ASSESSING ENVIRONMENTAL FACTORS AND CARBON SEQUESTRATION POTENTIAL OF UTRICULARIA AUREA L. IN THALE NOI, PHATTHALUNG, THAILAND: IMPLICATIONS FOR CLIMATE CHANGE MITIGATION AND AQUATIC ECOSYSTEM SUSTAINABILITY

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ABSTRACT

This study investigates the environmental factors influencing the distribution and carbon sequestration potential of bladderwort (*Utricularia aurea* L.) in the Thale Noi Non-Hunting Area, Phatthalung Province, Thailand. The research involved field surveys and the collection of water, soil, and bladderwort samples from four study sites:

1. Ban Ok Canal – a waterway that carries community runoff into Thale Noi.
2. Central Thale Noi – the open-water region of the lake.
3. Primary bladderwort habitat – the area with the highest bladderwort density.
4. Khlong Nang Riam – a canal connecting Thale Noi to Songkhla Lake.

The study was conducted between December 2024 and January 2025, with latitude and longitude coordinates (7.7822574242, 100.121685161). Environmental factors affecting bladderwort propagation were analyzed, including water quality, soil composition, and light intensity.

The results indicated that bladderwort thrives in areas with high water transparency, a pH range of 7.48–8.53, and an average light intensity of 5,365–5,417 Lux. Soil quality was a key factor in its growth, with the species flourishing in clay loam mixed with silt sand, where soil fertility ranged from 603.6 to 682.7 µS/cm. However, bladderwort propagation declined in areas where water conductivity exceeded 150 µS/cm or where heavy metal contamination was present, particularly in Khlong Nang Riam.

Regarding carbon sequestration, bladderwort was found to absorb atmospheric carbon dioxide through photosynthesis and store carbon in its biomass. Areas with high bladderwort density exhibited greater carbon storage potential, whereas regions contaminated with heavy metals showed reduced sequestration capacity.

These findings suggest that temperature, water quality, and soil composition are critical factors influencing bladderwort propagation and carbon sequestration efficiency. Therefore, restoration efforts, such as reducing heavy metal contamination and conserving aquatic ecosystems, should be prioritized to support bladderwort growth. Enhancing bladderwort populations may contribute to carbon sequestration and the overall stability of freshwater ecosystems.

Keywords:

Utricularia aurea, propagation, heavy metal contamination, carbon sequestration, environmental factors, Thale Noi Non-Hunting Area

INTRODUCTION

Thailand is currently experiencing the effects of global warming, with an increase in greenhouse gas emissions leading to rising global temperatures. The southern region of Thailand, including Phatthalung Province, is characterized by a hot and humid climate, exacerbated by greenhouse gases trapping heat from the sun. This contributes to climate change, which has intensified at an unprecedented rate due to deforestation, industrial production, and energy generation.

The Thale Noi Non-Hunting Area in Phatthalung Province is a conservation zone with a diverse ecosystem that includes freshwater bodies, wetlands, and various plant species. It serves as a habitat for aquatic animals, water buffalo, and numerous bird species. The region consists primarily of lowlands near the lake, with rice fields, peat swamps, and grasslands. The dominant vegetation includes reeds, algae, bulrush, water lettuce, water hyacinth, and various lotus species.

One significant plant found in this conservation area is bladderwort (*Utricularia aurea* L.), an aquatic flowering plant that thrives in still freshwater environments such as ponds, swamps, and rice fields. Bladderwort plays a crucial role in enriching aquatic ecosystems and contributes to the local economy. Its vibrant flowers attract tourists, providing economic benefits to the community. The species produces both pink and yellow flowers, with the yellow variety blooming between April and May and the pink variety flowering from January to June.

Bladderwort is commonly found in Khlong Ban Khao and Khlong Rapho, where it grows abundantly under favorable conditions. It thrives in clean freshwater but struggles to survive in polluted environments. In 2024, a significant increase in water pollution was observed due to severe flooding, a consequence of global warming. This has led to a decline in bladderwort populations, making them harder to find and indicating a potential long-term reduction in their numbers.

Given this issue, the research team aims to investigate the environmental factors affecting the propagation and carbon sequestration capacity of bladderwort in the Thale Noi Non-Hunting

Area, Phatthalung Province. The goal is to identify strategies to enhance the distribution of this plant, which not only enriches aquatic ecosystems but also attracts tourists due to its striking flowers. Additionally, increasing bladderwort populations could expand carbon sequestration areas, thereby mitigating the effects of global warming.

RESEARCH QUESTIONS

1. What environmental factors influence the distribution of bladderwort (*Utricularia aurea* L.) in the Thale Noi Non-Hunting Area, Phatthalung Province?
2. Does bladderwort contribute to carbon sequestration in the Thale Noi Non-Hunting Area? If so, how?
3. How do heavy metal concentrations in Thale Noi's water affect the growth and distribution of bladderwort?

RESEARCH HYPOTHESIS

1. Environmental factors such as air temperature, water temperature, dissolved oxygen (DO), water pH, soil pH, soil type, and light penetration influence the distribution of bladderwort.
2. Bladderwort (*Utricularia aurea* L.) contributes to carbon sequestration.
3. Heavy metal concentrations in Thale Noi's water impact the growth and distribution of bladderwort.

SCOPE OF THE STUDY

This research focuses on the environmental factors that affect the distribution and carbon sequestration capacity of bladderwort in the Thale Noi Non-Hunting Area, located in Phanang Tung Subdistrict, Khuan Khanun District, Phatthalung Province. The study examines four specific locations with the following coordinates:

Latitude: 7.7822574242 **Longitude:** 100.121685161

The study locations include:

1. **Ban Ok Canal** – The mouth of the canal where water from the community flows into Thale Noi.
2. **Central Thale Noi** – A central region of the lake where bladderwort is commonly found.

3. **Bladderwort Habitat** – A specific site known for a high concentration of bladderwort.

4. **Nang Riam Canal** – A canal connecting Thale Noi to Songkhla Lake.

The study was conducted from December 2024 to January 2025.

Study Locations

1. **Thale Noi Non-Hunting Area**, Phanang Tung Subdistrict, Khuan Khanun District, Phatthalung Province.

2. **Paphayompittayakom School**, Ban Phrao Subdistrict, Pa Phayom District, Phatthalung Province.

MATERIALS AND EQUIPMENT

Materials and Equipment for Sample Collection

For the collection of water and *Utricularia aurea* (bladderwort) samples in the Thale Noi Non-Hunting Area, Khuan Khanun District, Phatthalung Province, the following materials and equipment were used:

1. Plastic bottles
2. Gloves
3. pH meter
4. Wet and dry bulb thermometer
5. Secchi disk
6. Light intensity meter
7. Paper clips
8. Measuring tape
9. Mobile phone
10. Pen
11. Notebook
12. Permanent marker

Materials and Equipment for Water Quality Testing

The following materials and equipment were used to assess water quality in areas where *Utricularia aurea* is found in the Thale Noi Non-Hunting Area:

1. Beaker
2. Water quality test kit
3. Ammonia test kit
4. Dissolved oxygen (DO) test kit
5. Measuring cylinder
6. Petri dish
7. Dropper
8. Nitrate test kit
9. Forceps

10. Rubber gloves
11. Watch glass
12. NPK soil test kit
13. CO_2 carbon sequestration measurement device (Digital Professional Instruments)

RESEARCH METHODS

Method 1: Investigating Environmental Factors Influencing the Distribution and Carbon Sequestration of *Utricularia aurea*

1. Conduct a literature review on the distribution and carbon sequestration capacity of *Utricularia aurea* in the Thale Noi Non-Hunting Area.
2. Develop a research plan and establish guidelines for field surveys to investigate environmental factors affecting the distribution and carbon sequestration of *Utricularia aurea*.
3. Define the study area within the Thale Noi Non-Hunting Area, Phatthalung Province.
4. Divide the study area into four sampling locations:
    - Ban Ok Canal (water inflow from the community)
    - Central Thale Noi
    - Bladderwort habitat
    - Nang Riam Canal (connecting Thale Noi to Songkhla Lake)
5. Collect water and soil samples using standardized collection methods, such as:
    - Storing water samples in bottles
    - Storing soil samples in labeled bags
6. Collect *Utricularia aurea* samples and store them in jars for further analysis.
7. Identify sample collection points and record environmental conditions, including temperature, relative humidity, and carbon sequestration capacity.
8. Measure water quality parameters such as pH, total dissolved solids (TDS), electrical conductivity (EC), and dissolved oxygen (DO).
9. Conduct laboratory analyses and record results for water, soil, and *Utricularia aurea* samples.
10. Summarize the findings and analyze the environmental factors affecting the distribution and carbon sequestration of *Utricularia aurea* in the Thale Noi Non-Hunting Area.

Method 2: Collection and Analysis of Water and *Utricularia aurea* Samples

1. Collect water samples from three different points: upper, middle, and lower sections of the wildlife sanctuary. Store them in sealed bottles for further analysis.

2. Collect *Utricularia aurea* samples from identified habitats and store them in jars.

3. Measure air temperature and relative humidity using a wet and dry bulb thermometer.

4. Determine light intensity using a light intensity meter and assess water transparency using a Secchi disk, with a paper clip fixed at the water's surface for depth measurement.

5. Measure water temperature using a wet and dry bulb thermometer and determine pH levels using a pH meter.

6. Assess water quality by measuring:

- TDS, EC, and salinity using a pH meter
- DO levels using a DO test kit
- Water hardness and alkalinity
- Nitrate and ammonia concentrations using respective test kits
- Heavy metal concentrations using a water quality test kit and comparing results with standard reference charts

7. Measure carbon sequestration using a CO_2 gas detector.

8. Record and analyze all collected data.

Carbon Sequestration in *Utricularia aurea*

The calculation of carbon sequestration in aquatic plants, such as *Utricularia aurea*, involves assessing biomass and the amount of carbon stored in plant tissues. The following steps were used to estimate carbon sequestration capacity:

1. Biomass Measurement

Biomass refers to the dry weight of the plant that can be harvested. The biomass of *Utricularia aurea* was determined using the following method:

- Collect plant samples from the study area.
- Dry the samples by placing *Utricularia aurea* specimens (each approximately 1 meter in length) in an oven at 60–70°C until they reach a constant weight.
- Weigh the dried samples to determine biomass (in grams).

2. Carbon Content Calculation

Aquatic plants typically contain 40–50% carbon by dry weight. The amount of carbon sequestered can be calculated using the formula:

Carbon content (C) = Dry biomass (g) × Carbon proportion in biomass

Carbon content = 5.12 g × 0.45 = 2.304 g

3. Carbon Sequestration per Unit Area

To estimate carbon sequestration in a larger area, the study assumed 4,000 square meter sample site. Given that approximately 80–100 bladderwort plants are found per square meter, an average of 90 plants per square meter was used for calculations:

Carbon sequestered per square meter = 2.304×90=207.36 g

For the entire study area (4,000 square meter):

Total carbon sequestered = 207.36 × 4,000

= 829,440 g

= 829.44 kg

4. Impact of Environmental Changes

From fieldwork conducted in January 2025, it was observed that the *Utricularia aurea* habitat had decreased significantly following the severe flooding in southern Thailand in 2024. This reduction in habitat area could negatively affect the plant's capacity to sequester carbon in the long term. Further research is needed to evaluate the extent of this impact.

RESEARCH FINDING

1. Study of Environmental Factors in the Thale Noi Non-Hunting Area

Table 1: Air Temperature, Light Intensity, and Relative Humidity

Study Site	Air Temperature (°C)	Light Intensity (Lux)	Relative Humidity (%)
Ban Ok Canal	29.7	5027.3	72.3
Middle of the Sea	28.4	5417.3	77.0
Bladderwort Habitat	29.7	5365.0	76.6
Nang Riam Canal	29.4	5250.3	77.3

From Table 1, the environmental factors in the Thale Noi Non-Hunting Area were measured at four locations: Ban Ok Canal, Middle of the Sea, Bladderwort (*Utricularia aurea*) Habitat, and Nang Riam Canal. The average air temperature across these locations ranged from 28.4°C to 29.7°C, while light intensity varied between 5027.3 and 5417.3 Lux. Relative humidity values ranged from 72.3% to 77.3%.

Table 2: Soil Temperature, Soil Fertility, and Soil pH

Study Site	Soil Temperature (°C)	Soil Fertility (µS/cm)	Soil pH
Ban Ok Canal	29.9	626.0	5.16
Middle of the Sea	30.2	603.6	3.83
Bladderwort Habitat	29.3	682.7	5.16
Nang Riam Canal	29.6	787.3	3.50

Table 2 presents soil temperature, fertility, and pH values. The average soil temperature ranged from 29.3°C to 30.2°C, while soil fertility varied between 603.6 and 787.3 µS/cm. The pH values showed notable variation, with Ban Ok Canal and the Bladderwort Habitat having a moderate pH (5.16), while Middle of the Sea and Nang Riam Canal had more acidic soils (3.83 and 3.50, respectively).

Table 3: Water Quality Parameters

Study Site	Water Temperature (°C)	DO (ppm)	Water pH	Transparency (cm)	EC (µS/cm)	TDS (ppm)
Ban Ok Canal	28.3	0.5	8.53	47.3	118.33	56.66
Middle of the Sea	28.1	1.0	8.12	88.3	57.66	28.00
Bladderwort Habitat	26.7	1.7	7.64	67.3	86.00	42.66
Nang Riam Canal	26.7	1.0	7.48	53.6	158.66	73.33

Table 3 provides data on water quality parameters, including temperature, dissolved oxygen (DO), pH, transparency, electrical conductivity (EC), and total dissolved solids (TDS). The average water temperatures ranged from 26.7°C to 28.3°C, while DO levels were lowest at Ban Ok Canal (0.5 ppm) and highest at the Bladderwort Habitat (1.7 ppm). The highest water transparency was recorded at Middle of the Sea (88.3 cm), whereas Nang Riam Canal exhibited the highest EC (158.66 µS/cm), indicating a high concentration of ions and potential heavy metal contamination.

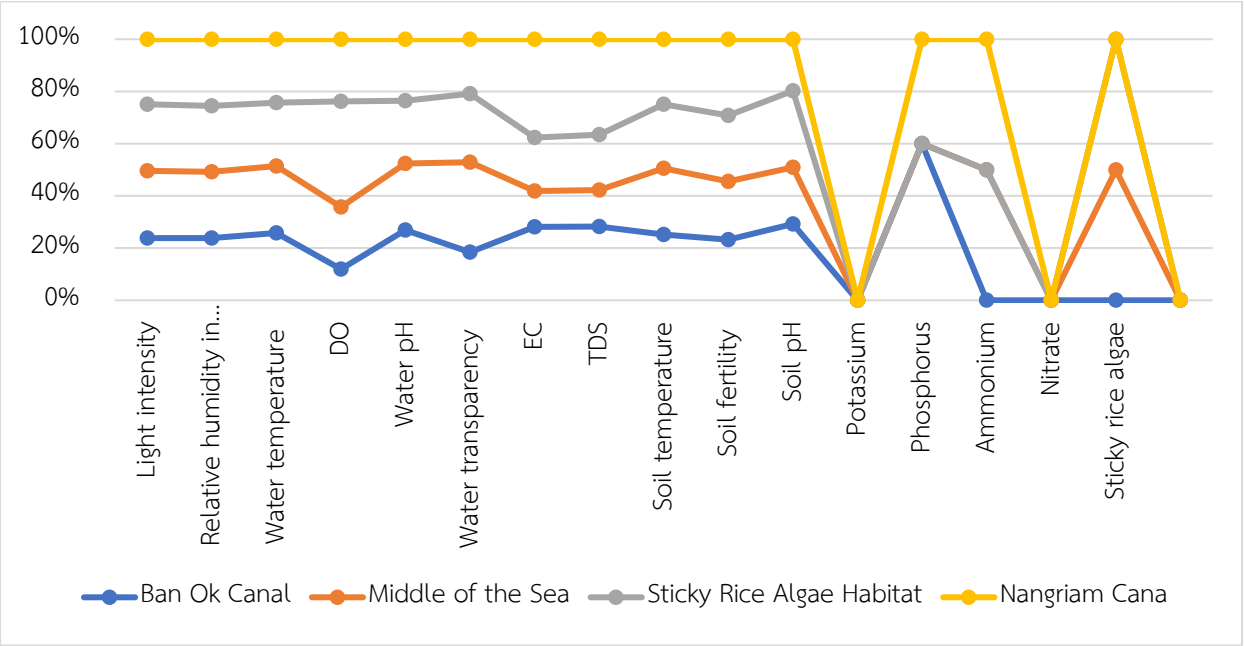
Table 4: Soil Characteristics and Nutrient Content

Study Site	Soil Type	Potassium	Phosphorus	Ammonium	Nitrate	Soil Color Shade
Ban Ok Canal	Loamy sand	Low	Very high	Low	Not available	10YR 2/1
Middle of the Sea	Clay loam with sandy texture	Low	Low	Very low	Not available	N 2.5/2
Bladderwort Habitat	Clay loam with sandy texture	Low	Low	Low	Not available	5Y 2.5/2
Nang Riam Canal	Clay loam with sandy texture	Low	High	Very low	Not available	2.5Y 3/2

From Table 4, it was found that all study sites had low potassium levels. Ban Ok Canal had very high phosphorus levels, while Nang Riam Canal exhibited high phosphorus content. Soil characteristics varied slightly, with most sites consisting of clay loam with a sandy texture.

2. Relationship Between Environmental Factors and the Spread of *Utricularia aurea*

The chart below illustrates the relationship between environmental conditions and *Utricularia aurea* distribution in the Thale Noi Non-Hunting Area.



It was observed that *Utricularia aurea* was found primarily in the middle of the lake, an area with moderate environmental conditions. This location, positioned between Ban Ok Canal (upstream) and Nang Riam Canal (downstream), had optimal light intensity and water transparency, which are crucial factors for the growth of aquatic plants.

3. Carbon Sequestration in *Utricularia aurea*

Table 5 shows the dry weight of sticky rice algae to measure the biomass quantity.

Trial	Dry Weight per 10 Plants (g)	Dry Weight per Plant (g)
1	528	5.28
2	495	4.95
3	513	5.13
Average	512	5.12

From Table 5, the average dry biomass per plant was found to be **5.12 g**.

3.1 Carbon Calculation in Biomass

Carbon (C) = Dry biomass (g) x Carbon ratio in biomass

= 5.12 x 0.45*

= 2.304 g

Note: Aquatic plants typically contain 40–50% carbon by dry weight; the calculation assumes a 45% carbon content.

3.2 Carbon Sequestration per Area

Considering a study area of 4,000 m² and an estimated 90 bladderwort plants per square meter:

Carbon sequestered per square meter = 2.304 × 90 = 207.36 g

Total carbon sequestration = 207.36 x 4,000

= 829,440 g

= 829.44 kg

In conclusion, as of January 2025, bladderwort populations covering approximately 4,000 m² sequestered an estimated **829.44 kg of carbon**.

SUMMARY AND DISCUSSION

1. Environmental Factors and *Utricularia aurea* Distribution

- *Utricularia aurea* thrived in areas with moderate water transparency (67.3–88.3 cm) and light intensity (5,365–5,417 Lux).

- he highest water pH (8.53) was recorded at Ban Ok Canal, while the lowest (7.48) was at Nang Riam Canal.

- Areas with high electrical conductivity (EC), such as Nang Riam Canal (158.66 µS/cm), likely contained heavy metal contamination, limiting plant growth.

2. Carbon Sequestration Potential

- *Utricularia aurea* exhibited a high capacity for carbon sequestration, with a total estimated absorption of 829.44 kg of carbon in 4,000 m^2.

- The results align with prior studies (Jirarat Phontewabhuncha, 2022), which found that bladderwort can spread over 500 rai, demonstrating significant potential for mitigating climate change.

This study suggests that *Utricularia aurea* plays a crucial role in both aquatic ecosystem health and carbon sequestration, making conservation efforts essential for sustainable environmental management.

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Appendix: Images of Data Collection

Badges

I am an Earth System Scientist

This research effectively demonstrates the **interconnectedness of Earth's systems** by investigating how environmental factors—such as **water quality, soil composition, and light intensity**—influence the distribution and carbon sequestration potential of *Utricularia aurea*. The study applies **scientific methodologies**, including data collection and analysis of air, water, and soil parameters, to understand how these factors interact.

By analyzing how heavy metal contamination affects plant propagation and carbon sequestration, the research showcases the **dynamic and interdependent nature of Earth's spheres** (biosphere, hydrosphere, pedosphere, and atmosphere). This aligns perfectly with the **Earth System Science approach** promoted by GLOBE.

 **Why it deserves this badge:**

- ☑ Demonstrates a strong understanding of Earth's interconnected systems
- ☑ Uses multiple GLOBE protocols to collect and analyze environmental data
- ☑ Provides insights into climate-related processes through real-world data

I make an Impact

This research is not just about understanding environmental changes—it **connects local issues to global challenges** and proposes real-world solutions. The findings highlight how **heavy metal contamination, water transparency, and soil fertility** impact bladderwort's ability to absorb carbon dioxide, directly linking the research to **climate change mitigation**.

The study also emphasizes **environmental conservation** by recommending actions such as **restoring water sources, reducing pollution, and protecting aquatic ecosystems**. These recommendations can benefit both **local communities and global climate efforts** by enhancing freshwater biodiversity and carbon sequestration potential.

🌍 **Why it deserves this badge:**

✅ Addresses a **real-world environmental issue** with global relevance

✅ Proposes practical solutions to improve freshwater ecosystems

✅ Highlights the role of bladderwort in **carbon sequestration and climate action**

I am a Data Scientist

This research is deeply rooted in **data-driven analysis**, utilizing both **field-collected and GLOBE data** to examine the relationship between environmental conditions and bladderwort distribution. The study applies **quantitative methods** to analyze key variables, including **pH levels, water transparency, conductivity, and soil fertility**, and provides **statistical insights** into their impact on plant growth and carbon sequestration.

Additionally, the research acknowledges **data limitations**, ensuring a scientifically sound interpretation of the findings. By integrating **real-time environmental data with predictive insights**, this study embodies the **scientific inquiry and analytical skills** essential for a **Data Scientist**.

📊 **Why it deserves this badge:**

✅ Conducts **comprehensive data collection and analysis**

✅ Uses **quantitative approaches** to evaluate environmental trends

✅ Identifies **patterns and correlations** in bladderwort growth and carbon sequestration