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Protecting Children's Learning Futures: Quantifying Climate-Related Loss and Damage in Eastern and Southern Africa

SUMMARY REPORT

PEOPLE'S POSTCODE LOTTERY

POSTCODE EDUCATION TRUST

Dalberg

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Executive Summary

At a glance

Climate change has **already resulted** in approximately

US$1.3 billion

in **direct loss and damage to education systems** – a figure that reflects both documented and estimated impacts – across Eastern and Southern Africa between 2005 and 2024.

Without strengthened action to address climate-related loss and damage, **future direct economic loss and damage to education** could exceed

US$3.3–3.8 billion

by 2050.

Between 2005 and 2024, climate-related learning disruptions affected an estimated 130 million children, resulting in

US$120–140 billion

in projected lifetime income losses.

If current trends continue, an additional **440–520 million children** could experience learning disruptions by 2050, leading to a further

US$260–380 billion

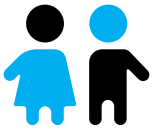
in lost future earnings.

Investments in climate-resilient education infrastructure yield strong economic returns, with benefit-cost ratios ranging from

2:1 to 13:1.

Climate change is intensifying the education crisis in the Eastern and Southern Africa Region (ESAR).[1] Learning poverty remains widespread: nine out of ten children aged 10 in ESAR are unable to read for comprehension. The situation is even more severe for children living in conflict- and climate-vulnerable contexts.[2] Climate-related shocks such as floods, droughts, heatwaves and cyclones are increasingly disrupting schooling and undermining learning continuity, generating significant loss and damage to education systems and eroding their capacity to respond and recover.

Learning poverty remains widespread: **9/10 children** aged 10 in ESAR are **unable to read** for comprehension.



UNICEF is prioritizing robust, evidence-based research to quantify the impact and support governments in addressing losses affecting education systems and children's learning. Despite the urgency, data on the economic and non-economic losses and damages from climate-induced disasters[3] impacting education remains limited, making systematic quantification a critical step for informing policies and climate-financing decisions, and strengthening resilience planning. This report provides the first regional estimate of the economic loss and damage of climate-related impacts on education in ESAR.

Extreme weather events have increased significantly in frequency, severity and human impact across ESAR since 2005. Over the past two

decades, the region experienced more than 700 extreme weather events, affecting 330 million people and resulting in more than 40,000 deaths. Floods, storms and droughts account for nearly all extreme events and associated impacts.

Evidence suggests that nearly three-quarters of these events (approximately 500–550 events) were made more likely or severe by climate change. These impacts undermine learning continuity and place increased pressure on education systems.

Direct economic loss and damage to education between 2005 and 2024 is estimated at approximately US$1.3 billion, with floods, droughts and storms driving the majority of impacts. Around US$0.2 billion is documented in post-disaster needs assessments (PDNAs) and similar assessments, while an additional US$1.1 billion was estimated for undocumented events using modelled extrapolation. Damages – primarily to infrastructure, classrooms, furniture and learning materials – account for half of the total impacts, with economic losses primarily arising from the additional expenditures required to establish temporary learning spaces following climate-related disruptions.

The scale of financing required to respond to climate-related loss and damage to education systems could have financed nearly **80,000 climate-resilient classrooms**, providing safe and sustainable learning environments for close to **five million children**. Set against already significant unmet education needs – where an estimated **58.7 million children aged 5–17 in Eastern and Southern Africa remain out of school** – these losses impose substantial **opportunity costs**, diverting scarce education financing away from expanding access, improving learning conditions and reaching children who are already excluded.[4] **If current trends continue, direct economic loss and damage to education could reach a net present value of US$3.3–3.8 billion between 2025 and 2050, with annual losses projected to rise sharply.** Direct annual loss and damage increased from roughly US$30 million in 2005 to around US$100 million in the 2020s, with peak years reaching approximately US$170 million. Projections suggest that, without strengthened action to avert, minimize and address loss and damage, annual impacts could rise to US$260–320 million by 2050, underscoring the escalating financial burden on education systems.

Direct economic loss and damage to education between 2005 and 2024 is estimated at approximately **US$1.3 billion,** with floods, droughts and storms driving the majority of impacts.

Long-term economic losses linked to reduced future earnings are substantial, with significant implications for children, families and national economies. Climate-related learning disruptions between 2005 and 2024 affected an estimated 130 million children cumulatively, resulting in US$120–140 billion in projected lifetime income losses. Projections suggest that, without strengthened action to avert, minimize and address climate-related loss and damage, cumulative learning disruptions could affect 440–520 million children between 2025 and 2050, resulting in an additional US$260–380 billion in economic losses. These findings indicate that long-term losses substantially exceed direct damages, underscoring the systemic and intergenerational consequences of climate-related loss and damage for education systems.

Beyond economic costs, climate change is driving significant non-economic loss and damage that undermines learning, safety, health and well-being across ESAR. Rising temperatures and heatwaves impair students' concentration, cognitive performance and exam outcomes, while negatively affecting teachers' attendance, productivity and mental health. Climate-related disasters and associated displacement disrupt school attendance and access, disproportionately affecting girls, children with disabilities and displaced populations. Climate-induced poverty and displacement further heighten protection risks, including child marriage, child labour, gender-based violence and recruitment by armed groups.

Overall, the findings underscore the urgent need to mobilize financing and strengthen education systems to address escalating climate-related loss and damage across ESAR. The evidence generated through this assessment supports governments and partners in informing financing decisions and integrating education priorities within technical assistance, capacity building, evidence generation and risk assessments across national and United Nations Framework Convention on Climate Change (UNFCCC) processes focused on loss and damage. Strengthened preparedness, response and recovery capacities are essential to safeguard learning outcomes, protect future earnings and uphold children's rights in a region facing increasingly severe climate risks.

I. Context and Background

UNICEF is prioritizing **robust, evidence-based research** to quantify the economic loss and damage caused by climate change to education systems in ESAR, with the aim of informing cost-effective, climate-responsive education planning.

UNICEF is prioritizing robust, evidence-based research to quantify the economic loss and damage[5] caused by climate change to education systems in ESAR, with the aim of informing cost-effective, climate-responsive education planning. An evidence-based approach empowers governments to develop effective policies and strategies; however, information on economic loss and damage to education from climate-induced disasters remains limited across ESAR. With climate and education as programmatic priorities within UNICEF's Strategic Plan (2026–2029),[6] UNICEF has commissioned this research to address critical evidence gaps, quantify economic loss and damage (to the extent data is available) and support governments in integrating these risks in Nationally Determined Contributions (NDCs), National Adaptation Plans (NAPs) and education sector plans and implementation.

The research aims to quantify the education-related climate impacts in ESAR to support government-led policy formulation and planning, inform national investment priorities and climate finance decision-making – including from multilateral climate finance mechanisms – and guide collective action to support the development of climate-resilient education systems in averting, minimizing and addressing climate-related risks and loss and damage.[7]

Cyclone Gezani's devastation is evident in the damaged Lycée Jacques Rabemananjara library in Toamasina, where destroyed infrastructure and flooded interiors have disrupted students' access to learning amid a wider humanitarian crisis affecting over 250,000 people.

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II. Economic Impacts

Scope and Principles

The quantitative elements of the analysis focus on direct (referred to in the report as immediate) economic impacts and a high-level estimate of indirect (referred to as long-term) economic impacts. The focus on direct economic loss and damage,[8] encompassing infrastructure, furniture, learning materials and the costs of temporary learning spaces, was prioritized due to higher data quality and availability for conducting the exercise. The quantitative study was developed using a simple and accessible approach, grounded in established frameworks, and built on robust data when available.

The high-level indicative estimate of long-term economic impacts was conducted using the "loss of future earnings" metric,[9] which drew on available data. Non-economic loss and damage were not covered in the quantitative analysis, but through qualitative case studies in the Non-Economic Impacts & Case Studies sections.

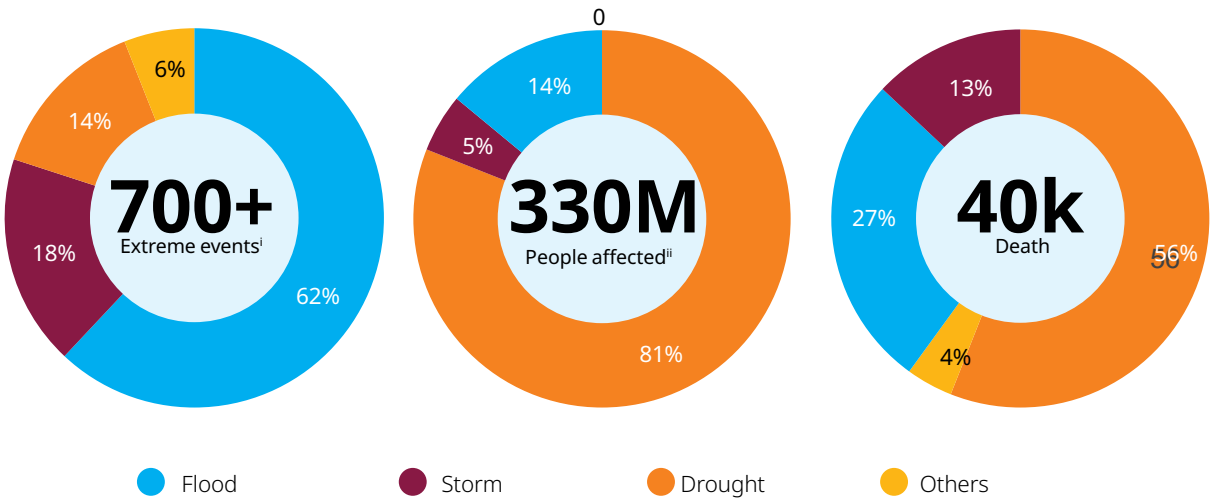
These findings should be interpreted as indicative estimates rather than precise forecasts. Details on assumptions and limitations are provided in the annex.

Key Results

Overview of Extreme Weather Events Impacting the Region

Since 2005, more than 700 extreme events have impacted ESAR, affecting a total of 330 million people and resulting in over 40,000 deaths. Floods, storms and droughts account for 94 per cent of all events, approximately 100 per cent of all people affected and 96 per cent of deaths – while floods make up the majority of events, droughts affected more people and led to more deaths. Around 74 per cent of events were made more likely or severe by climate change, and disasters are becoming more frequent and intense, affecting more people and leading to more deaths.[10]

FIGURE 1: Overview of all extreme weather events that impacted ESAR between 2005–2024



Direct economic loss and damage

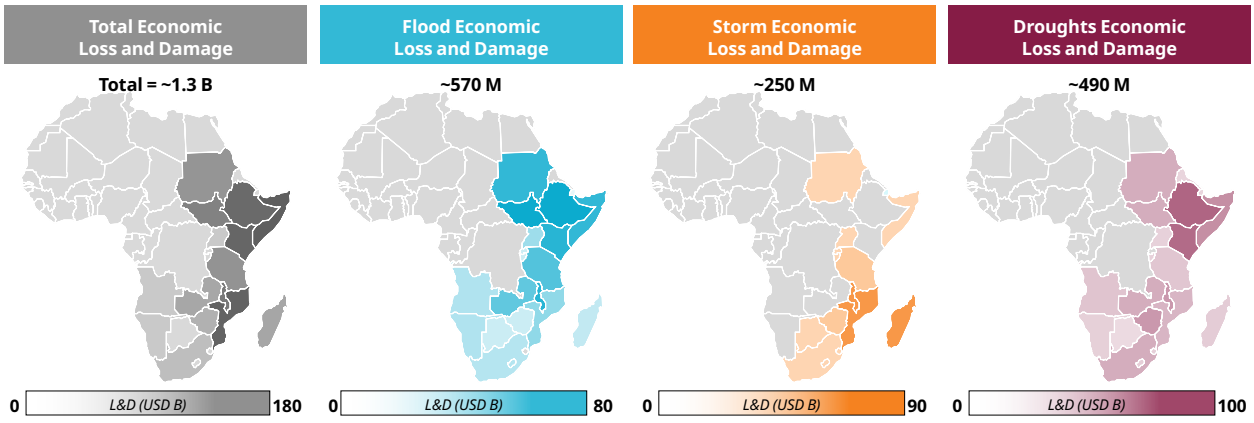
When focusing on education, the total direct (documented and estimated) economic loss and damage in ESAR is estimated to be approximately US$1.3 billion from 2005 to 2024. Around US$0.2 billion has been documented through post-disaster assessments (e.g., Post-Disaster Need Assessments, Rapid Impact and Needs Assessments, Drought Impact Needs Assessments, Humanitarian Response Plans, and Joint Damage, Losses and Needs Assessments), while approximately US$1.1 billion is estimated in this study based on modelling to address gaps in available documentation.

Damages account for half of the US$1.3 billion, with the other half comprising losses. Damages primarily affect infrastructure, furniture and learning materials, whereas losses are mostly related to additional costs of temporary learning spaces. The scale of damage could have financed nearly 80,000 climate-resilient classrooms, providing safe, sustainable learning for close to five million children.[11]

Floods contributed the most to the total direct economic loss and damage to education, which was mostly composed of damages, whereas drought represented a third of the economic loss and damage, mostly losses. Key flood events took place in Tanzania (2023), Somalia (2023) and Ethiopia (2023), and around two-thirds of the flood economic impact was damage, and one-third was losses. The most relevant storm events were Cyclone Freddy in Malawi (2023), Cyclone Kenneth in Tanzania (2019) and Cyclone Idai in Mozambique (2019), with approximately 75 per cent of the total impact being damages and approximately 25 per cent being losses. Key droughts heavily impacted Ethiopia (in 2015 and 2022) and South Africa (in 2015), with the majority of the impact being losses (primarily driven by additional costs for more meals, more expensive inputs and lost school fees).

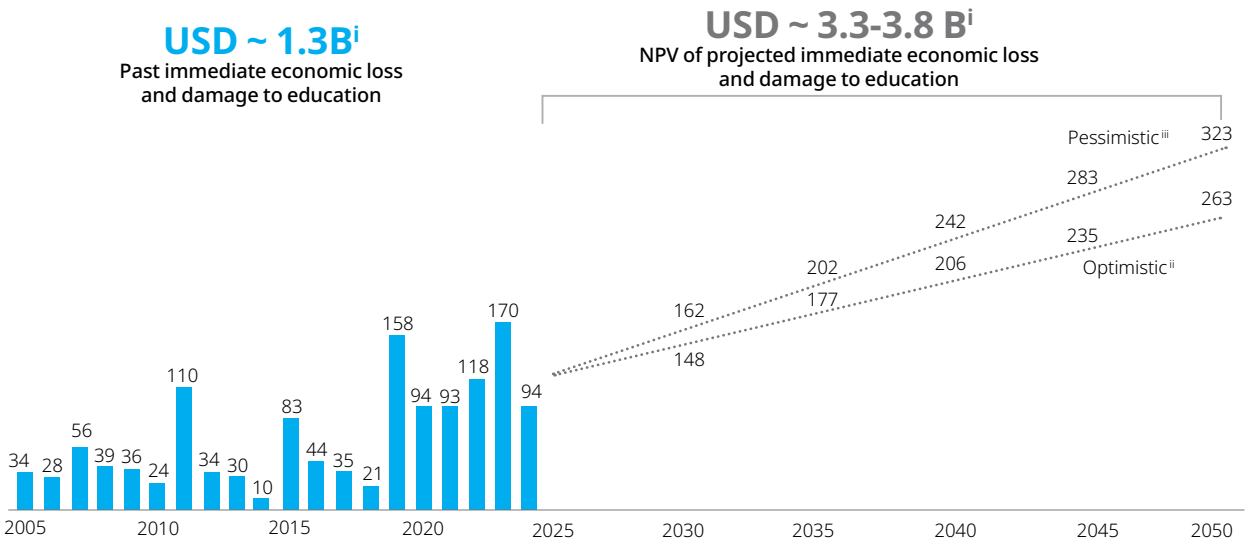
In the region, floods and droughts were most common in the East and the Horn of Africa, whereas storms affected mainly Southern Africa, especially Mozambique and Madagascar. Malawi was the worst affected (overall), followed by Ethiopia, Kenya and Somalia (especially impacted by droughts and floods), and Mozambique (heavily impacted by storms).

Figure 2: USD direct economic loss and damage to education in ESAR from 2005 to 2024, shown by disaster type and country



If current trends continue, total economic loss and damage to education in the ESA region has the potential to reach a net present value (NPV) of US$3.3–3.8 billion from 2025 to 2050. Direct annual loss and damage has increased from approximately US$30 million in 2005 to approximately US$100 million in the 2020s, reaching peaks of approximately US$170 million. This trajectory is projected to continue, reaching levels between US$260 and 320 million by 2050.

Figure 3: Past and projected direct economic loss and damage in ESAR[12]



Long-term Economic Loss and Damage

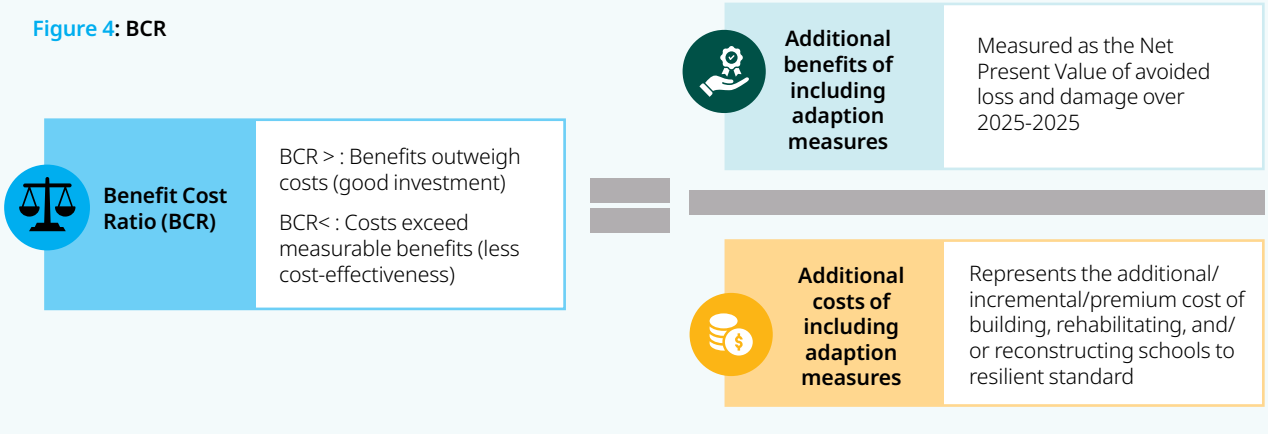
It is estimated that climate change has disrupted the learning of 130 million children cumulatively at pre-primary, primary and secondary levels between 2005 and 2024, resulting in an approximately US$120 to 140 billion in projected loss of future earnings. These impacts are expected to persist and compound over time. Without strengthened action to avert, minimize and address loss and damage, cumulative learning disruptions between 2025 and 2050 could affect an estimated 440 to 520 million children, leading to an additional US$260 to 380 billion of future earning losses.

Benefit-Cost Ratio (BCR)

It is estimated that every dollar invested in climate-resilient education infrastructure can generate 2 to 13 dollars in avoided or minimized future loss and damage. Investing in resilient schools is cost-effective, with a regional Benefit-Cost Ratio (BCR) analysis showing that resilient education infrastructure in ESAR delivers strong economic returns by reducing exposure to climate-related disruptions, underscoring the importance of including education across climate finance instruments, including loss and damage-relevant financing.

A BCR indicates the extent to which future loss and damage can be averted or minimized for every additional dollar invested in upgrading classroom construction standards. For example, investing upfront to upgrade a classroom to resilient standards can reduce future repair costs and learning disruptions resulting from floods, storms, or heatwaves that increasingly occur in repeated cycles across the region. This analysis finds that resilient construction delivers economic returns that substantially exceed the initial investment. BCRs therefore provide robust evidence to inform, prioritize and scale investments (in education) that reduce future climate-related loss and damage affecting education systems. Although some BCR estimates exist in other sectors, comparable analysis for resilient education infrastructure in ESAR remains limited to date.

Figure 4: BCR



A high-level analysis was conducted to estimate the BCR for resilient education infrastructure in the ESAR. Benefits were first estimated from the averted projected climate-related loss and damage, and costs were calculated based on the incremental cost per classroom of converting conventional infrastructure into climate-resilient facilities and the number of classrooms affected in the region. With both benefits and costs defined, the BCR was calculated, resulting in an estimate that every dollar spent on climate-resilient education infrastructure can save up to 2 to 13 dollars in reconstruction and recovery, with even higher returns when learning continuity and future earnings are factored in, in line with other benchmarks (Figure 5). The BCR can increase when other benefits (such as avoided losses of future earnings) are accounted for.

While the economic costs are significant, they represent only part of the overall impact. Climate change is also driving a wide range of non-economic impacts that undermine learning, safety and well-being. The next section highlights these impacts and illustrates them through country case studies.

Figure 5: BCR benchmark[13]

BCRs	Description	Hazard	Regions	Sectors	Source
4	Every USD 1 invested in making infrastructure disaster-resilient saves US$4 through fewer disruption and reduced economic impacts	Floods, storms, droughts and earthquakes	Low and middle income countries	Power, water and sanitation, transport and telecommunications	World Bank[1]
15	Every US$1 invested in risk reduction and prevention can save up to US$15 in post-disaster recovery	Aglobally and cross-sectorally recognized, generic cost-benefit ratio utilized by the UNDRR to underscore the necessity of moving international development financing toward pre-emptive disaster risk reduction			UNDRR[2]
3 to 50	Economic returns from climate-resilient investments are consistently positive, with BCRs typically above 3 and up to 50	Floods, storms and droughts	Synthesis of studies from around the world	Across sectors	Institute of Development Studies[3]
2 to 100	Each USD 1 spent on cliamte change adaptation interventions can yield USD 2 to USD 100 in benefits	Floods, storms and droughts	Africa	Across sectors	Swiss Re Institute[4]

III.Non-economic impacts & case studies

Overview of non-economic loss and damage

Beyond economic impacts, climate change is undermining education systems through multiple non-economic pathways that erode learning, safety and well-being. Schools are increasingly unsafe, exposed to heat stress and infrastructure damage, further compounding the barriers to equitable, continuous and quality learning across the region.

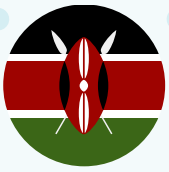
Learning outcomes and productivity: Rising temperatures and heatwaves reduce students' cognitive performance, concentration and exam results, while also impairing teachers' productivity and attendance.

Protection and equity: Climate-driven poverty and displacement have heightened protection risks such as child marriage, child labour, gender-based violence and recruitment by armed groups. Displacement and disaster-induced migration have severely affected attendance and access to education, especially for girls, children with disabilities and internally displaced populations.

(Mental) Health: Teachers also face increased absenteeism, burnout and mental health challenges, while students experience psychosocial trauma from the destruction of schools and social networks.

Case studies

The following section explores non-economic impacts of climate change through a series of case studies. Each case highlights different impacts of climate change unfolding in practice, from deepening inequality to the role of resilient infrastructure, and from the climate-conflict nexus to the effects of rising heat on learning. Together, they provide concrete examples of how these pathways shape children's experiences and why tailored responses are needed across the region.



The impact of climate change on equity: When flooding deepened educational inequities in Kenyan schools

The 2024 floods in Kenya illustrate how climate change is driving **non-economic loss and damage through deepening educational inequality**, with impacts falling most heavily on already marginalized learners. While flooding caused widespread physical damage to schools and communities, its most enduring effects were **less visible but more persistent**: the erosion of equitable access to education, the loss of safety and dignity for girls and children with disabilities and the deepening of pre-existing structural inequities. This case underscores the need for climate-resilient and equity-centred education systems that protect all learners, particularly during and after disasters.

In Kenya, floods are the most significant climate-related disaster, accounting for 80 per cent of recorded extreme events and 93 per cent of related deaths, with the 2024 floods being the deadliest to date.[14] In Kenya, human-induced global warming of about 1.2°C has made extreme rainfall events – which drive flooding – about twice as likely and 5 per cent more intense.[15]

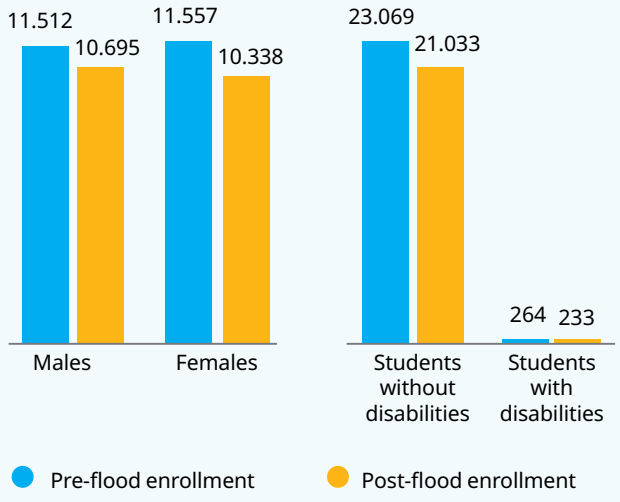
Floods are Kenya's most serious climate disaster, responsible for **80% of extreme events** and **93% of deaths**, with 2024 experiencing the deadliest floods.

The April–May 2024 floods were among the most destructive in recent history, with extensive loss of life, displacement and damage to critical infrastructure and productive assets. The floods severely disrupted education across Kenya, revealing gaps in the system's preparedness to safeguard learning and respond effectively. The total education recovery needs, including infrastructure rebuilding, a 10 per cent margin for building back better, and 5 per cent for inflation, are estimated at more than US$63.5 million.[16]

Flooding acts as a driver of non-economic loss and damage through deepening educational inequities: The floods disproportionately hit the most vulnerable hardest. The post-disaster enrolment drop was higher among girls than boys (10.5 per cent vs. 7.1 per cent), meaning roughly one and a half girls left school for every boy (see Figure 6 below).[17] The enrolment drop among students with disabilities was about one-third higher than for students without disabilities (11.7 per cent vs. 8.8 per cent).[18] These disparities reflect not only temporary disruptions but systemic losses of access, participation and inclusion.

Recovery processes can unintentionally reinforce exclusion. In many cases, aid and school repairs prioritize getting the majority of students back to class as quickly as possible, following standard processes that may overlook the specific barriers faced by learners with disabilities or girls, such as unsafe WASH environments.

Figure 6: Enrolment drop-off by gender (male vs. female) and disability (with vs. without), number of students[19]



Intersectionality and compounded non-economic losses: Dropout risks generally soar when gender intersects with enrolment in informal, non-government-backed schools. A comparison of two schools in Nairobi, both exposed to similar flood intensity, highlights how intersectionality matters. At Why Not School in Mathare, which operates without formal government support, girls faced a 29-point dropout gap compared to boys (29 per cent versus 0), more than double the 12-point gap (25 per cent versus 13 per cent) observed at Mathare North Primary, a government-backed school.[20] While government-backed schools tend to have stronger infrastructure and quicker access to recovery support, they still fall short of eliminating gender-based disparities, highlighting **structural inequities that disasters exacerbate rather than create**.

The steeper losses experienced by students with disabilities and girls illustrate how climate impacts compound existing inequities across sectors. Inaccessible facilities, heightened health risks, increased care burdens and restrictive social norms make their return to school significantly more difficult. Flood-damaged classrooms, unsafe sanitation facilities and damaged or inaccessible roads create physical barriers that disproportionately exclude children with disabilities, especially in rural areas.[21] The loss of assistive materials and adapted learning resources further delays re-enrolment and constrains meaningful participation even after schools reopen.[22] These barriers translate into **loss of autonomy, participation and equal treatment**, core dimensions of non-economic loss and damage.

For girls, economic and social pressures often intensify during crises. Families may prioritize boys' education, while girls are withdrawn from school to assume household duties, engage in income-generating activities, or, in some cases, even forced into child marriage as a negative coping mechanism. Inequalities are particularly stark across income groups: for every 100 girls from the richest quintile who complete primary school, only 16 from the poorest do.[23] Flooding further exacerbates these disparities, resulting in lasting losses to girls' agency, education attainment and life opportunities.

"The floods took all our harvest … I tried to negotiate to tell my parents that I wasn't ready, that I didn't want to get married, but they told me that I had to because that would mean one mouth less at the table. I had to get married because they didn't have enough to feed the whole family" – Ntonya (age 15, married at 13)[24]

This testimony illustrates how climate shocks can trigger **irreversible non-economic losses**, including the loss of childhood, education and personal autonomy, particularly for adolescent girls.

Lessons for ESA countries

The Kenya case demonstrates how climate-related disasters can **generate and entrench non-economic loss and damage through existing inequalities**, underscoring the need for recovery and preparedness efforts that place equity at the centre of education response. **To address deepening post-disaster inequities, recovery efforts must go beyond rebuilding infrastructure and adopt inclusive, equity-centered approaches:**

- **Disaster preparedness must be embedded at the school level** to protect infrastructure, WASH and learning continuity ahead of future floods. In flood-prone areas, schools should incorporate age-appropriate safety and preparedness education, including swimming and flood survival skills, complemented by child-sensitive early warning systems for schools and communities.
- **Equity gaps must be prioritized in recovery** to ensure girls, learners with disabilities and marginalized communities are not excluded when resources are constrained, including access to mental health and psychosocial support. Education recovery efforts should be more closely linked with household social protection and emergency cash support, coordinated with child protection and adolescent-focused services and supported by mobilizing school committees to support re-enrolment among these groups.
- **Use climate evidence to unlock adaptation finance:** Leverage data to strengthen NAP and NDC updates, and to develop climate-resilient school proposals under climate finance mechanisms.
- **Establish predictable financing for equitable recovery**, beyond ad-hoc donor responses, to fund safe classrooms, learning materials and psychosocial services. This includes ringfencing emergency response allocations within government education budgets to enable timely and equitable recovery and reduce reliance on external aid.
- **Integrate cross-sectoral solutions:** Coordinate education recovery with health, WASH, nutrition and livelihood interventions to reduce barriers to re-enrolment and sustained attendance.
- **Monitoring and accountability systems are needed** to track who returns to school, using disaggregated data by gender, income and displacement status to analyze intersecting vulnerabilities, identify who is being left behind and enable timely corrective action.
- **Government actions should also align with the African Union's Continental Education Strategy for Africa (CESA 16-25**), strengthening coherence with regional resilience and equity priorities.

When climate extremes threaten education in Zambia

Zambia's **changing temperatures and rainfall** have caused floods, droughts, and extreme events, including the 2023–24 El Niño drought, **affecting 17 million people** since 2005.

From prolonged drought to destructive flooding, Zambia's shifting climate is driving **non-economic loss and damage in education**, undermining children's learning, well-being and future opportunities. While infrastructure damage and economic losses are visible, the most enduring impacts are often **less tangible –** lost learning time, heightened stress, disrupted childhoods and increased protection risks. The recent El Niño crisis illustrates why education must be part of climate action, with investment in systems that can endure these growing risks. Zambia's climate has been disrupted by shifting temperatures and rainfall, leading to floods, droughts and extreme events such as the 2023–24 El Niño-induced drought, which has affected 17 million people since 2005.[25] Zambia's 2024 El Niño drought left nearly 10 million people without food, water, or power – one of its worst droughts in decades, affecting people across 84 districts.[26] The crisis created widespread humanitarian needs, with 6.6 million people requiring urgent assistance for health, WASH, nutrition, water and child protection services.[27]

"El Niño, which is especially intensified by human-induced climate change, highlights the widespread negative impact of the climate crisis on children"
UNICEF

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The drought forced children out of school and disrupted learning for those who remained. Drought-hit areas saw reduced school attendance as children worked to support families, and teachers also struggled with its impacts.[28] In Zambia, drought-driven blackouts left schools without water and power, disrupting operations and, in some cases, limiting school hours or attendance.[29] Even when children attended school, hunger, thirst and exhaustion impacted concentration and learning, while teachers faced power cuts and extra chores.[30] These disruptions reflect a broader regional pattern in which drought erodes household resilience and results in **persistent non-economic losses**, including interrupted education pathways, reduced learning quality and weakened psychosocial well-being.

From 2005 to 2024, total direct economic loss and damage on education in Zambia is estimated at around US$60 million, and is expected to reach between US$230–295 million by 2050 if no action is taken. Floods caused 60 per cent of the total direct economic loss and damage, primarily through infrastructure damage, while droughts accounted for 40 per cent of the total, mainly through the cost of restoring student meals. Without further investment, cumulative direct economic loss and damage on education in Zambia are expected to rise due to increasing climate extremes and population growth. Higher greenhouse gas concentrations are projected to increase Zambia's average temperatures by 1.6°C to 1.7°C by 2050 compared to 2005 levels.[31] At the same time, Zambia's population is set to nearly double, from about 21 million in 2024 to between 37 and 41 million by mid-century, with school-age children representing the fastest-growing group,[32] increasing pressure on already vulnerable education systems.

Beyond direct costs, climate-related disruptions to education have generated **substantial non-economic losses with lifelong implications**. **Since 2005, around 5 million children in Zambia have experienced climate-related learning disruptions, contributing to an estimated US$4 to 5 billion in lost future earnings, which is projected to reach 13 to 21 billion by 2050.** Missed school days today mean lower lifetime earnings tomorrow, as repeated school closures, reduced learning hours and shortened terms combine to cause long-term losses in productivity and income. The impacts are most severe in rural areas where families rely on subsistence farming, and children often leave school to work or migrate when crops fail or household income declines. Only 13 per cent of rural students complete upper secondary education compared to 50 per cent in urban areas. Girls face compounded income penalties, completing upper secondary school at lower rates than boys: a rate of 26 per cent compared to 33 for boys.[33] Climate shocks can widen this gap .

Beyond financial losses and disrupted schooling, Zambia's drought-flood cycles have caused deep social and psychological stress, especially for rural girls. Climate shocks displace families, break community ties and leave children socially isolated and traumatized. For rural girls, poverty from climate crises increases rates of child marriage and early pregnancy. National data show that early pregnancy and motherhood affect 36 per cent of girls aged 15–19 in rural areas, nearly double the rate in urban areas.[34] In Lusangazi District, reported teenage pregnancies doubled between January–June 2023 and during the same period in 2024.[35] These trends illustrate how climate-induced poverty compounds gender inequality, exposing girls to lasting educational, health and protection risks.

Figure 7: Early pregnancy and motherhood by residence, percentage of women age 15-19 who have begun childbearing[36]

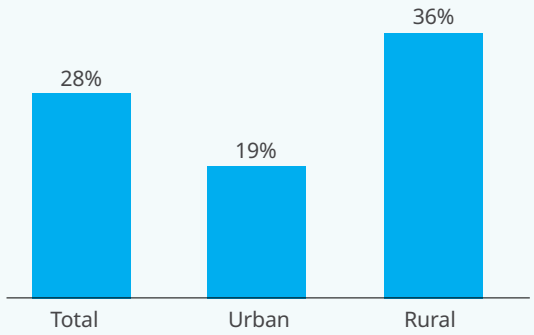
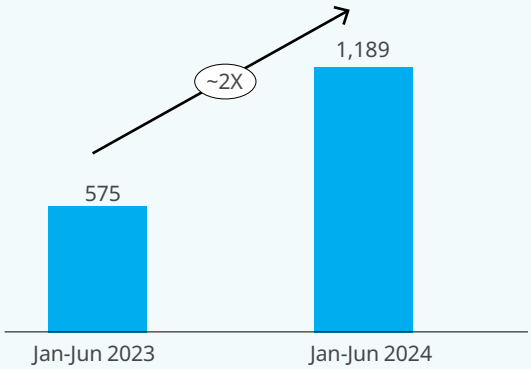


Figure 8: Reported pregnancies, girls aged 10-19 years in Lusangazi District[37]



Lessons for ESA countries

Zambia's case demonstrates why education must be prioritized within climate financing mechanisms.

- **Impact:** The Zambia case demonstrates the significant economic impacts of climate change on education, showing how both immediate shocks and longer-term disruptions undermine learning and child development. Strengthening the systematic collection of climate-related loss and damage data for education would enhance the evidence base, including through UNICEF's Global Child Hazard Database.
- **Invest in resilience to prevent non-economic losses:** Strengthening education systems to withstand climate shocks is essential to reduce future costs, protect schools and learning, and ensure continuity during climate-related disasters. Yet education remains severely underfunded within climate finance. Addressing this gap is critical, including through investments that help avert, minimize and address climate-related loss and damage affecting children and education systems.
- **Protect education as a child right:** Education is a basic right, and ensuring it is protected within climate-related financing and response efforts is an essential foundation for resilience and long-term recovery.

The power of resilient design: Lessons from Mozambique's cyclone-exposed classrooms in reducing loss and damage

Mozambique's experience shows that climate-**resilient schools reduce cyclone damage** and **help protect children's safety and learning continuity**.

Mozambique's experience demonstrates how climate-resilient school construction can prevent both economic and non-economic loss and damage, protecting children's safety, learning continuity and well-being even during major cyclones. While cyclones cause visible destruction to infrastructure, their most enduring impacts are often **non-economic**, including prolonged school closures, trauma, learning loss and increased protection risks for children. This case study shows how scaling resilient classrooms can significantly reduce these losses and preserve learning in high-risk contexts.

Mozambique is among the world's most climate-vulnerable countries, as it lies within the primary cyclone belt, and it is experiencing increasingly frequent and intense storms, with children disproportionately affected.[38] It ranks 10th out of 163 countries for children most at risk from climate change.[39] The scale of exposure was starkly demonstrated in 2019 when Cyclone Idai affected 900,000[40] children and caused US$2.8 billion in economic loss and damage. Just weeks later, Cyclone Kenneth affected 200,000 children, with an additional US$0.2 billion in loss and damage. Combined, these two cyclones affected 10,500 teachers across nearly 5,000 classrooms, with US$24 million in total economic loss and damage to the education sector.[41]

Mozambique is **among the countries most vulnerable to climate risks for children**, ranking 10th globally. In 2019, **Cyclones Idai and Kenneth affected about 1.1 million children**, caused **US$3 billion in losses**, and impacted **10,500 teachers and nearly 5,000 classrooms**, with **US$24 million in damage to the education sector**.

Beyond these quantified losses, repeated cyclone damage has driven **significant non-economic losses**, including prolonged disruption to learning, erosion of children's sense of safety and heightened psychosocial stress.[42] Even in "non-crisis" years, Mozambique loses an estimated 600 classrooms annually to storms and riverine erosion,[43] which steadily undermines educational access and continuity for thousands of students and produces cumulative learning losses over time. These repeated losses illustrate how climate-related hazards generate cumulative loss and damage in education systems, as repeated damage to classrooms disrupts schooling and compounds impacts on children's learning and development.

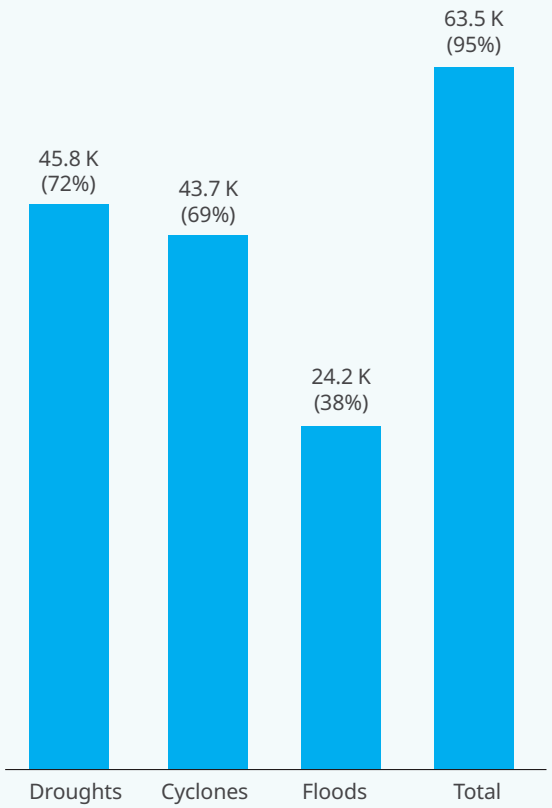
Amidst the widespread devastation caused by cyclones, schools built in accordance with the UN-Habitat Resilient School Guidelines have demonstrated the ability to withstand both physical destruction and minimize non-economic loss and damage. Resilient schools achieved a 100 per cent survival rate during Cyclones Idai and Kenneth, serving as safe havens during emergencies and enabling a much faster return to learning.[44] By preventing destruction and reducing prolonged school closures, these investments help avoid learning disruptions and the associated loss of future earnings. In addition, resilient school investments also avert non-economic losses and deliver important social benefits, keeping children safe, emotionally secure and in school, with particular benefits for girls.

Figure 9: BCR per classroom[45]

Avoided damage[i]	Reconstruction cost	USD 15,000[iv]	
	Cost of emergency response	USD 200	
	Cost of Asset Losses	USD 300	
	Total avoided damage	USD 15,500	
Premium cost[ii]	Cost of including adaptation measures	USD 6,500 (20% of original cost)	USD 3,250[v] (10% of original cost)
BCR[iii]	Damage prevented once	2.4x	4.8x
	Damage prevented twice	4.6x	9.1x
	Damage prevented three times	6.7x	13.5x

With nearly every classroom in Mozambique exposed to hazards – worsened by climate change – investing in resilient school construction is essential to protect children's safety and learning. In Mozambique, 95 per cent of classrooms are exposed to at least one major hazard, and 72 per cent of schools are located in high-risk areas for one or more hazards (Figure 10).[46] With support from UN-Habitat and UNICEF, Mozambique developed climate-resilient classroom designs tailored to local risks.[47] Despite progress, an immense funding gap remains.[48] Investing early is also more cost-effective. Incorporating resilience during new construction adds only about 10 per cent to costs, compared to up to 25 per cent when retrofitting or rebuilding after damage.[49] Delayed investment therefore results not only in higher economic costs but also in greater and more persistent non-economic losses, including extended learning disruption and increased child vulnerability. These impacts illustrate how delayed investment increases the accumulation of loss and damage over time.

Figure 10: Number of classrooms at risk, percentage and number of schools at risk[50]



Lessons for ESAR countries

The Mozambique case underscores the importance of **using resilient infrastructure as a means of preventing avoidable non-economic loss and damage in education**, particularly in cyclone- and flood-prone contexts. **Delivering resilient and inclusive education (in Mozambique) requires a sharper focus on where, how and for whom infrastructure is designed and built.**

- **Prioritize highest-risk zones to prevent disproportionate loss and damage:** Identify areas most vulnerable to climate change and direct initial resilient school investments where exposure to cyclones, floods and other shocks is highest.
- **Align infrastructure with zone-specific climate risks:** Select resilient school designs tailored to local hazard profiles, ensuring each investment addresses the relevant climate threats in that region (e.g., cyclone-proof designs for coastal areas and heat/drought-adapted models inland), ensuring resilience to compound risks where hazards overlap.
- **Invest in resilience from the outset:** Make resilient design mandatory for all new construction in high-risk zones, as early investments deliver the highest cost-benefit returns and prevent irreversible learning losses.
- **Mobilize innovative climate finance:** Unlock climate funds, risk-pooling instruments and blended finance to bridge Mozambique's US$3+ billion classroom resilience gap.[51] The current gap is over three times Mozambique's annual education budget and roughly 26 times its current capital investment in education.[52]
- **Centre equity and child protection:** Ensure that every infrastructure investment includes gender- and child-responsive design, safeguarding all learners regardless of geography, gender, or disability.
- **Pair physical resilience with social readiness:** Complement resilient school infrastructure with measures that address teachers' well-being, care burdens and social and economic stressors to ensure recovery and learning continuity are sustained beyond the physical environment.

Somalia's double crisis: How climate extremes and conflict reinforce exclusion from education

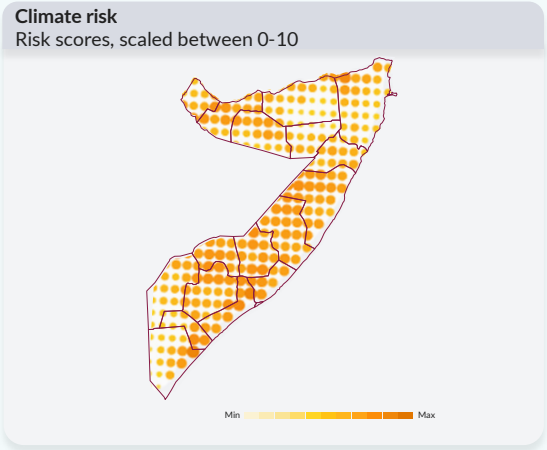
Climate hazards and violence overlap in some regions, damaging infrastructure and displacing families at scale, resulting in **the loss of learning continuity, safety and future educational opportunities for millions of children.** This case study highlights the need for integrated humanitarian, climate and peace responses that protect learning for the most vulnerable children. Highly exposed to climate hazards and with limited capacity to adapt, Somalia is one of the world's most climate-vulnerable countries. Somalia ranks 181st in vulnerability to climate change and 121st in readiness to adapt, out of 192 countries on the Notre Dame-Global Adaptation Index (ND-GAIN).[53] Somalia also ranks 4th out of the 163 countries and regions on UNICEF's Children's Climate Risk Index (CCRI), placing children in Somalia at "Extremely High" risk.[54]

Drought-flood whiplash and protracted conflict are driving mass displacement and combined economic losses estimated at 35–45 per cent of Somalia's GDP annually.[55] From 2017 to 2024, Somalia experienced 10.2 million internal displacements: Disasters (mainly drought and flooding) accounted for 6.6 million (~65 per cent), while conflict-related displacements totalled 3.6 million (~35 per cent). As a result, as of 2024, there are ~3.8 million Internally Displaced People (IDPs) in Somalia, with 81 per cent (3.1 million) due to conflict and 19 per cent (0.7 million) due to disasters.[56] Beyond economic losses, repeated displacement has resulted in significant non-economic losses, including the erosion of learning continuity, psychosocial well-being, community cohesion and children's sense of safety and belonging.

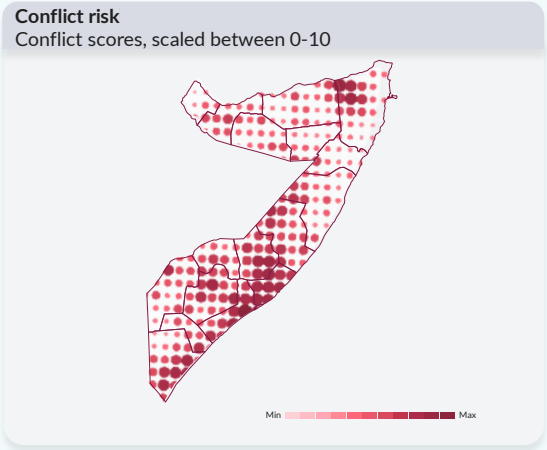
Climate shocks and conflict are reinforcing cycles of displacement and the disruption of (education) services, especially in south-central Somalia. Drought-flood cycles damage infrastructure, deplete natural resources and degrade farmland, driving competition over scarce water, pasture and arable land. This deepens livelihood losses and local tensions, fuelling conflict and insecurity. In turn, this leads to displacement and major disruptions to essential services, including education, resulting in cumulative and often irreversible learning losses and further weakening community resilience. Children in these areas face severe barriers to school access, where enrolment is already one-third below the national average.[57] The regions most exposed to climate risks are also Somalia's most exposed to conflict risks, illustrating a tightly interconnected climate and conflict nexus.[58]

Figure 11: **Climate and conflict risk[59]**

The southern and central regions of Somalia face the country's highest climate risks



Conflict is also concentrated in these same south-central regions, reinforcing vulnerability



Somalia is highly vulnerable to climate change, ranking **181st in vulnerability** and **121st in readiness** to adapt on the ND-GAIN Index. It also ranks **4th on UNICEF's Children's Climate Risk Index,** placing Somali children at extremely high climate risk.

This double crisis has made Somalia the country with the highest number of child displacements in ESAR, and has pushed over 4.5 million children out of school. Somalia accounted for one-third of child displacements in ESAR from 2017 to 2023.[60] The 4.5 million children and youth who are out of school in Somalia as a result of conflict, climate change and other crises represent more than 60 per cent of the school-aged population.[61] Displaced children are the most excluded, with attendance rates for newly displaced children as low as 21 per cent, compared with 39 per cent for children who are not displaced.[62] Girls face even greater barriers: only 23 per cent complete primary school versus 32 per cent of boys,[63] and as climate shocks and conflict deepen poverty, many girls are exposed to increased risks of child marriage and increased household responsibilities that further limit their ability to attend and complete school.[64] These outcomes represent profound non-economic losses with long-term, intergenerational consequences for children's development, agency and future livelihoods. **In addition, armed groups are deliberately targeting schools and subjecting thousands of children to recruitment, rape and abduction.**

Schools and education systems have become direct targets, with at least 92 school attacks from October 2019 to September 2021, and many children facing extreme conflict-related violations, including the recruitment and use of 2,852 children, the killing and maiming of 1,857, the rape or other forms of sexual violence of 701 and the abduction of 2,502.[65] Armed violence is concentrated in the same south-central regions hardest hit by climate shocks,[66] compounding children's loss of safety, dignity and access to education.

Despite ongoing crises, **Somalia is taking concrete steps to strengthen its education system, build climate resilience and advance peace and stability.** Among other initiatives, the government has launched the Education Sector Strategic Plan, which sets out priorities on access, equity, quality and governance;[67] expanded 134 temporary learning spaces across 12 drought-affected districts with the support of UNICEF;[68] and launched its Centennial Vision 2060 roadmap in mid-2025, focused on peace, stability and institutional reform as long-term goals.[69]

Lessons for ESA countries

The Somalia case underscores the importance of **strengthening the integration of climate and conflict risk considerations into education systems** to prevent avoidable non-economic losses, with relevance for ESA countries facing similar compound risks. **Education systems need to be redesigned to address climate change and conflict as interconnected challenges.**

- **Integrate the nexus of education, climate change and conflict into policy design:** Identify policy gaps and ensure education, climate and peace agendas are planned and financed as interconnected systems.
- **Prioritize inclusive and resilient education systems that support peacebuilding and climate adaptation:** Invest in school infrastructure, teacher training and curricula that equip children and youth with the knowledge and skills for adaptation and social cohesion.

- **Bridge federal-state-local coordination:** Strengthen governance and accountability mechanisms to ensure national policies translate into coherent local implementation across all administrative levels.
- **Institutionalize monitoring, evaluation, and learning:** Establish a unified Monitoring, Evaluation and Learning system with clear metrics across education, climate and conflict dimensions to track resilience outcomes and reduce long-term loss and damage.

The silent threat of rising heat on education in Ethiopia and beyond

Temperatures in Ethiopia have **risen by 0.8 °C** since 1950 and are **projected to increase by 1.9–3.4 °C** by the end of the century, **depending on emissions levels**.

Ethiopia's experience illustrates how increasing temperatures and intensifying heatwaves are driving **non-economic loss and damage in education, quietly eroding children's learning, health well-being and future opportunities.** Unlike sudden-onset disasters, heat-related impacts accumulate gradually and often go unnoticed, yet they result in **lasting and compounding losses** to children's cognitive development, school completion and life trajectories. This case study highlights similar patterns emerging across other countries and calls for climate-responsive solutions to prevent irreversible losses.

Climate impact reporting often prioritizes more visible extreme weather events, while the **slow-onset impacts of rising temperatures and heatwaves** receive far less attention**.** Yet increasing heat represents a significant driver of non-economic loss and damage, particularly in education, where learning time lost, cognitive impairment and reduced educational attainment cannot be fully recovered or compensated. This case study focuses on the direct but often overlooked link between rising heat exposure and enduring losses in educational outcomes.

Temperatures in Ethiopia have increased by 0.8°C since 1950 and are projected to rise by an additional 1.9°C to 3.4°C by the end of the century, depending on the emissions pathways.[70] Rising temperatures are increasing the frequency and intensity of heatwaves, which are already affecting 83 per cent of Ethiopian children. By 2050, an estimated 47 million children could be exposed to temperatures exceeding 35°C for more than 80 days per year[71] **–** significantly increasing heat exposure during critical learning and development periods.

Rising temperatures affect children's education through multiple pathways, including physiological, cognitive and psychosocial**, with the impact felt acutely in early development.** Heat exposure during pregnancy and childhood harms cognitive and physical development, reducing learning capacity and educational attainment. In school settings, sustained exposure to high classroom temperatures increases fatigue, illness and mental stress, undermining concentration, attendance and learning continuity. Together, these effects generate cumulative non-economic losses that extend well beyond short-term learning disruptions.

- **Early life and development impacts:** High temperatures during pregnancy or early childhood can result in irreversible developmental losses with long-term educational consequences. In Ethiopia, higher temperatures in utero are associated with severe stunting, which is associated with reduced neurocognitive function and lower educational attainment.[72] These early losses weaken foundational learning and compound over time, shaping a child's entire educational trajectory. Comparable evidence from other regions reinforces this pattern: in Southeast Asia, children exposed to heat stress in utero or early life completed 1.5 fewer years of schooling on average, while in Colombia, an exposure to extreme weather conditions before birth reduced the likelihood of remaining in school by approximately 5 per cent.[73] These findings illustrate how heat-related non-economic losses manifest across diverse contexts and persist across the life course.

- **Acute physiological and cognitive strain:** Heat stress impairs children's ability to learn by affecting their bodies' core functions as their bodies dehydrate more easily and have less efficient temperature regulation, making their immune systems more vulnerable.[74] Rising temperatures can impair reaction time, processing speed and accuracy by elevating heart and respiratory rates. On average, a child's heart rate increases by about 10 beats per minute and respiratory rate by up to two breaths per minute for every 1°C rise in body temperature, putting them at greater risk of heat-related illness and fatigue.[75] These physiological effects translate into **lost concentration, reduced learning quality and diminished educational experience**, all of which constitute non-economic losses.

- **Physical Health and Disease Burden:** Higher classroom temperatures have been linked to a range of respiratory and physical symptoms – including fatigue, headaches and dizziness[76] – affecting students' health and learning. Extreme heat can exacerbate asthma and other respiratory conditions, particularly in settings with poor indoor air quality. In Ethiopia, where four out of five children are exposed to heatwaves and indoor air pollution levels remain high, the combined impact of heat stress and air pollution heightens the risk of chronic respiratory disease.[77] These conditions result in persistent health-related non-economic losses, including reduced well-being, lower school participation and diminished learning capacity.

- **Mental and emotional health impacts:** Sustained exposure to extreme heat can undermine children's mental and emotional health, reducing concentration, disrupting learning and contributing to school absenteeism. Evidence suggests that sustained heat exposure may interfere with the development of emotional regulation circuits in the brains of unborn and young children. As a result, children and adolescents are particularly vulnerable to heat-related stress, anxiety and mood disturbances – non economic losses that have long-term implications for cognitive and emotional development.[78]

Exposure to high temperatures during the school years is linked to lower completion rates and lower exam performance, which can play a decisive role in shaping future opportunities. Ten extra hot days can reduce average performance by roughly 2.3 per cent, a figure that can play a decisive role in shaping future opportunities.[79] Higher temperatures also affect grade completion, with temperatures 0.5 standard deviation (SD) above village temperature mean linked with 21 per cent and 28 per cent lower odds of a child completing at least one grade of school.[80] These findings align with studies in other countries, which show that temperature increases are associated with poorer educational performance. In Brazil, one SD increase in the number of days above 34°C was associated with a 5.1 per cent increase in dropout rates (the effects were mainly in public schools in urban areas, possibly due to worse air conditioning access versus private schools and more crowded classrooms than in rural areas).[81] In Tanzania, hotter days are also associated with lower exam performance: taking exams when the outdoor temperature is 33°C results in 14 per cent of a SD lower exam performance relative to a day at 24°C, which, for the average Tanzanian student, means a 13 per cent lower chance of passing a given subject.[82] Together, these findings demonstrate how rising temperatures generate systemic, cumulative and often irreversible non-economic loss and damage in education systems.

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Lessons for ESA countries

With the growing evidence that rising temperatures are undermining students' performance in Ethiopia and around the world, political commitments to protect children's education must be translated into action. To address the direct effects of rising temperatures on learning, education authorities should improve classroom cooling and ventilation, adjust schedules to avoid peak heat and regularly assess thermal conditions.

- **Integrate heat-risk assessments into NAPs, NDCs and sector plans**: Ensure temperature and heatwave projections are reflected in infrastructure planning, school safety guidelines and education budget allocations.
- **Reduce heat exposure within the school environment:** Prioritize context-appropriate and low-cost solutions, such as passive measures, including tree planting to provide shade, reflective/white roofing, improved natural ventilation and insulating materials and, if possible, active cooling options (fans, air conditioning) to mitigate discomfort and improve learning conditions.
- **Consider adjustments to the academic day and calendar, and instructional** practices to protect students and teachers from the direct negative effects of peak heat, e.g., by modifying school schedules to start earlier and/or finish late,[83] and by aligning school holidays with the hottest season.
- **Implement a systematic evaluation of classroom learning environments,** particularly for thermal comfort, to guide infrastructural improvements and classroom management strategies.
- **Minimize impact by addressing health issues caused directly by heat exposure** to improve student alertness, concentration and attendance. This includes ensuring water availability to students during classroom hours, especially when temperatures are high.[84]

IV. Annexes

Definitions

Loss and damage concepts

- **Loss and Damage:** *"Loss and damage describes the impact associated with the adverse effects of climate change"*,[85] Loss and Damage (capitalized letters) is used to refer to the political debate under the United Nations Framework Convention on Climate Change (UNFCCC), in particular under the WIM and its ExCom, and Article 8 of the Paris Agreement, which recognizes loss and damage as the third pillar of climate action. [86]

- **Economic loss and damage:** *"Economic losses can be understood as the loss of resources, goods, and services that are commonly traded in markets"*,[87] and hence can be assigned a monetary value.

- **Non-economic loss and damage:** *"Non-economic losses can be understood as the remainder of items that are not economic items; that is to say that non-economic items are those that are not commonly traded in markets".*[88]

- **Economic loss:** Impacts on economic flows[89] and extra costs that arise because those assets are no longer fully usable.

- **Economic damage:** Impacts on physical stocks and assets,[90] a one-off reduction in the stock of capital.

Extreme vs. slow-onset events

- **Extreme weather events:** *"An extreme weather event is an event that is rare at a particular place and time of a year"*,[91] such as tropical cyclones, floods, droughts, heat waves and storm surges.

- **Slow-onset events***: "Slow-onset events usually develop gradually over time, and their impacts are often based on a confluence of several different events"*,[92] such as sea level rise, desertification and land degradation.

High-level Overview of the Methodology

Different approaches were used for the four key modules:

Please note that **direct economic loss and damage** refers to the immediate impacts of climate-related events. For ease of reference and consistency with the main report, the term "immediate economic loss and damage" has been used throughout the main report, although conceptually this corresponds to direct economic loss and damage.

Past direct (immediate) economic loss and damage: The analysis first estimates the impact of major events documented in Post-Disaster Assessments (e.g., Post-Disaster Needs Assessments, Rapid Impact and Needs Assessments, Drought Impact Needs Assessments, Humanitarian Response Plans and Joint Damage, Loss, and Needs Assessments). These events are then assessed for their potential attribution to climate change. For remaining events where economic loss and damage are not available but metrics such as the number of people affected are reported in EM-DAT, ratios such as impact per person affected are applied to extrapolate the likely economic loss and damage.

Future direct (immediate) economic loss and damage: Two approaches are applied. Approach A regresses past education-related economic loss and damage (calculated as described above) on student enrolment and temperature increases and then projects future loss and damage using population growth and temperature forecasts under two scenarios. Approach B draws on the INFORM Climate Change Risk Index, which provides country-level exposure data by disaster type for 2022 and 2050; these exposure metrics are used to forecast future economic loss and damage in the education sector – based on RCP 4.5 (moderate emissions) and SSP2 – Middle of the Road (Medium challenges to mitigation and adaptation), and RCP 8.5 (high emissions) and SSP 3 (Regional Rivalry – high challenges for both mitigation and adaptation, including higher population growth).

Past long-term economic loss and damage (loss of future earnings – high-level assessment): The loss of future income is estimated by multiplying: (i) the number of enrolled students across all cohorts from 2005–2024; (ii) the proportion of students affected by climate change (using UNICEF estimates); (iii) the average annual number of school days lost due to climate events (from World Bank analysis); and (iv) the estimated loss in future earnings per day of schooling lost (based on World Bank research on pandemic-related learning disruptions).

Future long-term economic loss and damage (loss of future earnings – high-level assessment): Two approaches are applied. Approach A uses the same high-level framework applied to past long-term losses of future earnings, with the difference that it uses student enrolment derived from expected population growth. Approach B relies on a similar approach but forecasts the number of students impacted based on the INFORM Climate Change Risk Index. Based on RCP 4.5 (moderate emissions) and SSP2 – Middle of the Road (Medium challenges to mitigation and adaptation) and RCP 8.5 (high emissions) and SSP 3 (Regional Rivalry – high challenges for both mitigation and adaptation, including higher population growth).

Benefit-Cost Ratio: This approach quantifies benefits based on projected economic losses and damage, and on an estimated avoided-loss range due to adaptation and resilience measures, using World Bank and UNDRR data. The cost is estimated based on the number of classrooms expected to be impacted and a resilience premium to reflect the additional cost of building, rehabilitating, or reconstructing resilient classrooms.

Across all modules, inputs and outputs were subjected to sense checks, and key assumptions were tested through scenario analyses.

Limitations

The main limitations of the estimate of immediate economic loss and damage can be seen below:

- **Relatively few documented events available through detailed assessments (e.g., PDNAs):** Although limited in number, PDNAs and similar assessments remain the strongest source of monetary loss and damage data, which is a key input for this exercise and follows relatively consistent definitions. To increase confidence, different correlations are tested; those with higher R^2 values are selected, and results are sense-checked against other aggregated datapoints.
- **Reliance on EM-DAT for over 700 "undocumented" events, which only includes disasters meeting a minimum threshold (≥10 deaths or ≥100 people affected):** While smaller disasters are excluded, EM-DAT continues to be the most comprehensive and publicly accessible database in the ESA region. Its use allows for replicability and results in conservative, rather than overstated, total estimates.
- **One cost-per-affected-person ratio is applied per disaster type, regardless of country context:** Although country-specific ratios would be ideal, data limitations prevent this. Stratifying by event type provided the best statistical fit (highest R^2) and kept the model transparent and easy to replicate.
- **Slow-onset hazards (e.g., sea-level rise, land degradation) were not included in this analysis:** These are typically not reported, and when information is available, it is not standardized, making robust inclusion infeasible within the current framework. This has been covered under the temperature increase case study.
- **Definition of loss and damage and possible bias in PDNAs:** In some instances, "loss" includes impact categories closely linked to long-term economic effects, and the granularity of reporting does not allow adjustments. PDNAs may also be biased toward more extreme events. Nevertheless, PDNAs and other needs assessments remain the primary source as they provide the highest-quality data available for this purpose.
- **Linear link between temperature rise, enrolment growth and monetary loss assumes no change in vulnerability over time.** This was done deliberately to illustrate the cost of inaction, i.e., the education losses that would occur if no additional resilience investments are made.
- **Enrolment projections are based on population growth, without adjustments for future shifts in enrolment rates, migration, or dropout.** Projections do not incorporate future changes in enrolment rates, migration, or dropout. These limitations are acknowledged, and the model may be refined using projected enrolment ratios or more granular datasets, such as UNICEF enrolment forecasts, should they become available.

The main limitations of the estimate of long-term economic loss and damage (loss of future earnings) are a consequence of the high-level approach applied:

- **Use of fixed numbers to simplify approach:** For example, the methodology uses: a fixed average school closure at 18 days throughout the period based on most recent climate-specific estimate available for Africa and low-income countries (when disruption may have been shorter in earlier years); a uniform USD loss per student-day applied across all income levels; fixed percentage of students affected (in practice, the proportion of affected students varies substantially by year, as shown in EM-DAT).

- **Assumption that the loss per student is proportional to the duration of closure.** The calculation of loss per student per day divides total loss per student by days of closure, implicitly assuming proportionality. This may not fully reflect reality, as losses could escalate non-linearly with longer disruptions, particularly for events with prolonged recovery times or higher dropout risk.

- **Long-term economic loss and damage limited to the loss of future earnings only.** Other long-term impacts are also relevant but fall outside the scope of this assessment. A high-level estimate of future earnings was included, given its importance as a policy-relevant and widely recognized metric for advocacy.

- **Use of COVID-19 school disruption studies to estimate learning-related income losses.** Although the nature of the disruptions differs (pandemic vs. climate events), the learning loss per day of schooling missed can be considered comparable. In the absence of climate-specific data, these studies provide the most reliable proxy.

More details on the methodology, key findings, limitations and full references can be found in the full report.

Endnotes

1 ESAR refers to the Eastern and Southern Africa Region, comprising the following countries: Angola, Botswana, Burundi, Comoros, Djibouti, Eswatini, Ethiopia, Eritrea, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Rwanda, Somalia, South Africa, South Sudan, Sudan, Uganda, United Republic of Tanzania, Zambia and Zimbabwe.

2 United Nations Children's Fund, 'Transforming education in Africa', UNICEF, <https://www.unicef.org/esa/education>.

3 Please see the methodology section of the main report (LINK HERE WHEN PUBLISHED).

4 UNESCO, 'UIS', <https://databrowser.uis.unesco.org/>.

5 Loss and damage: "Loss and damage describes the impact associated with the adverse effects of climate change"; Loss and Damage (capitalized letters) is used to refer to the political debate, and loss and damage (lowercase letters) to refer to impacts. Sources: UNFCCC, *Non-economic Losses In The Context Of The Work Programme On Loss And Damage*, 2013, <https://unfccc.int/resource/docs/2013/tp/02.pdf>; IPCC, 'Annex II: Glossary', 2022, <https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Annex-II.pdf>.

6 See section 5.1.c: Number of children reached with education services adapted to climate, environmental or disaster risks.

7 The research set out to answer the following questions:

1. What extreme events occurred since 2005 in the ESA region and which of those can be attributed to climate change?
2. What was the total cost of economic loss and damage incurred due to extreme climate-induced events on education infrastructure?
3. What is estimated to be the future cost of loss and damage to education infrastructure?
4. What can be learnt from selected case studies related to efforts to avert, minimize and address loss and damage on education systems?

8 Direct (immediate) economic loss and damage refers to the direct financial costs that occur when a climate event hits the education sector. This includes: education facilities and fixed services, learning materials and movable equipment, temporary or alternative learning spaces, transport and logistics assets, etc. These costs can be estimated through post-disaster assessments and other documented data.

9 Loss of future earnings refers to the long-term economic impact on children whose learning is disrupted. When students miss school because of the impacts of climate change (e.g., floods, droughts) their learning falls behind. Over time, this reduces their productivity and lifetime income. This is an indirect effect that accumulates over many years and requires modelling to estimate it. The methodology in the annex provides the detailed approach used to calculate this estimate.

10 EM-DAT, Database, <https://www.emdat.be/>.

11 Assuming a cost of building a new resilient school of US$16.5 thousand and an average of 60 students per classroom.

12 i) Note that bars and lines are yearly impacts in constant 2024 USD; ii) RCP 4.5 (moderate emissions) and SSP2 – Middle of the Road (Medium challenges to mitigation and adaptation); iii) RCP 8.5 (high emissions) and SSP 3 (Regional Rivalry – high challenges for both mitigation and adaptation, including higher population growth).

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