Application of Cyperus involucratus Rottb (Umbrella plant) Combined with GLOBE Hydrosphere Water Quality Measurements for the Restoration of Water in Concrete Canal, San Pa Liang Community, Mueang, Chiang Mai

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Abstract

The objective of this research was to study the water quality in the concrete canal, San Pa Liang Community, Mueang District, Chiang Mai Province, and to assess the efficiency of the Umbrella Plant (*Cyperus involucratus* Rottb) in restoring wastewater. This was done using measurements according to the GLOBE Hydrosphere Protocol alongside laboratory experiments. Field water sampling was conducted at 3 locations: Upstream, Midstream, and Downstream, once a week for 4 weeks. Water quality variables measured included temperature, turbidity, pH, DO value, phosphate, nitrite, alkalinity, and electrical conductivity.

The survey results found that water quality deteriorated as it flowed through the community area. Turbidity, phosphate, nitrite, and electrical conductivity values increased clearly in the midstream and downstream areas, reflecting contamination from household wastewater and community activities. Although the pH value was at a neutral level, other variables indicated a state of water pollution.

In the experiment of wastewater treatment using the Umbrella Plant, designed as a control group and an experimental group over a period of 15 days, it was found that the plant could effectively reduce turbidity and absorb phosphate and nitrite, making the water clearer and increasing the DO value. This was due to the function of the root system and microorganisms that help decompose waste. Additionally, electrical conductivity decreased slightly, indicating a reduction in the amount of ions in the water.

The comparison results before and after treatment indicate that the Umbrella Plant has high potential for restoring water quality in community canals, especially in reducing turbidity and excess nutrients, which are key factors in water pollution problems. This study helps create knowledge regarding the use of local aquatic plants to treat wastewater in an economical and environmentally friendly manner, while also promoting scientific skills, thinking processes, and STEAM integration for students. The results can be applied in the community for sustainable water management development.

Keywords: Umbrella Plant (*Cyperus involucratus* Rottb), Water Quality, GLOBE Hydrosphere

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The Research Team

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Chapter 1

Introduction

Background

Water resources are essential natural resources for the survival of humans, animals, and plants, as they play a vital role in consumption, agriculture, and as habitats for living organisms. Furthermore, ecosystems and human society rely on water resources to improve the quality of life of the community. Water resources are therefore part of the Earth System, linked to the atmosphere, soil, biology, etc.

Currently, the problem of deteriorated water quality has become more severe, especially in urban areas with high population density, such as Mueang District, Chiang Mai Province. The continuous expansion of communities and economic activities has affected many public water sources due to community wastewater and improper waste management. One clearly affected area is the concrete canal in the San Pa Liang community, which is an important drainage canal for the community and part of the ecosystem in Chiang Mai city.

From student surveys, it was found that the concrete canal in San Pa Liang faces problems of polluted water, foul odor, turbidity, and high sediment quantity. The main cause is the illegal discharge of wastewater from households and shops, including the continuous dumping of garbage into the canal. This causes water quality to deteriorate as it flows through the community area, severely affecting the Hydrosphere system and aquatic life, and directly reflecting the imbalance of the Earth System.

Realizing this problem, students became interested in studying methods to restore water quality in the concrete canal using natural methods by choosing the Umbrella Plant (*Cyperus involucratus* Rottb). This is an aquatic plant with properties for absorbing organic substances and improving water quality according to phytoremediation principles. It is also a plant that is easy to grow in the community and easy to find. Using the Umbrella Plant in an experiment combined with water quality measurement according to GLOBE Hydrosphere Protocols will help

obtain accurate, reliable scientific data that can be used as a guideline for practically restoring wastewater in the concrete canal.

This study is therefore important for both solving community environmental problems and developing scientific skills in learners. It uses the process of survey, observation, experiment, and analysis according to GLOBE guidelines, which link the relationship of soil, water, atmosphere, and living organisms holistically. The study results can be used as supporting information for community decision-making and as a model for phytoremediation innovation that can be applied sustainably.

Research Objectives

1. To study the effect of the Umbrella Plant on the restoration and improvement of water quality in the concrete canal.
2. To analyze the changes in physical and chemical properties of water after treatment with the Umbrella Plant.
3. To compare water quality at the Upstream, Midstream, and Downstream positions of the concrete canal.
4. To apply water quality measurement according to GLOBE Hydrosphere to assess the efficiency of phytoremediation.
5. To propose guidelines for restoring wastewater quality that can be practically used in the San Pa Liang community.

Research Questions

1. How much can the Umbrella Plant restore or improve water quality in the concrete canal when compared to water in the control group without treatment plants?
2. How do the physical and chemical properties of water, such as turbidity, pH, DO value, nitrite, and phosphate, change after treatment with the Umbrella Plant?
3. How does the water quality of the concrete canal differ at the Upstream, Midstream, and Downstream positions, and how do community activity factors affect water quality?

Research Hypotheses

1. The characteristics of water in the experimental group with the Umbrella Plant will have significantly better quality, such as reduced turbidity, pH closer to equilibrium, and higher DO values compared to the control group.
2. The Umbrella Plant can reduce the amount of excess nutrients in the water, namely nitrite and phosphate, more than the control group.
3. The water quality of the concrete canal will have reduced suitability according to the position flowing through the community, with Upstream having the best quality and Downstream having the worst quality.

Expected Benefits

1. Obtain scientific data on the efficiency of the Umbrella Plant in wastewater treatment, which can be used as a guideline or reference evidence for restoring water quality in other community areas.
2. The San Pa Liang community can apply the study results to develop a water restoration system in the concrete canal for sustainably better water quality and reduced environmental impact.
3. Students gain scientific skills according to the GLOBE project guidelines, including survey, data collection, analysis, use of Hydrosphere Protocol tools, and linking data to Earth System Science.
4. Create innovation in using local aquatic plants for wastewater treatment, which is a natural, low-cost method that can be practically applied in schools or communities.
5. Increase environmental awareness among learners and the community, creating participation in caring for water resources, reducing garbage dumping into canals, and changing behaviors that affect water quality.
6. Create a water quality database of the concrete canal according to GLOBE standards, which can be used to track long-term water quality change trends and report to the community or local agencies.

Scope of Research

1. Content Scope

1.1 Field Water Sampling: Collect water samples from the concrete canal, San Pa Liang Community, Mueang District, Chiang Mai Province from 3 positions: Upstream, Midstream (through community zone), and Downstream.

Frequency: Collect data once a week for 4 weeks.

Water Quality Indicators Measured:

- Water Temperature
- Turbidity
- pH
- Dissolved Oxygen (DO)
- Nitrite
- Phosphate
- Alkalinity
- Electrical Conductivity

1.2 Effect of Umbrella Plant (*Cyperus involucratus* Rottb) on Restoration and Improvement of Water Quality: Consider changes in physical and chemical properties of water:

Water Temperature

- Turbidity
- pH
- DO
- Nitrite
- Phosphate
- Alkalinity
- EC

1.3 Comparison of Treatment Results: The experiment on the effect of the Umbrella Plant on concrete canal water quality is designed into 2 sets:

- Control Group (No Umbrella Plant)
- Experimental Group (With 2 Umbrella Plants, 1 month old)
- Treatment Duration: Continuous experiment for 15 days.

- Measurement Frequency: Measure water quality every 3 days to collect data on changes in water quality values in each period.

1.4 Application of GLOBE Hydrosphere Protocol in the water quality measurement process and systematic data recording.

1.5 Study of water quality changes during the specified period to assess the efficiency of the Umbrella Plant in wastewater treatment.

2. Location Scope

2.1 Water Sampling Area: Concrete canal, San Pa Liang Community, Mueang District, Chiang Mai Province (Upstream, Midstream, and Downstream).

2.2 Water Treatment Experiment Area: Varee Chiangmai School, outdoor area arranged for the experimental set of water troughs for planting Umbrella Plants.

2.3 Water Quality Measurement Area (GLOBE Hydrosphere): Field site at the concrete canal, San Pa Liang Community, and Varee Chiangmai School outdoor area.

3. Time Scope

November 2025 - January 2026.

Chapter 2

Literature Review

In conducting the research on "Application of *Cyperus involucratus* Rottb (Umbrella plant) Combined with GLOBE Hydrosphere Water Quality Measurements for the Restoration of Water in Concrete Canal, San Pa Liang Community," the research team has studied and reviewed relevant research theory documents as follows:

2.1 Importance of Water Resources and Water Quality Problems in Communities

2.2 Physical and Chemical Water Quality Indicators

2.3 Characteristics and Properties of the Umbrella Plant (*Cyperus involucratus* Rottb)

2.4 Related Research

2.1 Importance of Water Resources and Water Quality Problems in Communities

Water resources are essential for humans. Our world consists of land and water. The water part accounts for approximately 3 parts (75%) and land 1 part (25%). Water is extremely important to the lives of plants and animals on Earth, including humans. Water is a renewable resource that never runs out. When sunlight hits the Earth's surface, water from seas and oceans evaporates into water vapor and rises because water vapor is lighter than air. When water vapor rises, it cools and condenses into small water droplets, floating together to form clouds. When they gather more and encounter cold, they condense into water droplets falling to Earth. Water on the Earth's surface evaporates into water vapor again when heated by the sun. Water vapor gathers into clouds and condenses into water droplets. This process occurs as a continuous cycle all the time, called the Water Cycle, causing water to occur on the Earth's surface regularly.

Figure 1: Ping River, Mueang, Chiang Mai

2.1.1 Benefits of Water

Water is the source of life for animals and plants. Humans cannot live without water for more than 3 days. Water is also essential in agriculture and industry, which are vital for national development. Benefits include: drinking, cooking, cleaning, agriculture, habitat for aquatic animals (food source), industrial production (washing waste, cooling machines), salt farming, energy source (hydroelectric dams), transportation, and tourism.

2.1.2 Water Resource Problems

Major problems occurring are:

1. Water Shortage: Resulting from deforestation, causing less rainfall and drought, damaging crops and livestock.
2. Excess Water (Flooding): Resulting from excessive deforestation, causing flash floods in the rainy season, damaging life and property.
3. Wastewater: A new problem caused by household wastewater, garbage and sewage dumped into canals, industrial wastewater, and rainwater washing toxic residues from agriculture into water sources. This wastewater damages health, endangers aquatic animals and humans, causes foul odors, and makes water sources unusable.

Figure 2: Wastewater problem due to household discharge and garbage dumping

2.1.3 Impact of Wastewater on the Environment

- Source of disease outbreaks (cholera, dysentery, diarrhea).
- Breeding ground for disease-carrying insects.
- Causes pollution of soil, water, and air.
- Causes nuisances such as foul odor.
- Loss of scenery (black water full of garbage).
- Economic loss (loss of fish species, reduced aquatic animals).
- Long-term ecosystem changes.

2.1.4 Water Conservation

1. Economical Water Use: Reduces costs and the amount of wastewater.
2. Water Preservation: Storing water for use (ponds, jars, reservoirs).
3. Water Source Development: Finding additional water sources (groundwater).
4. Wastewater Prevention: Not dumping garbage/sewage; treating industrial/hospital wastewater before discharge.
5. Water Reuse: Using wastewater from one activity for another (e.g., watering plants with dishwater).

2.2 Physical and Chemical Water Quality Indicators

Main indicators help assess water suitability for use:

2.2.1 Physical Quality:

- Color: Indicates organic matter or algae.
- Odor: From decaying matter or chemicals.
- Turbidity: From soil particles, sediment, or algae.
- Temperature: Affects oxygen solubility.
- Electrical Conductivity (EC): Indicates total ions in water.

2.2.2 Chemical Quality:

- pH: 6.5-8.5 is suitable for drinking water.
- Dissolved Oxygen (DO): Essential for aquatic life (high is good).
- Hardness: Calcium and Magnesium content.
- Organic Matter: Measured by BOD.
- COD: Chemical Oxygen Demand.
- Total Dissolved Solids (TDS).
- Nitrate: Excess nutrients cause health problems.
- Ammonia: Indicator of organic waste.
- Heavy Metals: Lead, Mercury, Cadmium.

2.3 Characteristics and Properties of the Umbrella Plant (*Cyperus involucratus* Rottb)

2.3.1 Umbrella Plant Data

The Umbrella Plant is an aquatic herbaceous plant with upright, triangular, green stems, growing up to 1-1.5 meters. It has hard underground rhizomes. Leaves are strip-like, overlapping at the tip like umbrella ribs. Small yellowish-brown flowers form a cluster at

the tip. It is prominent for decorating water gardens, treating wastewater, and weaving stems into utensils.

- Scientific Name: *Cyperus involucratus* Rottb. (Adjusted to match topic)
- Synonym: *Cyperus alternifolius* L.
- Common Name: Umbrella Plant
- Family: CYPERACEAE
- Trade Name: Kok Rachini, Kok Ranka, Kok Langka
- Origin: Southeast Asia
- Type: Herbaceous plant

Figure 3: Characteristics of Umbrella Plant

2.3.2 General Characteristics: An aquatic weed that grows well in the rainy season. It clumps, has tough stems. Seeds fall in the late rainy season and grow the next year. Propagated by seed or division. Often seen as a weed, but has over 4,000 species worldwide. Likes high moisture or flooded areas (ponds, swamps, drains, rice fields). Triangular stems. Rhizomes spread underground.

2.4 Related Research

2.4.1 The study of related research is an essential part that helps visualize concepts, theories, and previous research results regarding wastewater treatment using aquatic plants and Constructed Wetland systems, to serve as a guideline for designing this research. The related works can be summarized as follows:

Concepts regarding Constructed Wetlands A Constructed Wetland is a wastewater treatment system that mimics nature by using aquatic plants, soil, sand, and microorganisms working together to remove pollutants such as BOD, SS, TKN, and TP. Several research studies found that the Free Water Surface (FWS) system is suitable for community wastewater. The system helps increase oxygen in water (DO) through the photosynthesis process of aquatic plants. Organic matter is decomposed by microorganisms living around plant roots. Nitrogen and phosphorus are absorbed and accumulated in the plants. Work by Kadlec & Wallace (2009) stated that BOD can be reduced by more than 70% if there is an appropriate water retention time (6–10 days). Research in Thailand found that Cattail (*Typha*) is a plant that adapts well in wetland areas. It has a dense root structure that helps filter sediment and increase DO in water. It has a high capability to absorb TKN and TP. Kamonchanok (2019) found that a Constructed Wetland system using Cattail could reduce BOD by 70–85% and reduce phosphorus by more than 60% within a water retention period of 8–9 days, making it suitable for treating community wastewater and general wastewater.

2.4.2 Department of Applied Science, Faculty of Science Technology and Agriculture, Yala Rajabhat University

Topic: Comparison of Efficiency in Dye Wastewater Treatment Using Cyperus and Cattail The study of efficiency in treating wastewater from dye using Cyperus and Cattail to remove zeolite values and heavy metals conducted an operational efficiency experiment. The experiment was divided into 4 sets: the experimental set using Cyperus; the experimental set using Cattail; the experimental set not using aquatic plants (Control); and the experimental set using a combination of both plants. This experiment had a weekly duration. Wastewater samples from dye were analyzed for zeolite values and heavy metals, as well as the overall efficiency in treating dye wastewater. The study results found that using Cyperus and Cattail was efficient in treating

wastewater well. They could remove zeolite values and heavy metals, which decreased according to the wastewater retention time. The experimental set using Cattail had the best efficiency in reducing zeolite values, followed by the mixed plant set, and the Cyperus set, respectively. Furthermore, the study results found that both types of aquatic plants could adjust water quality conditions, such as pH value and turbidity, to be within more appropriate criteria. In conclusion, both types of aquatic plants have the potential to be applied for treating wastewater from dye efficiently and can be applied at the community level to be suitable for actual future use.

2.4.3 Maejo University (2020) studied various aquatic plants and found that the Umbrella Plant (Queen Sedge) gave good results in increasing DO values and reducing foul odors in community canals. The information provided stating that "Maejo University (2020) studied various aquatic plants and found that the Umbrella Plant gave good results in increasing DO values and reducing foul odors in community canals" is reliable data consistent with research on wastewater treatment using aquatic plants. Maejo University has research and products related to the use of plants and microorganisms (e.g., "Queen Sedge," "Vetiver Grass," "MMO Microorganisms") for treating wastewater and reducing odors. The Queen Sedge (*Cyperus giganteus*) is known for helping to increase Oxygen (DO) and absorb organic matter, making water cleaner and effectively reducing odors. Additional information supporting the function of the Umbrella Plant (Queen Sedge): The Umbrella Plant (*Cyperus giganteus*) has a strong root system and large leaf area, which helps increase gas exchange with the air and helps microorganisms in the water function better in decomposing organic matter. Related Research: There is research from Maejo University and other institutions studying the use of phytoremediation, including the Umbrella Plant, finding it effective in reducing BOD, COD, and odors. Practical Application: Maejo University has developed microorganism products (MMO) and knowledge to promote the use of aquatic plants for community wastewater treatment. Therefore, the aforementioned statement reflects accurate and beneficial study results from Maejo University regarding community wastewater management using biotechnology.

2.4.4 Kasetsart University, Faculty of Environment, The Laem Phak Bia Environmental Study, Research and Development Project under Royal Initiative, Chaipattana Foundation, Sri Bunyanon School Research on Wastewater Treatment with Aquatic Plants at Sri Bunyanon School, Mueang District, Nonthaburi Province: Project 2 The research "Wastewater Treatment with Aquatic Plants at Sri Bunyanon School, Mueang District, Nonthaburi Province: Project 2" is part of the Laem Phak Bia Environmental Study, Research and Development Project by Kasetsart University, which researched the efficiency of wastewater treatment in schools using aquatic plants to assess the results of implementing a natural wastewater treatment system (Constructed Wetland) with Cattail (*Typha*) as the main plant at Sri Bunyanon School to reduce pollution. The research results found that Cattail at a density of 25% and a planting spacing of 30x30 cm or 35x35 cm had high efficiency in treating wastewater.

Chapter 3

Research Methodology

Materials and Equipment

1.1 Field Water Sampling Equipment:

- 1000 mL water sampling bottle with tight lid
- Rope and water basket
- Rubber gloves
- Pen and sample labels
- Plastic bucket
- Safety goggles

1.2 GLOBE Hydrosphere Water Quality Measurement Equipment:

- Water Thermometer
- Turbidity Tube
- pH Meter
- DO Test Kit
- Nitrite Test Kit
- Phosphate Test Kit
- Alkalinity Test Kit
- EC Meter
- GLOBE Data Sheet

1.3 Plant Treatment Experiment Materials:

- Umbrella Plants (approx. 1 month old), 6 plants
- 6 experimental containers simulating the concrete canal (3 Control, 3 Experimental)
- Water from the concrete canal (collected from Downstream on the same day)

1.4 Data Analysis Materials:

- Computer for data entry
- Camera

2. Research Procedures

1. Survey the concrete canal, San Pa Liang Community: Determine study area and 3 sampling points:

- Upstream: Before entering community zone.
- Midstream: Through community (houses, shops).
- Downstream: After community, before exiting to large canal.

Frequency: Collect samples once a week for 4 weeks.



Figures 4 - 6: Upstream, Midstream, Downstream of the concrete canal

2. Collect Water Samples: Collect at 20-30 cm depth. Record temperature. Label bottles.

3. GLOBE Hydrosphere Measurement (following GLOBE Protocols. Record data and take photos) :

- Water Temperature
- Turbidity
- pH
- DO
- Nitrite, Phosphate
- Alkalinity
- EC

Figure 7: Water Quality Testing (Phosphate)

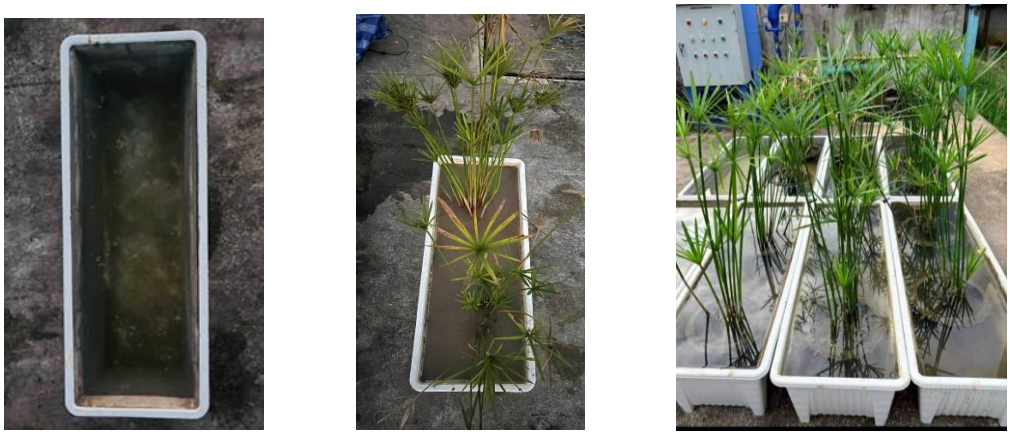
Figure 8: Water Quality Testing (Alkalinity)

4. Preparation of Umbrella Plant Treatment Experiment:

Design 2 sets:

- 3.1 Control Group: Concrete canal water (No plants), 3 sets.
- 3.2 Experimental Group: Concrete canal water + 2 Umbrella Plants (1 month old).

Preparation: Put equal amounts of concrete canal water (Downstream) in containers. Measure initial values (Day 0). Place plants in experimental set. Place in soft sunlight at school. Record environment.



Figures 9 - 11: Plant Treatment Experimental Set

5. Water Treatment Experiment:

- Duration: 15 days.
- Frequency: Every 3 days (Total 6 times).
- Measurements: Temperature, Turbidity, pH, DO, Nitrite, Phosphate, Alkalinity, EC.
- Method: Take 100-200 mL sample, measure values, record, take photos of root/stem changes.

6. Data Analysis:

6.1 Field Data Comparison: Analyze water quality at 3 positions (Upstream-Midstream-Downstream) to find degradation trends.

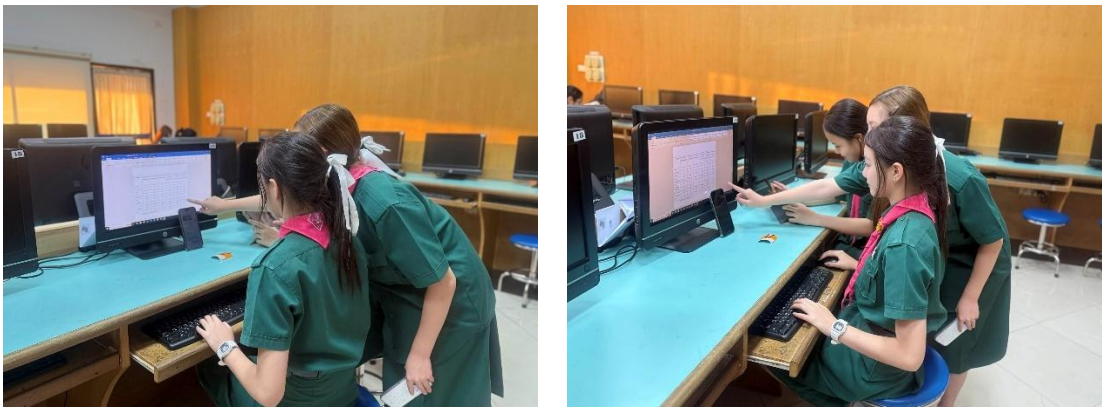


Figure 12: Analyzing Water Quality at 3 Positions (Upstream-Midstream-Downstream)

6.2 Treatment Analysis: Compare Control vs. Experimental groups. Analyze reduction in Turbidity, Nitrite, Phosphate, and increase in DO. Graph daily values.

6.3 Conclusion: Conclude based on hypotheses and scientific principles (root systems, microorganisms).

6.4 GLOBE Data Entry: Submit data to GLOBE and analyze.

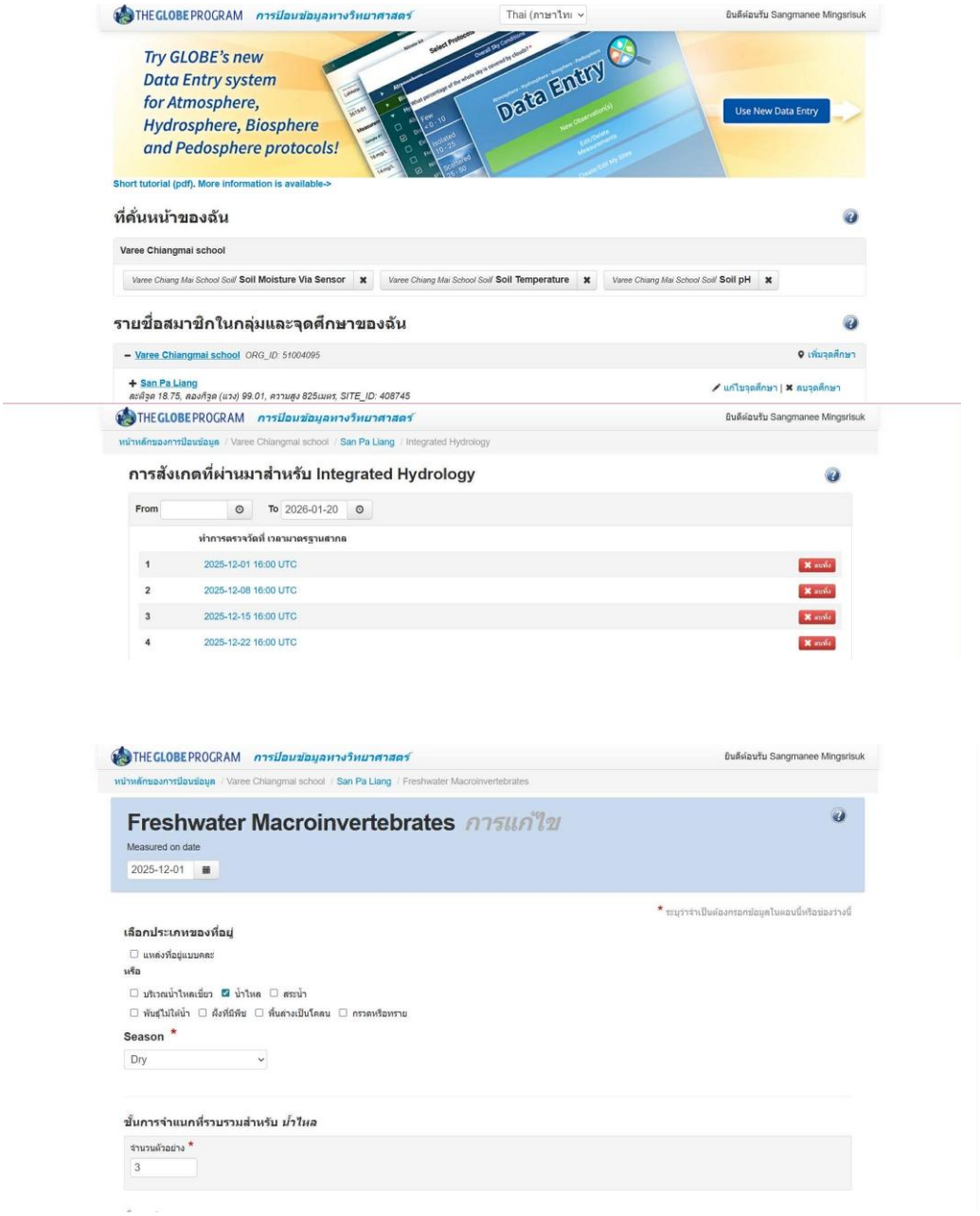


Figure 13: Data submitted to GLOBE Data Entry and used to analyze and compare study results.

7. Organize data to analyze and draw conclusions, and disseminate knowledge from the study for further education.

Chapter 4

Research Outcomes

This study involves the analysis of water quality in the concrete canal, San Pa Liang Community, Mueang District, Chiang Mai Province, and an experiment on the effect of the Umbrella Plant (Cyperus involucratus Rottb) on wastewater restoration. Data from field surveys and laboratory experiments were processed and compared.

The research results are presented in 3 parts, as follows:

1. Field Water Quality Measurement Results

Measurements at Upstream – Midstream – Downstream found:

Measurement Item	Upstream	Midstream	Downstream
Temperature (°C)	22.5	23.5	23.5
Turbidity (cm / NTU*)	27	27	35
pH	7.1	7.1	7.1
Dissolved Oxygen (DO)	9	13	19
Alkalinity (mg/L)	40	40	80
Phosphate (mg/L)	0.22	0.50	0.50
Nitrite (mg/L)	0.20	0.50	0.50
Conductivity (EC, µS/cm)	929	967	967

1.1 Temperature: 22.5–23.5°C, normal for natural canals.

1.2 Turbidity: Increased at downstream (35 cm), indicating more suspended sediment from community runoff.

1.3 pH: Constant at 7.1 (neutral), suitable for life.

1.4 DO: Increased from 9 to 19 mg/L. May be due to flow through open areas or aquatic plants producing oxygen.

1.5 Alkalinity: Increased to 80 mg/L at downstream, showing accumulation of bicarbonate/solutes.

1.6 Phosphate: Increased from 0.22 to 0.50 mg/L, reflecting contamination from household wastewater/detergents (risk of Eutrophication).

1.7 Nitrite: Increased from 0.2 to 0.5 mg/L, indicating organic decomposition and wastewater contamination.

1.8 Electrical Conductivity: High level (929–967 µS/cm), indicating high dissolved ions/salts, consistent with polluted community water.

2. Plant Treatment Experiment Results

- Umbrella Plants absorbed excess nutrients (Phosphate, Nitrite), reducing their values clearly.
- Roots/stems trapped sediment, reducing turbidity.
- Root respiration and microorganisms increased DO.
- Water became clearer; color and odor decreased.

3. Comparison of Treatment Efficiency Comparing before and after treatment:

- Turbidity decreased (Sedimentation).
- Phosphate and Nitrite decreased (Nutrient absorption).
- DO increased (Improved water condition).
- EC decreased slightly (Ion reduction).

In conclusion, the Umbrella Plant has high potential for treating community wastewater, especially in reducing turbidity and excess nutrients.

Chapter 5

Conclusion and Discussion

The study of the concrete canal water quality and the Umbrella Plant experiment found that the canal water deteriorates due to community impact. Turbidity, phosphate, nitrite, and EC were high, especially in midstream and downstream areas receiving household wastewater. Although pH was neutral, high turbidity and nutrients indicate unsafe water quality.

The Umbrella Plant treatment experiment showed it could improve water quality in multiple aspects. Roots trapped sediment (reducing turbidity), absorbed phosphate and nitrite (reducing rot causes), and hosted microorganisms that decomposed waste (increasing DO and reducing odor). These changes align with Constructed Wetland principles.

Comparing before and after treatment, turbidity decreased the most, followed by phosphate and nitrite. DO increased to suitable levels, and EC decreased slightly. Therefore, the Umbrella Plant is effective in treating concrete canal wastewater and can be practically applied in the community.

Overall, students saw the relationship between community wastewater problems and natural restoration methods alongside scientific measurement. This fostered analytical thinking, problem-solving, and STEAM integration for sustainable environmental restoration.

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