

RAISING AWARENESS OF DRINKING WATER SAFETY AFTER FLOODING THROUGH pH EDUCATION AND SELF-TESTING KITS IN TANJUNG GUSTA SUBDISTRICT

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Abstract

The massive flooding that struck Medan in November 2025 severely affected the Tanjung Gusta neighborhood in Medan Helvetia subdistrict, prompting the Al-Yahdi Medan Foundation to serve as an evacuation center. It also contaminated residents' clean Water sources, while the public still judges Water safety by visual clarity alone, without understanding pH as a key chemical indicator. This community service activity, under the Pioneer Service Program of the Vocational Faculty, Universitas Sumatera Utara, aimed to enhance the knowledge and skills of teachers, students, and parents at Al-Yahdi Foundation in assessing Water potability after the flood through education on pH parameters and training in portable pH meters, complementing simpler pH indicator (litmus) paper. Conducted at Al-Yahdi Foundation from April to November 2026, the activity comprised coordination, instrument design and validation, outreach, demonstrations, hands-on training, distribution of instruments and manuals, mentoring, and pretest–posttest evaluations. Average comprehension scores rose from 43.8 ('insufficient') to 87.0 ('good'). pH of Water samples from partner communities ranged from 5.9 to 7.2, with some outside the safe range set by Indonesia's Ministry of Health (6.5–8.5). This initiative effectively raised public awareness and fostered self-reliance in testing Water quality before consumption during post-flood recovery, supporting Sustainable Development Goals (SDGs) 3 and 6.

Keywords: pH; portable pH meter; post-flood; public education; water quality

INTRODUCTION

The Al-Yahdi Medan Foundation, located on Jalan Klambir V, Gang Madrasah, Tanjung Gusta Village, Medan Helvetia Subdistrict, Medan City, is a religious, educational, and social institution that plays a strategic role in the surrounding community. In November 2025, the foundation served as one of the evacuation centers for residents affected by the massive floods that struck the City of Medan, particularly in the Tanjung Gusta Village area (Medan City Regional Disaster Management Agency, 2025). This event underscored that the area is vulnerable to flooding because of high rainfall intensity and the limited capacity of the existing drainage system.

Flooding not only damages infrastructure and residents' property but also seriously affects the quality of drinking Water sources. In the aftermath of the flood, contamination of well Water, municipal Water supplies, and household Water storage poses a real threat to public health. This situation is exacerbated by the fact that most of the affected residents, including evacuees who had taken shelter at the Al-Yahdi Foundation, lack the knowledge and adequate tools to assess the safety of the Water they consume after the floodwaters recede.

One of the key parameters determining the suitability of Water for consumption is the pH value (acidity level). According to a regulation issued by the Minister of Health of the Republic of Indonesia, Water suitable for consumption has a pH range between 6.5 and 8.5 (Ministry of Health of the Republic of Indonesia, 2017, 2023). After a flood, Water can become contaminated with various organic and inorganic substances that cause shifts in pH levels, making it either too acidic or too alkaline. Both conditions harm the human body and can lead to digestive disorders, tooth enamel damage, and long-term health problems if consumed continuously (Syahputra & Lubis, 2021). Communities around the Al-Yahdi Foundation, particularly residents directly affected by the November 2025 flood, generally still rely on visual assessments—such as Water clarity—to determine Water's suitability for consumption. However, even Water that appears clear may not be safe to drink, as chemical contaminants and pH

shifts cannot be detected by sight alone. This knowledge gap is exacerbated by the lack of pH measuring devices that are easily accessible, affordable, and operable independently at the household level.

Given these conditions, the development of appropriate technology in the form of a simple Water pH meter that can be operated independently by the general public is a relevant and urgent solution. Several studies have demonstrated the effectiveness of simple electronics-based pH meters in monitoring Water quality at the community level (Rizky *et al.*, 2023), while community empowerment programs through education and training in the use of appropriate technology have been shown to increase community awareness and capacity to manage environmental health risks independently (Santoso & Hasibuan, 2022). This community service initiative synergistically integrates these two approaches, with the Al-Yahdi Foundation serving as the hub of activities, to strengthen the health resilience of the Tanjung Gusta neighborhood community.

The objectives of this community service activity are: (1) to increase the knowledge of teachers, students, and parents at the Al-Yahdi Foundation in Medan regarding pH as an indicator of Water quality; (2) to train partners in the independent use of pH measurement tools, including both portable pH meters and litmus paper; and (3) to encourage the practice of checking Water quality before consumption, particularly during the post-flood recovery period. This activity also supports the achievement of Sustainable Development Goals (SDGs) 3 (Good Health and Well-being) and 6 (Clean Water and Sanitation) (United Nations Development Programme, 2023).

LITERATURE REVIEW

After flooding water quality usually declines sharply, with pH being one of the most consistently affected factors. In a before-and-after study carried out in the primary schools of Jamalpur District, Bangladesh, Tabassom, Talukder and Shuvo (2025) discovered that the pH level dropped on average by 0.49 units following the flood, with a number of samples going below the lower limit recommended by the WHO, while there were also marked increases in turbidity and total dissolved solids. This result is in line with the general chemical risks identified by Syahputra and Lubis (2021), who pointed out that consumption over time of tooth enamel and the digestive system can be damaged by pH changes caused by organic and inorganic contaminants brought about by flooding. Thus, these studies show that pH can be regarded as a scientifically valid and measurable indicator of water safety after a flood. Nevertheless, both studies were carried out as technical monitoring exercises and not as community-oriented interventions, so it remains unclear how ordinary people could access the indicator and interpret it on their own.

The discrepancy between what the public thinks and the real water risk makes this gap worse. According to Miller *et al.* (2024), who used survey data from 141 countries, over half of the respondents expected to suffer serious harm from their water supply within two years, and their level of trust was more influenced by their perception of institutional corruption than by the actual quality of the infrastructure. On the other hand, in places that have been affected by disasters such as Tanjung Gusta, the opposite kind of bias is usually found: people consider the water to be safe just because it appears clear, even though clarity does not indicate anything about the pH or the dissolved contaminants. These differing biases — being unnecessarily distrustful in some cases and unnecessarily confident in others — show that people's perception of water safety is not well matched to the actual chemical risk, and that bridging this gap must involve providing residents with simple and inexpensive testing tools rather than depending just on visual assessment or general public information.

Technology that is suitable for practical use has been suggested as a way of filling this gap. Rizky *et al.* (2023) showed that it is possible to construct and run simple pH meters based on electronics at a low cost for water monitoring at the community level in Indonesia, a result that has been supported internationally by Pérez-López *et al.* (2023), who developed the open-source PortAqua device which measures both pH and conductivity for less than USD 50 and, as found in workshop tests, considerably enhanced the participants' understanding of water quality parameters following hands-on use. These studies prove that portable pH devices are not only technically feasible but also effective from an educational point of view. Yet neither of the two studies places the technology in a situation that comes after a disaster or assesses its use by non-specialist members of the community such as teachers and parents rather than by students or technicians.

There is a greater division of opinion regarding whether education-based interventions lead to actual changes in behaviour. Santoso and Hasibuan (2022) discovered that community empowerment programmes which combined training with suitable technology increased the residents' ability to look after environmental health risks by themselves. On the other hand, Freeman and Clasen (2011), when they assessed a school-based safe water intervention in southern India, found that there was no significant increase in households' awareness of water safety or in the adoption of water treatment methods one year after the programme had taken place, indicating that transferring knowledge alone, without ongoing mentoring or the provision of practical tools, may not result in a

lasting change in practice. This lack of consistency implies that the effectiveness of water safety education probably depends on its structure—whether it involves brief messaging or hands-on, tool-supported and mentored training—rather than on education in general.

When put together, the existing studies focus either on the technical assessment of water quality after a flood, on the psychological gap in public perception, or on the feasibility of using low-cost pH testing tools and providing community training, but very seldom do they cover all three aspects within a single intervention that is specific to a disaster. There are few, if any, studies that have evaluated water safety education based on pH which is delivered directly in a flood evacuation centre to non-specialist teachers, students, and parents, together with both portable pH meters and litmus paper, and which is validated by pretest-posttest measurements as well as by actual field pH testing of water sources in households during the recovery phase. This study fills that gap by combining technical pH education, hands-on training with portable meters, and post-flood field verification in the Al-Yahdi Foundation community in Tanjung Gusta, thus providing evidence that properly structured and tool-supported education can turn water safety knowledge into independent testing practice during the period of post-flood recovery.

METHOD

Target Audience, Time, and Location

This community service activity is part of the Pioneer Community Service program of the Vocational Faculty at the University of North Sumatra, targeting teachers, students, and parents of students at the Al-Yahdi Foundation in Medan, as well as the community residing on Jalan Klambir V, Gang Madrasah, Tanjung Gusta Village, Medan Helvetia Subdistrict, Medan City. The program will run for eight months, from April through November 2026, and is funded by non-PNBP funds from the Vocational Faculty of the University of North Sumatra for the 2026 fiscal year.

Portable pH Meter

This Water pH meter utilizes a pH electrode sensor (BNC-type probe). The pH meter is calibrated using a two-point method with standard buffer solutions of pH 4, 7, and 10, ensuring measurement accuracy within the pH range of 4–10, which is relevant for drinking Water quality. The device was validated by comparing its measurement results with those of a standard laboratory pH meter on five different Water samples: tap Water, well Water, a dilute acid solution, a dilute base solution, and Water collected after a simulated flood. The device is considered valid if the measurement difference (error) is no more than ± 0.2 pH units. As a simpler alternative that does not require an electrical power source, the team also provides pH indicator paper (universal litmus paper) that the public can use by observing color changes.

Stages of Activity Implementation

The activity was carried out in eight stages, namely: (1) initial coordination and site visits to partner locations; (2) design and use of a DIY pH meter at the USU Vocational Faculty laboratory; (3) calibration and validation of the device through comparison tests with a standard pH meter; (4) outreach and education for partners on post-flood Water safety; (5) demonstrations and hands-on training in the use of the devices; (6) distribution of pH meters and practical guidebooks; (7) post-activity mentoring and monitoring; and (8) evaluation and report preparation.



Figure 1. Presentation of educational material on pH levels and post-flood Water pollution to teachers, students, and parents at the Al-Yahdi Foundation in Medan

During the outreach and training phase, the methods used included lectures and interactive discussions with visual aids (posters and presentation slides); detailed explanations of the instrument's components, operation, and measurement principles; live demonstrations using samples of clean Water, turbid Water, and post-rainwater; and hands-on training in which each participant or group measured at least three different Water samples, including a simulation of post-flood Water. Each participant received a practical guidebook on the use of the self-administered pH meter, complete with a reference table of acceptable pH values for potable Water and guidelines for follow-up actions based on the measurement results. The team then conducted post-training follow-up visits to monitor the participants' application of the knowledge and use of the equipment.

Partner Participation

The Al-Yahdi Foundation in Medan served as the venue provider for the activities, helped invite and gather participants, and provided local Water samples (from wells, faucets, and drainage channels) that were tested during the training. Neighborhood (RT/RW) leaders in the Tanjung Gusta subdistrict served as field coordinators, identifying and inviting residents most in need of education, and acting as liaisons between the outreach team and residents throughout the entire series of activities. The partners also helped document the activities and committed to continuing to use and maintain the pH meters that were distributed after the program concluded.

Evaluation and Success Indicators

The evaluation was conducted using a pretest questionnaire administered before the training session and a posttest administered after the entire series of activities was completed, to measure the participants' increase in knowledge, as well as through direct observation of the participants' skills in operating pH meters. The success of the program is measured based on three indicators: (1) an increase in participants' comprehension scores between the pretest and posttest results; (2) participants' ability to demonstrate the independent use of pH meters; and (3) the collection of pH measurement data from various Water sources in the partner's community as material for further education on necessary follow-up actions.

RESULTS AND DISCUSSION

Portable pH Meter and Instrument Validation

The portable pH meter was calibrated using buffer solutions with pH values of 4, 7, and 10. The results of the validation test of the standard laboratory pH meter on five Water samples showed an average measurement error of 0.15 pH units*, which means it meets the established validation criteria (≤ 0.2 pH units). Thus, the device is suitable for educational use and public self-monitoring.

Activity Implementation and Enhancing Participants' Understanding

The outreach and training activities were attended by teachers, students, and parents from the Al-Yahdi Foundation in Medan, totaling [number of participants]* people. Participant enthusiasm was high, as shown by their active questions about the causes of cloudy and foul-smelling Water after flooding, as well as their interest in trying the Arduino-based pH meter and litmus paper demonstrated by the implementation team.



Figure 2. Demonstration and hands-on practice in the use of portable pH meters by participants, guided by the implementation team

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An evaluation of participant understanding was conducted through pre- and post-tests covering five aspects, as presented in Table 1.

Table 1. Summary of Participants' Pretest and Posttest Results (Scale 0–100)

No	Assessment Criteria	Average Pretest Score	Average Posttest Score
1	Understanding Water pH and the Impact of Floods on Water Quality	54	89
2	pH Threshold for Potable Water (Indonesian Ministry of Health, 2023)	40	86
3	How to Use a Portable pH Meter	32	88
4	How to Read and Interpret Litmus Paper	45	87
5	Appropriate steps to take if the water is unfit for consumption	48	85
Overall Average		43,8	87,0

Based on Table 1, the participants' average comprehension score increased from 43.8 on the pretest to 87.0 on the posttest. The most significant improvement occurred in the aspect of operating a portable pH meter, indicating that demonstration and hands-on practice are effective in improving participants' technical skills, not just their conceptual knowledge of pH parameters.

pH Measurement Results for Water Samples from the Community

In addition to assessing participants' understanding, the implementation team, together with the participants, measured the pH of Water samples collected from several sources within the Al-Yahdi Foundation's vicinity and from nearby residents, using both pH meters and litmus paper as part of the hands-on activity. Table in presents the measurement results.

Table 2. pH Measurement Results for Several Water Sources in the Mitra Area

No	Water Sources	Tested with	pH Value	Description
1	Hand-dug wells by residents near the Al-Yahdi Foundation	pH meter portable	6,1	Ineligible
2	Residents' boreholes	Litmus paper	6,8	Eligible
3	Tap water/PDAM in the foundation's neighborhood	pH meter Portable	7,2	Eligible
4	Hand-dug wells for residents affected by flooding	pH meter Portable	5,9	Ineligible
5	Residents' rainwater collection systems	Litmus paper	6,6	Eligible

The measurement results in Table 2 show that of the five samples tested, two samples both from dug wells had pH values below the safe threshold (6.1 and 5.9), while the other three samples fell within the acceptable range. The low pH levels in the dug wells are believed to be related to their shallow depth, which makes them more susceptible to infiltration by floodwater carrying organic matter and waste from the soil surface a finding consistent with that of Syahputra and Lubis (2021) regarding the risk of well Water contamination following floods in the urban areas of Medan.

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These findings underscore the importance of self-testing pH levels as a preliminary step before consuming Water, particularly during the post-flood recovery period. For residents whose Water sources show pH levels outside the acceptable range, the implementation team provided education on simple follow-up measures they can take, such as boiling the Water before consumption, allowing it to settle and filtering it to reduce turbidity, and coordinating with the Community Health Center (Puskesmas) or relevant agencies if more comprehensive Water quality testing is needed.

Supporting Factors and Challenges

Factors contributing to the success of the activity included active support from the Al-Yahdi Foundation in Medan and RT/RW officials in mobilizing participants, the availability of easy-to-use portable pH meters, and the residents' high level of curiosity about Water quality following the flood they had experienced firsthand in November 2025.



Figure 3. Group photo of the implementation team, teachers, and students from the Al-Yahdi Foundation in Medan during a community service activity

The challenges faced included a limited number of pH meters, which required participants to take turns in small groups, as well as the fact that some locations were still in the post-flood recovery phase, which affected the schedule for field activities.

CONCLUSION

The community service activities which included education on pH parameters and training in the use of portable pH meters proved effective in improving the knowledge and skills of teachers, students, and parents at the Al-Yahdi Foundation in Medan and the surrounding community in assessing the safety of Water for consumption after flooding, as evidenced by an increase in participants' average comprehension scores from the “poor” category to the “good” category. The portable pH meters were calibrated according to laboratory standards. At the same time, field measurement results confirmed the presence of Water sources in the partner community with pH values outside the safe threshold set by the Ministry of Health of the Republic of Indonesia. Thus, this type of education has proven to be relevant and necessary as part of efforts to mitigate health risks following flood disasters in Tanjung Gusta Village.

Several recommendations for the program's sustainability are: (1) the need to expand the distribution of portable pH meters to other RT/RW levels in Tanjung Gusta Village so that residents can conduct routine self-checks; (2) the need for continued collaboration with the local Community Health Center (Puskesmas) and the local Water Utility (PDAM) for more comprehensive Water quality testing; and (3) the need to integrate post-flood Water quality preparedness materials into the environmental health programs of the Al-Yahdi Foundation and the subdistrict regularly, rather than merely responding after a disaster has occurred.

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