PROJECT DRAWDOWN

DRAWDOWN LIFT

CLIMATE–POVERTY CONNECTIONS:
OPPORTUNITIES FOR SYNERGISTIC SOLUTIONS AT THE INTERSECTION OF PLANETARY AND HUMAN WELL-BEING

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FOREWORD

Climate change is one of the most important development challenges of our time. It intensifies the effects of poverty, inequality, population growth, rapid urbanization, and environmental degradation, and disrupts national economies and their long-term growth potential. No country is immune from the impacts of climate change. Reducing emissions and becoming more resilient are vital, and urgently require countries to make major social, economic, and technological changes.

This report shows that climate mitigation and socioeconomic development can be achieved simultaneously. It summarizes evidence of the human well-being co-benefits of proven climate mitigation solutions in the context of rural communities in sub-Saharan Africa and South Asia. The report complements global initiatives such as the Climate Action Pathways, a set of comprehensive road maps to fully implementing the Paris Agreement across all sectors.

The authors make a powerful case for strengthening the evidence of impact of climate solutions on human well-being. They also point out that the efficacy of several solutions that mitigate greenhouse gas emissions and improve human well-being either has not been tested in real-world settings or is rare. Thus, it would be beneficial to evaluate the impact of such climate solutions. The report also underscores the need to assess their unintended consequences and differential impacts by important dimensions such as gender and income.

Transformation of the global economy to net-zero emissions by 2050 would require significant expansion of annual investments. The good news is that developing countries do not need to develop first in a carbon-intensive pathway and then clean up and decarbonize. This report can serve as an important guide for policymakers, the private sector, donors, and decision makers at national and global levels as they plan future investments in programs and research that alleviate both poverty and carbon emissions.

The task of bending the emissions curve and improving livelihoods is extremely urgent. The gravity and scale of the challenge requires countries to learn quickly from each other, adapt to their own special circumstances, and be audacious in implementing effective climate policies. Properly designed and implemented policies for low-carbon and resilient growth can also help address poverty and inequality, enabling millions to live safer, more prosperous, more inclusive, and more sustainable lives.

This report presents the benefits of climate mitigation for human well-being in a scientifically coherent manner. We count it a great privilege to introduce it at this crucial moment of human history.

Ademola Braimoh, World Bank, and Monica Jain, 3ie

EXECUTIVE SUMMARY

Addressing climate change and improving the well-being of people experiencing extreme poverty—two grand challenges of the 21st century—must occur simultaneously and, ideally, synergistically. These two inextricably intertwined issues will shape the well-being of humanity for the rest of the century and beyond. People living in extreme poverty are more vulnerable to natural disasters and commonly live in regions that have been and are projected to be most impacted by climate change. Unfortunately, the benefits of addressing climate change in ways that simultaneously improve the human well-being (HWB) of people living in extreme poverty are commonly overlooked—despite their promise to yield substantial socioeconomic, health, equity, ecological, and biodiversity gains.

This report highlights evidence of the co-benefits to HWB of proven climate mitigation solutions. It showcases areas of greatest need for funders, policymakers, nongovernmental organizations (NGOs), and other decision-makers to act and drive approaches to meet climate, development, and HWB needs while boosting prosperity for rural communities, especially in sub-Saharan Africa (SSA) and South Asia. The world should not have to choose among sustainable development, poverty eradication, climate mitigation, and climate adaptation; win-win solutions are at hand.

We summarize evidence of the HWB co-benefits of 28 climate mitigation solutions previously analyzed by Project Drawdown. To explore linkages among these solutions and their potential to improve lives, the report builds upon the Doughnut Economics model to develop a Drawdown Lift Human Well-Being Index (HWI), which serves as a framework for assessing 12 health, socioeconomic, and societal dimensions of HWB and advances evidence of the nexus of climate mitigation solutions, poverty alleviation, and HWB.

Women and children in low- and middle-income countries are disproportionately harmed by climate change. Through collective and urgent action, we can shape a healthy and sustainable planet for future generations. *Credit: Ollivier Girard for Center for International Forestry Research (CIFOR)*

Investments in low-carbon development pathways, as well as climate adaptation, must prioritize countries that are first and worst impacted by climate change—particularly low- and middle-income countries (LMICs). The costs are high, yet the costs of inaction are far higher—and leaves those least responsible for the climate crisis without the resources for a better, more resilient future as their economies bend toward prosperity.

Responses to climate change must also directly address rural communities' economic, nutritional, and energy needs—particularly those of women. Many groups of climate mitigation solutions, including those that focus on ***Improving Agriculture and Agroforestry, Protecting and Restoring Ecosystems, Adopting Clean Cooking, Providing Clean Electricity,*** and ***Fostering Equality,*** depend on women's labor and shape women's livelihoods. Climate interventions can and should contribute to improved education, health, and gender equality.

> The world should not have to choose among human development, poverty eradication, climate mitigation, and climate adaptation; win-win solutions are at hand.

The opportunity to address climate change and improve HWB, particularly in LMICs, is enormous. Implementing the climate solutions presented in this report could make a dramatic difference for boosting HWB—especially when the solutions are implemented synergistically with cross-sectoral collaboration. This report raises awareness of the socioeconomic co-benefits of climate solutions, promotes cross-sectoral alliances to mobilize ambitious solutions, and seeks to channel funding for synergistic solutions from public, philanthropic, and private sectors.

We find that several actions can contribute to mobilizing win-win solutions to climate and poverty. Key recommendations include:

- Implement the 28 climate solutions highlighted in the report in synergistic ways to maximize co-benefits for boosting human well-being.
- Listen to, engage with, and work alongside diverse stakeholders—from local practitioners to senior policymakers—to build capacity and plan for synergistic climate-development actions.
- Include HWB co-benefits in multisector climate finance.
- Accelerate the development of innovative finance for climate solutions that include HWB co-benefits.
- Assemble additional evidence of HWB co-benefits to further drive a more holistic approach to climate solutions and poverty alleviation.

This report serves as a guide for decision-makers, policymakers, and donors working to advance low-carbon pathways to prosperity for under-resourced and socially disadvantaged groups in rural communities in LMICs. It seeks to support leaders and stakeholders in achieving the dual goals of alleviating poverty while limiting increases in global temperatures.

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ACRONYMS AND ABBREVIATIONS

CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide Equivalent
DE	Doughnut Economics
FAO	Food and Agriculture Organization
GBV	Gender-Based Violence
GDP	Gross Domestic Product
GHG	Greenhouse Gas
Gt	Gigatons
HAP	Household Air Pollution
HWB	Human Well-Being
HWI	Drawdown Lift Human Well-Being Index
IRENA	International Renewable Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LMICs	Low- and Middle-Income Countries
MPI	Multidimensional Poverty Index
NGO	Non-governmental Organization
NTFP	Non-timber Forest Product
N_2O	Nitrous Oxide
OECD	Organisation for Economic Co-operation and Development
SDGs	Sustainable Development Goals
SPI	Social Progress Index
SPV	Solar Photovoltaics
SSA	Sub-Saharan Africa
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization

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i Under a Global Health Support Initiative contract

1 INTRODUCTION

1.1 Addressing poverty and climate change: dual challenges for the 21st century

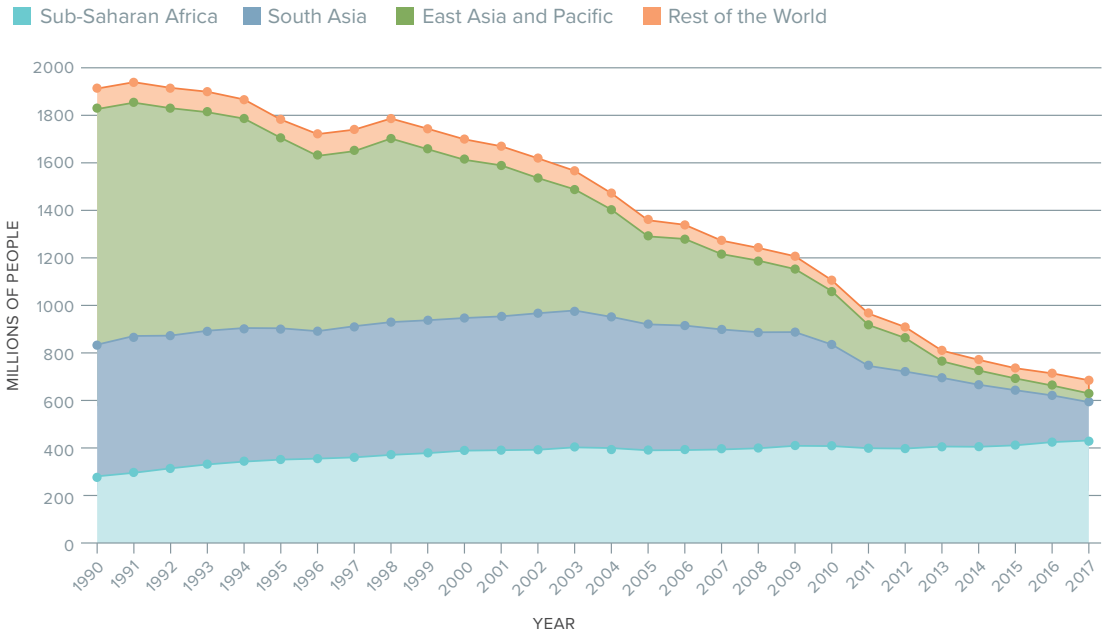
Eradicating extreme poverty and improving HWB[ii] are critical needs for humanity. In recent decades, LMICs have seen rapid economic growth and a steady decline in extreme poverty, alongside many improvements in HWB. Until 2020, extreme absolute poverty—defined as the condition of living on less than US$1.90 per day—had been declining for almost 25 years—alongside improvements in life expectancy and adult literacy, reduced child and maternal mortality, and lowered malnourishment.[3] However, much more work remains, as progress has been geographically uneven. It is starkest in SSA, where 40 percent of the population still lives in extreme poverty and over half of the population is multidimensionally poor;[iii] indeed, two-thirds of those experiencing multidimensional poverty live in Africa (Figure 1.1).[4]

COVID-19 and vaccine inequality have had major impacts on people living in low- and middle-income countries, many of whom are also burdened by the effects of climate change. *Credit: Matteo Guedia | Alamy Stock Photo*

ii HWB is multidimensional. It is defined as people's ability to access fundamental social, cultural, economic, and natural/environmental resources that are critical for sustaining a decent living standard and living a life they value (see also[1, 2]).

iii Multidimensional poverty goes beyond income to include deprivations around health, education, living standards, quality of work, safety, and environmental health.

Figure 1.1 — Number of people living in extreme poverty



The number of people living in extreme poverty (defined as < $1.90 per day) has decreased across all regions except sub-Saharan Africa since 1990. *Data source: Poverty and Shared Prosperity 2020 PovcalNet*

Eighteen of the 20 economies with the world's highest poverty rates are in SSA.[4] What is most startling is that poverty rates in the region have not budged for over a generation (since 1990) while, during the same period, poverty levels dropped dramatically in countries in the Pacific and East Asia (and pre-pandemic, more recently in South Asia).[4] Fragility, conflict, and, increasingly, climate change, all contribute to the continued high rate of poverty in SSA.[4,5] Even where there was rapid economic growth—in countries such as Kenya and Ethiopia, which saw a decrease in the share of their populations living on less than US$1.90 per day from 2005 to 2015[4]—it was countered by rapid population growth, so the number of people experiencing poverty actually increased during that period. Lifting people out of the poverty trap and building long-lasting resilience requires a complementary approach that includes increasing assets, building capacity, and addressing climate risks.[6]

> Effective policy to reduce poverty requires multi-dimensional thinking. Responses to only one among the financial, human, natural, physical and social capital that could help a family lift themselves out of poverty might miss the root causes of persistent, extreme poverty in a complex, real-world setting. Simultaneously addressing assets, capacities and the risk of [climate] shocks will have the best chance of creating lasting change for poor and vulnerable households.
>
> CHRISTOPHER BARRETT, MICHAEL CARTER, AND JEAN-PAUL CHAVAS[6]

Unfortunately, COVID-19 has set back years of progress and further deepened the poverty trap. Prior to the pandemic, roughly 65–75 million people globally were living in extreme poverty;[7] the latest projections suggest that the number of people experiencing poverty could nearly double,[8] with South Asia and SSA the most affected. One study estimates that 96 million more people will be pushed into poverty.[8]

Recent events also exacerbated the poverty gender gap. Pandemic lockdowns led to increased violence against women, while school closures and job losses increased rates of child, early, and forced marriage and unions. All of these exert dire effects on women's and adolescents' mobility and well-being.[9] In 2017, approximately 18 percent of children lived in poverty, compared with 8 percent of adults.[10] Women ages 25–34 are particularly vulnerable to poverty due largely to persistent challenges around gender inequality.[11]

As inequities deepen on our warming planet, the pandemic has made the economic, health, and planetary costs of inaction starker than ever.[12, 13] Synergistically addressing climate and poverty is possible; a low-carbon development path helps reduce inequality while also boosting absolute well-being.

1.2 Climate impacts on vulnerable populations

Under-resourced households experience disproportionate impacts of climate change. Thus, prioritizing climate mitigation solutions that also alleviate poverty, improve HWB, enhance climate adaptation, and facilitate low-carbon pathways to prosperity will doubly benefit such households.

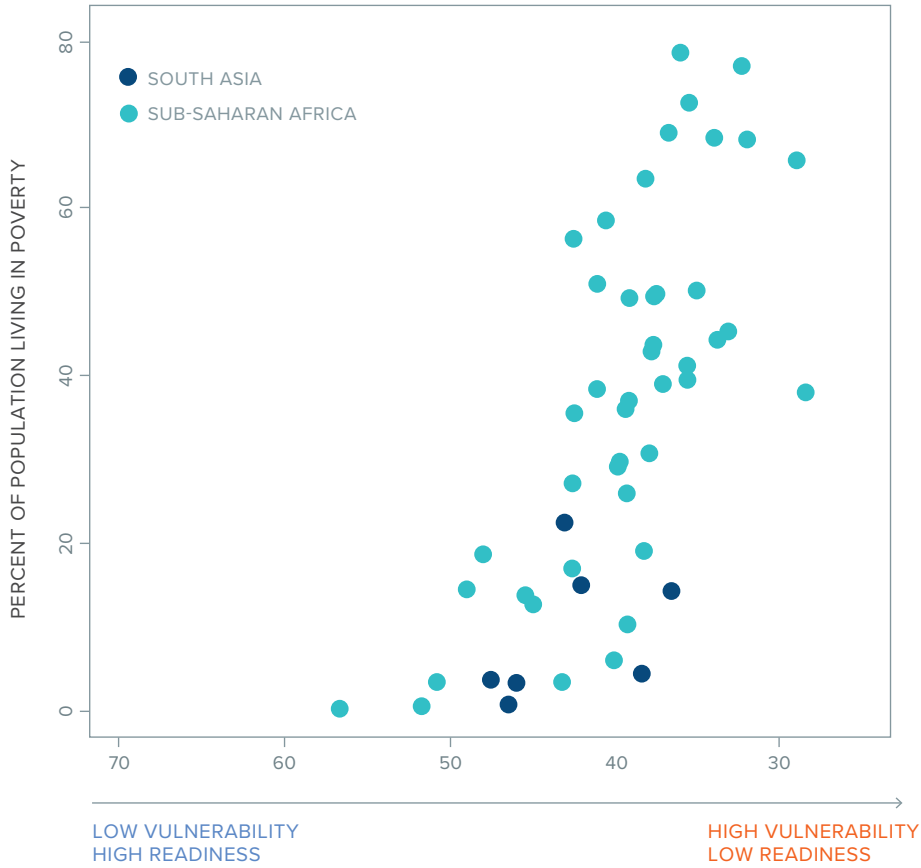
Climate vulnerability is also closely correlated with gender inequality. Improving gender equality lifts up vulnerable populations while generating multiplier effects for reducing climate vulnerability and achieving global development and climate goals.

Impacts of climate change vary enormously across countries and social groups. Some LMICs, particularly those in SSA, face a triple nexus of gender inequality, state fragility, and climate vulnerability, affecting both HWB and ecosystem health.[14] Women, people experiencing poverty, Indigenous peoples, ethnic minorities, persons with disabilities, and those who are socially disadvantaged are often the most vulnerable to climate hazards because their exclusion from economic, educational, and social systems limits their access to vital resources and opportunities, leading to less capacity to adapt or build resilience.[14] Women and girls in LMICs are disproportionately impacted by the effects of climate change,[15, 16] including extreme weather and natural disasters.[17, 18]

In many LMICs, climate change already threatens decades of progress across multiple areas of development. Changing climatic patterns oblige millions of vulnerable people to face more frequent and extreme weather events, climate variability and hazards, and threats to food security, water security, health, livelihoods, and cultural integrity. Rural populations and Indigenous peoples in LMICs—particularly in communities that depend on rain-fed and smallholder agriculture—rely extensively on natural ecosystems for their livelihoods, while many countries extract and export vital natural resources to generate economic growth. Climate change could shrink the gross domestic products (GDPs) of countries like Bangladesh, Madagascar, and Nigeria by more than 10 percent[19] and could push an additional 100 million people into poverty by 2030.[20]

Those experiencing poverty do not feel the effects of climate change equally. The most vulnerable and the least prepared countries also experience the highest levels of poverty (Figure 1.2).

Figure 1.2 — Poverty and vulnerability to climate change



Countries with high rates of poverty (percent of people earning < US$1.90 per day) tend to be more vulnerable to, and less ready for, climate change than those with lower poverty rates. *Data source: World Bank 2019, ND-GAIN 2019*[iv]

Just as people experience poverty in gender-specific ways, the adverse effects of climate change are also strongly gendered. Women and men have vastly divergent access to financial resources, natural resources, land tenure, education, health care, and decision-making power.[22] Those differences increase women's vulnerability and can limit their ability to adapt to climate change.[23] Indeed, two-thirds of the more than 835 million people who experience multidimensional poverty reside in households in which no women have completed at least six years of schooling.[24] Climate-driven hazardous events disproportionately harm women and exacerbate gender disparities in education, reproductive health, and socioeconomic status.[25]

iv The Notre Dame Global Adaptation Initiative (ND-GAIN) enhances understanding of climate adaptation through knowledge, products, and services that inform public and private actions and investments in vulnerable communities. The Country Index uses two decades of data across 45 indicators to rank 181 countries annually based on their level of vulnerability and their readiness to successfully implement adaptation solutions. Countries with a low ND-GAIN score are more vulnerable to climate change and less prepared to address it.[21]

Tackling climate change and achieving gender equality go hand in hand. Climate action must focus on the most vulnerable people and those who have been excluded from necessary and vital resources to better support themselves and their families. *Credit: Valerie Caldas | United States Agency for International Development Suaahara project*

It is crucial that women are represented as key stakeholders in all spheres of life and in climate negotiations and action; full, equal, and meaningful participation and leadership of women must take place in all aspects of United Nations Framework Convention on Climate Change (UNFCCC) processes and in local and national climate policy work to achieve shared climate goals[26] and advance more responsive, accountable governments.[27] According to a 2016 review of 162 submitted intended Nationally Determined Contributions, only 40 percent mention gender or women in their national priorities for reducing greenhouse gas (GHG) emissions.[28]

> Good governance and democracy require inclusive leadership and representation. While men and women are equally responsible for achieving gender equality, a larger number of women in office can influence gender responsive public policies and institutional practices. Women have a right to be equally represented and consulted in decision-making.
>
> REPORT OF THE SECRETARY GENERAL, 65TH COMMISSION ON STATUS OF WOMEN.[27]

The impact of climate change on children—especially those in LMICs—and future generations is particularly grim.[29] Babies born in 2020 in SSA are projected to experience around six times more extreme climate events over their lifetimes than those born in 1960.[30] Children experience adverse consequences in terms of nutrition, education, and health-care access after natural hazards and climate shocks.[31] Globally, more than 90 percent of children are exposed to at least two climate and environmental hazards over the course of their childhood.[32] Increases in temperature reduce food diversity and can undermine development interventions and impact children's health in regions experiencing long droughts and high temperatures.[33] All of these impacts can perpetuate intergenerational poverty.[32, 34]

1.3 Climate-smart development, the SDGs, and the Paris Agreement

The immensity of these challenges requires that poverty and climate change be addressed simultaneously. To do this, the world needs to find pathways for development that lift people out of extreme poverty without further exacerbating the risks of climate change.

Implementing climate solutions such as *Distributed Solar Photovoltaics, Farm Irrigation Efficiency,* and *Sustainable Intensification for Smallholders* together can provide win-wins for climate, human well-being, and sustainable development. *Credit: Joerg Boethling | Alamy Stock Photo*

In 2015, all 193 United Nations (UN) member countries adopted the integrated 2030 Agenda for Sustainable Development with crosscutting objectives to improve HWB, act on climate change, end hunger and poverty, realize human rights, ensure gender equality, and enable communities to thrive peacefully while protecting the planet from degradation. Similarly, the UNFCCC's 2015 Paris Agreement aims to "promote the mitigation of GHG emissions while fostering sustainable development."[35] One principle of the UN Sustainable Development Goals (SDGs) is to invest in areas that yield multiple benefits across the goals and avoid unnecessary trade-offs, such as development strategies that undermine climate change mitigation and adaptation, and vice versa.[36] Climate-resilient development that intentionally reduces existing inequalities and facilitates a just transition to low-carbon economies in LMICs (while preventing and minimizing adverse outcomes) will yield both sustainable economic and human development benefits.[37, 38]

As the world strives to achieve all 17 SDGs and keep global temperature increases well below 2˚C, implementing climate solutions that facilitate a just transition to a low-carbon economy while fostering sustainable economic and human development should be a top priority.[39] Achieving the SDGs and upholding the aims of the Paris Agreement in a mutually reinforcing way is possible.[39, 40] Global leaders and policymakers have an opportunity and an obligation to advance climate solutions that foster a low-carbon transition based on equitable and sustainable social, economic, and environmental development across all stages of policymaking.[37] The needs are daunting. For example, half of Africa's population does not yet have access to electricity. The opportunity to develop clean energy sources at national and regional levels as Africa powers up is vast, yet the costs to support economic development and build low-carbon infrastructure will also be great.[41, 42]

LMICs are historically the lowest GHG emitters, yet they are disproportionately impacted by climate change; countries in the Global South (including Latin America, Africa, the Middle East, and Asia) contribute only 8 percent of cumulative carbon dioxide (CO_2) emissions.[43] High-emitting countries must substantially reduce their emissions to ensure LMICs can develop without exceeding climate targets.[44] In addition, equalizing trade so that high consumption in the Global North is no longer subsidized by natural resource extraction and labor in the Global South is key to addressing inequality.[43]

> The climate crisis affects some parts of the planet more than others. Historical and present-day injustices have both left Black, Indigenous and people-of-colour communities exposed to far greater environmental health hazards than white communities. Those most affected by climate change are black and poor communities. As a continent we are one of the hardest hit by the impacts of climate change and we are left behind as the world progresses toward a low-carbon economy. Without taking into account those most affected, climate solutions will turn into climate exclusion."
>
> VERONICA MULENGA, ZAMBIAN CLIMATE ACTIVIST[45]

As emerging economies strive to meet people's needs sustainably, climate-smart development can bring wins for the climate and HWB. Synthesis reviews of climate mitigation policy found substantial co-benefits[46, 47] for air quality, health, and economic benefits. However, few papers have focused on the co-benefits for poverty alleviation, food security, and conflict resilience.[47] Furthermore, policymakers and decision-makers often fail to consider such co-benefits, resulting in suboptimal climate policies.[46] It is critical to center HWB co-benefits alongside climate-resilient development as countries experience rapid economic growth, urbanization, and industrialization along with high climate adaptation needs.

Reducing GHG emissions can benefit both climate and people in LMICs, for example through job creation (e.g., in clean energy production) that drives new opportunities for sustainable economic growth. Advances in formal job markets rely on boosting educational quality and learning outcomes—particularly around science, technology, engineering, and mathematics—subjects needed to support growth in jobs centered on low-carbon technology. This demonstrates how climate-smart development also depends on human capital development and raising climate literacy. Climate mitigation and adaptation are two sides of a coin that share the vital aim of diminishing climate change impacts in the immediate and long term.[48]

Development solutions that avoid or reduce GHG emissions can lead to more sustained HWB benefits and reduce risks of conflict and political instability. Globally, ambitious climate actions could generate more than 65 million low-carbon jobs and economic gains of US$26 trillion by 2030.[49]

FEATURE BOX

Hariyo Ban, Nepal: Centering climate mitigation, adaptation, and livelihoods

Nepal is an ecological hot spot, but climate change threatens people's livelihoods and the country's biodiversity. The Hariyo Ban ("Green Forests")—a community-driven, United States Agency for International Development (USAID)-funded climate adaptation program that ran from 2011 to 2021—worked to conserve biodiversity, build community and ecosystem resilience, and mitigate climate change by reducing emissions from deforestation and forest degradation.[50] The program's crosscutting work improved gender equality and social equity, and diversified livelihoods; it benefited tremendously from collaborations among local non-governmental organizations (NGOs), government agencies, the private sector, and community organizations with expertise in conservation, governance, community building, livelihoods, gender empowerment, and social inclusion. Results included the sequestration of 3.7 million metric tons of CO_2 emissions and improved access to cleaner energy for 173,000 people.[51] The program contributed to boosting the climate resilience of 400,000 people and provided skills training for 60,000 people in farming and off-farm activities. Hariyo Ban made a concerted effort to include women, youth, and marginalized communities. Hariyo Ban was implemented by a consortium of four NGOs: World Wildlife Fund, CARE Nepal, the Federation of Community Forest Users Nepal, and the National Trust for Nature Conservation; CARE provided the lead on governance and on gender and social inclusion.[52]

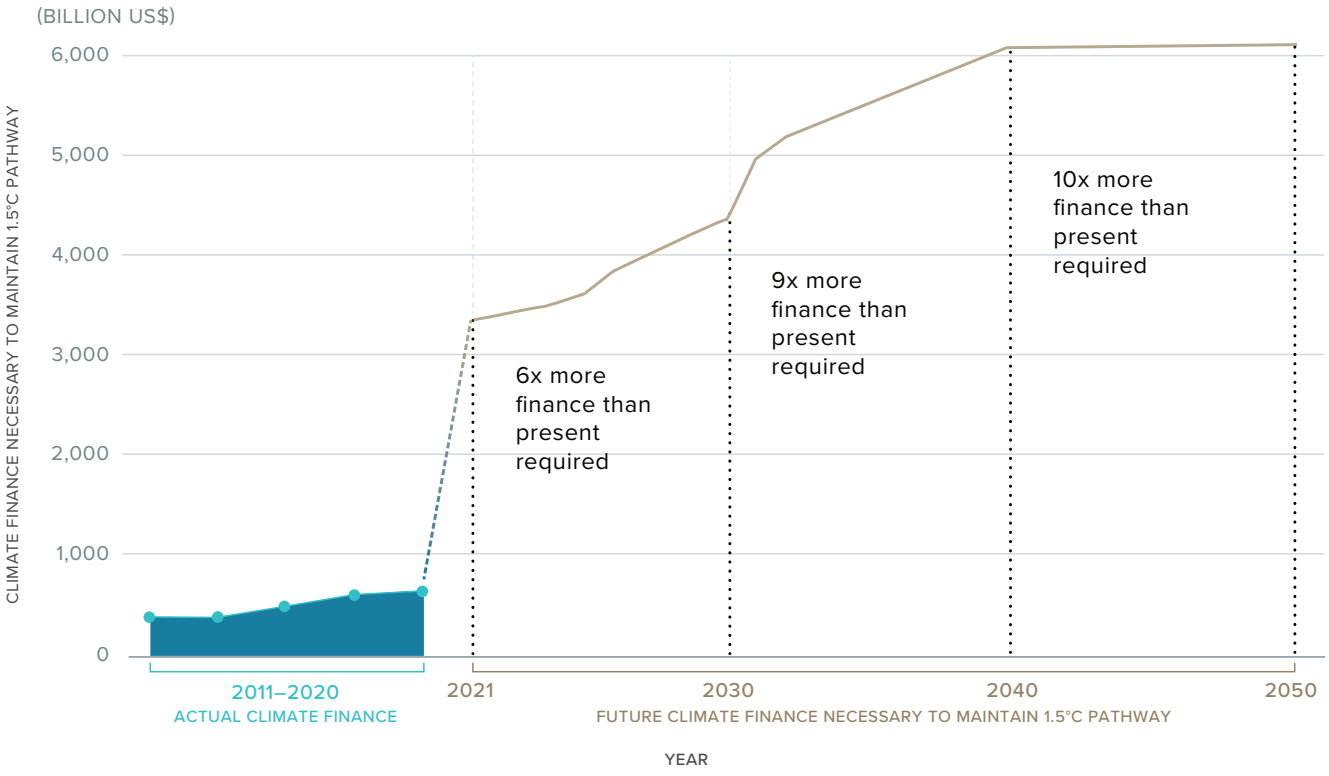
Hariyo Ban provided many benefits to both climate and human well-being over a 10-year period.
Photo credit: Karine Aigner | World Wildlife Fund-United States

1.4 Financing climate action

Climate action is not cheap, but the cost pales in comparison to the cost of inaction. Huge financial inputs are required to maintain the fossil-fuel-based status quo, and the costs of preventing, dealing with, and recovering from climate-catalyzed disasters, along with the costs of adapting to new environmental conditions in the absence of action, would be astronomical. According to Project Drawdown's financial analysis on the start-up and implementation costs of the suite of climate solutions over time, net operational savings exceed net implementation costs by four to five times (US$22.5–28.4 trillion versus US$95.1–145.5 trillion).[53] These costs do not include the monetary value of co-benefits (introduced in Chapter 2 of this report), which makes the financial case for immediate climate action even stronger. They also do not include the costs of avoided damages from climate change, which could be extreme.

Although global climate finance has steadily increased over the past decade, it is not keeping pace with needs (Figure 1.3). In 2019 and 2020, about US$632 billion per year was dedicated to global climate finance, but this annual average is not sufficient to limit global warming to well below 2˚C above preindustrial levels.[54] To meet international climate goals and objectives and avoid further catastrophic climate impacts, an increase of at least 590 percent (to US$4.35 trillion) in annual climate finance is needed by 2030 from diverse sources, including high-income countries, foundations, private companies, bilateral and multilateral donors, and NGOs, as well as in national budgets of LMICs.[54, 55]

Figure 1.3 — Current finance and future investment needed to limit global temperatures to 1.5°C above preindustrial levels



Although global climate finance steadily increased between 2011 and 2020, it is not keeping pace with future needs to limit global temperatures to 1.5°C. *Source: Climate Policy Initiative*

The vast majority of global climate finance (90 percent) goes to mitigation (US$571 billion), while adaptation funding (US$46 billion) makes up 7 percent, and dual uses account for the rest (US$15 billion).[54] Almost all tracked adaptation finance stems from the public sector and is mainly focused on water, wastewater, and cross-sectoral projects (such as support for capacity building, biodiversity, land and marine conservation, and disaster risk management).[54] In Africa in 2017 and 2018, 62 percent of total adaptation finance (US$6 billion) went to agriculture, forestry, land use and natural resource management, and water and wastewater management.[54]

From 2019 to 2020, three-quarters of global climate investments were concentrated in East Asia and the Pacific, Western Europe, and North America, and more than 75 percent of climate investments were raised and spent in the same country (close to US$479 billion).[54] During the same period, SSA received the largest share of international adaptation finance (around 25 percent).[54]

These adaptation investments in SSA are much less than what is needed.[54] High-income countries have yet to fulfill the joint pledges they made in 2009 at COP15[56, 57, 58] to mobilize US$100 billion per year by 2020 to meet the adaptation and mitigation needs of the most vulnerable low-income countries (prioritizing small island developing states and Africa).[59] Recent analyses suggest that climate finance (for both mitigation and adaptation) for low-income countries reached US$79.6 billion in 2019.[58] And yet, annual adaptation costs in low-income countries are projected to be US$155–330 billion by 2030 and US$310–555 billion by 2050.[54, 58]

> Adaptation … presents major opportunities to achieve a larger development agenda and put Africa on a new "green" and resilient pathway to growth. Adaptation and development work hand in hand, creating powerful synergies that can increase the chances of meeting global SDGs and additional goals that African nations have set for improving agricultural productivity.[55]

The Intergovernmental Panel on Climate Change (IPCC) estimates the need for US$1.6–3.8 trillion annually to fund climate solutions;[60] however, current investments fall far below this amount. Private investments are crucial to address the full scope of climate change.[61] At a recent World Bank conference, Making Climate Action Count: Turning Ambition Into Reality,[62] Mark Carney, the special envoy on climate action and finance for the UN, stated that funding for climate adaptation and mitigation should come from a mix of the private sector, multilateral grants, and foundations. Fortunately, private sector engagement in, and contributions toward, meeting the Paris Agreement objectives is gaining momentum.[63] Investment firms are also engaged, and can catalyze climate action through their investment mandates; the Net Zero Asset Owner Alliance, launched in 2019, includes members with assets in the trillions of dollars that are willing to invest in climate mitigation and adaptation.[64]

New finance mechanisms and innovative funds have great potential to shift climate action and bring about a global transformation that enables LMICs to meet their populations' self-identified needs, reduce risk, preserve natural resources, boost economic growth, and advance climate

goals.[65] Instead of financing status-quo fossil fuel technologies and practices, funding climate-smart development offers numerous benefits for people and the planet. The cost of inaction is astronomical; yet with intention and care, implementing climate solutions that contribute to a more equitable world is possible.

1.5 Report road map

This report relies primarily on peer-reviewed articles and reports and gray literature from government, NGOs, and donor institutions as the evidence base for examining linkages among 28 Project Drawdown climate solutions and 12 dimensions of HWB. The research cited here focuses on LMICs in South Asia and SSA unless otherwise noted.

Following an overview in Section 1, Section 2 explains the Drawdown Framework for Climate Solutions and highlights a subset of solutions with the potential to generate benefits for poverty alleviation and HWB in LMICs. Section 3 presents an HWB framework that explores linkages among Project Drawdown solutions and their potential co-benefits for HWB. Section 4 provides an in-depth analysis of evidence-based linkages between groups of Project Drawdown solutions and co-benefits for HWB. Section 5 focuses on the way forward for acting on synergistic climate–HWB solutions.

2

PROJECT DRAWDOWN CLIMATE SOLUTIONS AND CO-BENEFITS FOR HUMAN WELL-BEING

The most recent IPCC reports state that global warming will most likely reach 1.5˚C within the next two decades unless GHG emissions are reduced quickly and dramatically, and that parts of the world are quickly becoming unlivable.[13, 66] Considerable political, economic, and social forces stand in the way of achieving the dual goals of mitigating and adapting to climate change. Yet Project Drawdown's research suggests that it is technically possible, and financially viable, to limit warming safely and equitably to well below 2˚C by rapidly scaling existing climate solutions.[67]

2.1 The Drawdown Framework for Climate Solutions

Project Drawdown has identified more than 80 safe and equitable climate mitigation technologies and practices that reduce GHG levels in the atmosphere. These solutions are currently available and financially viable, have proven potential to reduce GHGs, and present sufficient data to model the amount of CO_2 equivalent (CO_2-eq)[v] sequestered or emitted. Project Drawdown published *Drawdown,* the first review and assessment of climate mitigation solutions that can lead to drawdown,[vi] in 2017.[68]

The *Drawdown Review,*[53] an update to *Drawdown*, organized the more than 80 climate solutions[vii] into a three-pronged framework: 1) reducing *sources* of GHG emissions, 2) supporting nature's carbon *sinks*, and 3) transforming *society* by fostering equality. It defines sector-specific solutions for each group and estimates the impacts of reducing CO_2-eq emissions at the global level for the period 2020–2050 for each solution (Figure 2.1). Each solution's emissions reductions are compared with a baseline scenario whereby few or no new climate solutions

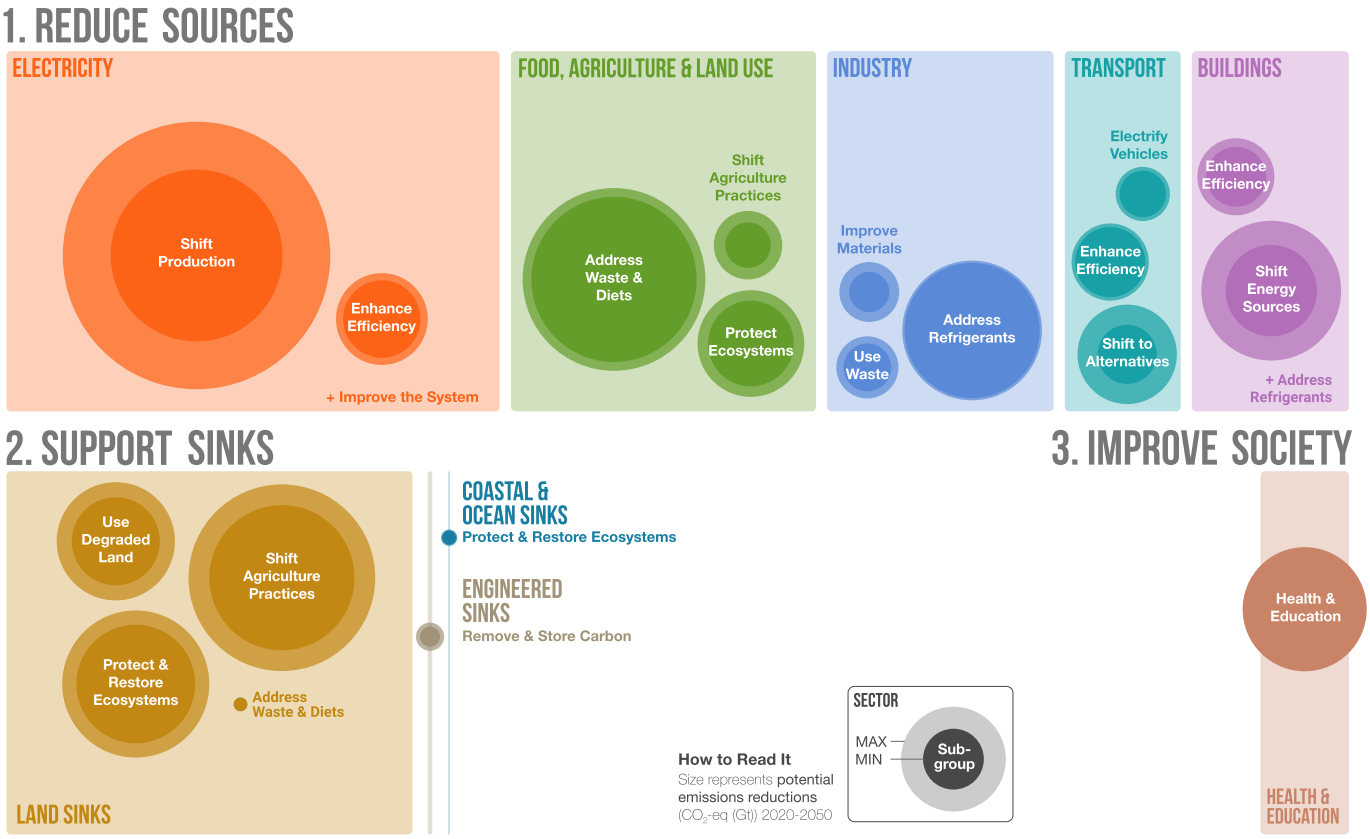
v CO_2 equivalents (CO_2-eq) are used to standardize calculations of climate impact across several GHGs: CO_2, methane, nitrous oxide, and fluorinated gases.

vi Drawdown is the future point in time when levels of GHGs in the atmosphere stop climbing and start to steadily decline, stopping catastrophic climate change.

vii The latest list of Project Drawdown solutions, which will include updates to existing solutions and some new solutions, will launch in 2022.

are adopted, otherwise known as "business as usual." In the baseline scenario, economic development will continue to use existing technologies instead of transitioning to clean ones. For example, with potential emissions reductions from *Distributed Solar Photovoltaics* are based on a comparison with using fossil fuel power plants for electricity generation.

Figure 2.1 — The Drawdown Framework for Climate Solutions



The Drawdown Framework for Climate Solutions illustrates the potential greenhouse gas emissions impact of solution subgroups within each climate solutions sector globally.

2.2 Climate solutions co-benefits for poverty alleviation and well-being

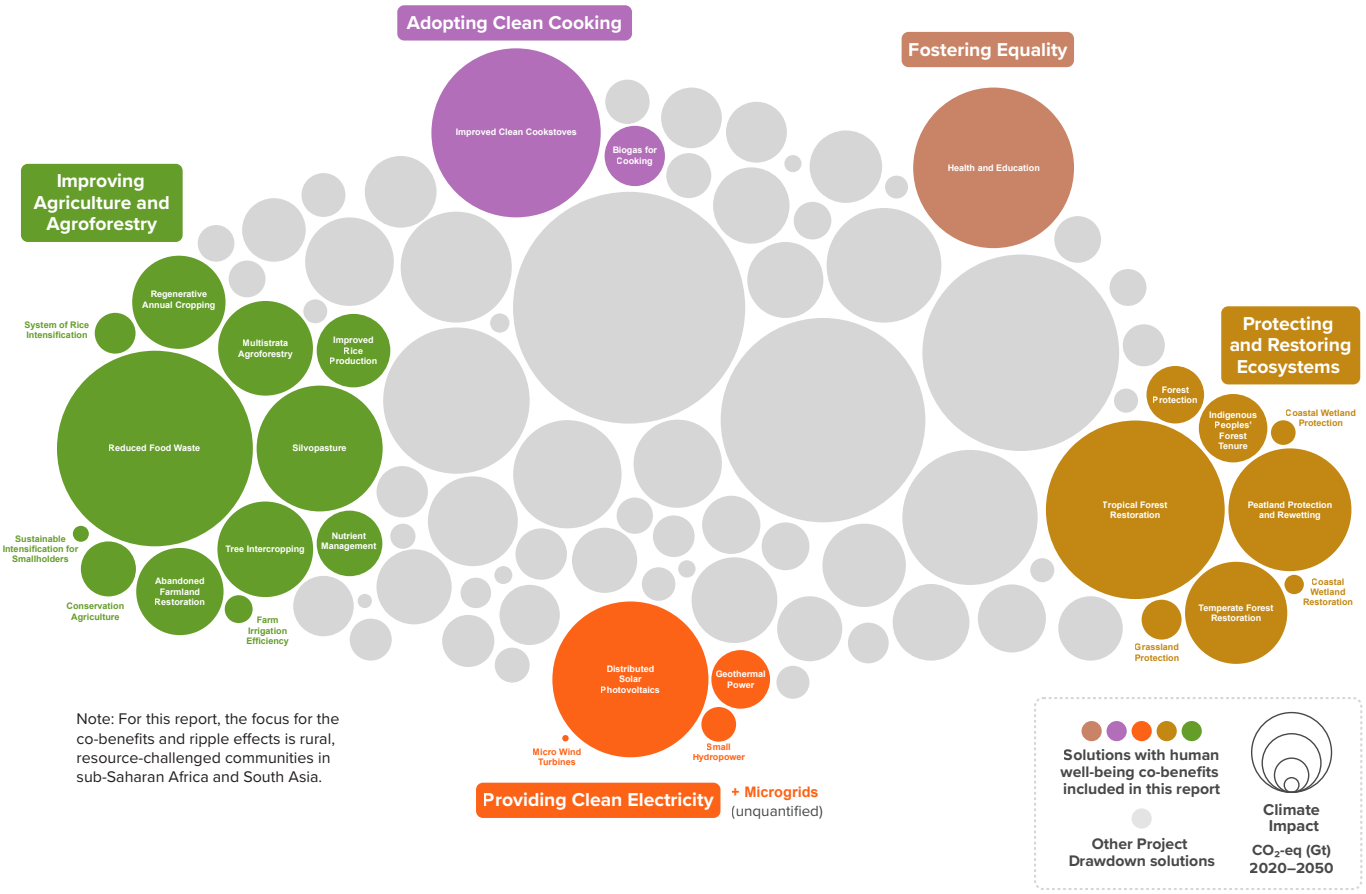
Many of Project Drawdown's climate solutions have multiple co-benefits[viii] for human development (including poverty alleviation) and climate adaptation, in alignment with the SDGs.[39, 70, 71, 72, 73] For this report, we focused on a subset of Project Drawdown solutions; we excluded solutions that were 1) not applicable to rural under-resourced regions in LMICs and/or 2) did not provide clear co-benefits for the dimensions of HWB and geographic focus of

viii In this report, co-benefits of Project Drawdown climate solutions are defined as tangible and positive effects that a climate action aimed at climate mitigation may have on HWB in sectors such as climate adaptation, gender equality, food security, inclusive economic growth, access to clean energy, health, conservation of natural resources, and others. Co-benefits can be direct or indirect, or have ripple effects, where one co-benefit generates another.[69] For more information on climate co-benefits in this report, please refer to Section 4. See also[40] for a deeper discussion on climate change mitigation co-benefits.

this report. Solutions like *Refrigerant Management* and *High-Efficiency Heat Pumps* fall into the first category because they are most applicable to people living in urban areas or in high-income countries. Solutions like *Dynamic Glass* and *Smart Thermostats* fall into the latter category. The 28 Project Drawdown solutions included in this report are those that most clearly generate co-benefits for poverty reduction, human health, gender equality, and overall well-being for rural and underserved communities in LMICs in South Asia and SSA (Figure 2.2).

We recognize that some of the 28 Project Drawdown solutions are applicable in both LMICs and high-income countries. This is the case, for example, for *Temperate Forest Restoration*, *Health and Education*, *Reduced Food Waste*, and several solutions in the ***Improving Agriculture and Agroforestry*** group. Brief descriptions of each solution are provided in Appendix A (Figure 2.2).

Figure 2.2 — Project Drawdown solutions with human well-being co-benefits



Of the 80-plus solutions in the Project Drawdown framework, 28 have clear well-being co-benefits for rural populations in LMICs. See Project Drawdown for in-depth information and technical reports for each solution.

3 FRAMEWORK FOR EVALUATING HUMAN WELL-BEING

Climate solutions such as *Nutrient Management* that enhance yield for smallholder farms can, in turn, provide farmers with more money for their families' needs and children's education (an important dimension of human well-being). *Credit: Jonathan Torgovnik | Getty Images | Images of Empowerment*

3.1 Introduction

Advancing the understanding of HWB in a country and synthesizing information about co-benefits of climate solutions for poverty alleviation and HWB are critical to contextualize and prioritize solutions that address both issues. The Paris Agreement and the SDGs, both developed in 2015, are complementary. The SDGs recognize that people's lives are integrated with various dimensions of human development and the environment. They go beyond national averages (favored by the prior Millennium Development Goals) to articulate a mandate to leave no one behind.

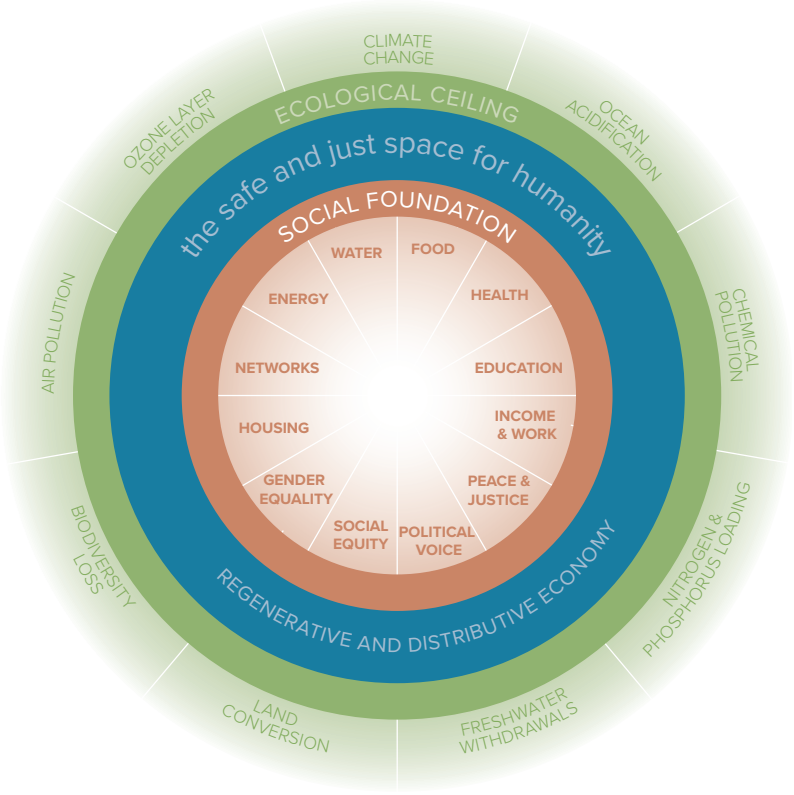
Several socioeconomic and well-being indices (Appendix B) are used to help assess progress toward attaining global agreements. Indices that provide a nuanced picture of the well-being of households, societies, or countries, such as the classic Human Development Index (HDI) developed in 1990 by the UN Development Programme and updated annually, have evolved over time.[1] The 2020 HDI included new metrics on planetary pressures such as climate change in recognition that planetary and social imbalances reinforce one another.[74] Reflecting the more expansive SDGs, measurements of socioeconomic development have thus shifted to be more multifaceted and inclusive visions of HWB. Multidimensional poverty indices, such as the World Bank's Multidimensional Poverty Measure (which go beyond income and consumption to capture deprivations in education, basic infrastructure, and other aspects of HWB) are essential to glean a deeper understanding of various facets of poverty.[75] The Social Progress Index (SPI) includes several gender-focused indicators, although it does not have a dimension exclusively focused on gender; other indices do not include a gender focus.

3.2 Drawdown Lift Human Well-Being Index

To systematically assess the co-benefits of climate solutions for HWB, this report adapts the Doughnut Economics (DE) framework to create a Drawdown Lift Human Well-Being Index (HWI).

The DE framework has 12 HWB dimensions. It was developed in 2011 and updated in 2017 to align with the SDGs. DE identifies an "environmentally safe and socially just space in which humanity can thrive"[76] (Figure 3.1). The HWI includes additional and/or slightly modified indicators of HWB, selected to support the evaluation of the co-benefits of Project Drawdown climate solutions for advancing the well-being of rural communities in SSA and South Asia that are experiencing poverty and are vulnerable to climate change.

Figure 3.1 — Doughnut Economics framework



The 12 socioeconomic dimensions of the classic Doughnut Economics framework (inner circle) served as a model for developing the Drawdown Lift Human Well-Being Index.
Source: Doughnut Economics

The HWI is based on the DE framework for two main reasons: its explicit inclusion of gender equality and its adaptability. Climate change and poverty disproportionately affect women and girls (see Subsection 1.2, above). Including indicators of **Gender Equality** is thus critical to evaluate the overall potential HWB co-benefits of climate solutions. Therefore, in addition to the DE framework's "women's representation in government" indicator, the HWI includes three other **Gender Equality** indicators: intimate partner violence, national abortion policies, and demand satisfied for family planning (Figure 3.2).[ix]

We also modified the indicators in select DE dimensions to address the needs of rural, under-resourced, and politically vulnerable communities in LMICs. For instance, in the **Food** dimension, in addition to the DE indicator for percentage of people who are undernourished, we also added an indicator for the prevalence of child malnutrition (Figure 3.2). In **Networks** we added freedom of movement, in the **Social Equity** dimension we added civil liberties, and in the **Peace and Justice** dimension we added political stability. Finally, we added suicide rate under the **Health** dimension in recognition of its importance in the context of LMICs. New indicators included in this report are noted in Figure 3.2 in orange.

The HWI comprises 31 indicators of HWB. It makes it possible to identify disparities in HWB across countries and examine how climate solutions can improve HWB. It is important to note that, although the HWI provides the relative status of national HWB globally, levels of inequality differ widely within and among regions, countries, communities, families, and gender.

We obtained national-level data predominantly from the Word Bank, UN, NGOs such as Transparency International, and global indices such as the Multidimensional Poverty Index (MPI) and Social Progress Index (SPI). Most of the indicators used are also included in the SDGs. Several indicators have a significant intranational rural–urban divide and gender gap. This analysis does not reflect those differences, primarily due to the lack of availability of intranational and gender-resolved data. Gender goes beyond the indicators in the **Gender Equality**[x] dimension, as it is important to know how women fare compared with men for dimensions like **Food**, **Education**, and **Income and Work**.

A brief description of the indicators and a comparison of other indices is provided in Appendix B (Tables B.1 and B.2). Methods for calculating the HWI are in Appendix C.

ix Insufficient data prevented us from disaggregating by gender. We recognize the value and importance of gender-disaggregated data (particularly regarding education and land tenure) and hope to utilize such data in the future.

x Gender is a crosscutting issue, and disparities between women and men exist across all the aspects of HWB, including access to energy, income, health, primary and secondary education, and housing. However, including these disparities across all the dimensions of HWB is beyond the scope of this report. While **Gender Equality** is an outcome in the HWI, gender is also an input and a crosscutting requirement.

Figure 3.2 — Drawdown Lift Human Well-Being Index Dimensions and related SDGs

DE: Doughnut Economics | SPI: Social Progress Index | MPI: Multidimensional Poverty Index
Indicators highlighted in orange are unique to the HWI

The Drawdown Lift Human Well-Being Index uses national-level data for 31 indicators across the 12 dimensions in the Doughnut Economics framework. Indicators from several multidimensional poverty indices are used. Sustainable Development Goals (SDGs) corresponding to each dimension are noted above. SDG 13, Climate Action, contributes to nearly all other 16 SDGs. See also Footnote X on gender. Methods described in Appendix C.

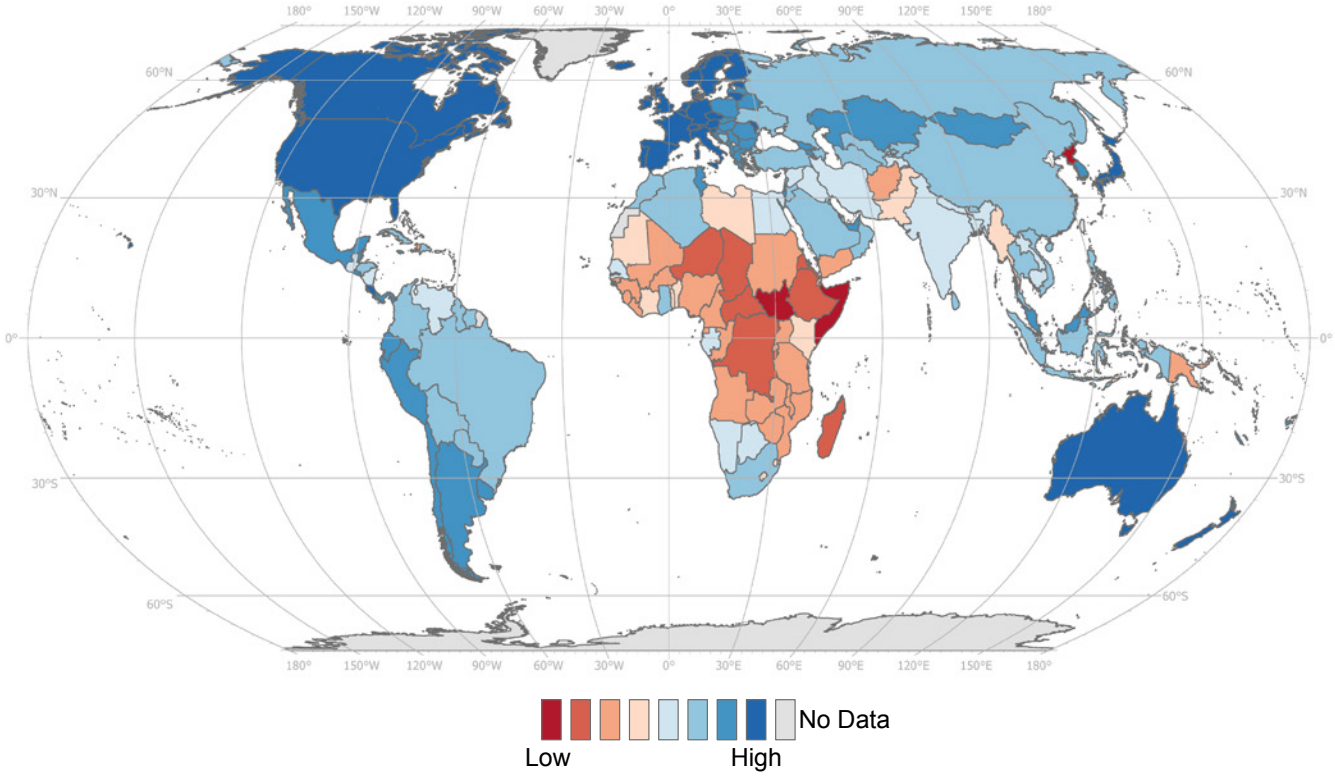
3.3 Global patterns of human well-being

High-income countries have higher overall HWB than LMICs across many dimensions of the HWI (Figure 3.3 and Figures C.1–C.3 in Appendix C). The results are similar to those of the SPI, HDI, and MPI. High-income countries in Western Europe, Australia, Canada, Japan, and New Zealand, followed by the United States, and a subset of countries in South America, Eastern Europe, and Central Asia, have the highest HWI dimensions. It is important to note that greater overall HWI dimensions in high-income countries mask data around specific indicators, such as homicide rate (which is very high in the United States), as well as inequities within high-income countries on specific indicators such as women's representation in government and maternal mortality.

Generally, SSA and South Asian countries have lower HWI values. However, reflective of countries' diverse cultures, history, geopolitics, and governance, there is significant variation in HWB among LMICs. Politically unstable countries such as South Sudan and Somalia have the lowest HWI, reflective of very low values in dimensions focused on human rights, such as **Gender Equality**, **Social Equity**, **Political Voice**, and **Peace and Justice** in addition to high needs in dimensions such as **Food**, **Energy**, and **Education**. Countries in the eastern Sahel, Central Africa, Ethiopia, Eritrea,

and Madagascar have low overall HWI values because they are low in fundamental dimensions such as **Energy**, **Water and Sanitation**, **Food**, and **Health**. Niger and Madagascar are among the world's poorest countries and also suffer from climate-exacerbated droughts and floods.

Figure 3.3 — Drawdown Lift Human Well-Being Index



The Drawdown Lift Human Well-Being Index has lower values in low- and middle-income countries, particularly in sub-Saharan Africa and South Asia. This pattern is largely driven by limited access to energy, clean water, and sanitation; inadequate education; and poor health. Appendix C describes the methods and includes maps of each of the 12 dimensions. *Source: Project Drawdown*

The status of individual HWB dimensions varies among countries and regions (Appendix C, Figures C.1–C.2). Maps in Appendix C can be used to prioritize countries with the most need to boost specific human well-being dimensions and highlight regions where Project Drawdown solutions might be most impactful. For example, **Energy, Water and Sanitation, Education**, and **Health** are lowest in SSA, except South Africa. Although access to electricity, water, and sanitation is moderately high in South Asia, the status of education and health similar to many countries in SSA. Despite a higher degree of electrification in South Asia (> 80 percent of households, except in Myanmar) compared with SSA, electricity deprivation remains an issue due to frequent long power outages in both rural and urban areas. Furthermore, lack of access to clean cooking fuel—an indicator within the **Energy** dimension—is pervasive in South Asia.

Unfortunately, the countries with medium to low overall HWI values are also among those most vulnerable to climate change and low readiness to adapt.[21] Furthermore, for several countries (e.g., Democratic Republic of Congo, Niger, and Tanzania) the population is expected to more than double within the next 30 years. In these countries and elsewhere, climate solutions can contribute to sustained boosts in HWB.

4

LINKING CLIMATE SOLUTIONS AND HUMAN WELL-BEING

Distributed Solar Photovoltaics is a climate solution that has numerous human well-being co-benefits and ripple effects that can benefit rural and under-resourced communities in sub-Saharan Africa and South Asia, particularly those with little to no access to electricity. *Credit: Abbie Trayler-Smith | Panos Pictures | Department for International Development*

Climate solutions generate tangible HWB co-benefits and ripple effects. Documenting the HWB co-benefits of climate solutions can help decision-makers understand how the various solutions not only reduce emissions but also address sustainable development needs.

This section links the HWI dimensions with the subset of 28 Project Drawdown solutions (see Appendix A for definitions of each solution) and presents evidence of the solutions' co-benefits and ripple effects on the different dimensions of HWB laid out in Subsection 3.2. Several solutions share HWB co-benefits and ripple effects and are thus grouped together. For example, *Distributed Solar Photovoltaics, Geothermal Power, Microgrids, Small Hydropower,* and *Micro Wind Turbines* are combined because they have similar co-benefits. The solutions are divided into five groups (Table 4.1).

Table 4.1 — Climate solution groups and human well-being dimensions

CLIMATE SOLUTION GROUP	HUMAN WELL-BEING DIMENSIONS											
	Food	Water and Sanitation	Energy	Health	Education	Income and Work	Gender Equality	Networks	Housing	Social Equity	Peace and Justice	Political Voice
IMPROVING AGRICULTURE & AGROFORESTRY	■	■	■	■	■	■	■	■	■	■	■	■
PROTECTING & RESTORING ECOSYSTEMS	■	■	■	■	■	■	■	■	■	■	■	■
ADOPTING CLEAN COOKING	■	■	■	■	■	■	■	■	■	■	■	■
PROVIDING CLEAN ELECTRICITY	■	■	■	■	■	■	■	■	■	■	■	■
FOSTERING EQUALITY	■	■	■	■	■	■	■	■	■	■	■	■

■ Direct co-benefits, strong evidence ■ Indirect co-benefits, strong evidence ■ Indirect co-benefits, moderate evidence ■ Ripple effects

The five Project Drawdown solution groups[xi] offer direct co-benefits, indirect co-benefits, and ripple effects for each of the 12 human well-being dimensions.

Evidence of co-benefits is classified as **strong** when systematic reviews, syntheses, or multiple studies across diverse geographies of peer-reviewed and gray literature report a positive correlation between the climate solution group and the dimension of HWB (Table 4.1). Evidence of co-benefits is classified as **moderate** when there is either limited geographic distribution of the studies or a similar number of studies report a mix of positive, neutral, and negative correlations. Climate solutions can have ripple effects across all aspects of HWB when incorporated into a synergistic set of solutions.

The quality and duration of connections within and across climate solutions and HWI dimensions depend on appropriate policies and investments, community-driven engagement, and local capacity strengthening. Actual development pathways and climate solutions are complex and interwoven, and multidisciplinary cooperation across emissions reduction, poverty alleviation, and HWB dimensions is needed to achieve maximum benefit.

xi Project Drawdown solutions comprising the solution groups are as follows:

Improving Agriculture and Agroforestry: *Abandoned Farmland Restoration, Conservation Agriculture, Farm Irrigation Efficiency, Improved Rice Production, Multistrata Agroforestry, Nutrient Management, Reduced Food Waste, Regenerative Annual Cropping, Silvopasture, Sustainable Intensification for Smallholders, System of Rice Intensification, Tree Intercropping.*

Protecting and Restoring Ecosystems: *Coastal Wetland Protection, Coastal Wetland Restoration, Forest Protection, Grassland Protection, Indigenous Peoples' Forest Tenure, Peatland Protection and Rewetting, Temperate Forest Restoration, Tropical Forest Restoration.*

Adopting Clean Cooking: *Biogas for Cooking, Improved Clean Cookstoves.*

Providing Clean Electricity: *Distributed Solar Photovoltaics, Geothermal Power, Micro Wind Turbines, Microgrids, and Small Hydropower.*

Fostering Equality: *Health and Education.*

Co-benefits are described as direct if there is an explicit—often material—link between action and outcomes. For instance, the link between the ***Improving Agriculture and Agroforestry*** solutions and **Income and Work** is direct because higher crop yield and improved crop resilience to climate extremes results in higher income. A co-benefit is indirect when a direct co-benefit enables other co-benefits, such as an increase in income due to ***Improving Agriculture and Agroforestry*** solutions enabling better **Education**. Direct and indirect co-benefits of climate solutions can also lead to cascading effects on other HWB dimensions. These are classified as ripple effects.

Subsections 4.1–4.5 provide detailed evidence of the HWB co-benefits of each climate solution group. The solution groups appear in order of their total global climate mitigation potential from greatest to least.[xii] Hence, we first present the evidence for ***Improving Agriculture and Agroforestry*** (highest net CO_2-eq reduction potential) followed by ***Protecting and Restoring Ecosystems, Adopting Clean Cooking, Providing Clean Electricity,*** and ***Fostering Equality***. Within each solution group, we present the HWI dimensions in descending order of the strength of the evidence.

We discuss the evidence around direct co-benefits of ***Improving Agriculture and Agroforestry, Protecting and Restoring Ecosystems,*** and ***Fostering Equality*** in subsections 4.1, 4.2, and 4.5. **Energy** is the only direct HWB co-benefit for ***Providing Clean Electricity and Adopting Clean Cooking;*** without energy, none of the indirect co-benefits are possible. Thus, in subsections 4.3 and 4.4, we also provide evidence for indirect co-benefits.

In subsection 4.6, we discuss the indirect co-benefits of ***Improving Agriculture and Agroforestry, Protecting and Restoring Ecosystems,*** and ***Fostering Equality*** (the direct co-benefits are discussed in each group's subsection) as well as the ripple effects of all five solution groups. We combined discussion of indirect co-benefits and ripple effects to avoid repetition of evidence as the co-benefit and ripple effect pathways for these HWB dimensions were similar for all of the solution groups.

4.1 Climate solutions for improving agriculture and agroforestry

In 2020, more than 2.3 billion people—one-third of the global population—experienced moderate or severe food insecurity.[77] The burden is not evenly distributed. Hunger, measured as undernourishment, is most prevalent for people living in Africa (21 percent of the population), Asia (9 percent), and Latin America and the Caribbean (9 percent).[77] Food insecurity among women is 10 percent higher than for men.[77]

The regions in which hunger is prevalent also have high rates of poverty. More than three-quarters of the world's most under-resourced people live in rural areas.[78] Over half of people living in poverty are in SSA.[78] The percentage of people living in extreme poverty in South Asia has been declining rapidly (8.6 percent of people in 2018), but the trend is slowing.[78]

xii The CO_2-eq calculations for each solution group are at the global level. We used Project Drawdown's 1.5°C Ambitious scenario, which calculates the total atmospheric CO_2-eq reduction between 2020 to 2050 for each solution (updated in early 2022) compared with a baseline scenario that utilizes a business-as-usual approach.

Climate solutions that improve agriculture and agroforestry are key to addressing poverty and eliminating hunger. Land tenure for women is an important factor to address; research shows that women farmers make up around 40 percent of the agricultural labor force in six sub-Saharan Africa countries. *Credit: Jonathan Torgovnik | Getty Images | Images of Empowerment*

Improving agricultural production is a key pathway for eliminating poverty and hunger. The Food and Agriculture Organization (FAO) estimates that improvements in agriculture are 11 times more effective at reducing extreme poverty in SSA than investments in other sectors.[79] Another study estimated that the country-level internal rate of return for investments in the agricultural sector across SSA ranged from 17 percent to 43 percent.[80] Despite its promise, substantial investments in agriculture in LMICs are still needed. In Africa, millions of people are already suffering the effects of climate change on rural livelihoods, where, by 2030, almost 200 million people will reside in areas where temperatures will have increased more than 2°C, affecting US$23 billion in crop and livestock production value.[81]

Investments in improving agriculture must also focus on women. In six SSA countries, women farmers make up around 40 percent of the agricultural labor force.[82] Although most women in LMICs are employed in agriculture, 85 percent lack the right to own land.[83] Achieving the direct and indirect co-benefits of land ownership is closely linked to land tenure. Secure land tenure, such as the *Indigenous Peoples' Forest Tenure* solution, increases the probability that farmers will adopt sustainability practices[84] like those described above, which lead to improved food security.[85] Increasing land tenure is particularly important for women[86] as it is linked to greater adoption of sustainable practices and better ecological outcomes.[87]

Regions where hunger, poverty, and farming are all prevalent also are the most vulnerable to climate change. Crop yields are projected to decrease most strongly across the subtropics and tropics[88] in both moderate and high warming scenarios. More alarming, climate change has already decreased staple crop yields in many countries,[89] including a 30–35 percent decrease across SSA.[90]

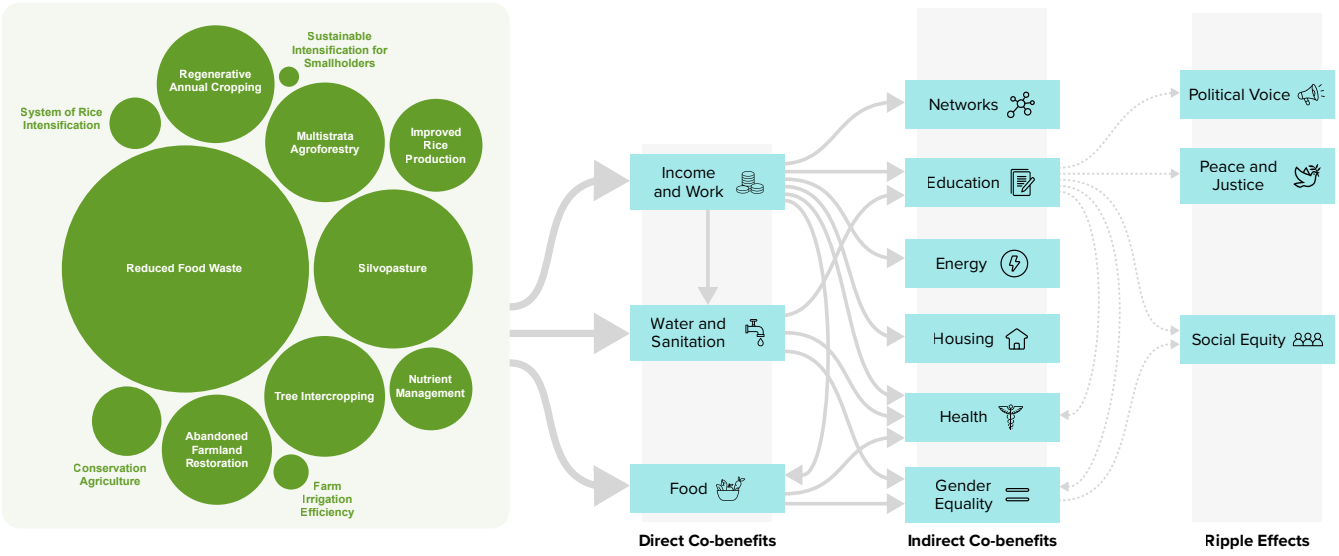
Globally, producing crops and livestock on croplands, pastures, and agroforestry systems accounts for ~15 percent of GHG emissions.[91] The primary sources of these emissions are methane from livestock and rice production as well as nitrous oxide (N_2O) emissions from

fertilizer and manure.[91] Although total GHG emissions are much lower in most LMICs than high-income countries, agriculture is the source of a high percentage of emissions in countries where there is extensive production of rice or cattle (from methane), excessive fertilizer application (from N_2O), or deforestation for agricultural expansion (from CO_2). The critical role of food production in climate mitigation is underscored by the fact that more than 90 percent of Nationally Determined Contributions reference agriculture.[92]

The primary climate benefit of ***Improving Agriculture and Agroforestry*** is increased carbon storage in soil and vegetation, particularly in agroforestry systems where trees are prevalent,[93, 94] although the amount of storage is context specific. Similarly, environmental, social, and economic factors influence the HWB co-benefits. Solutions must incorporate a complementary approach to minimize trade-offs.[95] For example, fertilizer inputs to boost crop yields can lead to reduced water quality and increased N_2O emissions.

Twelve of Project Drawdown's agriculture- and agroforestry-related climate solutions (*Abandoned Farmland Restoration, Conservation Agriculture, Farm Irrigation Efficiency, Improved Rice Production, Multistrata Agroforestry, Nutrient Management, Reduced Food Waste,*[xiii] *Regenerative Annual Cropping, Silvopasture, Sustainable Intensification for Smallholders, System of Rice Intensification,* and *Tree Intercropping*),[53, 96] have direct co-benefits for HWB, particularly around **Food** and **Income and Work**, as well as several indirect co-benefits (Figure 4.1).

Figure 4.1 — Human well-being benefits of climate solutions for Improving Agriculture and Agroforestry



This systems diagram highlights the direct (thick gray line) and indirect (thinner gray line) co-benefits of ***Improving Agriculture and Agroforestry*** for the 12 dimensions of human well-being. Ripple effects are shown by dashed gray lines. Local stakeholders, governments, and change makers are implicit along the connecting arrows. Potential CO_2-eq reduction for 2020 to 2050 is 277.6 gigatons.

xiii The *Reduced Food Waste* solution focuses on both food loss and waste. Given that this report discusses LMICs, where food loss is generally more of an issue, that is the focus for this section.

Human well-being benefits of improving agriculture and agroforestry

A group of agriculture and agroforestry climate solutions have direct co-benefits for **Food**, **Income and Work**, and **Water and Sanitation**. The high number of solutions reflects the diverse environmental and social conditions that span croplands, rangelands, and agroforestry systems. Several climate solutions—such as *Sustainable Intensification for Smallholders, Conservation Agriculture, Regenerative Agriculture, Nutrient Management, Improved Rice Production,* and *Farm Irrigation Efficiency*—increase food production while reducing climate and other environmental impacts. A second set of solutions, including *Multistrata Agroforestry* and *Silvopasture,* diversify food production, which can lead to more diverse diets and sources of income. Other solutions such as *Reduced Food Waste and Loss* and *Abandoned Farmland Restoration* increase the amount of food that is available or can be produced on existing agricultural lands.

Climate-smart agriculture can provide increased income, lead to more diverse diets, and provide environmental benefits. *Credit: Neil Palmer | Center for Tropical Agriculture (CIAT) 2011*

Food: Climate solutions improve food security directly by increasing yields and dietary diversity and buffering against weather shocks. Several climate solutions increase production on current fields, reducing the need to farm additional land. This is particularly important in densely populated rural areas, where land is limited.[97] Although yields of staple grains, which account for the majority of caloric intake, have stagnated across LMICs,[98] 70 percent of studies in a recent review of intensifying production on smallholder farms found increases in yields and/or income.[99]

Increasing yields of rice while also reducing its climate impact is critical, as rice is the largest source of GHG emissions from croplands[100, 101] and the staple food of 3.5 billion people. Using the best management practices for planting times, nutrient application, crop varieties, irrigation timing, and pest control has been shown to increase yields,[102] reduce methane emissions,[100] and improve water availability.[102] However, some solutions, like *System of Rice Intensification,* have limited adoption or applicability in certain geographies because of increased costs, time, soil conditions, and labor requirements.

Several studies found that changing management practices to improve soil fertility increases yields through application of organic matter and fertilizer.[99] Because the relationship between fertilizer application and N_2O emissions is nonlinear,[103] small additions of nitrogen fertilizer where little (or no) nitrogen is currently applied can increase crop yields with very low increases in N_2O emissions. For example, small additions of fertilizer improved crop yields and increased net income by an average of 33 percent in six countries across SSA.[104] The opposite is true in India and China, where government subsidies have led to the highest rates of nitrogen fertilizer application globally. In these countries, a small decrease in application rates has no impact on yield but dramatically reduces N_2O emissions.[103] Further, excess nitrogen on farmlands degrades air and water quality,[91, 105] and high amounts can acidify soils,[106, 107] in turn decreasing crop yields.

While the potential outcomes are highly context dependent, *Multistrata Agroforestry, Silvopasture,* and *Tree Intercropping* solutions all increase carbon storage and improve food security.[108] Although there is mixed evidence of the effects of these practices on yield,[99] the higher diversity of food products[109] in agroforestry systems is associated with higher dietary diversity.[110] These solutions also improve food production stability and drought resilience by creating diverse microclimates[111, 112] and increasing soil organic matter that can hold more water and nutrients.[113]

Income and Work: Increasing **Income and Work** is primarily associated with increasing yields. Additional production can be sold and/or reduce the income spent on food to supplement household farm production. Although the yields of individual crops can be lower in agroforestry systems,[99] the diversity of foods produced provides a buffer against economic shocks due to market prices or crop failure.[114, 115]

Reducing food waste and loss reduces the amount of food that must be produced or purchased. Globally, about one-third of all food produced is wasted.[116] In LMICs, food loss primarily occurs during production, post-harvest handling, and storage.[116] Effective strategies for reducing food loss in on-farm practices, such as post-harvest storage[117, 118] and integrated pest management, as well as off-farm efforts to improve roads, access to electricity, centralized storage, processing, and market development have been demonstrated to improve food security and increase income.[117]

Water and Sanitation: Increasing *Farm Irrigation Efficiency* has direct benefits to food security, income, and water availability and quality. Crop production in China and India accounts for 49 percent of water consumption in irrigation and 43 percent of global N_2O emissions.[119] Pakistan consumes another 15 percent of global water, largely for cotton production.[119] Although much of the irrigation is from storing and redirecting surface water (so there are few GHGs to mitigate), water consumption in those countries is greater than the amount replenished each year.[120] Reducing water for irrigation increases water available for people and avoids increased vulnerability should withdrawals become unsustainable.

Increasing *Farm Irrigation Efficiency* has also been shown to increase food production, income, and nutritional intakes.[121, 122] In Zimbabwe, drip irrigation enabled rural households in a dry village to significantly improve their nutrition and food consumption.[123] In Benin, households using solar-powered drip irrigation increased their fruit and vegetable production 26 percent and 55 percent, respectively.[124] Similar results were observed in the Sahel region of northern Benin, where solar-powered drip irrigation improved both household nutritional intake and income in the dry season.[125]

The need for irrigation can be reduced through *Multistrata Agroforestry* and *Silvopasture*, which increase soil carbon found in organic matter[93, 94] and boost soils' ability to store water.

FEATURE BOX

Climate-Smart Village project, India: Improving food security, income, and education

Nearly 30 percent of India's population experiences multidimensional poverty,[126] most of whom live in rural[127] areas and work in agriculture.[128] Climate change has already decreased the yields of the two main crop staples—wheat and rice.[89] The four-year (2016–2020) Climate-Smart Village project, managed by the CGIAR Research Program on Climate Change and Food Security, highlights how climate solutions can be combined with a suite of additional interventions that improve livelihoods.[129] Climate solutions such as increasing irrigation efficiency, composting, and reducing fertilizer all reduced GHG emissions and increased yields, water availability, and income. These practices and outcomes were further reinforced by establishing small businesses that loan and sell machinery, fertilizer, and pesticides. Women played central roles in decision-making and governance. Adding household gardens provided another source of income as well as improved nutrition. Installing clean cookstoves added benefits by reducing cooking time and the need to gather fuelwood and improving household air quality. The improved food security, lowered agricultural input costs, diversified income sources, and reduced time for gathering fuelwood enabled women to focus more attention on childhood education. Additional climate solutions, such as *Distributed Solar Photovoltaics* or *Microgrids*, would be needed to enable these benefits in places that currently lack access to electricity or where access to electricity is patchy and intermittent. Further, since increased production can suppress crop prices, policies that create markets and storage and processing facilities may be needed to ensure increased farm income.[129, 130, 131]

The Climate-Smart Village Project in northern India implemented irrigation and fertilizer efficiency, composting, and clean cookstoves while advancing women's decision-making authority and establishing new businesses. *Credit: Jacquelyn Turner | CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)*

4.2 Climate solutions for protecting and restoring ecosystems

Protecting forests, such as the Southwest Mau in southern Kenya, can help to support the more than 1 billion people experiencing extreme poverty who rely on forests to meet their basic needs for housing, water, fuel, and income. *Credit: Patrick Sheperd | Center for International Forestry Research*

Ecosystems provide multiple benefits for people. These include provisions such as food, water, and timber; protection from or reducing the impact of flooding, storm surges, and drought; and cultural and spiritual significance.[132, 133] Globally, more than 1 billion people depend on nature to meet their basic needs for housing, water, and fuel, as well as their primary source of income.[134] And over 1 billion people living in extreme poverty rely on forests for their livelihoods.[135] About 75 percent of people in Central and Eastern Africa rely on nature[134] —mostly for subsistence living. Thus, they are particularly vulnerable to extreme weather, climate change, and environmental degradation.

Indigenous peoples rely heavily on natural ecosystems and play a central role in conserving them, as they manage or have tenure on 25 percent of the world's land—and 40 percent of that land overlaps with protected areas or intact ecosystems.[136] Most of these lands are in boreal and tropical forest regions, although other regions are also critical. For example, around 100–200 million people are nomadic pastoralists[137] who move animals across large natural landscapes that cross countries and span diverse regions of the Sahel, Serengeti plains, Mongolian grasslands, and Arctic tundra. Aquatic and coastal regions are also important for conservation; for example, the UN Environment Programme (UNEP) estimates that the livelihoods of 1.2 million people depend on mangroves in the Western Indian Ocean countries of Kenya, Madagascar, Mozambique, and Tanzania.[138]

Habitat destruction and degradation reduce nature's many benefits to people and are a major source of GHG emissions. Consumption in high-income countries drives appropriation of natural resources from LMICs with negative consequences for protecting and sustaining ecosystems, while also fueling inequality.[139] Deforestation throughout SSA is largely due to clearing land for subsistence agriculture; a few commodities driven by large-scale agriculture account for most of the deforestation in Southeast Asia.[140] In addition to national policies that either encourage agricultural expansion or do not regulate deforestation, large-scale land acquisitions (or land grabs), commonly by foreign investors, accelerate deforestation and other habitat destruction,[141, 142] and reduce food security.[142, 143]

To stop biodiversity loss, researchers have proposed formally designating the protection of 30 percent of all terrestrial and marine areas.[144] In the past decade, at the global level, the area designated for land and marine biodiversity conservation expanded by 42 percent.[145] However, the increase in protected areas on land (28.1 million square kilometers)[145] was much smaller than the area deforested,[146] which does not include the loss of grasslands, savannas, coastal areas, and other ecosystem types. By storing carbon in vegetation and soil, nature-based climate solutions that conserve, restore, and improve land management across forests, wetlands, grasslands (and agricultural lands) can contribute to climate mitigation needed to hold global average temperature increases to well below 2°C, while also enhancing soil health, cleaning air and water, and sustaining biodiversity.[147]

Healthy forests often provide a variety of nutrient-rich foods that women commonly forage for and cultivate to provide for their families. *Credit: Joe Nkadaani | CIFOR*

Clearing natural ecosystems releases carbon stored in vegetation and soils into the atmosphere. These emissions from land use change account for 11 percent of global GHG emissions,[91] primarily driven by deforestation for agricultural expansion in the tropics.[148] Protecting ecosystems maintains the carbon they store (avoided emissions) and enables them to continue storing more carbon each year. Restoring ecosystems benefits climate through vegetation pulling CO_2 from the air and storing it in plants and soils. Project Drawdown estimates that ***Protecting and Restoring Ecosystems*** could reduce emissions between 2020 and 2050 by as much as 63.1 gigatons (Gt) and store an additional 120.1 Gt of CO_2.[53]

Eight Project Drawdown solutions focused on ***Protecting and Restoring Ecosystems*** (*Coastal Wetland Protection, Coastal Wetland Restoration, Forest Protection, Grassland Protection, Indigenous Peoples' Forest Tenure, Peatland Protection and Rewetting, Temperate Forest Restoration,* and *Tropical Forest Restoration*) have direct and indirect co-benefits for HWB.[xiv]

Human well-being benefits of protecting and restoring ecosystems

Climate solutions related to ***Protecting and Restoring Ecosystems*** provide many benefits for HWB. Nature provides many goods and services that benefit people[133,149] and a critical safety net for those who rely on nature to meet their basic daily needs through subsistence use of lands and waters.

xiv Project Drawdown will add more marine-based solutions in 2022.

Securing *Indigenous Peoples' Forest Tenure*[xv] and involving local communities in resource management decisions are critical to achieving the dual objectives of improving people's livelihoods and conserving nature.[84] Approximately 22 percent of all forest carbon in tropical and subtropical countries is on lands managed by Indigenous peoples.[150] The forest carbon on Indigenous forested lands is primarily (65 percent) in soils[150] in the three largest tropical peatland regions (*Peatland Protection and Rewetting*): the islands of Southeast Asia,[151] the central Congo River Basin,[152] and southwestern Amazonia.[153]

Positive ecological outcomes are more associated with land tenure security than with particular types of land tenure.[154] Most studies that examine the effect of interventions that improve land tenure security show positive outcomes for both HWB and nature.[84] Although securing land tenure creates a strong foundation for improving HWB, protecting nature and land tenure strategies must be part of a systemic approach that designs interventions to realize multiple benefits and ensures they are equitably distributed. Co-management by Indigenous peoples[155] and local community-based forest management[156] are associated with better conservation and social outcomes, although maintaining such efforts can be challenging without sustainable sources of funding. However, in some instances, efforts to formalize tenure for community-based forest management areas reduced people's access to and use of the land.[156]

Figure 4.2 — Securing land tenure for women leads to:

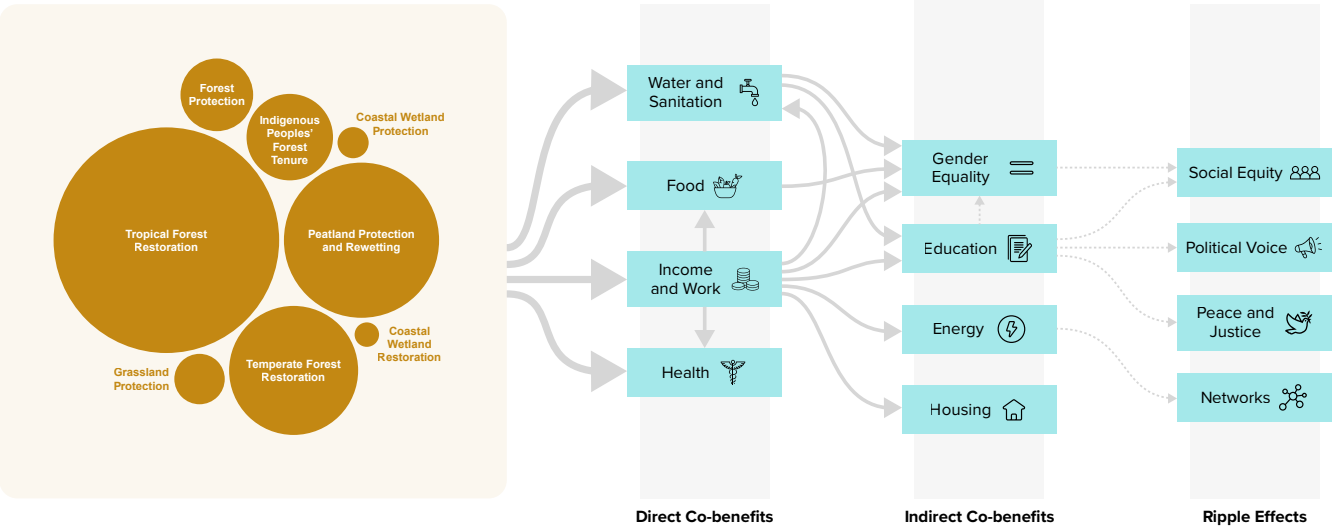
Strengthening land rights for women provides many human well-being benefits. *Credit: Mariola Acosta, Research Fellow | IITA/CCAFS*

xv For consistency with other Project Drawdown materials, this report uses the solution name *"Indigenous Peoples' Forest Tenure."* However, the evidence presented here also includes land tenure security for local communities and women.

> Studies across South Asia, SSA, and Latin America have demonstrated that women's involvement in forest governance and management resulted in higher adoption of sustainable resource management practices that led to improved ecological conditions.

Women play important roles in land tenure security (Figure 4.2). Studies across South Asia, SSA, and Latin America have demonstrated that women's involvement in forest governance and management resulted in higher adoption of sustainable resource management practices that led to improved ecological conditions.[157, 158] Women's influence on improving forest ecological conditions is likely a result of women's greater dependence on and knowledge about forest resources, as women are the primary providers and collectors of food and fuelwood for the family and increase income by selling non-timber forest products (NTFPs).[158] As a result, the direct and indirect co-benefits (Figure 4.3) are highly dependent on land tenure security for women and more fully engaging women in all aspects of ***Protecting and Restoring Ecosystems***.

Figure 4.3 — Human well-being benefits of climate solutions for Protecting and Restoring Ecosystems



This systems diagram highlights the direct (thick gray line) and indirect (thinner gray line) co-benefits of ***Protecting and Restoring Ecosystems*** for the 12 dimensions of human well-being. Ripple effects are shown by dashed gray lines. Local stakeholders, governments, and change makers are implicit along the connecting arrows. Potential CO_2-eq reduction for 2020 to 2050 is 181.5 gigatons.

Most studies that assess the impact of ***Protecting and Restoring Ecosystems*** on HWB focus on income and food security in forested environments.[84,154,155,159]

Income and Work: The strongest evidence linking *Forest Protection* with poverty alleviation is for ecotourism, community forestry, and agroforestry as drivers of income generation.[160] Positive economic outcomes for local communities are associated with land tenure security through community-based management.[87,155,156,161]

The most widespread source of income from nature is the sale of NTFPs such as fuel, food, and medicine. NTFPs make up 22–28 percent of the income of rural people experiencing poverty who live in or adjacent to forests.[162,163] Dependence on NTFPs for income is highest for those living in extreme poverty.[163,164] However, income from NTFPs may not reduce poverty, as NTFPs are largely consumed by individuals in the community rather than sold outside the community.[165] In such cases, forests still benefit HWB by reducing the income needed to purchase the goods and services that can be accessed from natural areas.

Ecotourism can be an important source of income. Tourism related to coral reefs alone generates US$36 billion each year.[166] However, several studies show that individuals who benefit from ecotourism were already doing relatively well,[160] so ecotourism could increase inequality. Community involvement in decision-making about ecotourism increases the benefits to local communities.[167]

Food: ***Protecting and Restoring Ecosystems*** can improve food security. Several studies across LMICs found that living in or near forested areas improved food security by either increasing food availability and dietary diversity[168,169] and/or increasing capacity to purchase food with tourism-generated income.[169] In grass-dominated ecosystems (*Grassland Protection*), nomadic pastoralists move cattle across large natural landscapes to produce food; these ecosystems generate the majority of annual GDP from agriculture in arid countries like Niger and Senegal.[170] In coastal regions, particularly in small island developing states, mangroves and other coastal ecosystems (*Coastal Wetland Protection, Coastal Wetland Restoration*) support subsistence fisheries that are critical for food security.[133, 171] For example, a 10 percent increase in restored mangrove area (*Coastal Wetland Restoration*) near a national park in Tanzania doubled income from shrimping near the restoration site.[172] Marine protected areas can lead to increased dietary diversity.[173]

Indigenous peoples, such as the Maasai in Tanzania and Kenya, are among those most impacted by climate change despite contributing the least to its causes. They are keepers of important traditional knowledge.
Credit: William Warby

Water and Sanitation: The condition of ecosystems affects water quantity and quality.[132, 133, 174] Human demand for water is changing the quantity and distribution of freshwater resources[175] and has resulted in scarcity in many regions.[120] Fertilizers, soil erosion, sewage, and industrial chemicals are major sources of water quality degradation. ***Protecting and Restoring Ecosystems*** improves water quantity and quality by facilitating filtration of precipitation by vegetation and soils. For example, a study of children across 35 countries found that increasing upstream forest cover (*Forest Protection, Temperate Forest Restoration,* and *Tropical Forest Restoration*) in a watershed by 30 percent decreased diarrheal disease to a rate similar to that from improvements in sanitation.[176]

Health: Natural ecosystems reduce the incidence of vector-borne diseases and exposure to extreme weather, improving the living and working environment and boosting mental health.

Ecosystem degradation can increase the likelihood that pathogens such as SARS-CoV-2 and Ebola viruses will jump from wildlife to people.[177] Deforestation and other forms of ecosystem degradation also increase the incidence of several vector-borne diseases. For example, the incidence of malaria increased following deforestation in the rainforests of Brazil,[178, 179] Indonesia,[180] and Uganda.[181] Deforestation is also linked to increased incidence of arboviruses, Chagas, and other vector-borne diseases.[182]

Meta-analyses highlight several studies that report a positive correlation between biodiversity and better health.[183] Children who live near protected areas like national parks were found to be healthier than children living far from protected areas.[169] Similarly, children living near forested areas (*Forest Protection, Temperate Forest Restoration*, and *Tropical Forest Restoration*) have higher dietary diversity than those living farther away from forests across 27 LMICs.[168] As forests are cleared or degraded, people must spend more time hunting and/or gathering food and fuelwood in the forest, which can have negative impacts on their health.

Children who live near protected areas like national parks were found to be healthier than children living far from protected areas.

Extreme weather poses a major global public health challenge for both psychological health and well-being, especially for the most vulnerable people in LMICs (and those who lack accessible, quality mental health care infrastructure)[184, 185] and children.[186] Natural ecosystems can buffer exposure to such events. Mangroves (*Coastal Wetland Protection, Coastal Wetland Restoration*) and coral reefs reduce the force of harmful waves during storm surges.[187, 188] Deforestation elevates heat stress for workers, reducing cognition and productivity,[189, 190] particularly in LMICs where heat waves hit under-resourced regions hardest.[191] Experiences of extreme weather events have been linked to anxiety and depression in children.[192]

FEATURE BOX

Gorongosa National Park, Mozambique: Lifting people out of poverty through conservation

The Gorongosa region experienced civil war and conflict for decades, devastating people, wildlife, and the ecosystem. The Gorongosa project began in 2008 as a 20-year public–private partnership between the government of Mozambique and the Carr Foundation to revive and conserve Gorongosa National Park, reduce conflict in the region, and sustainably unlock the park's economic potential as a driver for human development in nearby communities. It is funded primarily by USAID, Canada, Norway, and Irish Aid along with the Carr Foundation and includes collaboration among multiple local and international organizations, government agencies, and universities. The project recognizes that environmental conservation is possible by lifting people out of poverty. Integrating development and conservation are key components of the initiative, which addresses all 17 SDGs. Wildlife poaching incidence has decreased by 72 percent, and populations (including several endangered species) have increased. Girls' retention in school has significantly improved. Youth skills in environmental education, eco-tourism, and conservation have been enhanced. More than 11,000 farmers have increased crop yields due to better farming practices. The opening and improvement of health centers and training of health professionals has led to a significant decrease in malaria cases and improved child vaccination rates, and contributed to nutritional interventions for more than 30,000 children. Investments in sustainable agriculture activities boost livelihoods; products include Gorongosa coffee, cashew, fish, honey, and crafts. Peace clubs reintegrate former combatants into society. Health programs, in collaboration with the Ministry of Health, focus on water, sanitation, and hygiene (WASH), including in schools. These programs also support community health workers who provide primary health care services to rural communities, such as treatment for common diseases, family planning, and prenatal and postnatal care. The new forestry and climate action program protects and restores forests and plans to seek carbon offset certification. The project's success has led to an extension of the public–private partnership for another 25 years, a recognition of Gorongosa as a global model for alleviating poverty and improving human well-being while conserving biodiversity.[193]

Gorongosa National Park in Mozambique focuses on both conservation and poverty alleviation while addressing nearly all of the SDGs. *Credit: Brett Kuxhausen | Gorongosa National Park*

4.3 Climate solutions for adopting clean cooking

Approximately 2.6 billion people across 71 countries—one-third of the global population—use solid fuels, including wood, charcoal, dung, and crop residues, for cooking.[194] Household air pollution (HAP) resulting from the use of traditional cookstoves contributes to stroke, ischemic heart disease, chronic obstructive pulmonary disease, lung cancer, and adverse birth outcomes including low birth weight,[195] particularly in the most under-resourced settings.[195] HAP is estimated to cause more than 4 million premature deaths[194] every year and accounts for almost 4 percent of the global burden of disease,[195] and air pollution (including ambient ozone, ambient $PM_{2.5}$[xvi], and household pollution) contributes to nearly 12 percent of global deaths worldwide.[195] According to the most recent State of Global Air report,[195] in 2019, 0.5 million infant deaths in the first month of life can be attributed to poor air quality. The global loss of life expectancy attributable to HAP is 0.7 years, but it is approximately two years or higher in several SSA countries.[196] In Myanmar, where the use of traditional cookstoves is common, the relative risk of neonatal, infant, and under-5 mortality was two times higher in households using solid fuel than in those using clean fuel.[197] An analysis of children's exposure to HAP across 14 countries in SSA found a 30 percent higher risk of under-5 mortality for children who lived in homes with indoor cooking than for children in homes where cooking is done in a separate building or outside.[198]

Scalable, affordable, acceptable clean cooking technologies and user-informed, culturally grounded approaches will help to increase adoption of clean cooking that can lead to many **Energy, Health, Income and Work, Education,** and **Gender Equality** human well-being co-benefits. *Credit: Horst Vogel | Flickr*

Households must be able to secure fuel to provide food for their families, despite high socioeconomic costs. It is estimated that the combined adverse impacts of solid fuel cooking on health, the environment, and gender equality costs US$2.4 trillion annually.[199] Traditional wood and coal cookstoves can also have adverse environmental and climatic impacts, although it is difficult to delineate household fuel use from extraction for other purposes such as timber and challenging to accurately account for demand and regeneration.[200] And yet, creating scalable, affordable, and acceptable clean cooking[xvii] options remains a major challenge.[201]

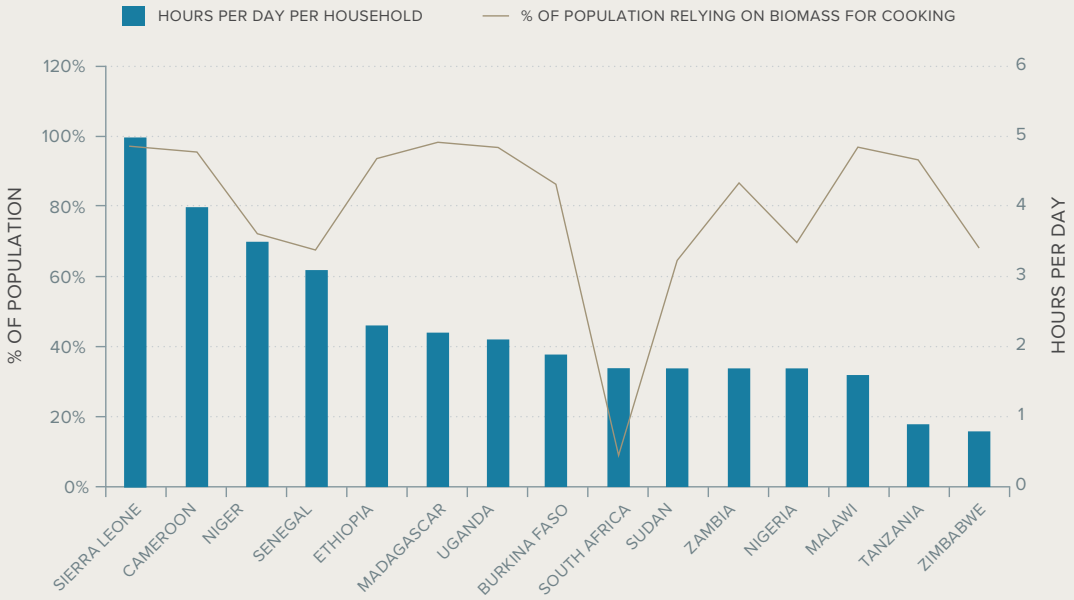
xvi $PM_{2.5}$ is defined as fine inhalable particles that are ≤ 2.5 micrometers in diameter.

xvii We define clean cooking as primary use of modern stoves and fuels (e.g., solar, electric, biogas, natural gas, liquefied petroleum gas [LPG], and alcohol, including ethanol) instead of coal and biomass fuels (e.g., wood, charcoal, dung, crop residues). However, Project Drawdown's calculation of the climate impact of these solutions excludes natural gas and LPG as fuel sources. We recognize that LPG has a much lower climate impact than coal and biomass and has an important role to play in cleaner cooking options in LMICs.

FEATURE BOX

Time spent by women and girls every day collecting fuel for cooking in several sub-Saharan African countries

Collecting fuelwood can be time-consuming, taking up to six to thirty hours per week. In many communities—largely dependent on cultural values and norms—the use of traditional cookstoves disproportionately affects women and girls as they spend hours daily collecting fuel, with associated physical, mental, and economic impacts.[202,203] In most countries gathering fuelwood falls predominantly on women and girls, although in some countries, such as India, Indonesia, and Nepal, men also collect fuel.[204,205] Adoption of clean cooking can substantially reduce the "time poverty" associated with collecting cooking fuel, providing family members, especially women and girls, the opportunity to pursue education and economic activities. Research in The Gambia, Guinea-Bissau, and Senegal showed that redeploying 50 percent of the time saved on gathering firewood to income-generating activities could result in an approximate annual income of US$83, US$100, and US$170, respectively.[206]



Household members in some African countries spend anywhere from less than one to five hours per day collecting fuel; in several countries, nearly the entire population relies on biomass to cook food. *Source: Organization for Economic Co-operation and Development.*[207]

At the global level, 1.9–2.3 percent of GHG emissions is derived from the use of wood fuels.[208] A World Bank analysis[209] showed that replacement of a traditional solid-fuel cookstove with a low-polluting cookstove can save up to 0.94 metric tons of CO_2-eq per year per cookstove; full adoption of clean cooking technologies could reduce global emissions by up to 1 billion metric tons of CO_2-eq every year between 2020 and 2050.[210] Further, traditional wood and coal stoves also produce black carbon, a pollutant that can accelerate near-term regional warming.

Phasing out traditional cookstoves could cool global temperature by 0.1°C by 2050[211] and improve human health. The highest potential impacts for both global temperature change and health (due to ambient air pollution) are in LMICs in Asia and SSA—including Bangladesh, Ethiopia, India, and Nigeria.[211]

Clean cooking is a powerful climate solution, both in the short and long term, and it also has impressive HWB co-benefits across multiple dimensions. Many people have benefited from impactful clean cooking projects in LMICs; since 2010, the Clean Cooking Alliance has worked to support rigorous research. And yet, the evidence regarding the potential co-benefits for HWB remains mixed.[212] Several studies have shown positive effects, while others have found limited benefits due to lack of oversight and monitoring of projects, mixed use of clean cooking and traditional methods at the household level, and unaffordability.[213, 214] The majority of studies analyzing the benefits of clean cooking focus on environmental and health benefits rather than time savings.[215] A systematic review of 45 publications on clean cooking and time poverty in LMICs found only two studies that measured time saved due to switching from biomass to clean fuel, both of which showed significant time savings.[215] To this end, there is a call to include additional questions in national surveys on the gendered dimensions of household energy use[216] and to explore the co-benefits of clean cooking on time poverty and gender equality.

The unsatisfactory adoption of clean cooking despite decades of efforts (and therefore poor research outcomes) could be due to a lack of understanding of the lived experience of extreme poverty and attendant fears and stresses.[217] Notwithstanding the research-focused limitations and shortcomings, we present the HWB co-benefits evidence below.

Adopting clean cooking stoves reduces the time spent collecting fuelwood (typically 10–30 hours each week per household) and improves indoor air quality for women and children. *Credit: Ollivier Girard | CIFOR*

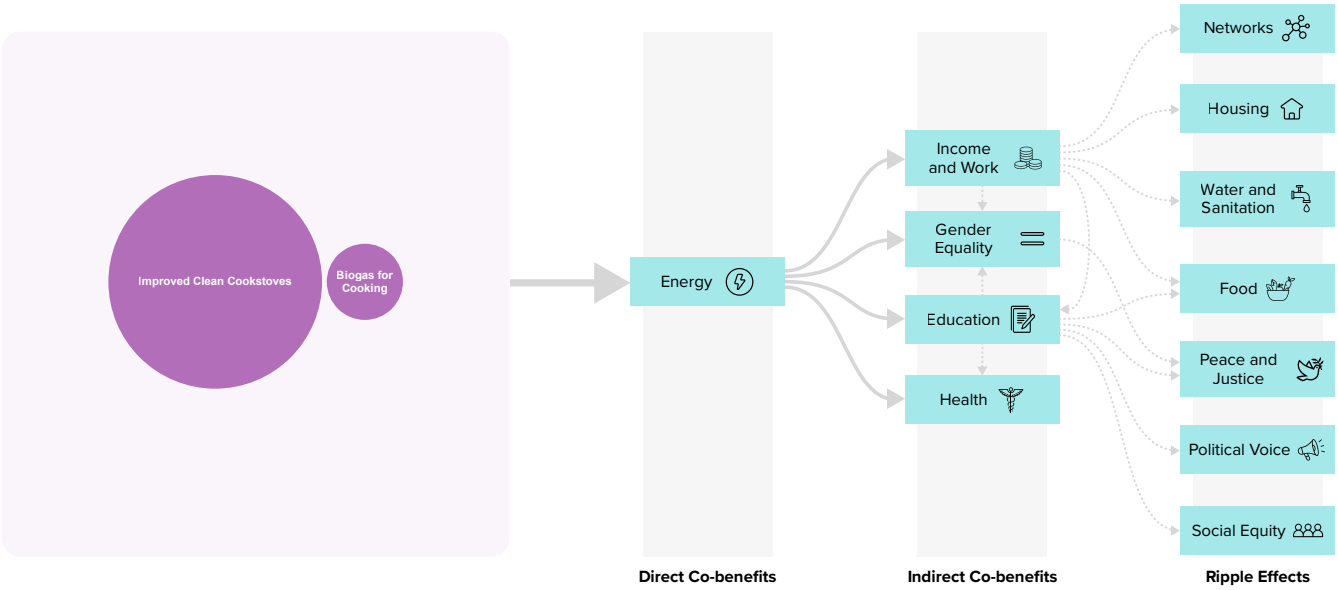
Two Project Drawdown solutions, *Biogas for Cooking* and *Improved Clean Cookstoves*[xviii] generate significant HWB co-benefits and ripple effects for people in under-resourced, rural communities in LMICs.

xviii We recognize that the terminology around "improved" or "clean" cookstoves can be contentious. We have retained its use in the report as *Improved Clean Cookstoves* is the name of the Project Drawdown solution related to clean cooking. It is important to note that the "clean" aspect of such cookstoves is reliant on the type of fuel used. Cookstoves should be both user- and women-informed to meet the diverse energy needs of households.

Human well-being benefits of clean cooking

Adopting clean cooking provides direct co-benefits for the **Energy** dimension and reduces energy poverty. The indirect co-benefits of clean energy are wide-ranging and particularly strong for **Health** and **Income and Work** (Figure 4.4).

Figure 4.4 — Human well-being benefits of climate solutions for Adopting Clean Cooking



This systems diagram highlights the direct (thick gray line) and indirect (thinner gray line) co-benefits of ***Adopting Clean Cooking*** for the 12 dimensions of human well-being. Ripple effects are shown by dashed gray lines. Local stakeholders, governments, and change makers are implicit along the connecting arrows. Potential CO_2-eq reduction for 2020 to 2050 is 86 gigatons.

Health: As exposure to HAP remains pervasive, reducing exposure through the promotion of less-polluting stoves and fuels may be a population-wide strategy to improve global health. Review studies and global analyses have shown that clean cooking can have positive impacts on adults, including a decline in respiratory and non-respiratory symptoms, chronic obstructive pulmonary disease, cough, conjunctivitis, and blood pressure.[218,219,220,221,222] Switching to clean cooking could prevent more than 22.5 million premature deaths between 2000 and 2100.[211]

Though the evidence for co-benefits of clean cooking in children is mixed, trials from Nigeria have shown that mothers cooking with clean fuel had babies with higher birth weight and lower prenatal mortality than households cooking with fuelwood and kerosene.[223] A study in Guatemala found that reduced exposure to wood smoke from cooking— achieved with a chimney stove—significantly reduced cases of severe childhood pneumonia.[224] However, large studies in Ghana, Kenya, and Malawi suggest that the provision of a clean stove or fuel did not result in significant reductions in pneumonia or improved birth weight.[225,226,227] This result was likely attributable to lack of uptake or adoption of the new stove technology, continued use of solid fuel stoves alongside clean fuel stoves, and the contributions of other local and regional air pollution sources.[228]

Shifting to clean stove stacking—a suite of electric, gas, and biomass options—instead of relying on just one type of stove for all cooking needs can help meet the diverse energy needs of a household while also reducing HAP.[200]

Income and Work: Access to clean cooking is hypothesized to provide households—and women in particular—additional time for income-generating activities.[205, 229, 230, 231] Studies from several SSA countries have shown that households using or switching to clean cooking fuel spent the most of their time savings in economic activities.[203, 204, 232, 233] A recent analysis from six LMICs showed that improved cookstoves save households an average of 34 minutes per day. The time savings were consistent across both rural and urban areas, were greatest for fuel collection and preparation, accrued to both women and men, and were highest for more advanced technologies and fuels (e.g., electricity, LPG, and biogas).[234]

Education: The time burden of fuel collection on children negatively impacts their school attendance.[235, 236, 237] Field studies in Ethiopia, Ghana, and Kenya have demonstrated that children's participation in collecting resources (such as wood and water) impedes school attendance.[238, 239, 240] The gendered nature of fuelwood gathering[241, 242, 243] disproportionately impacts girls' education.[203, 244] With rapid deforestation in many countries, the time burden has increased further, leading to an increase in girls' exposure to gender-based attacks or injury while collecting fuel resources, potentially further diminishing their educational opportunities.[203, 204, 245]

Relatively few studies directly examine how access to clean cooking affects school attendance, although limited evidence suggests that the impacts are largely positive. Households in South Asia that used improved cooking fuel enrolled their children in school at higher rates.[230] In Bangladesh, 18 percent of the time saved from using biogas for cooking was spent on education.[232]

Gender Equality: Besides negative health impacts, the time burden—which reflects cultural definitions of "gender-appropriate" work that disadvantages girls and women—associated with fuel collection leads to women's time poverty (a measure of women's subordinate status within the household and wider social arenas) that reduces time available for education, economic activities, childcare, and leisure. Improved cooking contributes to gender equality primarily through improvements in women's health and boosting opportunities to pursue economic activities and higher school enrollment by reducing time poverty.

Clean cooking also reduces risks of gender-based violence (GBV). Fuelwood collection increases the risk that women and girls will be exposed to GBV. The risks are particularly high in countries experiencing political instability and for those living in refugee camps. Reports of sexual attacks on women in refugee camps in Ethiopia, Kenya, Tanzania, and Uganda are widespread.[246] In Kenya's Dadaab refugee camp, more than 90 percent of GBV cases occurred when women ventured outside the camps in search of firewood or other sustenance.[204] GBV and fuelwood collection has been studied to a lesser extent[204] in South Asia. However, GBV related to resource collection and hygiene is pervasive; women in low-income resettlement areas in India reported near daily harassment while collecting water and using sanitation facilities.[247]

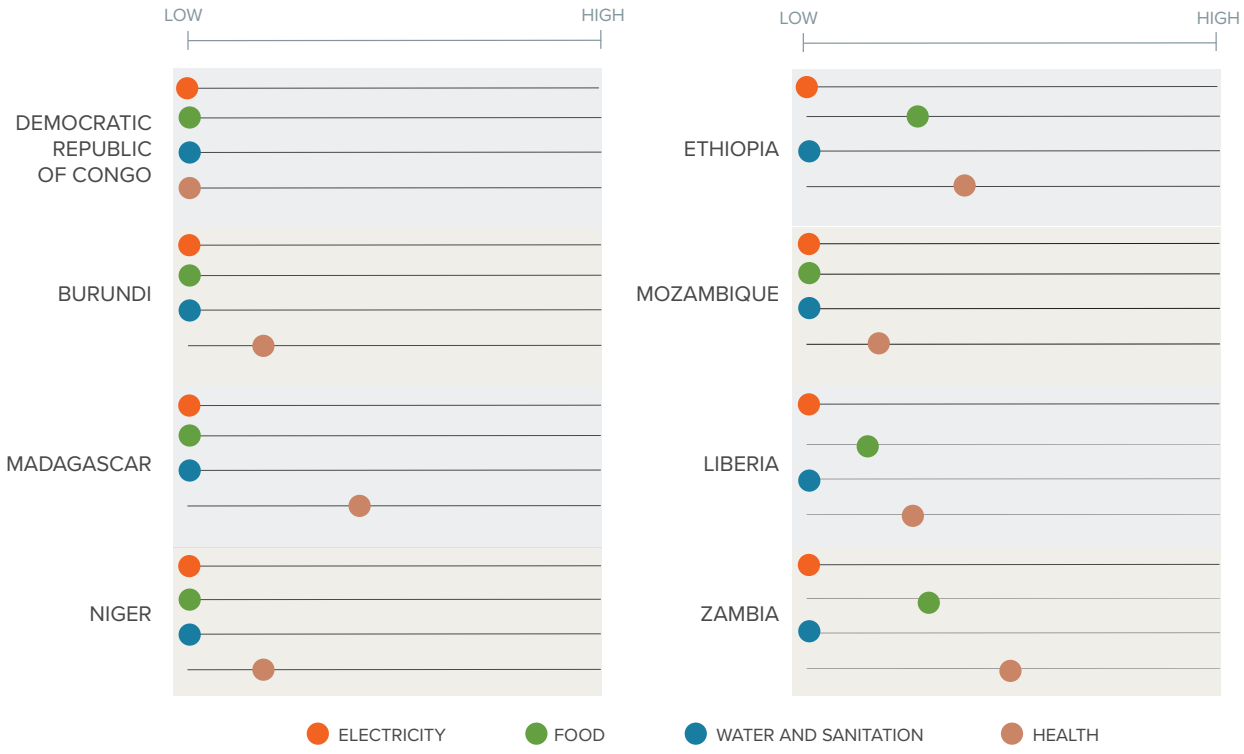
Culturally grounded approaches are needed in which roles are redefined through social change in ways that could help leverage the potential of clean cooking to truly benefit women (M. Greene, personal communication, January 21, 2022). Research that doesn't critique or promote gender myths about women and their relationship with energy and clean cooking is also necessary.[248] For best results for both positive climate impacts and HWB, we must complement advances in technology with a more equitable and just configuration of male and female roles (M. Greene, personal communication, January 21, 2022).

4.4 Climate solutions for providing clean electricity

Meeting basic energy needs (e.g., ensuring all households have access to electricity) and meeting energy requirements for broad, large-scale economic development are separate but related challenges. Modeling estimates show that to provide universal access to electricity by 2030, more than half of households that currently do not have electricity access would need to access mini-grid and off-grid technologies powered largely by solar photovoltaics.[249] Most energy-related GHG emissions are and will continue to be driven by consumption in places that largely do not have energy access problems, even as those economies shift to clean electricity. However, that doesn't preclude clean electricity from being a major part of the equation to meet needs at both the household and country level in LMICs. This report centers on the household level, as we are focused on getting electricity access for basic well-being to the approximately 750 million[250] who currently do not have it, particularly those living in rural areas.

Electricity and HWB are inextricably linked. A recent study[251] of linkages between multidimensional poverty and electricity found that people in countries with limited access to electricity also suffer from high food insecurity, lack access to improved water and sanitation, experience low income and work, and endure poor health (Figure 4.5).

Figure 4.5 — Human well-being levels in Food, Water and Sanitation, and Health for countries with low access to electricity



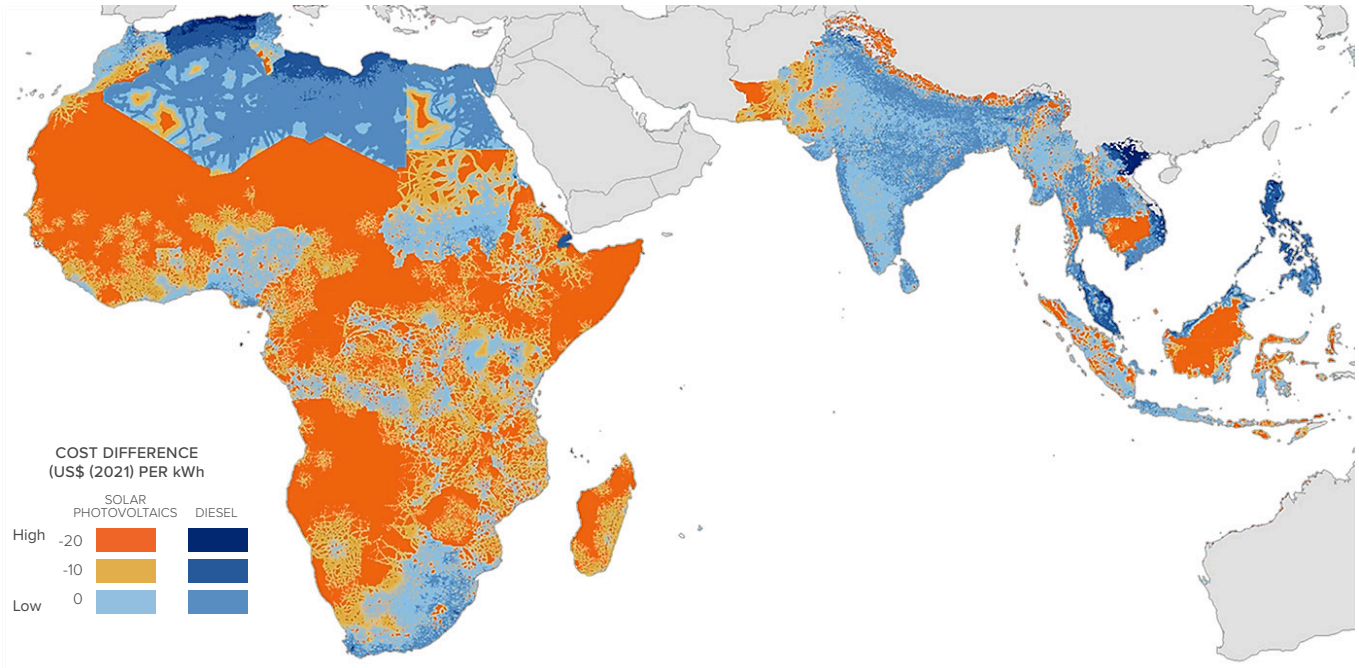
Sub-Saharan African countries that have low levels of access to electricity also tend to have low values in other dimensions of the Drawdown Lift Human Well-Being Index.

Off-grid distributed clean electricity could contribute to transforming the well-being of remote, under-resourced, vulnerable communities.[252, 253] In Bangladesh, which has championed off-grid and microgrid solar photovoltaics (SPV), 20 million people have gained access to electricity in the last few years, changing their lives in multiple positive ways.[254]

Grid-based clean geothermal energy in East Africa's Rift Valley could address rural and urban energy needs. However, most countries in the region, other than Kenya, have not yet pursued geothermal extensively due to lack of finance, knowledge, and workforce.[255] Kenya has increased its geothermal electricity production dramatically over the last five years; in 2019, geothermal contributed 47 percent of all electricity consumed in the country, and this number has been rising since then, although challenges related to unequal access in highly vulnerable rural areas remain.[256]

Minimizing electricity poverty is critical to improve HWB in SSA, where around 570 million people lack access to electricity.[250] A recent study[257] that analyzed current trends in electricity generation in Africa projected that less than ten percent of the total electricity generated by 2030 will come from solar, wind, or geothermal energy. However, according to the International Renewable Energy Agency (IRENA), appropriate government policies, regulation, and access to finance could allow SSA to meet more than 67 percent of its electricity needs from renewable sources by 2050 while also generating 2 million green jobs.[258] And, solar mini-grids are more cost-effective than fossil fuel–based mini-grids (Figure 4.6).

Figure 4.6 — Competitiveness of solar- and diesel-based mini-grids



Orange, yellow, and light blue represent regions where solar photovoltaics-based mini-grids are more cost-effective (cheaper) than diesel-based mini-grids. kWh: kilowatt-hour *Source: modified from Szabo et al. 2021.*

As presented below, several studies and reports have highlighted the positive impacts of renewable energy, especially SPV, on **Income, Networks, Education,** and **Gender Equality.** However, the number of studies rigorously analyzing the human and environmental co-benefits of these interventions are still limited,[212] primarily because widespread implementation of off-grid and microgrid networks is fairly recent. While more research is needed to evaluate whether solar technologies can deliver services beyond basic lighting, charging, and entertainment (such as powering a refrigerator),[212] there is evidence that basic access to clean energy provides multiple HWB co-benefits, which we detail below.

Five Project Drawdown electricity solutions—*Distributed Solar Photovoltaics*, *Geothermal Power, Micro Wind Turbines, Microgrids,* and *Small Hydropower*—can rapidly increase clean energy access to large populations that are underserved by grids or cannot afford or access grid connections. Except for *Geothermal Power*, which can address both rural and urban power needs, these solutions address the basic household electricity needs of largely rural people who lack access to electricity.

The majority of the evidence presented here is from studies and analyses conducted on off-grid and microgrid SPV, as they are more widely applicable and available than micro wind turbines and small hydropower, they have greater emissions reduction potential, and there is more evidence of co-benefits for HWB. However, the HWB co-benefits of the individual solutions in the ***Providing Clean Energy*** solution group should be similar as they all provide clean energy and reduce energy poverty.

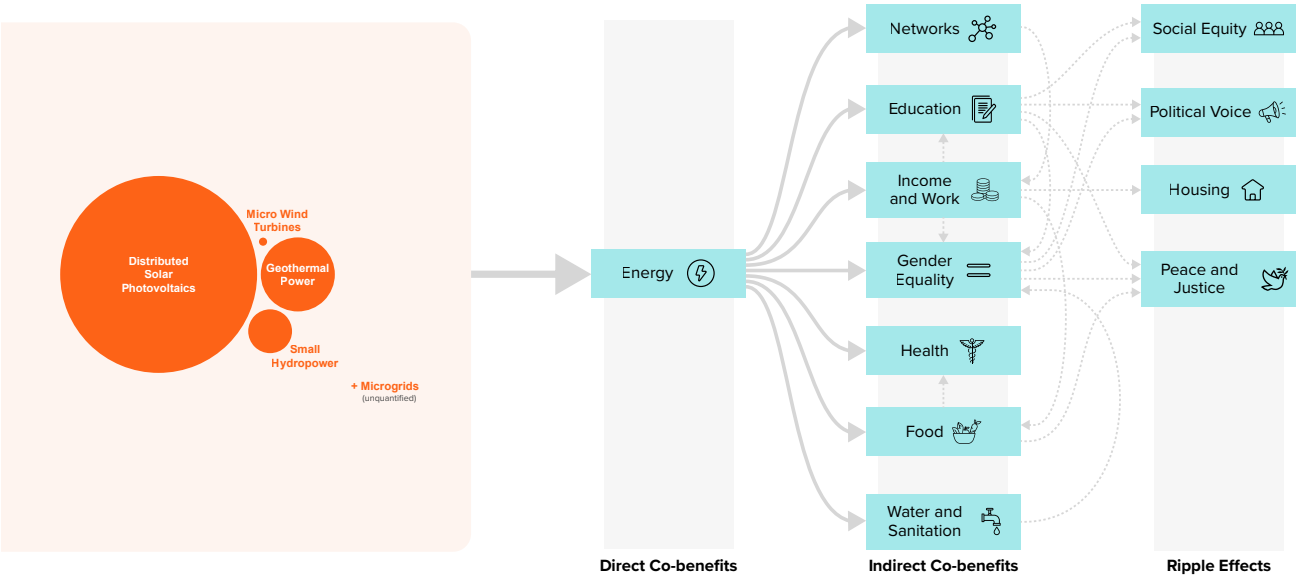
Human well-being benefits of clean electricity

Access to clean electricity fundamentally addresses energy poverty and provides direct co-benefits for the **Energy** dimension and through it, all other dimensions of HWB (Figure 4.7). While electricity—generated either by renewable or nonrenewable sources—is foundational for many aspects of HWB, it is crucial that households that are currently not connected to the grid be able to leapfrog to electricity generated by clean renewable sources. Off-grid and microgrid electricity would not only allow households to reap the benefits of electricity sooner, but they are also cheaper and, unlike fossil-fuel based energy, they are less polluting and don't have negative health effects.

Electricity is foundational for many aspects of HWB; it contributes to job creation and supports education, increases income, reduces food insecurity, and improves access to clean water, sanitation, and health.[259, 260] It also contributes to opening doors that advance women's economic empowerment[261] and builds resilience that promotes peace and justice by minimizing risks of conflict and large-scale migration.[262, 263]

Access to clean water is a basic human right and can be advanced through access to electricity. *Credit: Arne Hoel | World Bank*

Figure 4.7 — Human well-being benefits of climate solutions for Providing Clean Electricity



This systems diagram highlights the direct (thick gray line) and indirect (thinner gray line) co-benefits of ***Providing Clean Electricity*** for the 12 dimensions of human well-being. Ripple effects are shown by dashed gray lines. Local stakeholders, governments, and change makers are implicit along the connecting arrows. Potential CO_2-eq reduction for 2020 to 2050 is 77 gigatons.

Rural electrification positively impacts women's health and well-being; research in Africa shows that electrifying clinics to provide lighting and refrigeration for medicines improves maternal health, and public lighting enhances safety for all—particularly women and girls.[264] In India and Indonesia, evidence links more TV watching through new television access with smaller family size, a decrease in domestic violence, and increased female autonomy.[264] Although the mechanism through which electricity access in rural areas may impact gender relations is unclear, data support a positive correlation with women's welfare.[264]

Income and Work: Access to electricity leads to higher income, particularly for women, primarily through increased working hours.[265, 266, 267, 268] An analysis of the economic benefits of SPV from more than 2,300 off-grid SPV users from Kenya, Mozambique, Rwanda, Tanzania, and Uganda reported that 69 percent of SPV customers increased their incomes through longer working hours or by obtaining new jobs, and 33 percent of SPV owners' incomes increased by US$420 per year.[252] Additionally, most households decreased their energy expenditures for lighting by switching from kerosene to solar lamps.[252] Some studies, however, have suggested that the benefit of SPV for income, if any, is limited.[269, 270, 271]

Investments in decentralized and clean energy technologies can also create jobs. Decentralized renewable energy already employs more people than traditional energy in India, Kenya, and Nigeria.[272] A meta-analysis of more than 80 studies found that more granular technologies (such as *Distributed Solar Photovoltaics* and *Micro Wind Turbines*) generate more jobs over their lifetimes[273] than centralized technologies. Off-grid renewable energy could generate 4.5 million jobs globally by 2030.[274] For example, in Nigeria, the government-led Solar Power Naija program is projected to incentivize the creation of nearly 250,000 jobs in solar manufacturing

and assembly; in Burkina Faso, renewable energy equipment is being manufactured for domestic SPV use.[275] Large-scale implementation of Project Drawdown solutions that address energy poverty could significantly increase the incomes of households close to or below the poverty line, while creating millions of jobs in LMICs.

Networks: Off-grid SPV plays a vital role in increasing connectivity,[266] which contributes to increased job opportunities and income. In India, better connectivity resulting from solar-powered mobile phone chargers increased income for the users.[267] In Kenya, Mozambique, Rwanda, Tanzania, and Uganda, 89 percent of SPV users reported increased mobile phone usage, implying improved connectivity.[252]

About 750 million people, living mainly in rural areas of low- and middle-income countries, don't have access to electricity. Electrifying schools has led to increases in time studying, years of education, school enrollment, and digital literacy. *Credit: Chetan Soni | United Nations*

SPV-powered devices have played an important role in receiving early weather forecasts that contributed to saving thousands of lives; this is particularly important for countries such as Bangladesh that are prone to natural hazards.[268, 269, 276, 277] SPV has also contributed to increased access to TV and radio, resulting in increased awareness and positive behavior change around health, including family planning, sanitation, diarrhea, hygiene, and nutrition.[276,278,279,280,281] Penetration of mobile phones has led to an increase in financial inclusion for many low-income households. In Kenya, mobile finance boosted inclusion in the formal economic system from 26 percent in 2006 to 87 percent in 2019,[282] enhancing access to finance for education, business, and housing.

Education: Electrification of schools that are off-grid has led to increases in children's study time, years of schooling, and school enrollment.[277,283,284,285,286] Teachers are more willing to relocate to schools that are electrified.[283] SPV has played a crucial role in the computer education and training that is indispensable for many jobs; in several countries, digital literacy in rural schools is gained exclusively through use of solar-powered computers. School electrification can boost educational outcomes in LMICs and build skilled worker capacity to address future labor needs.

In India, studies suggest that access to high-quality light facilitates studying and reading for children as well as adults.[283, 287] However, the effect on educational quality outcomes is unclear. Whereas some studies have argued that SPV leads to better education outcomes, such as higher grades,[288] others have reported no improvement in performance due to the use of SPV-powered solar lanterns on national exams or test scores.[289, 290]

A major boost to education comes from the spillover effects of increased income due to SPV. Households in Kenya, Mozambique, Rwanda, Tanzania, and Uganda that experienced increases in income from SPV used around 25 percent of their additional income on education.[252] Students from low-income households with unstable income are more likely to drop out of school and less likely to graduate from secondary school.[291]

Solar-powered lamps enhance opportunities to study and work after sunset. They also reduce reliance on kerosene lamps, which pollute the indoor air and require purchase of fuel. *Credit: Solar Sister*

The COVID-19 pandemic has further highlighted opportunities to provide clean electricity to schools and households as part of a low-carbon pathway to development that also addresses multiple aspects of poverty alleviation, particularly energy poverty. Schoolchildren in LMICs suffer disproportionately due to lack of digital connectivity; in LMICs, less than 6 percent of children have Internet access at home, and only 10 percent of schools in South Asia have Internet.[292] Further, the effects of remote learning during the pandemic have not been equal across genders; for example, gendered demands on girls' time in East Africa has been detrimental to their remote learning.[293]

Health: SPV contributes to indirect human health co-benefits, such as improving pulmonary function and life expectancy due to reduced HAP. While kerosene lamps contribute less to HAP than cooking, replacing them with solar lamps results in fewer lung infections and diseases.[284, 294, 295, 296, 297] Adoption of solar lamps has also greatly reduced incidences of burns from kerosene lamps in LMICs that disproportionately affect adolescents' health.[298, 299, 300, 301, 302]

Access to electricity in health-care facilities improves the ability to provide services at night and store medicines properly and is linked to reduced maternal mortality. *Credit: Jake Lyell | Alamy Stock Photo*

Off-grid SPV can greatly enhance access to quality, modern health services in remote areas by providing services at night, enhancing access to equipment that runs on electricity, increasing retention of qualified staff, and ensuring proper storage of vaccines and medications.[303] Such benefits reduce maternal and child mortality rates in LMICs[304] and improve overall health. Several studies report significant decreases in maternal mortality rates, more deliveries in health centers per month, and better outpatient services due to SPV.[250, 303, 305, 306]

Evidence regarding the effect of SPV for mental health benefits is limited. However, increases in entertainment options,[265, 276, 277] social interactions, and standards of living[265, 267] can contribute to improved mental health.

Water and Sanitation: Clean electricity has played a vital role in providing clean and reliable water to communities in South Asia and SSA.[307, 308] It has also contributed to improved sanitation in rural communities by providing continuous access to clean water and light.[309, 310] Further, water pumps powered by clean energy have lower operational costs than those powered by diesel.[311, 312]

Clean electricity can play a role in providing clean water and improving sanitation facilities in rural communities, which could contribute to reducing the incidence of diarrhea and water-borne diseases that together are the third leading cause of death among children under age 5 globally.[313] Two-thirds of people in SSA rely on contaminated water sources.[314] Inadequate access to WASH accounts for 10 percent of the global disease burden.[315]

Food: A study across 54 LMICs found that access to electricity provides immediate benefits for both the production and utilization (preparation and storage) of food and is recommended to improve food security through household-level off-grid electricity investments.[316] Clean electricity boosts opportunities to implement water-efficient technologies such as solar-powered drip irrigation,[125] improves water governance, allows rural farmers to charge mobile phones that they use to boost agriculture productivity,[317] and reduces food waste.[318] Irrigation through solar water pumps can improve household nutritional intake and dietary diversity by increasing agriculture yield and household income for smallholders and facilitating livestock watering.[319, 320, 321, 322, 323, 324]

In Ethiopia, households that irrigate their lands are more likely than non-irrigated ones to meet minimum dietary requirements for women.[122, 325] For an extremely under-resourced community in Benin (living on less than US$1.25 per day), solar-powered drip irrigation in an unelectrified area increased income, food security, and micronutrient uptake.[125] However, other research suggests that the effect of irrigation on nutritional outcomes is context-specific and that positive outcomes are not always observed.[122, 326] More rigorous analysis is needed to evaluate the linkages between solar-powered irrigation and malnutrition and undernourishment within the context of extension agent support (e.g., so farmers can diversify into horticulture with higher water requirements).

Solar-powered pumps provide access to clean water and enable efficient use of water for irrigation to increase food production. *Credit: Joerg Boethling | Alamy Stock Photo*

Only about 5–6 percent of SSA cropland is irrigated.[327] The region frequently suffers from food insecurity[328] and accounts for the majority of the undernourished and malnourished population globally.[329] When accompanied by supply chain enhancement, extension and market support, and effective water governance and infrastructure maintenance, the application of renewable energy (powered by properly maintained solar water pumps) to irrigate millions of hectares of land in SSA[328] could be crucial to boost nutrition, food security, income, and employment[229] and would contribute to developing sustainable and resilient food systems, increasing income, and generating employment.[283, 319, 328, 330]

Gender Equality: By reducing women's household chores and extending useful hours in the day, clean electricity contributes to improving women's income and total hours of paid work, reducing time poverty and increasing participation in non-household work.[264, 268, 277, 331, 332] For example, in Tanzania, solar lamp ownership led to an increase in female labor supply and income;[333] women-inclusive solar lightning programs have been shown to positively impact household health, education, savings, and women's economic productivity and empowerment.[261] In Bangladesh, women have been shown to use the extra time for resting and entertainment.[268, 285] Studies have reported that SPV leads to an increase in women's household decision-making power.[334]

SPV has provided clean water[307] and improved sanitation in schools. Some studies have shown that water and sanitation can reduce dropout rates and absenteeism among girls[335,336,337] while others have reported limited links between girls' absenteeism and school-based water and sanitation facilities.[338]

FEATURE BOX

Solar Sister: Improving gender equality, income, health, and education by reducing energy poverty

Solar Sister is a women-centered network of entrepreneurs that brings off-grid solar electricity and cleaner cooking to underserved communities in SSA. The initiative was launched in Uganda in 2010 and has since expanded to Tanzania and Nigeria. It recruits and trains new entrepreneurs to sell durable, affordable solar-powered products (e.g., lights and phone chargers) and cleaner cookstoves to households without access to electricity or clean cooking. It has resulted in co-benefits for multiple HWB dimensions, including improved children's educational outcomes, health, and financial well-being. Household members can work more hours due to the addition of evening light indoors, or start new businesses using the money saved by not buying kerosene. Networking has also improved, as the solar batteries are used to charge mobile phones. Finally, Solar Sister has supported women to become entrepreneurs and leaders and has helped many feel more respected in their households and community.[339]

170%
increase in lighting hours after sunset

90%
of parents reported improvements in children's academic performances

31%
spent kerosene savings on education

54%
spent kerosene savings on food/water

24%
of households started new business

31%
of households reported an increase in income

The Solar Sister program generates multiple human well-benefits for women through the provision of solar power and clean cooking.

4.5 Climate solutions for fostering equality

High-quality education is linked to increases in income, participation in public service, and improved health. *Credit: United Nations Children's Fund (UNICEF) Ethiopia*

In SSA, about 30 percent (97.5 million) and in South Asia about 20 percent (93 million) of children and adolescents do not attend primary or secondary school.[340] Three-quarters of children who never enter primary school are girls from rural, under-resourced communities;[341] according to UNICEF, "44% of girls and 34% of boys (10–19 years old) from the poorest families have never attended school or dropped out before completing primary education."[342] In LMICs, 218 million women of reproductive age want to avoid becoming pregnant but do not use a modern method of contraception.[343, 344, 345]

Rights-based, voluntary family planning and quality universal education for all are essential human rights that can also generate cascading benefits for climate change by impacting population growth over time.[53,346,347,348,349,350] In addition, the benefits of contraception and high-quality universal education are well-established for many aspects of HWB, including maternal and child health, nutrition, economic development, gender equality, and resilience,[39,351,352,353,354,355,356] and contribute to overall planetary health.[349] Men, too, benefit from the opportunity to regulate their own fertility and play an important role in deciding with their partners whether and when to have children.[357]

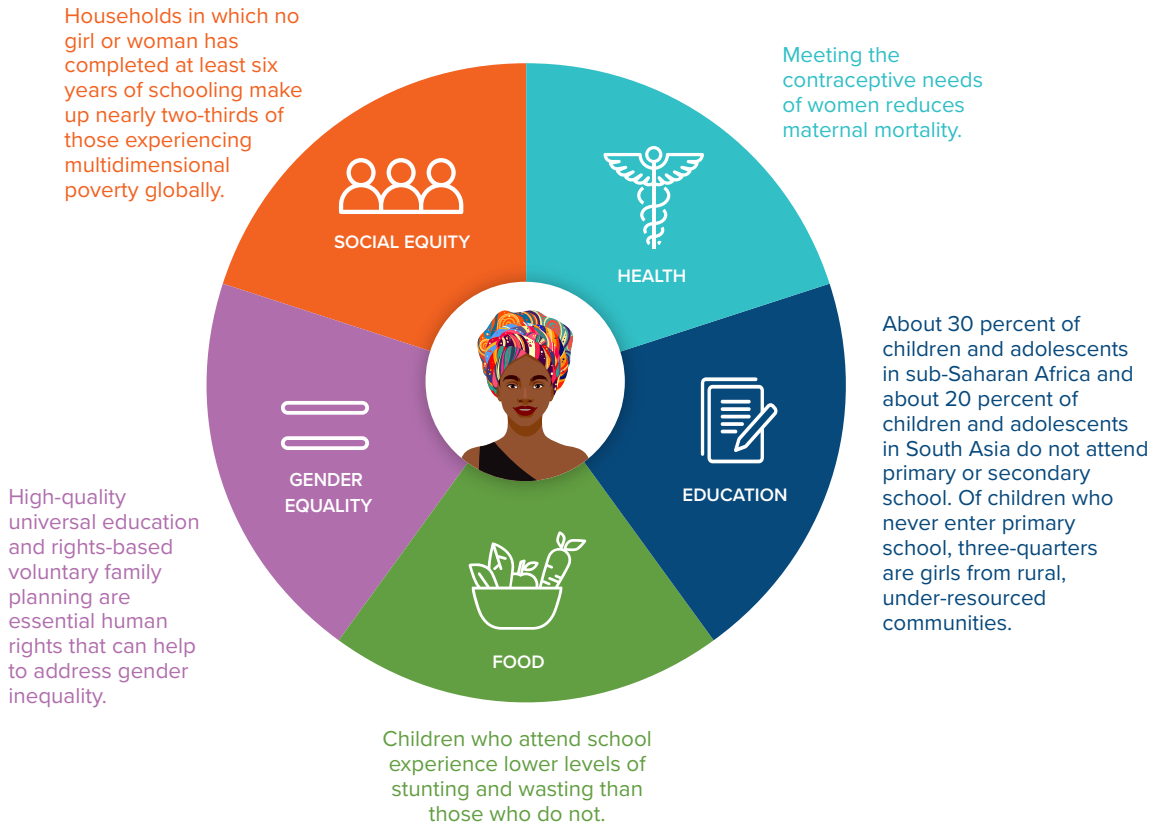
Family planning services, educational attainment, and fertility are closely linked,[348] although additional research is needed on the causal relationship between education and sexual and reproductive health outcomes.[358] Countries in SSA with low female literacy and low demand for family planning satisfied with modern methods are also highly vulnerable to climate change.[21, 359] Climate shocks and stressors often exacerbate gendered responsibilities such as performing household chores (e.g., fetching water and fuel sources, cooking, and sibling care), which can further impact girls' ability to remain in school.[237]

Family planning—ensuring everyone's individual contraceptive needs are met in a rights-based manner that centers bodily autonomy—is not in itself a climate mitigation strategy. Rather, it is the outcome of family planning, slower population growth, that is the climate mitigation strategy. Demography and climate change are linked;[347, 360, 361] slowing future population growth could translate into a 15 percent reduction in global CO_2 emissions by 2050 due to reduced demand for resources.[346] Project Drawdown estimates that meeting all needs for voluntary family

planning and providing universal education for all boys and girls between 2020 and 2050 could lead to a reduction of almost 70 Gt of GHG emissions at a global level due to slower population growth rates.[350]

Project Drawdown's *Health and Education*[xix] solution centers around actions that foster equality in society—specifically, rights-based, voluntary family planning and high-quality, inclusive education—and offer clear health and economic as well as long-term ancillary climate benefits (Figure 4.8).

Figure 4.8 — Challenges faced by women and children



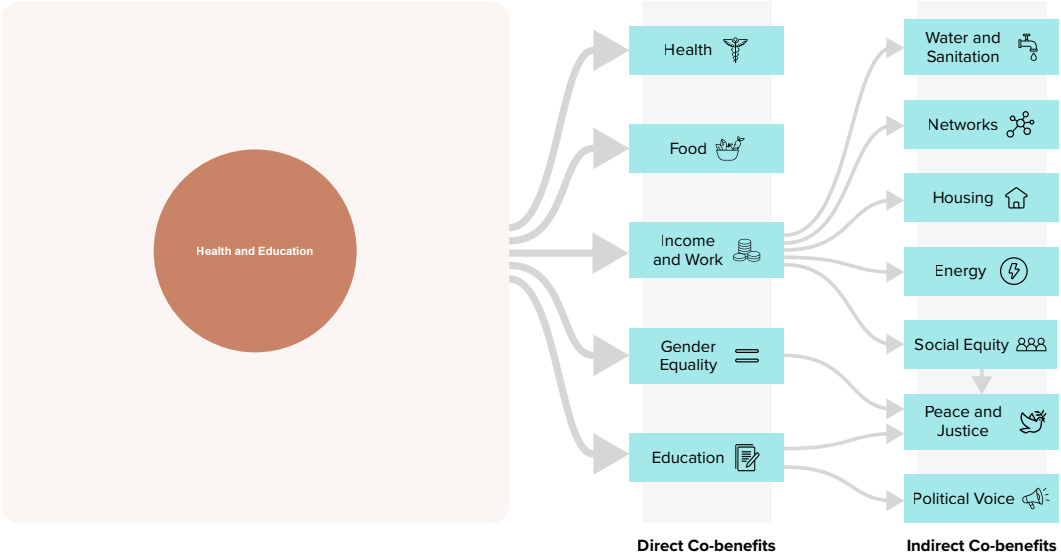
Equal access to high-quality education for girls and boys and rights-based voluntary family planning contribute to enhanced well-being in low- and middle-income countries.

Human well-being benefits of fostering equality

Rights-based family planning and improving access to and quality of universal education can boost HWB at the individual and household level, particularly for rural, under-resourced populations in LMICs where access to a wide range of contraception and high-quality education has typically been low (Figure 4.9). When people everywhere can make decisions about their fertility through the realization of universal access to rights-based sexual and reproductive health services, including voluntary family planning, the end result of slower global population growth can contribute to a long-term reduction in emissions.[346, 349]

xix It is important to note that Project Drawdown's *Health and Education* solution focuses only on 1) high-quality, voluntary family planning (no additional aspects of health) and 2) 12 years of universal, quality education for all children.

Figure 4.9 — Human well-being benefits of climate solutions for Fostering Equality



This systems diagram highlights the direct (thick gray line) and indirect (thinner gray line) co-benefits of ***Fostering Equality*** for the 12 dimensions of human well-being. Ripple effects are shown by dashed gray lines. Local stakeholders, governments, and change makers are implicit along the connecting arrows. Potential CO_2-eq reduction for 2020 to 2050 is 69 gigatons.

Health:[xx, xxi] Voluntary family planning programs—when accompanied by cultural shifts that give women full bodily autonomy—help women and couples realize their desired family size. When population growth rates slow, governments are better able to keep pace with population-driven needs—such as building and staffing health clinics and schools and staffing extension agents to meet rural populations' food security and natural resources needs.

The ability to plan and space births yields numerous benefits for mothers and children, notably decreased morbidity and mortality. Some 99 percent of all maternal deaths occur in LMICs, 66 percent in SSA;[363, 364] a recent study estimated that meeting the contraceptive and maternal care needs of women in LMICs could prevent nearly three-quarters of maternal deaths and dramatically decrease newborn mortality.[355] Children born four years after a previous birth are less likely to be underweight and stunted than children born after a two-year interval.[343] Family planning decreases vulnerability to environmental shocks and stressors such as flooding, drought, and food and water scarcity, all of which have adverse effects on women's health and are becoming more frequent due to climate change.[347, 356]

Educating girls, particularly through secondary school, is one of the most powerful ways to address gender inequality and long-term poverty. Increases in educational attainment globally among women of reproductive age led to 4.2 million fewer deaths among children younger than 5 years from 1970 to 2009.[351] In fact, the relationship between the length of a mother's schooling

xx There are myriad non-family-planning-related linkages between health and climate change; see, for example,[73] and follow the Pathfinder Initiative[362] on health and climate.

xxi Health is both an HWB dimension and part of a Project Drawdown climate solution, *Health and Education* (see also Footnote X on gender). As such, in this report, the **Health** dimension is an indirect co-benefit of other Project Drawdown climate solutions in the solution groups ***Providing Clean Electricity*** and ***Adopting Clean Cooking***. *Health and Education* is a Project Drawdown solution with direct co-benefits to the **Food, Income and Work, Gender Equality, Social Equity, Education,** and **Health** dimensions.

and child survival is linear, with no threshold.[351, 365] Researchers found that each additional year of secondary education was associated with decreases in HIV prevalence among all adolescents, but especially young women, particularly in South Asia, Latin America, and SSA.[354, 366, 367, 368]

Contraception enables sexually active adolescents to remain in school and pursue higher education, with sustained lifelong benefits. In LMICs, the unmet need for modern contraception among almost half of the 32 million adolescents ages 15–19 contributes to about 10 million unintended pregnancies each year.[345] The longer girls stay in school, on average, the longer they delay transitions such as childbearing.[369] Ensuring pregnant adolescents have full access to high-quality adolescent-friendly reproductive health services also helps them continue their education through and beyond secondary school. Should girls choose to become mothers, research has shown that mothers' schooling has a deeper positive impact on children than fathers' schooling.[348, 365, 370, 371]

Education:[xxii] Formal education is strongly associated with improving livelihoods, economic development, social progress, and individual and household well-being. Education has been shown to lead to decent jobs and freedom from poverty,[372, 373] adoption of healthier water and sanitation practices and clean cooking, participation in public life, and better health decisions.[374, 375, 376] Increasing climate literacy is a key tool for engaging in climate action and contributing to an enabling environment for mitigation, adaptation, and low-carbon pathways to development.[377]

Universal education and rights-based voluntary family planning provide benefits across the lifespan, including reduced maternal and child mortality; the outcomes of family planning contribute to slowing population growth at a global level. *Credit: Yagazie Emezi | Getty Images | Images of Empowerment*

xxii Education is both one of the HWB dimensions and part of a Project Drawdown climate solution, *Health and Education.* As such, in this report, the **Education** dimension is an indirect co-benefit of other Project Drawdown climate solutions, such as the set of solutions ***Providing Clean Electricity*** and ***Adopting Clean Cooking.*** *Health and Education* is a Project Drawdown solution with direct benefits to the **Health, Food, Income and Work, Gender Equality, Social Equity,** and **Education** dimensions.

Education is a fundamental human right for both girls and boys. Moreover, girls' education plays an important role in building adaptive capacity and reducing vulnerability to climate-related extreme events.[378, 379, 380] Educated women can better protect themselves and their families from environmental shocks and are able to participate more fully in decision-making.[237] Today, 129 million girls are out of school worldwide.[381] The COVID-19 pandemic has caused a substantive disruption in education, and projections suggest that as many as 11 million girls might not return to school.[382] This deprivation can hinder the ability to build long-term community resilience to climate change, enhance health, improve gender equality and social equity, eradicate poverty, and foster peace and justice.

Income and Work: Education and access to modern contraception provide women the opportunity to pursue and continue secondary and higher education and engage in formal and informal work. In recent years, this has become increasingly important in semi-arid regions of Africa and Asia, where the aspirations of many youth are shifting from the pastoral or agricultural lifestyles of their parents to education and work in the formal sector.[383] Opportunities are rising around climate-specific jobs in SSA and South Asia; globally, one-third of renewable energy sector employees are women, and plans are underway to increase gender parity.[275] The transition to a green economy in Africa could provide millions of jobs for women if barriers are addressed—namely, access to land and finance, gender discrimination in the education system and labor market, laws that restrict women's access to certain tasks and jobs, and inequalities reflecting social norms around unpaid care work, which largely fall on women.[384]

With better health and the ability to avoid unplanned pregnancies and lower childcare needs, women have more time and energy for other opportunities such as taking part in the labor force or building businesses.[347, 385] Improved reproductive health due to contraceptive uptake and girls' educational attainment, particularly at the secondary level, are closely linked.[348, 371] An educated woman is better able to translate her fertility preferences into practice with the use of contraception, which opens up income-based opportunities outside the home. In Bangladesh, women with access to contraception have fewer children and higher household incomes than those without.[386]

Food: Family planning and education help meet fundamental human needs for high-quality, culturally appropriate, healthy food. Family planning can influence the nutritional outcomes of infants and young children; when births are spaced and planned, mothers are healthier and often have more resources and time to breastfeed.[364] In addition, women who use or have better access to modern family planning are more likely to participate in household decision-making around nutrition and food security.[71, 364]

Higher educational attainment for household heads, particularly women, has been associated with beneficial nutrition practices that prevent childhood malnutrition.[387] Schools play a vital role in providing nutritious meals to children and in building capacity and knowledge for better food production and consumption.[77] Children who attended school and had higher literacy levels experienced lower levels of stunting and low weights.[388]

In Bangladesh and India, research has shown that child malnutrition and undernourishment is significantly related to a mother's education; children with a mother who is illiterate or undereducated are more likely to suffer from malnourishment, stunting, and wasting.[389, 390] Similar findings have been reported from Nigeria and Kenya.[391, 392]

Gender Equality: High-quality education—particularly for girls—and family planning help address underlying drivers of gender inequality. However, tackling patriarchy, the root cause of gender inequality, is essential to shift gender values and open opportunities for women and girls.[393] Low education levels limit economic opportunity and prolong social inequalities. Education and knowledge building are important for girls to become active community members and leaders[394] and involved in political, social, and economic spheres of life.

> Breaking patriarchal structures and enabling girls to go to school multiplies their economic choices, and increases their voice and influence in society.
>
> GRAÇA MACHEL, FIRST LADY OF MOZAMBIQUE AND SOUTH AFRICA, AND PRIME MINISTER ERNA SOLBERG, NORWAY[338]

Access to high-quality rights-based family planning fundamentally advances human rights.[71, 395] Access to safe abortion services and post-abortion care are included in WHO's list of essential health-care services; the lack of safe abortion services, which are still illegal in many countries, leads to an increase in unsafe abortions and associated morbidities.[355, 396] Almost 50 percent of all abortions globally are unsafe; 97 percent of those are in LMICs.[396] Up to 13 percent of maternal mortality every year is due to unsafe abortions in LMICs.[397]

Child, early, and forced marriage and unions are driven by many intersecting factors, including social norms, economic insecurity, lack of education, and the absence of legal frameworks.[398, 399, 400,401, 402] They are a major societal issue with impacts on gender equality: As of 2018, globally more than 650 million girls and women—primarily in SSA and South Asia—were married before they turned 18.[403] Early marriage has several adverse impacts on girls' education, social life, health, economic opportunities, and overall well-being.[401] Studies have shown that overcoming household poverty and providing secondary and higher education to girls significantly reduces their risk of child marriage,[404, 405, 406] while primary education alone is insufficient to reduce the practice.[407] Early marriage followed by early pregnancy and subsequent termination of a girl's education can contribute to a vicious cycle of intergenerational poverty and vulnerability.[341]

About one in three women worldwide experience GBV, often from an intimate partner.[355] According to Castañeda Camey et al., "Those who have experienced GBV may be discouraged from engaging in decision making, leadership, education and income generating opportunities—all of which directly affects economic empowerment and jeopardizes progress toward poverty reduction."[247] Research from Niger and India has found links between reproductive coercion and higher rates of GBV against adolescents and women, respectively.[408, 409] Addressing GBV is complex and multifaceted, requiring gender-transformative programming accompanied by an enabling policy environment to address power, social norms, and other drivers of inequality and violence.

FEATURE BOX

Tuungane Project, Tanzania: Creating healthier and more resilient families, fisheries, and forests

In western Tanzania, Lake Tanganyika and the adjacent forested mountains are home to 250 fish species found nowhere else and more than 90 percent of Tanzania's endangered chimpanzees. More than 500,000 people depend on farming and fishing within the 2 million–hectare landscape. Yet they face challenges around health and government services due to their remote location and additional challenges as the climate changes. The Tuungane Project, launched in 2012 by The Nature Conservancy and Pathfinder International, collaborates with local people, leaders, and government to develop community-led projects that conserve biodiversity—including habitats for forest reserves and grazing lands protected by eight communities—by generating revenue from the sale of carbon credits and protecting vital endangered chimpanzee habitats. Performance-based payments generate income for remote villages, transforming how local people and the government value forests. Conservation-smart agricultural practices adopted by more than 12,000 farmers have doubled maize yields, reduced pressure on chimpanzee habitats, and improved water quality in the lake. Newly community-managed fish reserves and fisher-enforced sustainable fisheries laws help ensure continued food and income. More than 50 community conservation banks have provided small loans to 1,700 people to start businesses and diversify income. The project used additional funding to build a dormitory for girls attending secondary school, reducing the dropout rate to zero and increasing the percentage of girls applying to colleges and vocational schools. Health clinics have been upgraded with solar suitcases that can provide electricity during nighttime births, dramatically reducing maternal and neonatal deaths. Reproductive health outreach and services reached more than 55,000 community members in 2020. Nearly 6,000 families volunteer to educate by example by modeling healthy and sustainable behaviors, such as using hand-washing stations, installing upgraded latrines, prioritizing voluntary family planning, using energy-saving stoves, and setting agricultural plots away from the lake (Sources: The Nature Conservancy Tuungane Project,[410] Craig Leisher, personal communication, January 13, 2022).

Projects like Tuungane integrate solutions for improving people's livelihoods and health and protecting and managing the natural resources they rely on. *Credit: Ami Vitale*

4.6 Additional indirect co-benefits and ripple effects on human well-being dimensions of Project Drawdown climate solutions

The five groups of climate solutions generate direct and indirect co-benefits and ripple effects for all HWI dimensions. As depicted in the systems diagrams (Figures 4.1, 4.3, 4.4, 4.7, 4.9) for each solution group, direct co-benefits flow to specific indirect co-benefits, and indirect co-benefits flow to specific ripple effects.

In this subsection, we detail the evidence around indirect co-benefits for the ***Improving Agriculture and Agroforestry, Protecting and Restoring Ecosystems,*** and ***Fostering Equality*** solution groups. The indirect co-benefits for the ***Adopting Clean Cooking*** and ***Providing Clean Electricity*** solution groups were covered in their respective subsections, above.

In addition, we present the evidence for the ripple effects that the solution groups generate for **Networks, Housing, Gender Equality, Social Equity, Peace and Justice,** and **Political Voice.**

As can be seen in the systems diagrams for the five solution groups, certain HWB dimensions generate many indirect co-benefits and ripple effects. **Income and Work** and **Education** generate the most indirect and ripple effects across all solution groups. These two HWB dimensions not only reinforce each other—e.g., increase in income leads to better education access and outcomes and vice versa[411, 412, 413]—but can also lead to indirect co-benefits and ripple effects on multiple other dimensions including **Energy, Health, Networks, Housing, Social Equity, Peace and Justice,** and **Political Voice** in various solution groups.

For instance, the co-benefits of **Education** on **Health** are well-established: Increased educational attainment has been linked with reduction in child mortality and improvement in public health, child health, and health equity.[351, 414, 415] The high rate of poor mental health among food insecure people in Africa[416] could be alleviated in part through ***Improving Agriculture and Agroforestry*** and other climate solutions that improve **Food** security. Suicide rates among farmers are high in several LMICs. While the causes driving rural people's, (including farmer's) suicide are complex, a study in India has linked it with socioeconomic factors as well as reduced yield from extreme weather events.[417] Increase in **Income and Work** and better **Food** security can potentially contribute to a reduction in suicide rates.

Here we present evidence of how these seven dimensions can generate co-benefits through ripple effects created by climate solutions when they are folded into climate-smart development projects and policies. While development pathways are complex, interrelated, and regionally specific, the ripple effects of climate solutions can contribute to resilience, promote gender equality, diminish inequality, and lift up the most vulnerable who are disproportionately impacted by climate-conflict shocks.[418]

Energy: Although access to clean energy depends on multiple factors, including government policies, supply and demand, and social factors, affordability is a major roadblock; household income and consumption of clean energy are closely intertwined. In SSA, high electric cost is a major hurdle for households that are within the reach of an electric grid to get connected to the grid.[419] Even for off-grid decentralized solar home systems, the upfront cost continues to be a major barrier for the lowest income households.[420]

Government policies that focus on educating households regarding the benefits of clean energy and supporting affordable finance of off-grid electricity and clean cooking could allow households to afford clean energy for basic needs. Increases in **Income and Work** from ***Improving Agriculture and Agroforestry, Protecting and Restoring Ecosystems*** and ***Fostering Equality*** solutions can contribute to a reduction in energy poverty for rural farming households in LMICs. Income and education can also be important determinants of cooking fuel use in urban and rural areas; households with lower education level and income more often rely on wood, biomass, and charcoal fuel for cooking, according to studies conducted in northern Sudan, Ghana, and Afghanistan.[421, 422, 423] In addition, boosting access to clean electricity in homes can also help address heat-stress inequality in LMICs by increasing electricity access while not adding pressure to fossil fuel–driven power grids.[191]

Housing: Income and education play critical roles in access to improved housing. A large-scale study from SSA showed that the prevalence of improved housing doubled (from 11 percent to 23 percent) between 2000 and 2015.[424] The analysis suggested strong links among improved housing, education, and wealth. The odds ratio of living in improved housing when the head of household was educated was 1.8 and for wealthy households was 2.0.[424] The proportion of improved housing increased the least in politically unstable countries, highlighting the role of national stability in improving this aspect of HWB.[424]

The TOSTAN Community Empowerment Program offers Senegalese women the opportunity to learn about their right to health and to be free from violence. *Credit: Jonathan Torgovnik | Getty Images | Images of Empowerment*

A major challenge to improving housing for rural populations and people living in poverty is lack of access to capital.[425] Most people experiencing poverty work in the informal sector, and 90 percent of the rural lands in SSA are not formally registered, thereby restricting access to formal financing.[425] The pay-as-you-go model has been successful in microfinancing the specific energy needs of rural and low-income households.[426] The model provides a unique opportunity to explore similar approaches to microfinance for improved housing in LMICs. A detailed survey in Kenya and Uganda found strong evidence that offering microfinance to

low-income households can lead to improved housing.[427] The co-benefits and ripple effects of Project Drawdown solutions in providing access to clean electricity and improving education can increase household incomes and improve networks, bringing more households into the formal economy and enabling them to obtain microfinance loans to improve their housing.

Networks: Studies and surveys have shown that **Income and Work** and **Education** are strongly linked with **Networks**. Income is a key barrier to accessing the Internet;[428, 429] in LMICs, smartphones are more common among highly educated, wealthier populations.[430] Improvements in **Education** and **Income and Work** can contribute to improving **Networks**.

Peace and Justice: Lack of economic development, joblessness, and poverty are strongly linked with conflict.[431] Development increases safety and promotes even more development; conversely, when development fails, the risk of conflict increases. This can have a great impact on the economy and further entrench a country in conflict.[431] Climate change has been described as a threat multiplier for global peace and security; it can collapse food production, decrease access to fresh water, and affect public health—things that are needed to promote security.[432]

Access to sanitation is a basic human right and leads to better health, which can contribute to improved capacity to work and ability to adapt to a changing climate. *Credit: United Nations Children's Fund Ethiopia 2014 | Nesbitt*

Long-term droughts and climate change have been linked to decreases in peace and security. One study across all SSA countries[433] estimated that a rise in average air temperature of 1.0˚C could potentially increase the likelihood of internal armed conflicts by 4.5 percent in the same year and by 0.9 percent in the following year. A global meta-analysis of 54 studies that analyzed conflicts after the 1950s suggested climate's influence on modern conflict could be substantial.[434] It has been estimated that climate change could lead up to 216 million people to migrate within their own countries by 2050 due to a lack of basic needs, including food and water.[263] More than two-thirds of the migration is expected to occur within SSA and South Asia.[263] However, if the global temperature stabilizes at 1.5°C above preindustrial levels, 80 percent of that migration could be prevented.[263] Whereas intensifying climate change can increase conflicts, it is worth noting that other drivers, such as socioeconomic development and low capabilities of state, have substantially greater influence on regional stability.[435]

Ripple effects are complex and have been understudied. However, climate solutions identified in this report can contribute to peace and justice through two pathways. The direct one is through reducing GHG emissions or enhancing carbon sinks, which mitigates climate change and thereby contributes to reducing drivers of conflict.[263] The other pathway is through co-

impacts with fundamental HWB dimensions that interact synergistically and can be additive. For instance, better food security, increased economic stability and income, and greater gender equality can play a part in minimizing risks of conflicts, reducing inequality, and improving peace and justice.[436]

Health and Education can also contribute to peace and justice by building the educational capacity of youth and helping countries make changes in fertility, thereby contributing to maturing the population age structure over time. This leads to a higher share of the working-age population able to contribute to economic growth[437] and stability.[438]

Robust studies analyzing the co-benefits of ***Providing Clean Energy*** for peace and justice are lacking.[268] However, anecdotal evidence suggests that SPV-powered electrification of neighborhoods can contribute to **Peace and Justice** through decreased crime and increased perceived safety by women and homeowners.[254, 265, 277, 332, 439, 440] (Such benefits can, however, also be realized by conventional [grid] energy sources.)

Gender Equality: Among the multiple solutions in the ***Improving Agriculture and Agroforestry*** and ***Protecting and Restoring Ecosystems*** groups, securing land tenure is a key solution that contributes tremendously to **Gender Equality**. Studies suggest that land tenure rights have several positive impacts on **Gender Equality**, such as increasing women's power socially, boosting ability to participate in community-level decision making, reaping economic benefits, benefiting from family assets, and reducing vulnerability to GBV.[247, 441] Other climate solutions in ***Improving Agriculture and Agroforestry*** and ***Protecting and Restoring Ecosystems*** groups further contribute to **Gender Equality** through increase in **Income**, strengthening of **Food** security, and improvements in **Water and Sanitation**.

Social Equity: More than three-quarters of global wealth is concentrated in the top 10 percent of wealthiest people, while the bottom 50 percent owns only 2 percent.[442] Income inequality has increased globally over the last few decades,[443] but this difference is highest in LMICs.[444] In India—home to the world's second largest population—the richest 1 percent own 60 percent of total wealth.[222] Income inequality affects HWB in myriad ways; its effect on public health is well-documented. It leads to increased mortality rates in infants and adolescents and lowers life expectancy.[222, 445, 446] Studies have also shown a higher prevalence of depression in countries with high income inequality.[222]

Climate change continues to exacerbate economic inequality,[447] as people experiencing poverty are generally more exposed to the adverse effects of climate change. Although low-income households are very resourceful and have high social capital, many have limited ability to cope with and recover from climate shocks, which can lead to higher levels of poverty.[34] Income inequality and climate change are mutually reinforcing.[448] Climate solutions identified in this report can address poverty when intentionally designed to do so. Low-carbon development pathways can not only contribute to lowering existing income inequality but can also protect vulnerable communities and individuals from falling back into poverty by increasing their resilience and decreasing future vulnerability to climate change.

Political Voice: Education and increased income can improve political voice. Several studies and surveys across the world have shown that education advancement leads to greater political participation and civic engagement.[449, 450, 451, 452, 453] However, the opposite has also been observed in authoritarian and non-democratic countries; education can decrease individual political participation as people may believe that participation legitimizes autocrats or is futile.[454]

Good governance and the collection and redistribution of tax revenue, particularly in natural resource–rich nations, plays a role in political voice and accountability. A low tax-to-GDP ratio enables governments to remain unaccountable to citizens for how they spend revenue. At the same time, citizens are not incentivized to pay taxes as they are not confident that the funds will be spent in ways that benefit them.[455] As LMICs, particularly in SSA, transition from economies focused on natural resource extraction to more diversified economies, tax revenue from manufacturing facilities linked to the green economy could be substantial.

> Where women can overcome structural barriers to their participation, they are uniquely positioned to contribute to sustainable natural resource management, climate-resilient communities, and enhanced peace and stability.
>
> JESSICA M. SMITH, LAUREN OLOSKY, AND JENNIFER GROSMAN FERNÁNDEZ,[418]
> THE CLIMATE-GENDER-CONFLICT NEXUS, GEORGETOWN INSTITUTE FOR WOMEN, PEACE AND SECURITY, 2021

4.7 Summary and conclusion

In addition to reducing carbon emissions, climate solutions like *Conservation Agriculture, Nutrient Management, and Distributed Solar Photovoltaics* can be combined to improve people's food security, access to water and electricity, and income, which can lead to positive ripple effects across their lives. *Credit: Ayush Manik (Independent Consultant) | CGIAR*

This literature review provides solid evidence for numerous co-benefits of climate change solutions for alleviating poverty and improving HWB. Many development initiatives in LMICs have a single focus, such as climate-smart agriculture, maternal health, or water and sanitation. Yet the challenges that under-resourced rural communities in LMICs face—such as poverty, hunger, lack of electricity, and poor water quality—are often linked, as shown in the HWI (Figure 3.3 and Appendix C).

The COVID-19 pandemic has amplified inequities in health, socioeconomic status, livelihoods, and access to crucial resources. At the same time, people around the world are demanding more urgent climate mitigation and adaptation actions as climate-driven drought, famine, wildfires, and floods become more devastating and frequent.

For people experiencing poverty in rural areas in LMICs—who have no insurance policies and limited government assistance to face and recover from pandemic and climate-induced shocks—climate solutions that complement and reinforce each other while also boosting HWB can be a part of a low-carbon pathway to prosperity, particularly when accompanied by stronger accountability from governments to citizens, cross-sectoral collaboration, and strengthened development planning.

> Many communities on the front lines of the climate crisis are already experiencing loss and damage. Communities cannot adapt to extinction, communities cannot adapt to starvation. The climate crisis is pushing so many people in places where they cannot adapt anymore.
>
> VANESSA NAKATE, CLIMATE ACTIVIST, UN VOICES OF CHANGE,[456] JANUARY 2022

5

MOBILIZING AROUND THE CLIMATE AND POVERTY NEXUS: CRITICAL ACTIONS

Improving the well-being of people experiencing extreme poverty and addressing climate change can and must be complementary: There should be no trade-offs between human well-being and climate action. Climate must become a central concern for development, and sustainable development must become a central path to fulfilling climate solutions.

The HWI, introduced in this report, serves as a framework for assessing 12 health, socioeconomic, and societal dimensions of human well-being and highlighting evidence of the nexus between climate mitigation solutions and human well-being in a scientifically consistent manner (Figure 3.3 and Appendix C). This report presents detailed scientific evidence of the many co-benefits and ripple effects for HWB that can be achieved by pursuing 28 Project Drawdown climate solutions at scale. Deeper understanding of the relative HWI value of a country and awareness of barriers to improving it are critical to better contextualize and prioritize climate solutions that both reduce emissions and alleviate poverty. Climate solutions not only provide mitigation benefits but can also improve HWB and boost economies in LMICs. This report intends to raise awareness of the socioeconomic co-benefits of climate solutions, promote cross-sectional alliances to mobilize ambitious solutions, and channel funding for synergistic solutions from public, philanthropic, and private sectors.

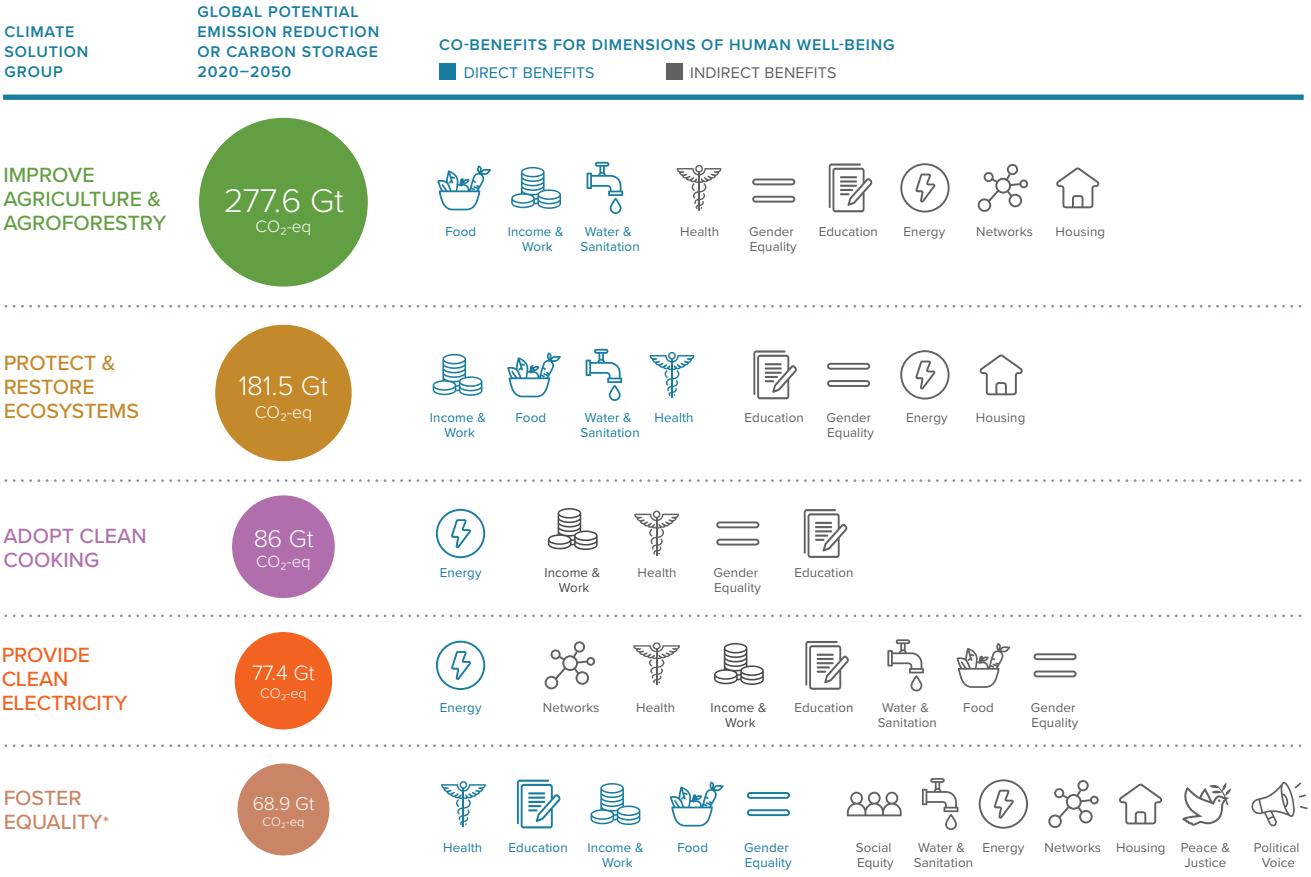
The win-win solutions presented here can provide tremendous benefits to HWB while simultaneously addressing climate change. Specifically, the total global CO_2-eq reduction potential of the 28 solutions presented here is approximately 690 Gt between 2020 and 2050 (Project Drawdown 2022 estimates[xxiii]); for comparison, global GHG emissions were between 48.1 and 50.6 Gt-CO_2-eq annually in 2018–2020. Several of the solutions with large GHG reduction potential at a global level are widely applicable in LMICs—*Tropical Forest Restoration, Indigenous Peoples Forest Tenure,* and *Improved Clean Cookstoves*—with tremendous

xxiii Updates to current solutions and new solutions will be posted to the Project Drawdown website in 2022.

potential benefits for people and the climate. These solutions alone contribute to a net reduction of 173 Gt CO_2-eq—about 25 percent of the CO_2-eq reduction potential of the solutions presented here.

All five of the climate solutions groups—***Improving Agriculture and Agroforestry, Protecting and Restoring Ecosystems, Adopting Clean Cooking, Providing Clean Electricity,*** and ***Fostering Equality***—generate enormous direct and indirect co-benefits to HWB. In particular, they generate benefits for people around **Income and Work**, **Health**, **Food Security**, **Education**, **Gender Equality**, and **Energy** that would be transformational in alleviating poverty and increasing resilience to current and future climate change. In addition, the ***Providing Clean Electricity*** solution group has strong co-benefits for **Networks**, while ***Fostering Equality*** has co-benefits for **Social Equity** and **Peace and Justice** (Figure 5.1).

Figure 5.1 — Climate solutions' co-benefits for human well-being



Project Drawdown's climate solutions offer substantial co-benefits for human well-being dimensions included in the Drawdown Lift Human Well-Being Index, from **Income and Work** (greatest) to **Political Voice** (least). (Gt CO_2-eq is gigatons of carbon dioxide equivalent.)

*Note: Family planning and education are not in themselves climate mitigation strategies. Rather, it is the outcome of Fostering Equality, slower population growth, that is a climate solution.

The opportunity to address climate change and improve HWB, particularly in LMICs, is enormous. Implementing the solutions presented here could make a dramatic difference for climate mitigation, climate adaptation, and improving HWB—especially when the solutions are implemented synergistically with cross-sectional collaboration.

In addition to implementing the solutions analyzed in this report, we find that several additional actions can also contribute to mobilizing win-win solutions to climate and poverty (Figure 5.2):

Listen to, engage with, and work alongside diverse stakeholders—from local practitioners to senior policymakers—to build capacity and plan for synergistic climate-development actions. Climate considerations need to become part of mainstream development efforts around green jobs, clean energy, food, health, infrastructure, and education—and vice versa. Global and national leaders must listen to and support women, youth, Indigenous peoples, and local communities in climate negotiations, include them in national and regional policy dialogues, and respect their demands for climate action. Simultaneously addressing climate change and fulfilling the fundamental needs of people around the world—in ways that incorporate their guidance and knowledge—is critical to advance equitable and climate-smart development.

The Health Development Initiative, founded by Rwandan physicians, facilitates conversations about sexual and reproductive health and rights. *Credit: Yagazie Emezi | Getty Images | Images of Empowerment*

Include HWB co-benefits in multisector climate finance. Development organizations and government ministries must collaborate with diverse organizations and institutions, policymakers, the private sector, and donors to scale the implementation of climate solutions that boost HWB. Extensive coordination is required to shed the tendency of development organizations and government ministries to focus on sector-specific goals and overlook climate policy co-benefits. In addition, stakeholders need to engage climate finance project teams that prepare, design, implement, and monitor climate finance projects and the implementing agencies and country focal points that oversee and collaborate with them to purposefully include HWB co-benefits in climate finance projects. More synergistic collaboration and coordination and intentional inclusion of co-benefits as part of climate finance also addresses inequality and bends the curve toward gender equality. For example, leaders can align and complement national climate strategies with other sector-specific approaches, such as national gender policies and national education plans.

Students in Lushoto, Tanzania, care for seedlings at school. *Credit: Georgina Smith | CIAT 2014*

Accelerate the development of innovative finance for climate solutions that include HWB co-benefits. As LMICs track the US$100-billion-per-year pledge for adaptation and mitigation measures, as well as new climate pledges from the philanthropic and private sectors, it is crucial to link climate mitigation solutions with HWB. Most climate finance goes to projects in middle-income countries and is focused on reducing emissions, which can often generate return on investment. Yet, needs are extremely high in low-income countries for adaptation. Linking climate mitigation solutions that provide clear co-benefits for HWB would enable the least developed and the most vulnerable countries to drive a shift in the approaches that private and public funding partners take to meet their self-identified environmental, social, and governance needs. Country focal points and implementing agencies could incorporate these win-win solutions more prominently into their Nationally Determined Contributions and National Adaptation Plans and tap into multilateral climate funds like the Adaptation Fund, Green Climate Fund, Climate Investment Funds, and Global Environment Facility to de-risk private investments. Decisionmakers must collectively leverage the incentives and strengths of public and private finance and use existing finance tools and institutions to manage risk and pursue innovation. Blended finance approaches whereby the private sector contributes to clean energy and conserving ecosystems, such as those developed by the Global Environment Facility, are becoming more common. The cost of inaction today outweighs the risks of financing climate action for the future.

Assemble additional evidence of HWB co-benefits to further drive a more holistic approach to climate solutions and poverty alleviation. As the report shows, many climate solutions can serve dual roles of mitigating GHG emissions and improving HWB. However, their efficacy in addressing HWB has not been widely tested in real-world settings. Research that evaluates the multiple co-benefits of a solution or a group of solutions is rare. Evaluations of potential co-benefits (and trade-offs) of climate solutions for HWB would be beneficial, along with analysis that looks for unintended consequences and differential impacts by gender, cultural integrity, and income. Researchers should collaborate with organizations advancing synergistic initiatives like the ones highlighted in case studies in this report that jointly address climate change and HWB.

Figure 5.2 — Key actions to foster synergistic solutions

Addressing multidimensional poverty is exceedingly complex; collaboratively aligning poverty alleviation efforts with climate-smart development is daunting. Countries and stakeholders at all levels of society should not have to choose among human development, climate mitigation, and climate adaptation; win-win solutions are at hand. The world has a window of opportunity to align strategies, complement funding, and harmonize policies at local, national, and international scales to simultaneously address climate change, alleviate poverty, and boost human well-being. By charting a more synergistic path, decisionmakers, policymakers, and funders—informed by and in collaboration with women, youth, Indigenous peoples, and local communities—can ensure a brighter future for people and the planet.

The global community must ensure that those most impacted by climate change (and often the least responsible for it) have access to resources necessary to adapt to climate change and mitigate future emissions to meet their self-identified needs and ensure a sustainable future for generations to come. *Credit: Ollivier Girard | CIFOR*

APPENDIX A

Descriptions of the 28 Project Drawdown solutions

Note: The hyperlink in each solution leads to the solution summary on Project Drawdown's website.

Abandoned Farmland Restoration: Degraded farmland is often abandoned, but it need not be. Restoration can bring these lands back into productivity and sequester carbon in the process.

Biogas for Cooking: Anaerobic digesters process backyard or farmyard organic waste into biogas and digestate fertilizer. Biogas stoves can reduce emissions when replacing biomass or kerosene for cooking.

Coastal Wetland Protection: Mangroves, salt marshes, and seagrasses sequester huge amounts of carbon in plants and soil. Protecting them inhibits degradation and safeguards their carbon sinks.

Coastal Wetland Restoration: Agriculture, development, and natural disasters have degraded many coastal wetlands. Restoring mangrove forests, salt marshes, and seagrass beds to health revives carbon sequestration.

Conservation Agriculture: Conservation agriculture uses cover crops, crop rotation, and minimal tilling in the production of annual crops. It protects soil, avoids emissions, and sequesters carbon.

Distributed Solar Photovoltaics: Whether grid-connected or part of stand-alone systems, rooftop solar panels and other distributed solar photovoltaic systems offer hyper-local, clean electricity generation.

Farm Irrigation Efficiency: Pumping and distributing water is energy-intensive. Drip and sprinkler irrigation, among other practices and technologies, make the use of farm water more precise and efficient.

Forest Protection: In their biomass and soil, forests are powerful carbon storehouses. Protection prevents emissions from deforestation, shields that carbon, and enables ongoing carbon sequestration.

Geothermal Power: Underground reservoirs of steamy hot water are the fuel for geothermal power. The water can be piped to the surface to drive turbines that produce electricity without pollution.

Grassland Protection: Grasslands hold large stocks of carbon, largely underground. Protecting them shields their carbon stores and avoids emissions from conversion to agricultural land or development.

Health and Education: Some initiatives, designed primarily to ensure rights and foster equality, also have cascading benefits to climate change. They include access to high-quality, voluntary reproductive health care and to high-quality, inclusive education, which are fundamental human rights and cornerstones of gender equality.

Improved Clean Cookstoves: Improved clean cookstoves can address the pollution from burning wood or biomass in traditional stoves. Using various technologies, they reduce emissions and protect human health.

Improved Rice Production: Flooded rice paddies produce large quantities of methane. Improved production techniques, including alternate wetting and drying, can reduce methane emissions and sequester carbon.

Indigenous People's Forest Tenure: Secure land tenure protects Indigenous peoples' rights. With sovereignty, traditional practices can continue—in turn protecting ecosystems and carbon sinks and preventing emissions from deforestation.

Micro Wind Turbines: Micro wind turbines can generate clean electricity in diverse locations, from urban centers to rural areas, without access to centralized grids.

Microgrids: A microgrid is a localized grouping of distributed electricity generation technologies, paired with energy storage or backup generation and tools to manage demand or "load."

Multistrata Agroforestry: Multistrata agroforestry systems mimic natural forests in structure. Multiple layers of trees and crops achieve high rates of both carbon sequestration and food production.

Nutrient Management: Overuse of nitrogen fertilizers—a frequent phenomenon in agriculture—creates nitrous oxide. More efficient use can curb these emissions and reduce energy-intensive fertilizer production.

Peatland Protection and Rewetting: Forestry, farming, and fuel extraction are among the threats to carbon-rich peatlands. Protection and rewetting can reduce emissions from degradation while supporting peatlands' role as carbon sinks.

Reduced Food Waste: Roughly one-third of the world's food is never eaten, which means the land and resources used and GHGs emitted in producing it were unnecessary. Interventions can reduce loss and waste as food moves from farm to fork, thereby reducing overall demand.

Regenerative Annual Cropping: Building on conservation agriculture with additional practices, regenerative annual cropping can include compost application, green manure, and organic production. It reduces emissions, increases soil organic matter, and sequesters carbon.

Silvopasture: An agroforestry practice, silvopasture integrates trees, pasture, and forage into a single system. Incorporating trees improves land health and significantly increases carbon sequestration.

Small Hydropower: Small hydropower systems capture the energy of free-flowing water without using dams. They can replace dirty diesel generators with clean electricity generation.

Sustainable Intensification for Smallholders: Sustainable intensification practices can increase smallholder yields which, in theory, reduce demand to clear additional land. Practices include intercropping, ecosystem-based pest management, and equal resources for women.

System of Rice Intensification: This is a holistic approach to sustainable rice cultivation. By minimizing water use and alternating wet and dry conditions, it minimizes methane production and emissions.

Temperate Forest Restoration: Almost all temperate forests have been altered in some way—timbered, converted to agriculture, or disrupted by development. Restoring them sequesters carbon in biomass and soil.

Tree Intercropping: Growing trees and annual crops together is a form of agroforestry. Tree intercropping practices vary, but all increase biomass, soil organic matter, and carbon sequestration.

Tropical Forest Restoration: Tropical forests have suffered extensive clearing, fragmentation, degradation, and depletion of biodiversity. Restoring these forests also restores their function as carbon sinks.

APPENDIX B

Summary of common human well-being indices and description of indicators used in this report

Table B.1 — Summary of commonly used socioeconomic and human well-being indices

INDEX NAME	Developer/ Institution	No. of indicators	Coverage	HUMAN WELL-BEING DIMENSIONS					
				Social	Education	Environment	Health	Economic	Gender
GLOBAL MULTIDIMENSIONAL POVERTY INDEX (MPI)*	UNDP/Oxford Poverty Human Development Initiative (OPHI)	10	LMICs	■	■		■		
HUMAN DEVELOPMENT INDEX	UNDP	4	Global		■		■	■	
ENVIRONMENTAL PERFORMANCE INDEX	Yale/Columbia University	32	Global			■	■		
BETTER LIFE INDICATOR	OECD	24	OECD countries	■	■	■	■	■	
SOCIAL PROGRESS INDEX	Social Progress Imperative	53	Global	■	■	■	■		■
DOUGHNUT ECONOMICS	Kate Raworth/Oxfam International	30**	Global	■	■	■	■	■	■

* Disaggregation of data by gender was introduced in the 2021 MPI.

** Two of these, air pollution and chemical pollution, did not have globally defined measures in the original framework.

Table B.2 — Brief description and data sources for the indicators included in the Drawdown Lift Human Well-Being Index

HWB DIMENSION	INDICATOR	DESCRIPTION	SOURCE
ENERGY	Access to electricity	Percentage of population with access to electricity	World Bank
	Access to clean cooking fuel and technology	Percentage of the population with primary reliance on clean fuels and technology for cooking	World Bank
WATER AND SANITATION	Access to clean water	Percentage of the population with access to water that is sourced from an improved source with a collection time of < 30 minutes	World Health Organization Joint Monitoring Programme (WHO JMP)
	Access to basic sanitation	Percentage of population with access to improved facilities not shared with other households	WHO JMP
FOOD	Population undernourished	Percentage of population that is undernourished (three-year average)	FAO
	Prevalence of child malnutrition	Percentage of children under age 5 who are stunted	FAO
HEALTH	Child mortality rate	Mortality rate under age 5 per 1,000 live births	World Bank
	Maternal mortality ratio[xxiv]	Number of maternal deaths per 100,000 live births	WHO
	Life expectancy	Life expectancy at birth (years)	WHO
	Demand satisfied for family planning	Percentage of women of reproductive age (15–49 years) whose need for family planning is satisfied with modern methods	United Nations
	Suicide rate	Number of suicide deaths per 100,000 people per year	WHO
EDUCATION	Literacy rate	Percentage of people aged 15 and above who can read and write, with understanding of a short, simple statement about their everyday life	United Nations Children's Fund
	Children enrolled in secondary school	Percentage of all eligible children enrolled in secondary education	World Bank
	Education quality	Expert evaluation of the extent to which high-quality basic education is guaranteed to all people, measured on a scale of 0 (extremely unequal access) to 4 (equal access)	SPI
INCOME AND WORK	Poverty rate	Percentage of people living on less than US$1.90 per day at 2011 international prices[xxv]	World Bank
	Unemployment rate	Percentage of the total workforce that is unemployed	World Bank
	Gender wage gap	Pay gap between men and women workers (%)	International Labor Organization

xxiv The Maternal Mortality Ratio is defined as the number of female deaths from pregnancy-related causes during pregnancy and childbirth or within 42 days of the termination of pregnancy during a given time period per 100,000 live births during the same time period. It represents the risk of maternal death relative to the number of live births and essentially captures the risk of death in a single pregnancy or live birth.

xxv Please refer to the World Bank's PovCal website for additional information on the methodology of calculating the poverty rate.

HWB DIMENSION	INDICATOR	DESCRIPTION	SOURCE
NETWORKS	Access to internet	Percentage of people that used the internet in the last three months	World Bank
	Access to mobile phone	Percentage of people with cell phone subscriptions	World Bank
	Freedom of movement	Composite of four indicators capturing domestic and international freedom of movement	World Bank
HOUSING	Inadequate housing	Households with inadequate housing materials in any of three components: floor, roof, or walls	Multidimensional Poverty Index
GENDER EQUALITY	Women's representation in government	Percentage of parliamentary seats held by women	World Bank
	Child, early, and forced marriage and unions	Percentage of women aged 20–24 who were married or in a union before age 18	UN Stats
	Intimate partner violence	Percentage of girls and women aged 15 and older that has ever experienced physical and/or sexual violence from an intimate partner	Our World in Data
	National abortion policies	Composite of four indicators (available at woman's request, legal and gestational limits around economic or social reasons, health, and life of the mother) to provide the extent of abortion restrictions	WHO Global Abortion Policy Database
SOCIAL EQUITY	Income distribution	The degree of inequality in the distribution of income or wealth among households or individuals	World Bank
	Civil liberties	Composite of four indicators: rule of law, personal autonomy and individual rights, freedom of expression and belief, and associational and organizational rights, ranging from 1 (strong liberties) to 7 (no liberties)	The Freedom House
PEACE AND JUSTICE	Corruption perception	Perceptions of administrative and political corruption by country experts and business people (calculated using data from surveys collected by reputable institutions)	Transparency International
	Political stability	Likelihood that a government will be removed through unconstitutional or violent means (index)	World Bank
	Homicide rate	Number of homicides per 100,000 people per year	The UN Office on Drugs and Crime
POLITICAL VOICE	Voice and accountability	Citizens' perception of the extent to which they can participate in selecting their government, as well as freedom of expression, freedom of association, and media freedom (index)	World Bank

APPENDIX C

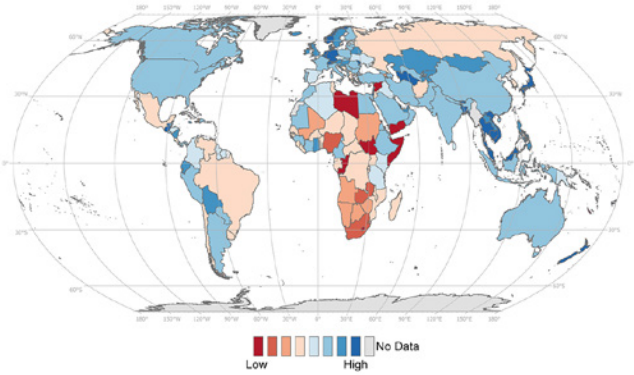
Calculating the Drawdown Lift Human Well-Being Index

For each indicator, we used the most recently available country-level data collected in the pre-COVID-19 era (e.g., child and maternal mortality rates from 2019). For a few countries and a select set of indicators, data from the same year were unavailable. For instance, the most recent Gini coefficient value (which measures the wealth inequality in a country) available for each country was included because this figure is not calculated every year. When calculating the HWI for a country, we did not include indicators with missing data. A brief description of each indicator and its data source(s) is provided in **Appendix B**.

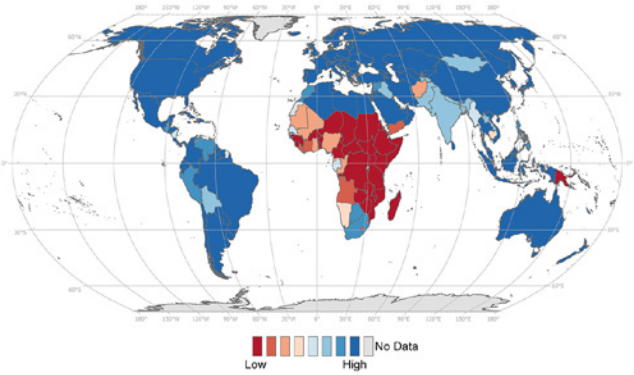
The approach to calculate the HWI was straightforward. First, for each indicator, outliers—defined as values falling outside the minimum (Q1 – 1.5*Q1) and the maximum (Q3 + 1.5*Q3) values, where Q1 and Q3 are the first and the third quartile—were removed to minimize the disproportionate effect of very low or high values. Data were then divided into five equal intervals, allowing for categorization into five percentile groups: 0–20 percent, 20–40 percent, 40–60 percent, 60–80 percent and 80–100 percent. Countries with values lower or higher than the defined minimum and maximum values were assigned to groups 0–20 percent and 80–100 percent, respectively. For indicators where increasing values reflect lower HWB (e.g., poverty rate), the ranks were inverted, assigning rank 1 to the 80–100 percentile. Finally, the ranks of the indicators were averaged to obtain the relative well-being of a country for a given dimension. A constraint of the Drawdown Lift Human Well-Being Index is that calculating the relative well-being of a country for a given dimension does not capture regional or community-level variations. All dimensions are weighted equally, and they were then averaged to obtain the overall HWI of a country. This approach was used to highlight the relative (not the absolute) difference between the countries.

Figure C.1 — Drawdown Lift Human Well-Being Index provides an indication of relative human well-being for A: Income and Work, B: Water and Sanitation, C: Food, D: Health, E: Gender Equality, and F: Energy

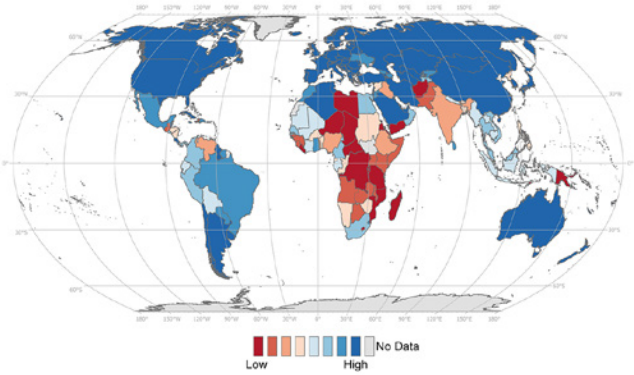
A: Income and Work



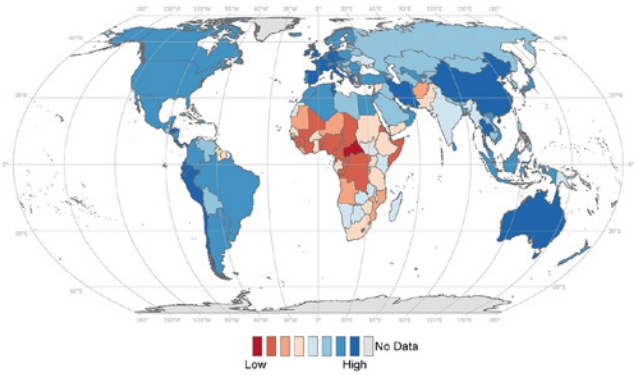
B: Water and Sanitation



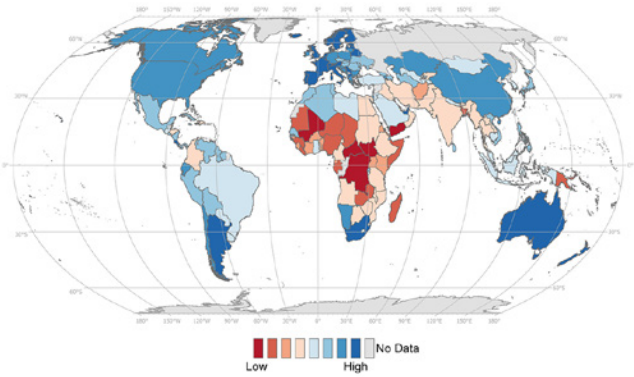
C: Food



D: Health



E: Gender Equality



F: Energy

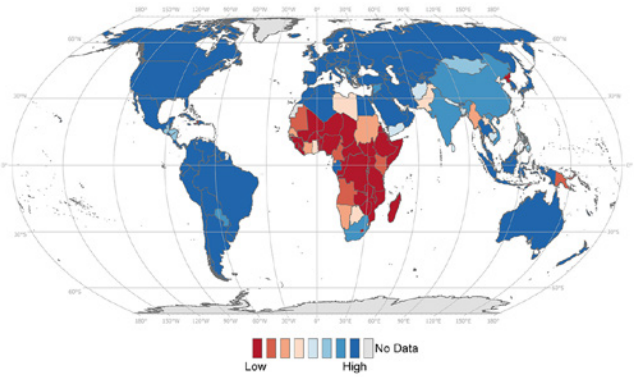
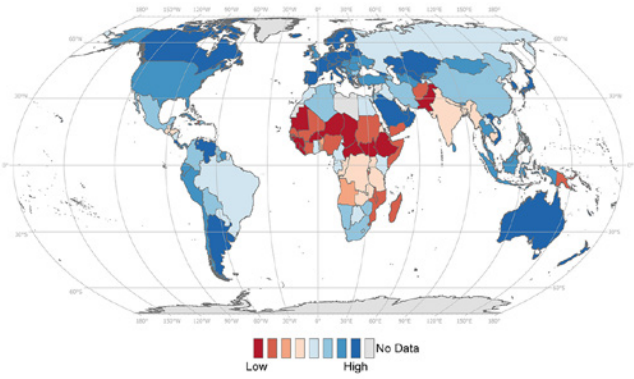
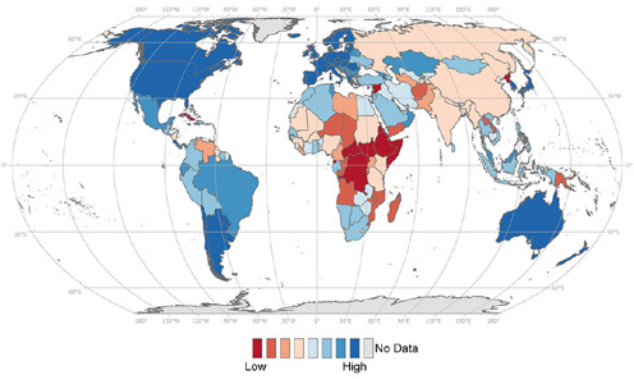


Figure C.2 — Drawdown Lift Human Well-Being Index provides an indication of relative national human well-being for A: Education, B: Networks, C: Housing, D: Peace and Justice, E: Political Voice, and F: Social Equity

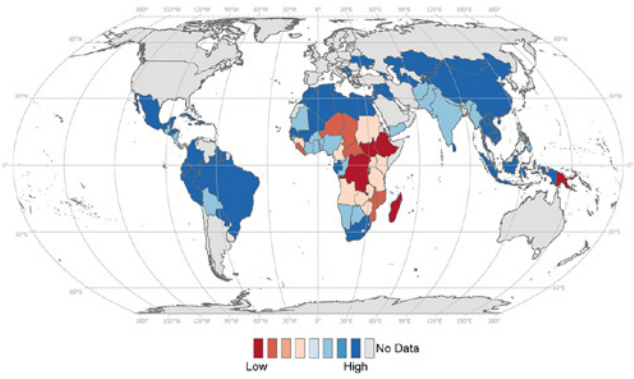
A: Education



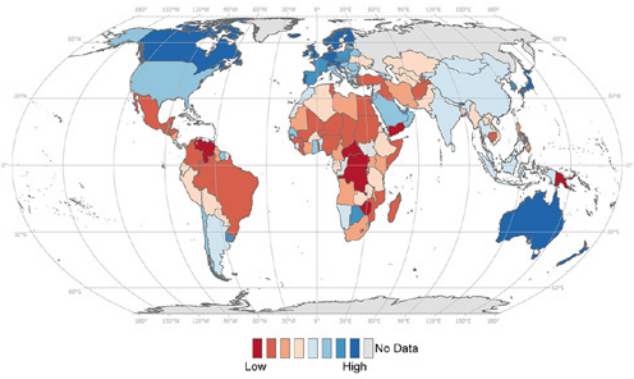
B: Networks



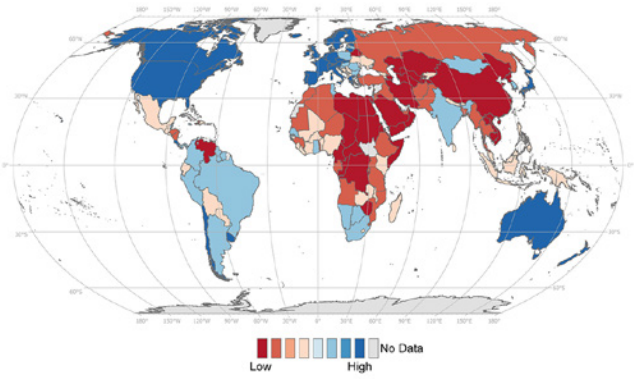
C: Housing



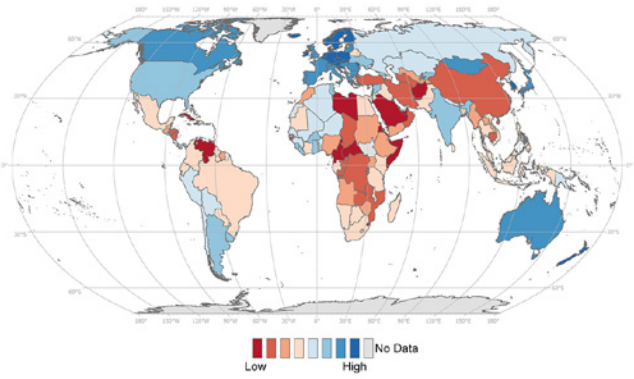
D: Peace and Justice



E: Political Voice



F: Social Equity



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ABOUT PROJECT DRAWDOWN

The World's Leading Resource for Climate Solutions

Founded in 2014, Project Drawdown is a nonprofit organization that seeks to help the world reach drawdown—the point in the future when levels of greenhouse gases in the atmosphere stop climbing and start to steadily decline, thereby stopping catastrophic climate change—as quickly, safely, and equitably as possible.

Since the 2017 publication of the New York Times bestseller *Drawdown*, the organization has emerged as a leading resource for information and insight about climate solutions. Project Drawdown supports climate action and research by conducting rigorous review and assessment of climate solutions, creating compelling communication across media outlets, and partnering with efforts to accelerate climate solutions globally. Cities, universities, corporations, philanthropies, policymakers, communities, and more turn to Project Drawdown as they look to advance effective climate action. The Project Drawdown team supports a growing constellation of efforts to move climate solutions forward globally.

In 2020, Project Drawdown released The Drawdown Review, a report building on the organization's inaugural analysis and best-selling book that considers the rapidly evolving landscape of climate solutions available today. A 501(c)(3) nonprofit organization, Project Drawdown is funded by individual and institutional donations.

ABOUT DRAWDOWN LIFT

Launched in 2021, Drawdown Lift works to deepen collective understanding of the links between climate change solutions and poverty alleviation, particularly in low- and middle-income countries in sub-Saharan Africa and South Asia. The Lift team seeks to help address both extreme poverty and climate change by collaboratively identifying, promoting, and advancing solutions designed to catalyze positive, equitable change. Though research in interconnected, overlapping areas of concern—reducing poverty and addressing climate impacts—should go together, work often exists in silos. Drawdown Lift works to break down disciplinary walls and find solutions that can address climate change and extreme poverty and lead to enhanced human well-being around the world. Drawdown Lift works alongside academic researchers, practitioners, and change makers interested in achieving evidence-based, high-impact poverty alleviation and climate solutions worldwide.

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