Mosquito Key Breeding Sites at the Pasak Jolasid Dam in Saraburi Province, Thailand

Students (Grade 18): Chanapat Kanjanasuk, Dechathorn Borisuth, Kantaworrawat Duangboon, Kanyapat Yaijui, Kanyavee Yaijui, Kulrapat Sriin, Nannapat Tirapairojana, Napath Krinara, Nantiwat Dabbaransi, Nittiya Chaosukum, Pichamol Kongchom,
Phenphitcha Burakhon, Phatcharapa Phetkhum, Praeploy Khoonsawad, Pirinya Wongvisit, Piriyaporn Puckdeepolgate, Suchanya Naksiri, Varatchaya Thongdee
School: Chonprathanwittaya School
Teacher: Dr. Nittaya Theparunrat, Kaset bubphapasom, Maneerat Moonsaeng, Kreangsak Dujjanuthas
Scientists: Assoc.Prof.Dr.Krisanadej Jaorensutasinee, Assoc.Prof.Dr. Mullica Jaroensutasinee, Dr. Wacharapong Srisang, Miss Thunwarut Sutthipun, and Miss Chacha Sattharat, Center of Excellence for Ecoinformatics, School of Science, Walailak University.
Email: Nayatoix@gmail.com, Maymaneeratmin@ gmail.com, bosskreangsak@gmail.com

Abstract

This study examines the relationship between container types and the abundance of mosquito larvae, emphasizing the influence of material and container characteristics on breeding patterns. The spatial analysis revealed distinct preferences for container types across surveyed areas, with earthen containers predominating within a 1 km radius and plastic containers being more significant in the Supatta Resort and Pa Sak Jolasid Dam areas. Larval indices highlighted a heightened risk of dengue transmission, providing vital data for public health planning and mosquito control strategies. Practical recommendations include promoting specific container usage, encouraging lid implementation, and incorporating environmental factors into intervention strategies. While acknowledging limitations such as regional focus and exclusion of certain larval stages, the study advocates for expanded research across different regions and ecological contexts. These findings offer valuable insights for mitigating mosquito-borne diseases.

Keywords: GLOBE Observer: MHM App, Mosquito, Thailand, Container

1. Introduction

Mosquitoes are one of the insects that are important to human ecology and health because of their essential role as vectors of various diseases such as malaria, dengue fever, Zika fever, and hepatitis, which have severe impacts on populations in many areas around the world, especially in tropical and temperate regions such as Southeast Asia, including Thailand, where mosquito-borne diseases are common in many places. Therefore, studying the types and distribution of mosquitoes is essential in controlling the spread of diseases and managing areas that may be mosquito breeding grounds. The

Pasak Jolasid Dam is located in Saraburi Province. It is a large dam essential in providing water for agriculture, consumption, and electricity generation. In addition, the environment is diverse in terms of water sources and natural ecosystems, making the Pasak Jolasid Dam area a habitat for aquatic animals and various organisms, including mosquitoes, which can be found in multiple types of stagnant water sources, such as peat swamp forests, grasslands, near the coast, and agricultural areas. The dense concentration of stagnant water and farming areas in this area results in a high chance for mosquitoes to grow and reproduce, which increases the risk of diseases that mosquitoes carry.

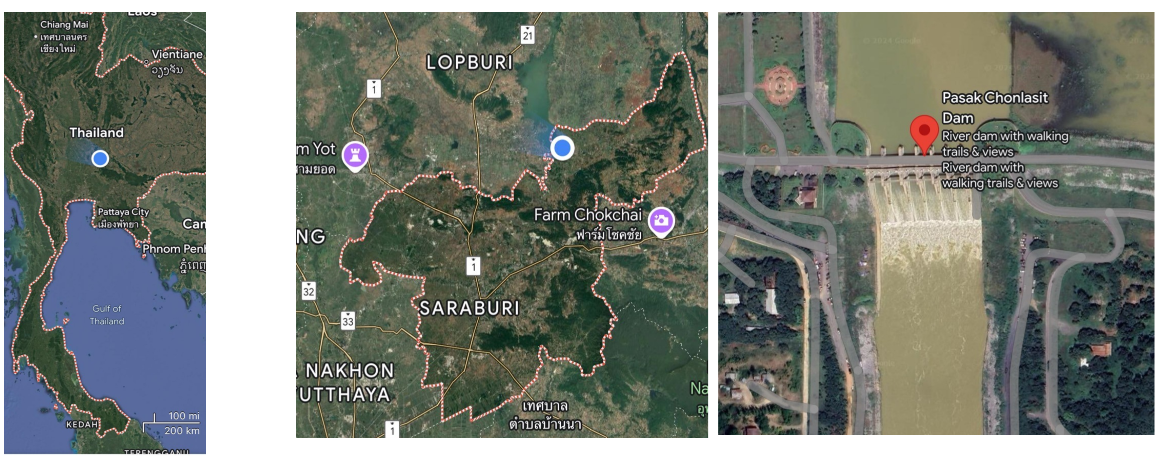
Thailand is one of many countries that have a dengue fever problem. The outbreak has been going on for more than 50 years with a higher morbidity rate than the average for the past 13 years (1997 to 2009). It was found that the central region has a higher dengue fever rate than other regions of Thailand. 2020 the central region had the highest sickness rate, 18.06 per 100,000 people. The Central Region has 4,052 cases and a case fatality rate of 0.10 percent, data from the Disease Surveillance Reporting System 506, Epidemiology Division, Department of Disease Control, as of April 28, 2020. From epidemiological disease surveillance data in 2023, there were 79,475 cumulative cases of dengue fever, calculated as an illness rate of 120.25 per 100,000 population, with 73 deaths as a death rate of 0.09 per 100,000 population. In this study, As of September 16, 2023, Saraburi province reported a cumulative total of 824 dengue fever cases. The incidence rate was 129.24 per 100,000 population, with one reported death, resulting in a fatality rate of 0.12. The age group with the highest incidence rate was 10-14 years old at 457.88 per 100,000 population, followed by the 5-9 years age group at 387.91 per 100,000 population and the 15-24 years age group at 224.66 per 100,000 population. When comparing the number of cases from 2023 to 2022 and the 5-year median (2021-2025), cases have continuously increased since June 2023. The number of cases in 2023 exceeded that in 2022 and was more than twice the median.

We investigated (1) whether the distance from the dam affects the diversity of mosquito larvae at Pa Sak Jolasid Dam, Saraburi Province, Central Thailand. To test this, we conducted our mosquito larvae in all outdoor containers within the area. We also examined the mosquito breeding sites as follows: (1) natural/artificial containers, (2) metal/ plastic / earthen containers, (3) containers with lid / without lid, (4) water levels (0-25%, 26-50%, 51-75%, 76-100%), (5) mosquito species: *Aedes* (*Ae. albopictus, Ae. aegyp*ti), *Culex* spp., *Armigeres* spp., *Toxorhynchites* spp., and (7) mosquito larval indices (i.e., container index).

2. Materials and methods

2.1 Study site

In November 2024, a survey of mosquito larvae and aquatic insect predators was conducted at Pa Sak Jolasid Dam in Saraburi Province, the central region of Thailand (14.86242° N, 101.06671° E). In Saraburi Province, there are three seasons: summer (mid-February to mid-May), rainy (mid-May to mid-October), and winter (mid-October to mid-February).



(a) Map of Thailand (b) Map of Saraburi (c) Pa Sak Jolasid Dam

Figure 1. (a) Map of Thailand. (b) Map of Saraburi and (c) Map of study sites at Pa Sak Jolasid Dam Saraburi Province

2.2 Sampling of mosquito larvae.

2.2.1 Collect mosquito larvae and identify them up to the species level.

2.2.2 Inspect every container, both with and without water.

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 the creature was found and save the information into the app.

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

2.3 Data collection

In this study, one sampling site was from Pa Sak Jolasid Dam. At each sampling site, we randomly selected 30 houses to collect mosquito larvae in outdoor containers within 15 m of each house.

We systematically documented and categorized all potential habitat types at each location, conducting thorough inspections for the presence or absence of mosquito larvae and their predators. Each habitat underwent 20 dips with a standard mosquito dipper to assess the aquatic environments. We efficiently collected specimens by employing a D-frame dip net measuring 0.3 m in width, affixed to a long pole and equipped with a cone-shaped bag for capturing mosquito larvae predators. Subsequently, the captured mosquito larvae and predators were promptly preserved in 90% ethanol for subsequent identification. Additionally, we measured in situ water physicochemical parameters, including pH, temperature, conductivity, total dissolved solids (TDS), and salinity, using a handheld multi-parameter meter.

We used the GLOBE observer: MHM app to find the latitude and longitude coordinates where mosquito larvae were found.

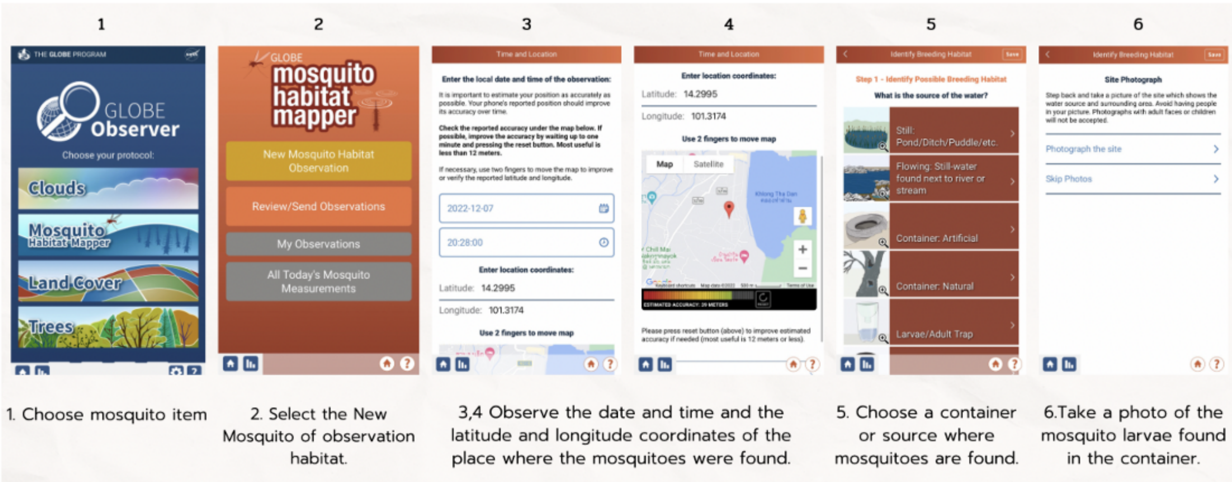


Figure 2. GLOBE Observer: MHM app

2.4 Entomological studies

In a rural community 1-5 km from Pa Sak Jolasid Dam, a comprehensive survey of mosquito larvae was conducted in all water containers. For smaller containers, the contents were directly emptied through them, while larger containers were sampled using a net. The net was swirled in a motion, covering all edges, ensuring a thorough sampling from the top to the bottom. All viable mosquito larvae were collected in plastic bags, transported to the laboratory, and preserved. The species level was identified using Rattanarithikul and Panthusiri's keys. Notably, the first and second instars and pupae were excluded from the study due to the challenges of identifying immature mosquitoes at these stages. The study involved a total of 129 container categories. Plastic water containers were further divided into two groups: large plastic containers designed for water storage (>100 L) and plastic bottles (i.e., 0.5–2.0 L water bottles). Earthen jars were also classified into two categories: small earthen jars with a volume of ≤100 L and large earthen jars exceeding 100 L in volume.

Water containers that were found at each house were classified as (1) natural/man-made containers, (2) metal/ plastic / earthen containers, (3) containers with lid / without lid, (4) water levels (0-25%, 26-50%, 51-75%, 76-100%), (5) positive/negative containers, (6) mosquito species: *Aedes* (*Ae. albopictus, Ae. aegypt*i), *Culex* spp., *Armigeres* spp., *Toxorhynchites* spp., and (7) mosquito larval indices (i.e., container index).

Three larval indices—namely, the House Index (HI), Container Index (CI), and Breteau Index (BI)—were computed using the established guidelines set by the World Health Organization (WHO). The House Index (HI) was determined by dividing the number of positive houses by the total number of houses inspected and multiplying the result by 100. Similarly, the Container Index (CI) was calculated by dividing the number of positive containers by the total number of containers inspected and multiplying the outcome by 100. The Breteau Index (BI) was computed by dividing the number of positive containers by the total number of houses inspected and multiplying the quotient by 100.

2.5 Statistical analysis

The Normality of all variables was assessed using the Komogorov-Smirnov test, and the equality of variances was examined through Levene's test. Descriptive statistics were employed to analyze the data. A one-way ANOVA test was utilized to investigate the quantities of mosquito larvae in different types of water containers, the number of positive containers, the households with positive containers, and the mosquito larvae count. The Chi-square test was applied to analyze the number of mosquitoes. Simple linear regression was employed to assess the relationship between water parameters and the quantities of mosquitoes and predators. All significant tests were conducted with a two-tailed approach.

3. Results

Ae. aegypti and *Ae. albopictus* larvae

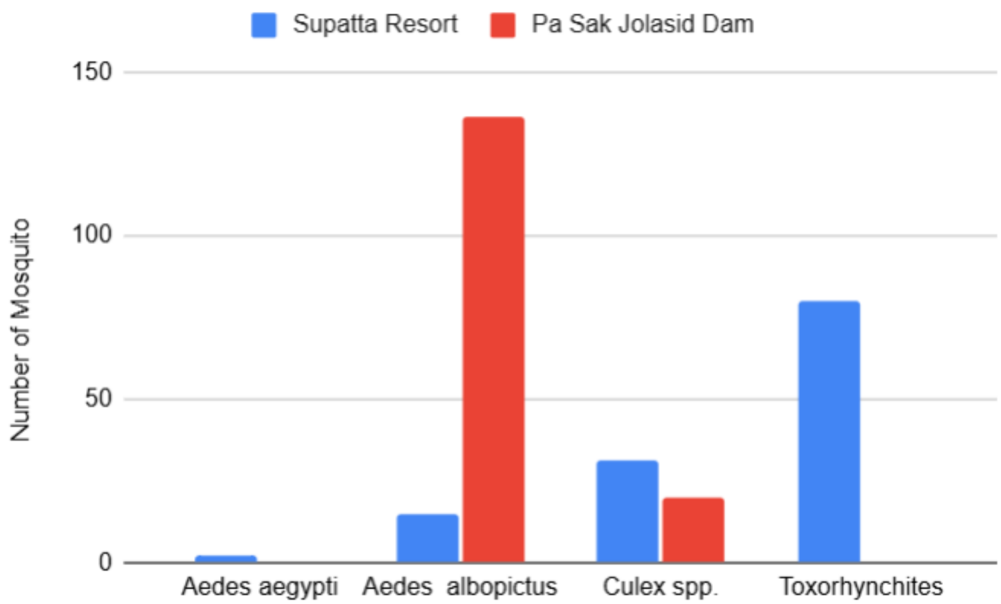
We found 5 Rubber containers and three Cement materials containers in other containers. In the Pa Sak Jolasid Dam area, we found one metal container, five plastic containers, and three earthen containers. From all four types of water containers, we found the highest number of mosquito larvae in other containers (23 larvae), followed by plastic containers (9 larvae), with earthen containers, and lowest in metal containers (2 larvae) (Table 1).

Table 1. The number of households (X ± SD) that had indoor/outdoor water containers in three topographical areas: Supatta Resort and Pa Sak Jolasid Dam at Saraburi Province, Thailand (*P<0.05,**P<0.01, ***P<0.001)

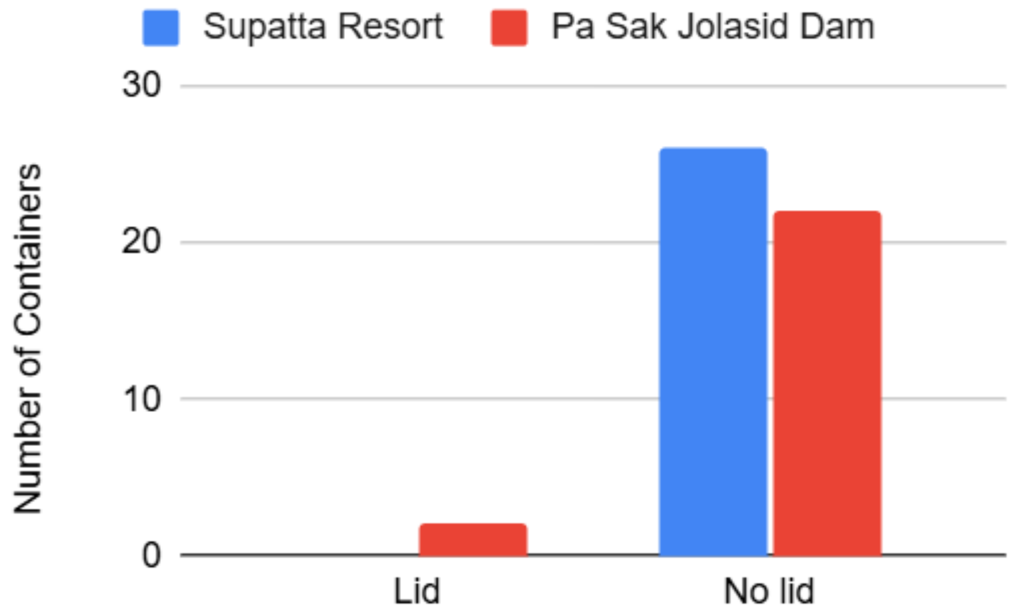
Container types	The number of water container

	Supatta Resort	Pasak Jolasid Dam	Number of mosquito larvae
Metal	0	2	2
Plastic	4	12	16
Earthen	5	4	9
Other containers	17	6	23

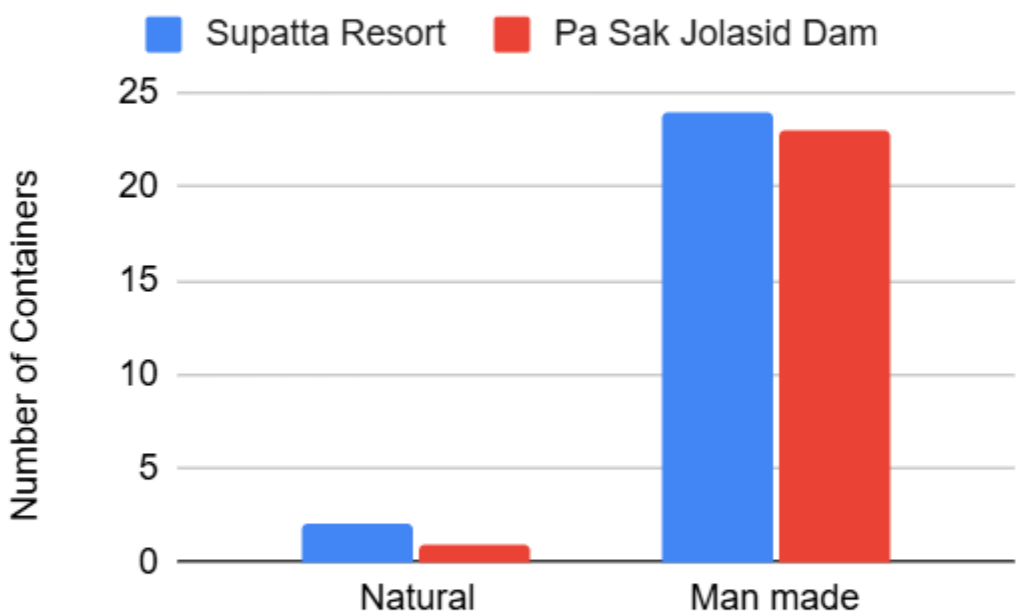
(a)



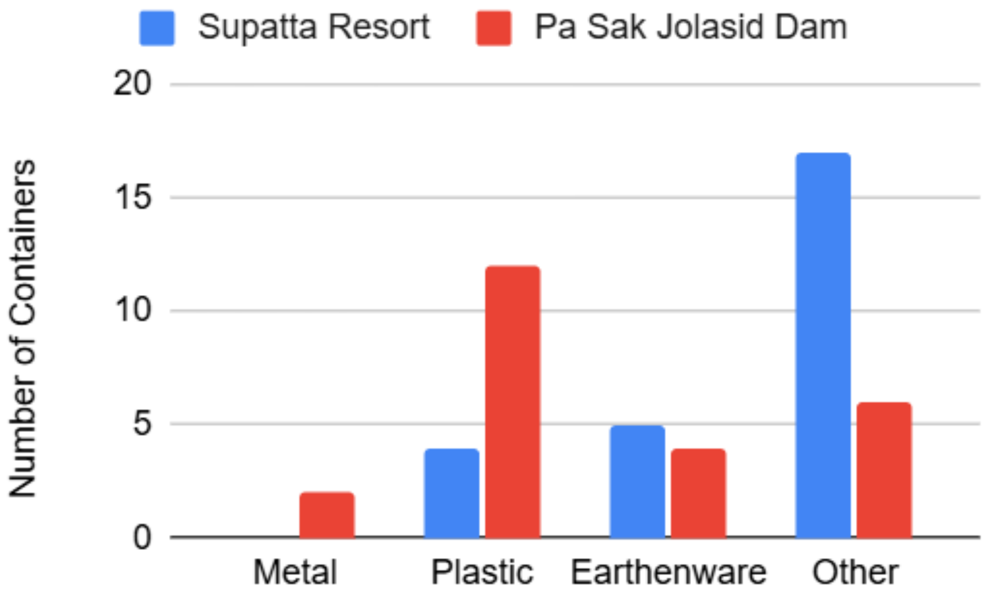
(b)


Supatta Resort
Pa Sak Jolasid Dam
30
20
10
0
Number of Containers
Lid
No lid

(e)


Supatta Resort
Pa Sak Jolasid Dam
25
20
15
10
5
0
Number of Containers
Natural
Man made

(f)



(g)

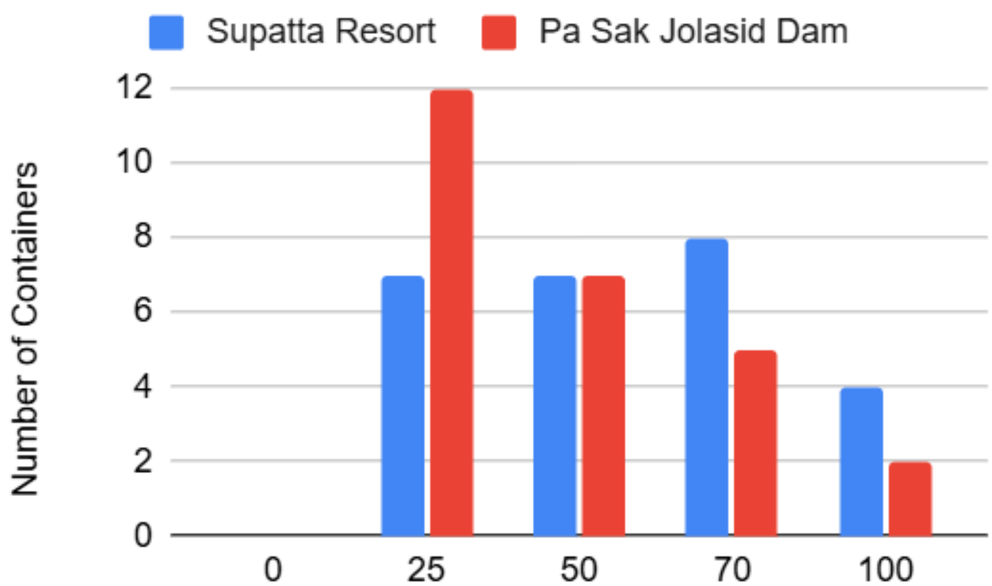


Figure 2. Water containers for mosquito larvae. (a) *Ae. aegypti*, *Ae. albopictus*, *Culex* spp., *Armigers* spp., and *Toxorhynchites* spp., (b) lid / without lid, (e) natural/artificial container, (f) metal/ plastic /earthen /other containers, (g) water levels (0-25%, 26-50%, 51-75%, 76-100%).

***Ae. aegypti, Ae. albopictus*, *Culex* spp. , *Armigeres* spp. and *Toxorhynchites* spp.**

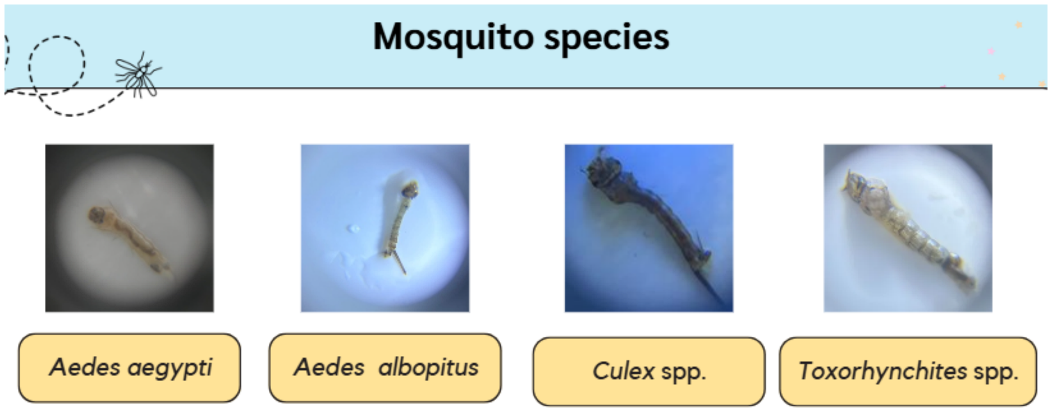


Figure 3. Mosquito species.

We identified mosquito species, including *Culex, Aedes albopictus, Armigeres subalbatus, Toxorhynchites*, and small water striders from the Veliidae family.

Containers / Breeding Sites

Across all surveyed areas, the number of water containers and the prevalence of containers serving as breeding sites with fish were higher compared to the Pasak Jolasid Dam

Lid / Without Lid Containers

In all surveyed areas, containers without lids exceeded those with lids.

Natural /Man-made Containers

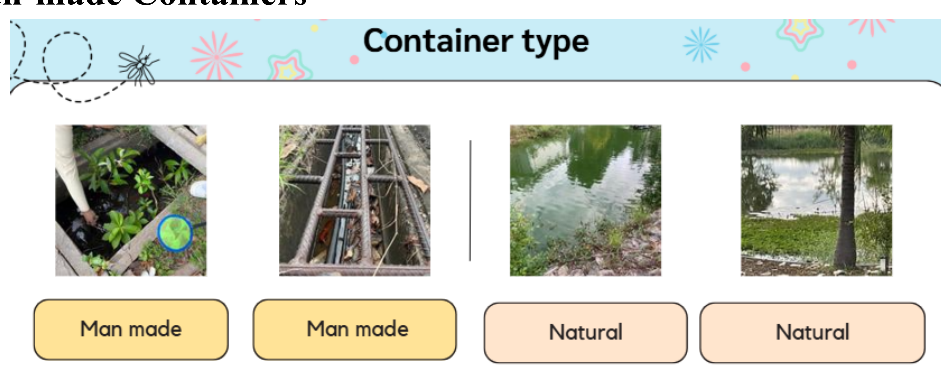


Figure 4. Container type.

Within a radius of Supatta Resort and Pa Sak Jolasid Dam, the prevalence of artificial containers exceeded that of natural containers. However, natural containers were not identified in the Supatta Resort or the Pa Sak Jolasid Dam (Figure 2e).

Metal/ Plastic /Earthen /Other Containers

Figure 5. Metal/Plastic/Earthen

The inventory in the vicinity of Supatta Resort comprised zero metal containers, five plastic containers, four earthen containers, 15 containers made of other materials, and two natural containers. The findings from Pa Sak Jolasid Dam included two metal containers, 12 plastic containers, four earthen containers, five containers made of other materials, and two natural containers.

Other Containers

Figure 6. Other Containers.

Water Levels (0%, 25%, 50%, 75%, 100%)

In every surveyed area, most containers exhibited a water level of 25% capacity. (Figure 2g).

Larval indices

The total number and number of positive containers in the area surrounding Supatta Resort, as shown in Table 2, were as follows: the Container Index (CI) was 57.69, and the Breteau Index (BI) was 25. These values were significantly higher than those in the Pa Sak Jolasid Dam area, where the CI was 33.33 and the BI was 13 (Table 2).

Table 2: This table indicates the number of household containers and larvae indices in Pa Sak Jolasid Dam

	Study sites at Supatta resort	**Study sites at Pa Sak Chonlasit Dam**
No. of containers	26	24
No. of positive containers	15	8
Larval index		
CI (%)	57.69	33.33
BI	25	13

Comparison of data between GLOBE website and survey in Saraburi province

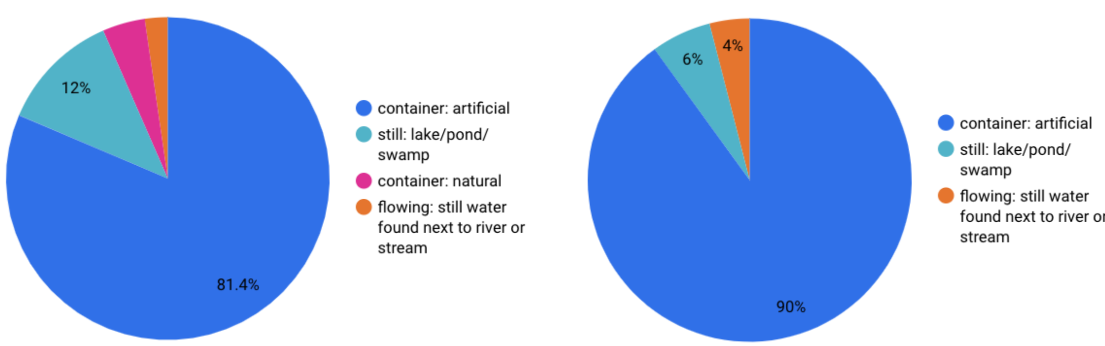


Figure 7. Comparison of container types from GLOBE data and surveys in Saraburi Province

From the figure based on a comparison of the past 7 years of data from the GLOBE website with new survey results from Saraburi Province, it was found that the container artificial category, or human-made water sources, accounted for as much as 90% in Saraburi, which is higher than the 7-year average from GLOBE at 81.4%. Meanwhile, the still lake/pond/swamp category, which includes natural water sources such as lakes, ponds, and swamps, represented only 6% in Saraburi, lower than the 7-year average from GLOBE at 12%. The flowing: still water found next to river or stream category, which refers to still water connected to rivers or streams, had the same proportion of 4% in both the 7-year average from GLOBE and the new survey in Saraburi.

In summary, the new survey in Saraburi highlights an increased proportion of human-made water sources compared to the 7-year average, while the proportion of natural water sources has decreased relative to historical data.

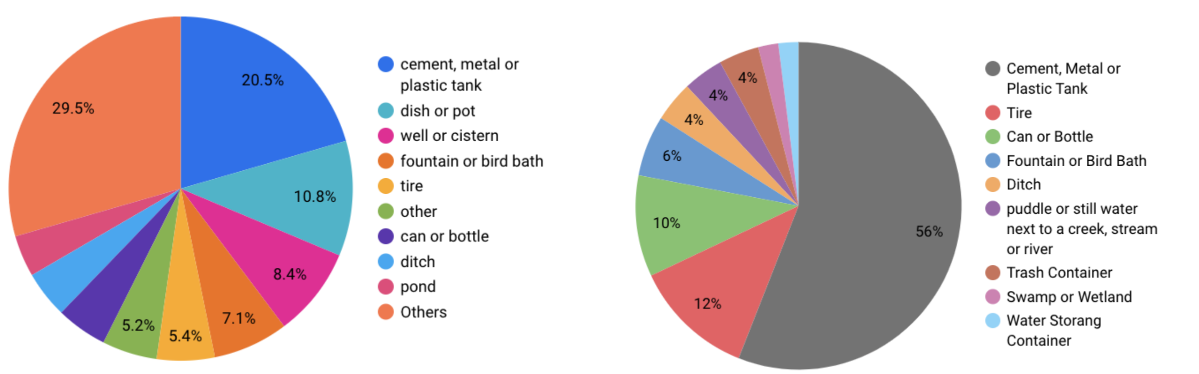


Figure 8. Comparison of containers from GLOBE data and surveys in Saraburi Province

From the charts, it can be concluded that the comparison between the two graphs shows that the category of water sources with the highest proportion in the second graph is Cement, Metal, or Plastic Tank, accounting for 56% of all water sources, while the first graph shows only 20.5%, which is significantly lower. Additionally, the second graph reveals that tires account for 12%, a category not included in the first graph. For the category of cans and bottles, the second graph shows a proportion of 10%, which is higher than the 5.4% in the first graph. Meanwhile, Fountain or Bird Bath has a similar proportion in both graphs, with the first graph at 7.1% and the second graph at 6%. As for ditches, the first graph shows a proportion of 5.2%, which is higher than the 4% in the second graph. Moreover, the second graph provides data on the category of Puddle or Still Water Next to a Creek/Stream or River, accounting for 4%, which is not mentioned in the first graph. For other types of water sources, the first graph shows a proportion of 29.5%, reflecting the diversity of water sources in that area, while the second graph does not explicitly mention this category. In conclusion, the second graph primarily focuses on Cement, Metal, or Plastic Tank and provides details on water sources related to tires and puddles near streams. In contrast, the first graph demonstrates greater diversity in water source types, particularly in the Others category.

4. Discussion

The study elucidates the relationship between container types and mosquito larvae abundance, underscoring the role of materials and container characteristics in influencing breeding. The spatial distribution of containers across surveyed areas revealed varying preferences, with earthen containers dominating the 1 km radius and plastic containers gaining significance in the Supatta Resort and Pa Sak Jolasid Dam. Calculated larval indices indicated a higher risk of dengue transmission in the zone, providing crucial information for public health planning and mosquito control prioritization. The discussion references previous studies, highlighting the significance of predator-prey relationships in mosquito population control and reinforcing the current findings. Practical implications are emphasized, suggesting community-based interventions for mosquito control based on the study's insights. Recommendations include promoting specific container types, advocating lid usage, and integrating environmental factors into mosquito control strategies. Acknowledging study limitations, such as the regional focus and exclusion of certain larval stages, the discussion calls for future research to expand the study to different regions and include additional ecological variables. This comprehensive discussion contributes valuable insights to understanding and mitigating mosquito-borne diseases.

5. Conclusion

This study highlights the significant relationship between container types and mosquito larvae abundance, emphasizing the critical role of container materials, characteristics, and spatial distribution in influencing mosquito breeding. Earthen containers were prevalent within specific zones, while plastic containers dominated others, reflecting diverse breeding preferences. The calculated larval indices underscore a heightened risk of dengue transmission in surveyed areas, stressing the importance of targeted public health interventions. Practical recommendations derived from the findings include promoting covered containers, discouraging open water storage, and integrating environmental factors into community-driven mosquito control strategies. While acknowledging limitations such as the regional scope and exclusion of certain larval stages, the study calls for further research to broaden the geographical focus and incorporate additional ecological variables. These insights contribute to advancing strategies for mosquito-borne disease prevention and control.

I would like to claim IVSS badges

1. **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.

2. **I am a STEM professional.**

The report distinctly outlines the collaboration with a STEM professional, which bolstered the research methods, enhanced precision, and facilitated more advanced analyses and interpretations of the results. The data underwent analysis through independent-sampled t-tests to compare the quantities of mosquito larvae in various container types.

3. **I am a data scientist.**

The report thoroughly examines the students' proprietary data and additional data sources. Students critically evaluate the limitations of these data, draw inferences about historical, current, or future events, and leverage the data to address questions or resolve issues within the depicted system. This may involve incorporating data from other educational institutions or utilizing information from external databases. The latitude and longitude of the locations where mosquito larvae were observed were recorded using the GLOBE Observer and MHM.

Acknowledgments

We thank Assoc. Prof. Dr. Krisanadej Jaroensutasinee, Assoc. and Prof. Dr. Mullica Jaroensutasinee, Dr.Wanwipa Sutthakiet, Mr.Trairat Sutthakiet, Mr.Prajuab Intharachot Director of Chonprathanwittaya School, Mr. Maloot Chabumnet Deputy Director of Chonprathanwittaya School, Miss Thunwarut Sutthipunand Miss Chacha Sattharat for helping with experimental design, fieldwork, data analysis, and manuscript preparation. Chonprathanwittaya School and the Center of Excellence for Ecoinformatics, Walailak University, partly supported this work.

References

Adebote DA, Oniye SJ, Muhammed YA (2008) Studies on mosquitoes breeding in rock pools on inselbergs around Zaria, northern Nigeria. J Vector Borne Dis 45:21–28

Anderson, M. T., Kiesecker, J. M., Chivers, D. P., and Blaustein, A. R. (2001.) The direct and indirect effects of temperature on a predator–prey relationship. Can J Zool 79: 1834–1841, doi: 10.1139/cjz-79-10-1834

Knight, R. L., Walton, W. E., O'Meara, G. F., Reisen, W. K., and Wass, R. (2003). Strategies for effective mosquito control in constructed treatment wetlands. Ecol Eng 21: 211–232.

McPeek, M.A., and Miller, T. E. (1996). Evolutionary biology and community ecology. Ecol 77: 1319–1320.

Mogi, M. (2007). Insects and other invertebrate predators. J Am Mos Cont Asso 23 (suppl 3): 93–109.

Munga, S., Vulule, J., and Kweka, E. J. (2013). Response of *Anopheles gambiae* s.l. (Diptera: Culicidae) to larval habitat age in western Kenya highlands. Parasites & Vectors 6: 13

Quiroz-Martinez, H., and Rodriguez-Castro, A. (2007). Aquatic insects as predators of mosquito larvae. JAm Mosq Control Assoc 23(2): 110–117

Schlagenhauf-lawlor, P., and Scott, J. (2001). Traveller's Malaria. PMPH Publsher's, USA, p 155009157

Shaalan, E. A., Canyon, D. V., Reinhold, M., Yones, W. F. M., Abdel-Wahab, H., and Mansour, A. (2007). A mosquito predator survey in Townsville, Australia and an assessment of *Diplonychus* sp. and *Anisops* sp. predatorial capacity against *Culex annulirostri*s mosquito immatures. J Vector Ecol 32(1): 16–21.

Shiff, C. (2002). Integrated approach to malaria control. Clin Microbiol Rev 15: 278–293.

Skourkeas, A., Kolyva-Machera, F., and Maheras, P. (2010). Estimating mean maximum summer and mean minimum winter temperatures over Greece in 2070–2100 using statistical downscaling methods. EuroAsian J Sustain Energy Dev Policy 2: 33–44.

Spieles DJ, Mitsch WJ (2000) The effects of season and hydrologic and chemical loading on nitrate retention in constructed wetlands: A comparison of low and high nutrient riverine systems. Ecol Eng 14: 77–91.

Tuno, N. W. O., Minakawa, N., Takagi, M., and Yan, G. (2005). Survivorship of *Anopheles gambiae* sensu stricto (Diptera: Culicidae) larvae in Western Kenya highland forest. J Med Entomol 42: 270–277.

Wilson, C., and Tisdell, C. (2001). Why farmers continue to use pesticides despite environmental, health, and sustainability costs. Ecol Econ 39:446–449

Witte, F., andVan Oijen M. J. P. (1990). Taxonomy, ecology and fishery of Lake Victoria haplochromine trophic groups. Zool verh, Leiden 262: 1–47.