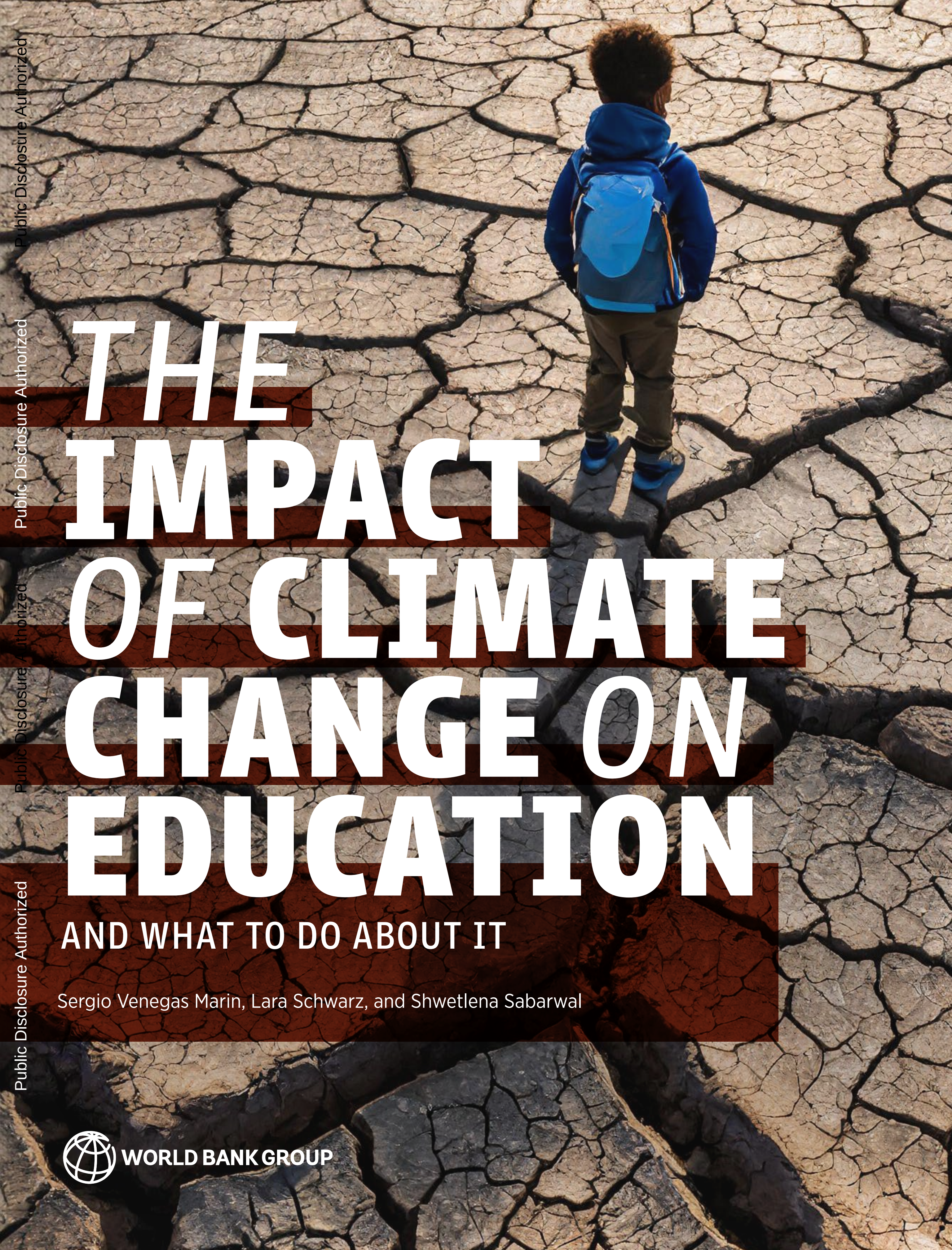

THE IMPACT OF CLIMATE CHANGE ON EDUCATION

AND WHAT TO DO ABOUT IT

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THE IMPACT OF CLIMATE CHANGE ON EDUCATION

AND WHAT TO DO ABOUT IT[1]

Sergio Venegas Marin, Lara Schwarz, and Shwetlena Sabarwal[2]

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[1] *Note:* This is the first part of the forthcoming global report on *Learning to Propel Climate Action* (June 2024). The second part of the report will discuss how the education sector can serve as a powerful catalyst for climate change mitigation and adaptation through mindset and behavior change, green skills, and innovation.

[2] This work has been done under the guidance of Luis Benveniste, Harry Patrinos, and Halil Dundar. We would like to thank Diego Ambasz, Marla Spivack, Noam Angrist, Anshuman Kamal Gupta, Surayya Masood, Devika Singh, Natasha Ahuja, and Debi Spindelman for their inputs and comments. The team received helpful feedback from Syud Amer Ahmed, Juan Baron, Pedro Cerdan-Infantes, Gabriel Demombynes, James Gresham, Julia Liberman, Craig Meisner, Meskerem Mulatu, Norbert Schady, Monica Yanez Pagans, and Penny Williams.

CONTENTS

SUMMARY

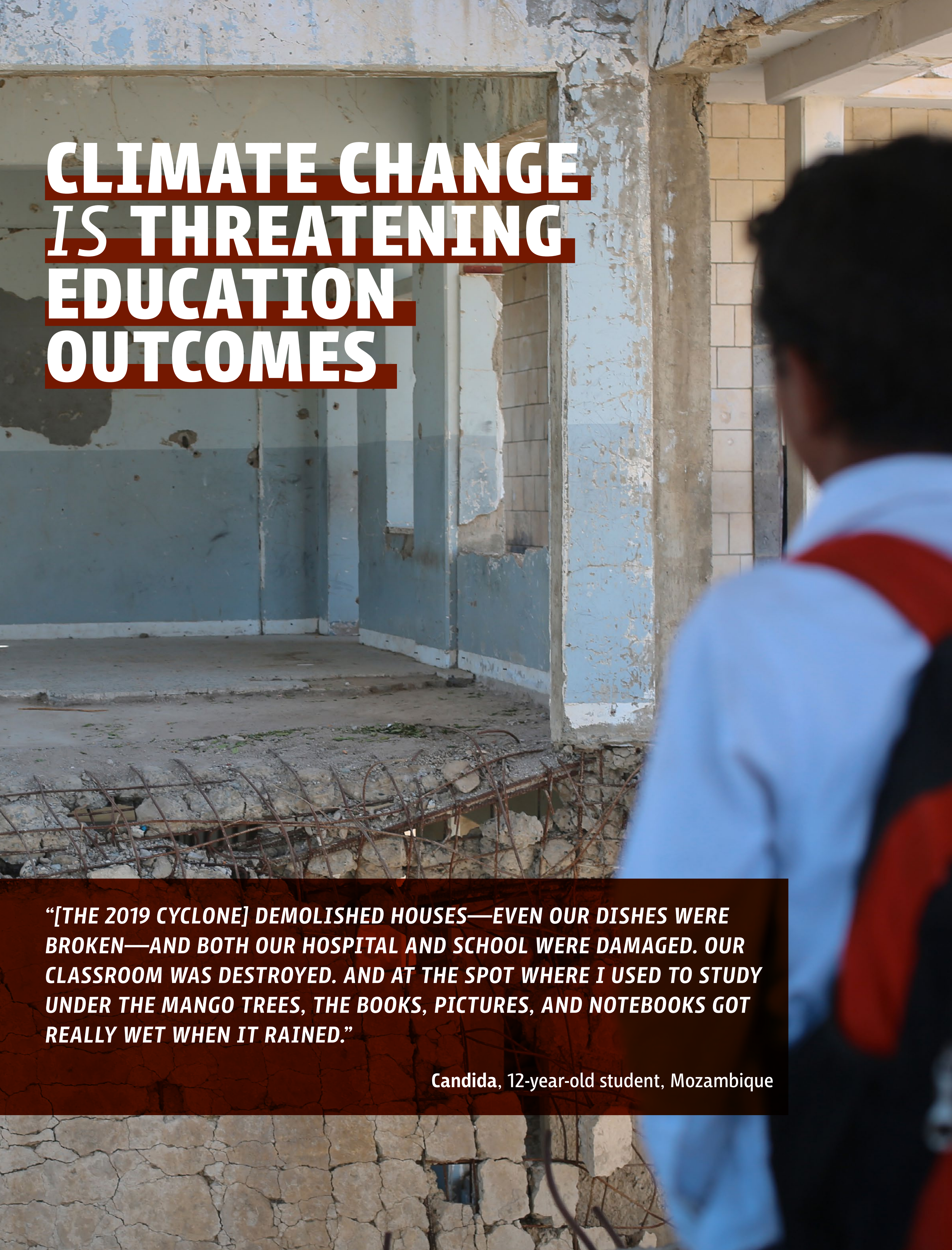
Education can be the key to ending poverty in a livable planet, but governments must act now to protect it. Climate change is increasing the frequency and intensity of extreme weather events such as cyclones, floods, droughts, heatwaves and wildfires. These extreme weather events are in turn disrupting schooling; precipitating learning losses, dropouts, and long-term impacts. Even if the most drastic climate mitigation strategies were implemented, extreme weather events will continue to have detrimental impacts on education outcomes.

Climate change is causing massive school closures. A 10-year-old in 2024 will experience twice as many wildfires and tropical cyclones, three times more river floods, four times more crop failures, and five times more droughts over her lifetime in a 3°C global warming pathway than a 10-year-old in 1970. Over the past 20 years, schools were closed in around 75 percent or more of the extreme weather events that impacted 5 million people or more. These closures were often prolonged due to infrastructure vulnerability and the use of school infrastructure for emergency sheltering. Rigorous evidence from COVID-19 shows that, on average, a day of school closures is a day of learning lost.

At the same time, rising temperatures are also inhibiting learning. A school day under extreme heat is a day in which some learning is lost. While the size of the impact remains uncertain and highly context specific, temperatures that are very high or deviate significantly from local trends do precipitate learning losses. Heat-related learning losses may appear unremarkable when looking at changes in average temperatures over time. However, detailed new analysis shows that even the small learning impacts of slowly increasing temperatures could amount to significant cumulative losses over time, especially for those in hotter regions.[3] Students in the hottest 10 percent of Brazilian municipalities, lost about 1 percent of learning per year due to increasing heat exposure. This would mean that an average student would lose between 0.66-1.5 years of learning due to rising temperatures. Together these effects will lead to significant learning losses which will turn into significant income losses, lower productivity, greater inequality, and possibly greater social unrest.

Despite these catastrophic consequences, education remains overlooked in the climate policy agenda. Education made up less than 1.3 percent of climate-related official development assistance in 2020 and mentioned in less than 1 in 3 Nationally Determined Contribution plans. This paper lays out four concrete ways in which governments can protect education systems from climate change so that their positive impacts on economic development, poverty alleviation, and social cohesion can be sustained and boosted. These are: (i) education management for resilience; (ii) school infrastructure for resilience; (iii) ensuring learning continuity in the face of climate shocks; and (iv) leveraging students and teachers as change agents. The paper presents an actionable agenda for each of these with operational examples in different contexts.

[3] Schady et al., forthcoming



CLIMATE CHANGE *IS* THREATENING EDUCATION OUTCOMES

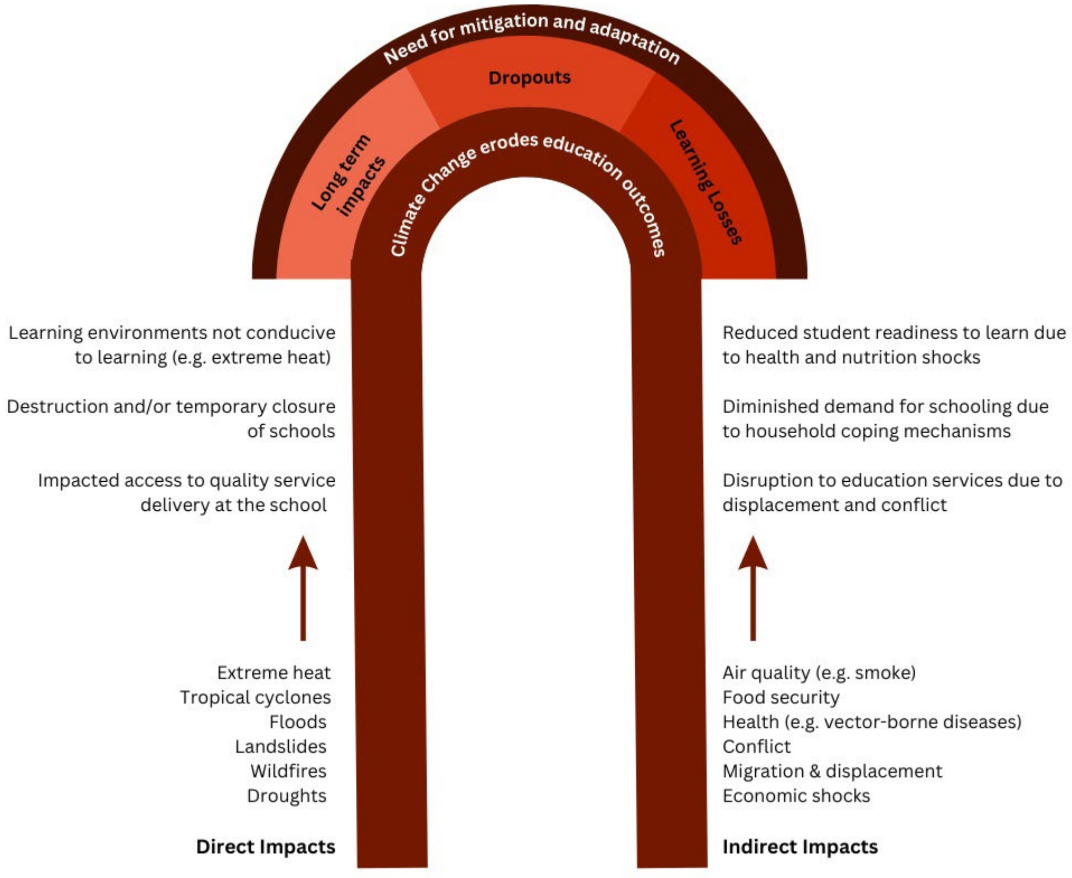
"[THE 2019 CYCLONE] DEMOLISHED HOUSES—EVEN OUR DISHES WERE BROKEN—AND BOTH OUR HOSPITAL AND SCHOOL WERE DAMAGED. OUR CLASSROOM WAS DESTROYED. AND AT THE SPOT WHERE I USED TO STUDY UNDER THE MANGO TREES, THE BOOKS, PICTURES, AND NOTEBOOKS GOT REALLY WET WHEN IT RAINED."

Candida, 12-year-old student, Mozambique

Education needs to be protected from climate change. Climate change is increasing the frequency and intensity of extreme weather events such as cyclones, floods, droughts, heatwaves and wildfires as well as the probability of co-occurring events.[1] These extreme weather events are increasingly disrupting schooling; precipitating learning losses, dropouts, and long-term impacts. The education of 75 million children is estimated to have been disrupted by conflict and natural disasters. These are projected to increase in frequency and severity with climate change.[2] Over 99 percent of children around the world are exposed to at least one major climate and environmental hazard, shock.[3] These are eroding education outcomes and recent progress in improving school access and learning.

Extreme weather events threaten learning, enrollment, and the future prospects of students through both direct and indirect channels.[4] Direct effects of climate shocks harm the quality-of-service delivery and classroom environment, increase school closures, extend the length of those school closures through the use of schools as emergency centers, and destroy school infrastructure. Indirect effects can emerge through economic shocks, food insecurity, health shocks, and increased conflict, migration, and displacement (see Figure 1). These indirect pathways result in reduced student readiness to learn due to health and nutrition shocks, diminished demand for schooling due to household coping mechanisms, and disruption to education services due to displacement and conflict.

FIGURE 1: ***CLIMATE CHANGE ERODES EDUCATION OUTCOMES THROUGH BOTH DIRECT AND INDIRECT IMPACTS***



CLIMATE CHANGE IS CAUSING MASSIVE SCHOOL CLOSURES

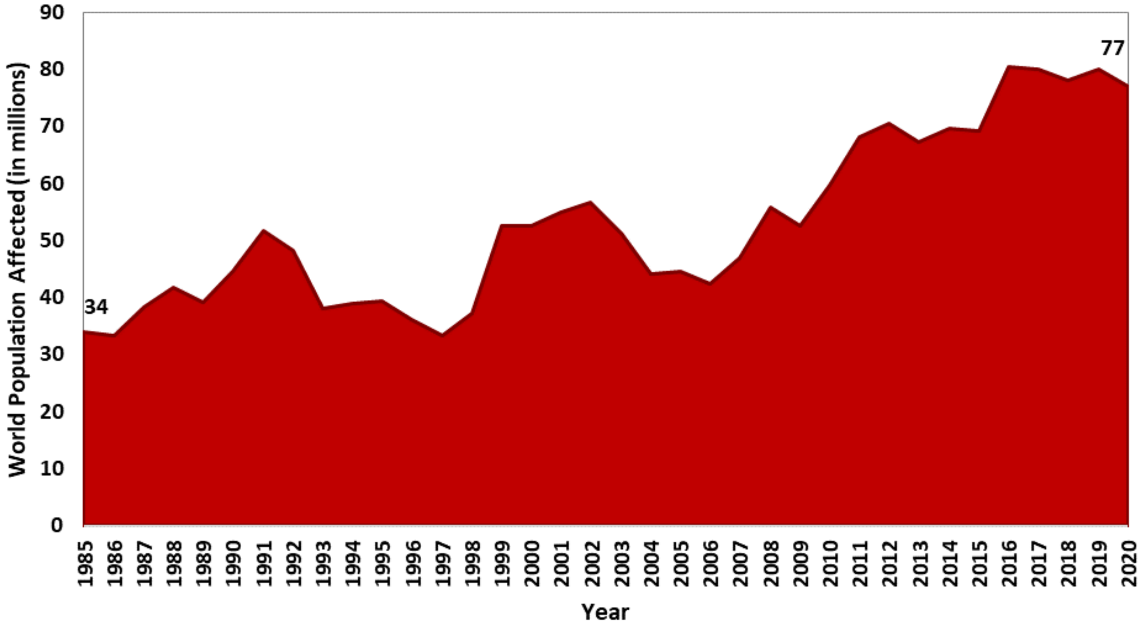
"I have only one thing to say about Cyclone Idai: we were left with nothing. Our houses were all destroyed; the school too. We didn't have classes because classrooms were full of water and the walls were damaged. Later, when the rains stopped, we continued to teach, but under the trees."

— **Celeste José Mucaisse**, Primary School Teacher, Mozambique

A 10-year-old in 2024 will experience three times more river floods, twice as many tropical cyclones and wildfires, four times more crop failures, five times more droughts, and 36 times more heat waves over their lifetimes in a 3°C global warming pathway compared to a 10-year-old in 1970.[5] Already, the population affected by climate shocks on an annual basis has more than doubled over the past 40 years (See Figure 2).

Cyclones, floods, wildfires, and storms cause widespread school closures which generate huge learning losses. When cyclone Freddy hit Southern Africa in March 2023 nearly 5 percent of students across Malawi faced school closures.[7] In the Philippines, over 21 percent of schools are flooded at least once every school year, and this can happen twice a month in some areas.[8] During the 2022 flooding in Pakistan, estimates show that 3.5 million children had schooling disrupted and 1 million children could stop attending school.[9] Higher impacts were observed for children of caregivers who had lower levels of education and income. These closures generate huge learning losses.[10] During COVID-19 (March 2020-2022), each month of school closures translated to a month of learning losses.[11] A day of school closures is a day of learning lost.

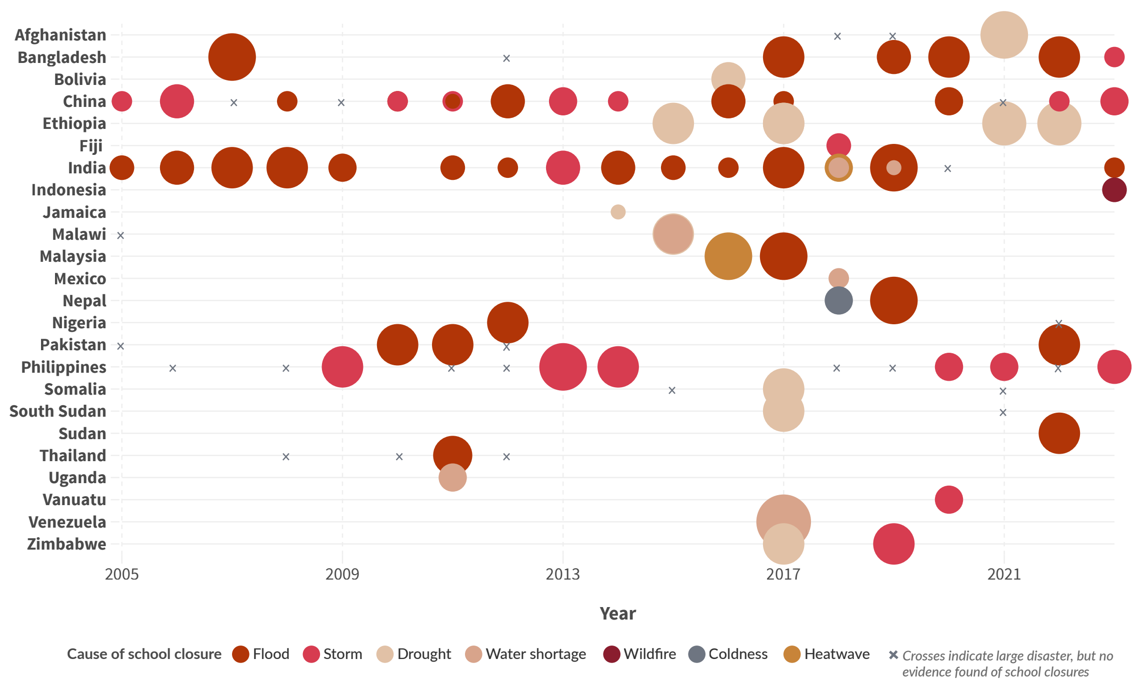
FIGURE 2: ***WORLD POPULATION AFFECTED BY CLIMATE SHOCKS IN 1981-2020, 5-YEAR MOVING AVERAGE***[6]



Cold weather can also disrupt schooling and learning. Although cold extremes have been decreasing globally, some regions such as central Asia and areas of Australia and South America have observed increases in both extreme heat and cold.[12] Cold snaps and storms can produce property damage and power failures which can have consequences on infrastructure and educational systems.[13] This can also produce school closures.[14] In Mongolia, children of schooling age living in severely affected districts during winter storms were less likely to have completed basic education ten years after the shock than those children in less affected districts.[15] In January and February 2024, winter storms caused school closures in central and eastern Europe and the midwestern United States.[16]

Most extreme weather events result in school closures. Over the past 20 years, schools were closed in at least 75 percent of the extreme weather events impacting 5 million people or more (see Figure 3). In Malawi, 42 percent of primary schools were closed due to the drought in 2015, forcing over 130,000 boys and girls to drop out of school. In the Philippines, cyclones in 2009 and 2013 damaged 4,300 and 19,300 schools respec-tively, leading to extended school closures. As the incidence of extreme weather events continues to increase, so does the likelihood of these school closures.

FIGURE 3: ***MOST COUNTRIES EXPERIENCE MORE CLIMATE-RELATED SCHOOL CLOSURES EVERY YEAR.***



Shown is an index on school closures that combines the duration of school closures and their geographic spread. The larger the bubble the larger either the length of the school closure or the number of people affected, or both. Source: Angrist et. at (2023). Building resilient education systems: Evidence from large-scale randomized trials in five countries. No. w31208. National Bureau of Economic Research. Compiled school closure information based on press releases of the United Nation's Office for the Coordination of Humanitarian Affairs (OCHA) ReliefWeb, World Vision, UNICEF, the BBC, and other local outlets.

The duration of school closures is prolonged when school infrastructure is vulnerable or when schools are used as evacuation centers. For example, between 50 to 90 percent of 6,000 school buildings across Samoa, Tonga, and Vanuatu may not withstand a strong cyclone.[17] In Zimbabwe, over half of schools (57%) reported the complete destruction of some infrastructure following Cyclone Idai which hit the country in 2019.[18] In Haiti, physical damage to the education sector from natural disasters has damaged four out of five schools across the country[19]. In addition, schools are often used as evacuation centers as seen in Haiti,[20] Japan,[21] Libya,[22] Pakistan,[23] and the Philippines[24] have shown. In Pakistan, 92 percent of households affected by flooding in 2022 were still uncertain six months later of when local schools would reopen.[25]

Even when schools do not close, extreme weather events reduce attendance and attainment. In Brazil there are more absences during the rainy season even when classes are not suspended. This is due to challenges in transportation, particularly for poorer and more vulnerable students. The number of days impacted by small-scale floods ranges from 7 to more than 12 days every year.[26] Students in flood-affected areas spend more time traveling from home to the university on flood days (2.54 hours compared to 1.24 hours on non-flood days).[27]Attendance is also affected with the percentage of students present for face-to-face classes decreasing from 77 percent on days without flooding to 27 percent on flood days.[28] Even online participation can be affected- overall participation on an online learning platform for undergraduate and graduate school courses decreased by 20 percent due to two major typhoon events that affected the Philippines in 2020.[29] In India and Kenya, positive rainfall shocks were associated with 0.2 to 0.8 less years of schooling, respectively.[30]

Some students do not return to school after school closures. In Chile, school closures increased the probability of students dropping out of high school by 49-68 percent.[31] Following COVID-19 school closures, in Ethiopia and Pakistan, school enrollment among children 6-14 dropped by 4 percentage points and 6 percentage points, respectively, once schools re-opened.[32] Declines were much larger for students from lower socioeconomic backgrounds.

RISING TEMPERATURES THREATEN CHILDREN AND THEIR EDUCATION

A school day under extreme heat is a day in which some learning is lost, but the size of the loss remains uncertain and very context specific. Across 58 developed and developing countries participating in the Programme for International Student Assessment (PISA), each additional hot day (above 26.7 °C) in the three years preceding exams lowered learning by 0.0018 standard deviations, equivalent to 1.08 days.[33] These impacts were stronger on school days and disproportionately affected poorer countries. However, it is difficult to extrapolate these findings to countries and regions of the world where starting temperatures are much higher, and thus, reaching high temperature thresholds represents less of a deviation from normal. In countries with higher temperatures, the temperature threshold needed to be surpassed for learning to be inhibited will naturally be higher. For instance, in India, each additional hot day lowered learning for reading for primary school students by 0.002 standard deviations, similar to the previously cited paper, but this impact was associated with days surpassing a temperature threshold of 29 °C compared to 26.7 °C.[34] A novel survey for this note, covering 94 education policymakers across 28 low- and middle-income countries, reveals that 47 percent of policymakers believe that learning is only compromised when temperatures are above 37.8 °C. This type of finding implies the incidence of days with extreme heat negatively impacts learning, but the size of the impact will be very much dependent on starting temperatures and the local context.

Extreme heat on exam day significantly reduces test scores. Even a modest increase of 1°C in outdoor temperature on exam days can result in a substantial decline in test scores.[35] In China, temperatures exceeding 32°C on exam days, compared to a more moderate range of 22°C–24°C, decreases math scores by 0.066 standard deviations.[36] In Vietnam, each 0.56°C increase in temperature on exam day for college entrance exams decreased standard deviation by 0.006. Notably, female students and those residing in rural areas were most vulnerable to these effects.[37] These big impacts could be particularly problematic for high-stake exams which disproportionately impact a student's future employment and earnings.[38] The effect of extreme heat on Korean college entrance exams is equivalent to increasing class sizes by 2-3 students.[39]

Higher average temperatures overall also negatively impact learning outcomes. In Brazil, an increase of 1°C during the 2 years prior to the basic education national assessment (SAEB) translates into a learning loss of 0.03 standard deviations in test scores,[40] or 10 percent of a typical year of learning.[4] In the United States, test scores decreased by 1 percent for every 0.56°C increase in temperature in the school years leading up to the test.[41] Similar results were also found for English/Language Arts and Math test scores for students in third grade through eighth grade across the United States. Strong effects were also observed when considering days of extreme heat above 37.8°C. [42]

Crossing specific temperature thresholds causes stronger learning losses than an overall relationship between average temperatures and learning may suggest. Therefore, studies that look at increases in the average temperature in the year(s) prior to an exam find relatively small impacts while studies that look at the impact of extreme heat on specific school days find larger impacts. In other words, strong learning losses may emerge only when temperature crosses certain thresholds.

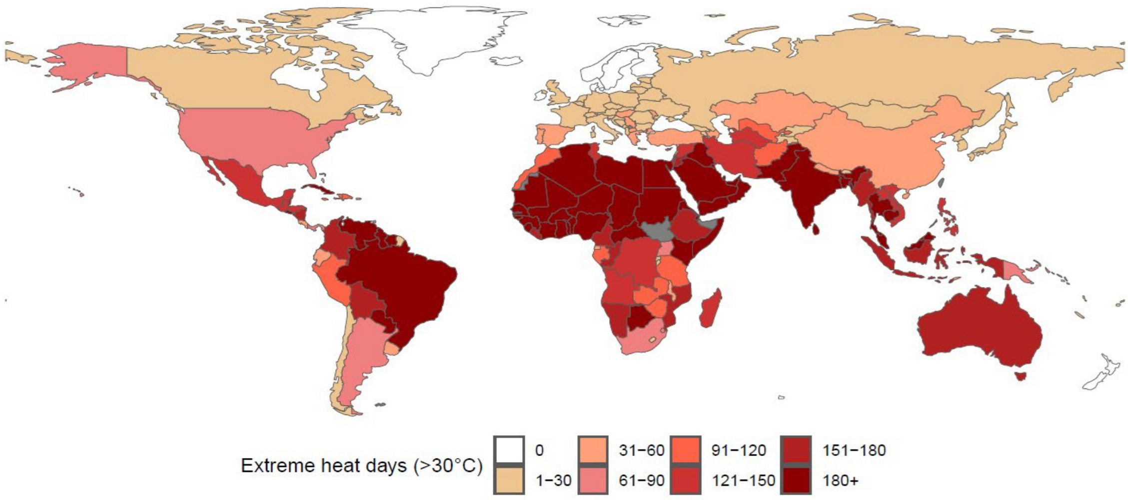
[4] This conversion assumes that a typical student learns 0.3 standard deviations per year (See Sabarwal et al., 2023 and Bau et al., 2021 for more information)

While there is some variation in the precise temperature level, it is clear that exceeding specific temperature thresholds compromise learning outcomes. In several middle- and high-income settings, the ideal classroom temperatures lie between 19.5 and 23.3°C.[43] In those settings, any temperature above 24°C can compromise reaction time, processing speed[44], and accuracy[45] through changes in heart rate and respiratory rates. The heart rates of children can increase by approximately 10 beats per minute for every degree Celsius increase in body temperature.[46] Similarly, respiratory rates can increase by up to 2 breaths per minute per degree Celsius increase in body temperature.[47] In China, higher classroom temperatures increased reported health symptoms of dry throat, dry skin and headaches, dizziness, difficulty in thinking and concentrating clearly, fatigue, and decreased well-being and mood.[48] Across 5 experimental studies, high temperature produced declines in student performance ranging from 2 to 12 percent for each 1°C increase in classroom temperature.[49]

Beyond exceeding temperature thresholds, deviations from normal also matter for learning, and this goes in both directions. The effects of extreme temperatures on learning will differ regionally due to local climate and adaptive capacity. In regions used to lower temperatures, hot days may have a larger effect as the students may not be used to such temperatures. In the United States, learning was more affected by hot days in schools with lower average temperatures (55° F compared to 85° F).[50] Students living in hotter climates may be more resilient to the effects of extreme temperatures and the schools may have stronger adaptation measures to combat these effects. While less common under climate change, the opposite is also true. In regions used to higher temperatures, cold days may have an equally negative impact on learning. For example, in Australia, an additional 10 cold school days with maximum temperature under 15.6°C in the exam year reduced test scores by 1.2% of a standard deviation, or 4% of a typical year of learning.[51]

Further, even the small learning impacts of slowly increasing temperatures could amount to significant cumulative losses over time. Novel analysis from Brazil shows that in the hottest 10 percent of municipalities, maximum daily temperatures rose more quickly (at a rate of about 0.6 degrees Celsius per decade) than in the other 90 percent.[52] In these municipalities, which are also the most disadvantaged, students lost about 1 percent of learning per year due to rising temperatures. If one assumes that learning is entirely cumulative with each year's learning building on the prior, and that each year only 1 percent of learning is lost, by the time a student completes grade 12, that student will have lost about 1.5 years of learning. In a more conservative and yet realistic scenario, if one assumes a mix of learning being entirely cumulative in the early years and more independent in the later years, by the time a student completes grade 12, that student will have lost about 0.66 years of learning. In essence, the study finds that a child who enters 1st grade today in a municipality already experiencing high temperatures will lose between 0.66 and 1.5 years of learning by the time she graduates from 12th grade.

FIGURE 4: ***GLOBAL INCIDENCE OF EXTREME HEAT DAYS (> 30˚C) IN 2020***[53]



Extreme heat will disproportionally affect the poorest regions. Warmer and lower resource settings are facing higher exposures to extreme heat conditions and as a result experiencing the greatest burden on educational outcomes (See Figure 4). A country like Gambia will experience a median of 280 hot days (above 35 C) a year under a pessimistic (SSP5-8.5) scenario while a lower impact of 209 days under a middle of the road (SSP2-4.5) scenario.[54] In contrast, the Netherlands is expected to experience around 2 hot days a year even under the most pessimistic climate scenario. In addition, within countries, hot days will disproportionately affect poorer students who are significantly more likely to attend schools without electricity (or air-conditioning).

CLIMATE CHANGE IMPACTS ON HEALTH AND FRAGILITY FURTHER ERODE EDUCATION OUTCOMES

> *"Because of climate change... now we have a crisis of water, and then a crisis of land... And then we have terrorist groups again... which has devolved into this civil war we are witnessing now in Mali. And then, because of this insecurity there is no education, there is no security, there is no development."*
>
> — **Houyame Hakmi**, Malian PhD student in Morocco

Climate change is adversely affecting education outcomes indirectly through a range of health shocks. A child exposed to high temperature in-utero or in early life will attain 1.5 fewer years of schooling in Southeast Asia.[55] Exposure to normal weather conditions in-utero as compared to extreme weather conditions decreases the probability of dropping out of school by 5 percent in Colombia.[56] Vector-borne diseases such as malaria, dengue and Lyme disease are highly sensitive to temperature and precipitation and will increase in many regions under climate change.[57] Around 48 million people could be at increased risk of seasonal malaria transmission and 62 million at an increased risk of endemic malaria transmission in Central, Eastern and Southern Africa by 2030.[58] Rising temperatures also amplify the impacts of air pollution, from wildfire smoke and other sources, on children's health and academic performance.[59] Exposure to fine particulate matter, a harmful air pollutant, lowers test scores as shown with evidence from Brazil, Chile, China, India, Iran, Italy, and the United States (See Box 1).[60]

The mental health of students is also compromised by climate shocks. Droughts, hurricanes, and wildfires can also have negative impacts on student mental health. Following hurricane Katrina in the United States, the majority of affected ninth grade ethnic minority students had mild or severe symptoms of post-traumatic stress disorder (PTSD).[66] College students affected by the Fort McMurray wildfires had a 11 percent in PTSD following the fires.[67] Climate anxiety has also been shown to be an increasingly prevalent stressor for youth.[68] Across 50 countries covering 56 percent of the world's population, almost 70 percent of children believe climate change is a global emergency which can produce higher stress and anxiety.[69] These mental health impacts are likely to adversely affect both student learning and retention.

Climate change is causing food insecurity and economic fragility which jeopardize school enrollment. It is estimated that up to 170 million additional people will be at risk of hunger by 2080 due to climate change.[70] This will have adverse effects on student learning and achievement.[71] Extreme weather events strain on household re-

BOX 1: *CLIMATE CHANGE, AIR POLLUTION AND EDUCATION*

Climate change can increase air pollutants through changes in photochemical reactions, ventilation and dilution, and removal processes such as precipitation.[61] Climate change is likely to increase global air pollution and associated mortality. Projections have shown that 14% of the overall increase in ozone mortality from 2000 to 2100 estimated in a high emissions scenario (RCP8.5) will be attributed to climate change.[62] Although particulate matter is expected to decrease overall, the decrease would be approximately 16% greater without the adverse effects of climate change.[63] Poor air quality can affect learning and schooling through closures and impacts on cognition and academic achievement. In Brazil, higher particulate matter (PM2.5) and nitrogen dioxide (NO2) around schools is associated with 0.05 percent and 1.02 percent lower scores, respectively.[64] In China, high air pollution increases school absences, and this was shown to persist for up to 4 days. An air quality that is 10 units higher can produce over 80 thousand student absences student across China every day.[65] The effects of climate change and air pollution can also co-occur and interact, continuing to produce even more detrimental effects in vulnerable regions.

sources and can lead to lower expenditure on schooling lasting years after a shock.[72] In Bangladesh, exposure to cyclones, floods, and droughts increased child marriages as families use bride payments as a coping mechanism to financial hardship.[73] The economic strain of climate shocks on households will increase learning poverty and prevent educational continuity.

Climate shocks exacerbate conflict, displacement, and migration, threatening education outcomes for millions of children. A one standard deviation change in climate (temperature and rainfall) can increase the risk of intergroup conflict by 14 percent and interpersonal violence by 4 percent.[74] Migration and displacement will also increase due to changes in water availability, crop productivity, and wealth which will impact educational continuity for children. Conflict, violence, and war in turn have severe consequences on children's educational attainment and achievement. In some settings, temperature shocks also increase recruitment of boy and girl as child soldiers.[75] Approximately 222 million children are out of school or at risk of dropping out of school due to conflict or crises.[76]

THE EDUCATION IMPACTS OF CLIMATE CHANGE ARE AN ECONOMIC TIME-BOMB

Reduced education attainment will translate into lower earnings and productivity. Climate change and weather extremes will have severe costs on human capital and human development.[77] School attainment is linked with higher earnings, with estimates suggesting a return of 9-10 percent for each additional year of schooling. These returns are higher in poorer countries and among girls. As climate shocks reduce education attainment, future earnings will suffer. As witnessed with the COVID-19 pandemic, learning losses and lower levels of education attainment reduce income and productivity, with students in grades 1-12 affected by school closures expected to earn 3 percent less in their lifetime. Studies looking at the impact of wildfires also infer deep impacts on future earnings, with estimates implying one year of higher wildfire smoke inhalation reduces future earnings of affected populations in the U.S. by $1.7 billion. This affects primarily disadvantaged groups.[78] These impacts are compounded by the direct economic effects brought about by climate shocks, which can directly reduce economic growth and levels of output.[79]

The impacts will be felt across generations, as lower education attainment perpetuates cycles of poverty and limits social mobility. Individuals with lower education attainment face economic disadvantages and restricted access to stable employment. These inequalities are transmitted from one generation to the next.[80] Parents with lower education attainment often struggle to offer adequate support and resources for children's education, further perpetuating the cycle of lower education levels within families.[81] This can manifest in various ways, such as limited access to early childhood education due to cost, fewer opportunities for enrichment activities, and inadequate academic support at home. Health disparities also arise, as lower education correlates with poorer health outcomes. The combination of these factors traps families in cycles of poverty, and further increases their vulnerability to climate shocks.[82]

The erosion of education outcomes threatens the progress on poverty reduction. The individual returns to education and the acquisition of skills add up to large benefits for economies. Three-quarters of the variation in growth of GDP per capita across countries from 1960 to 2000 can be explained by changes in math and science skills, highlighting the importance of education in economic security and growth.[83] But for many countries, realizing the benefits of education remains a challenge. In 2019, learning poverty rate in low- and middle-income countries was 57 percent, or 6 out of 10 children could not read and understand a basic text by age 10. In Sub-Saharan Africa, the rate was even higher, at 86 percent.[84] The looming threat of climate shocks, akin to the challenges posed by the COVID-19 pandemic, further worsens the acquisition of vital skills. Without these foundational skills, individuals lack the tools needed to secure stable employment and higher incomes, hindering poverty reduction efforts.

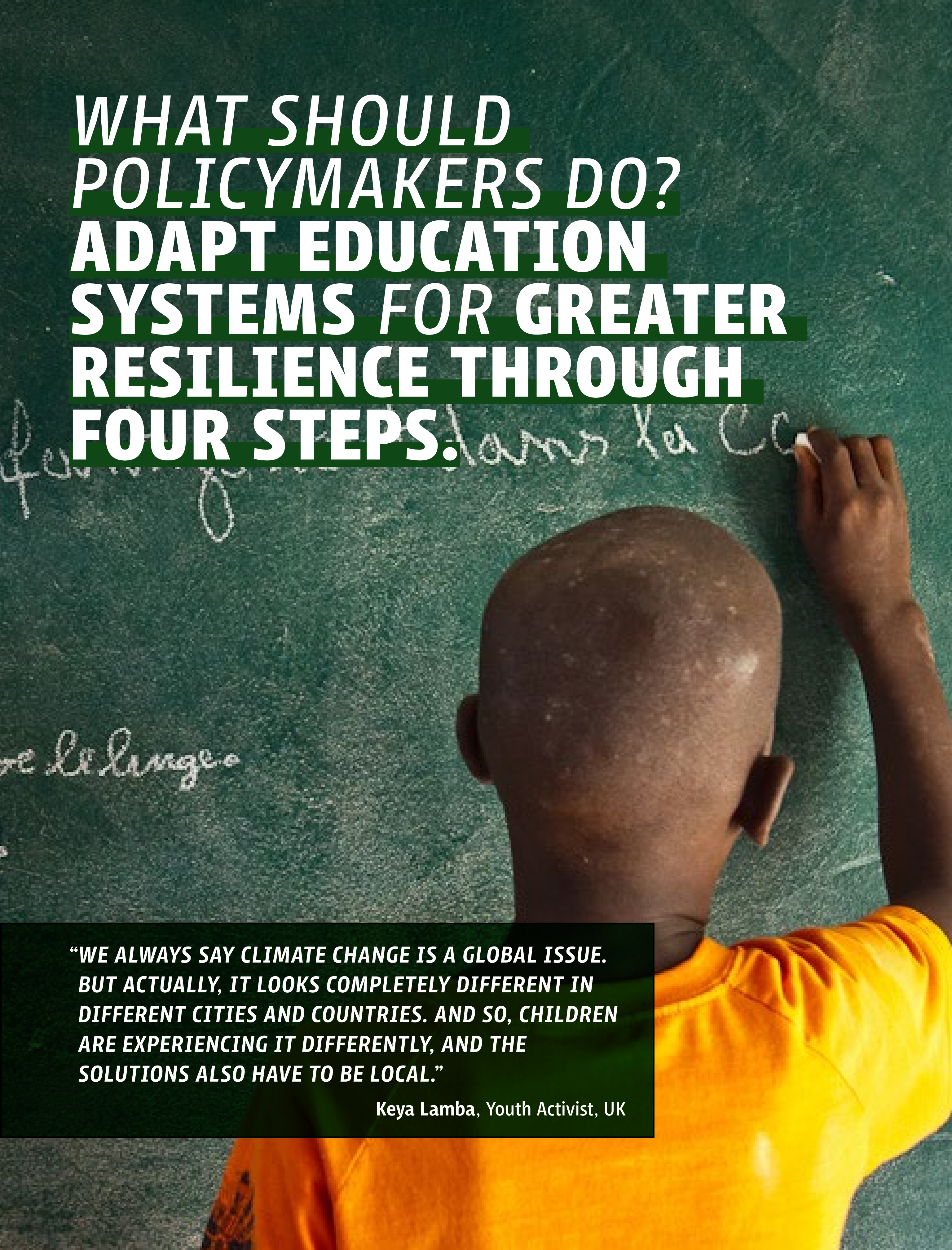
VULNERABLE COMMUNITIES, WHO HAVE CONTRIBUTED THE LEAST TO CLIMATE CHANGE, WILL BE THE MOST AFFECTED.

> *"Unfortunately, we are the ones who can no longer mitigate. We have to adapt."*
>
> **— Lashanti Jupp**, Education Activist, Bahamas

The more severe impacts of climate change will occur in low- to-middle-income countries (LMICs), which are home to 85 percent of the world's children.[85] Yet, these countries contribute the least to carbon emissions responsible for climate change. For example, the ten highest-risk countries collectively emit only 0.5 percent of global emissions. In addition, consumption-based emissions data shows that high income countries are responsible for 92 percent of excess global CO2 emissions.[86] In poor countries, economic growth is reduced by 1.3 percent for each 1°C increase in temperature each year.[87]

Within affected communities, the most vulnerable children will bear most of the effects. Approximately 90 percent of the global burden of disease associated with climate change affects children. According to the Young Lives study which followed the lives of 12,000 children in poor communities across Ethiopia, India, Peru, and Vietnam, children in the poorest households within each country are more affected by extreme weather events. For example, in Ethiopia, 81 percent of children from the poorest households had experienced one or more extreme weather events while 22 percent from the least poor households had been exposed to these events.[88] Certain groups of people will suffer greater climate impacts, including those with chronic illness and mobility challenges, people of color and women and girls, and those from low-income populations.[89]

Education impacts from climate disasters disproportionately harm young girls. Climate-related events prevent at least 4 million girls in low- and lower-middle-income countries from completing their education.[90] In India, girls and children from a lower socio-economic status are more susceptible to flooding and its effect on learning outcomes.[91] More broadly, girls and women are particularly vulnerable to the social responses triggered by weather shocks, especially in places where they face restrictive gender norms.[92] Coping strategies to extreme weather events can be particularly harmful to women. Girls are more likely to experience violence and exploitation related to climate shocks,[93] be forced into early marriage,[94] and become pregnant,[95] all of which can affect their ability to stay in school. During or after weather shocks, boys can also be taken out of schools to be put at work and young men working in agriculture are often forced to migrate to find alternative sources of income.[96]



WHAT SHOULD POLICYMAKERS DO? ADAPT EDUCATION SYSTEMS *FOR* GREATER RESILIENCE THROUGH FOUR STEPS.

“WE ALWAYS SAY CLIMATE CHANGE IS A GLOBAL ISSUE. BUT ACTUALLY, IT LOOKS COMPLETELY DIFFERENT IN DIFFERENT CITIES AND COUNTRIES. AND SO, CHILDREN ARE EXPERIENCING IT DIFFERENTLY, AND THE SOLUTIONS ALSO HAVE TO BE LOCAL.”

Keya Lamba, Youth Activist, UK

There is an urgent need to adapt education systems for climate change. Even if the most drastic climate mitigation strategies were implemented, we will continue to observe extreme weather events having detrimental impacts on education outcomes. For the millions of children that need to attend school over the next 50 years, the results of mitigation will simply come too late. Actions can be implemented now to increase the capacity of education systems to adapt and to cope with these increasingly prevalent climate stressors.

Education policymakers do not seem to fully appreciate the urgency for climate adaptation within the education sector. A novel survey for this note, covering 94 education policymakers across 28 low- and middle-income countries, reveals that only about half (53 percent) believe that hotter temperatures inhibit learning and nearly 46 percent also got one of five basic climate change related questions wrong. Further, nearly 61 percent said the protection of learning from climate change is among the bottom three priorities in their country (out of a set of ten priorities). The corresponding number for World Bank education task team leaders was 72 percent. This low prioritization of adaptation is troubling given that increasing heat exposure during the school year could come to explain around one-third of the difference in the PISA performance between countries like Brazil and South Korea.[97]

This section presents a broad menu of options that can be part of a sound adaptation strategy, as well as examples of how countries are applying these solutions. Ultimately, countries will need to contextualize their strategies according to the climate stressors they face, the resources available, and what would work best for their populations.

Adapting education systems for greater resilience requires policymakers to act on four fronts (see Figure 5): (i) education management for resilience; (ii) school infrastructure for resilience; (iii) ensuring learning continuity in the face of climate shocks; and (iv) leveraging students and teachers as change agents.

But this adaptation requires policymakers to allocate sufficient funding for boosting climate resilience within the education sector. Effectively implementing adaptation strategies to minimize harm and cope with climate shocks will require additional funds for the education sector. The case for education investment must be strengthened for improved domestic resource mobilization and increased allocation of global adaptation financing to education. Each dollar invested in disaster risk reduction to make education systems climate-smart can save up to 15 in post-disaster recovery.[98] Part of the strategy to mobilize funding may involve the education sector accessing existing, or setting up new, loss and damage funds.[99] Innovative financing mechanisms, such as the use of parametric insurance in the education sector, may also be useful in ensuring funds are available when coping with shocks.[100] Though no global figures exist to summarize the additional financing needed for this effort, scattered estimates give a sense of the scale. Looking at just damages due to tropical cyclones, global estimates indicate the education sector experiences financial losses of USD 4 billion annually.[101] In the Philippines alone, over 10,000 classrooms per year are damaged due to typhoons and floods.[102]

FIGURE 5: ***APPROACH TO ADAPT EDUCATION SYSTEMS TO CLIMATE CHANGE***

EDUCATION MANAGEMENT FOR CLIMATE RESILIENCE

First, support adaptation and disaster risk planning at the sector and school levels. Education policies, at the national and subnational levels, need to reflect the reality of climate change and what it means to their sector. Critical aspects to cover include an assessment of climate risks, strategies to minimize impacts to infrastructure and education outcomes, clear coping mechanisms to manage learning continuity during climate shocks, plans to effectively restore learning process after natural disasters, and a sensible approach to involve teachers, students, and their families in the overall adaptation process. Nearly 60 percent of countries in a 2017 survey of 68 high-risk countries for disasters include either disaster risk reduction or disaster response components in their education sector plan, but these are not always comprehensive.[103] The Ministry of Education of Liberia has integrated climate mitigation and adaptation measures into its education sector plan running through 2027, which identifies medium and long-term adaptation needs and implements strategies to address them.[104] Climate change learning strategies led by national institutions have been implemented by various countries such as Benin, Uganda and Indonesia to strengthen linkages between the education and training institutions and the climate change community.[105]

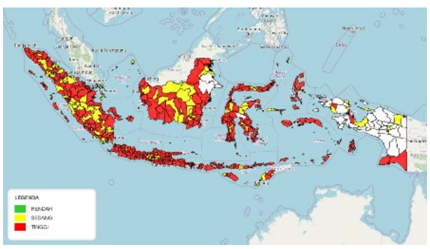
Such planning should be underpinned by clear data and analysis related to climate risks and possible coping strategies. Effectively preparing for, coping with, and recovering from climate shocks requires education policymakers to understand the climate risks faced by their sector. Periodically assembling and discussing data about schools that are at risk can help the system minimize negative impacts. Infrastructure assessments are equally important to identify sub-optimal school structures that need upgrading for greater resilience against climate shocks. The process of assembling these data may involve coordination and consultation with non-education ministries and experts.

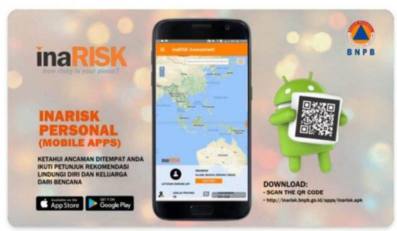
Second, invest in early warning systems. Investing in mechanisms to alert schools in real time and take early action will minimize the damage of adverse climate events on students, teachers, and schools. Risk reduction measures benefit schools and help communities learn of the risk through students. Multi-hazard early warning systems are being implemented in a growing number of countries and have been proven to minimize damage and the number of people impacted by climate shocks.[106] In the Philippines and Indonesia, an early warning system for typhoons, floods, and earthquakes is used for disaster preparedness and response. In Indonesia, the education sector is provided information through a mobile app to improve disaster knowledge for students and staff (see Box 2).[107]

Third, supporting good management at the school level can really pay off. Offering targeted in-service training to school principals on crisis response and overall management practices can help with risk mitigation and improve the speed and recovery following climate shocks. In Haiti, following Hurricane Matthew, better managed schools recovered faster, with the difference even more pronounced at higher levels of damage.[108] School principals scoring higher on a range of management practices were able to re-open schools faster, bring students and teachers back sooner, significantly minimize learning losses, and introduce disaster risk reduction measures in case of re-occurrence. Similarly, in Puerto Rico, school principals scoring higher on management practices were better able to keep students engaged though remote learning opportunities.[109]

BOX 2: *EXAMPLE EARLY WARNING SYSTEM FOR SCHOOL*

MOBILE APP FOR DISASTER RESPONSE – INDONESIA





InaRISK is a platform that summarizes results of local-level disaster risk following hazard assessments conducted by the local government. It has a mobile app that provides information about risks and guidance on how to take anticipatory actions during a disaster. Indonesia's education system, from primary schools to high schools, are using the app as part of the Disaster Safe Education Unit (SPAB) programme implemented by the Ministry of Education, Culture and Research and Technology to improve the disaster knowledge of students and staff. Schools receive alerts through different channels, and evacuation procedures are often practiced during drills.

Learn more!

SCHOOL INFRASTRUCTURE FOR CLIMATE RESILIENCE

For infrastructure the key actions are strengthening the resilience of existing buildings, protecting classrooms from heat, and adopting innovative best practices (for both resilience and cooling) for any new construction.

Compliance with local building codes must be enforced for all school buildings. Building codes are the minimum design and construction requirements to ensure safe and resilient structures. Though they vary by country, these codes establish the acceptable levels of risk from an engineering perspective. When school buildings operate outside the scope of the building codes, they are at risk of severe damage and destruction during climate shocks. This is unfortunately far too common. In Niger, nearly 47 percent of school infrastructure stock continues to rely on temporary structures (*classes paillotes*) made of straw, which are built based on demand and are dismantled annually during rainy season, leaving millions of children and youth without access to school.[110] Note however that different climate risks add different types of stress on school infrastructure, and thus require different solutions. Even for each specific risk, there is no one-size-fits-all solution as different contexts will have different resources available to respond and mitigate damage.

Structural adjustments can help minimize potential damage to schools from floods and landslides. Measures specifically aimed at preventing urban run-off and flooding can be implemented at the school building level. Options include the construction of retaining walls, improved gutters and drainage systems to guide water away from the schools, as well as the construction of schools with elevated foundations. Temporary retaining walls can even be made out of sandbags. In Rwanda, a new project is equipping 1,367 school sites with retaining walls to mitigate flood- and rainstorm-related landslides, as well as related risks to communities and their assets living downstream from the school location.[111] In Vietnam, schools in flood-prone areas have been designed with elevated foundations, and classrooms are often constructed on stilts to reduce the risk of inundation.[112] Infrastructure built for flood risk reduction not only increases resilience to climate stressors but can have co-benefits on environmental, social and economic systems.[113] There are programs like the World Bank Global Program for Safer Schools, that aim to improve the safety and resilience of schools to natural hazards through large-scale investments in safer school infrastructure.[114] In Peru, the program supported policy reform to improve resources for disaster risk management, reduce infrastructure vulnerabilities in the education and housing sectors including flood protection measures and increase governmental capacity for post-disaster recovery and reconstruction.[115]

Risk-informed location for new schools is critical. The geographical location of a school determines the climate hazards to which it is exposed. Hazard maps can be particularly useful. For existing infrastructure, an understanding of the exposure of each school facility to natural hazards can serve as a starting point for managing climate risk. For new infrastructure, knowledge of the risks of particular locations can guide decision-making into where to locate schools to minimize risk. If risk cannot be avoided, because of the location of the community that needs to be served by the new school facility, the risk information can inform the design of the new school building to minimize damage during the most likely climate shocks. In Indonesia, optimal locations for education facilities have been identified using a model for land suitability by considering a multi-hazard disaster risk index, with over 25 percent of schools currently located in high vulnerability areas.[116]

Classroom temperatures need to be better managed, but this doesn't need to be costly. As discussed above, heat impedes learning. Reducing classroom temperature from 30 °C to 20 °C could increase performance on learning-related tasks by 20 percent.[117] In Costa Rica, air conditioning units were used to reduce classroom temperatures from about 30 to 25°C and speed on cognitive tests increased up to 7.5 percent, and accuracy increased by 0.6 percent for each degree reduction in classroom temperature.[118] Interestingly, this effect was stronger for lower performing students. While installing air conditioning units in classrooms is an option that some countries have implemented, it is certainly not the only approach to lowering temperatures. Less costly solutions range from painting rooftops with solar-reflective white paint, increasing tree coverage in and around the school, leveraging water features to mist the air, to even modifying school schedules to avoid peak heat (See Box 3).

New classrooms can be designed to keep cool. The use of natural ventilation, insulating materials, and climate-responsive designs for schools can be alternative strategies to interventions like air conditioning, which may not be feasible in all contexts. School construction integrating natural daylight and cross-ventilation as well as trees and/or shade structures can reduce the energy needed.[119] For example, Kenya implemented a Green Economy Strategy and Implementation Plan that promotes bioclimatic design for school buildings and will increase thermal comfort for students during high temperatures.[120]

BOX 3: *SAMPLE STRATEGIES TO COMBAT CLASSROOM EXTREME HEAT*

Low Tech

INDONESIA

Painting rooftops white.
In Indonesia, a project established a facility to produce affordable coatings to install cool roofs on over 70 buildings including schools. Indoor temperatures were reduced by over 10 °C by replacing dark roofs with a white coating.

Learn more

Low Tech

KENYA

Tree planting.
Kenya has set a target to plant 15 billion trees by 2032. Trees will be planted by students and education workers and will provide shade in school grounds lowering temperatures. This practice can reduce temperatures in the school area by 1-5 °C.

Learn more

High Tech

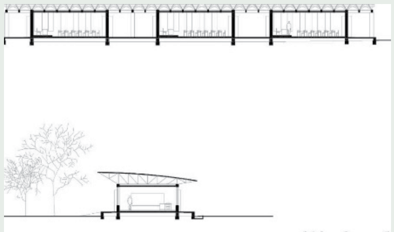
TAIWAN

Air conditioning in schools.
The government of Taiwan has invested $1.2 billion USD to install air conditioning in every public classroom. Evidence from Costa Rica has shown AC to be effective at managing temperatures and supporting learning.

Learn more

BOX 4: ***SAMPLE INNOVATIVE DESIGN FOR TEMPERATURE CONTROL***

GANDO PRIMARY SCHOOL – BURKINA FASO



The Gando Primary school was designed by Francis Kéré within the parameters set by cost, climate, resource availability and construction feasibility. For construction, Clay was used. This material is abundant in the region and can offer thermal protection against hot climate. To avoid overheating due to the commonly used corrugated metal roof, the design pulls the roof of the Gando Primary School away from the learning space of the interior. A dry-stacked brick ceiling is introduced in between, allowing for maximum ventilation: cool air is pulled in from the interior windows, while hot air is released out through perforations in the clay roof. This also significantly reduces the ecological footprint of the school by alleviating the need for air-conditioning.

Learn more

In Burkina Faso (see Box 4), the Gando Primary School is a good example of locally-contextualized and innovative design that addresses the issue of extreme heat in classrooms.

When the schools are running, make sure water runs as well. Access to water, beyond a basic human need, is also a highly effective practice for increasing attendance, enrollment, and learning.[121] Ensuring this provision, especially in water-scarce environments, requires innovative thinking and local solutions. In Kenya, water tanks and sanitation infrastructure were installed on rooftops through a water harvesting project. This not only creates storage to harvest water during the rainy season to provide water access during the drier months but can also help minimize local flooding of schools.[122] In Vietnam, 300,000 water purifiers are being distributed to schools and other community institutions to provide access to clean drinking water to 2 million children. This option provides clean water to students and is expected to reduce carbon emissions by 6 million tons over 10 years.[123]

Ultimately, climate shocks add a level of stress to school infrastructure that cannot be fully remedied, but enhancing the resilience of school buildings and ensuring continuity of learning during school closures can significantly reduce their impacts.[124]

ENSURING LEARNING CONTINUITY IN THE FACE OF CLIMATE SHOCKS

Keep schools open (to the extent possible). There is overwhelming evidence that school closures lead to tremendous learning losses, especially for the disadvantaged. And these losses may be impossible to recover. Therefore, schools should only be closed when essential and every effort should be made to reopen as soon as possible.

Minimize the time schools are exclusively used as emergency shelters. A key part of minimizing school closures is to minimize their use as evacuation centers and/or emergency shelters. While these centers offer a lifeline to the community, they do so at the expense of children's learning and their future. At times of crisis, it is normal for countries to resort to their public infrastructure to meet the needs of their people, and this includes schools. However, given the high-cost school closures can have on students and their learning, it is important to minimize the length of the school disruption regardless of how the school buildings are being used. Establishing alternative options, keeping dual functions by using classrooms as shelters only at night and reverting to classes during the day, or using alternative temporary learning facilities on school sites can lower impacts on schooling.[125]

In the event of school closures, four actions can protect or even boost education outcomes.

1. **Strengthen remote learning mechanisms to ensure learning continuity during climate-related disruptions.** COVID-19 disruptions demonstrated that remote learning needs to be done more effectively. It's time to put these lessons to work to protect learning from climate shocks. Across five countries (India, Kenya, Nepal, Philippines and Uganda) phone-based targeted instruction significantly improved learning by delivering up to four years of quality instruction for every 100 dollars spent.[126] On flood days in Brazil, students who had only face-to-face classes had approximately 33 percent lower test scores, but no difference was observed when students had access to virtual learning options.[127] Remote learning models can be an important adaptation strategy to ensure continuous learning during school closures. Remote instruction proved to be most successful when it ensured fit-for-purpose, enhanced effectiveness of teachers, established meaningful interactions, and engaged parents and students as partners.[128]

2. **Conduct re-enrollment campaigns if school closures last long.** As schools re-open, many children do not return on their own.[129] Back to school communication campaigns, both general and targeted to at-risk students, can help increase attendance and re-enrollment rates.[130] As parental concerns about risk and safety may be an important factor keeping children from returning, addressing those fears and ensuring safety will enhance the effectiveness of those campaigns. Following COVID-19-related school closures, Ghana conducted a very successful back-to-school campaign resulting in nearly 100 percent re-enrollment.[131] This campaign was successful because it was conducted at the district level, involving government, civil society, and media, and it leveraged different means of communication including radio, TV, and community events.

3. **Targeted financial support to disadvantaged students may be needed to bring them back to school.** After climate emergencies, poor households may not send children back to school for financial reasons. Removing school fees, offering subsidies to cover the cost of textbooks and uniforms, or giving cash transfers to families have all been shown to increase school participation in the aftermath of shocks. In Sierra Leone, following the school closures associated with the Ebola outbreak in 2014,

the government removed school fees for two years, and offered subsidies to cover basic inputs like textbooks.[132] These efforts to boost re-enrollment increased access to schooling with an additional 800,000 children enrolling. Broader cash transfer programs that were conditional on schooling in Brazil and Mexico have also increased the resilience of households as well as school participation.[133] Easing transport difficulties after climate shocks can also be impactful, such as providing bicycles to rural girls, which increases access to schools (as seen in Zambia and India).[134]

4. **Targeted and customized support may be needed for girls.** Following shocks, girls are more likely to fall prey to violence and exploitation,[135] experience deeper income losses,[136] be forced into early marriage as a coping mechanism,[137] become pregnant,[138] and drop out of school as a result. These vulnerabilities make them most likely to benefit from communication campaigns as well as financial and nonfinancial incentives, so long as they are targeted appropriately. Following COVID-19 related school closures, Bangladesh, Benin, Ethiopia, Ghana, Pakistan, and Uganda implemented advocacy campaigns for girls' re-enrollment.[139] Other incentives such as scholarships and adaptations for young mothers have also shown success in bringing back girls to school after shocks.[140]

As students return, catch up and remedial programs may be needed. When schools reopen after climate shocks, not all students will be at the same level as learning losses will likely take place; catch-up programs and extension of the academic calendar can address learning losses for the most impacted students. There are numerous examples of remedial and catch-up programs that proved effective in mitigating learning losses once schools re-open after COVID-19, which can offer valuable insights as countries prepare for increasing climate shocks.[141] Common elements of success in those programs include the use of regular classroom assessments to guide instruction and the teaching prioritization of fundamental skills.

School feeding programs can keep students enrolled through climate shocks and offset some of their indirect impacts by improving nutrition and health. Globally, 418 million children have access to school meals[142] and many rely on them for their entire caloric intake. This reliance is growing as increasing weather and climate extreme events are driving millions of people towards acute food insecurity. Hence, the provision of school meals offers a strong incentive for children to go to school daily. It can also be an effective tool to keep children well-nourished, healthier, and enrolled. There is also evidence that school meals can support better learning outcomes. In India, children receiving school meals for prolonged periods of time achieved better test scores in math and reading.[143] In the Philippines, children enrolled in early childhood nutrition programs performed significantly better in school and every dollar invested in these programs produced a three-dollar gain in academic achievement.[144]

Schools may need to provide socio-emotional programs to help address students' anxiety and distress after climate shocks. Climate change and climate shocks are affecting mental health and psychological well-being of students. And mental health is strongly correlated with academic performance.[145] School-based mental health services for elementary school-aged children can be effective in decreasing mental health problems and improving academic performance.[146] For example, California provided mental health services to address the psychological impact on students after the Camp Fire ravaged through Paradise, California in 2018.[147] In Mozambique, following multiple climate shocks, primary school teachers were trained to provide mental health and psychosocial support (MHPSS) to students affected by natural disasters, conflict, and COVID-19 (See Box 5 for more details).[148]

BOX 5: *POLICY STRATEGIES TO INCREASE RESILIENCE OF EDUCATION SYSTEM TO CLIMATE STRESSORS.*

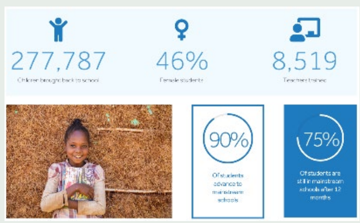
Learning continuity

BANGLADESH

Online learning program. Bangladesh had one of the longest school closures during the COVID-19 pandemic which lasted 18 months. A project that helped students continue education through distance learning helped around 3.26 million children, providing training to teachers and the development of digital content. This increases the resilience of students to stressors by ensuring learning continuity through school closures.

Learn more

Catch-up programs



LIBERIA

Second Chance

The Luminos Fund Second Chance Program is a remedial learning program for Liberian out-of-school children aged 8 to 14. The 10-month program helps students develop literacy and numeracy skills to transition back into the formal education system. Children in the program increased their reading skills from under 5 correct words per minute to 39. Over 12,000 have participated and 90% have transitioned to formal schooling.

Learn more

Socio-emotional programs

MOZAMBIQUE

Increasing teacher capacity to provide psychosocial support

UNICEF and its education partners have established a program in Mozambique to ensure access to mental health and psychological services in crisis-affected provinces. This includes mental health and psychosocial support interventions and manuals for professionals and school staff to support student well-being before, during and after cyclones and other emergencies.

Learn more

LEVERAGING STUDENTS AND TEACHERS AS CHANGE AGENTS

Students don't have to be passive victims of climate shocks; they can play a key role in risk management. Disaster risk reduction involving student training and leadership can be a low-cost strategy to increasing climate resilience. Primary schools in Cambodia with frequent schooling interruptions from floods, droughts and storms have raised disaster risk knowledge among students by integrating disaster risk reduction into the primary social studies and science curriculum.[149] These efforts focus on integrating relevant examples into existing curriculum to ensure students are exposed to this critical and relevant information without needing to expand the already-complex curriculum. Activities such as capacity building and simulation drills can be implemented with low costs and resources and are effective at increasing student and school resilience to climate hazards. Similarly, the Ministry of Education in Thailand reformed the Basic Education Core Curriculum to embed disaster education. Lessons are based on a prominent community-based risk management framework and are mainstreamed to learners from elementary school to senior high school.[150]

As the people on the frontline, teachers have a critical role to play in risk management. Prior to extreme weather events, they can ensure students are aware of the climate risks and how to act in the event of one of them materializing. During and after climate shocks, teachers are instrumental in keeping students engaged in remote learning opportunities if access to school is disrupted. After climate shocks, they hold the key to ensuring learners have their needs met.

For teachers to play this role successfully, they need to be trained effectively on climate change risk reduction and resilience building. An education climate-adaptation policy will fail to deliver results if the messaging doesn't reach those at the frontline: teachers and students. Teachers need to be able to communicate fluently with their students on what climate change is, the risks affecting their region, what to do in case of an emergency, as well as the role students themselves could play in risk management. Novel data for this paper shows that across six LMICs[151] from three regions, nearly 81 percent of teachers claimed to include climate themes in their lessons but over 74 percent got at least one (out of five) basic climate change question wrong. Several countries are implementing this type of training. For instance, in Buenos Aires, Argentina, teachers in regions highly susceptible to flooding have been trained in flood resilience.[152] Teachers, government officials, and technical experts were brought together to design educational content and spaces that encourage children and young people to adopt more environmentally friendly habits. The initiative has given rise to more than 100 schools having teachers trained in flood resilience, with many more schools in the country expected to join.

To meet the needs of students after school closures, teachers will need to be equipped with the right knowledge and tools. The student that leaves the classroom before a climate shock will be very different from the student that returns after. Learning losses, emotional shock, and a likely less prosperous community will add stress to the learning process and limits to how much can be achieved in the classroom. To meet the needs of the students, teachers will need guidance and capacity building on key aspects. These are well-captured in World Bank's R.A.P.I.D. framework which was developed to tackle learning losses caused by COVID-related school closures and has tremendous relevance for climate-change related school closures. It is based on five evidence-based policy actions for learning recovering after education disruptions:[153]

- **R**each all children.
- **A**ssess learning.
- **P**rioritize the fundamentals.
- **I**ncrease the efficiency of instruction.
- **D**evelop psychosocial health and wellbeing**.**

BOX 6: ***EXAMPLE OF TEACHER AND STUDENT TRAINING PROGRAM ON DISASTER RESILIENCE***

DISASTER RISK REDUCTION THROUGH SCHOOL TRAINING – KYRGYZ REPUBLIC


The Comprehensive School Safety Framework program in the Kyrgyz Republic is training students and teachers on safe behaviors during an emergency including floods, landslides and earthquakes. The program trains educators and students starting at the preschool level on how to understand and manage disaster risk. This also includes a mobile application and online course including interactive games for primary school children to explain safe behaviors during emergency situations. School-based disaster risk reduction training is being expanded to 1,800 schools across the country and is expected to reach 1 million school children.

Learn more!

Teachers have needs of their own, offering support to them after climate shocks will be important. Climate shocks will undoubtably impact teachers directly. Their physical and mental health, food and water security and housing can all be impacted by weather extremes. In parallel, more of them will be expected in their classrooms as students cope with the direct and indirect impacts of the climate shock. In countries like in the Philippines, teachers are even expected to take additional responsibilities to coordinate schools as shelters and provide make-up classes on Saturdays following flooding events, without receiving any additional compensation or recognition.[154] This combination can easily lead to teacher burnout, absenteeism and for teachers to eventually leave their jobs.[155] To counter these risks, education systems can ensure teachers continue to be paid regularly, and that any additional responsibility is recognized either monetarily or through other means that may boost motivation. Programs active in the school to guarantee access to water and food to students can also be extended to teachers. Similarly, while teachers can play a role in offering mental health support to students, it will be important to offer services to them through either institutional support, peer support groups, or other interventions.[156]

EDUCATION *CAN BE THE* **KEY TO ENDING POVERTY** *IN A* **LIVABLE PLANET,** *BUT* **GOVERNMENTS MUST ACT NOW** *TO* **PROTECT EDUCATION** *FROM* **CLIMATE CHANGE**

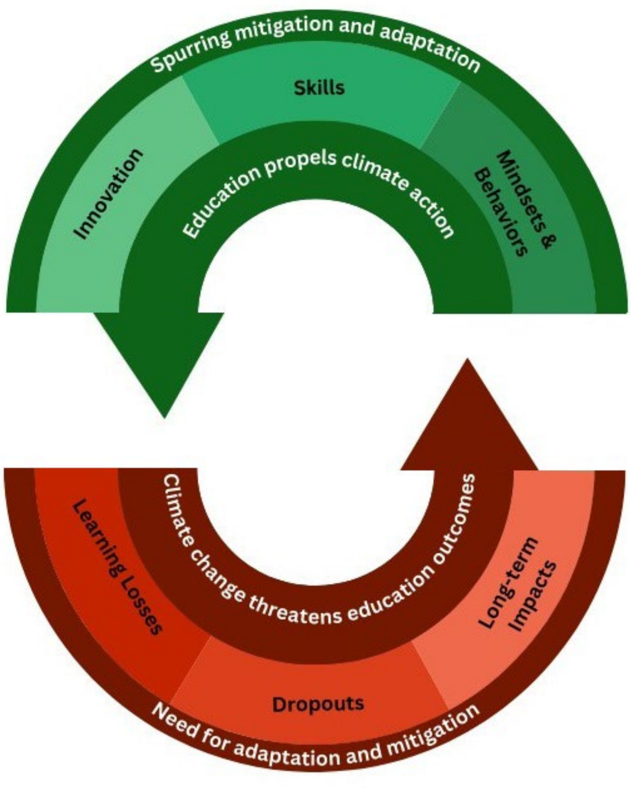
"WE CAN'T BE OBLIVIOUS TO THE FACT THAT WE ARE FACING A GLOBAL CRISIS... AT SOME POINT, WE'RE GOING TO HAVE TO TAKE A BACK STEP AND ACKNOWLEDGE WE'RE IN A CRISIS AND WE NEED TO ADDRESS IT ACCORDINGLY."

Boitumelo Molete, Youth Activist, South Africa

Education generates enormous returns for people and societies. For individuals, education promotes employment, earnings, resilience, and health. For societies, it drives economic development, reduces poverty, promotes social cohesion, and nurtures a more informed and innovative citizenry. Spending on education is thus not a mere government expenditure, but a powerful investment in the well-being and progress of societies. Each additional year of learning is estimated to generate a 10 percent increase in earnings annually.[157] These higher incomes result in significant improvements in health outcomes, especially for mothers and their kids.[158] Combined, these benefits lift people out of poverty in large numbers. If all children got basic reading skills from school, 171 million people could be lifted out of extreme poverty which would be a 12 percent decrease in extreme poverty globally.[159] For nations, these benefits translate into stronger and more sustainable economic growth. Over the period 1960–2000, three-quarters of the variation in growth of GDP per capita across countries can be explained by differences in international measures of math and science skills.[160]

Children and their communities are more resilient to shocks and transitions when they have access to quality education. More educated individuals are better able to prepare for, cope with, and recover from shocks, including those related to extreme weather events. Studies from Brazil, Cuba, Dominican Republic, El Salvador, Haiti, Mali, Senegal, and Thailand provide robust evidence on the positive impact of education on vulnerability reduction.[161] In these studies, people with higher levels of education exhibit greater disaster preparedness and response, experience reduced adverse effects, and recover more quickly from disasters. Education attainment directly influences risk perception, skills, and knowledge, all of which empower individuals to be better prepared against extreme weather events and thus reduce impacts.

FIGURE 6*: THE BI-DIRECTIONAL RELATIONSHIP OF CLIMATE CHANGE AND EDUCATION*



Improving educational outcomes could reduce the climate risks borne by 275 million children globally.[162] Higher levels of education attainment can also contribute to climate resilience indirectly through reduced poverty, improved health, and slower population growth, all of which are linked with higher community-level adaptive capacity.[163]

Education attainment also fosters pro-climate behaviors. An additional year of education can increase pro-climate beliefs by 6.3 percent, increase pro-climate behavior by 8.5 percent, and produce a 35 percent increase in green voting across 16 European countries.[164] In China, education attainment is associated with a 2 percent increase in pro-environmental attitudes and behaviors.[165] Similarly, in Thailand, a study found that additional years of schooling are associated with knowledge-based environmentally friendly actions such as increasing regular use of cloth bags by 5 percent and energy-efficient appliances by 7.7 percent.[166] Globally, the level of education attained emerges as the most influential factor in predicting climate change awareness.[167] Education also exhibits a robust correlation with environmental concern and support for policies that benefit the environment.[168] The education sector can play a catalytic role in climate change mitigation and adaptation by reshaping mindsets, behaviors, skills, and innovation.

But climate change is threatening these benefits. Extreme weather events – high temperatures, tropical cyclones, droughts, floods, and wildfires – harm children and their future through their impacts on education. This is especially true for children in the most vulnerable settings, who need education the most. As climate change increases the frequency and intensity of extreme weather events, climate related learning losses are likely to grow. Today's students could lose not just learning but also a significant share of their future average annual earnings. Beyond reducing incomes, these learning losses will lead to lower productivity, greater inequality, and possibly greater social unrest for decades to come. But these trends can be reversed if countries act quickly and decisively, guided by evidence on what works.

Adaptation within the education sector is urgently needed to protect the benefits of education. To minimize impacts of climate change on education outcomes, it will be important to promote adaptation and resilience in the education sector. This is particularly urgent because these adverse impacts will continue to become more severe. Even if the most drastic climate mitigation strategies were implemented, we will continue to observe extreme weather events having detrimental impacts on education outcomes. For the millions of children that need to attend school over the next 50 years, the results of climate mitigation will simply come too late. Actions can be implemented now to increase the capacity of educational systems to adapt and cope with these increasingly prevalent climate stressors.

Despite the risks and opportunities, education remains overlooked in climate discourse. While climate-related official development assistance (ODA) increased from 21.7 percent in 2013 to 33.4 percent in 2020, education made up less than 1.3 percent of this change.[169] In terms of action plans, less than 1 in 3 Nationally Determined Contribution (NDC) plans mention climate education, and less than 1 in 4 NDCs mention green skills. More broadly, only half of NDCs have any child-sensitive education commitments.[170] Education is mentioned 9 times less frequently relative to energy and infrastructure in World Bank Country Climate Development Reports.[171] Out of 15 review articles on the economic impacts of climate change published since 2010, only three mention the impacts of climate change on education.[172] Of the research on the impacts of climate on education that does exist, nearly 78 percent comes from high-income countries.[173]

The education sector must become more active in climate discourse. This includes focused policy action to protect education systems from the impacts of climate change. Without this, both large-scale poverty reduction and climate action are at risk.

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NOTES

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$$Days\ of\ learning\ lost = \frac{SD_{change}}{0.3\ LAYS} * 9\ months * 20\ days$$

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[172] First three pages of google scholar search of search terms climate AND impact AND economic including only articles published 2010 and onwards that are review articles on the broad impacts on economy/social and excluding articles on a specific sector or with a methods focus or that have a specific regional focus.
[173] A Web of Science search on the topic "climate and impact" with the search terms, health resulted in 24,980, economic produced 31,243 and education produced 5,732. From these results, we can conclude that there is four times more research on the economic impacts of climate and five times more research on health impacts of climate than there is research considering the educational impacts of climate. Out of the 5,732 results from Web of Science of climate impacts on education, 1903 (33%) are based in the United States and 4,467 (78%) are from high-income economies (based on WBG classifications). This is based on web of science classifications and may not describe where the research for the manuscript it based.

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