

Assessing the Impact of Climate-Induced Flooding on Mathematics Achievement Among Secondary Students in Nigeria

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Abstract

Climate change refers to variations in the weather pattern of a place over some time, which may lead to flooding, drought, or wildfire. In the River Niger Basin of the South-South Zone of Nigeria, climate change has resulted in flooding, which led to disruption in communication, commerce, economy, agriculture, and education. It also resulted in an interruption in academic activities in schools and thereafter, the consequential implication on the academic achievement of students which followed. This paper is a report of a causal-comparative or ex-post factor research into the effect of flooding on the achievement of secondary school students in mathematics in Ogba, Egbema, and Ndoni Local Government Area of Rivers State, Nigeria. Ten out of twenty-seven secondary schools were randomly sampled for the study. Five hundred students in their Senior Secondary Class Two (SS2) were randomly selected for the study. This comprised 250 boys and 250 girls. Fifty students (25 boys and 25 girls) were randomly selected from each of the ten schools. The students' examination results used for the study for three terms were collected from the examination result master sheets and their achievement scores in mathematics were extracted and used for the analysis. The findings revealed that there exist significant differences in the achievement in mathematics of the students before, during, and after flooding. The data were analyzed using analysis of variance (ANOVA) with Scheffe's test and *t*-test. The result shows that achievement in mathematics was higher before and after flooding than during the flooding. The effect of climate change (flooding) on gender and achievement in mathematics was also studied. It was discovered that the gender gap in mathematics achievement of secondary school students widened during the flooding. This indicated that the effects of climate change on girls are worse than on boys educationally. The use of palliative to mitigate the effect of climate change-flooding, on the achievement of students in mathematics and, most importantly, the achievement of the girl child is recommended.

Keywords: effect of climate change, impact of climate, students' performance, flooding, achievement, Mathematics, students, secondary school

Introduction

Climate change is a long-term variation in the world's average temperature and weather conditions over a long period, which may be caused by human activities and intrusion into the ecosystem, leading to abnormal heat waves and a rise in sea level (BBC NEWS, 2024). It can also be defined as the rise in global temperature that took place from the middle of the 20th century due to exploitation of the ecosystem such as tracking, which is the method of exploring and drilling petroleum that is linked with heat generation and global warming causing seasonal change in temperature and rainfall resulting in draught and flooding (National Geographic Society, 2023).

Linsey and Dahlman (2024) averred that the earth's temperature has risen on average by .06°C every ten years since 1850 and that the rate of warming has increased by more than .20°C per decade since 1982, 2023 was the warmest year recorded; as a result, this temperature rise induces a reduction in snow cover and sea ice causing heavy rainfall and changing

habitat ranges for plants and animals. The rise associated with climate change cannot be reduced to zero. Therefore, the government must take responsibility to help households and businesses manage climate principles for designing strategies for climate change as such, build the foundation for rapid and inclusive development to help people and firms revise land use in order to protect critical infrastructure recover quickly and managing the impact at the macroeconomic level, prioritizing according to needs, implement across sectors and monitor progress (World Bank Group, 2020).

In a nutshell, climate change is a variation in an average pattern of weather, related change in oceans, land surfaces, and ice sheets occurring over time on a large scale for decades or longer, caused by man and natural factors (Australian Academy of Science, 2024). This has negative effects on education.

Flooding is one of the regular disasters in many communities. It leads to the loss of lives and internal displacement for some time, sometimes not less than two to four weeks. In 2022 flooding caused over 600 deaths and affected not less than 3.2 million

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persons in Nigeria, of which 1.4 million persons were displaced, affecting 569,000 hectares of farmland and destroying crops (Eleke, 2022; UNOCHA, 2022). The devastating flood was caused by the sudden release of water from dams in Nigeria and the Lagdo dam in Cameroon and has affected over 27 out of the 36 states in Nigeria. The consequence is severe because people fail to heed the warning given by the government through the National Emergency Management Agency) and take proactive measures. (Eleke, 2022; Khalid & Maishman, 2022; Umoru, 2022).

The devastation of flooding seriously affected communities in Omuku, the headquarters of Ogba, Egbema and Ndoni Local Government of Rivers State, resulting in the closure of schools disruption of commercial activities and movement – transportation and communication. (Adeyiye, 2022; Eleke, 2022; Lawal, 2022). The unfortunate thing is flooding reached some of the communities by midnight, causing serious danger such that people had to move through water filled with wild animals that reached up to the waist with their loads on their heads. Some moved out with canoes to the Internally Displaced Persons (IDP) centers, which were school compounds (Adeyiye, 2022; Anayo, 2022; Asinobi, 2022). Education suffered a severe setback due to flooding. In Ogba, Egbema and Ndoni Local Government of Rivers State, as well as other places that were affected by flooding, schooling was interrupted and school premises turned to IDP camps. Learners became traumatized by the flooding and loss of concentration in learning and school activities (Munsaka and Mutasa, 2020). Flood has a direct, devastating impact on primary and secondary education, resulting in students' poor performance (Chaudbury & Tamsina, 2017). Ezekwesili (2022) laments the effects of flooding on education, including drop in school attendance, loss of manpower (brain drain), loss of learning hours, health challenges from waterborne disease, and low coverage performance. Effective measures to stem this flood disaster are needed to bring succor and respites to education. They include proper dredging of rivers and brooks, re-channeling and drying lake construction and adhering to NEMA's warning (Asinobi, 2022).

Notwithstanding that flooding affects education adversely, it is observed from the literature that the effects of flooding on achievement in individual subjects have not been studied. The gravity or degree to which flooding affects learning with regard to subjects like mathematics, which is compulsory and quite essential in schools and society alike, is the focus of this study.

The effect of flooding, which occurs occasionally in affected communities, has serious consequences on the life and existence of the people. A study conducted on 120 households in Janibutu in Yola, Adamawa State, Nigeria, using a questionnaire to measure demographic variables and the impact of flooding on socio-economics statuses such as agriculture, education, health, housing, water, and sanitation established that flooding has negative impact on the well-being of the residents of the affected communities thereby recommending provision of low-cost estate to move the flood affected persons from the flood-prone areas (Danjuma et al., 2021). The effect of flooding on female gender has been noted to be very severe. Rakib et al. (2017) stated that the female gender is the most vulnerable to the negative consequences of flooding, which affects many socio-economic sectors, including education. A survey of 405 Irish citizens' comprising 168 girls and 237 boys, revealed that there exists a gender gap in favor of boys in response to disasters, noting that girls require further education to level with males (McDowell et al., 2020).

The consequence of flooding is more severe for girls (Bukhari & Kizvi, 2010). Like any other disaster such as drought and earthquake, flood affects the female gender maliciously and at a higher rate than it affects males (World Bank Group, 2021). Proper investigation is required to unveil the negative consequences of flooding and other natural disasters on female genders and the rate at which they occur (Hudson et al., 2019).

There has always existed a gender gap in achievement in mathematics between males and females in favor of males worldwide (Raise & Zu, 2022). This occurs even when there is no disaster, indeed, flood and other emergencies would worsen the situation. Girls have been noted to have poor attitudes toward mathematics, resulting in poor performance (Rodríguez et al.,

2020). A study conducted with 1,754 Senior Secondary Schools in SSC2 reveals a significant gender difference in achievement in mathematics in favor of the male gender, who performed significantly better than the female counterpart (Oribhabor, 2020). In a flood situation, the disparity will still exist, but there is a degree of doubt whether the trauma inflated by the disaster can change the situation. Therefore, the study is concerned about the effect of climate change resulting in flooding on the achievement and attitude of Basic Five Pupils towards mathematics. It is also interested in studying the effect of remedial measures in mitigating the negative effect of flooding on the achievement and attitude of the pupils towards mathematics and gender issues associated with the effect of flooding on achievement and attitude towards mathematics.

Statement of the Problem

The ravaging effect of climate change, which has led to flooding in the South-South zone of Nigeria, has brought hardship to the people as it disrupts social and economic activities including education. The teaching and learning of mathematics, a compulsory subject in the school curriculum, is affected. Government intervention to mitigate the adverse consequences of flooding has not captured in specificity its effects on teaching and learning of mathematics. Hence, the effect of climate change on achievement and attitude toward mathematics is evaluated and a remediation strategy is given in this study.

Objective

The study is carried out to evaluate the effect of climate change on the achievement and attitude of pupils towards mathematics. It provides a remediation strategy to mitigate the adverse effect of climate change on the achievement and attitude of pupils towards mathematics and examines how it affects gender.

Hypotheses

1. There is no significant effect of climate change on students' mathematics achievement.
2. There is no significant effect of climate change on gender and achievement of students in mathematics.

Methodology

Design

Causal comparative and experimental designs are used in the study. Data are collected from existing records and analyzed before experimenting to determine the effect of remediation.

Sample

Five hundred students in their Senior Secondary Class Two (SS2) were randomly selected for the study. This comprised 250 boys and 250 girls. Fifty students (25 boys and 25 girls) were randomly selected from each of the ten schools. The students' examination results used for the study for three terms were collected from the examination result master sheets. Their achievement scores in mathematics were extracted and used for the analysis.

Data Collection

The data used for the study was the terminal examination result of the students in mathematics extracted from the examination broadsheets for the term that was affected by the flood, the term before and after the flood. The scores of the students for the three terms were collected, randomly sampled and used for the data analysis to obtain the result on the effect of climate change (flooding). It is noteworthy to state that the term that was affected by flooding ended abruptly, but the examination was taken in all the subjects in the abnormal proviso.

Data Analyses Procedure

Data will be analyzed using analysis of variance (ANOVA) with Scheffe' correction and *t*-test significance level.

Results

Hypothesis 1: There is no significant effect of climate change on students' mathematics achievement. The data analysis for testing hypothesis 1 is given in the Table 1 below.

Table 1
Analysis of Variance (ANOVA) of Mathematics Achievement Scores of Students Across Before, During, and After Flood

Terms	<i>M</i>	Sum of square between	Sum of square within	<i>df</i> between	<i>df</i> Within	<i>F</i>	Decision
Before flood	59.1						
During flood	36.43	155,093.63	329,890.55	2	1497	351.9	Reject
After flood	56.7						

Note. *N* = 500.

Considering that the critical value of *F* with the degree of freedom between $df = K - 1 = 2$ and within $df = N - k = 1500 - 3 = 1497$ at .05 significance level is 2.99, hypothesis 1 is rejected. There is a significant difference between the students' achievement scores in mathematics in terms of before, during and after the flooding. The Scheffe's tests yielded $F = 291.51$ for a significant difference between scores before and after flooding, $F = 11.5$ for a significant difference between scores during and after flooding and $F = 1.36$ for a significant difference between scores before and after flooding. Showing that the differences between scores obtained before and after flooding were not significant. The result is further elaborated in tables 2, 3, and 4 below.

Table 2, at a .05 level of significance, shows a significant difference in achievement before and during climate change

catastrophe (flooding). Hence, hypothesis 1 is rejected because there exists a significant change in achievement, considering the critical value of $t = 1.96$.

Table 3, at .05 significance level, shows a significant difference in achievement before and during climate change catastrophe (flooding). Hence, hypothesis 1 is rejected because there exists a significant change in achievement, considering the critical value of $t = 1.96$.

Table 4, at a .05 level of significance, shows a significant difference in achievement before and during climate change catastrophe (flooding). Hence, hypothesis 1 is rejected because there exists a significant change in achievement, considering the critical value of $t = 1.96$.

Table 2
Mathematics Achievement Scores of Students Between Before and During Flood

Terms	<i>M</i>	<i>SD</i>	<i>df</i>	<i>t</i> -ratio	Decision
Before flood	59.1	12.71	1498	32.98	Reject
During flood	36.43	13.8			

Note. *N* = 500.

Table 3
Mathematics Achievement Scores of Students Between During and After Flood

Terms	<i>M</i>	<i>SD</i>	<i>df</i>	<i>t</i> -ratio	Decision
During flood	36.43	13.8	1498	24.85	Reject
After flood	56.7	17.54			

Note. *N* = 500.

Table 4
Mathematics Achievement Scores of Students Between Before and After Flood

Terms	<i>M</i>	<i>SD</i>	<i>df</i>	<i>t</i> -ratio	Decision
Before flooding	59.1	12.71	1498	2.47	Reject
After flooding	56.7	17.54			

Note. *N* = 500.

Hypothesis 2: There is no significant effect of climate change on gender and achievement of students in mathematics. The data analysis for testing the hypothesis 2 is given in the Table 5.

Considering that the critical value of *F* with the degree of freedom between $df = K - 1 = 5$ and within $df = N - k = 1500 - 6 = 1494$ at .05 significance level is 2.21, hypothesis 2 is rejected. There is a significant effect of climate change on gender and achievement scores of the students in mathematics in terms of before, during, and after the flooding.

The Scheffe' tests yielded $F = 4.76$ for the significant difference between scores obtained by boys and girls students in mathematics achievement before flooding. $F = 9.45$ for a significant difference between scores obtained by boys and girls students in mathematics achievement during flooding. $F = 13.89$ for the significant difference between scores obtained by boys and girls students in mathematics achievement after flooding.

$F = 48.49$ for the significant difference between scores obtained by girls students in mathematics achievement before and during flooding. $F = 30.52$ for the significant difference between scores obtained by girls students in mathematics achievement during and after flooding. $F = 2.07$ for the significant difference between scores obtained by girls students in mathematics achievement before and after flooding.

$F = 36.84$ for the significant difference between scores obtained by boys students in mathematics achievement before and during flooding. $F = 0.01$ for the significant difference between scores obtained by boys students in mathematics achievement during and after flooding. $F = 38.16$ for the significant difference between scores obtained by boys students in mathematics achievement before and after flooding.

The shows no significant differences existed between scores obtained by girls students before and after flooding with $F = 2.07$

and scores obtained by boys students before and after flooding with $F = .01$, which are less than the critical value of $F = 2.21$. During

flooding, the scores are different. There are significant differences. The result is further elaborated in Table 6 and Figure 1.

Table 5
Analysis of Variance (ANOVA) of Achievement Scores of Boys and Girls Students in the Terms Before, During, and After Flood

Terms	Gender	n	MS	Sum of Square between	Sum of Square within	Degree of freedom between	Degree of freedom within	F	Decision
Before Flood	Boys	250	62.14	162995.5	371804.9	5	1494	131	Reject
	Girls	250	55.26						
During Flood	Boys	250	42.99						
	Girls	250	33.29						
After Flood	Boys	250	62.48						
	Girls	250	50.72						

Note. $N = 500$.

Table 6
Gender-Specific Comparison of Mean and Standard Deviation in Mathematics Achievement Before, During, and After Flooding Events

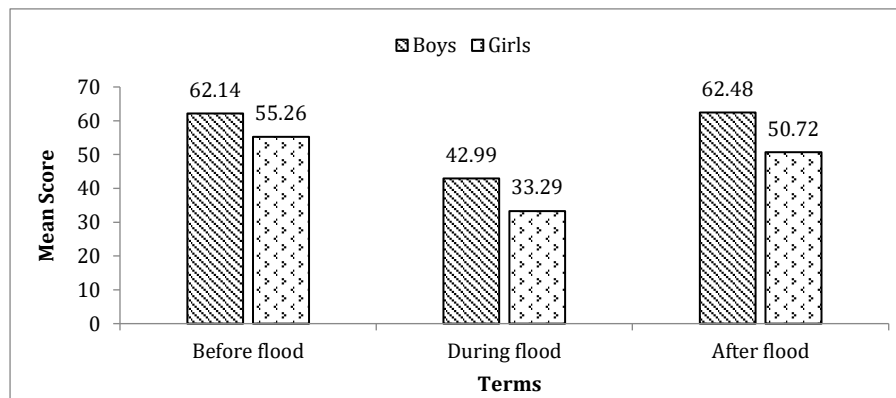
	Gender	n	M	SD	df	t-ratio	Decision
Before flood	Boys	250	62.14	23.7	498	3.74	Reject
	Girls	250	55.26	12.37			
During flood	Boys	250	42.99	2.48	498	8.51	Reject
	Girls	250	33.29	17.81			
After flood	Boys	250	62.48	18.28	498	11.66	Reject
	Girls	250	50.72	15.33			

Note. $N = 500$.

Table 6, at a .05 level of significance, shows a significant difference in the achievement of boys and girls students before the climate change catastrophe (flooding). Hence, there exists a significant change in achievement, considering the critical value of $t = 1.96$. The result shows a significant difference in the achievement of boys and girls students during climate change catastrophes (flooding). Hence, hypothesis 2 is accepted because

there exists a significant change in achievement, considering the critical value of $t = 1.96$. The result indicated a significant difference in the achievement of boys and girls students after the climate change catastrophe (flooding). Hence, hypothesis 2 is accepted because there exists a significant change in achievement, considering the critical value of $t = 1.96$.

Figure 1
Comparative Analysis of Gender-Specific Mean Mathematics Achievement Scores Before, During, and After Flooding Events



Discussion

One of the consequences of climate change, flood has been noticed to have a direct devastating impact on education, resulting in students' poor performance (Chaudbry & Tamsina, 2017; Ezekwesili, 2022), which is confirmed by this study. The effect of one of the components of climate change catastrophe (flooding) on students' achievement in mathematics was researched in this study. The terminal examination scores in mathematics for the term before flooding, the term ravaged by flood and the term after the flood were collected for the school year 2022/2023 and used for data analysis, from which it was discovered that there exists a significant difference in the mean achievement scores of the students during flood and other terms. This is shown in Table 1, where the calculated value of F -ratio, $F = 351.9$ for a critical value of $F = 2.99$, indicates that there is a significant difference in the mean achievement of students in mathematics before

flooding and during flooding as well as during and after flooding. Scheffe's test of $F = 1.36$ for a significant difference between scores before and after flooding at a .05 level of significance with the degree of freedom of $F = 2.99$ indicates no significant difference between mean achievement scores in mathematics terms before and after flooding.

Table 1 displays the effect of climate change on the achievement of students in mathematics. It can be seen that the mean achievement score of the samples reduced drastically from 59.1% before flooding to 36.43% during flooding and staggered to 56.7% after flooding instead of improving as the students mature. This demonstrates clearly that flooding resulted in serious damage to education and achievement in mathematics specifically.

This study confirms the assertion that the effect of flooding on girls' has been noted to be very severe. Rakib et al. (2017) stated that the female gender is the most vulnerable to the negative consequences of flooding, which affects many socio-economic

sectors, including education. It is clear from the data in Figure 1 that there is a conformity in the result of this study. The finding of a survey of 405 Ireland citizens, comprising 168 girls and 237 boys, revealed that there exists a gender gap in favor of boys in response to disasters, noting that girls require further education to level with boys (McDowell et al., 2020).

The study's findings equally agree with the fact that the consequence of flooding is more severe for the female gender (Bukhari & Kizvi, 2010). Like any other disaster, such as drought and earthquake, flood affects the female gender maliciously and at a rate that is higher than it affects boys (World Bank, 2021).

This study equally conducts a proper investigation to unveil the negative consequences of flooding as a natural disaster for girls genders. The rate at which it occurs was recommended by Hudson et al. (2019). The study's finding, as displayed in Figure 1, confirms that the consequences of flooding are more severe on the girls, as is seen in the effect on achievement in mathematics. From Table 5, it is clear that there is a significant effect of flooding on gender and achievement in mathematics. It can be seen that while boys students collapsed from a mean achievement of 62.14% before flood to 42.99% during flooding, a different of 19.15%, girls fell from a mean achievement score of 55.26% before flooding to 33.29% during flood, a different of 21.97%. Similarly, while the boys students recovered and had a higher mean achievement score of 62.48% after the flooding than the 62.14% they scored before the flood, a positive difference of .34%, which is commensurate with their maturation during the period, the girls gender who had a mean score of 55.26% before flooding could only achieve 50.72% after flooding, a negative difference of 4.54%. This shows that the girls took a long time to recover from the effect of the climate change catastrophe, which is flooding in this case.

Further evaluation of the result of the data analysis in Table 5 revealed that the boys' gender obtained an $F = 0.01$ for evaluation of the mean achievement score obtained before and after the flooding, while the girls had $F = 2.07$. Considering the result at a .05 level of significance, it is obvious that there is clearly no significant difference between the mean score of the boys students and girls students before and after the flooding. However, it is uniquely important to state that boys had higher mean scores after the flooding while girls had lower mean scores.

Conclusion

The findings of this study underscore the profound impact of climate-induced flooding on the academic achievement of secondary school students in mathematics. Students' performance was significantly lower during flooding compared to before and after the disaster, highlighting the disruptions in learning caused by such events. Moreover, the analysis revealed a pronounced gender disparity, with female students experiencing greater setbacks in their mathematics achievement and slower recovery compared to their male counterparts. This disparity suggests that climate disasters exacerbate pre-existing inequalities, underscoring the urgent need for targeted interventions to address these gaps. The results affirm the critical role of preparedness and systemic support in mitigating the adverse effects of climate-related challenges on education.

Recommendations

Following the findings of this study it is recommended that:

1. Comprehensive Recovery Programs: Implement targeted remedial programs, including extra classes and tutoring, to compensate for lost learning time, with special attention to female students who are disproportionately affected.
2. Disaster-Resilient Educational Planning: Develop policies to ensure the continuity of education during climate-related disruptions, such as virtual learning platforms or mobile classrooms.
3. Psychosocial Support: Provide mental health resources and counseling for students affected by flooding to address trauma and improve their focus on learning.
4. Community-Based Interventions: Engage local communities in creating awareness and preparedness programs,

emphasizing the importance of education resilience during and after disasters.

5. Government and Stakeholder Involvement: Advocate for infrastructural investments to prevent flooding in schools, such as improved drainage systems and flood-resistant buildings, while ensuring adherence to emergency management protocols.
6. Gender-Specific Policies: Formulate gender-sensitive strategies to reduce disparities, including mentorship programs, scholarships, and advocacy initiatives for female students in STEM fields.
7. Educational Equity Policies: Ensure uniform school closure and resumption policies across regions to maintain equity and consistency in learning opportunities during disruptions.

These recommendations aim to mitigate the academic and psychological impacts of flooding, fostering resilience in students and educational systems against future climate-related challenges.

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