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FLOOD HAZARD PREPAREDNESS OF BASIC EDUCATION SYSTEMS: A CASE OF TANA RIVER COUNTY, KENYA

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Abstract: *Recurrent flooding in Kenya's Tana River County has disrupted schooling, damaged school infrastructure and affected the ability of schools to deliver teaching and learning. There are policy frameworks on national disaster risk reduction and education in emergencies. However, there are still significant gaps in the operationalisation of school-based flood preparedness and converting this to sustained educational resilience. The study aimed to assess the preparedness of basic education systems for flood hazards in Tana River County, Kenya. The investigation was founded on Bronfenbrenner's Bioecological Systems Theory. The study adopted a sequential explanatory mixed-methods design, multistage and simple random sampling. The target population comprised 1,219 teachers in Tana River County. Using Yamane's formula, the study arrived at a sample size of 301 teachers. Data were collected using questionnaires, semi-structured interviews, and focus group discussions, and analyzed using descriptive and inferential statistics in RStudio, alongside thematic analysis for qualitative data. The study found that basic education systems had relatively low levels of flood hazard preparedness, $M = 2.65$, $SD = 1.27$, and preparedness differed based on person characteristics; gender $t\ (248.84) = 3.99$, $p < .001$, age, $F\ (4, 296) = 5.331$, $p < .001$, and, teaching experience $F\ (4, 296) = 6.061$, $p < .001$ significantly influenced preparedness. The study concluded that strengthening school level flood preparedness requires greater emphasis on operational planning, teacher training, regular simulation drills, and institutional support.*

Keywords: *Flood hazard preparedness; Basic education systems; Bioecological Systems Theory; Tana River County.*

INTRODUCTION

Preparedness to flood hazards is a crucial aspect to enabling education systems adapt to and withstand flood impacts (Kaffenberger, 2025). The concept of flood education is strongly supported by the SFDRR as an approach to enhance the preparedness of schools to hazards (Intaramuean et al., 2025). However, a global analysis by Masocha et al. (2025) revealed a critical gap where the school curriculum remains underutilized as a conduit for disaster resilience: pedagogy often fails to move beyond knowledge dissemination to harness the skills, attitude and active participation necessary for effective Disaster Risk Reduction (DRR) integration.

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Evidence from the US and Japan shows a recurrent pattern where strong institutional frameworks do not automatically translate into individual-level readiness. In the United States (US), districts affected by Hurricane Matthew in 2016 applied the lessons learnt to prepare for Hurricane Florence in 2018 (Davis & Sarah, 2019). Following Hurricane Matthew and Florence, research by Davis & Sarah (2019) found that schools in the US develop organisational learning strategies regardless of whether they experience a single or multiple hazards. Hurricane Florence caused widespread impacts on educational facilities, leading to extended school closures in the USA. Further, research by Morrill & Westall (2023), found that education disruptions disproportionately impact students who previously struggled academically as it is more difficult for them to catch up.

Davis et al., (2021) state that poor preparedness of schools for hazards leads to reduced instructional time and often overlooks teachers' needs, delaying the reopening of schools. In recent studies conducted by Chu et al. (2025), respondents called for the adoption of emergency plans for students. The researcher further highlighted the existing gap in that there is a mismatch between drills that are conducted to simulate real-life hazard experiences and the skills that are required by teachers to carry out response during emergency situations in the USA. The findings suggest that current preparedness activities may fail to build genuine capacity and may contribute to a false sense of security. This finding contrasts with Davis & Sarah (2019) regarding district organisational learning across hurricanes. While the districts in this study may have accumulated institutional experience over time, this experience does not appear to have translated into individual teacher readiness.

The devastating impacts of the Sichuan Earthquake forced China to develop better preparedness measures, especially in education. Since 2008, China has strictly enforced building codes and standards for schools, developed school safety management manuals, introduced regular risk assessment checklists, and mandated drills to ensure emergency plans proactively prepare students and staff (UNDRR, 2018). Though flood risk assessment is vital for schools, it has not been carried out in many countries (Yousefi et al., 2020). There is a need to pay close attention to education in schools due to the threat that hazards pose because children spend most of their time in these institutions (Yousefi et al., 2020). While China's policy reforms are well-documented, the transferability of these approaches to other contexts remains unclear.

Japan's school flood preparedness plans remain current, comprehensively updated, and highly effective in reducing disaster risk. According to Sakurai (2016), Japan's approach to enhancing school preparedness has continuously evolved by incorporating lessons learned from major disasters. Lessons from the 1995 Hanshin-Awaji earthquake formed the foundation of a national-level policy geared towards school safety. This policy was later updated and refined in line with experiences gained from the Great East Japan Earthquake and Tsunami that occurred in 2011 (Sakurai, 2016). Though these policies exist, Kawasaki et al. (2022), found that there was an almost complete absence of prior disaster training or experience among aspiring teachers in Japan. These studies show that although Japan has a strong national framework, teacher education and training on hazard preparedness and response still lag. This finding mirrors the US finding that policy strength does not guarantee individual-level readiness and that education systems have found themselves in similar circumstances.

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Schools in Khyber Pakhtunkhwa province show significant gaps in flood emergency preparedness, especially regarding students with disabilities, continuation of learning, evacuation routes, and disaster preparedness guidelines. Local communities have relied on school buildings and infrastructure for emergency shelter when their homes were ravaged by floods within the country (Shah et al., 2018). In later studies by Shah et al. (2020), the authors found out that school level preparedness was generally low across the region due to insufficient resource capabilities. The study also found that children did not have adequate knowledge in disaster risk management making them susceptible to the adverse impacts of hazards. Although these studies clearly indicate what needs to be done in Pakistan, later floods in 2022 affected over 2 million children, forcing them to miss attending classes due to the damage the floods caused in 27,000 school buildings (UNICEF, 2022). This scenario demonstrates that more still needs to be done to enhance the preparedness of schools to flood hazards, promoting the safety of students in these schools.

Studies from South Africa reveal that education on disaster risk reduction is still inconsistent and insufficiently supported, as many educational institutions lack educators with appropriate disaster training (Lunga et al., 2026). The study also noted the significant difference across the wider SADC region, with 75% of schools without staff trained in DRR and only 11% carrying out annual drills, pointing to a persistent gap between policy commitments and practice on the ground. Similar trends are observed in higher education, with South African research showing that although teachers acknowledge the importance of integrating DRR into their teaching, they are constrained by busy curricula, limited funding, lack of academic resources and lack of practical materials (Koen et al., 2024). Concerns that graduates may not be prepared for leadership and response roles are raised by similar discrepancies in disaster management training in environmental health programs, which are characterised by little work-integrated learning and a lack of standardisation across institutions (Mbola et al., 2025). Taken together, the studies support the idea that effective hazard training requires a solid grasp of the subject matter and ongoing institutional support.

In Kenya, schools are still vulnerable to flood hazards, and preparedness efforts tend to be reactive rather than preventative (Malemba et al., 2024). This vulnerability is tied to school resource limitations and the ability of schools to support learners facing socioeconomic deprivation in flood-prone schools in western Kenya, making preparedness inseparable from equal access to quality learning (Erima & Maringe, 2021). The robustness of school-based DRR measures at the national level seems to be a key indicator of teacher and learner preparedness. Preparedness strategies need institutional support and buy-in at the local level to operate in the daily school life (Gichuhi, 2022). These studies point to inadequate training, low community awareness, unsafe infrastructure and the lack of well-practised safety systems as recurring factors that help explain the continued substantial disaster risk of Kenyan schools. Kenya implemented the Education Sector Disaster Management Policy in 2017 with the ministry striving to ensure that the school environment is learner friendly and has minimal hazards. The development of this framework was to enhance preparedness of education to floods and ensure the safety of the learners, infrastructure and instructional materials. Despite having the policy in place, the floods that occurred in 2024 caused substantial damage to schools. The floods affected 13 counties including Tana River, Nairobi,

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Kisumu, Homabay, Kilifi, Baringo, Busia and Machakos. The impact of these floods was largely felt along riverine areas, coastal plains, and low-lying urban areas.

The 2024 floods affected 17 schools in Tana River County and further intensified these systemic vulnerabilities. The institutions affected included Hola Primary where classes were relocated under trees, Kongo Primary with the school fields being submerged, and Nyangwani Primary (Elimu Bora Working Group, 2024). The life-threatening nature of these floods was underscored when a boat capsized in April 2024 while trying to ferry people across the swelling river Tana and this prompted emergency response by the Kenya Defence Forces (Otsialo, 2024). This highlighted a critical deficit in localized emergency evacuation infrastructure for vulnerable groups.

Despite the existence of national policy frameworks, such as the 2018 School Safety Standards Manual and Education Sector Disaster Management Policy, that mandate disaster risk reduction measures such as safe site selection, emergency plans, regular drills, and resilient construction, the basic education in Kenya remains unprepared for flood events. Additionally, although there has been recurrent flooding in the county, there is limited empirical evidence on the preparedness of basic education to flood hazards. It is against this problem that the study sought to examine the preparedness of basic education systems to flood hazards in Tana River County, Kenya.

METHODOLOGY

2.1. Research Design

The study adopted a sequential explanatory mixed method research design. Mixed methods research design, involves the use of both numerical data and qualitative analysis to investigate a social phenomenon in depth (Creswell & Clark, 2017). The sequential explanatory design was adopted, being the most appropriate, as it allowed for quantitative results to be established first, then explained through qualitative data.

2.2. Target population

The study sought to gather information from all 1,219 teachers and 347 headteachers in primary schools and ECDEs in Tana River County and members of the Disaster Risk Management Committee (DRMC) to assess flood hazards preparedness of the basic education systems in Tana River County.

2.3. Sampling procedures and sample Size

The study adopted multistage sampling. Schools were stratified by the three constituencies (Garsen, Galole and Bura). Simple random sampling was adopted to acquire a representative population of teachers from each of the sub counties. Using the study's teacher population, $N_T = 1{,}219$ and assuming a 95% confidence planning precision of $e = 0.05$, the required sample size of teachers as computed by Yamane formula was 301. The formula used as illustrated by Mburu (2026),

$$n_T = \frac{N_T}{1 + N_T(0.05)^2}$$

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$$n_T = \frac{1{,}219}{1 + 1{,}219(0.05)^2}$$

Therefore, required Sample Size $n_T = 301$

The heads of schools were selected purposefully from the schools already sampled for the teacher survey, on the grounds that they have direct responsibility for overseeing the planning and implementation of flood preparedness at the school level. Eighteen headteachers were interviewed until data saturation was reached and sampled proportionately across the three constituencies. This was supported by Weller et al. (2018) who found that 90% of near saturation was attained between 15-23 interviews, and Hennink & Kaiser (2022) similarly confirm that empirical studies attain saturation within 9-17 interviews.

The researcher conducted one Focus Group Discussion (FGD) with five participants; the county director special programs, a deputy county commissioner, two members of the National Drought Management Authority (NDMA), and one representative from a Non-Governmental Organization. The primary goal was to triangulate institutional perspectives and coordination challenges.

Qualitative data gathered from the headteacher interviews and FGD were used to explain and contextualize quantitative data, especially the patterns observed in school level planning, teacher training, simulation drills and institutional barriers.

2.4. Data Collection Instruments

The researcher employed a mixed-methods approach to data collection, utilizing a focus group discussion, interviews, and administered questionnaires to gather comprehensive insights. The researcher used a questionnaire to gather information from the 301 teachers, a semi-structured interview guide for the 18 headteachers, and a focus group discussion guide for the disaster management officials. The questionnaire contained sections on demographic characteristics and four dimensions of flood hazard preparedness: curriculum integration, preparedness plans, simulation and drills, and teacher roles and responsibilities measured on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) and open-ended questions used to measure flood preparedness.

The interview guide provided more depth on the actions head teachers take in relation to flood hazard preparedness of the basic education systems. The FGD guide had three sections namely introduction, discussion, and closing sections to encourage participants' contributions to the study.

2.5. Analysis Techniques

The research employed descriptive statistics to summarize respondent characteristics and other key questionnaire constructs. The analysis of categorical variables and individual Likert items were reported as frequencies and percentages and composite scoring was used for multiple Likert items. To assess the interaction between the developing person and flood preparedness, as presented in the PPCT model, person-level characteristics were tested against overall flood preparedness scores. An independent sample t-test was conducted to examine the difference in mean preparedness scores between female and male teachers. The study used a one-way analysis

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of Variance (ANOVA) to assess the influence of age and highest level of education on preparedness across basic education systems.

Qualitative data were coded, grouped into themes, and analysed using R, following the six-phase thematic approach of Braun and Clarke as applied by Ahmed et al. (2025): familiarizing with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report.

2.6. Ethical Considerations

The research was approved by The National Defence University and a research permit was obtained from the National Commission for Science, Technology and Innovation (NACOSTI). Permission was also sought from Tana River County Director of Education and respective school administrations before data collection. All participants gave their informed consent and were made aware of the purpose of the study and their right to withdraw at any stage with no consequences. The responses were also explained to be confidential. Data were anonymized during the analysis and no identifying information is reported in the results.

RESULTS

3.1 Background Characteristics

The sample contained more female teachers (n = 180, 59.8%) than male teachers (n = 121, 40.2%). In terms of age, the majority of the respondents were aged 25–34 years (n = 131, 43.5%), followed by 35–44 years (n = 112, 37.2%). The proportions were lower among those aged 45–54 years (n = 38, 12.6%), below 25 years (n = 11, 3.7%) and 55 years and above (n = 9, 3.0%). Most of the teachers had 5–10 years of teaching experience (n = 135, 44.9%) and the rest of the teachers had less than 5 years of experience (n = 85, 28.2%). 45 respondents (15.0%) were teachers with 11-15 years of experience, 24 teachers (8.0%) had more than 20 years of experience and only 12 teachers (4.0%) were with 16-20 years of experience. Regarding educational qualifications, most of them were certificate holders (n = 132, 43.9%) followed by diploma holders (n = 117, 38.9%). The population of teachers was also smaller for teachers with a bachelor’s degree (n = 40, 13.3%), KCSE (n = 6, 2.0%), a master’s degree (n = 4, 1.3%) and other qualifications (n = 2, 0.7%).

3.2 Descriptive Findings Supported by Qualitative Narrations

The study examined the preparedness of basic education systems to flood hazard in Tana River County, Kenya. This was done by examining the indicators, preparedness plans, simulation and drills, curriculum integration, and teacher roles and responsibilities.

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Table 1: Overall Flood Hazard Preparedness

Survey Item	1	2	3	4	5	*M* *SD*
I am confident in teaching flood preparedness and safety topics	29 (9.6%)	49 (16.3%)	24 (8%)	120 (39.9%)	79 (26.2%)	3.57 1.30
Flood preparedness and safety topics are integrated into your teaching and learning activities	44 (14.6%)	61 (20.3%)	25 (8.3%)	130 (43.2%)	41 (13.6%)	3.21 1.31
Flood emergency procedures are communicated to staff and learners.	44 (14.6%)	64 (21.3%)	18 (6%)	153 (50.8%)	22 (7.3%)	3.15 1.26
Roles and responsibilities during flood events are clearly defined	52 (17.3%)	94 (31.2%)	37 (12.3%)	105 (34.9%)	13 (4.3%)	2.78 1.22
The school has a written flood preparedness plan	83 (27.6%)	116 (38.5%)	27 (9%)	47 (15.6%)	28 (9.3%)	2.41 1.29
The school regularly reviews its flood preparedness plan	71 (23.6%)	130 (43.2%)	39 (13%)	53 (17.6%)	8 (2.7%)	2.33 1.10
Teachers receive adequate training on response to flood emergencies	77 (25.6%)	110 (36.5%)	59 (19.6%)	49 (16.3%)	6 (2%)	2.33 1.09
Flood simulation drills are conducted regularly	86 (28.6%)	141 (46.8%)	55 (18.3%)	17 (5.6%)	2 (0.7%)	2.03 0.87
Flood simulation drills conducted at your school are effective in improving flood preparedness	86 (28.6%)	145 (48.2%)	49 (16.3%)	17 (5.6%)	4 (1.3%)	2.03 0.89

Note. Values represent frequency followed by percentage in parentheses: f (%). 1 = Strongly Disagree; 2 = Disagree; 3 = Neither Agree nor Disagree; 4 = Agree; 5 = Strongly Agree. M and SD based on 1–5 scale.

Teachers reported relatively strong confidence in teaching flood preparedness and safety topics $(M = 3.57, SD = 1.30)$. Integration of flood preparedness into teaching and learning activities was also comparatively favourable $(M = 3.21, SD = 1.31)$. They also agreed that flood emergency procedures were communicated during floods $(M = 3.15, SD = 1.26)$. Qualitative evidence supported the curricular integration finding, with 13 headteachers (72.2%) reporting that learners acquired flood awareness through Environmental Studies.

The respondents disagreed with the statements that demonstrated a presence of written flood preparedness plans $(M = 2.41, SD = 1.29)$, and the regular review of these plans scored even lower $(M = 2.33, SD = 1.10)$. This indicates that basic education institutions have not implemented flood preparedness plans uniformly across their institutions. This is likely to have contributed to the low perception on roles and responsibilities being clearly defined during floods $(M = 2.78, SD = 1.22)$.

The teachers disagreed that they received adequate training on response to flood emergencies $(M = 2.33, SD = 1.09)$. They also disagreed that flood simulation drills were conducted

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regularly ($M = 2.03, SD = 0.87$), and that drills were effective in improving preparedness ($M = 2.03, SD = 0.89$). The survey findings converged with the qualitative findings: 11 of the 18 headteachers (61.1%) stated that their schools had not carried out flood preparedness drills, although some schools had carried out fire drills. Additionally, during the focus group discussion, one of the respondents noted that,

> We've not trained any teacher or head teacher. The only person that we've been engaging in terms of flood hazards, is the ministry, the director of education and the sub-county directors (FGD, 2026)

Further, a second respondent stated that, “Drills are conducted mostly in communities. We have few cases for schools” (FGD, 2026)

Overall, teachers reported relatively low levels of flood hazard preparedness, $M = 2.65$, $SD = 1.27$. The relatively high standard deviations across most items (ranging from SD = 0.87 to SD = 1.31) indicate considerable heterogeneity in perceptions of preparedness across basic education institutions. The qualitative results supported this trend with financing (30.0%), education and training (17.7%), inadequate support materials and infrastructure (17.3%) and institutional barriers (12.3%) being the main barriers to preparedness. The qualitative findings also revealed differing stakeholder perceptions of preparedness. One participant considered schools to be “very much okay and prepared,” while another reported that, “not much has been done on preparedness of basic education to flood hazard, most efforts are focused on community” (FGD, 2026).

3.3 Inferential Findings

An independent sample t-test using the Welch-Satterthwaite correction was conducted to examine the difference in mean preparedness scores between female and male teachers. Tests of normality revealed non-normality for both groups (Shapiro-Wilk test, $p = .019$ for male teachers and $p = .005$ for female teachers); however, the t-test was retained given its established robustness to non-normality at this sample size (Field, 2018). Furthermore, Levene's test indicated that the assumption of homogeneity of variance was met, $F(1, 299) = .19$, $p = .666$. Female teachers reported higher overall preparedness ($M = 2.80$, $SD = 0.76$) than male teachers ($M = 2.43$, $SD = 0.80$), $t(248.84) = 3.99$, $p < .001$, 95% CI [0.19, 0.55]. The effect size ($d = 0.47$, 95% CI [0.24, 0.71]) indicated a moderate difference, corresponding to an approximate 63% probability that a randomly selected female teacher would report higher preparedness than a randomly selected male teacher (Fritz et al., 2012). These results provide sufficient evidence to reject H1; flood hazard preparedness differed significantly between male and female teachers.

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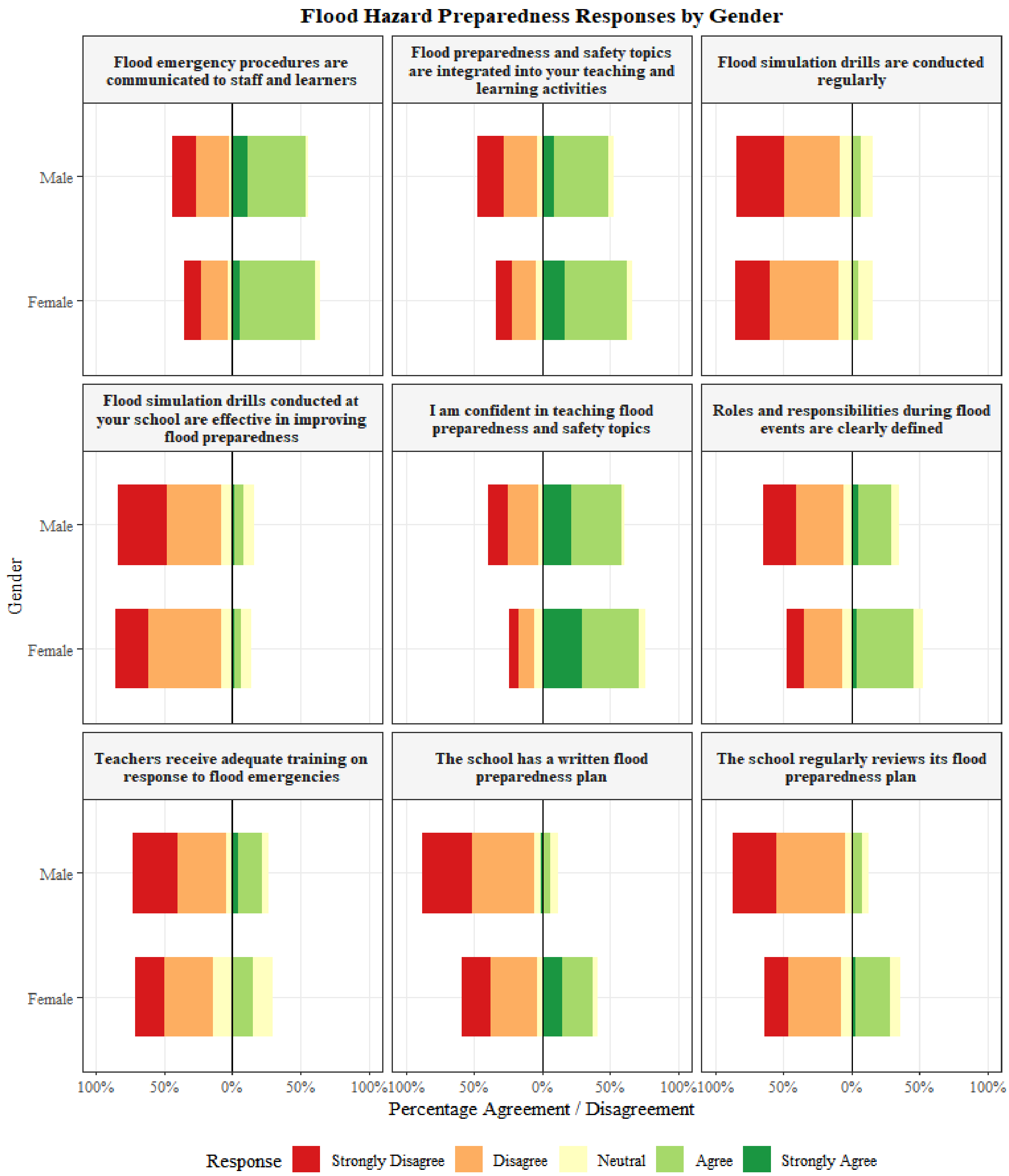

Figure 1: Flood Hazard Preparedness by Gender

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An ANOVA test was conducted to assess the effect of teachers' age and teaching experience on overall preparedness. The ANOVA was retained, as it is robust to moderate departures from normality at this sample size and normality held across the remaining age brackets (Field, 2018). Levene's test confirmed homogeneity of variance for age, F (4, 296) = .882, p = .475. The ANOVA result for age was statistically significant, F (4, 296) = 5.331, p < .001 despite non-normality in the 35–44 age group (Shapiro-Wilk, W = .965, p = .005). The study therefore provided enough evidence to reject the null hypothesis (H_2) as teachers' age had statistically significant effect on flood hazard preparedness.

Table 2: ANOVA Age and Flood Hazard Preparedness

Source of Variation	**df**	**Sum of Squares**	**Mean Square**	**F**	**p-value**
Age Bracket (Between Groups)	4	12.85	3.214	5.331	< 0.001
Residuals (Within Groups)	296	178.43	0.603		
Note: * p < .05, ** p < .01, *** p < .001					

Source: Researcher (2026)

The Tukey HSD post-hoc test showed that preparedness among teachers aged 25–34 and 35–44 was significantly higher than among those aged 45–54, and that preparedness among teachers aged 25–34 was also significantly higher than among those aged 55 and above.

Table 3: Tukey HSD Flood Preparedness by Age

Age Bracket Comparison	Difference	Lower CI	Upper CI	p-value (adj)
35–44-25–34	0.140	-0.134	0.415	0.625
45–54-25–34	-0.451	-0.843	-0.058	**0.015**
55 and above-25–34	-0.565	-1.300	0.169	0.217
Below 25-25–34	0.114	-0.555	0.783	0.990
45–54-35–44	-0.591	-0.991	-0.191	**< 0.001**
55 and above-35–44	-0.706	-1.444	0.033	0.069
Below 25-35–44	-0.027	-0.700	0.647	1.000
55 and above-45–54	-0.115	-0.905	0.675	0.995
Below 25-45–54	0.564	-0.165	1.294	0.213
Below 25-55 and above	0.679	-0.279	1.637	0.296

Note. Tukey HSD post-hoc test; statistically significant pairs (p < .05) are bolded.

As shown in Figure 2, preparedness declined with age beyond the 35–44 bracket.

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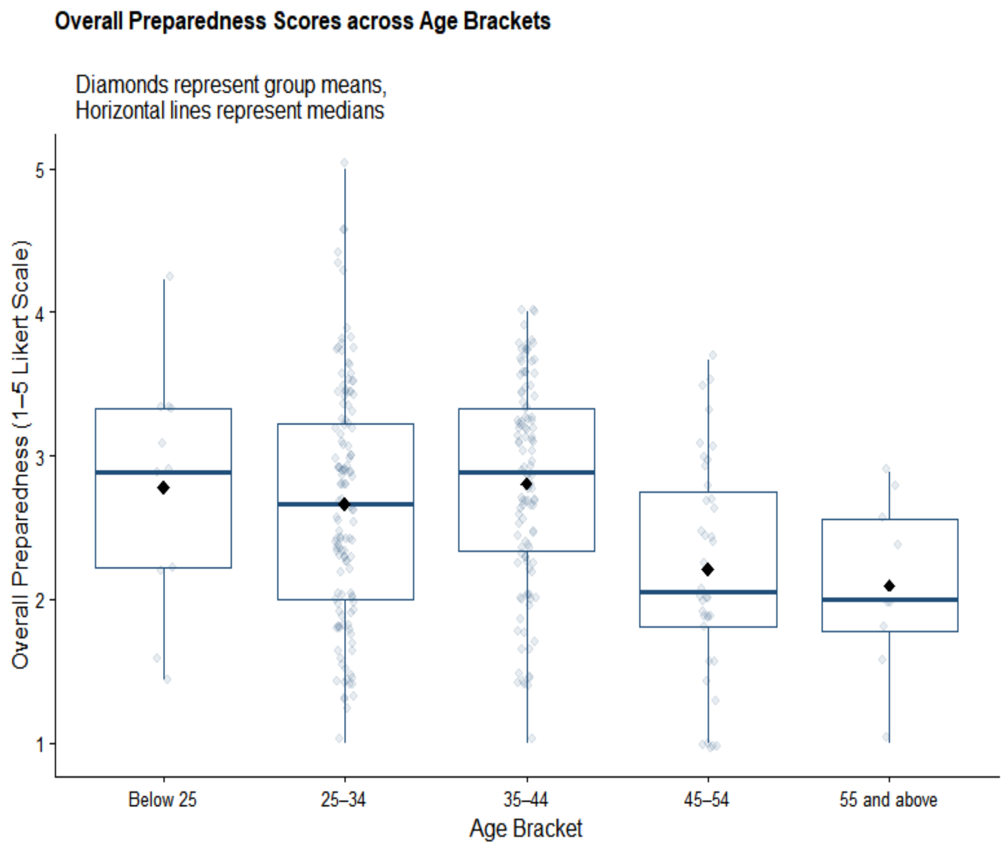

Figure 2: Flood Hazard Preparedness by Age.

The ANOVA was retained because it is robust to moderate normality violations at this sample size, despite non-normality in the 5–10 years' experience group (Shapiro-Wilk, $W = .973$, $p = .008$). Levene's test confirmed homogeneity of variance ($p = .283$). The ANOVA showed a statistically significant effect of years of experience on teachers' flood hazard preparedness, $F(4, 296) = 6.061$, $p < .001$. The study also rejected null hypothesis H_3, indicating that years of teaching experience had a statistically significant effect on flood hazard preparedness.

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Table 4: ANOVA Flood Hazard Preparedness and Teaching Experience

Source of Variation	df	Sum of Squares	Mean Square	F	p-value
Teaching Experience (Between Groups)	4	14.48	3.621	6.061	< 0.001
Residuals (Within Groups)	296	176.81	0.597		

Note: * p < .05, ** p < .01, *** p < .001
Source: Researcher (2026)

Tukey HSD post-hoc comparisons showed that teachers with more than 20 years of experience reported significantly lower preparedness than those with 5–10 years (Mean Difference = −0.683, $p < .001$) and those with 11–15 years (Mean Difference = −0.701, $p = .004$), with no other pairwise comparisons reaching significance.

Table 5: Tukey HSD Flood Hazard Preparedness and Teaching Experience

Teaching Experience Comparison	Difference	Lower CI	Upper CI	p-value (adj)
16–20-11–15	-0.618	-1.307	0.071	0.103
5–10-11–15	-0.018	-0.383	0.347	1.000
Less than 5-11–15	-0.272	-0.664	0.119	0.313
More than 20-11–15	-0.701	-1.237	-0.165	**0.004**
5–10-16–20	0.600	-0.039	1.239	0.077
Less than 5-16–20	0.345	-0.309	1.000	0.596
More than 20-16–20	-0.083	-0.833	0.667	0.998
Less than 5-5–10	-0.254	-0.548	0.039	0.125
More than 20-5–10	-0.683	-1.153	-0.213	**< 0.001**
More than 20-Less than 5	-0.429	-0.919	0.062	0.118

Note: Tukey HSD post-hoc test; statistically significant pairs (p < .05) are bolded.
Source: Researcher (2026)

Preparedness therefore appears to follow a "rise then decline" pattern across a teaching career, peaking in the mid-career years before declining among the most experienced teachers, closely mirroring the age-related pattern above.

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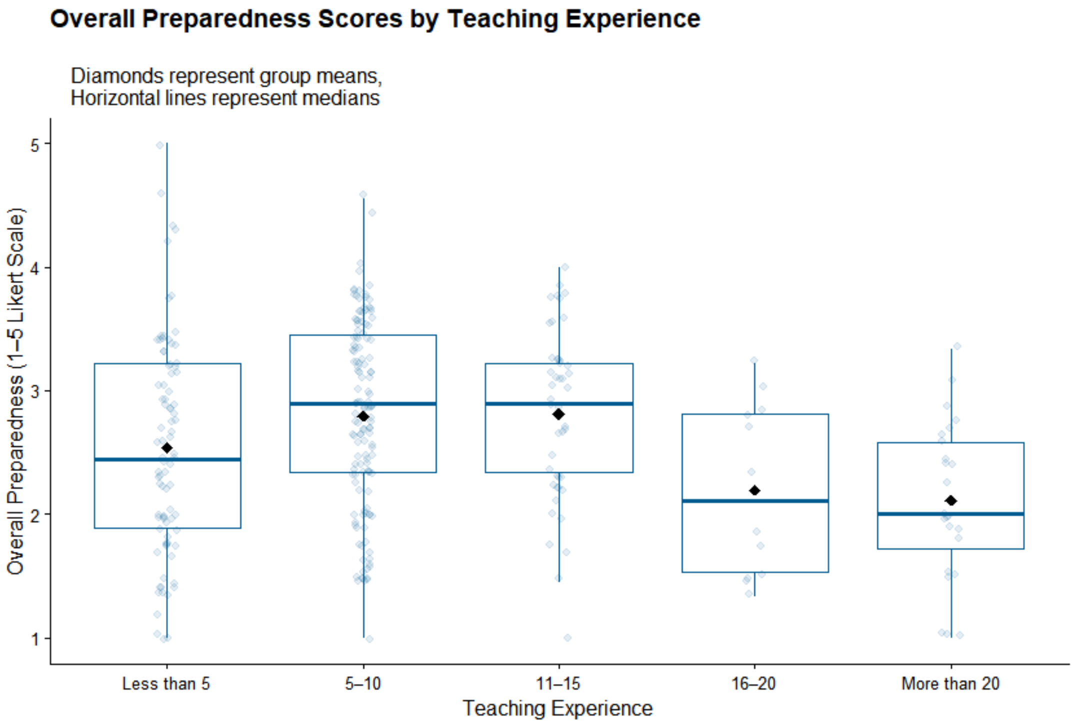

Figure 3: Flood Hazard Preparedness by Teaching Experience

A Welch's ANOVA was used in place of the standard ANOVA to assess the effect of teacher's highest level of education on overall preparedness. This was because the Shapiro-Wilk test scores for teachers holding a diploma deviated from a normal distribution ($W = .937, p = .000$), and the Levene's test indicated a violation of the homogeneity of variance assumption (p = .016). The Welch's ANOVA found no statistically significant difference in preparedness across education levels, p = .074.

Table 6: Welch ANOVA for Preparedness by Education Level

Source	df1 (num)	df2 (denom)	F	p-value
Education Level (Welch's ANOVA)	4	15.67	2.634	0.074

Note. Welch's ANOVA used due to violation of the homogeneity of variance assumption.
Source: Researcher (2026)

The non-significant effect of formal education suggests that a teacher's academic qualification, as a Person-level Resource characteristic, does not, on its own, translate into greater flood preparedness in this context. These results are not sufficient to reject H4. Teachers' highest level of education had no statistically significant effect on flood hazard preparedness.

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DISCUSSION

The findings indicate that basic education institutions in Tana River County have relatively limited flood hazard preparedness, although preparedness varies considerably across institutions and dimensions. Teachers reported relatively low overall preparedness, while the qualitative findings identified financing, education and training, inadequate support materials and infrastructure, and institutional barriers as the main constraints. The divergence in stakeholder perceptions suggests that preparedness measures are not experienced or implemented uniformly across schools. Rather than indicating that schools are categorically unprepared, the findings point to uneven institutional capacity to translate preparedness expectations into consistent practice.

Teachers demonstrated relatively strong confidence in teaching flood safety and integrating flood-related content into learning activities. However, a critical operational gap persists due to inadequate training, limited institutional support, and weak practical preparedness mechanisms. Flood preparedness planning in the basic education systems was found to be inadequate. The lower scores for regular review of preparedness plans further suggest that even where plans exist, their implementation and maintenance may be limited. This creates a potential gap between formal preparedness requirements and operational readiness at school level. In the absence of current and regularly reviewed plans, emergency management may rely more heavily on ad hoc decisions by individual staff during an actual flood event, potentially increasing risks to learners and staff. Training, simulation and drills were the weakest element of preparedness. Participants indicated that flood-related training and drills were more commonly undertaken within communities than schools. Financing was the most frequently identified qualitative barrier, followed by education and training, inadequate support materials and infrastructure, and institutional barriers.

The interpretation on the gap between knowledge-oriented preparedness and skills-based operational preparedness is consistent with Masocha et al. (2025), who observed that school curricula globally tend not to move beyond knowledge dissemination toward skills-based disaster preparedness. The present findings similarly suggest that curriculum exposure does not necessarily translate into practical preparedness capacity. Shiwaku et al. (2016), Davis et al. (2021) and Tan & Chua (2025) emphasised the importance of teacher training in enabling effective hazard preparedness and emergency response. The findings on low preparedness due to inadequate planning is consistent with Shah et al. (2020), who found that school level preparedness tends to be low where preparedness plans are absent. Although the Education Sector Disaster Management Policy, 2017 stresses the need for preparedness within the education sector, the findings suggest that this policy expectation has not been translated consistently into school level preparedness planning. Chu et al. (2025) found a gap between drills and real-life emergency situations. The current findings, however, point to an earlier challenge, namely that opportunities to practice flood response seem to be limited in many schools in the first place. This result is in line with the findings of Kawasaki et al. (2022), who discovered that adequate teacher education and training are not always correlated with robust national disaster preparedness policies.

In addition to these institutional and resource-based constraints, preparedness was also influenced by the character of the individual teacher. In alignment with H_1, female educators indicated greater

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overall readiness compared to their male counterparts. The finding indicates that readiness is not evenly spread throughout the teaching population. However, the study did not directly address the reasons for this gender difference, and therefore, the finding should not be taken as an indication that female teachers receive more engagement or training in preparedness. Instead, it suggests that gender-sensitive assessment of training needs may be warranted, particularly to ensure that teachers with lower reported preparedness are adequately reached by preparedness communication, training and practical exercises.

H_2 and H_3 results revealed a similar "rise then decline" pattern concerning age and teaching experience, with the highest reported preparedness being among middle-aged and experienced teachers, and lower preparedness among the oldest and most experienced teachers. Since this is a cross-sectional study, this pattern should be interpreted as an association rather than as evidence of a causal or cohort effect. However, the pattern's consistency across age and years of teaching experience suggests that preparedness may vary over stages of teachers' professional lives. The lower preparedness reported by the most experienced teachers may be indicative of a need for refresher training and continued professional development, especially where preparedness knowledge and practices have changed over time.

H_4 was not rejected and there was no significant relationship between teacher academic qualification and flood hazard preparedness. The significance of this finding is that formal academic achievement does not necessarily get transmuted into improved practical readiness. The results support past research findings which have highlighted the value of institutional support, practical training and skills-based involvement in addition to formal education. In the PPCT model, academic credentials are a Person-level resource, but the extent to which they can contribute to preparedness may depend on the Processes and Contexts that facilitate the translation of this resource into actionable knowledge.

The results of hypothesis testing collectively reinforce the Person aspect of Bronfenbrenner's Process-Person-Context-Time (PPCT) framework. Gender, age and teaching experience were significantly associated with preparedness, but academic qualifications did not have a significant association with preparedness. The findings suggest that individual characteristics and experiential knowledge are more relevant to preparedness in this context than formal education. The remaining PPCT dimensions are reflected in the descriptive and qualitative findings. At the Process level, curriculum integration gives a relatively positive basis but limited training and lack of drill opportunities inhibit the development of practical preparedness skills. Teachers and learners do not have enough opportunities to engage repeatedly and in practice with flood preparedness. The Context level is characterized by inadequate preparedness planning, funding, infrastructure and institutional support, which limits schools' ability to operationalize preparedness expectations. The national policy environment represents a macrosystem influence that requires supporting mechanisms at the exosystem and microsystem levels, and this conversion is not yet complete.

The findings therefore suggest that improving flood hazard preparedness requires more than the provision of policy guidance or curriculum content. It needs constant practical involvement, regularly reviewed school level preparedness plans, regular flood simulations and drills, focused

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training of teachers and adequate institutional resources. Broader, school-wide preparedness efforts could be supplemented by more targeted efforts such as refresher training for older, more experienced teachers and targeted outreach to groups reporting lower preparedness. This unified interpretation corresponds with the PPCT framework, highlighting that individual attributes do not exist in isolation but interact with proximal processes, contextual circumstances, and time to determine developmental and behavioral outcomes.

CONCLUSION

The study established that preparedness of basic education systems to flood hazard was inadequate in Tana River County, Kenya. The evidence gathered in this study provides empirical support for key propositions of Bronfenbrenner's Bioecological Systems Theory. Preparedness varied significantly by person characteristics within the Process-Person-Context-Time framework where female teachers reported significantly higher preparedness than male teachers, and preparedness varied substantially across age and teaching-experience groups, with lower preparedness among older and highly experienced teachers. The results also highlighted that although institutions in Tana River County have some level of readiness to handle flood hazards, their preparedness is weakened by inadequate planning, training, drills and unclear response duties. This indicated that the preparedness of basic education systems is not only built on proximal processes but also on the dynamic interaction between microsystemic practices and the supporting exosystemic and macrosystemic structures. The study therefore concludes that strengthening flood preparedness requires a shift from reactive arrangements towards more proactive and anticipatory approaches, supported by emergency-specific standard operating procedures that define operational procedures, roles and responsibilities, training and drills, coordination, and financial requirements.

The study recommends that the Ministry of Education together with the County Government need to produce emergency specific standard operating procedures for flood preparedness in basic education institutions in Kenya. These procedures should include clearly defined terms, operationalisation, roles and responsibilities, training and drills, and financial allocation. Teachers and headteachers need to be actively involved and empowered to ensure these procedures are well implemented. This is expected to ensure all basic education institutions in Tana River County are operating under a standardised, documented flood response protocol within two years of rollout, replacing the current inconsistent, ad hoc institutional responses. In view of the statistically significant finding that gender is a significant factor in flood preparedness, future research should examine the role of gender in flood preparedness planning to inform gender-responsive approaches for preparedness of basic education systems.

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