Policy Brief

The impacts of climate change on education outcomes: assessment and response

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Key Findings

Evidence indicates that climate hazards are severely impacting children's education. The current research base is most extensive regarding learning outcomes, where most studies document a significant decline. There is also a robust body of research on school access; however, the findings are mixed. Research on grade attainment – though based on a smaller set of studies – consistently points to a decline driven by climate hazards.

Climate hazards reduce educational outcomes in three main ways: school closures and damage to infrastructure; impacts on maternal and child health; and pressures on household resources, leading to an increase in children's paid or unpaid labour.

Within the studies examining if impacts vary across different groups, age, gender and socio-economic status are the categories most studied. While differences by gender vary greatly by context, there is more consistent evidence that young and economically disadvantaged students are more severely impacted by climate hazards.

Further research is needed to understand the long-term compounding effects of climate shocks on understudied pathways like mental health, understudied groups such as children with disabilities and the effectiveness of programmes and policies that can mitigate these effects.

Recommendations

Implement interventions reducing the effects of climate-related economic shocks on households, increase investments in climate-resilient school infrastructure and the development of flexible, remote and accelerated learning models to ensure learning continuity.

Increase education ambition in Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs), and ensure country readiness support also focuses on education capacity to access climate finance from multilateral sources.

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1 Overview

This brief summarises insights from a global systematic review on the impacts of climate change on primary and secondary education across low-, middle- and high-income countries. The review covers global literature on how major climate hazards including floods, rainfall variability, droughts, cyclones, temperature variations and wildfires affect education. It outlines how these climate hazards, combined with socioeconomic vulnerabilities such as gender, age, race/ethnicity and socio-economic status, impact educational outcomes, with a specific focus on:

1. **Access:** Who participates in education and how they move through the system.
2. **Attainment:** The level of formal qualifications achieved, often measured as years of schooling completed.
3. **Learning:** Cognitive outcomes such as literacy, numeracy and standardised test scores.

The core analysis is based on 90 econometric studies, supported by additional qualitative, mixed-methods and other research articles to provide richer contextual insights.

2 Study distribution

The econometric studies used for analysis in this systematic review are distributed across 33 countries, with the United States (17 studies), Ethiopia (10), India (seven), Viet Nam (five) and India and China (four each) particularly well represented. In addition, there were five multi-country studies covering between 13 and 59 countries. The most studied hazard is temperature, followed by rainfall patterns (see Figure 1). The least studied hazards are wildfires, and there is no econometric evidence on the effects of windstorms. Impacts on learning outcomes are the most studied, followed by impacts on access and then attainment (see Figure 2).

Figure 1 Distribution of climate hazards across econometric studies

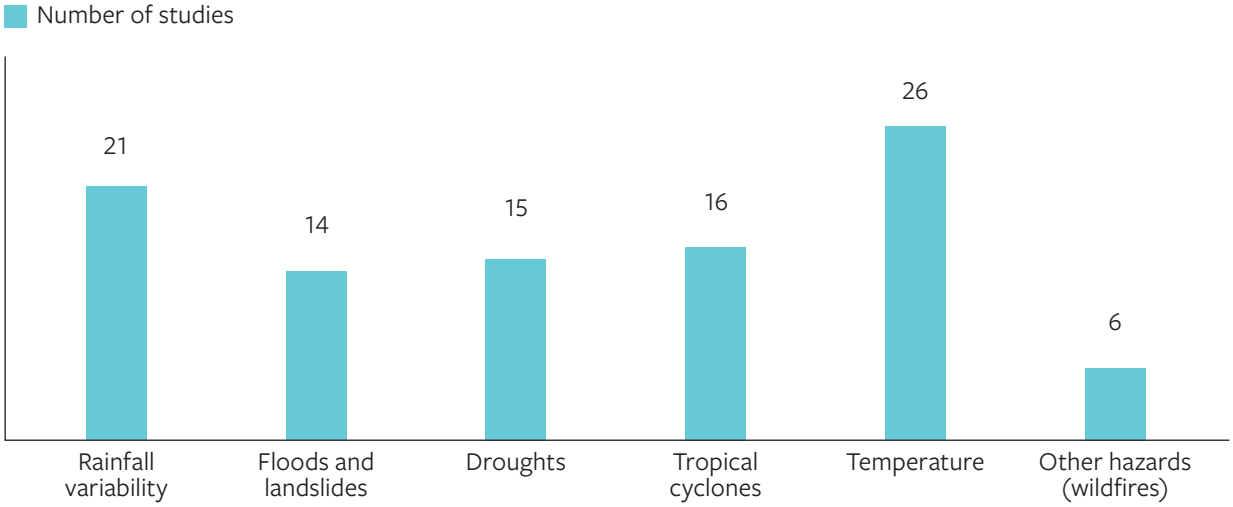
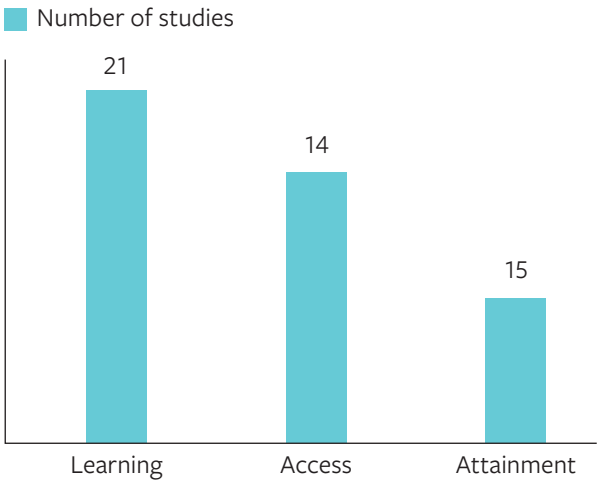


Figure 2 Distribution of educational outcomes covered by econometric studies



3 Impact of climate hazards on education outcomes

Table 1 summarises available evidence on the impact of each climate hazard on each of the education outcomes: access, attainment and learning.

Table 1 Impact of climate hazards by education outcome

Hazard	Geography	Access	Attainment	Learning
Rainfall variability[1] (21 studies)	Africa, Asia and Central and South America	Mixed results. Two studies found increases in attendance and enrolment, two found no effects and one found reduced access.	Mixed results. Two studies found increased attainment, while three studies found that rainfall shocks (increases or decreases) reduced attainment.	Consistent evidence of reduced learning. Six of eight studies found declines in literacy, numeracy or cognitive scores following rainfall shocks.
Floods and landslides (14 studies)	Asia, Central and South America and the Caribbean	Mixed evidence. Four studies found lower enrolment and higher dropout rates, but three studies in these same countries found that floods have no impact on access.	Consistent evidence of reduced years of schooling, lower completion rates or probability of being on track (six studies).	Consistent evidence of higher illiteracy rates (two studies) but mixed evidence on test scores. All six studies find lower test scores; this varies by age, country or flood intensity.
Drought (15 studies)	Africa, Asia and Latin America	Most evidence shows reduced access. Five of the seven studies reported that droughts reduce enrolment or increase dropout rates.	Most evidence finds reduced attainment. Three out of four studies found early-life or severe drought exposure reduced years of schooling and completion rates.	Mixed evidence. Four out of nine studies found declines in cognitive, literacy or numeracy skills, four found mixed results and one found no effect.
Tropical cyclones (16 studies)	Asia, Africa and Latin America and the Caribbean	Most evidence finds reduced access (five of six studies).	Consistent evidence on reduced years of schooling (seven studies).	Most evidence finds weaker learning outcomes (eight of nine studies), but the effects are very small[2]

1 This set of studies includes those that present findings on the impact of non-extreme increases and decreases in rainfall and those that examine the impact of changing rainfall variability, rather than those that only examine extreme changes resulting in floods or droughts.

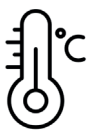
2 An effect size of 0.1 standard deviations (SD) was considered small for the purpose of this systematic review.

Table 1 Impact of climate hazards by education outcome (continued)

Hazard	Geography	Access	Attainment	Learning
Temperature change (26 studies)	North America, Asia and Africa	Consistent evidence of high temperatures reducing attendance (three studies) and enrolment (one study). Mixed evidence on the impact of cold.	Most evidence on heat shows reduced school completion (three studies). Mixed evidence on the impact of heat when exposure is prenatal. Mixed evidence on the impact of cold. Impact varies greatly by context, severity and duration.	Consistent evidence shows heat reduces learning outcomes. Maths results tend to be more affected than literacy. Mixed evidence on the impact of cold.
Wildfires (6 studies)	North America, Oceania and South Asia	No significant evidence of impact on access. Only one study finds delays in school enrolment.	Emerging evidence on reduced attainment (two studies).	Consistent evidence of weaker learning outcomes (lower English and maths test scores); two of five studies show very small impact.

A small number of studies directly compared the impacts of different climate hazards within given contexts. This comparative analysis is presented in Table 2.

Table 2 Comparative impacts of climate hazards on education outcomes

	Droughts often have more severe and lasting consequences than floods on educational access, attainment and learning (four of six studies). This may reflect the long-term impact of droughts on household resources and nutrition.
	Floods and landslides decrease grade attainment and learning more significantly (three studies) than rainfall variability, tropical cyclones and hailstorms/frosts. This may reflect the more intense nature of flooding compared to rainfall variability or frosts, and the greater possibility of preparing for tropical cyclones but not for floods.
	Rainfall variability shocks have a smaller impact on learning and grade attainment compared to droughts and cyclones (two studies). Rainfall shocks were more damaging to attainment than raised temperatures (two studies).
	Higher temperatures (in spring and summer) can decrease years of schooling more than droughts (one study). Frosts and hailstorms could be as damaging as droughts and more damaging than floods (one study).

4 Difference in impacts on education outcomes by social group

Evidence shows that climate-related hazards have heterogenous effects on children depending on their age, gender and socio-economic status.

Age. Fifteen studies highlight that prenatal and early-life (first two years) exposure to climate hazards reduces access, learning and attainment outcomes. There is mixed evidence on whether prenatal exposure or exposure in infancy is more significant. Additional studies comparing older cohorts show that younger children tend to be more affected, especially in regard to test scores.

Gender. Thirty-five studies show that differences between boys and girls vary by context. Girls commonly face greater impacts on attendance and attainment (10 studies) linked to increased domestic work and safety concerns. Fewer studies found impacts on boys' attendance and access (four studies) and those that did highlighted boys' engagement in farm labour in response to economic stressors. Some qualitative studies highlighted early marriage as a specific threat facing girls.

Socio-economic status. Sixteen of the 21 studies examining heterogenous effects by socio-economic group show that poorer children suffer larger and more persistent setbacks due to lower capacity to absorb shocks, greater physical exposure to hazards and poorer school facilities (including less cooling).

Table 3 discusses the main factors affecting how the impacts of each hazard vary by social group.

Table 3 Influence of demographic characteristics on education impact by climate hazard

Hazard	Heterogenous effects
Rainfall	• Children exposed between conception and age two are vulnerable to rainfall variation. • Gendered results are mixed: in some contexts, girls are more affected due to care and domestic work, while in others, boys are more impacted because of increased demand for agricultural labour. • Children from poorer households, or without access to social protection schemes, experience greater disruption than their counterparts.
Floods and landslides	• Prenatal exposure leads to a decrease in years of schooling and lower cognitive test scores in three studies compared to exposure between the ages of 0–2. Two studies also found floods led to lower test scores for younger children. • Evidence regarding gender-specific impacts remains sparse. However, one study suggests that girls experience more prolonged disruptions to school access than boys.
Droughts	• Early childhood is a critical period of vulnerability. • There is mixed evidence on how impact varies by gender, with two studies finding that gender norms affect girls' education more, one that it affects boys more and two finding no difference. • Children from poorer households or public schools face greater educational disruption.
Tropical cyclones	• Girls' attendance is more adversely affected than boys', but no evidence was found on gender differences in learning outcomes. Gendered impacts on attainment vary with time. • Five of the six studies examining differences in socio-economic impacts found that attainment and learning outcomes were impacted by socio-economic status. Three showed that poorer children were more negatively impacted.
Temperature change	• Attendance, attainment and learning outcomes of students from marginalised racial and socio-economic groups were disproportionately affected by heat, due to their lack of access to cooling systems. • For cold, across all three outcomes, socio-economic and racial differences were also significant. • Four studies – all of heatwaves – found gender differences in impacts; in two, boys were more affected, and in two, girls were. • Only three studies compared impacts on children of different age groups; two (one of cold, one of heat) found that younger (pre-school and primary school age) children were more affected.
Wildfires	• There were mixed results on impact of age, gender and race, ethnicity or caste on children's attainment and learning outcomes. • Three studies found consistent evidence of impact of socio-economic status on attainment and learning.

5 Pathways to education impact

Climate hazards affect education through three primary pathways: school closure and infrastructure damage, health (mainly illness, lack of nutrition and inability to concentrate), and increased pressure on household resources (reduced spending on education and increased need for children's paid or unpaid work).

Table 4 outlines the main pathways discussed by hazard. These are discussed in more detail in the companion brief '*How does climate change affect educational outcomes: key pathways*'.

Table 4 Pathways to education impact by climate hazard

Hazard	Pathways
Rainfall	Loss of household income, increased need for paid labour and health, particularly malnutrition during early life.
Floods and landslides	Loss of household income, increased need for paid labour, health (prenatal or early childhood malnutrition) and damage to school infrastructure and roads.
Droughts	Loss of household income, increased need for paid labour or unpaid domestic work, health and nutrition, teacher shortages and school closures.
Tropical cyclones	School closures and damage, increased household expenditure (in cases of damage to family property), increased need for paid labour or unpaid domestic work, displacement and health (nutrition and cognitive development).
Temperature change	Higher temperatures: reduced ability to concentrate and, less commonly, loss of household income (via reduced agricultural outputs). Colder temperatures: loss of household income/increase in household expenditure (in LMICs) and health and transport disruption (in HICs).
Wildfires	Health (cognitive development and respiratory infections), increase in household expenditure and school closures.

6 Interventions addressing the impact of climate hazards on educational outcomes

The evidence on interventions protecting education outcomes and promoting learning resilience in the context of climate change is growing but remains limited, at 17 rigorous evaluations. As Table 5 shows, most of these studies focus on social protection and infrastructure improvements.

Table 5 Key insights on interventions protecting education outcomes in the context of climate hazards

Type of intervention	Impact
Poverty reduction (11 studies)	Social protection programmes such as cash transfers and employment guarantees show moderate promise in helping protect school enrolment and attendance from the impacts of droughts and floods.
Infrastructure (4 studies)	Investing in resilient school infrastructure (e.g. typhoon-resistant buildings) and regulating classroom temperatures through ventilation or cooling systems leads to measurable learning gains.
Teaching and learning (2 studies)	There is limited rigorous evidence. One study found that remote tutoring via phone calls was effective in protecting learning after a typhoon, while simple SMS messages were not.

7 Research gaps and policy recommendations

The review identifies a lack of evidence on:

1. The long-term, cumulative impact of repeated exposure to multiple climate hazards on education.
2. Less visible pathways to impact, such as mental health and teacher wellbeing.
3. Impacts on marginalised groups of children, such as children with disabilities.
4. The impact of interventions on children's educational outcomes rather than on intermediate factors such as classroom temperature or nutritional status.

Recommendations:

1. Consistently integrate education into national climate adaptation strategies and loss and damage frameworks and adequately resource resulting policies through climate funding with greater ambition for protecting and promoting education.
2. Scale up promising interventions, including social protection programmes to protect against the impacts of climate-induced economic shocks; investment in climate-resilient school infrastructure; and the development of flexible, remote and accelerated learning models to ensure learning continuity when schools close.

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