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Original Research

Influence of Environmental Shocks and Child Labour on Upper Basic Education Students' Learning Outcomes: Evidence from South-East, Nigeria

Emmanuel Chukwuma Eze, Ikechukwu Giveson Okafor
Department of Social Science Education, University Of Nigeria, Nsukka, Nigeria

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ABSTRACT

This study investigated the influence of environmental shocks and child labour on upper basic education students' learning outcomes in South-East Nigeria. The design for the study is an ex post facto design. The study sampled 571 upper basic education students. An environmental screening survey and a child time use survey were used to obtain data for this study. Students' academic records and demographic information were obtained from the school authorities. Frequencies and mean statistics were used to analyze data collected, while ANCOVA was used to test the null hypotheses at a 0.05 level of significance. It was discovered that environmental shock and child labour significantly influence students' learning outcomes. The study's results highlight the need for policymakers and stakeholders to address the issues of environmental shock and child labour to improve the learning outcomes of students in South-East Nigeria.

Corresponding Author:

Ikechukwu Giveson Okafor
Department of Social Science Education, University of Nigeria, Nsukka
UNN Main campus, Nsukka Road, Ihe Nsukka 410001, Nsukka, Enugu State, Nigeria
Email: okafornelson98@gmail.com

1. INTRODUCTION

Environmental shocks are natural events that cause a serious disruption of the functioning of a community or society and lead to one or more of the following: human, material, immaterial, natural, and economic losses and impacts. These environmental shocks are evident in life-threatening environmental conditions such as heatwaves, flooding, winter, storms, hurricanes, drought, and wildfires (IPCC, 2022). Environmental shocks, particularly high-impact natural disasters such as floods, hurricanes, droughts, and earthquakes, affect an average of 224 million people worldwide per year (Ritchie et al., 2022). According to Koohi-Kmali & Roy (2021), environmental shocks have harmed many individuals, causing severe injuries, disruptions to livelihood, and economic damage.

The consistent waves, flooding, and climate change-induced sea level rises have led millions of people to count their losses. In South-East Nigeria, Seasonal flooding has forced people to leave their ancestral homes to settle in internally displaced people's camps within the upland area. Lai & Greca (2020) noted that environmental disasters present a significant and growing threat to the well-being of children. Children are on the receiving end of these environmental shocks because exposure to such experiences increases the problems associated with their physical, mental, academic, and economic well-being.

Previous studies have been done on the influence of environmental shocks on school children's learning outcomes. Lassa et al. (2023) used a qualitative and quantitative research approach to assess the impact of a natural disaster (flooding) on educational outcomes. The study revealed that flooding has a negative impact on students' learning outcomes as well as a destructive impact on school facilities in Jakarta, Indonesia. In addition, Onigbinde (2018) used a panel study to assess the impact of natural disasters on educational attainment for the entire population and by gender in 85 countries from 1960 to 1990. The study revealed that natural disasters have substantial damage to per capita income, which substantially impacts secondary school students' grade retention rate. Furthermore, Thamtanajit (2020) used the difference-in-difference approach strategy to estimate the impact of natural disasters on students' achievement using evidence from flooding in Thailand. This study found that floods in Thailand led to a substantial reduction in all students' test scores except for social studies. Moreso, Segarra-Alméstica et al. (2022) noted that just like floods, the damaging effects of natural disasters (hurricanes) have a higher probability of decreasing children's academic achievement. Similarly, Koohi-Kamali & Roy (2021) found a lack of substantial difference in aggregate achievement scores between students involved in fishing activities and those who are not in Ghana.

Also, the disruption from environmental shock is forcing families to engage their children to earn money to cope with food insecurity, which is exacerbating child labour. Child labour is a complex phenomenon that requires examination from social, economic, and cultural perspectives. According to the International Labour Organization (ILO) (2017), child labour is work that deprives children of their childhood potential and dignity, and that is harmful to their physical and mental development. Koohi-Kamali & Roy (2021) refer to child labour as any work performed by children under the age of 12, non-light work done by children aged 12-14, and hazardous work done by children aged 15-17.

Research has shown that both the global south and northern countries are guilty of the circumstance. According to the ILO (2017), a total of 152 million children, 64 million girls, and 88 million boys are in child labour worldwide, accounting for almost one in ten of all children globally. Almost half of all the 152 million victims of child labour are aged 5-11 years, 42 million (28%) are 12-14 years old, and 37 million (24%) are 15-17 years old. The organization further noted that almost half of the child labour (72.1 million) is to be found in Africa, 62.1 million in Asia and the Pacific, 10.7 million in the Americas, 1.2 million in the Arab states, and 5.5 million in Europe and central Asia. Kim et al. (2020) noted that in terms of prevalence, the African region, Nigeria inclusive, ranks highest in the percentage of children in child labour and also pointed out that child labour is concentrated primarily in agriculture and comprises both subsistence and commercial farming, 17% in services, and 12% in the industrial sector, including mining. Suffice it to say that most communities in South-East Nigeria are agrarian communities that majorly grow crops such as rice, yams, cassava, beans, pepper, garden eggs, and rear animals like goats, sheep, and cows, which are victims of the circumstance. Also, some parts of the communities engage in fishing.

Consequently, it might not be an overstatement to say that children in these communities are engaged in child labour, even as the country, Nigeria, is witnessing economic meltdown, where the rate of a dollar to Naira is increasing day by day, with a rise in goods and services. Studies on child labour in Nigeria's agrarian communities indicate that children engage in various agricultural activities, including farming, fishing, and livestock rearing, often before attending school (Ofuoku et al., 2014; U.S. Department of Labor, 2024). Research from nearby regions shows children involved in land clearing, cultivation, weeding, and other farm operations (Aminu et al., 2016). Also, it was observed that most of the work done is carried out in family enterprises and mostly within the family home in the form of housework or as non-remunerated work. Hence, the prevalence of Child labour may have impacted the learning outcomes of students in affected communities.

Several scholars and organizations reported the impact of child labour on the educational outcomes of students. For example, ILO (2017) reported that child labour is unfavourable and unsafe to children's health and denies them proper education. Hamenoo et al. (2018) posit that children who combine work and school experience negative psycho-social effects on their educational progress and performance. Also, Anumaka (2012) conducted a study involving 2,307 pupils who sat for the primary leaving examination in the Nebbi District of North-East Uganda. The researcher found that many of the children who did not perform well were those who had engaged in child labour activities. Al-Gamal et al. (2013), in a study conducted in Jordan, found that children who were not engaged in any form of labour performed better in school than those who were engaged in child labour. Abdalla et al. (2021) affirmed that in various studies, child labour adversely affects the health of children, leading to severe health complications that adversely affect their education. Afenyadu (2010) contended that not all work is dangerous to children's mental development and that work improves their basic knowledge and skills. He noted that the damage that child labour may do depends on the intensity and the nature of the work. Holgado et al. (2014) argued that there is no simple linear association between child labour and academic performance and that multiple factors,

including labour conditions, morning work schedules, and the number of hours worked per week, can negatively affect the academic performance of child labourers.

Kwadzo & Kofi-Annan (2022) assessed the nature of child labour and its impact on academic outcomes in Ghana using a correlation survey design. It was revealed that there was no substantial difference in the average score between students involved in fishing activities and those who were actively engaged. Koohi-Kamali & Roy (2021) conducted a study on child education and child labour and revealed that there is a negative link between child education and child labour. Children who combine work and school can experience negative psychological effects on their educational progress and performance. Abdalla et al. (2021) and Hamenoo et al. (2018) affirmed in various studies that child labour adversely affects the health of children, leading to several health complications that adversely affect their education. Rahman & Khanam (2012) found that child labour had a negative effect on learning attainment in the areas of arithmetic and reading in Ghana. Thus, there are inconsistencies in the findings of the studies, and also no evidence of a study of this nature in South-East Nigeria. Hence, there is a need for researchers to examine the influence of environmental shocks and child labour on the learning outcomes of upper basic secondary school students in South-East, Nigeria. The specific objectives of the study were to:

1. Examine the influence of environmental shocks on students' learning outcomes.
2. Examine the influence of child labour on students' learning outcomes.
3. Examine the joint influence of environmental shocks and child labour on learning outcomes.

The following hypotheses were formulated to guide this study.

$H0_1$: There is no significant influence of environmental shocks on students' learning outcomes.
$H0_2$: There is no significant influence of child labour on students' learning outcomes.
$H0_3$: There is no significant joint influence of environmental shocks and child labour on learning outcomes.

2. THEORETICAL FRAMEWORK

This study is anchored on an integrated theoretical framework combining the Theory of Constraints (ToC) by Goldratt (1984) and Bronfenbrenner's Ecological Systems Theory (1979). This integration provides a robust lens for understanding how external factors can impede educational outcomes by conceptualizing them as multi-level systemic constraints.

Goldratt's Theory of Constraints posits that every system, regardless of its design or performance, possesses at least one constraint that limits its ability to achieve its goals. These constraints, once identified, can be managed, restructured, or mitigated to enhance overall system efficiency and effectiveness. While ToC was originally developed for industrial and organizational contexts, its core premise—that systems are limited by identifiable bottlenecks—offers a valuable heuristic for analyzing the educational system. In this study, the educational system's primary goal is defined as the optimization of students' learning outcomes. Any factor that systematically impedes the achievement of this goal can be theoretically framed as a constraint.

However, ToC alone is insufficient to explain the nature and origin of the constraints affecting learners. To address this limitation, this study integrates Bronfenbrenner's Ecological Systems Theory, which provides a multi-layered framework for understanding human development within the context of interconnected environmental systems. Bronfenbrenner posits that a child's development is shaped by interactions across five nested systems: the microsystem (immediate environment, e.g., family, school), the mesosystem (interactions between microsystem elements), the exosystem (indirect environmental influences, e.g., community, parental employment), the macrosystem (cultural and societal values), and the chronosystem (changes over time).

By synthesizing these two theoretical perspectives, this study conceptualizes environmental shocks and child labour as "exogenous systemic constraints" originating primarily within the exosystem and macrosystem. Specifically:

(1) Environmental shocks (e.g., floods, droughts) are conceptualized as exosystem-level disruptions. They are external events originating in the physical environment and community structure that cascade downward, disrupting the microsystem (e.g., damaging school infrastructure, displacing families from homes) and generating psychological stressors that impair individual cognitive functioning. This aligns with the discussion of how such shocks create anxiety and trauma, which neurobiologically compromise the executive functions essential for learning.

(2) Child labour is conceptualized as a constraint embedded within the interaction between the exosystem and microsystem. It is often a household-level coping strategy driven by exosystem factors such as poverty and economic insecurity. Once enacted, it directly alters the child's microsystem, introducing the "dual burden" of work and school, depleting temporal and cognitive resources, and inducing chronic fatigue and stress. This directly corresponds to the theoretical mechanisms discussed—resource dilution, cognitive load, and the activation of physiological stress responses.

The integration of these theories allows this study to move beyond merely identifying the existence of constraints (as per ToC) to explaining the pathways through which they operate (as per Bronfenbrenner). The "identification" step in Goldratt's framework is fulfilled by empirically establishing the significant influence of environmental shocks and child labour on learning outcomes, thereby confirming them as genuine constraints within the educational system.

Furthermore, the subsequent steps in ToC—"exploiting the constraints" (finding ways to mitigate them) and "evaluation"—are reframed within this integrated model. In this context, "exploiting the constraints" does not imply making child labour or environmental shocks more efficient. Rather, it translates into identifying leverage points within the ecological system for intervention. This includes:

(1) At the exosystem level: Developing disaster-resilient infrastructure and implementing social protection policies (e.g., conditional cash transfers) that buffer households against the economic shocks that precipitate child labour.
(2) At the microsystem level: Designing trauma-informed pedagogical practices and school-based support systems that address the psychosocial and cognitive consequences of these stressors.
(3) At the macrosystem level: Advocating for policy frameworks that simultaneously address climate resilience and child protection, recognizing their interconnectedness.

Finally, the "evaluation" step corresponds to assessing whether policies informed by this understanding are effective in improving learning outcomes, thereby reducing the constraining influence of these factors. This integrated framework, therefore, not only justifies the investigation of environmental shocks and child labour as critical constraints on educational achievement but also provides a structured, multi-level guide for interpreting findings and formulating holistic, ecologically valid policy recommendations. The significant, albeit modest, effect sizes found in this study (3.8% and 5.6%) are interpreted within this framework as evidence that while these are meaningful constraints, they operate alongside numerous other factors within the child's complex ecological system, underscoring the need for comprehensive, multi-level interventions.

3. MATERIALS AND METHODS

3.1. Design

The design for the study is an ex post facto design. An ex post facto design is a type of non-experimental research design where the researcher examines the effect of an independent variable on a dependent variable without manipulating the independent variable (Kerlinger, 1973; Cohen et al., 2018). In this design, the researcher attempts to link environmental shocks and child labour to learning outcomes.

3.2. Population and sampling

The population for this study comprised all upper basic education students in Junior Secondary School 2 (JSS2) in South-East Nigeria, specifically in Anambra and Enugu states. According to the National Bureau of Statistics (2023), the total enrollment of JSS2 students in public secondary schools in the two states was approximately 145,680 students, with Anambra State accounting for 78,340 students and Enugu State accounting for 67,340 students.

A multistage stratified random sampling technique was employed to select the study sample. In the first stage, the study area was stratified into two environmental zones based on flood risk assessment using quantitative criteria adapted from Ogunrinde et al. (2019). High rainfall/flood risk areas were defined as Local Government Areas (LGAs) with annual rainfall exceeding 2,500mm, a documented history of seasonal flooding between 2015 and 2023, proximity to major river basins such as the Niger-Benue confluence and Anambra River, and elevation below 100m above sea level. LGAs meeting these criteria included Uzo Uwani in Enugu State and Ayamelu, Ogbaru, Anambra West, Anambra East, and Awka North in Anambra State. Conversely, low rainfall/flood risk areas were characterized by annual rainfall below 2,000mm, no documented flooding incidents in the past five years, and elevation above 150m above sea level. LGAs in this category included Awka South, Dunukofia, Njikoka, Idemili North and South, Nsukka, Igbo Etiti, Udi, Ezeagu, and Igbo Eze North and South.

In the second stage, a list of all public secondary schools in each stratum was obtained from the State Universal Basic Education Boards (SUBEB). Schools were assigned random numbers and systematic random sampling was used to select six schools, with three schools randomly selected from high-risk LGAs (experimental group) and three schools randomly selected from low-risk LGAs (control group). In the third stage, all JSS2 students present during the data collection period in October 2024 were included in the study. This yielded 323 students from high rainfall/flood risk areas and 248 students from low rainfall/flood risk areas, totaling 571 students. The sample size is adequate for an ex post facto research design for a population of over 100,000 (Krejcie & Morgan, 1970).

Students were included in the study if they were enrolled in JSS2 during the 2024 academic session, had academic records available for first and third terms, and provided parental consent and personal assent. Students who transferred to the school within the current academic year, had incomplete academic records, or were absent during the data collection period were excluded from the study. The choice of JSS2 students, typically aged 12-14 years, aligns with the International Labour Organization's definition of child labour, where children aged 12-14 working at least 14 hours per week in economic activity are considered in child labour. Additionally, the timing of data collection in October coincided with the post-flooding period following the peak flooding season from July to September, ensuring maximum capture of environmental shock effects on students' learning outcomes.

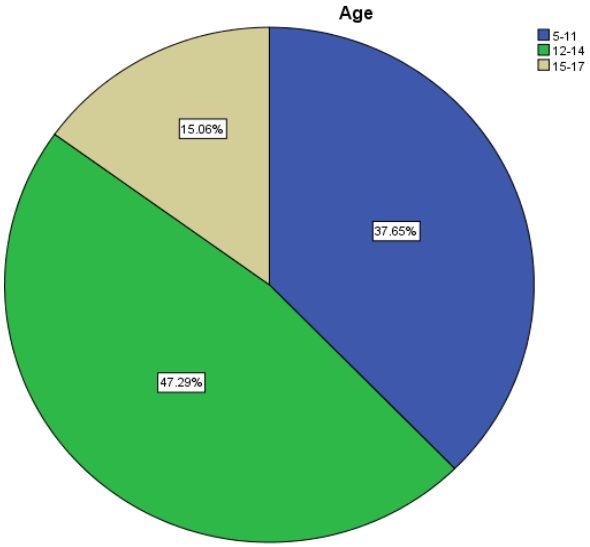

Figure 1. Age distribution of respondents

Analysis of Figure 1 shows that the majority of the respondents are between the ages of 12 and 14, which is ideal based on the class of the students used for the survey. By gender, there were male students (288; 50.4%) and female students (283; 49.6%), as shown in Table 1. In this study, the proportion of students by gender was balanced to ensure gender representation.

Table 1. Gender distribution of respondents

Gender	Frequency	Percent
Male	288	50.4
Female	283	49.6
Total	**571**	**100.0**

3.3. Data collection

Ethical approval for this study was obtained from the Department of Social Science Education, Faculty of Education, Research Ethics and Publication Committee of the University of Nigeria, Nsukka, prior to data collection. Additional approval was secured from the Anambra State Universal Basic Education Board (SUBEB) and Enugu State Universal Basic Education Board, followed by permission from the principals of the six participating secondary schools. Given that participants were minors aged 12-14 years, a dual consent process was implemented in accordance with ethical guidelines for research involving children (British Educational Research Association, 2018). Written informed consent was obtained from parents or legal guardians through consent forms sent home via students, explaining the study's purpose, procedures, voluntary nature of participation, and confidentiality provisions. Subsequently, written assent was obtained from each participating student after the study objectives were explained in age-appropriate language. All participants were assured that their responses would remain confidential, that participation was voluntary, and that they could withdraw at any time without penalty or impact on their academic standing. Confidentiality was maintained through the use of unique identification codes, secure storage of data, and removal of all personal identifiers from the dataset.

3.3.1. Learning outcomes

Learning outcome in this study is defined as the students' academic performance. The academic records of students, as well as demographic information such as gender and age, were collected from the office of the vice-principal academic of the various sampled schools under study. The third and First term

continuous assessment scores and the end-of-term examination scores of the Upper Basic Education class 2 students on the four core subjects, which every student should offer, viz. English, Mathematics, Basic Science, and Social Studies were used to measure students' learning outcomes. The continuous assessment and the end-of-term examination are scored as follows 40% and 60%, respectively, making a total of 100%. The choice of using the first term result and even conducting the research within this period is because the months of March and October are when communities witness high rainfall every year, with July-September being the peak of flooding, sea level rise, increased precipitation, coastal erosion, and rising temperature (Ogunrinde et al., 2019).

3.3.2. Environmental shock

The environmental Screen Survey was used to obtain information on the identified extreme weather events that have occurred within the two communities in recent times. The students are required to indicate by ticking a particular extreme weather event that has brought action on the schooling activities of the students. The shocks listed in the survey included: volcanic eruption, cyclone, tornado/hurricane, drought, earthquake, flooding, and forest fire. Responses of the respondents were shown in Table 2 in order of the most frequently occurring. From the foregoing, it can be implied that the main environmental shock prevalent in South-East Nigeria is flooding, which is a result of heavy rainfall. The main communities affected by this flooding are in the Uzo Uwani local government area of Enugu state, Ayamelu, Ogbaru, Anambra West, Anambra East, and the Awka North local government area of Anambra state, as shown in the red-marked area on Figure 2.

Table 2. Frequency of occurrence of natural disasters

S/n	Disaster	Frequency of Occurrence within the year
1	Volcanic Eruption	Never
2	Cyclone	Never
3	Tornado/Hurricane	Never
4	Drought	Rarely
5	Earthquake	Never
6	Flooding	Very Frequent
7	Forest Fire	Rarely

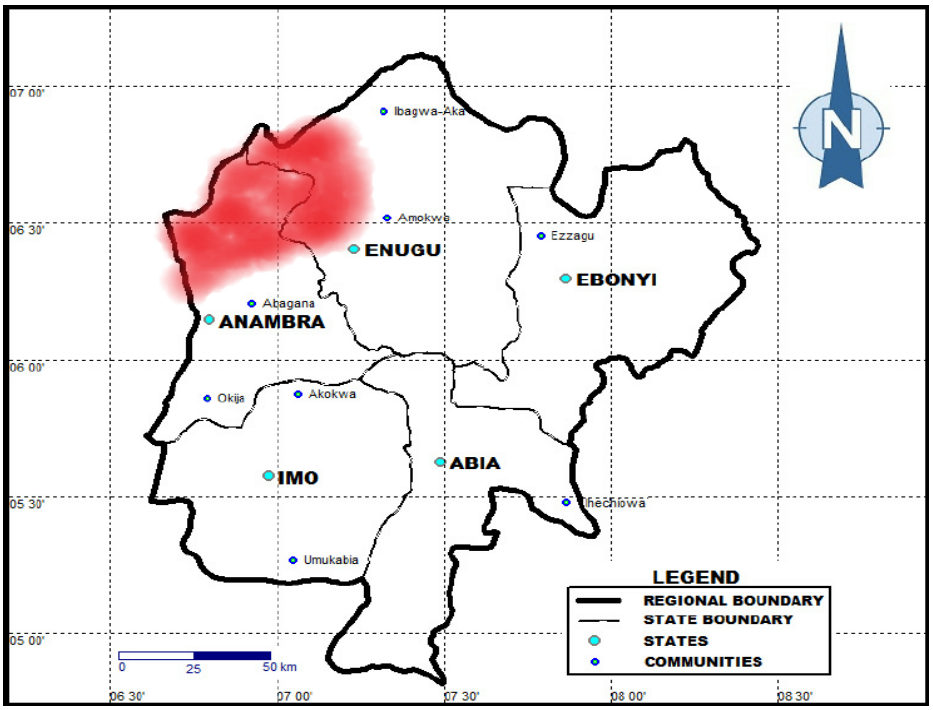

Figure 2. Map of South-East Nigeria showing high flood risk areas

The study categorized the respondents into two groups: those within the marked area were considered at high risk of the rainfall zone, which eventually leads to flooding. This includes students in schools in Uzo Uwani local government area of Enugu state, Ayamelu, Ogbaru, Anambra West, Anambra East, and Awka North local government area of Anambra state. However, students in surrounding local

governments such as Awka South, Dunukofia, Njikoka, Idemili North and South, Nsukka, Igbo Etiti, Udi, Ezeagu, Igbo Eze North and South. Thus, high-risk areas can be referred to as the experimental group, i.e., those impacted by flooding, while the surrounding schools were used as the control group in this study.

Mean school attendance of students within this period was 75.65%, implying that students missed out on an average 24.35% of attendance within the period under investigation. Further inquiry was made as to why students missed out on school activities.

Table 3. Why are you not in full-time education

		Frequency	Percent
Valid	Agricultural/Domestic Work	207	36.3
	Environmental/Seasonal reasons	197	34.5
	Insecurity	90	15.8
	School Fees	77	13.5
	Total	571	100.0

From the survey, 36.3% of the students reported that they had missed school attendance because they had to do Agricultural/Domestic work. 34.5% of the students reported environmental reasons such as rainfall and flooding. Other reasons included insecurities. Table 3 showed that environmental problems were one of the significant reasons students missed school attendance. Crosstabulation of school attendance and areas recorded as high rainfall risk areas showed that the mean attendance of students in High Rainfall risk areas was 70.70%, while that of low rainfall risk areas was 82.09%, implying that attendance was higher in low rainfall risk areas than in high rainfall risk areas, as shown in Table 4.

Table 4. Mean school attendance in areas of high and low rainfall

Environmental Shock		N	Minimum	Maximum	Mean	Std. Deviation
High	School Attendance (%)	323	25.00	100.00	70.7043	25.97679
	Valid N (listwise)	323				
Low	School Attendance (%)	248	25.00	100.00	82.0968	15.55123
	Valid N (listwise)	248				

3.3.3. Child labour

To ascertain the prevalence of child labour, a time-use survey was administered to all the respondents. The child time use survey assesses the amount of time in hours a child spends on fourteen (14) items during a typical day, where a typical day is defined as a weekday or normal school day, excluding holidays, festivals, and days of rest during the weekend. The students were required to tick the activities they did in the specific time period. They were required to mark one thing only for each period. Thus, the scoring was done by summing up the number of hours the child spent on the fourteen identified activities during a typical day. By International Labour Organization standards, children between 5 and 11 years working at least 1 hour per week in economic activity are considered child labour. Children between 12 and 14 years working at least 14 hours per week in economic activity are considered child labour. And children between 15 and 17 years working more than 43 hours per week in economic activity are considered child labour. The survey showed that 69.9% of the children were in child labour. With a higher prevalence of child labour among female students.

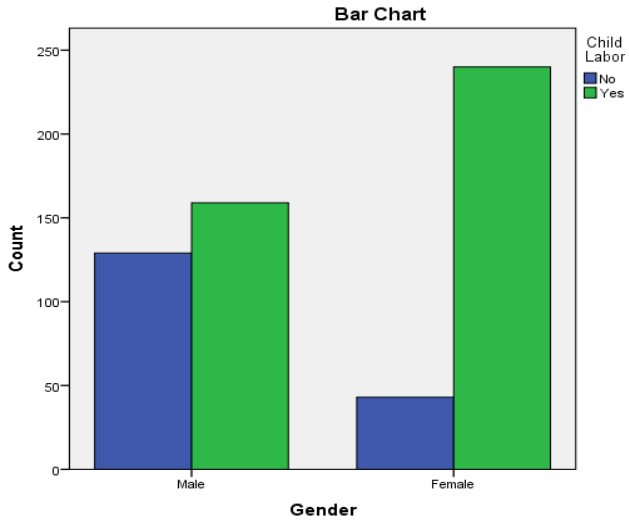

Figure 3. Gender and child labour

From Table 3 above, one can see that Agricultural/Domestic Work was a major reason why students missed school, implying the prevalence of child labour. Thus, Table 5 below shows that school attendance for students experiencing child labour is 64.93%, which is way below that of those not experiencing child labour (87.31%).

Table 5. School attendance and child labour

Child Labour	N	Minimum	Maximum	Mean	Std. Deviation
No	172	25.00	100.00	87.3110	20.60668
Yes	399	25.00	100.00	64.9373	23.61415

3.4. Data analysis

Child use time survey and Environmental Screen survey were subjected to face validity by three experts, one in Geography and Environmental Sustainability, another in Economics, and the other in Measurement and Evaluation, all from the University of XX. The experts were required to assess the suitability of the items and indicate whether or not the language used was appropriate. Also, they were required to add any other item that they considered applicable, which was unconsciously omitted. The suggestions of the experts were used to modify the instrument. The reliability of the instrument was assessed to determine the accuracy of the instrument and whether the respondent's responses could yield the expected results. This was done using 50 students in secondary schools outside the study area. The internal consistency of the instruments was determined using Cronbach's Alpha, and an index of .78 and .88 was obtained. This indicates that the instrument was reliable for use.

The continuous assessment score and the end-of-term examination score were collected from the teachers in the schools in the area of the study. The results did not undergo any further validity since they were collected after the exercise had been done. Frequency and mean statistics were used to analyze data collected while the hypotheses were tested using Analysis of Covariance at a 0.05 level of significance.

4. RESULTS AND DISCUSSION

Table 6 shows that the learning outcome of students with high rainfall averaged at 49.57% as opposed to those in low rainfall areas, which averaged at 62.06%. Then, Table 7 shows that the learning outcome of students in child labour appeared lower than that of students who are not in child labour, averaged at 51.04% and 64.17%, respectively.

Table 6. Environmental shock and learning outcomes

Environmental Shock	Mean	Std. Deviation	N
High Rainfall	49.5743	26.41773	323
Low Rainfall	62.0665	16.32441	248
Total	55.0000	23.41230	571

Table 7. Child labour and learning outcomes

Child Labour	Mean	Std. Deviation	N
No	64.1715	11.20990	172
Yes	51.0464	26.05774	399
Total	55.0000	23.41230	571

Table 8. Rainfall, child labour, and learning outcomes

Environmental Shock	Child Labour	Mean	Std. Deviation	N
High Rainfall	No	64.5122	11.91171	82
	Yes	**44.4917**	28.04063	241
	Total	49.5743	26.41773	323
Low Rainfall	No	63.8611	10.58779	90
	Yes	61.0443	18.78307	158
	Total	62.0665	16.32441	248

Table 8 shows the interaction of rainfall, child labour, and learning outcomes. Students in areas with high rainfall and experiencing child labour recorded lower learning outcomes compared to others. This is shown in Figure 4.

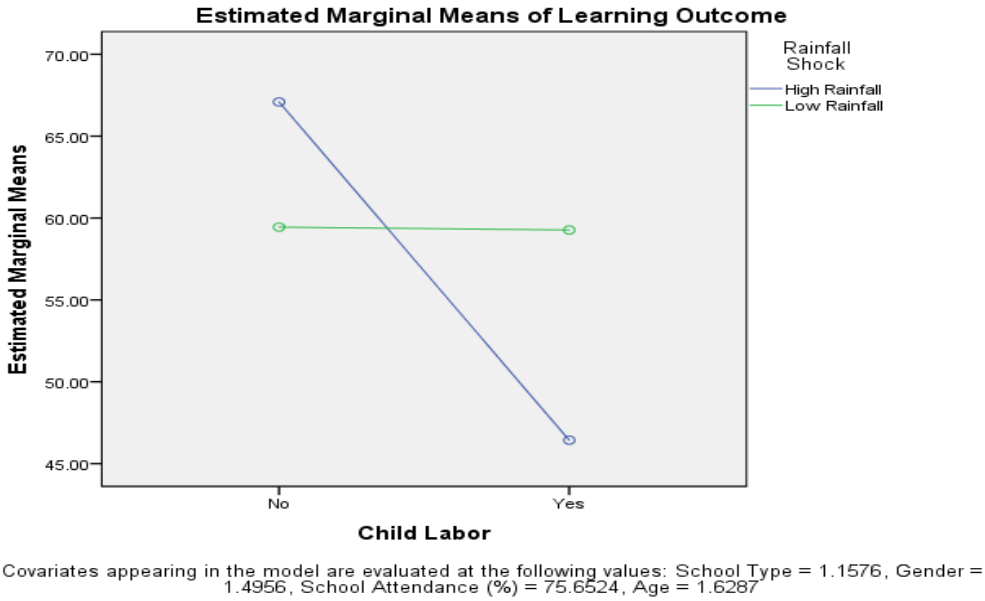

Figure 4. Interaction effects of environmental shock, child labour, and learning outcome

Table 9. Influence of environmental shock and child labour on learning outcomes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	55945.721[a]	6	9324.287	20.503	.000	.179
Intercept	35939.696	1	35939.696	79.028	.000	.123
Sex	1719.292	1	1719.292	3.781	.052	.007
Age	2079.557	1	2079.557	4.573	.033	.008
Shock	**10118.494**	**1**	**10118.494**	**22.250**	**.000**	**.038**
Labour	**15197.990**	**1**	**15197.990**	**33.419**	**.000**	**.056**
Labour * Shock	**9487.815**	**1**	**9487.815**	**20.863**	**.000**	**.036**
Error	256491.779	564	454.773			
Total	2039712.500	571				
Corrected Total	312437.500	570				

a. R Squared = .179 (Adjusted R Squared = .170)

4.1. The influence of environmental shocks on learning outcomes

The analysis revealed that environmental shocks exert a statistically significant influence on students' learning outcomes (p = 0.000; <0.05), leading to the rejection of the null hypothesis ($H0_1$). However, the effect size, indicated by a partial eta squared of 0.038, falls within the conventional threshold for a "small" effect, accounting for merely 3.8% of the variance in learning outcomes. This positions environmental shocks as a significant yet modest contributing factor within the broader ecological model of educational achievement, suggesting that while these shocks are detrimental, they operate alongside numerous other psychosocial, pedagogical, and socioeconomic determinants.

The underlying mechanisms for this relationship are best understood through the lens of ecological systems theory (Bronfenbrenner, 1979) and recent advances in stress physiology and neuroeducation. Environmental shocks such as floods or droughts function as macrosystem-level disruptions that cascade through multiple layers of a child's ecosystem. They can cause significant displacement, damage to educational infrastructure, and the breakdown of daily routines at the exosystem level, while simultaneously generating acute psychosocial stressors—including anxiety, trauma, and a pervasive sense of insecurity—that directly impact the microsystem of family and school. From a neurocognitive perspective, chronic stress activates the hypothalamic-pituitary-adrenal (HPA) axis, elevating cortisol levels that are known to impair hippocampal functioning and prefrontal cortex activity. These neurobiological changes specifically compromise working memory, attentional control, and cognitive flexibility—core executive functions essential for knowledge acquisition and academic success. This mechanistic pathway has been well-documented in the educational neuroscience literature, with recent studies demonstrating that disaster-related stress can alter brain development trajectories in ways that persist long after the immediate crisis subsides.

This finding is consistent with a substantial and methodologically diverse body of empirical literature. Lai & Greca (2020) established a broad link between environmental disasters and compromised

child well-being, encompassing academic performance, through their meta-analytic synthesis of post-disaster psychological outcomes. More specifically, Lassa et al. (2023) in Jakarta and Thamtanajit (2020) in Thailand documented the negative impact of flooding on students' learning outcomes and test scores, respectively, employing difference-in-differences methodologies that strengthen causal inference. Further global evidence is provided by Onigbinde (2018), who linked natural disasters to grade retention rates using longitudinal cohort data, and Segarra-Alméstica et al. (2022), who associated hurricanes with decreased academic achievement through analysis of standardized test performance before and after hurricane events. A recent systematic review by Wang (2024), synthesizing 22 studies, confirms that climate-related disasters consistently disrupt student enrollment in higher education programs, with the most severe effects being felt by disadvantaged populations. The impact is moderated by disaster severity, socioeconomic context, and the availability of post-disaster educational support, affecting all stages from application to graduation.

While a study by Koohi-Kamali & Roy (2021) in Ghana found no significant difference in aggregate achievement among students in fishing communities, this apparent anomaly warrants careful theoretical consideration rather than dismissal. The authors themselves suggest that the seasonal nature of fishing activities—which often coincide with academic breaks—may explain the null finding, a pattern consistent with the "seasonal work" hypothesis advanced by educational anthropologists studying livelihood-education intersections. This interpretation is supported by Dunne & Humphreys (2020), who found that the educational impact of children's work varies substantially based on its timing, intensity, and compatibility with school schedules. Moreover, Research in agricultural communities reveals that the relationship between environmental shocks and education is non-linear and context-dependent. Ponnusamy (2025) provides direct evidence of the "opportunity cost paradox," showing that in Pakistan, positive rainfall shocks reduce schooling for older children by increasing the demand for their labor in agriculture. This finding aligns with the theoretical framework established by Alam et al. (2022), who note that the effect of weather shocks on human capital investment is theoretically ambiguous and can result in both positive and negative schooling outcomes depending on the context. This complexity suggests that while the broader consensus affirms the detrimental effects of severe environmental shocks on education, the relationship is mediated by intricate interactions between household economic strategies, labor market conditions, and the timing of shocks relative to academic calendars.

4.2. The influence of child labour on learning outcomes

Reinforcing the pattern observed with environmental shocks, child labour demonstrated a statistically significant negative influence on students' learning outcomes (p = 0.000; <0.05), leading to the rejection of the null hypothesis ($H0_2$). With a partial eta squared of 0.056, child labour accounts for 5.6% of the variance in learning outcomes, a slightly larger contribution than environmental shocks within this model. This effect size, while modest, is consistent with the magnitude of impacts reported in recent meta-analyses examining student employment and academic performance across diverse contexts.

The negative influence of child labour can be theoretically situated within the framework of resource dilution and cognitive load theories. Children engaged in labour face a fundamental incompatibility between their dual roles as students and workers, creating what psychologists term a "dual burden" that depletes both temporal and cognitive resources. Chronic fatigue directly reduces time available for study, homework completion, and restorative rest, which economists conceptualize as a zero-sum time allocation problem. Furthermore, the responsibilities and pressures associated with work induce significant stress and anxiety, activating physiological stress responses that impair executive functions, including working memory, attentional control, and cognitive flexibility. This creates a detrimental feedback loop wherein physical and psychological exhaustion leads to reduced school participation and diminished academic performance, consistent with the "scarcity mindset" framework proposed by Mullainathan and Shafir, which posits that resource scarcity itself consumes mental bandwidth.

This interpretation is robustly supported by empirical evidence from diverse geographical and methodological contexts. Hamenoo et al. (2018) explicitly linked child labour to negative psychosocial effects that impede educational progress, a finding echoed in recent reconceptualizations of child labour as fundamentally a psycho-social dynamic and form of rights violation. Quantitative impacts on achievement are evident in studies by Anumaka (2012) in Uganda, where child labourers performed poorly on primary leaving examinations, and by Rahman & Khanam (2012) in Ghana, who found negative effects on arithmetic and reading skills. Delprato & Akyeampong (2019) and Byun et al. (2014) further reinforced this by demonstrating significant performance gaps between working and non-working children. A comprehensive review by Boutin & Jouvin (2022) synthesizing evidence from 25 studies across developing countries confirms that the consequences of child labour on education are predominantly negative, though the authors caution that methodological limitations suggest these findings represent potential effects rather than precise quantifications of impact.

Collectively, these studies, along with Koohi-Kamali & Roy's (2021) findings on the negative psychological effects of combining work and school, build a strong consensus that child labour constitutes a serious impediment to optimal educational outcomes. However, it is important to acknowledge that this relationship is not universally deterministic. Kwadzo & Annan (2022), in their study of fishing communities in Ghana's Central Region, found no statistically significant difference in aggregate examination mean scores between students involved in fishery activities and those who were not, a finding they attribute to the distinction between "child work" (light, regular activities) and "child labour" (hazardous or exploitative work). This nuance underscores the importance of disaggregating types and intensities of child work when assessing educational impacts.

The edu-workscape framework proposed by Dunne & Humphreys (2022) offers a valuable theoretical lens for contextualizing these findings within broader rural livelihoods in Sub-Saharan Africa . This framework challenges the oppositional binary embedded in dominant child rights discourses—which position schooling and child labour as inherently competitive—by demonstrating how work, learning, and harm intersect across multiple social arenas, including households, schools, and workplaces. From this perspective, the 5.6% variance explained by child labour in the present study represents not merely a statistical effect but an entry point for understanding how children's working and educational lives are dynamically intertwined within specific socio-economic contexts. The framework further suggests that interventions focused solely on eliminating child labour without addressing the structural conditions that necessitate it—including household poverty, inadequate social protection, and the hidden labour demands of schooling itself—may fail to improve educational outcomes and could paradoxically increase children's vulnerability.

4.3. The simultaneous influence of environmental shocks and child labour

Further analysis confirmed that, when considered jointly, environmental shocks and child labour exert a statistically significant influence on learning outcomes (p = 0.000; <0.05), thus rejecting the null hypothesis ($H0_3$) of no joint effect. The combined model, with a partial eta squared of 0.036, explains 3.6% of the variance. Notably, this combined effect size is marginally smaller than the partial effect of child labour alone (5.6%) and slightly less than that of environmental shocks (3.8%). This pattern suggests potential shared variance between the two predictors, indicating that their coexistence may not be purely additive but rather reflect an underlying causal pathway wherein environmental shocks exacerbate the very conditions that precipitate child labour. This interpretation aligns with the scoping review by Eze et al. (2024), which synthesized evidence that environmental shocks often operate as drivers of child labour, rather than as independent, parallel stressors.

The theoretical significance of this simultaneous influence is robustly framed by the concept of compounding vulnerability or what some scholars term "double vulnerability". Environmental shocks do not merely act as an independent stressor on educational outcomes (Ferdiansyah & Rumiati, 2024); they also function as a catalyst within the household livelihood framework, intensifying the economic pressures that drive child labour. This mechanism is corroborated by longitudinal studies from various contexts. For instance, research in Brazil by Santos (2025) demonstrated that natural disasters are associated with a subsequent increase in child labour, particularly in municipalities with lower socioeconomic infrastructure, suggesting an adaptive, yet detrimental, household response to income loss or asset destruction. Similarly, multi-country analyses in Latin America, Asia, and Africa have consistently identified a causal link between climate-induced shocks and the withdrawal of children from school to contribute to household income. The recent PNAS study by Jing et al. (2025) across 13 low- and middle-income countries found that exposure to tropical cyclones during preschool age significantly increased the likelihood of never attending school, with effects more pronounced in less cyclone-prone areas, indicating a lack of adaptive capacity.

This dynamic creates what the International Labour Organization (ILO) describes as a "vicious cycle" where climate-related losses push families into poverty, which in turn forces children into work, further eroding their human capital and perpetuating intergenerational poverty. The combined influence observed in this study provides empirical support for this cycle. However, the slightly smaller combined effect size relative to the individual predictors invites a more nuanced theoretical consideration. It may suggest that a portion of the negative impact attributed to environmental shocks on learning outcomes is mediated through its intensification of child labour. In other words, environmental shocks harm educational outcomes both directly and indirectly by increasing children's economic burden. This mediating role is supported by research on household coping strategies, where shocks to income or assets are met with increased child labour as a form of ex-post risk management.

Nevertheless, the persistence of a significant combined effect, even after accounting for individual contributions, underscores that these factors are not merely substitutes but also mutually reinforcing. This finding challenges simplistic unidirectional models and supports more complex frameworks, such as the

sustainable livelihoods framework, which posits that vulnerability contexts (shocks, seasonality) interact with household assets to determine livelihood strategies, including investment in children's education versus reliance on their labour. Intriguingly, recent research by Bau et al. (2025) complicates this picture further, finding that in contexts with high child labour rates, positive early-life human capital shocks—such as those from improved nutrition following good rainfall—can paradoxically lead to reduced schooling, as more capable children become more valuable workers. This suggests the relationship between environmental factors, child labour, and education is not linear and is deeply mediated by local labour markets and parental decision-making.

This finding carries significant policy implications. Fragmented interventions addressing only one issue in isolation are likely to be less effective. The recognition that environmental shocks can trigger child labour necessitates integrated policy responses that simultaneously build climate resilience and strengthen child protection systems. Disaster response and preparedness programs must be designed with an explicit focus on child protection, incorporating mechanisms such as conditional cash transfers tied to school attendance to prevent dropout and child labour post-disaster. Concurrently, efforts to combat child labour must be sensitive to environmental contexts, providing robust social safety nets for families vulnerable to climate shocks, thereby removing the economic imperative that drives children into the workforce. As highlighted by UNICEF, investing in teachers and creating education systems responsive to children's vulnerabilities is crucial but insufficient unless combined with expanded social protection measures for vulnerable households. Programs that couple financial education with post-training mentoring, as piloted by the ILO's ACCEL Africa project, show promise in helping households stabilize incomes and prepare for financial shocks, building the resilience that allows children to remain in school.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

This study investigated the impact of environmental shock and child labour on the learning outcomes of students in South-East Nigeria. The results showed that both environmental shock and child labour have a significant negative influence on students' learning outcomes. The interaction effect of environmental shock and child labour also revealed a significant negative impact on learning outcomes. These findings suggest that students who experience environmental shock and child labour are more likely to have poor learning outcomes. The study's results highlight the need for policymakers and stakeholders to address the issues of environmental shock and child labour to improve the learning outcomes of students in South-East Nigeria. Policymakers and educators should develop strategies to mitigate the impact of environmental shock on students' learning outcomes. This could include providing alternative learning arrangements during periods of heavy rainfall or flooding. Secondly, efforts should be made to reduce child labour in South-East Nigeria. This could involve implementing policies and programs that provide alternative sources of income for families and support education for children. Finally, educators and policymakers should develop programs that provide support for students who have experienced environmental shock and child labour.

5.2. Recommendations

1. State Ministries of Education should establish mobile schools and digital learning platforms for flood-prone LGAs (Uzo Uwani, Ogbaru, Ayamelu, Anambra West/East, Awka North) during July-September flooding seasons, with SUBEB coordinating alternative venues and catch-up classes.
2. State governments should provide conditional cash transfers (minimum ₦20,000/month) to families in agrarian communities during peak agricultural seasons, with LGA social welfare departments verifying school attendance before disbursement.
3. Universal Basic Education Commission (UBEC) should relocate schools in high-risk flood zones to elevated grounds and provide waterproof learning materials, while school management committees develop evacuation and continuity plans.
4. Nigeria Labour Congress and Ministry of Labour should conduct quarterly monitoring in farming and fishing communities, prosecuting employers/families exceeding ILO limits (14+ hours/week for ages 12-14), with community leaders reporting violations.

6. SUGGESTIONS FOR FURTHER STUDY

The following are suggested for further studies:

1. Examine the long-term educational outcomes of students exposed to both environmental shocks and child labour over multiple academic years and across other regions.
2. Test and compare different mitigation strategies (cash transfers, flexible schooling, infrastructure improvements) on learning outcomes in affected communities.

3. Investigate whether environmental shocks and child labour differentially impact performance across subjects (Mathematics, Science, English, Social Studies) to inform targeted interventions.
4. Examine the moderating influence of school support and socioeconomic status on the relationship between environmental shocks, child labour, and students' learning outcomes.

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DECLARATION OF INTEREST

The authors declare no conflicts of interest.

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ETHICAL STATEMENT

The conduct of this study adhered to strict ethical protocols. Approval was first secured from the University of Nigeria, Nsukka's Research Ethics Committee, followed by authorization from the Anambra and Enugu State Universal Basic Education Boards (SUBEB) and the principals of the six participating schools prior to data collection.

AI USE STATEMENT

The authors declare that the generative artificial intelligence (AI) tool Grammarly was used exclusively for language editing and/or grammatical improvement. The use of AI did not influence the scientific content, study design, data analysis, data interpretation, results, or conclusions of the manuscript. Full responsibility for the content remains with the authors.

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