Water Properties and Mosquito Breeding Sites: A Student-Led Study of Container Habitats in Walailak University

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Abstract

Mosquitoes are bugs that can make people very sick. They lay their eggs in still water that collects in things like buckets, pots, and puddles around our homes. In this project, we wanted to find out which containers in our community have the most mosquito babies (called larvae). We went around, checked different containers, and measured the water's temperature and pH. We found that plastic containers and buckets often had the most mosquito larvae. Using what we learned, we made a simple "Mosquito-Free Home Guide" to teach our neighbors how to empty, cover, or clean up these containers to stop mosquitoes from breeding. This helps keep our community safer from diseases.

Keywords: Mosquito surveillance, larval habitat, citizen science, GLOBE Observer, *Aedes aegypti*, *Armegeres* spp., Breeding sites, disease risk, vector control, Thailand

1. Introduction

Mosquitoes remain globally significant vectors of numerous debilitating and life-threatening pathogens, including viruses responsible for Dengue Fever, Zika, and Chikungunya, and parasites that cause Malaria, thereby posing a continual threat to human health security and economic stability, particularly in tropical and subtropical regions (Ryan et al., 2020; WHO, 2021). The escalating challenges presented by these vector-borne diseases are inextricably linked to the successful propagation and dispersal of their mosquito vectors. Effective disease prevention and control strategies critically depend on thorough vector surveillance, which is most efficiently targeted at the larval stage the immobile, aquatic phase of the mosquito life cycle, as its characteristics and habitat specificity provide a crucial window for intervention (Clements, 2017).

In urban and peri-urban residential areas, such as the Walailak housing area, the proliferation of artificial containers creates abundant potential breeding habitats. These artificial breeding sites (ABS), which include water storage containers, plant pots, buckets, and discarded refuse, predominantly favour container-breeding species such as Aedes aegypti and Aedes albopictus, the primary vectors of Dengue and Zika viruses (Powell & Tabachnick, 2021). The specific conditions within these containers, including water quality parameters such as pH and temperature, are critical yet understudied factors that influence mosquito oviposition preference and larval development (Midega et al., 2022). A significant gap in local disease risk assessment is the absence of systematic, community-level data linking specific container types and their physicochemical water properties to the presence of mosquito larvae.

This study leverages the citizen science framework of the GLOBE Observer: Mosquito Habitat Mapper to conduct a high-resolution analysis of mosquito breeding patterns in selected fishing communities (GLOBE Program, 2023). Citizen science initiatives provide a reliable and scalable means of augmenting national surveillance systems by engaging students and local communities to collect real-time, widespread data (Bonney et al., 2016; Palmer et al., 2017). By integrating larval surveillance data identified using standard taxonomic keys (Rattanarithikul et al., 2005) with advanced entomological metrics, this research aims to: (1) measure and record the pH, temperature, and type of water containers around the Walailak University area to see which conditions are linked to more mosquito larvae and (2)To create and share a simple community guide on how to manage different container types (like buckets, pots, and tanks) based on our water quality findings, to help reduce mosquito breeding at home.

2. Materials and methods

2.1 Study site

In this study, we conducted a mosquito larval survey during 17-21 January 2026 at Walailak University, Nakhon Si Thammarat Province, southern Thailand (8.6538° North, 99.9017° East). Nakhon Si Thammarat Province has three seasons: summer (mid-February to mid-May), rainy season (mid-May to mid-October), and winter (mid-October to mid-February).

Map of Thailand (a) | Map of Nakhon Si Thammarat (b) | Map of Walailak University (c)

Figure 1. (a) Map of Thailand, (b) Map of Nakhon Si Thammarati, and (c) Map of Walailak University

2.2 Sampling of mosquito larvae.

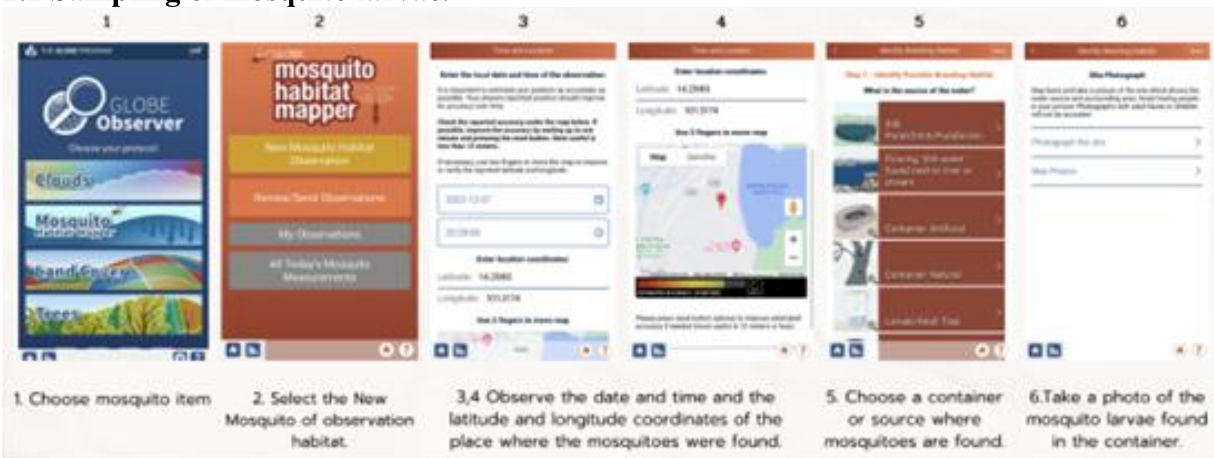

Figure 2. GLOBE Observer: MHM App

2.2.1 Survey the Walailak University area, then collect samples of larvae and larval predators for classification.

2.2.2 Inspect every container, both with and without water. Measure the pH and temperature of the water in the container.

2.2.3 Measure the amount of water in the container and check whether it has a lid.

2.2.4 Scoop up and put living things, including mosquito larvae and predators, into plastic bags.

2.2.5 Use the MHM app to find the latitude and longitude coordinates of the area where mosquito larvae were found and save the information in the GO MHM app (Figure 2).

2.2.6 The captured organisms were returned to be classified as species and recorded.

2.3 Data collection

For this study, data were collected through field observations conducted by students from Walailak University in Nakhon Si Thammarat, Thailand. Students collected data on mosquito larvae and on environmental factors such as water temperature and pH, and identified mosquito species. The field surveys were conducted in multiple outdoor containers across the campus and surrounding areas, ensuring that the data captured a range of ecological conditions. The data were then analyzed to classify different mosquito species and determine the water conditions in the local region. We used the GLOBE Observer: MHM app to determine the latitude and longitude coordinates of the locations where mosquito larvae were found.

2.4 Entomological studies

This study integrates mosquito larval data collected directly from the Walailak University area. Larval collection followed a standardized protocol: smaller containers were emptied and filtered, whereas larger containers were sampled with nets to ensure comprehensive coverage (Indriyani et al., 2024). Collected larvae were preserved and identified as species using Rattanarithikul and Panthusiri's keys. Early instar larvae and pupae were excluded due to identification challenges. The study included 360 container categories. Plastic water containers were further divided into two groups: large (>100 L) plastic water containers for water storage and plastic bottles (0.5–2.0 L). Earthen jars were also classified into two categories: small earthen jars with a volume ≤ 100 L and large earthen jars with a volume > 100 L. The GLOBE data, which provide broader spatial coverage, were used to analyze mosquito species distributions, breeding-site preferences, and container indices across various Asian countries. Combining these datasets allowed a more comprehensive understanding of mosquito ecology and the factors influencing their regional populations.

2.5 Statistical analysis

We analyzed our data using Google Sheets. First, we sorted the containers we checked into groups based on their pH and temperature readings in the spreadsheet, calculated the averages for each container type, plotted the graphs, and used simple formulas to calculate the percentage of containers in each group that had mosquito larvae, helping us see which water conditions mosquitoes preferred. Next, we used the sheets to list all container types and to calculate their relative frequencies and the proportions that contained larvae under the measured conditions. This helped us identify the most important containers to include in our community guide. Using these programs facilitated calculations and graphing, enabling us to translate our measurements into clear guidance for managing containers and reducing mosquito breeding at home (Horstick et al., 2010).

3. Results

3.1 Species diversity in the Walailak University Area

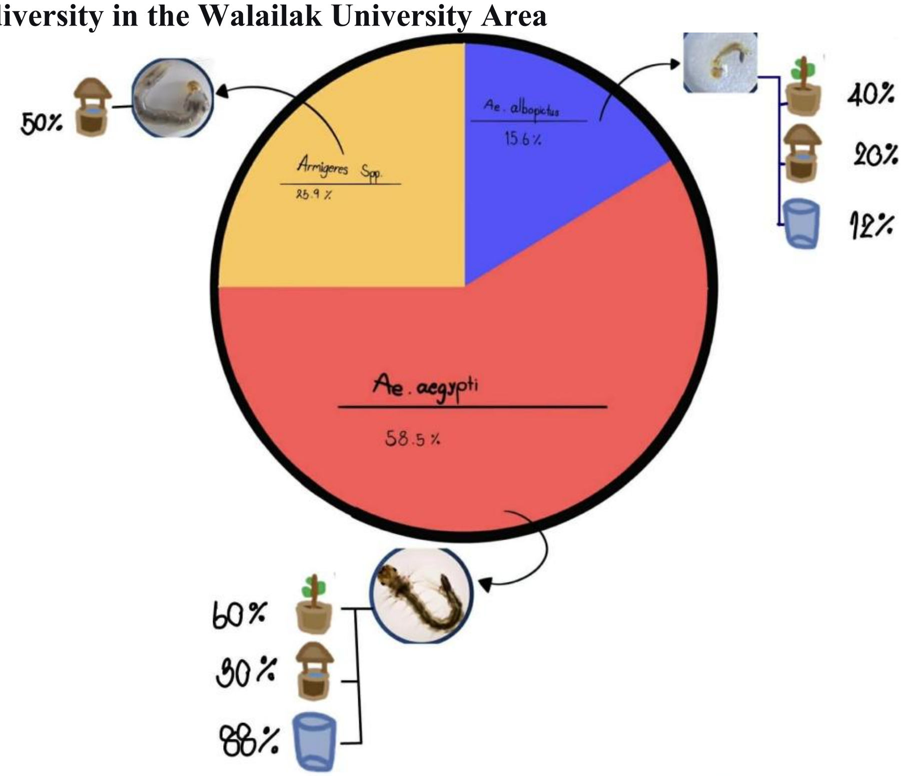

Figure 3. Mosquito diversity

The species composition data reveal a clear dominance hierarchy within the sampled mosquito population, with *Aedes aegypti* constituting the majority of specimens (58..50%), followed by *Aedes albopictus* (23.9%), and a small proportion of *Armigeres* spp. (15.6%). This distribution indicates that, *Ae.aegypti* is the most prevalent and likely the primary container-breeding vector in this habitat. Combined with the earlier finding of a significant preference for artificial containers, its numerical dominance underscores it as the key target for source-reduction campaigns, while the notable presence of *Ae. Aedes aegypti* denotes a secondary but essential vector risk that requires concurrent management.

3.2 Water quality of the Breeding sites in Walailak Areas

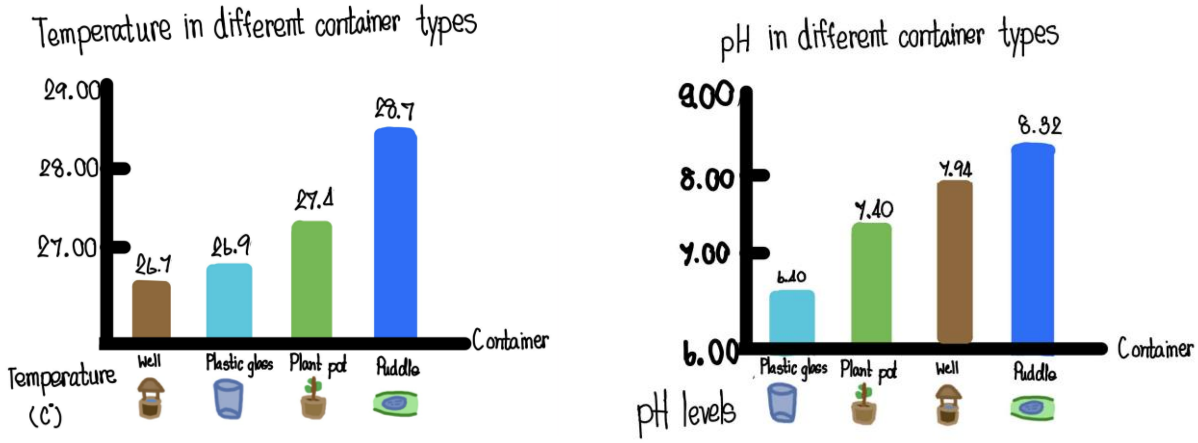

Figure 4: Water Quality in the Area (a) Temperature (b) pH

The data is organized into two clear tables, allowing for direct comparison across the sample types: Well, Plastic Glass, Plant Peat, and Puddle.

1. Temperature Analysis(ºC):

   The temperature readings reveal a transparent thermal gradient among the sample types. The Puddle sample exhibited the highest recorded temperature at 28.7°C. This is logically consistent with its nature as a shallow, stagnant surface water body exposed to direct solar radiation and with its low thermal mass, which allows rapid heating. The Well water recorded the second-highest temperature at 27.7°C. Subsurface water typically exhibits greater thermal stability than surface water; this elevated temperature suggests that the healthy water may be influenced by surface heating or that the aquifer is relatively shallow and subject to diurnal temperature fluctuations. The Plant Peat sample measured 27.4°C. As an organic, porous medium that holds water, peat likely provides some insulation but may also foster microbial activity that could generate slight heat, resulting in a temperature midway between the contained plastic glass and the natural water bodies. The Plastic Glass sample registered the lowest temperature at 26.9°C. This sample, presumably a controlled container of collected water, likely experienced the least direct environmental heating and potentially some evaporative cooling, representing a baseline or sheltered condition compared to the environmental exposures of the other samples.

2. pH Analysis:

   The pH values show a marked range from slightly acidic to moderately alkaline, indicating differences in the chemical environments of the water samples. The most acidic condition was found in the Plastic Glass (pH 6.40). This slight acidity could result from the dissolution of atmospheric carbon dioxide into the standing water, a lack of buffering minerals, or potential leaching of organic acids from the plastic container itself. The Plant Peat sample had a near-neutral pH of 7.40. Peat is known for its organic acidity, but it also contains decomposed plant matter that can release compounds with buffering capacity, potentially stabilizing the pH close to neutral. The Well water was slightly alkaline, with a pH of 7.90. This mild alkalinity is common in groundwater, often resulting from the dissolution of mineral carbonates (e.g., calcium carbonate) from surrounding rocks and soil as the water percolates through the substrate. The most alkaline sample was the Puddle, with a pH of 8.32. This elevated pH could be attributed to several factors: evaporation concentrating dissolved alkaline minerals, photosynthetic activity of algae or microorganisms consuming carbon dioxide and thus raising the pH, or contact with alkaline soil or concrete surfaces.

3.4 Guide to Mosquito-Free Home

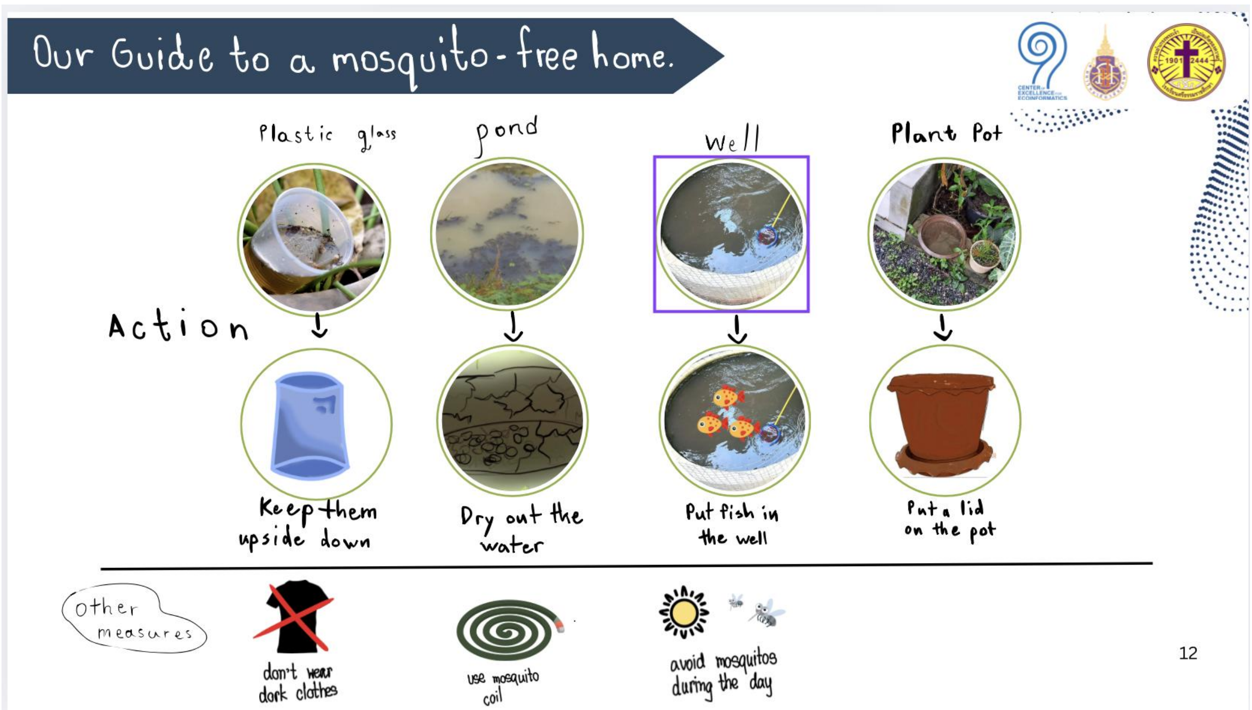

Figure 5. Guide for Mosquito-Free Home

Here is the enhanced description of your community guide, written in clear paragraphs.

Based on our scientific observations, we developed a straightforward community resource titled "The Mosquito-Free Home Guide." This guide translates our findings into practical, actionable steps that households can take to eliminate mosquito breeding sites on their property.

The core of the guide focuses on managing the different types of water-holding containers we identified as risks. For small, disposable items like plastic cups and buckets, the advice is simple: store them upside down or dispose of them properly to prevent water accumulation. For larger, permanent fixtures like ponds or unused fountains, we recommend covering them with tight lids, draining them whenever possible, or filling them with soil. A key suggestion for permanent water sources, such as wells, is the introduction of natural predators, specifically mosquito fish (Gambusia), which consume larvae and provide sustainable biological control. For everyday household items like plant pots, the guide emphasizes keeping saucers dry and ensuring any water storage pots are securely covered.

In addition to these environmental management strategies, the guide includes essential personal protection measures to prevent bites and reduce the risk of disease transmission. It advises community members to wear protective clothing such as long sleeves and pants, apply mosquito repellent, and be particularly cautious during peak biting hours for the prevalent Aedes mosquitoes, which are active during the day. By combining targeted container management with these daily personal habits, our guide aims to empower the community to significantly reduce both mosquito populations and the risk of associated diseases.

4. Discussion

4.1 Dominance of *Aedes aegypti* and Implications for Vector Control

The pronounced dominance of *Aedes aegypti* (58.50%) establishes it as the principal container-breeding mosquito and the likely primary arboviral vector in this habitat. This finding aligns with its well-documented steno tropic nature—a strong preference for human-dominated environments and artificial water-holding containers (Kraemer et al., 2019). The significant secondary presence of *Aedes albopictus* (23.9%) indicates a sympatric population of a secondary vector, a common pattern in Southeast Asian urban and peri-urban landscapes (Lwande et al., 2020). This co-circulation amplifies the local risk for simultaneous transmission of dengue, chikungunya, and Zika viruses. The numerical supremacy of *Ae. aegypti*, directly linked to our finding of its significant preference for artificial containers, unequivocally identifies it as the key target for any source reduction campaign. Effective control must prioritize the removal or management of these man-made habitats to disrupt its lifecycle at the most vulnerable larval stage.

4.2 Breeding Site Water Quality as a Facilitator of Proliferation

The physicochemical analysis of breeding site water reveals conditions highly permissive for *Aedes* larval development. The recorded temperature range (26.90–28.77°C) across all samples falls within the optimal thermal range for *Ae. aegypti*, which maximizes population growth rates between 26°C and 30°C (Mordecai et al., 2019). The elevated temperature in exposed habitats like puddles may accelerate larval metabolism, potentially shortening generation time. Furthermore, the wide pH tolerance observed (6.40 to 8.32) underscores the ecological plasticity of these vectors. While extremes can be lethal, *Ae. aegypti* thrives across a broad spectrum, with the microbial food web within containers being more critical than specific pH (Reiskind & Lounibos, 2013). The alkaline conditions in sites like puddles may be driven by evaporation and photosynthetic activity of microalgae, which also contribute to larval nutrition (Vittor et al., 2009). These data collectively indicate that the *availability* of containers, rather than specific water parameters within them, is the primary driver of vector productivity in this setting. This makes physical habitat modification the most robust control strategy.

4.3 Translation of Evidence into Community Action: The IVM Guide

In direct response to these ecological findings, the development of the "Mosquito-Free Home Guide" represents the critical translation of evidence into a practical Integrated Vector Management (IVM) tool. IVM advocates for locally adapted, evidence-based, and sustainable strategies (WHO, 2012). The guide's core recommendations—targeted container management, biological control in wells using larvivorous fish (*Gambusia spp.*), and personal protection measures—are direct applications of our study's conclusions. Focusing on container management disrupts the lifecycle of the dominant *Ae. aegypti*, while the inclusion of biological control offers a sustainable solution for permanent water features, aligning with WHO recommendations (WHO, 2020). Incorporating personal protection (e.g., repellents, clothing) addresses the day-biting behavior of *Aedes* mosquitoes, a factor source reduction alone cannot mitigate. This multi-modal approach is essential for reducing both vector density and human-vector contact, thereby lowering disease transmission risk.

4.4 Study Limitations and Future Directions

While this study provides a strong snapshot of the local vector ecology, certain limitations must be acknowledged. The cross-sectional design captures data from a specific period; seasonal variations in mosquito diversity, abundance, and breeding site productivity are likely and were not assessed. Future longitudinal studies are needed to understand these dynamics. Furthermore, the efficacy of the developed guide, while grounded in strong evidence, requires empirical validation through community-based implementation and monitoring. Success depends on sustained community engagement, education, and motivation—factors known to be critical yet challenging in vector control programs (Heintze et al., 2007). Future work should involve implementing the guide as a formal intervention, paired with entomological monitoring (e.g., House Index, Container Index) to quantitatively measure its impact on reducing larval habitats and, ultimately, adult vector populations.

4.5 Conclusion

In conclusion, the Walailak University area presents an environment highly conducive to the proliferation of the primary arboviral vector *Ae. aegypti*, driven by an abundance of artificial containers. The water quality in these containers is broadly suitable for larval development, making their physical removal or management the most effective control point. The "Mosquito-Free Home Guide" synthesizes these insights into a actionable framework for community-based IVM. For sustained public health impact, this guide should be integrated into a broader, ongoing vector control program that includes community mobilization, routine monitoring, and institutional support to mitigate the persistent threat of mosquito-borne diseases effectively.

I would like to claim IVSS badges

I make an impact

The document explicitly outlines the link between a community concern and the research inquiries, establishing connections between local and global repercussions. The students must depict how their research has positively influenced their community by providing recommendations or implementing actions derived from their findings. Exploring the ecology of mosquito larvae offers insights that can be utilized to safeguard the community against disease transmission via animal vectors, achieved by modifying or minimizing the use of specific container materials.

I am a collaborator.

All research team members are listed, including collaborators from other organizations, along with clearly defined roles, how these roles support one another, and descriptions of each researcher's contribution. If the researchers collaborated with others outside of their organization, describe how the collaboration improved the research.

I am a problem solver.

While working on environmental investigations, researchers may learn how they can be part of possible solutions to the problems they are investigating. This badge will be awarded to projects that demonstrate how GLOBE researchers are using Earth system science for a better world.

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