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Knowledge, Attitudes and Practices Towards Water, Sanitation and Hygiene among Household Residents in Flash-Flood-Prone Areas in the City of Cauayan, Province of Isabela, Northern Philippines

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Abstract: This study examined household knowledge, attitudes, and practices (KAP) related to water, sanitation, and hygiene (WASH) in five flash-flood–prone barangays of Cauayan City, Isabela, Northern Philippines. Using a cross-sectional survey of 107 households, descriptive statistics, chi-square tests, and logistic regression were employed to analyze patterns, associations, and predictors of WASH behaviors. Results revealed strong awareness of hygiene at food- and toilet-related moments and high availability of handwashing stations and soap. However, critical weaknesses were observed in childcare-related hygiene, consistent water treatment, fecal sludge management, and safe disposal of child feces. Reliance on kiosks and public taps, compounded by intermittent supply, created last-mile vulnerabilities where infrastructure reliability, rather than knowledge or attitudes, determined safe behavior during floods. Statistical analyses showed negligible associations among KAP domains, as even high-knowledge or positive-attitude households often reported poor practices. Logistic regression indicated that water shortage increased willingness to pay for improved services, while community-sharing norms reduced it; no predictors significantly explained water treatment or critical handwashing. These findings highlight the limits of information-based interventions and underscore the need for integrated strategies combining resilient infrastructure, institutionalized fecal sludge management, community-compatible financing, and interpersonal reinforcement to strengthen disaster preparedness and advance Sustainable Development Goal 6.

Keywords: Water; Sanitation and hygiene; Knowledge; Attitudes and practices; Flash floods; Household resilience; Fecal sludge management; Disaster preparedness; Water access; Northern Philippines

1 Introduction

Achieving Sustainable Development Goal 6, which seeks universal access to safe water and sanitation by 2030, remains a pressing global challenge. Although progress supports health, poverty reduction, and environmental sustainability, many low- and middle-income countries face persistent barriers, including inadequate infrastructure, limited financing, climate-related pressures, and governance gaps [1–3]. These constraints contribute to unequal access between urban and rural areas, perpetuating sanitation-related health risks [4]. Sustainable Development Goal 6, therefore, remains a central policy framework for integrated action linking environmental sustainability, public health, and human rights [5, 6].

Building on this global agenda, water, sanitation, and hygiene (WASH) are increasingly recognized as core determinants of public health and disaster resilience. Weak WASH systems heighten disease risks, particularly when disasters disrupt infrastructure and contaminate water supplies [7]. Climate change further intensifies these risks by increasing the frequency and severity of floods, storms, and droughts, which places additional strain on fragile systems [8–10]. Flash floods are especially disruptive because they can overwhelm sanitation facilities, submerge sewer lines, and contaminate water sources within hours. When systems fail, households often resort to unsafe coping strategies, such as using untreated water or returning to open defecation, which compounds public health risks in vulnerable communities [11, 12]. These dynamics help explain why unsafe WASH remains associated with substantial mortality and disability-adjusted lifen years (DALYs), disproportionately affecting children under five [13]. Strengthening resilient WASH systems is therefore central to disaster preparedness and risk reduction [14].

These global challenges are particularly relevant to the Philippines, one of the world's most disaster-prone countries, where recurrent flooding intersects with persistent WASH inequities. National surveys reveal marked disparities: while nearly all wealthy households have access to basic water, this falls to 80% among the poorest, and only 58% of the poorest have basic sanitation compared with near-universal coverage among the richest [15, 16]. In underserved rural and flood-prone areas, poverty, governance constraints, and environmental stressors further intensify vulnerabilities [17–19]. These inequities contribute to preventable disease and malnutrition but also translate into economic losses estimated at up to 7% of GDP [20, 21]. The Philippine case therefore iullustrates how disaster risks and social inequalities intersect to create systemic WASH vulnerabilities.

Within the Philippines, Northern Luzon exemplifies this intersection but remains comparatively underexamined in relation to household WASH outcomes. While the region is highly exposed to floods and flash floods, most studies have focused on governance, preparedness, or economic impacts rather than household WASH outcomes. For instance, assessments in Central Luzon highlight socio-economic impacts [22] while research in Regions I and CAR documents recurrent flooding and damaged infrastructure [23]. Other studies show that preparedness behaviors are shaped by previous flood experiences [24] and propose decision-support tools for evacuation planning in the Cagayan Valley [25]. While these contributions are important, they offer limited evidence on household-level WASH practices in inland, flood-prone settings, leaving a critical gap in both academic and policy knowledge.

Cauayan City in Isabela Province represents a key site to address this gap. Located in the Cagayan River Basin, it is highly exposed to flash floods due to its geographic and climatic conditions [26, 27]. Flooding frequently overwhelms drainage systems, damages sanitation infrastructure, and contaminates water supplies; however, limited research has examined how these hazards affect household knowledge, attitudes, and practices (KAP) related to WASH. Understanding these dynamics is essential for designing disaster preparedness and resilience strategies tailored to inland flood-prone communities in Northern Philippines.

This study is among the first to investigate WASH-related KAP in flash-flood–prone barangays of Cauayan City. It highlights the distinct challenges posed by flash floods, identifies behavioral and infrastructural-linked vulnerabilities, and provides localized evidence to guide preparedness and resilience-building. While WASH KAP studies are well established globally, few have focused on inland, flood-prone areas of Northern Philippines. By addressing this gap, the study contributes to academic literature on WASH in emergencies while also offering practical evidence for local policymaking and disaster risk reduction.

Specifically, the study aimed to:

1. Describe household KAP related to WASH in flash-flood–prone areas of Cauayan City, Isabela.
2. Examine associations between KAP using cross-tabulations and chi-square tests.
3. Identify predictors of good WASH practices using binary logistic regression analysis.
4. Derive implications for disaster preparedness and policymaking by linking household WASH behaviors with structural and systemic barriers in flood-prone communities.

To situtate these objectives, the next section synthesizes global and Philippine evidence on WASH, disaster impacts, and household behaviors, identifying gaps that this study seeks to address.

2 Literature Review

Research on WASH has expanded globally, with studies examining access disparities, disaster-related disruptions to infrastructure, and the role of household behaviors in reducing health risks. However, findings vary by context, and gaps remains limited for inland, flood-prone regions such as Northern Philippines. This review situates the present study by summarizing conceptual foundations and KAP applications, global disaster-related WASH challenges, the Philippine WASH landscape, and disaster-linked vulnerabilites. It then narrows to studies in Northern Luzon and the Cagayan Valley before synthesizing the specific research gap this study addresses.

2.1 Conceptual and Theoretical Foundations

Access to WASH is both a human right and a determinant of health and development [7]. The WHO–UNICEF Joint Monitoring Programme (JMP) reports persistent disparities across wealth and regions, with large populations still lacking safely managed drinking water and sanitation srvices [28, 29]. To analyze these patterns, KAP surveys are widely used in both WASH and humanitarian contexts. KAP instruments capture awareness, perceptions, and behaviors, generating actionable insights for interventions [30]. For instance, studies in Mozambique, Swaziland, and Haiti used KAP findings to design campaigns that addressed gaps between awareness and practice, particularly in disaster-prone areas where infrastructure disruption contributed to unsafe coping behaviors [31–33].

2.2 Global WASH Challenges and Disaster Context

Globally, inadequate WASH remains a leading cause of preventable disease, linked to over 1.4 million deaths each year, with children under five most affected [34, 35]. Disasters magnify these risks by disrupting water supply and sanitation systems [36]. Across regions, disasters consistently undermine WASH systems by disrupting supply networks, damaging sanitation facilities, and exposing households to pathogens. In Africa, for instance, floods in Ghana and Togo contaminated drinking water, forcing reliance on unsafe alternatives [37, 38]. Similar patterns emerged in South Asia, where the 2015 Gorkha earthquake destroyed water facilities in Nepal and Bangladesh's monsoon floods heightened diarrheal risks [39, 40]. In Latin America, Brazil and Mexico reported disease outbreaks linked to contaminated floodwaters, including leptospirosis [41, 42]. Collectivelty, these studies show that disasters can reverse WASH gains and expose systemic fragility. However, most studies emphasize infrastructure damage and health outcomes, with less attention to household-level practices, an evidence gap relevant to the present study.

2.3 Philippine WASH Landscape

The Philippines has made progress in WASH access, but large inequities persist. By 2017, approximately 91% of households had access to basic water, but only half had safely managed services [15, 17]. Nearly six million Filipinos still practice open defecation, with disparities sharpest in BARMM, where only 57% of families have basic sanitation and almost 10% defecate in the open [15, 43]. In schools, inadequate toilets, water supply, and hygiene facilities are linked to diarrhea, absenteeism, and menstrual hygiene challenges [44].

Economically, poor WASH costs the Philippines billions annually, up to 7% of GDP, while each dollar invested yields up to $7 in returns [21]. Weak enforcement and governance remain major barriers, though community-driven efforts have shown promise when supported by institutions [45]. These national patterns demonstrate persistent inequities, but they also raise questions about how disasters, such as floods, further shape household WASH practices, an issue discussed in the next section.

2.4 Disasters, Flood Risks, and WASH in the Philippines

As one of the most disaster-prone countries globally, the Philippines experiences frequent typhoons and floods that strain WASH systems. For example, Typhoon Ketsana in 2009 triggered leptospirosis outbreaks in Manila [46] while waterborne disease risks complicated recovery after Typhoon Haiyan in Leyte [47]. Flood exposure is also associated with increased risks of gastroenteritis, typhoid, and leptospirosis risks, particularly where sanitation is poor [48, 49]. Vulnerable housing conditions, including informal settlements, further amplifies risks [50, 51]. Governance challenges also persist, as task forces and inter-agency responses are often reactive and fragmented [52]. These dynamics highlight the systemic fragility of WASH in disaster contexts. These studies show how disasters undermine WASH nationwide. However, they tend to focus on large-scale disasters and coastal areas, while inland flood-prone regions, particularly Northern Luzon, remain less understood.

2.5 Northern Luzon and Cagayan Valley Studies

In Northern Luzon, most research has focused on flood risk, preparedness, and governance. Central Luzon assessments emphasize socio-economic vulnerabilities [22], while studies in Regions I and CAR describe recurrent flash floods and damaged infrastructure [23]. Behavioral studies show that preparedness is influenced by prior flood experiences [24], and governance-focused work in the Cagayan Valley has developed tools for evacuation planning [25]. Community-level studies in Tuguegarao and Amulung document coping strategies during flood events [53]. However, few of these studies examine household WASH practices, leaving a gap in understanding behavioral vulnerabilities in inland, flood-prone settings.

2.6 Synthesis and Research Gap

Across global and Philippine contexts, disasters consistently disrupt WASH, leading to outbreaks and unsafe practices. KAP surveys are valuable for identifying household behaviors, yet most studies in the Philippines have emphasized governance and preparedness rather than household-level WASH in inland, flood-prone communities. This gap is particularly evident in Northern Luzon, where flash floods are recurrent but little is known about how they shape WASH practices.

To address this gap, the present study uses a mixed analytical approach, combining descriptive statistics with chi-square tests and logistic regression. This approach documents household WASH behaviors and identifies predictors of good practices, producing evidence that can guide local governments and policymakers in strengthening WASH as part of disaster risk reduction strategies in the Cagayan Valley.

3 Methodology

3.1 Research Design

This study employed a cross-sectional, non-experimental, quantitative design. Its primary aim was to assess household KAP related to WASH in flash-flood-prone barangays of Cauayan City, Isabela. The cross-sectional approach was appropriate for capturing a snapshot of household conditions and for examining patterns, associations, and predictors of WASH behaviors in disaster-prone settings.

3.2 Study Area and Sampling

Researchers purposively sampled five riverine barangays in Cauayan City: Mabantad, Carabatan Chica, Carabatan Punta, Catalina, and Andarayan, which were identified as flash-flood-prone by the Mines and Geosciences Bureau (MGB) and the local government's disaster risk reduction office. The sample therefore represents households in inland, river-adjacent, flood-prone areas rather than the entire city population. From a total population of 3,453 in the selected barangays, 854 household members met the age criterion ($\geq$15 years), and 356 initially consented to participate. A total of 107 respondents completed the survey due to availability during data collection and voluntary withdrawal. Although attrition reduced the final sample size, it was considered sufficient for exploratory analyses. The sample also met minimum adequacy guidelines for chi-square tests and logistic regression, following the events-per-variable rule [54].

3.3 Research Instrument

Data were collected using a questionnaire adapted and revised from WHO and UNICEF (2015) [55], structured into three domains: (1) knowledge (handwashing, diarrhea prevention, sanitation, and water safety); (2) attitudes (perceptions of WASH, willingness to share facilities, and payment preferences); and (3) practices (actual hygiene behaviors, water use, sanitation management, and waste disposal). The instrument was reviewed by two public health specialists and one disaster risk reduction (DRR) expert to establish content validity. Because items were analyzed primarily as single indicators in categorical and descriptive analyses, multi-item scale validation was not conducted.

3.4 Data Collection

Researchers coordinated with barangay officials and obtained written informed consent from participants. Surveys were self-administered, with researcher support available for clarification. Questionnaires were provided in English, Tagalog or Ilocano based on respondent preference to avoid comprehension barriers. Completed questionnaires were stored securely and were accessible only to the research team, ensuring confidentiality and data integrity.

3.5 Data Analysis

Data were analyzed in three stages. First, descriptive statistics (frequencies and percentages) were computed to profile household KAP levels. Second, associations among domains were examined using cross-tabulations and Pearson's chi-square tests, with Cramér's V used to estimate the effect size. Finally, predictive modeling was conducted using binary logistic regression to identify significant predictors of three outcomes: (1) willingness to pay for improved water services, (2) household water treatment practices, and (3) critical handwashing behaviors. Model adequacy was evaluated using classification accuracy and the area under the receiver operating characteristic (ROC) curve. All tests were evaluated at the 0.05 significance level.

4 Results

4.1 Knowledge and Practices on Handwashing and Diarrhea Prevention

Household knowledge and practices on handwashing and diarrhea prevention are summarized in Table 1. Awareness of critical handwashing times was highest before eating (91.6%), after defecation (82.2%), and before cooking or meal preparation (79.4%). Lower proportions reported handwashing before feeding children (37.4%), after handling child feces (42.1%), and before breastfeeding (16.8%). Nearly nine in ten households had a handwashing device or station in their dwelling (88.8%), and 83.2% reported having soap available. However, only 57.9% indicated that a handwashing station was present at the latrine.

Radio was the most frequently cited source of hygiene information (63.6%), followed by community meetings (16.8%) and printed flyers (9.4%). Visits from community health workers (18.7%) and participation in hygiene meetings (26.2%) were reported by relatively few households. With regard to knowledge of diarrhea transmission, a majority identified flies as a source (58.9%), while only 12.2% recognized risks from contaminated surface water or contact with sick individuals.

For diarrhea prevention, boiling or treating water before drinking was most frequently mentioned (83.2%), followed by washing hands with soap and water (71.0%) and cooking food thoroughly (63.6%). Fewer respondents cited washing fruits and vegetables (38.3%), cleaning cooking utensils (47.7%), or covering food (57.0%). Only 26.8% mentioned consistent use of toilets or latrines, and 16.8% mentioned safe disposal of children's feces.

Table 1. Knowledge and practices on handwashing and diarrhea prevention

Domain/Item	Response Category	Frequency (f)	Percentage (%)
Most important circumstances to wash hands	Before eating	98	91.6
	Before cooking/meal preparation	85	79.4
	After defecation	88	82.2
	Before breastfeeding	18	16.8
	Before feeding children	40	37.4
	After handling a child's stool/changing a nappy	45	42.1
	Other non-hygiene reason (e.g., before prayer)	17	15.9
	Don't know	0	0.0
Handwashing practices and facilities—Handwashing device/station in household	Yes	95	88.8
	No	12	11.2
Handwashing practices and facilities—Handwashing station at the latrine	Yes	62	57.9
	No	45	42.1
Handwashing practices and facilities—Soap present at handwashing station	Yes	89	83.2
	No	18	16.8
Preferred communication for health and hygiene messages	Radio	68	63.6
	SMS	8	7.5
	Printed flyers	10	9.4
	Community meetings	18	16.8
	Focus group discussion	3	2.8
Sources of knowledge—Community health worker visit	Yes	20	18.7
	No	70	65.4
	Don't know	17	15.9
Sources of knowledge—Attended health/hygiene meeting	Yes	28	26.2
	No	67	62.6
	Don't know	12	11.2
Knowledge of sources of diarrhea	From flies	63	58.9
	From contact with sick person	13	12.2
	From swimming/bathing in surface water	13	12.2
	Don't know	5	4.7
Knowledge of diarrhea prevention	Boil/treat water before drinking	89	83.2
	Wash hands with soap and water	76	71.0
	Cook food well	68	63.6
	Wash fruits and vegetables	41	38.3
	Cover food	61	57.0
	Clean cooking utensils	51	47.7

Note: N = 107. Items in most important circumstances, preferred communication, knowledge of sources of diarrhea, and knowledge of diarrhea prevention were multiple-response. Percentages represent the proportion of respondents selecting each option; totals therefore do not sum to 100% within these item blocks.

4.2 Attitudes of the Community in Water, Sanitation, and Hygiene

Table 2 presents household attitudes and sanitation characteristics. Most households (76.6%) paid for water, and 68.2% expressed willingness to pay for improved services. In terms of sanitation hardware, most households reported having flush or pour-flush toilets (94.4%), with only a small share using pit latrines (1.9%) or composting toilets (3.7%). Construction materials for latrines were predominantly concrete (86.0%), with a smaller portion made of wood (14.0%).

Regarding sanitation management, only 20.6% of households have ever emptied their pit latrine or septic tank, while 65.4% have never done so, and 14.0% are unsure. Concerning sharing practices, 44.9% of respondents are willing to share their latrine or toilet with another household, whereas 55.1% are not.

Table 2. Community attitudes and sanitation characteristics

Domain	Item	Response Option	Frequency (f)	Percentage (%)
Access & payment	Do you pay for water?	Yes	82	76.64
		No	25	23.36
	Willing to pay for water or an improved service?	Yes	73	68.22
		No	34	31.78
Sanitation hardware	Type of household latrine	Flush toilet	101	94.39
		Pit latrine	2	1.87
		Composting toilet	4	3.74
	Main construction material (latrine/toilet)	Wood	15	14.02
		Concrete	92	85.98
Sanitation management	Has your pit latrine or septic tank ever been emptied?	Yes, emptied	22	20.56
		No, never emptied	70	65.42
		Don't know	15	14.02
Sharing	Willing to share your latrine/toilet with another household?	Yes	48	44.86
		No	59	55.14

Note: N = 107 households. All items are single-response; percentages are computed per item based on valid responses. f = denotes frequency (count).

4.3 Practices of the Community in Water, Sanitation, and Hygiene

Table 3 summarizes household practices related to water, sanitation, and hygiene. Primary drinking water were kiosks or water sellers (42.1%), public taps or standpipes (32.7%), and handpumps or boreholes (22.4%). Only 2.8% of households reported piped connections to their home or a neighbor's house. As a secondary sources, 42.1% of households reported no additional collection, while others used boreholes (22.4%), public taps (15.9%), and kiosks (12.1%).

In terms of access and reliability, 81.3% of households had water available on their premises, while 26.2% experienced water shortages in the previous month. Water treatment practices showed inconsistency: 25.2% of households always treated their water, 27.1% sometimes treated it, 1.9% did not, and 45.8% were unsure.

Sanitation practices among members aged $\geq$5 years were dominated by household latrine use (82.2%), followed by communal latrines (9.3%), shared household latrines (3.7%), and other practices such as plastic bags or open defecation (1.9%). For children under five, 51.4% primarily used household latrines, while others used shared latrines (6.5%), communal latrines (3.7%), open defecation (1.9%), plastic bags (8.4%), or pots (4.7%). About 23.4% of households reported having no child under five.

Adult open defecation was uncommon, with 93.4% reporting no practice and 5.6% acknowledging it. Solid waste disposal was most commonly handled through street bins or containers for collection (70.1%), followed by household pits (10.3%), communal pits (9.3%), open areas (5.6%), burial (2.8%), and burning (1.9%).

4.4 Statistical Associations of Household WASH Knowledge, Attitudes, and Practices

The chi-square tests of independence indicated no statistically significant associations among WASH knowledge, attitudes, and practices (Table 4). Knowledge was not associated with practice (χ^2 = 0.855, df = 1, p = 0.355), attitudes were not associated with practice (χ^2 = 0.228, df = 1, p = 0.633), and knowledge was not associated with attitudes (χ^2 = 0.000, df = 1, p = 1.000). Effect sizes were negligible (Cramér's V = 0.089, 0.046, and 0.000, respectively).

Table 3. Community practices in WASH

Domain	Item	Response Option	Frequency (*f*)	Percentage (%)
Drinking water sources	Principal source of drinking water	Public tap/standpipe	35	32.71
		Handpumps/boreholes	24	22.43
		Water seller/kiosks	45	42.06
		Piped connection to house (or neighbor's house)	3	2.80
	Secondary source of drinking water	Public tap/standpipe	17	15.89
		Handpumps/boreholes	24	22.43
		Water seller/kiosks	13	12.15
		Piped connection to house (or neighbor's house)	3	2.80
		Protected spring	1	0.93
		Bottled water/sachets	2	1.87
		Tanker truck from a protected source	2	1.87
		Did not collect water from another source	45	42.06
Access & reliability	Water source available directly on premises (courtyard/ near house)	Yes	87	81.31
		No	15	14.02
		Don't know	5	4.67
	In the past month, the household had times when there was not enough drinking water when needed	Yes	28	26.17
		No	79	73.83
		Don't know	0	0.00
Water treatment practice	Someone in the household treats water to make it safe for drinking	Yes, always	27	25.23
		Yes, sometimes	29	27.10
		No	2	1.87
		Don't know	49	45.79
Defecation practices (≥5 years)	Primary practice among members aged ≥5	Household latrine	88	82.24
		Shared household latrine	4	3.74
		Communal latrine	10	9.35
		Plastic bag	1	0.93
		Other	1	0.93
		Don't know	3	2.80
Defecation practices (<5 years)	Primary practice among members under 5	Household latrine	55	51.40
		Shared household latrine	7	6.54
		Communal latrine	4	3.74
		Open defecation	2	1.87
		Plastic bag	9	8.41
		Plastic pot	5	4.67
		No child under 5 years old	25	23.36
Adult open defecation	Adults in the household practicing open defecation	Yes	6	5.61
		No	101	93.39
Solid waste management	Household solid waste disposal area	Household pit	11	10.28
		Communal pit	10	9.34
		Street bin/container for garbage collection	75	70.09
		Designated open area	6	5.61
		Bury it	3	2.80
		Burn it	2	1.87

Note: All items are single-response; percentages are based on N = 107 and may not total 100% due to rounding. "*f*" denotes frequency (count).

Table 4. Pairwise associations among KAP domains (Pearson's χ^2)

Cross-Tabulation	χ^2	df	p-Value	Significant ($\alpha = 0.05$)	Cramér's V	Effect Size
Knowledge vs Practice	0.855	1	0.355	No	0.089	Small
Attitude vs Practice	0.228	1	0.633	No	0.046	Small
Knowledge vs Attitude	0.000	1	1.000	No	0.000	-

Note: N = 107. Pearson's χ^2; two-sided p-values; α = 0.05. Cramér's V reported for effect size.

Figure 1 visualizes these cross-tabulations and confirms minimal distributional differences across groups.

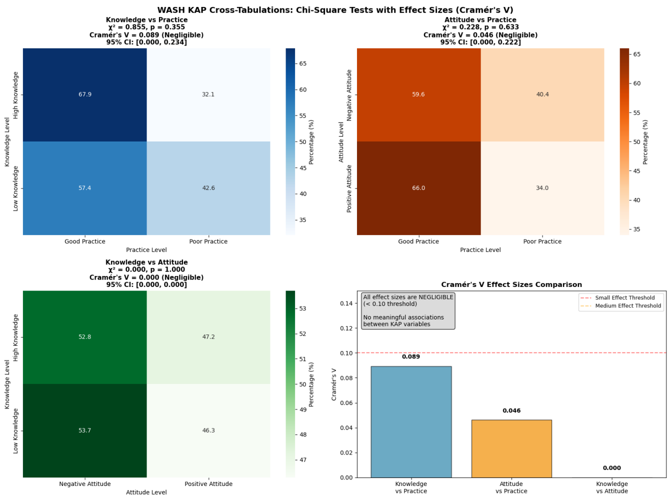

Figure 1. WASH KAP cross-tabulations and effect sizes (Chi-Square Tests with Cramér's V)

Note: Figure 1 presents the cross-tabulations of KAP domains and summarizes effect sizes; detailed test statistics are provided in Table 4.

Table 5 cross-tabulates knowledge levels with WASH practices, and Figure 2 provides a visual summary of this relationship. Among respondents with high knowledge, 36 (67.9%) reported good practice and 17 (32.1%) reported poor practice. For those with low knowledge, 31 (57.4%) demonstrated good practice and 23 (42.6%) reported poor practice. Overall, 62.6% of respondents reported good practice, while 37.4% reported poor practice. The chi-square test confirmed that the association between knowledge and practice was not statistically significant (χ^2 = 0.8545, p = 0.3553), and the effect size was negligible (Cramér's V = 0.0894).

Table 5. Cross-tabulation of knowledge level by practice toward WASH

Knowledge Level	Good Practice n (%)	Poor Practice n (%)	Total n
High knowledge	36 (67.9)	1(32.1)	53
Low knowledge	31 (57.4)	23 (42.6)	54
Total	67 (62.6)	40 (37.4)	107

Note: N = 107.

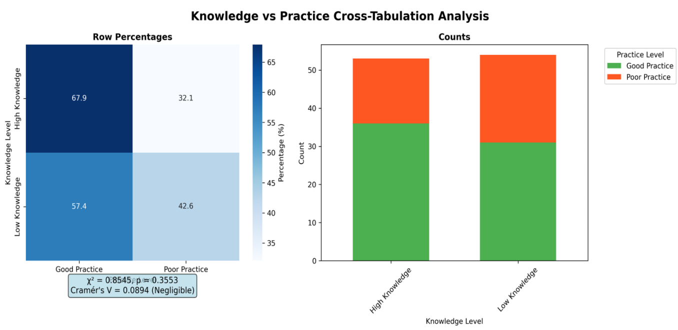

Figure 2. Knowledge vs practice cross-tabulation analysis

Note: The heatmap (left) shows row percentages, while the bar chart (right) presents counts of good vs poor practice by knowledge level. The chi-square test confirmed no significant association, χ^2 = 0.8545, p = 0.3553, Cramér's V = 0.0894 (negligible effect).

Table 6 presents the cross-tabulation of attitudes and WASH practices. Among households with negative attitudes, 34 (59.6%) reported good practices and 23 (40.4%) reported poor practices. For those with positive attitudes, 33 (66.0%) demonstrated good practices and 17 (34.0%) reported poor practices. In total, 62.6% of households reported good practices and 37.4% reported poor practices. The chi-square test indicated no significant association between attitudes and practices (χ^2 = 0.228, p = 0.633), with a negligible effect size (Cramér's V = 0.046).

Table 6. Cross-tabulation of attitude and practice

Attitude Level	Good Practice n (%)	Poor Practice n (%)	Total n
Negative attitude	34 (59.6)	23 (40.4)	57
Positive attitude	33 (66.0)	17 (34.0)	50
Total	67 (62.6)	40 (37.4)	107

Note: N = 107.

Figure 3 displays these results in a heatmap and bar chart. The visual distributions show only slight differences between positive- and negative-attitude groups, consistent with the chi-square findings that attitudes did not significantly influence practice levels.

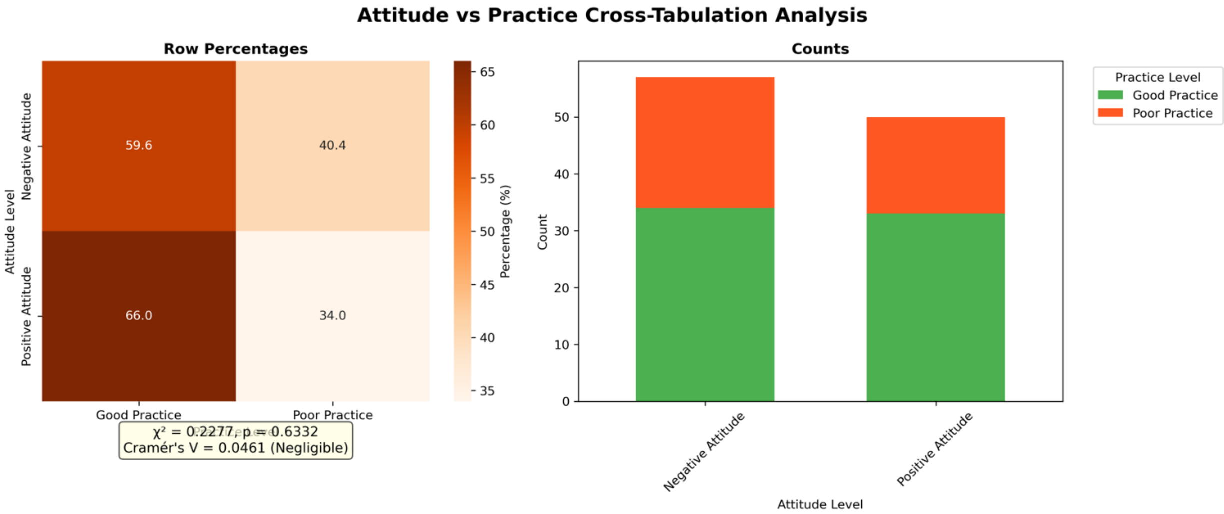

Figure 3. Attitude vs practice cross-tabulation analysis

Note: The heatmap (left) shows row percentages of good versus poor practice by attitude level. Among those with positive attitudes, 66.0% reported good practice and 34.0% reported poor practice, while among those with negative attitudes, 59.6% reported good practice and 40.4% reported poor practice. The bar chart (right) displays the counts of practice levels across the two attitude groups. The chi-square test indicated no significant association (χ^2 = 0.228, p = 0.633), and Cramér's V confirmed a negligible effect size (0.046).

Table 7 presents the cross-tabulation of knowledge level by attitudes toward WASH. Among respondents with high knowledge, 28 (52.8%) reported negative attitudes and 25 (47.2%) reported positive attitudes. Similarly, for those with low knowledge, 29 (53.7%) expressed negative attitudes and 25 (46.3%) reported positive attitudes. Overall, 53.3% of respondents had negative attitudes, while 46.7% had positive attitudes. The chi-square test confirmed no significant association between knowledge and attitudes (χ^2 = 0.000, p = 1.000), and the effect size was negligible (Cramér's V = 0.000).

Table 7. Cross-tabulation of knowledge level by attitude toward WASH

Knowledge Level	Negative Attitude n (%)	Positive Attitude n (%)	Total n
High knowledge	2 (52.8 %)	2 (47.2 %)	53
Low knowledge	29 (53.7 %)	25 (46.3 %)	54
Total	57 (53.3 %)	50 (46.7 %)	107

Note: N = 107.

Figure 4 presents the same results through a heatmap and bar chart. The visual distributions show nearly identical proportions of positive and negative attitudes between high- and low-knowledge groups, reinforcing the chi-square test result of no meaningful association.

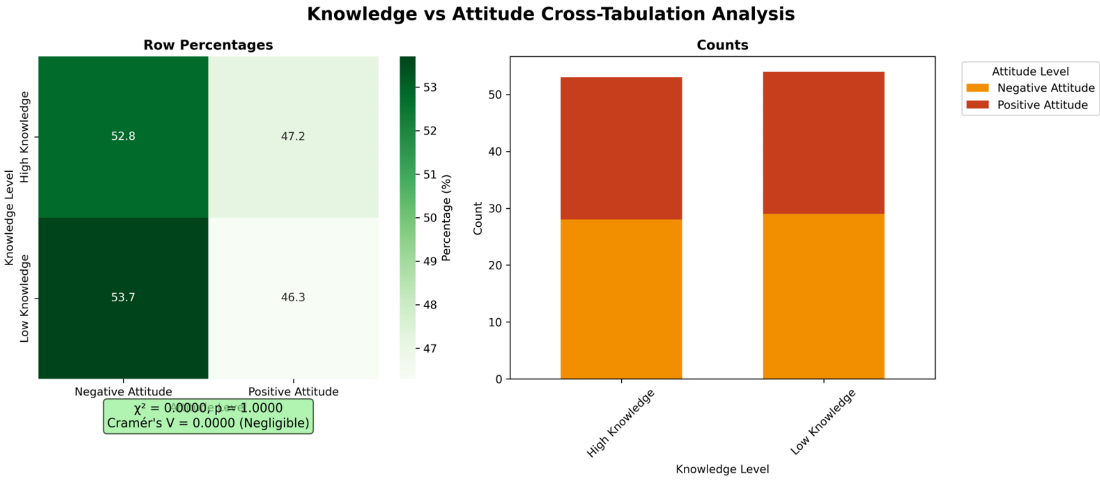

Figure 4. Knowledge vs attitude cross-tabulation analysis

Note: The heatmap (left) shows row percentages of negative versus positive attitudes by knowledge level. Among respondents with high knowledge, 52.8% had negative attitudes and 47.2% had positive attitudes. Similarly, among those with low knowledge, 53.7% reported negative attitudes and 46.3% reported positive attitudes. The bar chart (right) presents the distribution counts for each category. The chi-square test indicated no significant association (χ^2= 0.000, p = 1.000), and Cramér's V confirmed a negligible effect size (0.000).

4.5 Determinants of Household WASH Practices: Logistic Regression Results

Table 8 shows the logistic regression model predicting household willingness to pay for improved water services. Two predictors were statistically significant. Households experiencing water shortages were about eight times more likely to express willingness to pay (β = 2.08, OR = 8.02, 95% CI = 1.79–36.03, p = 0.007). In contrast, households with stronger community-sharing attitudes were significantly less likely to pay (β = -1.20, OR = 0.30, 95% CI = 0.10–0.90, p = 0.032). All other predictors, including knowledge of handwashing devices, importance of soap, and awareness of diarrhea prevention, were not significant. The overall model showed good performance, with 73.8% accuracy and an area under the ROC curve (AUC) of 0.82.

Table 8. Logistic regression predicting willingness to pay for water

Predictor	β (Coefficient)	OR (Odds Ratio)	95% CI for OR	p-Value	Interpretation
Knowledge: handwashing device	0.05	1.05	0.17–6.65	0.955	No significant effect
Knowledge: soap important	0.27	1.31	0.36–4.76	0.681	No significant effect
Knowledge: diarrhea prevention	0.00	1.00	0.11–8.87	0.999	No significant effect
Attitude: community sharing	-1.20	0.30	0.10–0.90	0.032	Negative predictor; households with stronger sharing attitudes were less likely to pay
Household: water on premises	-0.31	0.74	0.08–6.79	0.787	No significant effect
Household: water shortage	2.08	8.02	1.79–36.03	0.007	Strong positive predictor; households experiencing shortages were eight times more likely to pay
Household: Pays for water	0.89	2.44	0.29–20.26	0.408	No significant effect

Note: N = 107. Model performance: accuracy = 73.8%; AUC (ROC) = 0.82. Estimates are β (logit), OR, and Wald 95% CIs; α = 0.05. Significant predictors (p < 0.05): Attitude: Community Sharing (β = -1.20, OR = 0.30, 95% CI 0.10–0.90), Household: Water Shortage (β = 2.08, OR = 8.02, 95% CI 1.79–36.03).

Table 9 presents the logistic regression model predicting household water treatment practices. None of the predictors reached statistical significance at the 0.05 level. The largest, though non-significant, effect was observed for knowledge of soap importance, which suggested lower odds of treatment among households reporting this knowledge (β = -0.71, OR = 0.49, 95% CI = 0.15–1.63, p = 0.245). Minor, non-significant positive effects were noted for households with water on premises (OR = 1.45, p = 0.718) and those reporting recent water shortages (OR = 1.32, p = 0.536). Overall model accuracy was 57.0%, with an AUC of 0.62, indicating modest discrimination.

Table 9. Logistic regression predicting household water treatment behavior

Predictor	β (Coefficient)	OR (Odds Ratio)	95% CI for OR	p-Value	Interpretation
Knowledge: handwashing device	-0.19	0.83	0.17–4.03	0.815	No significant effect
Knowledge: soap important	-0.71	0.49	0.15–1.63	0.245	No significant effect
Knowledge: diarrhea prevention	0.00	1.00	0.15–6.74	0.999	No significant effect
Attitude: community sharing	0.19	1.21	0.50–2.96	0.675	No significant effect
Household: water on premises	0.37	1.45	0.20–10.70	0.718	No significant effect
Household: water shortage	0.28	1.32	0.55–3.20	0.536	No significant effect
Household: pays for water	-0.09	0.91	0.14–6.03	0.923	No significant effect

Note: N = 107. Model performance: accuracy = 57.0%; AUC (ROC) = 0.62. Estimates are β (logit), OR, and Wald 95% CIs; α = 0.05. No predictor reached statistical significance (all p > 0.05).

Table 10. Logistic regression predicting critical handwashing

Predictor	β (Coefficient)	OR (Odds Ratio)	95% CI for OR	p-Value	Interpretation
Knowledge: handwashing device	-0.42	0.66	0.02–17.92	0.802	No significant effect
Knowledge: soap important	-0.58	0.56	0.03–9.36	0.686	No significant effect
Knowledge: diarrhea prevention	0.00	1.00	0.02–53.15	1.000	No significant effect
Attitude: community sharing	1.14	3.12	0.32–30.39	0.326	No significant effect
Household: water on premises	0.23	1.26	0.06–24.58	0.877	No significant effect
Household: water shortage	0.04	1.04	0.18–5.93	0.967	No significant effect
Household: pays for water	0.59	1.80	0.10–33.69	0.695	No significant effect

Note: N = 107. Model performance: accuracy = 93.5%; AUC (ROC) = 0.82. Estimates are β (logit), OR, and Wald 95% CIs: α = 0.05. No predictor reached statistical significance (all p > 0.05).

Table 10 presents the logistic regression model predicting critical handwashing practices. No predictors was statistically significant at $\alpha = 0.05$. The largest, though still non-significant, effect was found for community sharing attitudes ($\beta = 1.14$, OR = 3.12, 95% CI = 0.32–30.39, $p = 0.326$), suggesting that households with stronger sharing norms were somewhat more likely to engage in critical handwashing. Knowledge-related predictors, such as the importance of soap (OR = 0.56, $p = 0.686$) and handwashing device presence (OR = 0.66, $p = 0.802$), showed small and imprecise associations, all below the threshold of significance. Access variables, such as having water on premises (OR = 1.26, $p = 0.877$) and reporting water shortages (OR = 1.04, $p = 0.967$), also failed to reach significance. The model demonstrated high classification accuracy (93.5%) and an AUC of 0.82, though this performance did not translate into statistically reliable effects for individual predictors.

5 Discussion

This study examined household KAP related to WASH in five flood-prone barangays of Cauayan City, Isabela. Overall, the findings indicate that although awareness of hygiene is relatively high, consistent and safe practices remain limited due to structural barriers intensified by flash-flood events.

Descriptively, households reported strong knowledge of hand hygiene at food- and toilet-related moments. Most respondents indicated handwashing before eating and after defecation. Nearly nine in ten had a handwashing device and soap available, and sanitation hardware coverage was also high, with the majority using flush or pour-flush toilets made of durable materials (Tables 1and 2). These results suggest that basic awareness and infrastructure are present in the community.

However, gaps emerged in areas most sensitive to disease transmission during floods. Childcare-related hygiene was comparatively weak, with only 16.8% washing hands before breastfeeding and 42.1% after handling child feces (Table 1). Similarly, only one in five households had ever emptied their septic tanks, leaving systems vulnerable to overflow when inundated (Table 2). In water use, reliance on kiosks and public taps remained high, while nearly half of households reported not treating their water or being unsure of its safety (Table 3). These patterns indicate "last-mile" vulnerabilities, where infrastructure and knowledge exist but do not translate into consistent safe practice.

The inferential analyses help explain these gaps. Pearon's chi-square tests showed no significant associations among knowledge, attitudes, and practices, with negligible effect sizes across comparisons (Table 4, Figure 1). Cross-tabulations confirmed this independence: about one-third of households with high knowledge still reported poor practices (Table 5, Figure 2), and over one-third of those with positive attitudes also failed to practice safely (Table 6, Figure 3). Knowledge and attitudes themselves were unrelated, as respondents with high awareness were just as likely to hold negative attitudes as those with lower awareness (Table 7, Figure 4). These findings highlight a persistent disconnect between what households know or believe and what they do in practice. This disconnect reflects similar results in Bangladesh, Zimbabwe, and Lesotho, where high awareness coexisted with inconsistent practice due to absent facilities, weak fecal sludge management, and water service interruptions [56–58]. In the flood-prone context of Cauayan, these constraints are magnified by intermittent supply, damaged infrastructure, and unsafe coping strategies during floods.

The logistic regression models provide further insight into what drives household behavior. Willingness to pay for improved water services was strongly predicted by household shortages but reduced by strong community-sharing norms (Table 8). This pattern suggests that scarcity creates urgency for investment, while collective traditions limit acceptance of individual payment schemes. Similar dynamics have been reported in Uganda and Latin America, where reliability and scarcity influenced payment more than awareness, and reciprocity norms shaped willingness to contribute [59, 60]. In contrast, no predictors were statistically significant for household water treatment or critical handwashing (Tables 9, 10). This null pattern reinforces the descriptive findings of Table 1 and Table 3, showing that preventive practices depend less on knowledge or attitudes and more on enabling conditions, such as convenient, consistently stocked facilities and low-burden technologies. Global reviews confirm that point-of-use treatment often fails due to cost, convenience, or taste, while handwashing compliance increases when water and soap are placed at the point of need [61–63].

Taken together, the results suggest that knowledge and attitudes were present but operated independently of practice, as confirmed by Tables 4–7 and Figures 1–4. This explains why regression models (Tables 9–10) found no knowledge- or attitude-based predictors of household practices. Instead, systemic vulnerabilities, shortages, desludging gaps, absence of latrine-adjacent facilities, and weak reliability, emerged as decisive constraints. In flood-prone communities, these vulnerabilities become acute, as floodwaters quickly spread pathogens from unemptied pits, submerged taps, or unsafe child feces disposal. Comparable cases from Ghana, Mexico, and Southeast Asia demonstrate that floods reverse WASH gains by exposing fragile systems, regardless of household awareness [37, 39, 63].

From a policy perspective, the findings imply that messaging-based interventions alone are insufficient to sustain safe WASH behaviors in flash-flood settings. Effective programs must prioritize structural enablers. Resilient and reliable water supply systems should be installed in shortage-prone barangays, fecal sludge management should be institutionalized to prevent overflow during floods, and latrine-adjacent handwashing stations must be established and maintained. Financing mechanisms need to account for sharing norms by incorporating group tariffs or barangay-level funds. At the same time, interpersonal reinforcement through community health workers should complement mass media campaigns, especially radio, which households identified as their most trusted communication channel (Table 1). By integrating these strategies, local governments can address both behavioral and systemic barriers, strengthen resilience, and reduce health risks during floods.

These results contribute to both scholarship and practice by reinforcing evidence that awareness is insufficient without enabling environments, while adding localized insights from inland, riverine communities of Northern Philippines, a setting rarely studied. By highlighting how flash floods intensify WASH vulnerabilities, the study underscores the need for interventions that combine infrastructure, governance, and social systems with behavior change. Such approaches are essential for disaster preparedness and for advancing Sustainable Development Goal 6 in contexts where climate-related floods repeatedly test the resilience of households and services.

6 Conclusion

This study investigated household KAP toward WASH in five inland barangays of Cauayan City, Isabela that are highly prone to flash floods. City, Isabela. The results indicate that while households reported strong awareness of hygiene at food- and toilet-related moments and high availability of handwashing facilities and soap, critical weaknesses persisted in childcare-related hygiene, consistent household water treatment, fecal sludge management, and safe disposal of child feces. Reliance on kiosks and public taps, coupled with intermittent supply, created "last-mile" vulnerabilities where infrastructure reliability, rather than awareness alone, determined safe behavior during floods.

Analyses further demonstrated that knowledge, attitudes, and practices operated largely independently, with chi-square tests and cross-tabulations showing negligible associations. Even households with high knowledge or positive attitudes often reported poor practices, reflecting systemic barriers such as weak desludging services, absence of latrine-adjacent handwashing stations, and flood-related service disruptions. Logistic regression reinforced this pattern: water shortage strongly increased willingness to pay for improved services, while community-sharing norms reduced it. In contrast, no predictors significantly explained household water treatment or critical handwashing, highlighting that such preventive behaviors depend more on enabling conditions and low-burden technologies than on information alone.

Overall, these findings imply that messaging-based interventions, though valuable, are insufficient for sustaining safe WASH behaviors in disaster-prone areas. Integrated strategies are required, combining structural enablers, such as resilient water systems, institutionalized fecal sludge management, and reliable, latrine-adjacent handwashing facilities, with community-compatible financing mechanisms and interpersonal reinforcement through health workers. In the inland, flood-prone context of Northern Philippines, these approaches are essential to strengthen resilience, reduce disease risk, and advance progress toward Sustainable Development Goal 6.

7 Limitations and Directions for Future Research

This study's cross-sectional design limits causal inference, pointing to the need for longitudinal tracking of household practices across multiple flood seasons. Attitudes and norms were measured using brief items; future studies should apply validated multi-item scales and incorporate constructs such as habit, self-efficacy, and social influence. The focus on five riverine barangays limits generalizability to the wider Cauayan City population, suggesting the need to extend research to other inland, flood-prone cities across Cagayan Valley. Finally, intervention trials comparing software-only approaches (e.g., behavior prompts) with integrated hardware–software strategies (e.g., latrine-adjacent handwashing stations, passive chlorination) are recommended to identify which combinations yield the most sustained improvements in household WASH practices.

Author Contributions

Conceptualization, P.A.A.T., M.S.F., and L.C.T.; methodology, P.A.A.T.; software, P.A.A.T.; validation, P.A.A.T., M.S.F., and L.C.T.; formal analysis, P.A.A.T.; investigation, P.A.A.T., M.S.F., and L.C.T.; resources, M.S.F. and L.C.T.; data curation, P.A.A.T.; writing—original draft preparation, P.A.A.T.; writing—review and editing, P.A.A.T., M.S.F., and L.C.T.; visualization, P.A.A.T.; supervision, M.S.F. and L.C.T.; project administration, P.A.A.T.; funding acquisition, P.A.A.T. All authors have read and agreed to the published version of the manuscript.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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