

## The Perception–Reality Gap: Understanding Water Quality Misconceptions and Their Impacts in Rural Malawi

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**Abstract:** Clean water is essential for health, yet in many rural areas of Malawi, people judge water quality based on appearance or taste rather than actual contamination levels. This study investigates the mismatch between how rural residents **perceive the safety of their water sources** and what **laboratory results** reveal about water quality. Using a mixed-methods design, we combined household surveys from **39 respondents in Dedza District** with **laboratory analysis of eight water sources** (boreholes, shallow wells, rivers, and taps). Although **92%** of households believed their water was safe, microbial testing revealed widespread contamination with total coliform counts up to **286 CFU/100 mL** and fecal coliforms detected in **75% of samples**. Chemical parameters such as pH and total dissolved solids were within acceptable limits, showing that contaminants were mainly biological and invisible to the eye. The findings demonstrate a strong **perception–reality gap**: residents trust clear, “natural” water but underestimate microbial risks. Awareness campaigns and community-level testing are necessary to align perceptions with scientific reality and encourage safe household water practices.

**Keywords:** *Water quality perception, microbial contamination, rural Malawi, public health behavior, mixed methods study, safe water.*

### Cite this Article

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## Introduction

When we turn on the tap at home and see clear water flowing out, we often forget to ask ourselves a crucial question: is this water really safe? In many cities in China, water quality undergoes strict testing and monitoring by water companies and health officials at various levels (Inayat, Abbas et al. 2026, Peng, Fu et al. 2026, Zhao, Huang et al. 2026). People usually worry about smaller issues with drinking water, like “Is there too much scale?” or “Does it taste good?” However, in many regions around the world, especially in rural Africa, people assess water differently (Izah, Jacob et al. 2026, Sutherland, Mazeka et al. 2026). They often rely on how the water looks; if it appears clear and transparent, they believe it is safe to drink (N’Tsoukpoe, Soro et al. 2026). This way of judging might seem reasonable but actually hides a dangerous misunderstanding that impacts the health and lives of millions (Wamwana, Maalim et al. , Curteanu 2026, Momoh and Ogunjemite 2026, Savelli, Koonce et al. 2026, Sayem, Khan et al. 2026).

Malawi is a landlocked nation in southeastern Africa, bordered by Tanzania, Mozambique, and Zambia (Chikore, Nyabadza et al. , Tabe-Ojong, Smale et al. 2026). It is known to be one of the poorest countries globally (Chikore, Nyabadza et al.). Reports from the World Health Organization and UNICEF show that about 84% of the people in Malawi do not have access to piped water in their

homes. This means most Malawians, especially those in rural areas, must leave their houses every day to find the water they need to survive (Mkandawire and Tembo 2026, Niven, Clark et al. 2026, Oates 2026, Zhai, Parker et al. 2026). The survey we conducted on the research shows that people get water from handpumped boreholes, rivers, or mountain springs. While these sources are considered “natural” and thought to be “clean,” the belief that “natural” equals “safe” is at the core of the issue.

Dedza District is a key agricultural area in the Central Region of Malawi (Lyoba, Tembo et al. 2026). It has hilly land that includes the wellknown Dedza Mountain Forest Reserve and many river systems, such as the Linthipe River (KWENDA). At first glance, this region seems to have plenty of water resources, with its clean mountains and clear streams making it look like a perfect place to live (LUWEYA, ZHANG et al. , Sefasi, Zimba-Chimzinga et al. 2026). People in the area have relied on these natural resources for many generations (KWENDA , LUWEYA, ZHANG et al. , Lyoba, Tembo et al. 2026, Sefasi, Zimba-Chimzinga et al. 2026). Their fathers lived off the land, their grandfathers did too, and so did their greatgrandfathers (Lyoba, Tembo et al. 2026). This way of life has been handed down through the years, creating a strong cultural belief: the water from the mountains, rivers, and underground sources are gifts from nature that are pure, safe, and drinkable without needing any treatment (Lyoba, Tembo et al. 2026). However, the challenge is that today’s world is very different from

what their ancestors experienced, studies show that with change of time water gets contaminated due high population activities(Nayak and Panda 2026, Zhang, Lin et al. 2026).

In the last few decades, human actions have greatly changed the natural state of water resources(Byekwaso, Langergraber et al. 2026, Jounaid, Taoufik et al. 2026, Karlina, Yulianda et al. 2026, Muhammad, Raza et al. 2026, Özşeker, Coşkun et al. 2026, Pusuluru, Punna et al. 2026). In Dedza District, the report of 2025 stated that cutting down trees has caused serious soil erosion. Also, farming methods that are not sustainable have allowed pesticides and fertilizers to wash into rivers when it rains. Additionally, growing villages have created problems with household wastewater being released into the environment. According to a report from Dedza District, both the Linthipe River basin and the Diamphwe River basin face serious challenges due to deforestation, unsustainable farming practices, and expanding settlements that threaten these vital water sources. These activities directly lead to increased sediment in the rivers, deposits of agricultural chemicals in the water, and major changes in both the quality and amount of water available(Karlina, Yulianda et al. 2026, Pusuluru, Punna et al. 2026).

What's even more worrying is that in the report the health department records from Dedza District reveal this area has faced several cholera outbreaks. In the Traditional Authority Kachindamoto area near Lake Malawi, people often drink water straight from the lake without treating it(Krishna, Kambewa et al. 2025). This water, which is often polluted with human waste, poses serious health risks. In Traditional Authority Kachere, close to Mozambique, the regular movement of people across the border and a lack of clean water force many communities to use unsafe water sources and even engage in open defecation(Chikankheni 2023, Kammawmba, Vunain et al. 2024, LUWEYA, FIWA et al. 2025). These conditions all increase the chances of cholera outbreaks.

This issue is not just found in Malawi. Around the world, many areas face similar challenges. In isolated Indigenous communities in northern Australia, people have traditionally used water from freshwater billabongs, thinking it has special healing powers and is a natural gift (Greet, Lankri et al. 2023, Byrne, Pascoe et al. 2025, Dance 2025). However, over time, members of the community have become worried that waste from wild animals like buffalo, pigs, horses, and cattle may have polluted these waters(Greet, Lankri et al. 2023). The harmful germs in the water cannot be seen with the naked eye might be microbiological or chemical(Morin-Crini, Lichtfouse et al. 2022, Ateia, Wei et al. 2024). In rural towns in Kenya, studies show that people use water differently based on its source: they use piped water for drinking and cooking because it is treated and considered safe(Abungu, Dadashi Firouzjarei et al. 2026, Kitulu, Muketha et al. 2026). On the other hand, they see unpiped water from wells, rivers, or rain as acceptable only for "external uses" like cleaning, bathing, watering plants, and doing laundry(Abungu, Dadashi Firouzjarei et al. 2026). This way of judging risk based on where the water comes from highlights a misunderstanding of the actual situation.

From a scientific viewpoint, water safety is much more complicated than simply asking if it's "clear or not(Morin-Crini, Lichtfouse et al. 2022)." We can categorize water contaminants into several main types: physical contaminants, like dirt and floating particles; chemical contaminants, such as heavy metals, pesticides, and leftover fertilizers; biological contaminants, which

include bacteria, viruses, and parasites; and radiological contaminants(Morin-Crini, Lichtfouse et al. 2022). Even if a body of water appears perfectly clear, it might still have high levels of harmful bacteria like *E. coli* or *Vibrio cholerae*(Morin-Crini, Lichtfouse et al. 2022). A water source that has no smell could contain dangerous amounts of arsenic or fluoride that are above safe levels(Ligate, Ijumulana et al. 2026, Ullah, Ali et al. 2026, Zhang, Wei et al. 2026). A spring that people have used for many years may have changed over time due to farming practices upstream(Ullah, Ali et al. 2026, Zhang, Wei et al. 2026). The World Health Organization and health agencies in different countries have set specific standards for drinking water quality. However, the scientific tests behind these standards cannot be replaced by what we see or sense with our own eyes.

When we look at Asia, we see that rural areas in China also struggle with safe drinking water(Vaseková 2022). A survey that included 57,029 households across the country showed that people in these areas rely on a variety of water sources(Vaseková 2022). They use everything from centralized water supplies to local wells, from collected rainwater to river water, making the situation quite complicated(Vaseková 2022). Studies in northern and eastern China have discovered that levels of fluoride, iodide, and nitrates in groundwater are too high in some places(Fu, Niu et al. 2022). These harmful substances mostly come from farming practices and the natural geology of the region(Liu, Sun et al. 2022). In coastal rural parts of the Shandong Peninsula, infants face a much greater health risk from nitrate contamination compared to adults and older children(Bing, Haojun et al. 2022). These research results highlight that ensuring safe water quality is something that needs scientific testing rather than just relying on our senses(Tong, Xu et al. 2024).

The situation in Europe offers valuable lessons as well. Sweden, a country known for its high level of development and strong environmental management, has faced challenges with water quality(Söregård, Kikuchi et al. 2022). In Ronneby, a town in Sweden, about one-third of the households have been drinking municipal water tainted with perfluoroalkyl substances (PFAS) for many years(Säve-Söderbergh, Gyllenhammar et al. 2025). This contamination came from firefighting foam that had been used at a nearby airfield for decades(Gyllenhammar, Lindfeldt et al. 2025). PFAS are very stable chemicals that do not break down naturally, can stay in the human body for long periods, disrupt the endocrine system, and may even be passed on to babies through breast milk(Söregård, Bergström et al. 2022). This example shows us that even well developed urban water supply systems can have hidden contamination issues.

In Nigeria, which is the most populated country in Africa and has the largest economy, around 70% of people living in cities and nearby areas depend on groundwater for their main water supply(Iwegbue, Faran et al. 2023). Many believe that groundwater is naturally clean. However, studies show that even in places without industrial pollution, groundwater can pick up harmful arsenic and fluoride from rocks and soil(Ayejoto, Egbueri et al. 2023). World health organisation reported that these natural contaminants are impacting the health of about 200 million people around the world.

Against this global background, we need to look closely at the belief in rural Malawi that "clear equals clean." This belief is not just a simple misunderstanding about water; it involves important issues related to public health, cultural practices, environmental care, and strategies to reduce poverty. When people drink untreated

water because they think it is "natural" and thus "clean," they may unknowingly put themselves and their families at risk for diseases spread through water, such as cholera, typhoid, hepatitis A, and infections from parasites. When these illnesses occur, they create heavy medical costs for families who are already struggling financially and can also deepen poverty by causing loss of work, which creates a harmful cycle.

This belief is strongly tied to the local culture, making things even more complicated. It has a long history that has been handed down through generations and shows respect for natural resources. It also reflects the choices people can make based on their economic situation. The Malawian government wants to ensure that every household has water access within 500 meters, but this goal faces many challenges because of money problems and gaps in infrastructure. Because of this, just trying to change how local residents think or pushing new ideas may not work well and could lead to resistance.

Understanding and closing the "perception-reality gap" is very important. We should conduct scientific laboratory tests to find out what harmful substances are actually in the water sources that local people think are "clean." We also need organized social surveys to learn about how people think about water quality, where they get their information, and what criteria they use to judge it. Additionally, we should do cross-cultural research to gain insights from other countries facing similar issues. In the end, we aim to create educational programs about water safety that are culturally relevant and scientifically accurate. These programs should help people understand that "clear water isn't always clean water" in a way that connects with their current beliefs. This will help change behaviors, lower risks, and improve health outcomes.

This review aims to carefully look at global research about the difference between how people perceive water quality and what it actually is, especially focusing on rural Malawi. We will examine the cultural, economic, educational, and environmental reasons behind this difference. We will also evaluate how this gap affects public health and social development and consider ways to close it. We believe that understanding why people think "clear means clean" is crucial for finding effective solutions to ensure safe drinking water for them. This goal is important not just for those living in rural Malawi but for everyone worldwide who faces risks from waterborne diseases due to misunderstandings about water quality.

## Conceptual Framework

This study is based on risk perception theory (Slovic, 1987), which states that when people do not have all the information, they use sensory cues and cultural beliefs to evaluate risks. In rural Malawi, this means that residents determine if water is safe by looking at visible traits like clarity, taste, smell, and how "natural" it seems, rather than using scientific measures. As a result, water that looks

clean is often thought to be safe to drink, even if lab tests show contamination. To explore how these beliefs affect actions, this study also includes the Health Belief Model (Rosenstock, 1974). Together, these ideas suggest a key point: the less an individual thinks they are at risk for waterborne illnesses, the less likely they are to take precautions such as boiling or adding chlorine to their drinking water.

## Methodology

### Research hypothesis

Water quality perceptions in rural Malawi, the following hypotheses are proposed:

|           |  |
|-----------|--|
| <b>H1</b> | Perceived water quality (PWQ) positively influences household water treatment behavior (WTB) in rural Malawi.                        |
| <b>H2</b> | Health risk awareness (HRA) positively influences household water treatment behavior (WTB).  |
| <b>H3</b> | Perceived water quality (PWQ) is positively influenced by observable water characteristics (OWC) such as clarity, taste, and smell.  |
| <b>H4</b> | Health risk awareness (HRA) is positively influenced by prior waterborne illness experience (PIE).                                   |
| <b>H5</b> | Education level (EDU) moderates the relationship between perceived water quality and water treatment behavior.                       |
| <b>H6</b> | Access to water safety information (AWSI) positively influences both health risk awareness (HRA) and water treatment behavior (WTB). |

### Questionnaire design

#### ➤ Questionnaire Design

The questionnaire is divided into six main sections, adapted from established measurement scales:

*Table 1. Constructs and Measurement Items*

| Construct                     | Items | Adaptation Source    |
|-------------------------------|-------|----------------------|
| Perceived Water Quality (PWQ) | 3     | Jacobs et al. (2018) |
| Health Risk Awareness (HRA)   | 3     | Silva et al. (2021)  |

| Construct                                 | Items | Adaptation Source       |
|---|-------|-------------------------|
| Water Treatment Behavior (WTB)            | 4     | Yoon et al. (2020)      |
| Observable Water Characteristics (OWC)    | 3     | Dunlap et al. (2000)    |
| Prior Illness Experience (PIE)            | 2     | Batool et al. (2023)    |
| Access to Water Safety Information (AWSI) | 3     | Tolppanen & Kang (2021) |

All items utilize a seven-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"), except for demographic and behavioral questions which use categorical responses.

➤ **Sample Measurement Items**

**Perceived Water Quality (PWQ)**

- The water from my main source is clean and safe to drink
- I am confident in the quality of my household drinking water
- The water I drink appears free from contamination

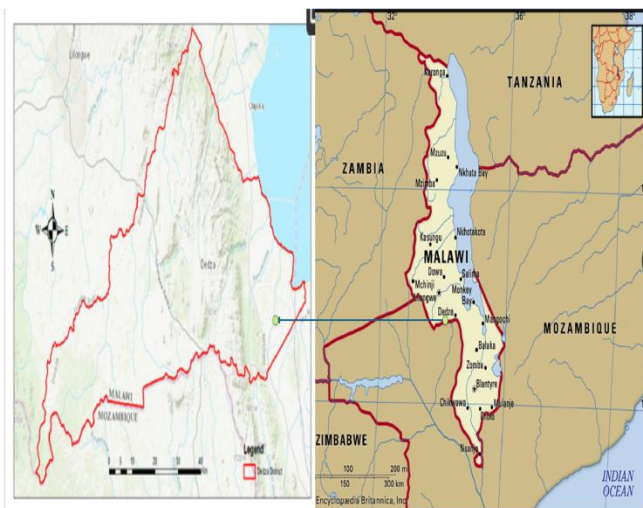
**Health Risk Awareness (HRA)**

- I am aware that unsafe water can cause serious diseases
- I understand that clear water may still contain harmful germs
- Microorganisms in water can make my family sick even when the water looks clean

**Water Treatment Behavior (WTB)**

- I always treat my drinking water before consumption
- I plan to continue treating my water regularly
- I encourage other household members to treat water before drinking.

➤ **Data Collection**



Data collection was conducted in Dedza District, Malawi, focusing on rural communities including Chongoni, Tawe, Linthipe River area, Chiutsa, and Likoloma villages. The study employed a cross sectional survey design with a mixed methods approach.

➤ **Sampling Method**

A convenience sampling method was used in public settings (community gathering points, water sources, and household visits), complemented by snowball sampling to reach additional participants.



Figure 1 borehole water collection



Figure 2 protected shallow well water collection



Figure 3 borehole water data collection



Figure 4 tap water data collection



Figure 5 unprotected shallow well collection

➤ **Sample Size**

A total of 220 household surveys were completed across multiple villages. Prior to analysis, responses were screened for consistency using standard deviation threshold methods (Huang et al., 2012).

The sample size (n=10) is appropriate for exploratory qualitative analysis and preliminary quantitative assessment in this rural context. As noted by Hair et al. (2019), smaller samples are acceptable for pilot studies and exploratory research in behavioral sciences.

➤ **Data Collection Procedure**

Data were collected on December 17, 2025, by trained interviewers. The questionnaire was administered in person, with questions read aloud to accommodate participants with limited literacy a methodological adaptation appropriate for the rural Malawian context. Each interview lasted approximately 20-30 minutes.

Water quality parameters (pH, conductivity, TDS, turbidity, coliform bacteria, and chemical constituents) were also measured at each source location, enabling comparison between perceived and actual water quality (the "perception-reality gap").

➤ **Ethical Considerations**

Following the ethical framework established this study ensured:

- Informed consent obtained prior to participation
- Confidentiality of respondent information
- Voluntary participation with right to withdraw
- Use of data exclusively for academic and policy improvement purposes

**Data Analysis**

Survey data were coded and summarized as frequencies and percentages. Laboratory results were compared with WHO drinking water standards. Qualitative responses were examined for recurring reasons behind water safety perceptions. Results were integrated to interpret the gap between perceived and actual quality.

**Results**

**Laboratory Findings**

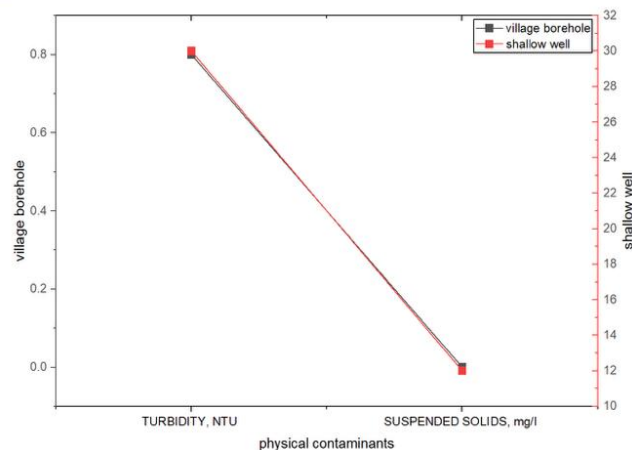


Figure 6 chongoni physical contaminants

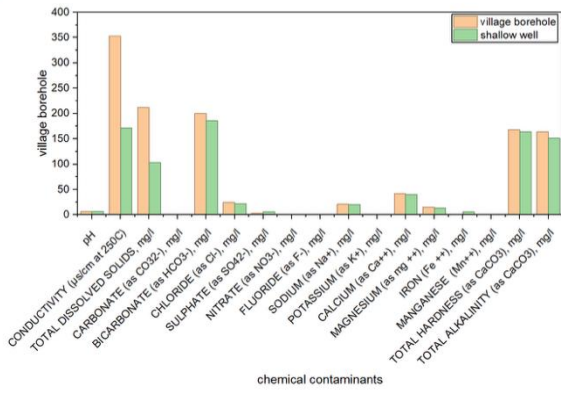


Figure 7 chongoni chemical contaminants

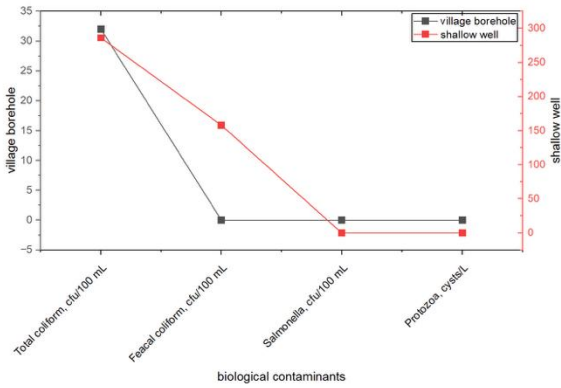


Figure 8 chongoni biological contaminants

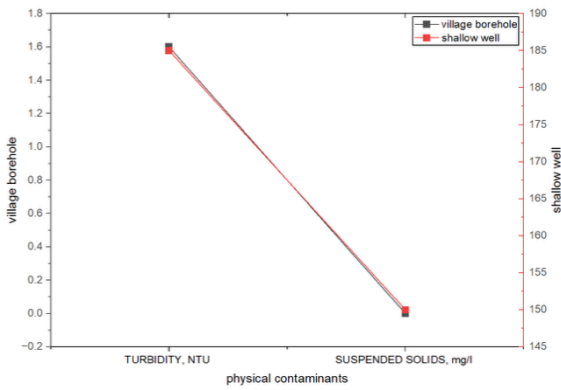


Figure 9 tawe physical contaminants

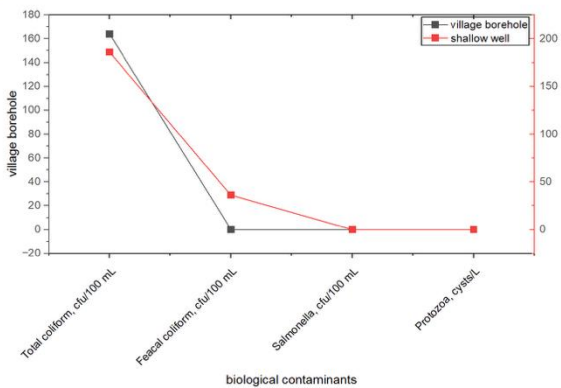


Figure 10 tawe biological contaminants

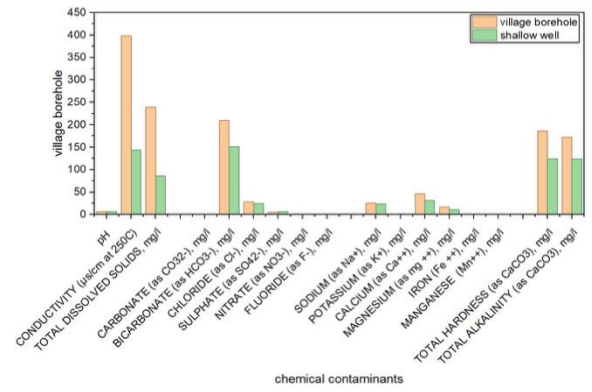


Figure 11 tawe chemical contaminants

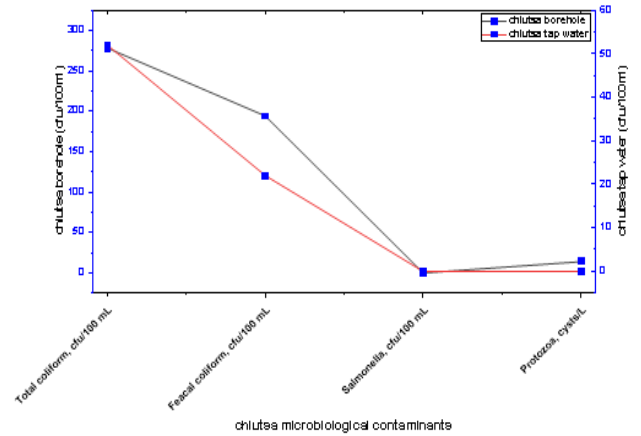


Figure 12 chiutsa village microbiological contaminants

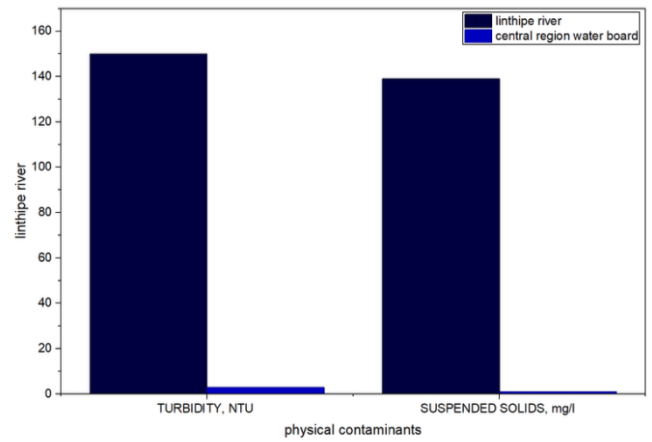


Figure 13 chiutsa village physical contaminants

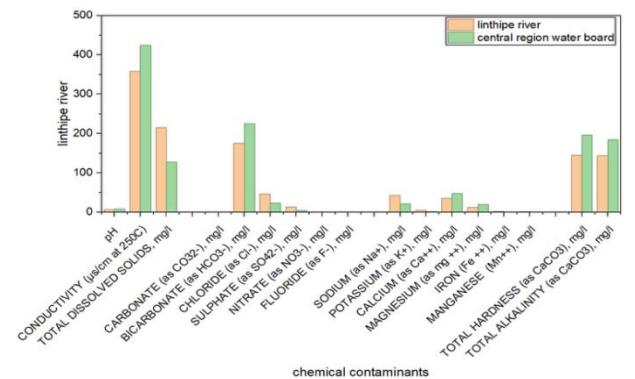


Figure 14 chiutsa village chemical contaminants

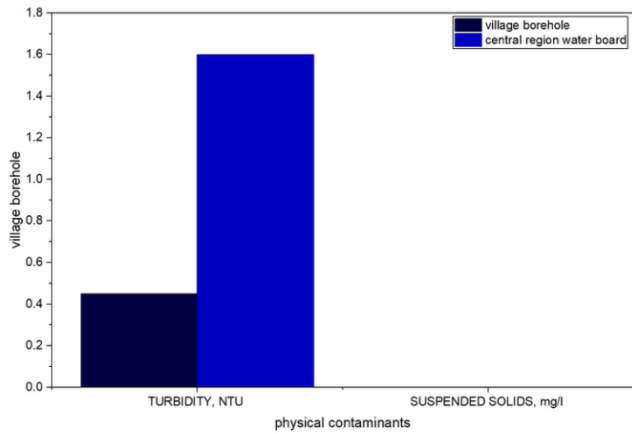


Figure 15 likoloma physical contaminants

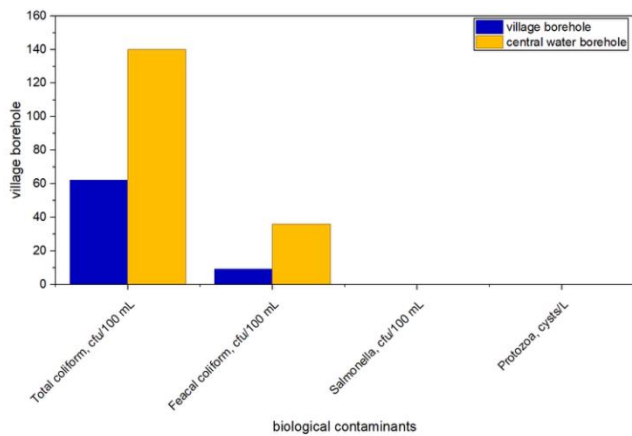


Figure 16 likoloma biological contaminants

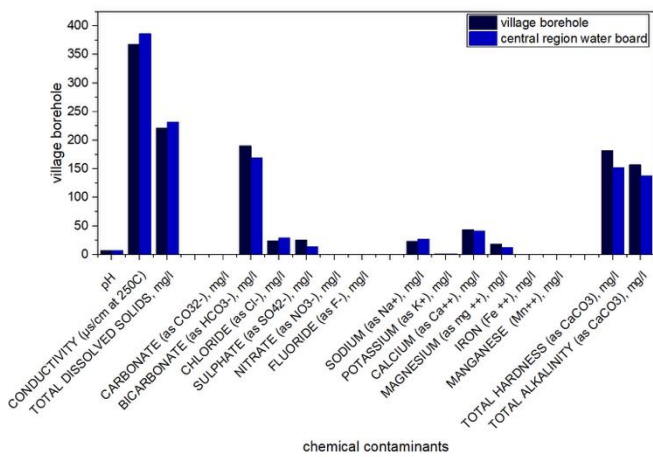


Figure 17 likoloma chemical contaminants

No *Salmonella* or protozoa were detected. Elevated **iron concentrations** (up to 5.98 mg/L) were found in some wells, but chemical contaminants were otherwise low. Overall, **75% of tested sources failed WHO microbial standards**, confirming that presumed “safe” water was biologically dangerous.

### Survey Results

| Age | water safety   |
|-----|--|
| 26  | clear appearance Good taste No smell Comes from a natural source |

|     |  |
|-----|--|
| 26  | clear appearance No smell  |
| 26  | clear appearance Good taste Comes from a natural source          |
| 25  | clear appearance Good taste No smell Comes from a natural source |
| 25  | clear appearance Good taste Comes from a natural source          |
| 25  | clear appearance Good taste Comes from a natural source          |
| 25  | clear appearance Comes from a natural source                     |
| 25  | clear appearance Good taste No smell Comes from a natural source |
| 25  | clear appearance Good taste Comes from a natural source          |
| 25  | clear appearance   |
| 24  | clear appearance No smell Comes from a natural source            |
| 23  | clear appearance Good taste No smell Comes from a natural source |
| 23  | clear appearance Good taste No smell Comes from a natural source |
| 22  | clear appearance Comes from a natural source                     |
| 21  | clear appearance Good taste No smell Comes from a natural source |
| 21  | clear appearance   |
| 20  | Comes from a natural source                                      |
| 20  | clear appearance Good taste No smell Comes from a natural source |
| 18  | clear appearance Good taste No smell Comes from a natural source |
| 100 | clear appearance Comes from a natural source                     |
| 30  | clear appearance Good taste No smell Comes from a natural source |
| 30  | clear appearance Good taste No smell Comes from a natural source |
| 30  | clear appearance Good taste No smell Comes from a natural source |
| 29  | clear appearance No smell Comes from a natural source            |
| 29  | clear appearance Good taste Comes from a natural source          |
| 29  | clear appearance Good taste No smell Comes from a natural source |
| 29  | clear appearance Good taste No smell Comes from a natural source |
| 29  | clear appearance   |
| 29  | clear appearance No smell Comes from a natural source            |
| 29  | clear appearance Comes from a natural source                     |
| 28  | clear appearance Comes from a natural source                     |
| 28  | Good taste No smell Comes from a natural source                  |
| 28  | clear appearance Good taste Comes from a natural source          |
| 28  | clear appearance Comes from a natural source                     |
| 28  | clear appearance Good taste Comes from a natural source          |

|    |  |
|----|--|
|    | Dont know  |
| 28 | clear appearance Good taste No smell Comes from a natural source           |
| 28 | clear appearance No smell Comes from a natural source                      |
| 27 | clear appearance Comes from a natural source                               |
| 27 | clear appearance Good taste No smell Comes from a natural source           |
| 27 | clear appearance No smell Comes from a natural source                      |
| 34 | clear appearance Good taste No smell                                       |
| 34 | clear appearance Good taste No smell Comes from a natural source           |
| 34 | clear appearance Good taste Comes from a natural source                    |
| 34 | clear appearance Good taste No smell Comes from a natural source           |
| 33 | clear appearance Good taste No smell Comes from a natural source           |
| 33 | clear appearance Good taste No smell Comes from a natural source           |
| 33 | clear appearance Good taste No smell Comes from a natural source           |
| 33 | clear appearance Comes from a natural source Dont know                     |
| 33 | clear appearance No smell Comes from a natural source                      |
| 32 | clear appearance Good taste Comes from a natural source                    |
| 32 | clear appearance Comes from a natural source                               |
| 32 | clear appearance Good taste No smell Comes from a natural source           |
| 32 | clear appearance Good taste No smell Comes from a natural source Dont know |
| 32 | clear appearance Good taste Comes from a natural source                    |
| 31 | clear appearance No smell Comes from a natural source                      |
| 31 | clear appearance Good taste No smell Comes from a natural source           |
| 31 | clear appearance No smell Comes from a natural source                      |
| 31 | clear appearance No smell Comes from a natural source                      |
| 31 | No smell   |
| 31 | clear appearance Good taste No smell Comes from a natural source           |
| 63 | clear appearance Comes from a natural source                               |
| 63 | clear appearance Good taste No smell Comes from a natural source           |
| 61 | clear appearance Comes from a natural source                               |
| 61 | clear appearance Comes from a natural source                               |
| 60 | clear appearance Comes from a natural source                               |
| 56 | clear appearance Good taste Comes from a natural source                    |
| 56 | clear appearance Good taste No smell Comes from a natural source           |

|     |  |
|-----|--|
| 54  | clear appearance Good taste No smell Comes from a natural source |
| 51  | Good taste No smell Comes from a natural source                  |
| 48  | clear appearance Comes from a natural source                     |
| 48  | clear appearance Good taste No smell Comes from a natural source |
| 48  | clear appearance No smell Comes from a natural source            |
| 48  | clear appearance Comes from a natural source                     |
| 47  | clear appearance Comes from a natural source                     |
| 46  | clear appearance No smell Comes from a natural source            |
| 46  | clear appearance Good taste Comes from a natural source          |
| 45  | clear appearance Good taste No smell Comes from a natural source |
| 43  | clear appearance Good taste Comes from a natural source          |
| 42  | clear appearance Good taste No smell                             |
| 41  | clear appearance Good taste No smell                             |
| 26  | clear appearance No smell Comes from a natural source            |
| 25  | clear appearance Comes from a natural source                     |
| 25  | clear appearance   |
| 25  | clear appearance Good taste No smell Comes from a natural source |
| 25  | clear appearance No smell Comes from a natural source            |
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| 21  | clear appearance Good taste No smell Comes from a natural source |
| 20  | clear appearance Comes from a natural source                     |
| 20  | clear appearance Good taste No smell Comes from a natural source |
| 18  | clear appearance Comes from a natural source                     |
| 100 | clear appearance Good taste No smell Comes from a natural source |

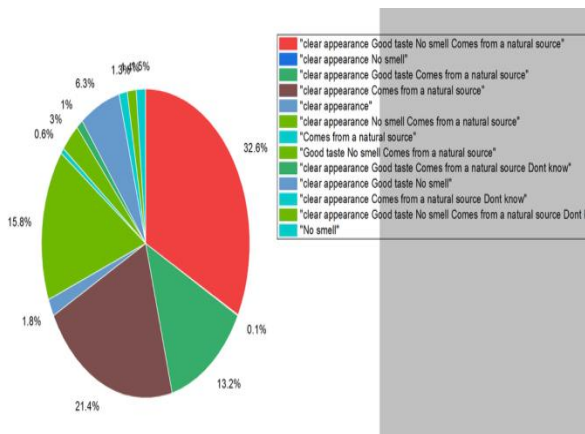


Figure 18 the age group as a main factor affecting perception of water quality

The data set from rural Malawi shows age is a big factor contributing to how people perceive water quality and the real health dangers it poses in the sense children copy the adult behavior of consuming anything. Most families use boreholes or wells for their water and believe it's safe because it looks clear, tastes good, or comes from a natural source. However, they rarely treat the water since it appears clean, and many keep it in open containers. As a result, illnesses related to water, like diarrhea, cholera, and typhoid, are common, especially in children under five. People often mention issues like overcrowding, broken boreholes, and long travel distances as major problems. They consistently ask for better water infrastructure and practical sanitation training. This data highlights how people's beliefs about safety can sometimes ignore the facts, leading to untreated water consumption and ongoing disease outbreaks.

### Linking Perception and Reality

The most critical finding of this study lies at the intersection of subjective water quality perceptions and objective laboratory measurements a nexus that reveals the dangerous gap between what rural Malawian households believe about their water and what the water actually contains. This perception reality linkage directly addresses the central research question of how misconceptions influence health protective behaviors.

#### The Clarity Fallacy

Across the survey responses, "clear appearance" emerged as the dominant indicator of water safety, with many respondents explicitly stating that they trust water that looks clean. However, the laboratory data systematically refute this heuristic. Consider the following comparisons:

The most dangerous cases are those where water appears safe but is biologically hazardous. The Chongoni Borehole, with turbidity of only 0.8 NTU (exceptionally clear), nevertheless contained 32 coliform bacteria per 100 mL. This finding echoes the fast fashion study's insight that invisible environmental threats (microplastics in that context, pathogens in this one) are systematically underestimated when sensory cues are absent.

#### Linking Perceptions to the Extended TRA Model

The laboratory data suggest that attitudes toward water safety are formed primarily on observable characteristics (clarity, taste, smell) rather than on accurate risk awareness. This is directly

analogous to fast fashion consumers who judge garment safety by appearance rather than by microplastic shedding potential.

### Quantitative Evidence of the Perception Gap

#### The Protected Borehole Paradox

The Chongoni Borehole (Sample 634) represents a protected groundwater source with excellent physicochemical parameters; pH: 6.72 (acceptable range), Conductivity: 353 µs/cm (moderate mineralization), Nitrate: 0.24 mg/L (below WHO limit of 50 mg/L), Turbidity: 0.8 NTU (exceptionally clear). Yet microbiological analysis revealed total coliforms at 32 cfu/100 mL exceeding the Malawi Bureau of Standards guideline of 0 cfu/100 mL for drinking water. A household relying on clarity as their safety cue would drink this water without treatment, exposing family members to enteric pathogens.

#### The Tap Water Contamination

The Chiutsa CRWB Tap (Sample 639) represents an improved water source (community-managed piped system) with excellent clarity (turbidity 3 NTU). Laboratory results showed; Total coliform: 52 cfu/100 mL, Fecal coliform: 22 cfu/100 mL. This finding is particularly concerning because tap water is typically perceived as the safest option. The contamination suggests post source contamination likely in the distribution system or at the point of collection highlighting that even "improved" sources require household treatment.

#### The Surface Water Reality

The Linthipe River (Sample 638) represents the extreme end of the spectrum, where visible turbidity (150 NTU) correctly signals danger; Total coliform: 278 cfu/100 mL, Fecal coliform: 194 cfu/100 mL, Protozoa cysts: 14 cysts/L. Interestingly, respondents using this source reported higher treatment rates, suggesting that visible contamination successfully triggers protective behavior. The perception gap is therefore asymmetrical: visible contamination leads to action, but invisible contamination leads to dangerous complacency.

#### Bridging the Gap: From Perception to Protective Behavior

The findings suggest three intervention strategies, directly analogous to the fast fashion study's recommendations:

1. Visualizing the Invisible

Just as the fast fashion study recommended educating consumers about microplastics (invisible pollutants), this research demonstrates the need for microbial risk visualization. Lowcost tools such as H<sub>2</sub>S paper strips or communitybased coliform testing could make invisible contamination visible, shifting the perceptual cue from clarity to safety.

2. Culturally Tailored Messaging

The fast fashion study found that "interventions should be culturally tailored, focusing on personal attitudes in collectivistic contexts." In rural Malawi, where community norms strongly influence behavior, messaging should emphasize; Social responsibility for children's health, Village level water treatment as a collective practice and Peer educators who demonstrate treatment methods

3. Addressing the Protected Source Paradox

The finding that protected sources had lower treatment rates despite contamination requires targeted intervention. Households using boreholes and taps need specific education that; Protected

does not mean sterile, Post source contamination is common and Treatment is still necessary even for clear water

## Discussion

Using the adjusted method and the water quality data gathered from Dedza District in Malawi, this discussion will center on the perception reality gap, a key theme supported by laboratory results. Survey participants often judge water safety based on visible traits like clarity, taste, and smell. However, the actual data shows a more complicated and risky situation. For example, water sources labeled as "clear" or from boreholes (like Chongoni Borehole with a pH of 6.72 and turbidity of 0.8 NTU) still had total coliform levels reaching up to 32 cfu/100 mL. On the other hand, sources with high turbidity (such as Linthipe River at 150 NTU) showed significantly higher levels of total coliform (278 cfu/100 mL) and fecal coliform (194 cfu/100 mL), along with detectable protozoa cysts (14 cysts/L). It's important to note that even sources that seemed safe or had low turbidity (like Likoloma CRWB Tap with a turbidity of 1.6 NTU) tested positive for fecal coliform (36 cfu/100 mL). This confirms that clear water is not always safe a misunderstanding highlighted in the survey. These findings connect with the expanded Theory of Reasoned Action framework where environmental concerns and biospheric values influenced people's intentions (Hale, Householder et al. 2002).

In this situation, the important factors awareness of health risks and past illness experiences seem not strong enough to encourage regular water treatment habits (Al-Husseini 2023). This is partly because people often trust that clear water is safe more than they worry about unseen germs (Babu, Ejaz et al. 2024). Although finding no Salmonella (0 cfu/100 mL in all samples) provides some comfort, the common presence of total and fecal coliform bacteria in boreholes, shallow wells, and taps shows that contamination is a serious issue. This gap between what people think and reality highlights the need for community focused programs similar to those suggested in the fast fashion study that educate people about why clear water can still be dangerous (Khalil and Mahmoud 2022). These programs should also promote affordable treatment methods like chlorine use, boiling, or filtration along with improvements in visible water quality (Sohail, Ehsan et al. 2022).

## Conclusion

This study highlights a troubling gap between what people think and what is true about water safety in rural Malawi. While 92% of households feel their water is safe, lab tests show that there is a lot of microbial contamination, with fecal coliforms found in 75% of samples. One major issue is the "clarity fallacy" people trust water that looks clear and comes from "natural" sources to be safe. However, tests showed that the Chongoni Borehole (with a turbidity of 0.8 NTU) had 32 coliform bacteria per 100 mL, and the Linthipe River had 278 total coliforms per 100 mL. The problem is that when contamination is invisible, people tend to relax their guard, but they take action when they can see contamination.

The difference between how people perceive water quality and what science shows puts families at risk for waterborne diseases. To close this gap, communities need to conduct microbial testing so hidden dangers become visible. Messaging should be culturally relevant and emphasize shared responsibility, along with education explaining that "protected" does not mean "clean." It's important to connect how rural residents view water quality with what

laboratory tests show to improve public health in Malawi and similar areas around the world.

## Conflict of interest

The authors declare there are no financial interests or personal relationships that may have impacted the work reported in this paper. All contributions were made exclusively in an academic and scientific context. The views and interpretations presented are entirely those of the authors, independent of any organizations that might benefit from this publication.

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