Title:	Assessment of Water Quality from Natural Sources in Ban Mae Tao Din and Ban Huai Kaew, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province, Thailand.

Authors:

Master Apiwich	Boonmak
Master Thanakit	Ekalaksananan
Master Nuntin	Sammuenkham
Master Eunwoo	Kim
Miss Anyada	Maliwan
Miss Yuna	Kumada

Advisor: Miss Panisa Tongkamgirato
Miss Sirinya Tualue
Miss Panita Chenrukmatupoom

External Advisor: T.T.M.D Tanaputh Sangsiy
President of the Lanna Traditional Thai Medicine Club

School: Varee Chiang Mai School

Abstract

This research aimed to investigate the quality of drinking water from natural water sources in Ban Mae Tao Din and Ban Huai Kaeo, Huai Kaeo Subdistrict, Mae On District, Chiang Mai Province. These water sources are used by the local community for domestic consumption, daily use, and agricultural purposes. The study evaluated the physical and chemical properties of the water and compared the results with the Thailand Drinking Water Quality Standards and the World Health Organization (WHO) guidelines.

Water samples were collected from three sources: groundwater from Ban Huai Kaeo, groundwater from Ban Mae Tao Din, and mountain runoff water in the Ban Mae Tao Din area (upstream, midstream, and downstream). Sampling was conducted during three periods between 2 August 2025 and 18 January 2026, covering both the rainy and winter seasons. Water quality parameters analyzed included pH, Total Dissolved Solids (TDS), and contamination by ammonia and nitrate, using standard water quality testing instruments. The data were analyzed using descriptive statistics.

The results showed that water from all sources was clear, odorless, and free from abnormal coloration. The pH values were within acceptable standard ranges, TDS values were below the permissible limits, and no ammonia or nitrate contamination was detected during any sampling period. These findings indicate that the natural water sources in the study area are of acceptable quality and suitable for domestic consumption. The results can serve as baseline information for community-based water resource management and conservation, contributing to sustainable development goals (SDGs) related to public health and environmental sustainability.

Acknowledgements

This research was successfully completed through the collaboration and support of many individuals and organizations. The researchers, six primary school students in grades 4–5, would like to express their deepest gratitude to the academic advisors and three primary school teachers who kindly provided academic guidance, assisted with documentation, accompanied the team in field surveys and water sampling, and offered training in presentation skills. Their support enabled the researchers to develop and demonstrate their potential to the fullest.

The researchers also wish to thank the Department of Health, Ministry of Public Health, for publishing drinking water standards and academic references, which served as essential guidelines in assessing water quality in this study. Sincere appreciation is extended to the communities of Ban Mae Tao Din and Ban Huai Kaew, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province, for their cooperation in field data collection, granting access to natural water sources, and providing valuable information for the research.

In addition, the researchers gratefully acknowledge the external advisor for offering academic insights on water and its connection to traditional Thai medicine, which enriched the study and added diverse academic perspectives.

Finally, the six researchers would like to express heartfelt thanks to their parents for their encouragement, support for learning, and assistance throughout every stage of the research process. Appreciation is also extended to colleagues and research assistants who contributed to data collection and analysis, ensuring the successful completion of this study and its readiness for presentation.

The Research Team

Contents

Chapter 1
Introduction

Background and Significance of the Problem

Natural water sources remain the primary supply of drinking water for populations in many rural regions of Thailand. In particular, the community of Ban Mae Tao Din, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province, continues to rely predominantly on streams and groundwater emerging from mountainous areas as the principal sources of potable water for daily consumption. Despite their longstanding role in sustaining local livelihoods, these natural water sources are increasingly vulnerable to environmental changes as well as anthropogenic activities and behaviors, which may adversely affect water quality and consequently pose potential risks to public health.

Water is an indispensable resource for human survival, with drinking water requiring stringent standards of quality and safety to ensure health protection. Accordingly, the investigation of drinking water quality from natural sources in Ban Mae Tao Din is of critical importance. Such an assessment provides an evidence-based evaluation of the safety of water consumed by the community and establishes a foundation for the formulation of strategies aimed at the management, improvement, and sustainable development of local water resources. This research thereby contributes to both public health safeguarding and the advancement of community-based resource sustainability.

Research Objectives

Primary Objectives:

1. To examine the physical quality of drinking water derived from natural sources in Ban Mae Tao Din and Ban Huai Kaew (SDG 4).
2. To compare the obtained water quality parameters with the drinking water standards set by the Ministry of Public Health.
3. To recommend approaches for improving water quality to ensure safety for consumption, while fostering collective stewardship of community water resources in a sustainable manner (SDG 12).

Research Hypothesis

Main Hypothesis

Natural water sources in Ban Mae Tao Din and Ban Huai Kaew possess physical, chemical, and microbiological qualities that comply with the drinking water standards established by the Ministry of Public Health of Thailand, and are therefore considered suitable for human consumption.

Specific Hypotheses

1. The physical properties of natural drinking water (e.g., color, odor, turbidity, temperature) comply with the drinking water standards established by the Ministry of Public Health of Thailand, in alignment with Sustainable Development Goal 6: Clean Water and Sanitation.
2. The pH values of natural drinking water remain within the safe range defined by the drinking water standards, consistent with Sustainable Development Goal 3: Good Health and Well-being.
3. Natural water sources are free from contamination by heavy metals (e.g., lead, cadmium, arsenic) exceeding the permissible limits set by the drinking water standards.
4. Natural water sources are free from contamination by harmful microorganisms beyond the acceptable thresholds of the drinking water standards.

Alternative Hypothesis

Certain characteristics of natural water (e.g., concentrations of minerals or specific heavy metals) may exceed the conventional drinking water standards. However, these levels remain within ranges that are not hazardous to human health when consumed in normal quantities.

Scope of Research

Geographical Scope

This study focuses on the quality of natural drinking water from sources located in Ban Mae Tao Din, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province. These sources are utilized by the community for drinking, domestic use, and agricultural purposes.

Content Scope

The study examines the quality of natural drinking water with respect to:

1.Physical properties: color, odor, turbidity, and temperature.

2.Chemical properties: pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), ammonia, and nitrate concentrations.

Time Frame

Water samples will be collected during two distinct seasons—rainy and dry—in order to compare seasonal variations in water quality. The overall duration of data collection and analysis is approximately six months.

Operational Definitions

Natural Water Sources

Streams, groundwater, and natural springs located within the Ban Mae Tao Din area.

Drinking Water Quality

Indicators that reflect the safety of water for human consumption, as defined by the drinking water standards established by the Ministry of Public Health of Thailand.

Chapter 2
Literature Review and Related Research

Concepts and Theories on Drinking Water Quality

Drinking water quality comprises three key components: physical, chemical, and microbiological characteristics. These parameters are used to assess the safety and suitability of water for human consumption.

Groundwater

Groundwater refers to subsurface water stored in soil and rock layers beneath the Earth's surface. It originates from rainfall or surface water that infiltrates through pores, fractures, and voids in soil and rock, and is retained underground. It can be accessed through dug wells or boreholes.

1.Dictionary Definition

Groundwater is defined as water that permeates beneath the surface into soil or rock layers and can be extracted by pumping or drilling.

2.Scientific Formation of Groundwater

Groundwater is formed through the following processes:

- Rainfall reaches the ground.
- Some water flows over the surface.
- A portion infiltrates into the subsurface.
- Water accumulates in aquifers, which may consist of gravel, sand, fractured rock, or cavernous limestone.

3.Types of Groundwater

- Shallow Groundwater: Located near the surface, easily accessed by digging, but prone to contamination and seasonal variation.
- Deep Groundwater: Found at greater depths, requires drilling equipment, generally stable in quality, and contains higher mineral content.

4. Differences Between Groundwater and Surface Water

Aspect	Groundwater	Surface Water
Location	Underground	Rivers, canals, reservoirs
Flow	Slow	Fast
Cleanliness	Relatively clean	Easily contaminated
Accessibility	Requires drilling	Easily accessible

5. Importance of Groundwater

- For Humans:
  Groundwater serves as a source of drinking water and domestic use, provides reserve water during the dry season, and supports agricultural and industrial activities.
- For the Environment:
  Groundwater sustains springs and streams, maintains the balance of hydrological systems, and prevents the depletion of surface water resources.

6. Problems and Impacts of Groundwater Use

- Excessive pumping → land subsidence
- Saltwater intrusion (in coastal areas)
- Contamination by chemicals and heavy metals
- Decline in groundwater quality

7. Groundwater Conservation

- Practice efficient water use.
- Regulate and control groundwater well drilling.
- Promote reforestation to enhance water infiltration.
- Prevent chemical pollutants from seeping into the soil.

Summary

Groundwater is a subsurface water resource formed by rainfall infiltration. It is vital for human life and the environment but must be managed with caution to ensure long-term sustainability.

Groundwater as Part of the Hydrological Cycle

Groundwater constitutes an integral component of the hydrological cycle. It originates from rainfall that infiltrates the soil surface and percolates into subsurface voids within soil and rock formations, eventually accumulating in underground aquifers. Groundwater moves slowly within the saturated zone, and its level may fluctuate seasonally. Ultimately, groundwater discharges into springs, streams, rivers, or the sea, thereby playing a vital role in sustaining ecosystems and supporting human utilization.

Scientific Definition of Springs

A spring is a natural point where groundwater flows to the Earth's surface. Springs are formed when rainfall infiltrates the soil, accumulates underground, and subsequently emerges through fractures, porous rock layers, or suitable geological formations.

Springs are commonly found at the base of mountains, rock cliffs, geological fault zones, or areas where aquifers are exposed or truncated.

The Hydrologic Cycle and the Formation of Springs

Springs are part of the hydrologic cycle. The key processes include:

- Precipitation: Rainfall reaches the ground.
- Infiltration: Water infiltrates into the soil.
- Percolation: Water flows downward through soil and rock layers.
- Aquifer Storage: Water accumulates in aquifers.
- Discharge: Groundwater flows naturally to the surface, forming springs.

Geological Structures Contributing to Spring Formation

- Aquifers: Geological formations of soil or rock with porosity (void spaces) and permeability (capacity to transmit water). Examples include sandstone, gravel, sand, and cavernous limestone.
- Impermeable Layers: Layers such as clay or shale that act as barriers, preventing deeper infiltration and forcing water to accumulate and discharge laterally.
- Fractures and Faults: Cracks in rock and tectonic faults serve as “pathways” that allow groundwater to rise to the surface.

Mechanisms of Spring Flow

The discharge of springs is governed by physical principles:

- Gravity: Water flows from higher to lower elevations. When the groundwater level is above the land surface, water naturally emerges.
- Hydraulic Pressure: In certain cases, groundwater is confined between impermeable layers. When an opening occurs, the pressure forces water to flow upward, creating an artesian spring.

Types of Springs (Scientific Perspective)

- Gravity Spring: The most common type; water flows naturally to the surface because the groundwater level is higher than the land surface.
- Artesian Spring: Pressurized groundwater emerges spontaneously without pumping, due to confinement between impermeable layers.
- Fault Spring: Occurs along geological fault lines where fractures allow groundwater to discharge.
- Thermal Spring: Deep groundwater heated by geothermal energy, often enriched with minerals.

Why Spring Water is “Clear and Clean”

- Natural Filtration: Water passes through multiple layers of soil, sand, and rock, removing impurities.
- Partial Disinfection: Pressure and certain minerals help reduce microbial presence.

- Mineral Content: Spring water often contains minerals such as calcium, magnesium, and sodium bicarbonate, depending on the rock types it flows through, which also influences its taste.

Relationship Between Springs and Ecosystems

- Springs serve as headwaters of streams.
- They nourish forests and help maintain soil moisture.
- Springs act as permanent water sources during dry seasons, supporting biodiversity and ecological balance.

Why Springs May Dry Up

Springs can dry up due to several factors:

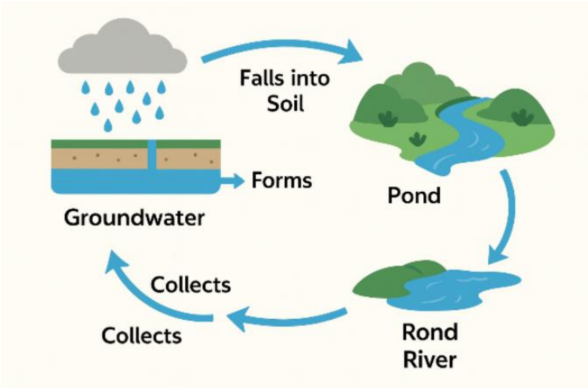
- Deforestation: Reduced forest cover decreases infiltration of rainwater into the soil.
- Over-extraction of Groundwater: Excessive pumping lowers the water table.
- Geological Changes: Earthquakes or shifts in rock structures alter groundwater pathways.
- Climate Change: Variations in rainfall and temperature affect groundwater recharge.

Springs are the outcome of the hydrologic cycle, geology, and physics. They originate from rainfall that undergoes natural filtration, accumulates underground, and flows out through suitable rock structures.

Comparison Between Groundwater and Spring Water

Aspect	Groundwater	Spring Water
Status	Subsurface water	Water emerging at the surface
Location	Within soil or rock layers	Specific discharge points on land
Visibility	Not visible	Visible
Movement	Slow seepage	Flows outward
Flow Rate	Very slow	Faster than groundwater
Source	Storage reservoir	Discharge outlet
Contamination Risk	Lower	Higher

Systemic Interrelationship



Scientific Summary

Groundwater is the “subsurface water reservoir”, while springs are the “discharge outlets of groundwater to the Earth’s surface.” Both are integral parts of the natural hydrological system. The degradation of groundwater resources inevitably leads to the drying up of springs.

Water in Traditional Thai Medicine

In Traditional Thai Medicine, the term “water” does not refer merely to drinking water or ordinary liquid. Instead, it is considered one of the fundamental elements of the human body, carrying profound meaning and playing a crucial role in sustaining life, health, and bodily balance.

1. The Meaning of “Water” in Traditional Thai Medicine

Traditional Thai Medicine explains the human body through the concept of the Four Elements:

• Earth • Water • Wind • Fire

The Water Element represents all substances with liquid characteristics, moisture, coolness, circulation, and nourishment within the body. It prevents the body from becoming excessively dry, rigid, or overheated, and supports the proper functioning of the other elements.

2. Components of the “Water Element” in the Human Body (12 Types)

Traditional Thai Medicine classifies the Water Element in the body into twelve forms:

1. Blood – Nourishes organs.
2. Lymph – Supports immunity.
3. Pus – Produced from inflammation.
4. Saliva – Aids digestion.
5. Mucus – Protects against foreign particles.
6. Tears – Moisturizes and nourishes the eyes.
7. Sweat – Regulates body heat.
8. Urine – Eliminates waste.
9. Liquid Feces – Facilitates excretion.
10. Synovial Fluid – Lubricates joints.
11. Body Oil – Provides moisture.
12. Bile – Assists in fat digestion.

The Importance of the Water Element in the Human Body

Nourishment of the Body

The Water Element functions to transport nutrients and energy, nourish organs, and maintain moisture in the skin, ligaments, and joints. A deficiency of water leads to dryness, weakness, and fatigue.

Regulation of Heat (Balance with Fire)

Water counterbalances the Fire Element, preventing fever, reducing inflammation, and regulating body temperature. When water is depleted, symptoms such as internal heat, thirst, and dry mouth may occur.

Connection with Emotion and Mind in Traditional Thai Medicine

- Balanced Water Element → calm, gentle, compassionate disposition.
- Imbalanced Water Element → sluggishness, depression, excessive worry, or mood instability.

Excretion and Immunity

The Water Element supports the elimination of waste, prevents toxin accumulation, and strengthens immunity (through lymphatic fluid).

Symptoms of Water Element Imbalance

- Deficiency of Water Element: Dry mouth, dry throat, dry skin, dizziness, constipation, irritability.
- Excess of Water Element: Edema, excessive phlegm, heaviness, drowsiness, slow digestion, bloating.

Maintenance of the Water Element in Traditional Thai Medicine

- Drink warm water in moderation.
- Consume foods with bland or astringent tastes.
- Avoid excessively oily or sweet foods.
- Exercise moderately to induce sweating.
- Ensure adequate sleep.

Summary

In Traditional Thai Medicine, *water* represents the element of moisture, nourishment, and balance. When the Water Element is in equilibrium, the body functions smoothly, remains strong, and the mind is calm. Conversely, imbalance in the Water Element is linked to specific diseases through cause–effect relationships as explained in traditional Thai medical theory.

Water in the Global Environmental Context

Water is not merely a natural resource but the core of the Earth System, linking the atmosphere, land, oceans, living organisms, and humanity. It serves as the medium of energy, matter, and life. Without water, Earth could not sustain itself as a living planet.

Water as the Foundation of Life on Earth

All forms of life on Earth originate and persist through water. It is the primary solvent of biological substances, the medium for chemical reactions within cells, and a fundamental component of the structure of living organisms—from soil microorganisms and forest plants to humans.

Water nourishes cells, regulates body temperature, and provides pathways for the transport of nutrients and waste. In the absence of water, the entire cycle of life would cease.

Water as a Connector of Earth Systems

From an environmental perspective, water functions as a linking element among the major subsystems of the Earth: the atmosphere (air), the hydrosphere (water), the lithosphere (soil and rock), and the biosphere (living organisms).

Through the hydrologic cycle, water evaporates from the oceans, forms clouds, falls as precipitation, infiltrates the soil, flows across the land surface, and eventually returns to the sea. This cycle distributes solar energy across the globe, regulates climate, dissipates excess heat, and prevents the Earth from becoming excessively hot or cold.

Water as a Regulator of Global Climate and Temperature

Water possesses a unique property: a high capacity to absorb and release heat. Oceans act as vast reservoirs of thermal energy, stabilizing global temperatures. Ocean currents transport heat from tropical regions to higher latitudes, enabling human habitation even in areas with otherwise harsh climates.

Thus, water directly governs the balance of Earth's energy system, ensuring climate stability and the habitability of diverse regions.

Water as a Sustainer of Ecosystems

All ecosystems—from tropical rainforests, mangroves, and grasslands to rivers and coral reefs—depend on water. Water determines the types of organisms present, the level of biodiversity, and the productivity of each habitat. The quantity and quality of water are decisive factors that determine whether ecosystems thrive, degrade, or collapse.

Water as a Carrier of Substances and Nutrients

Water serves as a vital medium for transporting substances across the planet, including nutrients, minerals, sediments, and even pollutants. Rivers carry nutrients from mountains to plains and eventually to the sea, creating fertile areas such as river deltas. At the same time, if water becomes contaminated, pollutants can spread widely, impacting living organisms across ecosystems.

Water as a Limited Resource of the Earth

Although water covers more than 70% of the Earth's surface, usable freshwater is scarce and unevenly distributed. Water is therefore not an inexhaustible resource. If exploited unsustainably, groundwater may dry up, rivers may diminish, and ecosystems may collapse. Water scarcity has become one of the most pressing environmental and human security challenges.

Water as a Reflection of the Planet's Health

Water quality serves as a mirror of Earth's health. Clean and clear water indicates balanced ecosystems, while polluted water, eutrophication, or "dead seas" are warning signs that humanity is exceeding the natural limits of resource use.

Water and the Relationship Between Humans and the Earth

Humans depend on water for agriculture, industry, daily life, and culture. Cities, ancient sites, and civilizations have all emerged near water sources. Thus, water is not merely a resource but the foundation of society and civilization. Mismanagement of water without understanding natural systems impacts both the environment and humanity itself.

Environmental Summary

From an environmental perspective, water is the lifeblood of the Earth—nourishing, connecting, and regulating the planet's systems. Caring for water is not only about conserving a resource but about preserving the balance of the Earth and the future of all life forms.

Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) are a set of 17 universal goals established by the United Nations (UN) as a blueprint for building a better and more sustainable future for all. They aim to end poverty, protect the planet, and promote peace, prosperity, and well-being by the year 2030. The goals encompass social, economic, and environmental dimensions, are interconnected, and require collaboration across all sectors worldwide.

Selected Goals

- SDG 3: Good Health and Well-being
- SDG 4: Quality Education
- SDG 6: Clean Water and Sanitation
- SDG 12: Responsible Consumption and Production

Health Impacts of Unsafe Drinking Water

This study highlights that unsafe drinking water poses significant risks to human health. Contamination with pathogens, chemicals, or heavy metals can directly cause gastrointestinal diseases such as diarrhea, cholera, and dysentery. Moreover, certain chemical substances may accumulate in the body, leading to chronic toxicity that affects vital organs including the kidneys, liver, and nervous system. Vulnerable groups, particularly children and the elderly, face heightened risks. Continuous consumption of unsafe water not only diminishes quality of life but also imposes a long-term burden on public health systems. Drinking Water Laws and Standards in Thailand

Drinking Water Laws and Standards in Thailand

Ministry of Public Health Announcement on Drinking Water Standards for Consumption

The Ministry of Public Health has issued regulations establishing standards for drinking water to ensure safety and quality for public consumption.

Water-related Legislation

Under Thai law, groundwater is designated as a state-owned resource. Any drilling or utilization of groundwater requires prior authorization from government agencies in order to regulate extraction volumes and prevent environmental impacts. The state has the authority to declare restricted or prohibited zones for groundwater use. Violations of these regulations may result in penalties, including fines, imprisonment, or the sealing of wells. The primary objective of this legislation is to promote the appropriate and sustainable use of groundwater resources.

Department of Groundwater Resources. 1977. Groundwater Act B.E. 2520 (latest revision). Ministry of Natural Resources and Environment, Thailand. Accessed August 3, 2025. https://www.dgr.go.th/th/download/707?utm_source=chatgpt.com

Drinking Water Standards by the Ministry of Public Health (Thailand)

The drinking water standards of Thailand are quality criteria established by the Department of Health, Ministry of Public Health, to ensure that water consumed is safe and does not cause waterborne diseases. These standards are aligned with food and water sanitation principles and the national framework for drinking water quality control.

Drinking Water Quality Standards in Thailand

The drinking water quality standards in Thailand are categorized into several aspects:

1.Physical Properties

Basic characteristics that must be examined include clarity (water must not be turbid), color, odor, and taste, which should be normal and free from abnormalities. Turbidity levels must remain within the prescribed range to prevent excessive sediment or suspended particles.

WEPA Database. n.d. *Drinking Water Quality Standards in Thailand.* Accessed August 3, 2025. https://wepa-db.net/archive/policies/law/thailand/std_drinking.htm?utm_source=chatgpt.com

2. Acidity–Alkalinity (pH)

- The standard pH range for drinking water is approximately 6.5–8.5, which is considered neutral and not harmful to the human body.
- This parameter ensures that water is neither excessively acidic nor alkaline, conditions that could negatively affect health or damage water distribution systems.

3. Chemical Properties

Drinking water must contain chemical substances at safe levels, such as:

- Total Dissolved Solids (TDS): must not exceed the specified limit.
- Iron (Fe) and Manganese (Mn): must remain within safe concentrations.
- Chloride or Sulfate: levels must not be excessively high.
- Nitrate (NO_3): must comply with standards to prevent harmful chemical effects in the body.

Examples of parameters used to assess drinking water quality under one standard system include:

Parameter	Standard Value
pH	6.5–8.5
Iron (Fe)	≤ 0.5 mg/L
Manganese (Mn)	≤ 0.3 mg/L
Nitrate (NO_3)	≤ 45 mg/L
Total Dissolved Solids	≤ 500 mg/L

(The numerical values in the table are referenced from general standards commonly applied in the assessment of water quality.)

4. Biological Properties (Microorganisms)

Drinking water must be free from harmful microorganisms, such as E. coli or other pathogenic bacteria. Contamination with these organisms poses risks of gastrointestinal diseases and other infectious illnesses.

According to the standards of the Ministry of Public Health (Thailand), the acceptable level is defined as safe or non-detectable in water samples. Department of Health, Ministry of Public Health. 2020. *Drinking Water Quality Standards.* Accessed August 3, 2025. https://foodsan.anamai.moph.go.th/th/water-quality/204437?utm_source=chatgpt.com

WHO Drinking Water Standards

Related Research

Research on Water Quality in Rural Northern Communities

Mae Fah Luang University Institutional Repository. n.d. *Water Supply Quality and Health Impacts on Hill Tribe People: A Case Study of the Akha Hill Tribe Village, Chiang Rai, Thailand.* Accessed August 3, 2025. https://mfuir.mfu.ac.th/jspui/handle/123456789/1116?utm_source=chatgpt.com

Srisuphan, W., and J. Chompikul. 2021. Quality of Sources of Drinking Water and Health among the Hill Tribe People of Northern Thailand. Journal of Public Health and Development 19 (1): 1–14. Accessed August 3, 2025. https://pubmed.ncbi.nlm.nih.gov/34114160/

Thailand Research Fund. n.d. Community-Based Water Resource Management: The Role of Participatory Action Research in Lampang, Northern Thailand. Accessed August 4, 2025. https://elibrary.tsri.or.th/fullP/RDG54N0009/RDG54N0009_full.pdf?utm_source=chatgpt.com

Thai Beverage Public Company Limited. 2024. Clean Water Projects by ThaiBev (WASH & Community Water Projects). Accessed August 4, 2025. https://sustainability.thaibev.com/2024/en/water_stewardship.php?utm_source=chatgpt.com

Chapter 3
Research Methodology

Academic Translation (Research Context):

Population: Natural water sources located in Village No. 4, Ban Mae Tao Din, and Village No. 5, Ban Huai Kaew, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province, Thailand.

Sample Group: Actual water sources utilized by local residents, including drinking water, domestic water, agricultural water, groundwater, and mountain spring water.

Materials and Equipment

1. Water quality test kits for ammonia and nitrate determination
2. Water quality measuring instruments (pH meter, TDS & ED meters)
3. Thailand's National Drinking Water Standards Manual
4. Water samples collected from two villages:Village No. 4, Ban Mae Tao Din: groundwater and mountain spring water (samples collected at upstream, midstream, and downstream points)Village No. 5, Ban Huai Kaew: groundwater, located in Huai Kaew Subdistrict, Mae On District, Chiang Mai Province
5. Glass sampling bottles with a capacity of 1,000 cc, sealed with rubber stoppers
6. Distilled water
7. Data recording sheets for water sample collection

Research Methodology

Study Areas

- Area 1: Village 5, groundwater (Suan Phueng), Ban Huai Kaew, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province.
- Area 2: Village 4, groundwater, Ban Mae Tao Din, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province.
- Area 3: Village 4, mountain spring water (source, midstream, downstream), Ban Mae Tao Din, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province.

Water Sampling

Water samples of 5 liters were collected from each study area for analysis of physical and chemical properties.

Data Collection Periods

Water samples from each source were collected during rainy and dry seasons, three times as follows:

- First Collection: August 2, 2025 (Rainy season), covering the period August 2 – September 27, 2025 (57 days).

- Second Collection: September 28, 2025 (Rainy season), covering the period September 28 – November 23, 2025 (57 days).
- Third Collection: January 18, 2026 (Winter season), covering the period November 24, 2025 – January 18, 2026 (56 days).

Data Analysis

Collection and analysis of data, including measurement of ammonia and nitrate levels in water (pH Meter, TDS & ED).

1. Analysis using descriptive statistics.
2. Summarization of water quality analysis results compared with the drinking water standards of the Ministry of Public Health.
3. Analysis of risk factors affecting water quality.
4. Laboratory analysis of water quality (referencing water testing conducted in Village 4, Ban Mae Tao Din, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province).

Chapter 4
Data Analysis and Research Results

Table of Water Quality Values from Each Source
Date: August 2, 2025 Time: 13:30 – 15:30 hrs

Location	Weather	Temperature (°C)	Water Clarity	TDS & EC (ppm)	pH	Ammonia (mg/L)	Nitrate (mg/L)
Groundwater, Suan Phueng, Village 5	Rainy	23	Clear	200	7.12	0	0
Groundwater, Village 4	Rainy	23	Clear	112	7.18	0	0
Mountain Spring (Upstream), Village 4	Rainy	21	Clear	36	6.94	0	0
Mountain Spring (Midstream), Village 4	Rainy	23	Clear	23	6.67	0	0
Mountain Spring (Downstream), Village 4	Rainy	23	Clear	23	6.50	0	0

Sampling Environment

All water sources were sampled during rainy conditions, with ambient temperatures ranging from 21–23°C, which is considered suitable for water quality assessment. The water at all sampling points was clear, with no sediment or abnormal coloration, indicating the cleanliness of the natural sources.

Water Quality Analysis Results

- TDS and EC: Total dissolved solids and electrical conductivity showed a decreasing trend from groundwater to upstream, midstream, and downstream mountain spring water. Groundwater exhibited the highest TDS value (200 ppm), which remains within the safe threshold.
- pH: Ranged from 6.50 to 7.18, indicating neutral to slightly acidic conditions, suitable for natural water and non-harmful to aquatic life.
- Ammonia and Nitrate: All sources recorded zero values, suggesting no contamination from organic waste or chemical fertilizers.

Key Observations

- Mountain spring water (from upstream to downstream) showed a slight decrease in electrical conductivity and pH, possibly due to natural filtration or organic matter accumulation.
- Groundwater values remained stable and are suitable for domestic consumption.

Overall Summary

All water sources demonstrated good quality, free from hazardous chemicals or human-induced contamination. They are appropriate for community use, both for domestic consumption and as raw water for public water supply systems.

Chapter 4: Data Analysis and Research Results

Table of Water Quality Values from Each Source

Date: September 28, 2025 Time: Afternoon

Location	Weather	Temperature (°C)	Water Clarity	TDS & EC (ppm)	pH	Ammonia (mg/L)	Nitrate (mg/L)
Groundwater, Suan Phueng, Village 5	Cloudy	23	Clear	218	7.13	0	0
Groundwater, Village 4	Cloudy	23	Clear	183	7.18	0	0
Mountain Spring (Upstream), Village 4	Cloudy	21	Clear	40	7.00	0	0
Mountain Spring (Midstream), Village 4	Cloudy	23	Clear	24	6.95	0	0
Mountain Spring (Downstream), Village 4	Cloudy	23	Clear	25	6.72	0	0

Sampling Environment

All sampling points experienced cloudy weather with temperatures ranging from 21–23°C, which are suitable conditions for water quality assessment. The water at all sources was clear, free from sediment or discoloration, indicating the cleanliness of the natural water sources.

Water Quality Analysis

TDS & EC (Total Dissolved Solids and Electrical Conductivity)

- Groundwater showed the highest TDS values (218 and 183 ppm), reflecting mineral accumulation from soil layers.
- Mountain spring water (upstream and midstream) had low TDS values (40 and 24 ppm), indicating the purity of water naturally filtered through rocks and vegetation.

pH (Acidity-Alkalinity Level)

- Ranged from 6.95 to 7.18, considered neutral and suitable for natural water, posing no harm to living organisms.

Ammonia and Nitrate

- All sampling points recorded zero values, indicating no contamination from organic waste or chemical fertilizers.

Key Observations

- Groundwater showed stable values and is suitable for domestic use.
- Mountain spring water demonstrated excellent quality, ideal as a raw water source for public water supply.
- No hazardous chemicals or human-induced contamination were detected in any of the sampled sources.

Overall Summary

Water from all sources exhibited excellent quality—clean, safe, and suitable for community use, including domestic consumption and agriculture. In particular, mountain spring water, with its low and neutral values, reflects the natural purity of the environment.

Chapter 4: Data Analysis and Research Results

Table of Water Quality Values from Each Source

Date: January 18, 2026 Time: Morning

Location	Weather	Temperature (°C)	Water Clarity	TDS & EC (ppm)	pH	Ammonia (mg/L)	Nitrate (mg/L)
Groundwater, Ban Ta Kha Suan Phueng, Village 5	Sunny	23	Clear	200	7.43	0	0
Groundwater, Ban Ta Kha, Village 4	Sunny	23	Clear	183	7.84	0	0
Mountain Spring (Upstream), Village 4	Sunny	22	Clear	40	7.10	0	0

Location	Weather	Temperature (°C)	Water Clarity	TDS & EC (ppm)	pH	Ammonia (mg/L)	Nitrate (mg/L)
Mountain Spring (Midstream), Village 4	Sunny	23	Clear	26	7.80	0	0
Mountain Spring (Downstream), Village 4	Sunny	23	Clear	26	7.40	0	0

Sampling Environment

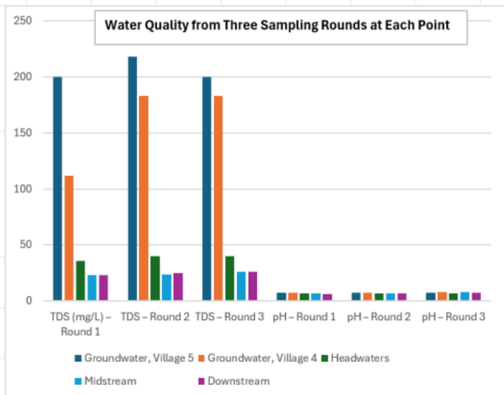
- All sampling points experienced sunny weather with temperatures ranging from 22–23°C, suitable for water quality assessment.
- Water at all sources was clear, with no sediment or discoloration, indicating the cleanliness of natural water sources.

Water Quality Analysis

- TDS & EC (Total Dissolved Solids and Electrical Conductivity):
  - Groundwater showed the highest TDS values (200 and 183 ppm), typical of mineral accumulation in subsurface water.
  - Mountain spring water (upstream, midstream, downstream) had low TDS values (40 and 26 ppm), reflecting the purity of water naturally filtered through geological and ecological processes.
- pH (Acidity-Alkalinity Level):
  - Ranged from 7.10 to 7.84, indicating neutral to slightly alkaline conditions, suitable for drinking and general use.
- Ammonia and Nitrate:
  - All sampling points recorded zero values, indicating no contamination from organic waste or chemical fertilizers.

Key Observations

- Groundwater exhibited stable values and is suitable for domestic consumption.
- Mountain spring water demonstrated excellent quality, ideal as a raw water source for public water supply.
- No hazardous chemicals or human-induced contamination were detected in any of the sampled sources.



Water Quality from Three Sampling Rounds at Each Point

Sampling Point	TDS (mg/L) – Round 1	TDS – Round 2	TDS – Round 3	pH – Round 1	pH – Round 2	pH – Round 3
Groundwater, Village 5	200	218	200	7.12	7.13	7.43
Groundwater, Village 4	112	183	183	7.18	7.18	7.84
Headwaters	36	40	40	6.94	7.00	7.10
Midstream	23	24	26	6.67	6.95	7.80
Downstream	23	25	26	6.50	6.72	7.40

Comparative Summary of Groundwater and Mountain Runoff Based on Three Sampling Rounds

1. Groundwater exhibited higher levels of Total Dissolved Solids (TDS) and Electrical Conductivity (EC) compared to mountain runoff, reflecting mineral accumulation in subsurface layers. However, the values remained within safe limits, making groundwater suitable for domestic consumption.
2. Mountain runoff (from headwaters to downstream) showed consistently low TDS levels, indicating natural purity. This type of water is ideal as a raw source for municipal water production.
3. The pH of groundwater ranged from neutral to slightly acidic, while mountain water ranged from neutral to slightly alkaline. Both types are appropriate for sustaining aquatic life and general usage.
4. No traces of ammonia or nitrate were detected in any water source, suggesting an absence of contamination from human activities or organic waste.
5. Overall, groundwater demonstrated stability and safety, whereas mountain runoff showed high purity and is particularly well-suited for water supply production and community use.
6. All water sources met international and Thai drinking water standards, confirming their cleanliness, safety, and suitability for consumption.

Overall Summary

Water from all sources exhibited excellent quality—clean, safe, and suitable for community use, including domestic consumption, agriculture, and water supply production. In particular, mountain spring water, with its low and neutral values, reflects natural purity.

Chapter 5
Conclusion, Discussion, and Recommendations

Comparison with Drinking Water Standards

The results of water quality measurements across the three sampling periods (August 2, 2025; September 28, 2025; and January 18, 2026) revealed that all values were within the drinking water standards established by the World Health Organization (WHO) and Thailand. No hazardous contaminants, such as ammonia and nitrate, were detected.

Comparison of Values with Drinking Water Standards

Indicator	Detected Values (Range)	WHO/Thai Standard	Interpretation
pH	6.50 – 7.84	6.5 – 8.5	Within standard range; suitable for consumption
TDS	23 – 218 mg/L	< 500 mg/L (WHO)	Much lower than standard; indicates clean water
Ammonia	0 mg/L	< 0.5 mg/L	Not detected; considered excellent
Nitrate	0 mg/L	< 50 mg/L (WHO)	Not detected; safe for health

Summary of Comparison

- All measured values were within both international and Thai drinking water standards.
- No contamination by hazardous chemicals such as ammonia or nitrate was detected.
- TDS values were very low compared to the WHO guideline (<500 mg/L), indicating the purity of the water.
- pH values were within the appropriate range, neither excessively acidic nor alkaline.

Analysis of Seasonal Trends in Water Quality

Based on data collected across the three seasonal sampling periods, overall water quality remained stable and within standard limits, with no detection of ammonia or nitrate contamination. During the rainy season (August–September), TDS and pH values tended to be slightly lower, reflecting dilution by rainfall. In contrast, during the winter season (January), both pH and TDS values increased slightly, attributable to the concentration of groundwater. In summary, mountain spring water consistently exhibited low values and natural purity across all seasons, while groundwater showed higher mineral content but remained within safe limits.

Summary of Comparison

- All measured values were within both international and Thai drinking water standards.
- No contamination by hazardous chemicals such as ammonia or nitrate was detected.
- TDS values were very low compared to the WHO guideline (<500 mg/L), indicating the purity of the water.
- pH values were within the appropriate range, neither excessively acidic nor alkaline.

Analysis of Seasonal Trends in Water Quality

Based on data collected across the three seasonal sampling periods, overall water quality remained stable and within standard limits, with no detection of ammonia or nitrate contamination. During the rainy season (August–September), TDS and pH values tended to be slightly lower, reflecting dilution by rainfall. In contrast, during the winter season (January), both pH and TDS values increased slightly, attributable to the concentration of groundwater. In summary, mountain spring water consistently exhibited low values and natural purity across all seasons, while groundwater showed higher mineral content but remained within safe limits.

Policy Recommendations for Local Authorities on Improving Drinking Water Quality

Local authorities should establish regular monitoring of water quality using standardized procedures to build public confidence. Investment in basic filtration and treatment systems is recommended, particularly in areas relying on groundwater, which tends to have higher TDS values compared to surface water. Community participation should be encouraged in monitoring and reporting water-related issues to ensure timely and targeted management. Furthermore, water quality monitoring data should be integrated into local development plans to promote sustainable water resource management and safeguard public health.

Recommendations for Future Research

Future studies should focus on in-depth data collection during the rainy season to compare water quality with the dry season and to analyze the impacts of runoff and soil leaching. Research should also examine the relationship between water quality parameters and public health outcomes in the study area to assess potential health risks. Long-term monitoring is essential to identify trends in water quality changes and their environmental impacts. Additionally, integrating research with community participation will help build a robust database and support sustainable water management practices.

Appendix

Laboratory Analysis of Water Quality

(Referenced from laboratory testing of water samples collected from Village 4, Ban Mae Tao Din, Ban Huai Kaew, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province)

บริษัท ห้องปฏิบัติการกลาง (ประเทศไทย) จำกัด
Central Laboratory (Thailand) Co.,Ltd.
สาขาเชียงใหม่ : 164/86 หมู่ที่ 3 ต.ดอนแก้ว อ.แม่ริม จ.เชียงใหม่ 50180 ประเทศไทย
Chiangmai Branch: 164/86 Moo 3, Donkaew, Maerim, Chiangmai 50180 Thailand.
Tel : (66) 0 5389 6131, (66) 0 5389 6133 Fax : (66) 0 5389 6052, (66) 0 5389 6131 ต่อ 705
http://www.centrallabthai.com

ilac-MRA | QUALITY ASSURANCE DMSc | ISO/IEC 17025 Accreditation No. 1079/46

Central Lab One Stop & Fast Services

รายงานผลการทดสอบ

วันที่ออกรายงาน 05 กันยายน 2568
เลขที่รายงาน TRCM68/23734 Rev.1
หน้า 01/03

รายงานฉบับนี้ออกทดแทน TRCM68/23734 ที่ถูกยกเลิก

ชื่อและที่อยู่ลูกค้า (ข้อมูลจากลูกค้า): บริษัท น้ำแร่เพอร์เฟค 2017 จำกัด
8/1 หมู่ 4 ตำบลห้วยแก้ว อำเภอแม่ออน จังหวัดเชียงใหม่ 50130

รายละเอียดตัวอย่าง (ข้อมูลจากลูกค้า): น้ำแร่เพอร์เฟค

รหัสตัวอย่าง: CM68/14496-001

ลักษณะและสภาพตัวอย่าง: ประเภทตัวอย่าง : น้ำ
ภาชนะบรรจุ : ขวดพลาสติก ปิดสนิท, จำนวน : 12 ขวด, น้ำหนัก/ปริมาตร : 500 มิลลิลิตร/ขวด
อุณหภูมิขณะรับ : อุณหภูมิห้อง, สภาพตัวอย่างปกติ

วันที่รับตัวอย่าง: 19 สิงหาคม 2568

วันที่ทดสอบ: 19 สิงหาคม 2568 - 28 สิงหาคม 2568

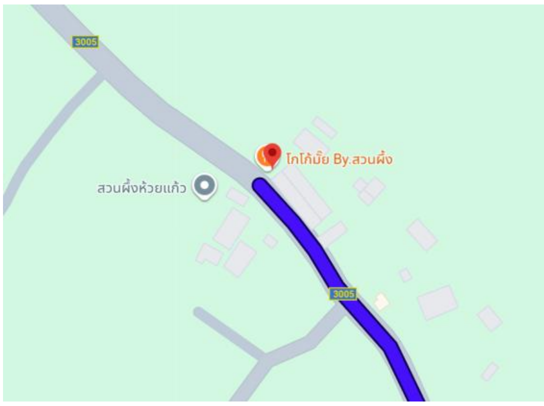
ผลการทดสอบ

รายการทดสอบ	ผลการทดสอบ	ค่ามาตรฐาน	หน่วย	LOD	วิธีทดสอบอ้างอิง
Alkyl benzyl sulfonate (ABS) •	Not Detected	-	mg/L	0.05	TIS. 257 (2521)
Bicarbonate •	54.29	-	mg/L as CaCO3	-	APHA-AWWA(2005)
Chloride •	7.66	-	mg/L	-	APHA-AWWA(2005)
Color •	0.03	-	Pt-Co unit	-	In house method based on TIS. 257 (2527)
Fluoride •	0.21	-	mg/L	-	APHA-AWWA (2017)
Nitrate-N •	1.35	≤ 50	mg/L	-	AOAC (2016) 973.50
pH •	7.87	-	-	-	AOAC (2010) 973.41
Phenol •	Not Detected	-	mg/L	0.001	APHA-AWWA (2017)
Total Solid •	141.00	-	mg/L	-	APHA-AWWA(2005)
Cyanide •	Not Detected	≤ 0.07	mg/L	0.040	APHA-AWWA (2023)
Odor •	Unobjectionable	-	-	-	APHA-AWWA (2023)
Silicon as Silica •	31.04	-	mg/L	-	Detected by ICP-OES Calculated from Silicon
Sulphate (as SO_4^{2-}) •	6.37	-	mg/L	-	APHA-AWWA (2023)
Total Hardness (as $CaCO_3$) •	63.0	-	mg/L	-	APHA-AWWA (2023)

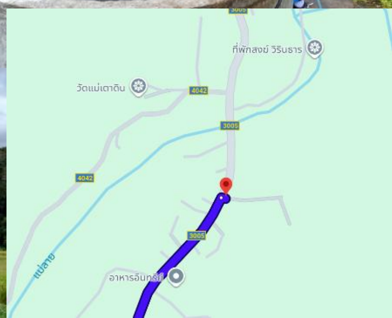
รายงานฉบับนี้มีผลเฉพาะกับตัวอย่างที่ได้รับเท่านั้น
รายงานผลการทดสอบต้องไม่ถูกทำสำเนาเฉพาะเพียงบางส่วน โดยไม่ได้รับความยินยอมเป็นลายลักษณ์อักษรจากห้องปฏิบัติการ ยกเว้นทำทั้งฉบับ

FM-QP-24-01-001-R05(18/01/64)P1/3-CM

Area 1: Groundwater (Suan Phueng), Village 5, Ban Huai Kaew, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province

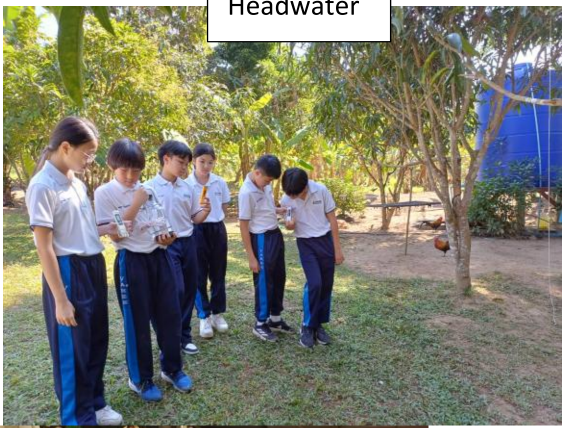


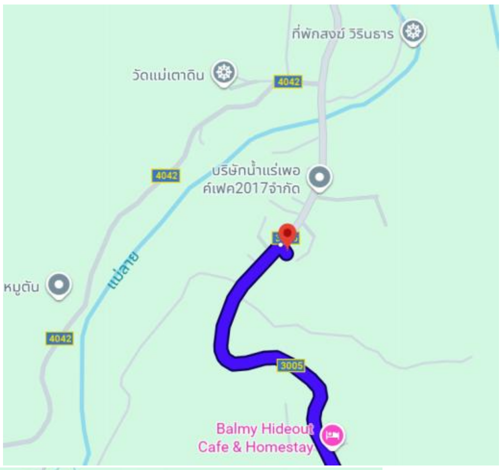
Area 2: Groundwater, Village 4, Ban Mae Tao Din, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province



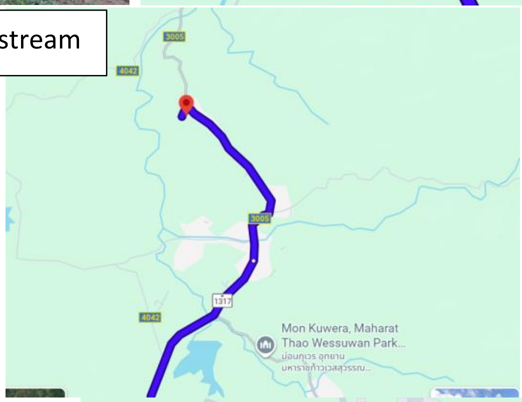
Area 3: Mountain Runoff (Headwaters, Midstream, Downstream), Village 4, Ban Mae Tao Din, Huai Kaew Subdistrict, Mae On District, Chiang Mai Province

Headwater

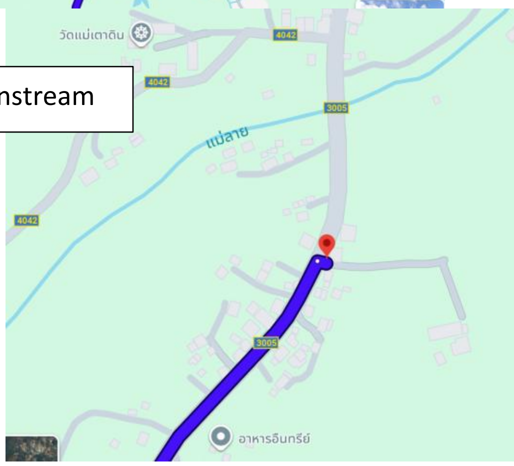




Midstream

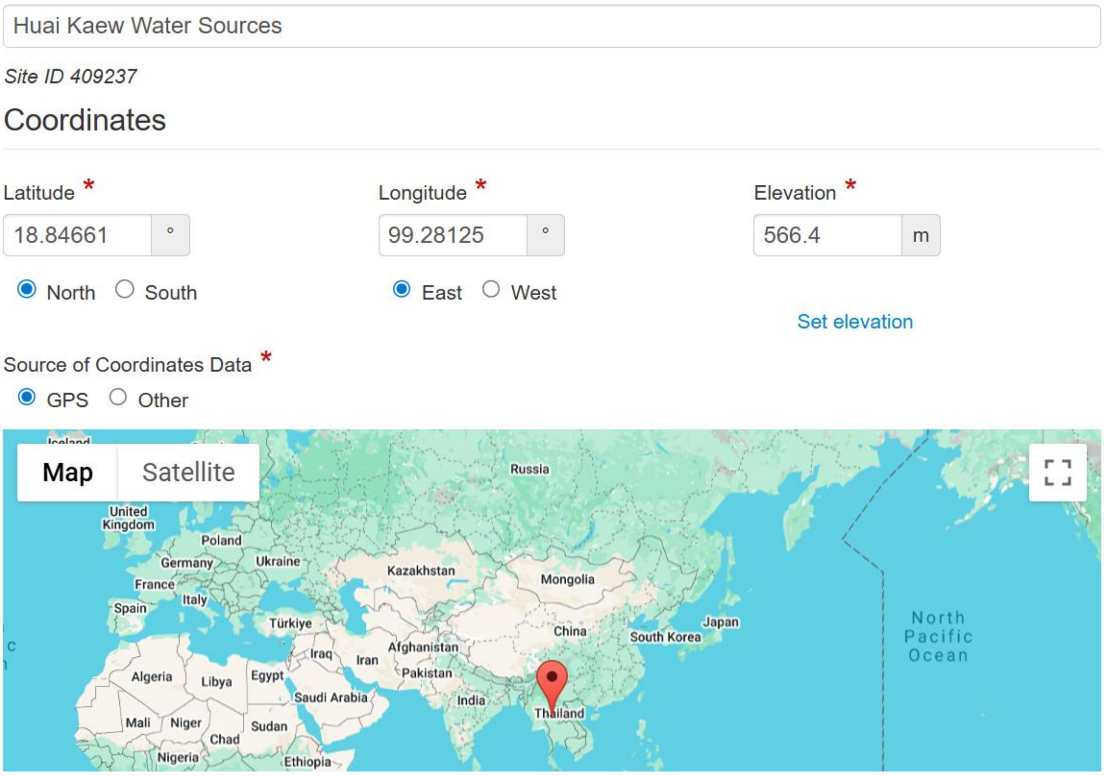


Downstream



“Materials and Equipment for Research”


THE GLOBE PROGRAM
SCIENCE Data Entry
English
Welcome Panisa Tongkamgirato
Try GLOBE's new Data Entry system for Atmosphere, Hydrosphere, Biosphere and Pedosphere protocols!
Data Entry
Use New Data Entry
Short tutorial (pdf). More information is available->
My Bookmarks
You have not bookmarked any investigations yet. Expand the organizations and click the stars next to the investigations to create a bookmark.
My Organizations and Sites
Varee Chiangmai school ORG_ID: 51004095
Add site
Huai Kaew Water Sources
Latitude 18.84661, Longitude 99.28125, Elevation 566.4m, SITE_ID: 409237
Edit site | Delete site


Huai Kaew Water Sources
Site ID 409237
Coordinates
Latitude *
18.84661 °
North South
Longitude *
99.28125 °
East West
Elevation *
566.4 m
Set elevation
Source of Coordinates Data *
GPS Other
Map
Satellite
Russia
United Kingdom
Poland
Germany
Ukraine
Kazakhstan
Mongolia
France
Italy
Spain
Türkiye
China
South Korea
Japan
North Pacific Ocean
Afghanistan
Iraq
Iran
Pakistan
Algeria
Libya
Egypt
Saudi Arabia
India
Thailand
Mali
Niger
Sudan
Chad
Nigeria
Ethiopia