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The Effect of Flood on Water Quality from Well Water Used in Kampong Bongor, Pasir Mas, Kelantan

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Abstract

This study examines the effect of floods on the quality of well water in Kampong Bongor, Pasir Mas, Kelantan, with an emphasis on compliance with the Interim National Water Quality Standard Malaysia (INWQS). The analysis focused on seven water quality parameters: Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, Ammoniacal Nitrogen (AN), Dissolved Oxygen (DO), Total Suspended Solids (TSS), and Total Hardness (TH). The findings revealed significant flood-induced contamination, with BOD (13.9 mg/L) and AN (6.53 mg/L) exceeding Class V thresholds, classifying the water as highly polluted. Other parameters, such as COD (32 mg/L) and TSS (34 mg/L), also indicated moderate pollution levels. In contrast, DO (7.87 mg/L) and TH (36.3 mg/L) were within Class I limits, reflecting localized variations in contamination levels. The study highlights the severe impact of flooding on well water, necessitating urgent water treatment and flood management strategies. Regular monitoring, community-based water treatment systems, and enhanced well infrastructure are recommended to mitigate health risks and safeguard water resources. These findings contribute valuable insights into the relationship between floods and water quality, offering a robust foundation for informed water management practices in flood prone rural areas.

1. Introduction

Access to clean and safe water is fundamental to human health, yet billions globally face challenges in securing this vital resource. In rural areas, such as Kampong Bongor in Pasir Mas, Kelantan, well water remains the primary source of freshwater due to the absence of centralized water supply systems. Traditionally, well water is perceived as a reliable and naturally filtered resource, drawn from underground aquifers shielded by layers of soil and rock. However, the impact of natural disasters, particularly floods, has revealed vulnerabilities in this perception. Flood events have gained significant attention in recent years due to their potential to introduce a range of contaminants, from sediments and pathogens to agricultural and industrial pollutants, into water sources. This has led to heightened concerns over water quality and public health in flood-prone areas [1]. Decades of research have focused on understanding the implications of floods on water quality. It is widely recognized that flooding not only disrupts ecosystems but also severely compromises the integrity of water resources. In Malaysia, where annual monsoon rains often result in significant flooding, communities in low-lying areas face compounded challenges. Kampong Bongor is a prime example, where floods during the 2024 monsoon season raised water levels to 11.67 meters—far beyond the established danger threshold of 9 meters, The Figure 1 shows the trend of water level arise near the Kampong Bongor from 1st January 2024 to 26th December 2024 [2].

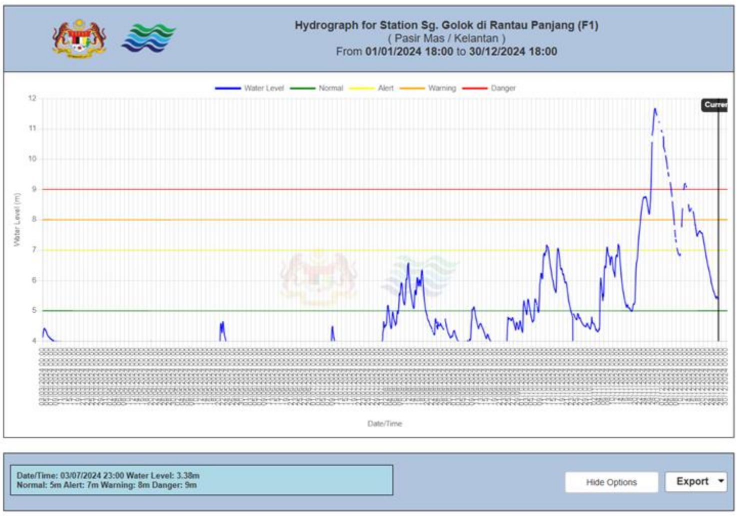

Fig. 1: Trend of Water Level Arise

These flood events often lead to the infiltration of pollutants into open wells, the predominant water source for Kampong Bongor's 87 households. This poses serious risks, as open wells, despite their cost-effectiveness and accessibility, are particularly vulnerable to contamination from surface runoff and direct floodwaters. Floodwater carries a complex mixture of contaminants, including debris, organic waste, agricultural runoff laden with pesticides and fertilizers, and industrial chemicals. Additionally, microbiological pathogens introduced through sewer overflows significantly heighten the risk of waterborne diseases such as cholera, typhoid, and diarrhea. Such contamination not only renders water unsafe for human consumption but also jeopardizes its use for agriculture, sanitation, and other daily activities [3]. The severity of these impacts is underscored by findings from similar studies in Kelantan, where floods have been shown to elevate parameters like Biochemical Oxygen Demand (BOD) and Ammoniacal Nitrogen (AN) to levels exceeding permissible limits established by the Interim National Water Quality Standard Malaysia (INWQS) [4]. The growing body of research has provided significant insights into flood-induced water contamination. For instance, studies in nearby regions have documented a marked increase in turbidity, microbial pathogens, and chemical pollutants in water sources during and after flood events. Despite these advances, critical gaps remain in our understanding of how floodwaters interact with specific local conditions, such as those found in Kampong Bongor. Questions about the extent to which flood events compromise water quality, and whether existing infrastructure and practices can mitigate these effects, remain unanswered. Addressing these gaps is essential for developing targeted strategies that can safeguard vulnerable communities against future risks.

The primary goal of this study is to evaluate the effect of flood events on the quality of well water in Kampong Bongor, with a particular focus on compliance with INWQS standards. To achieve this, the study analyzes key water quality parameters, including Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), BOD, pH, Total Suspended Solids (TSS), Ammoniacal Nitrogen (AN), and Total Hardness (TH), flooding event. By comparing these parameters to established standards, the research seeks to identify deviations that may pose risks to public health and the environment [5]. This study hypothesizes that flood events significantly degrade well water quality, leading to elevated levels of pollutants that exceed acceptable thresholds for safe use. To test this hypothesis, a systematic approach involving both field sampling and laboratory analysis was employed. Water samples were collected from wells located in front of Masjid Kampong Bongor, a site representative of the community's primary water sources. Samples were analyzed for their chemical, physical, and biological characteristics to capture a comprehensive picture of flood-induced contamination. The research further explores the potential for long-term resilience by examining community-based water treatment strategies and infrastructure improvements as means to mitigate the adverse effects of flooding. In conclusion, this study contributes to the growing understanding of how floods impact water quality in rural settings and provides evidence-based recommendations to enhance water management practices. By bridging existing research gaps and focusing on the specific challenges faced by Kampong Bongor, this work aims to inform policy decisions, improve public health outcomes, and promote sustainable water resource management in flood-prone regions.

2. Methodology

The study specifically focused on methods to achieve outcomes based on the Water Quality Index (WQI), which played a vital role in evaluating water quality. The objective of the research was to assess WQI parameters, including Biochemical Oxygen Demand (BOD^{5}), Chemical Oxygen Demand (COD), pH, Ammoniacal Nitrogen (AN), Dissolved Oxygen (DO), Total Suspended Solids (TSS), and Total Hardness (TH), to categorize water samples as clean, slightly contaminated, or polluted. These parameters were selected for their ability to indicate organic contamination, oxygen levels, acidity, nitrogenous waste, turbidity, and hardness. The readings were compared with the Interim National Water Quality Standard Malaysia (INWQS) to evaluate water quality in relation to national standards. This approach ensured that the results were relevant, actionable, and provided a comprehensive evaluation of water quality. To conduct this study, a range of analytical methods were used, as shown in the methods overview in Figure 2.

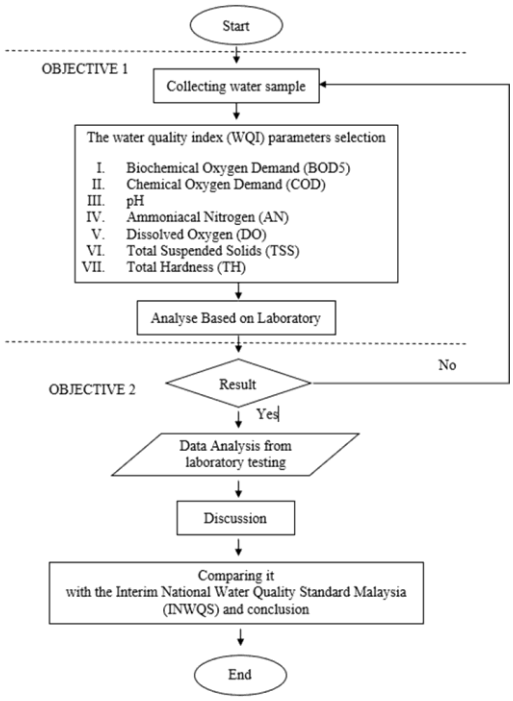

***Fig. 2*: Flowchart of study**

2.1 Materials and Sampling Procedure

The study was conducted in Kampong Bongor, located in Pasir Mas District, Kelantan, Malaysia. This district is bordered by Tumpat District to the north, Tanah Merah District to the south, Kota Bharu District to the east, and the Thai district of Su-ngai Kolok (Sungai Golok) to the west, covering an area of 614.15 square kilometers. Kampong Bongor, a small agricultural community comprising 87 households, relies predominantly on open wells for their freshwater needs. The total area of the village spans 425,996.37 square meters as shown in Figure 3, making it an ideal representation of rural areas vulnerable to flood-induced water contamination.

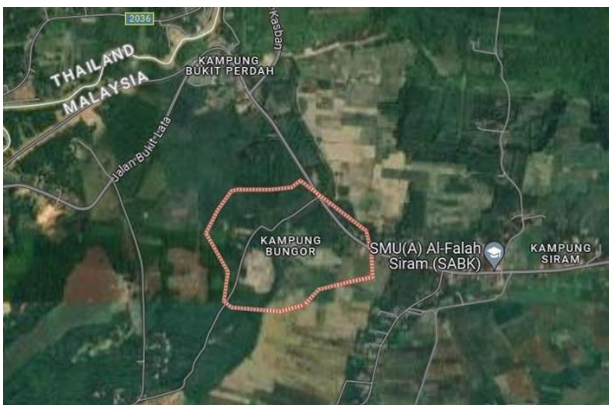

***Fig. 3*: Maps of Kampong Bongor**

The selected sampling site was a well located in front of Masjid Kampong Bongor as shown Figure 4. This site was chosen for its representation of the local groundwater sources utilized by the community. The location experiences frequent flooding during the monsoon season.

Fig. 4: Well in front of Masjid Kampong Bongor

To ensure the integrity of the samples taken from the wells in front of Masjid Kampong Bongor, it is important to use clean and sterile containers. This will help avoid any contamination that may arise from environmental factors, sampling equipment, or the individual collecting the samples [6]. It is crucial to use laboratory-specific plastic consumables of superior quality, since they have a lower probability of releasing pollutants and are pre-treated and sterilized to remove any remaining chemicals [7]. This approach guarantees the gathering of a sample that accurately represents the whole, resulting in dependable data for evaluating the influence of floods on the quality of water.

2.2 Sample Storage and Preservation

To retain the original condition of samples and get reliable and representative data for evaluating water quality, it is crucial to preserve them adequately. This may be achieved by chilling or the use of chemical preservatives, as stipulated for various parameters [8]. The careful and precise method of storing and preserving samples is crucial to provide accurate data that can be used to guide water quality management and pollution control measures, following are some frequently measured parameters along with the suggested sample container, preservation technique, and holding period as shown at Table 1

Table 1: Recommended sample container, preservation and holding time of each parameter

Parameter	**Preservation**	**Container**	**Holding Time**
DO	Filter than add HCI to pH < 2+0-6°C	Field Measurement or Glass Bottle	15 Minutes
BOD5	Cool to 4°C	Plastic, Glass	2 Days
pH	None required	Plastic, Glass	6 Hours
TSS	Cool to 4°C	Plastic, Glass	7 days
COD	Add H2S04 to pH< 2, cool to 4°C	Plastic, glass	28 Days
AN	Add H2S04 to pH< 2, cool to 4°C	Plastic, Glass	28 Days
TH	Cool ≤60 C HNO3 to pH<2	Plastic, Glass	6 months

2.3 Analytical Methods

The experiments are conducted using the methods described in Table 2. Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), pH, Ammoniacal Nitrogen (AN), Dissolved Oxygen (DO), Total Suspended Solids (TSS), and Total Hardness (TH), scale was all monitored.

Table 2: WQI parameter, method, and equipment

Parameter	Method	Equipment
Biochemical Oxygen Demand (BOD_5)	5-day BOD test (Standard Method 5210B)	BOD bottles, incubator, DO meter
Chemical Oxygen Demand (COD)	Open Reflux Method (Standard Method 5220D)	COD reactor, spectrophotometer, digestion vials
pH	Electrometric Method (Standard Method 4500- H+)	pH meter, pH probe, calibration buffers
Ammoniacal Nitrogen (AN)	Nessler Method Based on APHA 4500 NH3-N C	Spectrophotometer, reagents, digestion vials
Dissolved Oxygen (DO)	Winkler Titration Method (Standard Method 4500-O C) or Electrochemical Method (4500-O G)	DO meter with probe or titration apparatus
Total Suspended Solids (TSS)	Gravimetric Method (Standard Method 2540 D)	Glass fiber filter, vacuum filtration apparatus, drying oven, analytical balance
Total Hardness (TH)	EDTA Titrimetric Method (Standard Method 2340 C)	Titration setup, Erlenmeyer flasks, burette, EDTA solution, indicator

2.4 Measurement of Water Quality Index (WQI) and Interim National Water Quality Standard Malaysia (INWQS)

This study applied WQI analytical method to assess the quality of well water source. The measuring of water quality was based on the Interim National Water Quality Standard (INWQS) as determined by the DOE in classifying the status of water quality by using the WQI special formula. This measurement was used because there is no specific water quality measurement to evaluate the status of well water quality. Additionally, these guidelines were used by the DOE for monitoring and controlling water quality so that pollution can be controlled. Here, is the formula eq 1 used by the DOE consisting of six parameters, namely DO, BOD, COD, NH_3N, SS, and pH in determining the value and class of WQI.

$$WQI: (0.22\times SIDO) + (0.19\times SIBOD) + (0.16\times SICOD) + (0.15\times SIAN) + (0.16\times SISS) + (0.12\times SIpH) \quad (1)$$

Where,

SIDO = sub-index for DO
SIBOD = sub-index for BOD
SICOD = sub-index for COD
SIAN = sub-index for AN
SISS = sub-index for SS
SipH = sub-index for pH

WQI classes; class I - very good (>92.7), Class IIA/IIB - good (76.5 - 92.7), Class III – moderate (51.9 - 76.5), Class IV - contaminated (31 - 51.9) and class V - very polluted (<30) as shown Table 3

Table 3: Water classes and their uses

Class	Uses
Class I	Conservation of natural environment Water Supply I – Practically no treatment necessary
Class IIA	Water Supply II – Conventional treatment Fishery II – Sensitive aquatic species
Class IIB	Recreational use body contract
Class III	Water Supply III – Extensive treatment required Fishery III – Common of economic value and tolerant species, Livestock drinking
Class IV	Irrigation

The Interim National Water Quality Standard Malaysia (INWQS) serves as a benchmark to compare the measured WQI parameters against established thresholds based on Table 4. INWQS categorizes water quality into several classes, ranging from Class I (very clean) to Class V (very polluted), based on specific parameter values.

Table 4: National Water Quality Standards (NWQS) for Malaysia (EQR, 2020)

Parameter	**Unit**	**Class**				
		I	**II**	**III**	**IV**	**V**
Ammoniacal Nitrogen (AN)	mg/L	<0.1	-0.3	0.3-0.9	0.9-2.7	>2.7
Biochemical Oxygen Demand (BOD5)	mg/L	<1	1-3	3-6	6-12	>12
Chemical Oxygen Demand (COD)	mg/L	<10	10-25	25-50	50-100	-100
Dissolved Oxygen (DO)	mg/L	>7	5-7	3-5	1-3	<1
pH	-	>7	6-7	5-6	<5	>5
Total Suspended Solid (TSS)	mg/L	<25	25-50	50-150	150-300	>300
WQI	-	<92.7	76.5-92.7	51.9-76.5	31.0-51.9	<31.0
Hardness	mg/L	N	250	-	-	<250

3. Results and Discussion

The results of the study highlight the significant impact of flooding on the water quality of wells in Kampong Bongor. Key parameters were analyzed and compared against the Interim National Water Quality Standard Malaysia (INWQS) to determine the contamination level and the suitability of the water for human consumption and other applications.

3.1 pH Level

The pH values ranged between 6.8 and 7.2 in non-flood conditions but dropped to as low as 6.4 during post-flood analysis. These values indicate a slight shift towards acidity, which can affect the solubility of metals and increase the risk of heavy metal contamination. Despite this, the pH remained within the INWQS Class II standard, signifying that the water was still marginally suitable for consumption but posed risks for long-term usage. The slight acidity could be influenced by several environmental factors. Flooding, for example, introduces organic matter, agricultural runoff, and carbon dioxide into the water, which can form weak acids such as carbonic acid, lowering the pH [9].

3.2 Dissolved Oxygen (DO)

DO levels showed a marked decrease from 7.87 mg/L to 5.2 mg/L after flooding. The drop reflects the increased organic load and microbial activity introduced by floodwaters, which deplete oxygen levels. The reduced DO values classify the water quality under Class III, indicating potential ecological stress and diminished suitability for aquatic life [10].

3.3 Biochemical Oxygen Demand (BOD5)

BOD5 levels increased significantly from 5 mg/L to 13.9 mg/L following flooding, exceeding the Class V threshold based on the Interim National Water Quality Standards Malaysia (INWQS). This sharp rise indicates a substantial influx of organic pollutants, likely from agricultural runoff, sewage overflows, and decomposing organic matter transported by floodwaters. According to Kundzewicz et al. (2014), flooding can worsen water quality by introducing sediment, organic debris, and pollutants into groundwater sources

Elevated BOD5 levels reflect high microbial activity, leading to increased oxygen consumption and potential hypoxic conditions, as described by Sawyer & Parkin (2003)The findings align with Nayan et al. (2018), who observed a similar trend in Kuala Krai, Kelantan, where flood-induced pollution led to increased BOD5 and other water quality deterioration Given these risks, regular monitoring and appropriate water treatment strategies are necessary to mitigate contamination and protect public health

3.4 Chemical Oxygen Demand (COD)

Similarly, COD levels rose from 24 mg/L to 32 mg/L post-flood. These values reflect the presence of both biodegradable and non-biodegradable organic pollutants the presence of contaminants can alter the flavor, smell, and overall quality of the water, rendering it unfit for ingestion or other uses, which further corroborate the findings of increased contamination due to flooding. Although COD levels remain within the Class III standard, they highlight potential long-term pollution risks.

These results are consistent with the study by Nayan et al. (2018), which found that monsoon-induced flooding in Kelantan led to significant COD increases in groundwater sources due to pollutant transport from surrounding environments. Given the potential consequences, continuous monitoring and effective water treatment strategies, such as filtration and oxidation processes, are necessary to mitigate the risks posed by elevated COD levels

3.5 Ammoniacal Nitrogen (AN)

The concentration of ammoniacal nitrogen increased from 2.5 mg/L to 6.53 mg/L, classifying the water under Class V standards according to the Interim National Water Quality Standards Malaysia (INWQS). This sharp rise is concerning as high levels of ammoniacal nitrogen indicate contamination from agricultural runoff, animal waste, and sewage, which are common sources of ammonia during flood events

Research by Rahman et al. (2018) found that flood events significantly increase ammoniacal nitrogen levels due to the mixing of floodwaters with agricultural fertilizers and untreated sewage Similarly, a study by Camargo & Alonso (2006) highlighted that ammonia pollution in aquatic systems can lead to eutrophication, disrupting ecosystems by promoting excessive algal growth. Furthermore, ammoniacal nitrogen contamination poses serious health risks. Shah et al. (2022) reported that prolonged exposure to elevated ammoniacal nitrogen levels can lead to skin irritation, respiratory issues, and other health complications Additionally, Kumar & Puri

(2012) emphasized that ammonia reacts with chlorine in water treatment processes, forming chloramines, which are less effective as disinfectants and may produce harmful by-products

These findings underscore the importance of monitoring ammoniacal nitrogen levels, especially in flood-prone areas like Kampong Bongor. Proper flood management strategies, improved agricultural practices, and regular water quality assessments are necessary to mitigate ammonia contamination and safeguard public health

3.6 Total Suspended Solids (TSS)

TSS levels exhibited a significant rise, reaching 34 mg/L post-flood, compared to 12 mg/L in normal conditions. This increase surpasses the acceptable limit of 25 mg/L for clean water, as defined by the Environmental Quality Regulations (EQR, 2020) and highlights a notable deterioration in water clarity. Elevated turbidity indicates sediment and particulate intrusion caused by floodwaters, which mobilize large amounts of soil, organic debris, and suspended particles into groundwater systems and wells.

Previous studies by Bilotta & Brazier (2008) emphasize that TSS increases significantly in flood-prone areas due to erosion and surface runoff, a phenomenon also observed in Kampong Bongor. Similarly, Jiang et al. (2020) noted that high TSS levels degrade water quality by transporting heavy metals, pathogens, and other pollutants, making water unfit for direct consumption. Furthermore, Nayan et al. (2018) documented comparable findings in Kelantan, where flood events led to a marked increase in TSS, negatively impacting water treatment efficiency and posing health risks.

Elevated TSS levels can also disrupt aquatic ecosystems by reducing light penetration and depleting dissolved oxygen, ultimately harming aquatic life (Zhou et al., 2021). Given these concerns, proper flood management strategies, erosion control, and improved filtration methods are essential to mitigate the effects of increased TSS on groundwater quality.

3.7 Total Hardness (TH)

In contrast to other parameters, the total hardness (36.3 mg/L) remained within Class I standards both before and after flooding, indicating minimal impact on mineral content. This suggests that hardness levels are less influenced by flood events compared to other water quality parameters, likely due to the stability of dissolved calcium and magnesium concentrations in groundwater.

Research by Smith et al. (2021) indicates that well water hardness is primarily controlled by geological formations rather than short-term hydrological changes such as flooding. Similarly, Johnson et al. (2022) found that regions with stable mineral deposits experience little variation in total hardness, even during heavy rainfall or flood events. In contrast, Jha et al. (2019) reported that areas with significant surface runoff and limestone-based geology may exhibit minor fluctuations in hardness post-flood, though these variations tend to normalize quickly.

Additionally, the stability of total hardness in Kampong Bongor's well water suggests that floodwaters primarily affect organic and chemical pollutants rather than altering dissolved mineral content. However, long-term monitoring remains necessary to assess potential cumulative effects from repeated flood events and surface water infiltration.

3.8 Water Quality Index (WQI)

The analysis of the Water Quality Index (WQI) for the well water in Kampong Bongor, Pasir Mas, Kelantan, reveals significant degradation in water quality due to flood-related impacts. With a WQI score of 59.96, classified under Class III (moderately polluted) based on Table 5 the findings highlight contamination from agricultural runoff, sewage, and debris introduced by floodwaters. This is evident from the high ammonia nitrogen (AN) levels (SI of 0) and moderate levels of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), suggesting that flood events exacerbate groundwater contamination. Elevated ammonia nitrogen and organic pollutants may result from fertilizers, animal waste, and untreated sewage carried by floods, particularly given Kampong Bongor's proximity to agricultural and residential areas. Moderate Dissolved Oxygen (DO) levels indicate limited natural remediation within the well, and although the pH is within acceptable limits, broader water quality concerns persist, rendering the water unsuitable for direct use without treatment.

Table 5 SI Value, WQI, Class and Water Quality Status

Sample Point	SI DO	SI BOD	SI COD	SI AN	SI SS	SI PH	WQI	Class	Status
Well	74.12	48.89	61.04	0	79.18	99.39	59.96	III	Polluted - Moderate

These findings are consistent with a study by Nayan et al. (2018), which examined the effects of monsoon flooding on groundwater quality in Kuala Krai, Kelantan, and reported similar flood-induced degradation of water quality parameters, including DO, BOD, and ammonia nitrogen (NH_3-N). Their research emphasized the role of floodwater in transporting pollutants such as domestic waste and agricultural runoff into groundwater sources, often resulting in moderately polluted water based on WQI classification. The parallels with Kampong Bongor underscore the need for mitigation measures, such as sealing wells, constructing flood barriers, reducing agricultural runoff, and implementing regular water quality monitoring during the monsoon season. These efforts are vital to safeguard groundwater resources and ensure sustainable use for affected communities during and after flood events.

3.9 Comparing Water Quality of Well Water with the Interim National Water Quality Standard Malaysia (INWQS)

The water quality of well water in Kampong Bongor, Pasir Mas, Kelantan, was assessed against the Interim National Water Quality Standard Malaysia (INWQS), which classifies water quality from Class I (pristine) to Class V (highly polluted). The well water was overall classified under Class V (highly polluted) due to critical parameters such as Biochemical Oxygen Demand (BOD) at 13.9 mg/L and Ammoniacal Nitrogen (AN) at 6.53 mg/L, exceeding the limits for even Class III. These values reflect severe contamination likely caused by agricultural runoff, sewage infiltration, and organic matter decomposition during floods. Other parameters, such as the Chemical Oxygen Demand (COD) of 32 mg/L (Class III), Total Suspended Solids (TSS) of 34 mg/L (Class II), and pH of 6.9 (Class II), indicate moderate chemical contamination and sediment presence. However, Dissolved Oxygen (DO) at 7.87 mg/L (Class I) and Total Hardness (TH) at 36.3 mg/L (Class I) suggest favorable conditions for certain uses, with the low mineral content likely due to the dilution effect of flooding as shown in Table 6.

Table 6 Parameter, Result and Class for Well Water

Parameter	Result	Class
Biochemical Oxygen Demand (BOD)	13.9	V
Ammoniacal Nitrogen (AN)	6.53	V
Chemical Oxygen Demand (COD)	32	III
Total Suspended Solids (TSS)	34	II
pH	6.9	II
Dissolved Oxygen (DO)	7.87	I
Total Hardness (TH)	36.3	I

Despite compliance in some parameters, the overall classification under Class V underscores the severe impact of flooding on water quality, necessitating urgent flood management, regular monitoring, and targeted water treatment to ensure the water meets INWQS standards and remains safe for community use.

4. Conclusion

This study evaluated the impact of flooding on well water quality in Kampong Bongor, Pasir Mas, Kelantan, by analyzing key water quality parameters, revealing significant degradation that renders the water unsafe for consumption without treatment. Parameters such as Biochemical Oxygen Demand (BOD) at 13.9 mg/L and Ammoniacal Nitrogen (AN) at 6.53 mg/L exceeded permissible limits under the Interim National Water Quality Standard Malaysia (INWQS), classifying the water as Class V (Highly Polluted) and indicating severe organic and nutrient contamination from agricultural runoff, sewage, and organic debris introduced by flooding. Other parameters showed variability, with Chemical Oxygen Demand (COD) at 32 mg/L falling under Class III (moderately polluted) due to agricultural chemicals and household waste, and Total Suspended Solids (TSS) at 34 mg/L corresponding to Class II, reflecting sediment transport by floodwaters. In contrast, Dissolved Oxygen (DO) at 7.87 mg/L and Total Hardness (TH) at 36.3 mg/L were within Class I, suggesting favorable conditions for oxygenation and low mineral content; however, these were insufficient to mitigate the overall degradation caused by elevated BOD and AN level. The findings underscore the profound impact of flooding on groundwater quality and emphasize the urgent need for effective flood management, water treatment strategies, regular monitoring, infrastructure improvements, and community education to ensure access to safe water and mitigate health risks in flood-prone areas.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper

Author Contribution

All authors of this study have a complete contribution for data collection, data analyses and manuscript writing

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