

HOW TO PROTECT, BUILD, AND USE HUMAN CAPITAL TO ADDRESS CLIMATE CHANGE



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Foreword

“We talk about the numbers, the temperature, and how much money we need, but all of those consequences have a human narrative.” - Her Excellency Oulimata Sarr, Minister of Economy, Planning and Cooperation in Senegal

Human capital—the knowledge, skills, and good health that people accumulate over their lifetimes—empowers people to deal with climate change. Healthier, better educated people are spurring innovative climate solutions and powering the green industries of tomorrow. Human capital also makes people more resilient to a warming world.

Simultaneously, climate change is eroding our human capital. It has broad and long-lasting impacts on schooling, health and people’s ability to earn an income, particularly for the world’s most vulnerable people. Consider these words from Esther Duflo, 2019 Nobel Laureate in Economics and Poverty Alleviation and Development Professor at the Massachusetts Institute of Technology: “Climate change will potentially undermine the progress that has been made in human capital, in low-and middle-income countries, mainly by the efforts of the countries themselves. We need ingenuity to find solutions.”

During the 2023 World Bank Group-IMF Spring Meetings, Ministers of Finance, Planning, and Budget gathered at the Human Capital Ministerial Conclave to discuss the link between human capital and climate change. I would like to thank the Ministers for the conversation at the Conclave and for their commitment to investing in people to address climate change. This note extends that conversation on how to *protect, build, and use* human capital to face the challenges of a warming world.



A handwritten signature in black ink that reads "Mamta Murthi".

MAMTA MURTHI
Human Development
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Executive Summary

Solutions to climate change require investments in people. Climate change is a direct threat to human capital—the knowledge, skills, and good health that people accumulate over their lifetimes. It stifles learning, undermines livelihoods, and intensifies diseases and malnutrition. At the same time, human capital empowers people to advocate for climate action, to work in jobs created by the green transition, and to pioneer the technology for a net-zero-emissions future. This note catalogs the impacts of climate change on people and explains how to *protect*, *build*, and *use* human capital to ensure a livable planet.

Climate change is reversing human development. As an example, heat-related deaths across the globe have increased 68 percent in the last two decades.² If greenhouse gas emissions continue unchecked, by 2100 the death toll from extreme heat will exceed today’s global mortality rate from all infectious diseases combined.³

Investing in human capital will limit the impact of climate change on people and help people to combat climate change itself. Key strategies include the following:

- **Protect people from climate change with social safety nets.** In the aftermath of floods, fires, and severe storms, programs like cash transfers help people get back to work, avoid falling into poverty, and keep their children well-nourished and in school.⁴
- **Protect health care and education from climate change while reducing their carbon footprint.** Governments need to ensure continued access to health care and schooling after natural disasters. Energy-efficient designs for schools and hospitals directly reduce greenhouse gas emissions and provide a model to private companies for climate-friendly infrastructure.
- **Build education for climate action.** Education empowers people to work for a brighter climate future. An additional year of education increases pro-climate beliefs, behaviors, and policy preferences.⁵ And environmental education for children both shapes the conduct of the next generation and influences the views of their parents.⁶
- **Build skills for the climate transition.** A global economy based on renewable energy requires people with the expertise to develop and implement low-carbon technology. Demand for those “green skills” is growing nearly twice as quickly as the number of people who have them.⁷
- **Use human capital to empower people for the green economy.** Jobs programs are helping workers displaced by the shift away from fossil fuels to reskill and find new opportunities.⁸ The International Finance Corporation (IFC) estimates that climate business can generate 213 million jobs around the world by 2030.⁹

By protecting, building, and using human capital, we can make people agents for climate action. Through the strategies outlined in this note, human capital investments can drive climate adaptation and mitigation, while promoting a just transition.

¹ This policy note was prepared by the World Bank’s Human Capital Project. It was authored by German Caruso, Inés de Marcos, Daisy Demirag, Sarah Eleuterio Comer, and Emily Weedon Chapman. The authors thank Diego Ambasz, Stephen Dorey, Jessica Flannery, Maria Gracheva, Alexander Jaeger, Sergio Marin, Tamer Rabie, Elizabeth Ruppert, Shwetlena Sabarwal, Valeria Salvador, and Andrea Woodhouse for their insightful technical inputs and greatly appreciate the guidance and advice from Wendy Cunningham, Gabriel Demombynes, Stephane Hallegatte, Jamele Rigolini, Alberto Rodriguez, Iffath Sharif, and Penny Williams. Mamta Murthi provided leadership and direction in setting the policy and priorities outlined herein.

² Romanello et al. (2022).

³ Carleton et al. (2022).

⁴ Adhvaryu et al. (2018); Asfaw et al. (2017); De Janvry et al. (2006a, 2006b).

⁵ Angrist et al. (2023).

⁶ Lee, Markowitz, Howe, Ko, and Leiserowitz (2015).

⁷ LinkedIn (2023).

⁸ Andrews et al. (2021).

⁹ IFC (2021).

SECTION 1:

The Intergenerational Impacts of Climate Change

People are threatened by climate change. Human capital is the health, knowledge, and skills that people accumulate over their lifetime. At an individual level, people with more human capital are healthier, live longer, and earn more. At a national level, human capital promotes inclusive and sustainable development. It accounts for 70 percent of the national wealth in high-income countries, compared to 41 percent in low-income countries.¹⁰ Climate change threatens to upend decades of progress in human capital accumulation that has helped people live better lives and their countries become more prosperous.

Climate change disruptions at any life stage can have long-lasting and intergenerational effects. Climate shocks and slower-onset climate change experienced early in life can have detrimental effects on health, livelihoods, productivity, and asset accumulation in adulthood. The impacts on young people and adults spill over to younger and older cohorts, as lower household income limits investments in health care, education, and nutrition for themselves and their dependents. Recent studies from multiple countries link climate shocks that reduce household income with lower learning outcomes for children and increases in child labor.¹¹

Climate shocks are increasingly having severe and immediate repercussions on people across the globe. Flooding, landslides, hurricanes, and tornadoes interrupt schooling and health services, limit people's ability to earn an income, and displace millions. The impacts cut across all stages of life—from droughts that affect food security and threaten infant nutrition to heat waves that exacerbate health risks, particularly for the elderly.

Slow-onset climate trends may not make headlines, but they are no less dangerous to people's well-being and productivity. Changing weather patterns, rising heat, drought, and desertification can reduce crop yields, increasing malnutrition, and push families into poverty. Changing weather and flooding increase the prevalence of vector-borne and water-borne diseases. Increasing food prices and health impacts from climate change are likely to drive the largest increases in climate-induced poverty levels.¹²

Across and within countries, the poorest and the most vulnerable people are disproportionately exposed to climate risks and less able to cope with them.¹³ Poverty forces people to live in less desirable areas that are more likely to flood, are more prone to excessive heat or desertification, and lack access to water. Lack of quality housing or other assets also puts poor people at higher exposure to climate risks within these locations. Poor people have fewer savings and assets to recover from climate shocks or adapt to climate trends (Box 1).

Climate change also threatens to worsen gender inequalities.¹⁴ Girls, for example, are at a greater risk of dropping out of school during shocks. The increasing frequency and intensity of climate shocks could amplify this further. Women are particularly reliant on nature-based livelihoods, and so, longer-term climate trends, like drought and desertification, may have an outsized impact on their earnings.

¹⁰ Lange, Wodon, and Carey (2018).

¹¹ Diallo (2022); Koohi-Kamali and Roy (2021); Nguyen and Pham (2018).

¹² Jafino, Walsh, Rozenberg, and Hallegatte (2020).

¹³ Islam and Winkel (2017).

¹⁴ Deininger et al. (2023); Caruso et al. (2022).

This section presents evidence on how quick-onset climate shocks and longer-term climate trends affect human capital accumulation and usage across the lifecycle, as well its impact across generations. The analysis synthesizes existing global research about climate change’s impacts on people’s health, well-being, education, and skills by age cohort: in-utero and early childhood development, school-aged children and youth, the working-age population, and the elderly population.

Understanding how climate change affects people at different stages of life can point to policies that benefit people and the planet. Smart human capital investments can help counteract the threats of climate change. And policies that leverage people’s potential are also central to reducing climate change itself.

Figure 1: Direct links between the impacts of climate change on people informs climate-smart investments in human capital

Key Climate Vulnerabilities	Life Cycle	Implications for Human Capital
In-utero exposure to climate shocks.	Pregnancy and Early Childhood	Premature birth, low birth weight, fetal and neonatal mortality, potentially irreversible consequences for physical and cognitive growth and development.
Adverse effects of malnutrition and disease.		Increased risk of infant and under-5-mortality, stunting, permanent effects on cognitive development and educational achievement.
Family resource constraints, and destroyed infrastructure	School-aged Children and Youth	Reduced access to schooling and healthcare, reduced educational outcomes, early dropout, malnutrition and disease, and adverse investment decisions in human capital.
Adverse effects of disease and exposure to climate shocks.	Working-age	Repercussion on incomes and poverty, increased workloads, poor health and productivity due to climate shocks, heat exposure and exacerbation of vector-borne and water-borne diseases.
Pre-existing health conditions and lack of mobility.	Elderly	Increased morbidity and mortality, increased respiratory conditions and reduced cognitive functions.





Pregnancy and early childhood development

The impacts of climate shocks begin in-utero. Water-borne diseases, like diarrhea and cholera, can affect the fetus during pregnancy and are strongly linked to adverse health outcomes, especially fetal death.¹⁵ Increasing droughts can amplify these health hazards through reduced availability of clean water for drinking, cooking, and hygiene. Further, extreme weather events can significantly reduce antenatal care visits, institutional deliveries, and postpartum care visits.¹⁶ In Mozambique, an extensive study conducted following a cyclone highlighted substantial disruptions in health services, with first antenatal care and postpartum visits within the initial week following the disaster decreasing by 23 percent.¹⁷ Fewer antenatal care visits are associated with adverse fetal and neonatal outcomes, including low-birth-weight infants and more fetal and neonatal deaths.¹⁸

Both food insecurity and rising temperatures resulting from longer-term climate trends are linked to lower birth weights.¹⁹ Over time, decreased seasonal precipitation can result in lower food production, affecting pregnant women's nutrition and resulting in cohorts with low birth weights. A study of 19 Sub-Saharan African countries between 1986 and 2010 found that an increased number of hot days and decreasing precipitation were correlated with lower birth weights and a higher proportion of low birth rates regardless of socioeconomic status, season of birth, or country of residence.²⁰ In Vietnam, one standard deviation increase in temperature relative to the local norm during the first trimester of pregnancy reduced a child's weight at birth by 2.2 percent. In Colombia, exposure to moderate heat waves during the third trimester reduced birth weight of babies by 4.1 grams.

Climate impacts in early childhood can have permanent effects on cognitive development and educational achievement. Fast-onset climate shocks escalate the likelihood that a child will be stunted. Flooding, for example, is linked to higher rates of stunting due to increased prevalence of water-borne and vector-borne diseases, such as diarrhea, cholera, and malaria.²¹ In Ethiopia, children who experience seasonal food scarcity during the intra-uterine period exhibit shorter stature during childhood. An additional month of prenatal exposure to food scarcity is associated with an estimated decrease in height of at least 0.44 cm by the age of eight. This effect becomes even more pronounced with age, with a magnitude of 0.56 cm by the age of twelve.²² Longer-term trends also have long-lasting implications on a child's learning. A study conducted in Southeast Asia shows that a child who encounters temperatures two standard deviations above the average in early life is likely to attain 1.5 fewer years of schooling compared to a child exposed to average temperatures.²³

¹⁵ Tran et al. (2015).

¹⁶ Baten et al. (2020).

¹⁷ Fernandes et al. (2022).

¹⁸ Alkema et al. (2016); Raatikainen (2007); Zhao et al. (2021).

¹⁹ Le and Nguyen (2021).

²⁰ Grace et al. (2015).

²¹ Dimitrova and Bora 2020; Skoufias and Vinha 2012; Umbers, Aitken, and Rogerson 2011.

²² Miller (2017).

²³ Randell and Gray (2019).



School-age children and youth

For children and youth, climate shocks disrupt access to schooling and health care. Children face disruptions from damaged infrastructure including schools, hospitals, and clinics that provide services, as well as bridges and roads that they rely on for access. Even one climate shock can set back decades of human capital investments: in Mozambique, flooding in a single year destroyed more than 500 schools constructed over the previous 20 years.²⁴ In addition to damaged infrastructure, loss of household income from a climate shock may cause parents to pull children out of school. In southern India, adverse rainfall shocks led households to send children to work instead of school to supplement the household earnings.²⁵

Education is more at risk for girls than boys from climate-related shocks. Families with less income are more likely to withdraw girls from school.²⁶ For example, girls accounted for 70 percent of children withdrawn from school after droughts in Botswana.²⁷ In Madagascar, during periods of less rainfall and more cyclones, adolescents are more likely to drop out of school and start working, especially those from poorer.²⁸ Evidence from Vietnam showed that rainfall shocks experienced early in life reduced the probability of that women, but not men, would have formal sector jobs as adults.²⁹

While climate shocks may be short-term events, they cause children to fall behind permanently due to missing school or dropping out altogether.³⁰ For example, drought-affected households in Zimbabwe delayed the start of school for children by an average of 3.7 months, resulting in children completing 0.4 fewer grades³¹. In Mexico, children who withdrew from school during climate-induced economic shocks were about 30 percent less likely to continue studying relative to children who stay in school.³² Moreover, a series of droughts in rural central Mexico led to less schooling and increases in child labor in areas with insufficient social protection.³³ The Young Lives surveys which tracked nearly 12,000 children over two decades in Ethiopia, India, Peru, and Vietnam showed clear correlations between climate shocks and lower cognitive and learning outcomes, due to crop failures and other climate impacts which reduced food security and household incomes.³⁴

²⁴ Baez, de la Fuente, and Santos (2010).

²⁵ Jacoby and Skoufias (1997).

²⁶ Björkman-Nyqvist (2013).

²⁷ Babugura (2008).

²⁸ Marchetta, Sahn, and Tiberti (2019).

²⁹ Feeny et al. (2021).

³⁰ Baez, de la Fuente, and Santos (2010).

³¹ Alderman et al. (2016)

³² de Janvry et al. (2006a, 2006b).

³³ de Janvry et al. (2006a, 2006b).

³⁴ Porter (2021).

Children’s long-term development also suffers from the slow onset of climate change. For example, higher temperatures and greater CO₂ concentrations promote the growth of aeroallergens, such as pollen and mold, which increase allergies and asthma among children.³⁵ Exposure to air pollution contributes to cell loss within the central nervous system among young children in urban areas, creating subtle neurocognitive effects indicating early evidence of neurodegenerative changes.³⁶

Air pollution and heat exposure affect learning and educational outcomes, with the current infrastructure ill-suited to the changing climate. A study of the Organisation for Economic Co-operation and Development (OECD) International Student Assessment data from 58 countries found that increases in the number of hot school days contributed to differences across and within countries in educational achievement, especially among students from low-income households.³⁷ In Texas, a study of 39 schools found that high levels of air pollution resulted in a significant increase in absenteeism, negatively affecting learning and test scores.³⁸

Working-age population

Among the working-age population, climate shocks have lasting repercussions on incomes and poverty. In Bangladesh, the catastrophic flooding in 1998 resulted in wage declines of non-agricultural workers by 8.4 to 13 percent one-year after the flood, especially among those working in the services sector.³⁹ In Brazil, beyond the immediate impacts of a drought, rural workers experienced wage losses that took up to five years to recover.⁴⁰ Six years after the 1999–2000 drought in Ethiopia, 95 percent of the households who became poor remained in poverty.⁴¹ More recently, a study in Niger found that a one standard deviation decrease in rainfall led to an 11 percent drop in per capita income, as well as negative effects on household consumption, poverty, nutritional status, and school attainment. The adaptive ability of households, including agricultural capital and income diversification, played a crucial role in determining the impact of these shocks.⁴²



³⁵ Beggs and Bambrick (2005).

³⁶ Brockmeyer and D’Angiulli (2016).

³⁷ Park, Behrer, and Goodman (2021).

³⁸ Currie et al. (2009).

³⁹ Mueller and Quisumbing (2011).

⁴⁰ Mueller and Osgood (2009).

⁴¹ Little et al. (2006)

⁴² Diallo (2022).

Adults also suffer increased workloads from climate disasters, with different impacts on men and women. Men usually have more work during extreme events (for instance, protecting dikes and dams; harvesting flood crops; and participating in search, rescue, and evacuation), whereas women's workload usually increases before the events (helping with disaster preparedness, such as protecting seedlings and crops in the fields) and after the events (caring for children, the sick, and the elderly). These traditional roles are being challenged, however, because of seasonal outmigration among men. In India, more women than men work as wage laborers to compensate for crop losses, while in Tanzania, wealthier women hire poorer women to collect animal fodder during droughts.⁴³

Overall, climate shocks have a disproportionate impact on women's well-being. On average, natural disasters, such as droughts, floods, and storms, kill more women than men and tend to kill women at a younger age. Analysis in 141 countries between 1981 and 2002 showed that the gender-gap effects on life expectancy tend to be greater in more severe disasters and in places in which the socioeconomic status of women is particularly low.⁴⁴ In Nicaragua, for example, socially determined gender norms dictate that middle-class women are expected to stay in the home even during floods and in risk-prone areas.⁴⁵

Longer-term climate trends also affect poverty and productivity. The relationship between heat and labor productivity is increasingly clear, likely with global implications. In 2021, heat exposure led to 470 billion potential labor hours lost globally among working adults.⁴⁶ Increasing temperatures reduce the availability of workers in industries with high climate exposure such as farming and other outdoor activities.⁴⁷ In South Africa, a study on the long-term impacts of future climate change on labor supply shows the welfare in terms of output per adult drops by 20 percent compared to the baseline case with no climate change.⁴⁸ In Germany, modeling of climate scenarios in 2071 to 2100 suggests that rising temperatures could result in an estimated output loss of between 0.1 percent and 0.5 percent of the gross domestic product (GDP).⁴⁹

Like climate shocks, climate trends have an outsized impact on women's ability to take advantage of economic opportunities. Climate change's impacts reverberate in unequal ways due to women facing systemic disadvantages in access to jobs, income, resources, finance, and information. Droughts, extreme rainfall, and floods reduce women's employment, especially in households where parents have less education.⁵⁰ In India, empirical estimates suggest that flood damages affect female employment more negatively than male employment in the long run.⁵¹ Similar results are found for droughts, showing women's workdays in India fall by 19 percent more than men's when a drought occurs, driven by the former's lack of diversification to the nonfarm sector.⁵² Climate change can also worsen women's time poverty. Household chores such as collecting water and fuel tend to fall on women and girls. Depletion of these resources through land degradation, deforestation, and drought force women and girls to spend more time on household tasks, reducing their time to learn, work, and earn.⁵³

Climate change directly affects adult health and productivity, as temperature and weather changes exacerbate vector-borne and waterborne diseases.⁵⁴ In Taiwan, a study showed how hotter and more humid conditions increased the probability of the working-age population being infected by dengue fever.⁵⁵ Outdoor workers are at a higher risk of vector-borne infections because of their proximity to vector species and habitats, and farmers have

⁴³ Lambrou and Nelson (2013); Muthoni and Wangui (2013).

⁴⁴ Neumayer and Plümpert (2007).

⁴⁵ Bradshaw (2010).

⁴⁶ Romanello et al. (2022).

⁴⁷ Antonelli et al. (2020).

⁴⁸ Shayegh, Manoussi, and Dasgupta (2020).

⁴⁹ Hübner, Klepper, and Peterson (2008).

⁵⁰ Fruttero et al. (2023).

⁵¹ Afridi, Mahajan, and Sangwan (2022); Chowdhury, Parida, and Agarwal (2022).

⁵² Afridi, Mahajan, and Sangwan (2022).

⁵³ UN Women (2009); UNFCCC (2022).

⁵⁴ Malaney, Spielman, and Sachs (2004); Romanello et al. (2022).

⁵⁵ Tseng et al. (2009).

increased exposure to some vector-borne diseases amplified by contamination of drinking water and irrigation supplies by their livestock.⁵⁶ These diseases, such as malaria, reduce productivity through absenteeism as worker hours are lost.⁵⁷ In Côte d'Ivoire, a study showed significant decreased productivity for farm workers infected with malaria, highlighting the correlation between work absenteeism and overall yields and revenues.⁵⁸

Elderly population

The elderly population is vulnerable to climate change given preexisting health conditions and mobility challenges.⁵⁹ Older adults with limited mobility may find it more challenging to evacuate before, during, and after a climate shock. Some older adults, especially those with disabilities, may also need help with daily activities post disaster, making their recovery more difficult. Further, they are more likely to have preexisting health conditions that make them more sensitive to climate hazards and elevate physical and mental health risks. Finally, extreme weather events can cause emotional trauma, and older people with cognitive disabilities can have more difficulty in coping with these events.⁶⁰

Poorer health in the elderly population also makes them less equipped to cope with slow-onset climate change. Aging changes the body's ability to respond to heat. Extreme heat exposure can increase the risk of illness and death among older adults, and heat-related death most often occurs in vulnerable elderly people.⁶¹ Climate change may increase outdoor air pollutants, such as ground-level ozone and particulate matter in wildfire smoke and dust from droughts. Poor air quality worsens respiratory conditions and impedes cognitive functions among older adults who are less able to compensate for these environmental hazards. In South Korea, outdoor air pollution decreased cognitive function, especially among elderly women living in urban areas.⁶²

Section 3 continues by presenting how public policies and programs can protect people from quick-onset climate shocks, build their resilience to longer-term climate trends, as well as build and use human capital to help minimize future climate shocks and change longer-term climate trends.



⁵⁶ Caminade, McIntyre, and Jones (2019); McManus et al. (2010).

⁵⁷ Lukwa et al. (2019).

⁵⁸ Girardin et al. (2004).

⁵⁹ Gamble et al. (2016).

⁶⁰ Dodgen et al. (2016).

⁶¹ Basu and Ostro (2008)

⁶² Kim et al. (2019).

Box 1. Climate change entrenches existing poverty

Poor countries suffer disproportionately from the effects of climate change. They are more exposed to climate risks and have less ability to cope with and recover from them. In the aggregate, vulnerabilities are magnified in developing countries by a host of underlying factors, such as greater incidence of disease, limited infrastructure and services, weak economies, insufficient emergency management, lack of insurance and funds for recovery after disasters, and poorly informed governance and decision-making processes (Bowen and Ebi 2015; Hallegatte et al. 2020).

At the household level, the poor are more exposed to climate shocks due to their location. Poorer households tend to be in locations that are hotter and at greater risk of various climate shocks and trends, due to both poor infrastructure in that area and the location itself. Informal settlements are at risk because of lower-quality infrastructure, unsuitable building designs, and lack of full access to essential services (Hallegatte et al. 2016). In Mumbai, India, evidence illustrates how inadequate infrastructure in low-income neighborhoods worsens flood risks (Patankar 2015). In Vietnam's Mekong Delta, the poor are nearly 10 percentage points more likely than the nonpoor to live in areas that frequently flood (Lam-Dao et al. 2011).

Poor people also are more likely to adopt negative coping strategies. Without savings to draw on, poorer households are more likely to have to cut spending on basic needs and essential consumption (for example, reducing food and health expenditures, withdrawing children from school, sending children to work, and taking on added debt), thus potentially damaging their long-term prospects (UNDP 2016). After the 1998 floods in Bangladesh, affected households living in poverty had to borrow an amount equal to six–eight times the level of government transfers (del Ninno, Dorosh, and Smith 2003).

Climate-induced shocks result in the poor losing a more significant share of income. Consumption losses and recovery times for disaster-affected households vary according to socioeconomic status and the availability of resources. In relative terms, poor people lose more than nonpoor people from floods and storms. In Bangladesh, one study found that poor people lost 42 percent of their household income due to flood damage compared with 17 percent among nonpoor people (Brouwer et al. 2007). A study of Mumbai's 2005 floods suggests that total losses from the event reached 85 percent of the average annual income of the poorest people. These impacts hindered the ability of households to recover their pre-disaster levels of income and consumption (Patankar and Patwardhan 2016).

And climate change is driving up poverty rates. Impacts on agriculture triggered by climate change affect poor people through food production impacts, higher prices, and declines in rural incomes (Hallegatte et al. 2016). In addition, poor nonagricultural and poor urban households, which are net buyers of food, are the most at risk of higher food prices. In a meta-study of 49 cases of food insecurity in southern Africa, Misselhorn (2005) shows that climatic drivers and poverty were the two dominant and interacting causal factors.

SECTION 2:

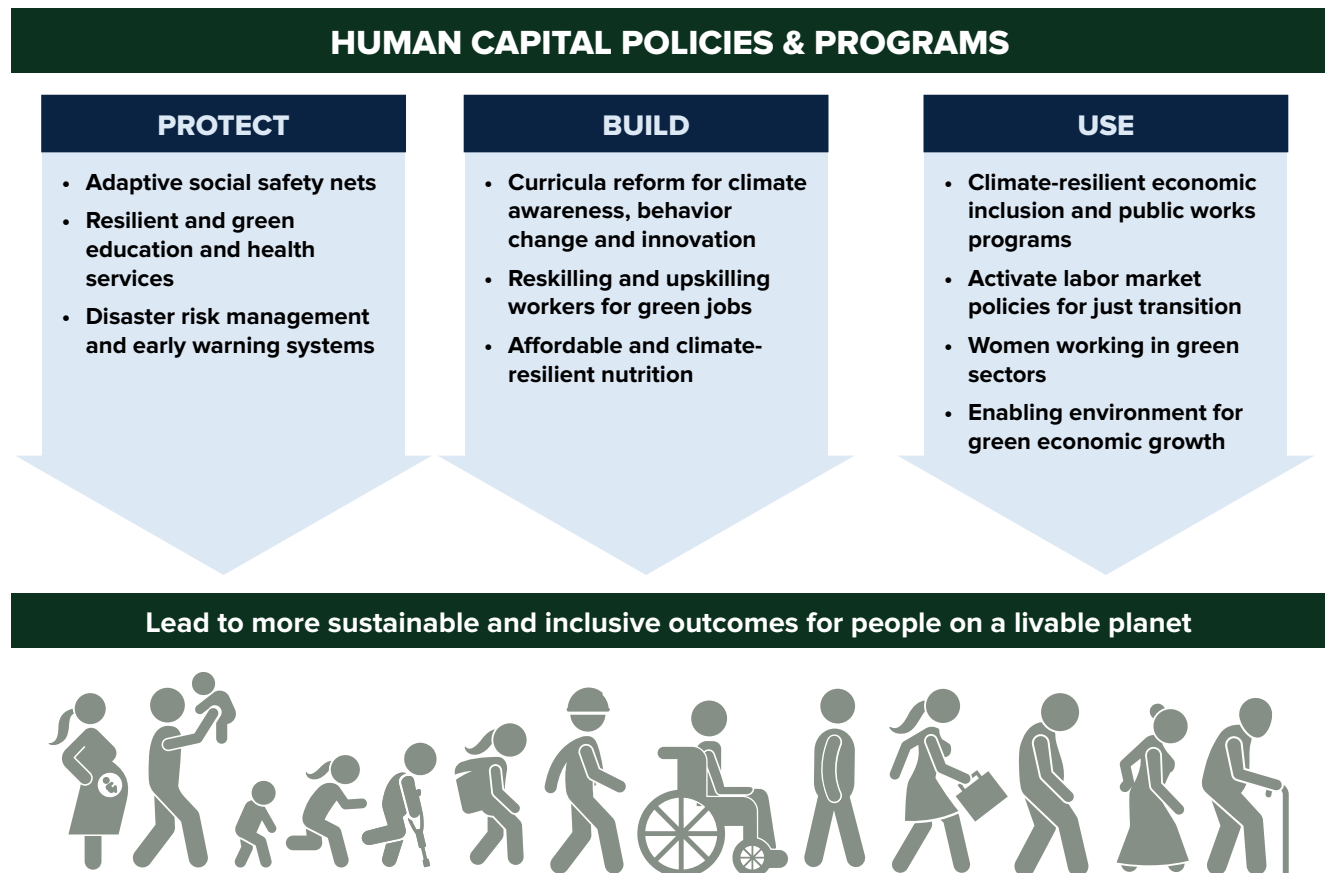
Protecting, Building, and Using Human Capital for Better Climate Outcomes

Investing in human capital can create a virtuous cycle to protect people from the impacts of climate change outlined in Section 1 and to empower them to build and use their human capital for climate action. Policies and investments summarized in Figure 2 protect, build, and use human capital to help deliver more sustainable and inclusive development. These investments cut across the lifecycle with intergenerational impacts that improve people's current well-being and that of future generations.

Policies to protect human capital minimize impacts across all age groups, as discussed in Section 1. They address both the short-term shocks that people face from climate events and promote their resilience to longer-term climate change impacts. In addition to safeguarding gains already realized in health, nutrition, and education, these investments ensure that people have more resources to reinvest in human capital for themselves and their families. This is a key first step in changing the current downward trends of climate change on people to an upwardly reinforcing cycle.

Build and use policies focus more on school-age children, youth, and working-age people to create a positive dynamic between human capital and climate change. These policies aim to prepare people to cope with climate shocks and the medium- to longer-term changes resulting from climate change. Build and use policies equip people to take advantage of new climate opportunities for their jobs and livelihoods, enabling broad participation

Figure 2: Human capital and climate policy and program framework



in creating and managing a green economy and sustaining income, assets, and intergenerational human capital. Green investments in people also reduce climate change itself, preventing further damage to people's health and education across ages and generations.

This section presents effective human capital investments that lessen the climate impacts presented in Section 1, by both improving resilience to climate change today and driving better climate outcomes for tomorrow. Each investment area provides a summary of human capital policies and programs related to climate change and the potential outcomes from effective investment. The *Protect* section also distinguishes between policies and programs to respond to climate shocks as compared to climate trends. The evidence draws on country examples to illustrate concrete actions and results. The section concludes with Box 2 to illustrate how the World Bank could help leverage additional funding for the investments outlined here.

PROTECT

Protecting human capital requires policies and programs that safeguard people's health, food security, education, and earnings from the impacts of climate change. Differentiating between climate shocks and climate trends is most relevant here. Interventions include ensuring that people vulnerable to climate risks are equipped with climate-responsive safety nets; adapting health and education services to be resilient in the face of climate risks; and investing in inclusive disaster risk management (DRM) systems, including early warning systems (EWSs).

Adaptive safety nets to smooth consumption and build resilience of the poor and vulnerable

Adaptive safety nets (ASNs) are noncontributory cash or in-kind transfer programs for poor and vulnerable households to help smooth consumption and buffer against income loss during crises.⁶³ Examples of ASN that protect households from climate impacts include anticipatory transfers, disaster risk financing for households without access to insurance, and public works activities that are shock-responsive by having the systems in place to scale up quickly during emergencies.



⁶³ Del Ninno and Mills (2015).

Cash and in-kind transfers can protect human capital from negative impacts of climate shocks, such as food insecurity and lost income. After a climate shock, transfers can offset income or asset losses, helping prevent households from adopting negative coping mechanisms such as pulling children out of school to help generate income, selling livestock and other assets, and skipping meals, or falling into—or further into—poverty. In Bangladesh, an anticipatory cash transfer delivered to flood-prone households through mobile money resulted in 36 percent less likelihood of those households being food insecure and a significant decrease in asset loss and damage, especially for productive assets, and costly borrowing. Evidence also suggests that three months ex post, households that received the transfer had higher levels of food consumption and higher earning potential compared to the control group.⁶⁴

The effectiveness of ASNs to respond to climate shocks requires investing in systems that can scale up quickly in times of crisis. Social registries collect information from households that may not qualify for regular cash transfers but are vulnerable. For example, Mauritania’s Social Safety Net program provides cash transfers to over 90,000 households on a regular basis, and it also has a social registry with information on 300,000 households that could be vulnerable to shocks. This allowed the Government to reach an additional 70,000 food-insecure households quickly during the 2022 lean season, the worst in a decade.⁶⁵ Digital payment systems, such as in the Bangladesh example above, can also facilitate quick and effective cash transfers in times of crises.

In addition, ASNs can improve resilience against longer-term climate trends and help prevent long-lasting negatives outcomes across the lifecycle. To build resilience to climate trends, ASNs can help increase savings and productive assets, diversify livelihoods, create community assets, and provide health insurance to vulnerable populations. The Sahel Adaptive Social Protection Program leverages cash transfers to reach the poorest households across six Sahelian countries (Burkina Faso, Chad, Niger, Mauritania, Mali, and Senegal) while promoting investments in human capital and productive inclusion to increase the resilience of the poor. Results from Niger show that productive inclusion—which combine regular cash transfers with complementary support, such as trainings or additional financing—demonstrate strong improvements in households’ economic diversification, resulting in greater welfare and food security.⁶⁶ These investments have lasting positive impacts on household health, nutrition, and education, further improving the long-term resilience of groups vulnerable to future climate trends.⁶⁷

Resilient and green service delivery to avoid disruptions to learning and healthcare

Resilient service delivery helps ensure continuity of care of climate-affected people of all ages. Avoiding disruptions in health, education, and training service delivery due to climate shocks or changing how services are delivered to reflect climate trends can have direct benefits on people from early childhood to old age.

Climate-resilient services require infrastructure that withstands climate shocks and responds to slower-onset climate trends. Existing education and health infrastructure, for instance, needs to be updated to withstand climate shocks such as floods or hurricanes, and new facilities should be built to cope with extreme events and located both to avoid areas prone to storms and to consider rising sea levels. Other adaptations to adjust to longer-term climate change include heat-resilient classrooms and health care facilities; improved ventilation to protect against disease vectors and rising air pollution levels; and roads and bridges that are passable for students, patients, and staff during increased rainfall.⁶⁸

But infrastructure is insufficient: resilient services must have flexible modes of delivery and capacity for rapid expansion in times of need.⁶⁹ Flexible delivery may include using virtual learning platforms to facilitate e-learning, moving to temporary learning centers, and leveraging primary health care and community health systems for better surveillance and response, including sufficient emergency stocks, storage facilities, and trained staff. Integrated disaster risk planning, with procurement and implementation plans, enables these responses across systems, as well as tools for disaster risk finance and data and communication such as social registries and monitoring and evaluation systems.⁷⁰

⁶⁴ Pople et al. (2021).

⁶⁵ Social Safety Net System Project II (P171125) Implementation Status and Results Report (June 2023).

⁶⁶ Bossuroy and Premand (2021).

⁶⁷ de Groot et al. (2017); Skoufias, Unar, and Gonzalez-Cossio (2008); Taaffe, Longosz, and Wilson (2017); Zimmerman et al. (2021).

⁶⁸ World Health Organization (2020).

⁶⁹ Newton-Lewis et al. (2021).

⁷⁰ Kagawa (2022).



Countries are successfully implementing climate-ready service delivery systems to help maintain access to education and health care in the face of climate shocks, with broad and long-term impacts on human capital outcomes. For example, the Philippines implemented a program to improve the infrastructure of secondary schools given the risks from typhoons. The school infrastructure program almost entirely mitigated the negative effect of typhoons on educational attainment and had positive returns on years of schooling and labor market outcomes such as the likelihood of working in a high-skilled occupation or in the nonagricultural sector, reflecting benefits at later stages in the human capital lifecycle.

The same is true in preparing for longer-term climate trends, such as minimizing the health impacts of rising temperatures. In Ahmedabad, India, extreme heat in 2010 inspired city leaders to develop a Heat Action Plan. Interventions included using ‘cool roofs’ to reduce temperatures inside health facilities and moving neonatal units to cooler hospital first floors to reduce heat-related illness, particularly among newborns. The plan integrated several components that went beyond infrastructure, including increasing public awareness, initiating an EWS, and building capacity for health care professionals that resulted in city-wide reductions in heat-related morbidity and mortality. Overall, it is estimated that this planning has averted an estimated 1,190 deaths every year over the last decade and has encouraged other Indian cities to develop Heat Action Plans.⁷¹

Integrating climate resilience into school infrastructure and curricula can also protect education outcomes. Nigeria’s Adolescent Girls Initiative for Learning and Empowerment (AGILE) invests in constructing climate-resilient, energy-efficient, and eco-friendly schools with adaptations such as rainwater harvesting structures to assist with both climate shocks such as floods and long-term climate trends related to water availability. At the same time, the program provides digital literacy and remote learning so that schooling can continue during climate shocks. In addition, it uses schools as a platform to teach about climate change and help students and teachers alike adopt climate-friendly behavior through eco-clubs and climate champions.⁷²

In addition, investing in upgrading health and education facilities can contribute to national targets for GHG emission reductions. If health care were a country, it would be the planet’s fifth largest emitter.⁷³ In total, it accounts for between 4 and 5 percent of global GHG emissions. Health care supply chains make up 70 percent of this total, and addressing this is vital for decarbonization.⁷⁴ Education contributes a smaller but still significant 2–3 percent of global emissions.⁷⁵ Given the scope of education and health services within most national budgets and infrastructure systems, these two sectors represent a significant opportunity for reducing national carbon footprints.

⁷¹ Hess et al. (2018); Natural Resources Defense Council (2016).

⁷² World Bank Group. 2020. <https://documents1.worldbank.org/curated/en/613581596247523870/pdf/Nigeria-Adolescent-Girls-Initiative-for-Learning-and-Empowerment-Project.pdf>; World Bank Group (2023). <https://blogs.worldbank.org/nasikiliza/changing-lives-adolescent-girls-through-learning-and-empowerment>.

⁷³ Health Care Without Harm (2019); Rodríguez-Jiménez et al. (2023).

⁷⁴ Health Care Without Harm (2021).

⁷⁵ World Bank (2023).

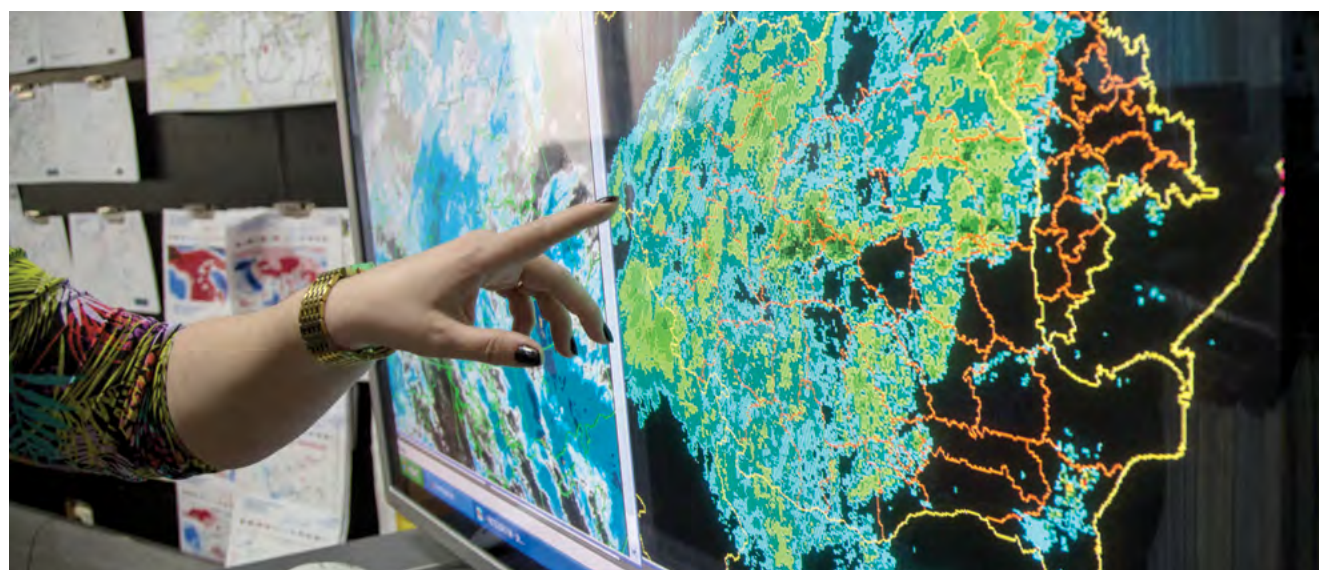
Climate-smart health and education systems capitalize on the dual benefits of decarbonizing and improving resilience. Creating zero-emissions buildings and infrastructure can include adopting features like natural ventilation, solar shading, and rainwater management. It can also involve using telehealth and e-learning technologies. Renewable energy sources, such as solar, wind, and thermal energy, backed up by robust microgrids and battery storage, not only slash carbon footprints but also help maintain service delivery amid climate shocks and trends.⁷⁶ Many low-carbon approaches also provide health benefits such as reduced respiratory infections from less air pollution and lower infectious disease risk from improved sanitation and ventilation.⁷⁷

Disaster risk management tools to minimize negative impacts of climate shocks

By creating systems to predict, prepare for, and respond to quick-onset climate shocks, DRM helps protect people from their worst impacts. These losses include increased mortality and morbidity, infrastructure destruction, and financial costs. Emergency preparedness can include contingency measures to address droughts, flooding, and heatwaves such as EWSs, relocation centers, climate insurance, or national emergency preparedness plans at the national, subnational, or facility levels.

At the community level, EWSs help predict and prepare for climate events or health risks. An essential part of DRM, EWS may include hydrological and meteorological (hydromet) services that look at weather variability, seasonal changes, or extreme events. EWS also supports disease surveillance to monitor for seasonal outbreaks of dengue or cholera.⁷⁸ Yemen's national electronic Disease Early Warning System (eDEWS) was critical to detecting and alerting health authorities of cholera outbreaks between 2016 and 2018 despite the ongoing conflict.⁷⁹

At the household level, a robust DRM system helps ensure that even the poorest and the most vulnerable can use savings and access rapid support to restore assets, income, and livelihoods.⁸⁰ In Morocco, the World Bank-financed Integrated Disaster Risk Management and Resilience Program uses disaster-risk financing and insurance components to provide financial protection for households to enable them to recover from catastrophic events. The insurance scheme provided pre-planned financial protection to more than 6 million people—more than 18 percent of Morocco's population—who became permanently injured or died or had their assets destroyed because of a catastrophe.⁸¹



⁷⁶ Health Care Without Harm (2021).

⁷⁷ World Bank (2017).

⁷⁸ Rentschler et al. (2021).

⁷⁹ Dureab et al. (2019).

⁸⁰ Hallegatte, Rentschler, and Walsh (n.d.).

⁸¹ GFDRR (2023).

BUILD

Building human capital moves from the foundation of protecting people from climate change to investments to realize people's potential to contribute to climate action and a green economy. These investments cut across the lifecycle from affordable and climate-resilient nutrition to new curricula on climate knowledge and climate-friendly behaviors for younger generations as agents of change to reskilling and upskilling working-age adults already in the labor market.

Curricula reform to promote foundational knowledge of children and behavior change at all ages

Education is key to improving people's awareness of climate risks and helping shift their behaviors to mitigate its effects across generations. Increasing educational attainment broadly is linked to better climate behaviors. In Europe, legal reforms taken between 1960s and 1980s to promote compulsory education in certain countries to improve educational attainment and showed a causal increase in pro-climate beliefs among present-day adults by 6.3 percent and an increase in pro-climate behaviors by nearly 9 percent.⁸² Furthermore, tailored environmental education programs can magnify positive behaviors. Meta-analysis of 169 studies on children and adolescents across 43 countries found that environmental education significantly improved environmental knowledge, attitudes, intentions, and self-reported behavior.⁸³

Incorporating soft skills, such as problem solving, into curricula reform can prepare graduates to help create innovative solutions to climate challenges. Transitioning to greener methods of production, including goods and services in traditional economic sectors, requires innovative thinking and problem solving. High- and medium-skilled workers in green jobs display higher-level cognitive skills, as well as higher levels of formal education and on-the-job training, compared to workers in non-green sectors.⁸⁴ Knowledge around sustainability and climate risks together with innovation skills can support the development of local solutions that ultimately create greener jobs.

Children's education is also a channel for intergenerational knowledge transfer and behavior change among adults. Research shows that school-age children can be active agents of change in disseminating information across communities on social and climate-related risks through their access to information from schools, media, and technology.⁸⁵ A study among youth in the United States found that teaching youth about global warming increased concerns of climate change among parents, with girls being more effective in influencing parents.⁸⁶ Educating children, therefore, has the dual effect of creating a climate-conscious future generation and creating motivation for parents to effect change immediately.

With thoughtful planning, the green transition is an opportunity to focus on girls' education to reduce economic gender gaps in the labor market.⁸⁷ A recent study found that only 62 women for every 100 men are considered to have explicit skills in green technology (renewable energy, solar energy, or power distribution) that make economic activities more environmentally sustainable, a figure that has remained stagnant since 2015.⁸⁸ Social norms and attitudes toward girls' education in these fields can act as a barrier, but climate change's disruption and demand for action present an opportunity to use education to upend stereotypes in science, technology, engineering, and mathematics (STEM) fields. In Ghana, female participation in STEM at tertiary institutions rose from 12 to 15 percent after clinics were set up to help female secondary students participate in STEM.⁸⁹ In Türkiye, an all-girls STEM program called Girls Meet Science provided female STEM mentors to young girls from disadvantaged socioeconomic groups and led to increased interest in STEM careers.⁹⁰

⁸² Angrist et al. (2023).

⁸³ van de Wetering et al. (2022).

⁸⁴ Consoli et al. (2016).

⁸⁵ Tanner (2010).

⁸⁶ Lawson et al. (2019).

⁸⁷ Kwauk and Braga (2017).

⁸⁸ LinkedIn (2022).

⁸⁹ Bermingham and Engmann (2012).

⁹⁰ Yabas et al. (2022).



Reskilling and upskilling young and working-age people for green jobs

A green transition requires building new skills among young people and adults to engage and evolve with the green economy. IFC analysis suggests that climate business could generate 213 million jobs in emerging-market economies between 2020 and 2030.⁹¹ But to capitalize on this, the labor force must be well equipped with the skills to make the green transition possible. A recent study by LinkedIn analyzing vacancies in 43 middle- and high-income countries indicates the proportion of job advertisements requiring green skills (in renewable or solar energy) grew by 23 percent between 2022 and 2023, but the share of those with green skills increased by only 12 percent.⁹²

Powering the green transition requires policy interventions to overcome the mismatch between the demand for new skills and gaps in current public and private training programs. Skilling may range from on-the-job training to help workers transition across sectors or establishing new tertiary education programs and curriculums within technical and vocational education and training (TVET) institutions to meet the needs of the future labor market. In Malaysia, the TVET sector developed a new curriculum on topics such as energy efficiency, energy measurement and instrumentation, and renewable energy to upskill the labor supply for green jobs.⁹³ In India, the Skills Council for Green Jobs identified the skills needs for renewable energy, transport, waste management, construction, and water management. The Skills Council also built credibility for new green training modules by integrating them into the National Skills Qualification Framework.⁹⁴

Labor market analysis of green industries can inform reforms needed within skills training programs and which types of skills could spark higher levels of job creation. Across various countries in the Middle East and North Africa, the World Bank is partnering with governments to look at employment in renewable energy and energy efficiency. Analysis in the Arab Republic of Egypt and Morocco shows that careful planning for these energy transitions could increase the annual job creation in these industries, particularly from investing in innovations that improve the installation of clean energy systems. In addition, the research shows potential multiplier effects across the economy and labor market more broadly from household energy cost savings as green energies become more cost-effective.⁹⁵

Reskilling and upskilling in agriculture and aquaculture are key to ensure that people across all skill levels have access to jobs that promote better climate outcomes. Kenya's Climate Smart Agricultural Project aims to improve agricultural productivity and build resilience to climate change by reskilling smallholder farmers to adopt new climate-smart technologies. As of April 2023, the project supported more than 400,000 beneficiaries to adopt at least one modern agricultural technology, innovation, and management practice to access markets and a range

⁹¹ International Finance Corporation (2021).

⁹² LinkedIn (2023).

⁹³ Pavlova (2019).

⁹⁴ Pavlova (2019).

⁹⁵ World Bank MENA Energy (2022a, 2022b).

of agro-weather and advisory services.⁹⁶ With support from the World Bank, the Maldives is working to protect its marine ecosystems through more sustainable waste management systems while developing a new cadre of workers for sustainable jobs and entrepreneurship opportunities. The programs are strengthening waste-related curricula for supervisory and policy professionals, providing essential vocational skills and training for youth just entering the job market, and offering a ‘Waste to Wealth’ certificate course. Notably, the program provides green jobs to people across a range of skill sets and across formal and informal sectors.

Affordable and climate-resilient nutrition for healthier children and adults

High-return investments in nutrition can help reduce climate impacts for young children and mothers with long-lasting effects on physical and cognitive development.⁹⁷ These include nutrition-specific (for example, micro-nutrient supplementation and fortification for children, promotion of optimum breastfeeding and complementary feeding practices, and emergency nutrition)⁹⁸ and nutrition-sensitive (for example, agriculture and food security, water, sanitation, and hygiene)⁹⁹ interventions that address the underlying causes of malnutrition as well as broader constraints to promoting better nutrition outcomes.¹⁰⁰ While these are particularly relevant in times of climate shocks that increase food insecurity, not all of these interventions are available in areas of current need or where climate change may increase future demand. For example, the use of high-nutrient ready-to-use therapeutic foods (RUTF) has demonstrated impacts to prevent or treat malnutrition by ensuring food security in the context of quick-onset climate shocks, but local availability of ingredients often limits production.¹⁰¹ Pakistan has been successful in producing its own RUTF based on locally sourced food, which has enabled more accessibility and cost-effectiveness to provide climate-smart nutrition to vulnerable groups.¹⁰²

In the face of longer-term climate impacts, improving food security requires climate-resilient agriculture that promotes better nutrition outcomes.¹⁰³ Integrating climate-smart agricultural practices such as planting two or more crop types simultaneously, using improved seeds and fertilizer, crop rotation, and reduced tillage can help support climate resilience and increase the production of high-nutrient crops. In Zambia, an evaluation of climate-smart agriculture found that legume intercropping significantly increased yields and reduced the probability of low yields even under critical weather stress during the growing season.¹⁰⁴



⁹⁶ Kenya Climate Smart Agriculture Project (P154784) Implementation Status & Results Report (June 2023).

⁹⁷ Tirado et al. (2013).

⁹⁸ Ruel and Alderman (2013).

⁹⁹ Ruel and Alderman (2013).

¹⁰⁰ See The Lancet (https://www.thelancet.com/pb/assets/raw/Lancet/pdfs/nutrition_4.pdf) and Scaling Up Nutrition.

¹⁰¹ Tirado et al. (2013).

¹⁰² Testa, Polese, and Barile (2023).

¹⁰³ Tirado et al. (2013).

¹⁰⁴ Arslan et al. (2015).

USE

Effective use of human capital requires policies that overcome the constraints that climate change poses to livelihoods, jobs, and incomes, as well as policies that help men and women find greener jobs. The transition across sectors may produce a skills mismatch, an important obstacle to the greening economy. Further, the transition may be concentrated geographically, posing difficulties for workers who lack geographic mobility, potentially resulting in diminished wages in their new roles. Climate-resilient economic inclusion and public works programs help poor and vulnerable workers have better and greener job opportunities. Active labor market policies help youth and working-age people more broadly not only transition away from brown jobs but also help encourage new green industries. Ensuring that climate policies are gender sensitive can foster a successful and inclusive green transition. Policies for green growth, research and development, and innovation also empower people in ways that spur greening the global economy.



Climate-resilient economic inclusion programs and green public works for vulnerable workers

Climate-resilient economic inclusion programs invest in low-skilled youth and working-age people to diversify their livelihoods and to use their human capital in more resilient employment opportunities. Economic inclusion programs boost the income and assets of poor people through coordinated support such as coaching, skills training, access to finance, and linkages to markets. With an emphasis on climate resilience, these programs can help vulnerable groups develop new practices for climate-smart agriculture or support households to diversify income by developing off-farm self-employment skills, such as petty trade, shopkeeping, or other entrepreneurial activities. In Rwanda, an integrated approach to managing cropland, livestock, forests, and fisheries addresses the interlinked challenges of marginal rural livelihoods and climate-smart agriculture, while increasing productivity in irrigated areas tenfold.

Green public works programs also benefit vulnerable populations, helping to both mitigate the impacts of climate change and provide temporary employment opportunities. Green public works programs may integrate community rehabilitation schemes such as watershed and soil conservation, reforestation programs, and rainwater management. They also support people to diversify or transition into less emissions-intensive work and can help ecosystem transitions by encouraging conservation, restoration, and natural resources management. The Productive Safety Net Program in Ethiopia was able to increase tree coverage in participating districts by 3.8 percent, equivalent to 4.16 million metric tons of annual negative CO₂ emissions, by providing temporary employment through the public works component, for up to 6.8 million people over a 15-year period.¹⁰⁵ The program exemplifies how human capital can be used to drive better climate outcomes.

¹⁰⁵ Hirvonen et al (2022).

Labor market policies to support an inclusive, just transition

Active labor market policies (ALMPs) can facilitate people's transitions to greener jobs, helping promote better and more sustainable earnings and incomes. Climate change is changing the job market in myriad ways. First, through climate shocks, it can disrupt people's jobs and livelihoods. Second, national and global targets for decarbonization are eliminating so-called brown jobs, such as those in the coal sector. Without adequate skills to transition toward green jobs, lower-skilled workers may become unemployed and find employment in low-productivity, unregulated, low-skilled services. And third, the development of green industries, such as renewable energy or water and waste management, is creating new job opportunities for current and future workers.

ALMPs can help build resilience to climate shocks and longer-term climate trends by minimizing their impacts on people's earnings. DRM and ASNs discussed in the Protect section play an important role in offsetting lost earnings during climate shocks. ALMPs can complement these investments, helping create resilience before such events, particularly for workers whose livelihoods depend on agriculture or natural resources. The Philippines Green Jobs Act enacted in 2016 includes developing an unemployment insurance system to support workers affected by structural change resulting from climate change and the transition toward a greener economy.¹⁰⁶

ALMPs are also critical in realizing a just transition away from brown jobs. To minimize scarring from job losses, there is a need for policies that help workers through these losses and transition into alternative jobs.¹⁰⁷ ALMPs may include the provision of unemployment benefits, public employment services, job search assistance, mobility grants, or hiring subsidies. In Poland, the World Bank employed a machine learning tool to help identify transferrable skills and potential job transition pathways for coal mine workers, building on international best practices to develop guidelines for tailored support packages to ease the transition of the affected people.¹⁰⁸

As noted in the *Build* section, the transition to a greener economy will create opportunities for more and better jobs too, and ALMPs can help prepare workers to meet this labor demand. Public employment services, job search assistance, and hiring subsidies will be important instruments. Skills for new industries also will be critical. The nature of the transformation of the industry will need to be country specific, and evidence-based analysis can inform the design of specific policies to help workers most effectively. In China, the World Bank is supporting research on the challenges and opportunities of a green and low-carbon transition on jobs and the labor market including investigating the transition costs and cost-sharing mechanism for a just transition.¹⁰⁹

Gender-sensitive investments for women to work in the green economy

Breaking social norms and barriers to women's economic participation in the labor market is fundamental to ensure that 'all hands are on deck' in transitioning to a greener economy. As an essential catalyst to climate action, women's empowerment and leadership are associated with better resource governance, conservation outcomes, disaster readiness, and the adoption of more climate-friendly decisions in the private sector.¹¹⁰ Women's global labor force participation rate is under 47 percent compared to 72 percent for men, and sectors likely to see green job growth tend to have even lower levels of participation by women. Discriminatory laws and social norms; biased hiring practices; lack of access to mentoring, networking, or training opportunities; lack of preventative measures against workplace sexual harassment; and inflexible childcare policies all present obstacles to women's ability to join the workforce and pursue different types of jobs, with spillovers that limit their engagement in climate opportunities.¹¹¹

An increasing number of governments are integrating gender equality goals into their climate change policies and frameworks, complemented by programs that support both women's economic empowerment and climate action. Costa Rica was the first country among 12 tropical countries engaged in REDD+ to establish rewards for

¹⁰⁶ Sharpe and Martinez-Fernandez (2021).

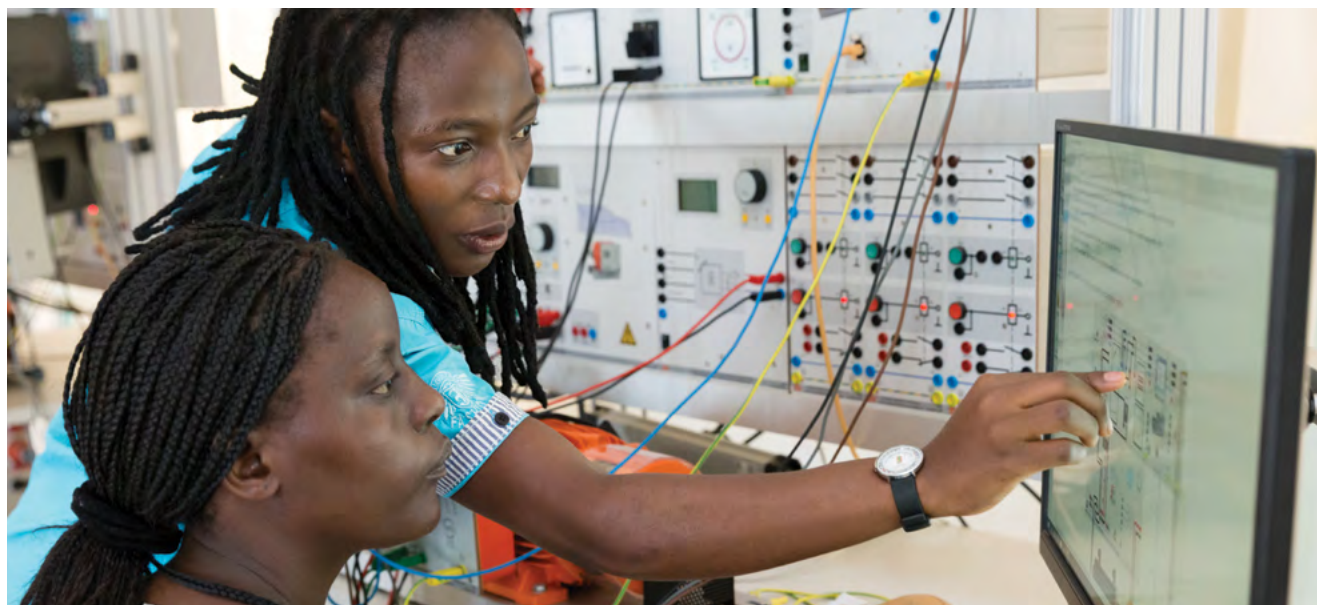
¹⁰⁷ Bowen and Kuralbayeva (2015).

¹⁰⁸ Christiaensen et al (2022).

¹⁰⁹ World Bank Group. China Labor and Social Protection Reform Programmatic ASA FY23-25. <https://opswork.worldbank.org/home/P180156>.

¹¹⁰ Altunbas et al. (2021).

¹¹¹ Deininger et al. (2023).



women conservationists, recognizing the leading role that women play in natural resource management.¹¹² Several other programs in Costa Rica also link women's income generation and livelihood improvements to conservation and sustainability efforts to protect the country's forest areas. In Tajikistan, the World Bank-supported Rural Electrification Project aims to increase women's participation in green electrification, such as solar photovoltaic (PV) and small hydro, wind, and battery energy storage systems. It focuses on access to electricity and income-generating opportunities for households led by women, collaboration with energy companies focused on making human resources policies more gender inclusive, providing career development workshops and trainings to women employees, and raising awareness around unconscious gender bias.¹¹³

Human capital to promote research and development and to catalyze green economic growth

Research and development that can create future green employment opportunities and fight climate change requires people with climate knowledge and skills. Research and development for climate action can include measures to lower energy consumption and minimize ecosystem impacts, eco-marketing, or use of environmental management systems in the production of goods and services. Innovation and entrepreneurship play an essential role in greening production and in climate change adaptation and mitigation solutions. The Indonesia Green Entrepreneurship Program (IGEP), funded jointly by the Republic of Korea and the International Labour Organization, aims to promote an enabling environment and dialogue on green entrepreneurship complemented by tools for universities and business development services to support green entrepreneurs with a 'Start Your Green Business' toolkit and training.¹¹⁴

People also need to use their human capital to create economic policies that promote environmental protection and green innovation.¹¹⁵ Establishing guidelines and standards on sustainability can have upstream effects on the demand for labor equipped with green skills, or downstream effects on how green human capital can improve firm performance. In South Africa, a study on the automobile manufacturing sector found that firms that skilled their workforce with increased innovation and training programs on environmental innovation adoption positively influenced circular economy practices in supply chain management, quality assurance, and remanufacturing operations, resulting in a significantly positive effect on firm performance.¹¹⁶

¹¹² The Warsaw Framework for REDD+ was adopted by COP19. 'REDD' stands for 'reducing emissions from deforestation and forest degradation in developing countries. The '+' refers to additional forest-related activities to protect the climate, including sustainable forest management and forest carbon stocks.

¹¹³ Deininger et al. (2023).

¹¹⁴ Indonesian Green Entrepreneurship Program (IGEP) | Green Growth Knowledge Partnership (n.d.).

¹¹⁵ Platform for Advancing Green Human Capital (2017).

¹¹⁶ Bag and Gupta (2019).

Box 2. The World Bank, climate financing, and human capital

The scale of needed climate financing is massive: the United Nations Conference on Trade and Development (UNCTAD) estimates a need for US\$1.7 trillion annually in developing countries just for renewable energy. But, in 2022, they attracted only US\$544 in foreign direct investment for clean energy (UNCTAD 2023). Meeting these needs requires new resources and improving efficient allocation and delivery of existing resources.

Increasing the available financing

The World Bank and international community are working to increase funding available for climate change. The World Bank Group is the largest financier of climate action in developing countries, providing over \$31.7 billion in fiscal year 2022. Scaling Climate Action by Lowering Emissions (SCALE) and Enhancing Access to Benefits while Lowering Emissions (EnABLE) comprise a new multi-donor trust fund focused on enhancing access to international carbon markets and ensuring inclusion of marginalized communities and disadvantaged groups in those programs. Other trust funds initiatives include Bio-Carbon Initiative for Sustainable Forest Landscapes (Bio-ISFL), the Carbon Initiative for Development (Ci-Dev), and the Forest Carbon Partnership Facility (FCPF). The Crisis Response Window (CRW) provides International Development Association (IDA) countries with additional resources that can help respond to severe natural disasters, such as the floods and droughts in Malawi in 2015 and 2016 that devastated the agricultural sector and pushed vulnerable households into poverty.

Crowding in private sector finance will be key in reaching the necessary scale of climate investments. In Vietnam, the World Bank supported a US\$50 million Emission Reduction-Linked Bond that leverages Verified Carbon Units for private sector investment to pay for 300,000 water purifiers and distribute them to schools. These will make clean water available to around two million children and—by avoiding traditional methods of boiling water—also reduce carbon dioxide emissions by almost 3 million tons over five years (World Bank 2023).

Improving the efficiency of current spending

Countries must also look internally to reallocate current spending toward climate-smart investments. Increasing the efficiency of domestic resource allocation can help. In Indonesia, three rounds of fuel subsidy reform helped create the fiscal space for financing a massive expansion of poverty-targeted programs such as cash transfers reaching 10 million poor households—about 28 percent of the country's poor. The World Bank can help countries identify possible reform areas through Public Expenditure Reviews and Human Capital Reviews.

But the financing itself is not enough: countries need the systems to deliver resources in times of crisis. The World Bank has various tools that help countries prepare with the mechanisms needed to react quickly. At the macro level, the World Bank also offers Disaster Risk Financing through the Catastrophic Deferred Drawdown (Cat DDO), which is a contingent financing line that provides immediate liquidity while funds from other sources are mobilized (World Bank 2018). At a program level, the Contingency Emergency Response Component (CERC) is embedded in World Bank operations as a contingent finance mechanism. In 2021, the World Bank activated CERCs under two existing operations to redirect financing quickly to 70,000 vulnerable households affected by drought in Madagascar (World Bank 2021).

SECTION 3:

Conclusion

To respond to climate change effectively, human capital needs to be at the heart of policy responses. This policy note demonstrates the impacts of climate change across the lifecycle and provides a framework of policy and program interventions to protect, build, and use human capital to minimize climate change impacts and create opportunities for more sustainable and inclusive development on a livable planet. By demonstrating the scope of impacts of climate change on people and people's potential to contribute to climate action, the note also makes a case for prioritizing human capital investments as part of countries' Nationally Determined Contributions (NDCs) and other climate strategies.

Countries must customize their response to human capital investments for better climate outcomes based on their specific context. A country's income level, human capital outcomes, existing basic service delivery systems, levels of greenhouse gas (GHG) emissions, and exposures to different climate shocks and trends will inform the policy and program investments needed. Country-specific analysis can build an evidence base to determine which of these policies are most critical, given underlying and changing realities. Figure 3 outlines how human capital investments contribute to the adaptation and mitigation goals typical of NDCs, the climate pledges that countries make toward the Paris Agreement.

Figure 3. Investing in people empowers them to contribute to climate action



Countries that are more vulnerable to climate impacts but contribute less to GHG would likely prioritize adaptation-focused policy agendas. Adaptive capacity means the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change. People's adaptive capacity is strengthened by protecting health, education, and social safety net services during crisis periods, protecting income stability and increasing diversification, building skills to learn and use climate-smart practices, and using human capital in green public works and to promote productive inclusion.

Countries with higher GHG emissions may prioritize just transition and climate mitigation policies. Climate mitigation is the limiting or removal of GHG emissions to reduce the rate of climate change. A just transition away from GHG emitting industries requires policies and programs, such as job search assistance, mobility grants, or hiring subsidies, to ensure that people can use their human capital in alternative jobs, despite losses in brown industries. Human capital also promotes the use of healthy, skilled, and capable people to harness opportunities afforded by climate mitigation to promote a green and inclusive economy through innovation and technology.

Elevating human capital investments in the climate agenda creates a virtuous cycle, shifting the emphasis from people as victims of climate change to agents of climate action. Human capital investments contribute to the capacity to adapt to climate change, as well as the effectiveness of mitigation actions. Through protecting, building, and using human capital, people are better off in the face of climate shocks, more resilient to longer-term climate trends, and empowered to contribute to a better climate future.

Human capital ensures that healthy, educated, and empowered people can deliver sustainable and inclusive development on a livable planet.



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