capacities to cope with climate change, then absent mitigating factors, some worsening inequality due to climate change is already "baked in." Furthermore, the idea of "soft" and "hard" adaptation limits, as well as "loss and damage" and "residual climate-related risks," in the climate change literature is a recognition of the variability of communities and human institutions to respond to and cope with climate change impacts.[3] The IPCC's 2018 special report on global warming of 1.5°C briefly summarizes the latest literature on approaches and policy options to address residual risk and loss and damage, looking at adaptation and disaster risk reduction strategies; compensatory, distributive and procedural equity considerations; litigation and litigation risks; international assistance (such as for regional public insurance mechanisms); and global governance.[4]

The IPCC's Fifth Assessment Report concluded with very high confidence that climate change would worsen existing poverty and exacerbate inequalities.[5] The IPCC's 2018 special report summarized subsequent literature showing that "the poor will continue to experience climate change severely, and climate change will exacerbate poverty (*very high confidence*)."[6] The special report cites evidence of poorer subsistence communities already affected by climate change through declines in crop production and quality, increases in crop pests and diseases, and disruption to culture. A series of studies referenced in the special report indicates that children and the elderly are disproportionally affected by climate change and that it can increase gender inequality. The special report also cites a 2017 report that claims that by 2030, 122 million additional people could become extremely poor, due mainly to higher food prices and worse health. The poorest 20 percent across 92 countries would suffer substantial income losses. Lower-income countries are projected to experience disproportional socioeconomic losses from climate change, placing pressure towards greater inequality between countries and countering prevailing trends of recent decades towards less inequality between countries.[7] Furthermore, the special report identifies critical research gaps, stating that "impacts are likely to occur simultaneously across livelihood, food, human, water and ecosystem security…but the literature on interacting and cascading effects remains scarce."[8]

A 2016 United Nations Department of Economic and Social Affairs (UNDESA) report summarizes the literature on structural inequalities and their relationship to climate-related exposure and vulnerability.[9] Within countries, the UNDESA report notes that many poor people live in floodplains, along riverbanks or on precarious hillsides for lack of alternatives, putting them at greater risk of flooding, mudslides and other weather-related disasters. A climate change axiom is that wetter

Some worsening of inequality due to climate change is already "baked in." The idea of "soft" and "hard" adaptation limits is a recognition of the variability of communities and human institutions to respond to and cope with climate change impacts areas will become wetter and dry areas drier. Flood frequencies are expected to double for 450 million more people in flood-prone areas.[10] Climate change will also place additional drought-related stress on those in arid and semi-arid areas, where large concentrations of poor and marginalized people live. Poor people are expected to be more exposed to droughts for warming scenarios above 1.5°C in several countries in Asia and in Southern and West Africa.[11] The rural poor in poor countries will suffer a double whammy from climate change: a negative shock to their livelihoods and spikes in food prices resulting from drops in global yields.

Notes

1 Tschakert (2016), based on data from Bassett and Fogelman (2013).
2 IPCC 2014.
3 Klein and others (2014), as cited in Roy and others (2019).
4 Roy and others 2019.
5 IPCC 2014.
6 Roy and others 2019, p. 451.
7 Pretis and others (2018), as cited in Roy and others (2019).
8 Roy and others 2019, p. 452.
9 UNDESA 2016.
10 Arnell and Gosling (2016), as cited in Roy and others (2019).
11 Winsemius and others (2018), as cited in Roy and others (2019).