Regional Analysis of GLOBE Mosquito Data in Asia: Examining Species Diversity, Breeding Sites, and Container Index

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Abstract

This study analyzes data collected through the GLOBE Mosquito Habitat Mapper in Asia to investigate mosquito species diversity, breeding site preferences, container indices, and their potential links to disease transmission. Asia, a region with diverse ecosystems and dense populations, is a hotspot for mosquito-borne diseases. Understanding the ecological dynamics of mosquito populations is crucial for effective vector control. This research explicitly examines (1) mosquito species distribution across Asian countries, (2) the types of breeding containers utilized by mosquitoes in different regions, and (3) the container index (percentage of infested water-holding containers). This study aims to identify key factors influencing mosquito populations and assess their role in disease transmission by integrating GLOBE data with environmental and epidemiological information. The findings will contribute to a deeper understanding of mosquito ecology in Asia and inform the development of evidence-based vector control strategies to protect public health.

Keywords: Mosquito ecology, Asia, GLOBE Mosquito Habitat Mapper, species diversity, breeding sites, container index, vector-borne diseases, disease transmission, citizen science, vector control, *Aedes*, *Culex*, *Anopheles*

1. Introduction

Mosquitoes, belonging to the family Culicidae, are ubiquitous insects that pose a significant threat to human health, particularly in tropical and subtropical regions (World Health Organization, 2023). They are vectors for numerous diseases, including malaria, dengue fever, chikungunya, and Zika virus, which collectively cause millions of deaths and disabilities annually (Centers for Disease Control and Prevention, 2023). This study, which aims to understand the ecological dynamics of mosquito populations, including species diversity, breeding site preferences, and factors influencing their abundance, is crucial for developing effective vector control strategies and mitigating disease transmission (Sleigh & Liu, 2019).

With its diverse ecosystems and dense human populations, Asia is a significant hotspot for mosquito-borne diseases (Bhatt et al., 2015). The region harbors various mosquito species with varying vectorial capacities and ecological adaptations (Rueda & Patel, 2014). Climate change, urbanization, and land use patterns influence mosquito distribution and abundance, further complicating disease control efforts (Laurance & Macdonald, 2017). Therefore, comprehensive surveillance and monitoring of mosquito populations are essential to assess disease risks and implement targeted interventions.

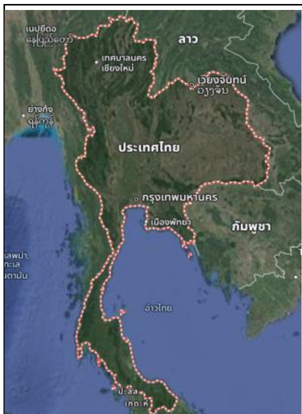
Citizen science initiatives, such as the GLOBE Mosquito Habitat Mapper, offer a valuable tool for collecting large-scale data on mosquito populations (GLOBE Program, 2023). By engaging volunteers in mosquito sampling and habitat identification, these programs can supplement traditional surveillance methods and provide critical information on mosquito areas (Bonney et al., 2016). The GLOBE Mosquito Habitat Mapper, in particular, allows for the collection of vast geographic data on mosquito species, breeding sites, and container indices, which can be used to assess the potential for disease transmission in different regions (Becker-Lindholdt et al., 2019).

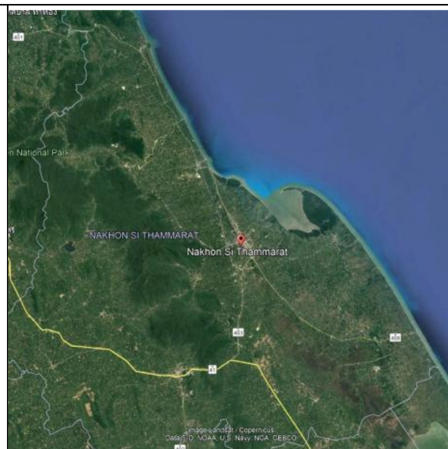
This study aims to analyze the GLOBE Observer: Mosquito Habitat Mapper App collected in Asia to examine mosquito species diversity, breeding site preferences, and container indices. Specifically, this research will (1) analyze mosquito species distribution across different countries in Asia using GLOBE mosquito data; (2) identify and compare breeding container types used by mosquitoes in various regions; and (3) assess the container index (percentage of water-holding containers infested with larvae) in different countries. By integrating these data with environmental variables and epidemiological information, we seek to identify key factors influencing mosquito populations and assess their potential role in disease transmission. The findings of this study will contribute to a better understanding of mosquito ecology in Asia and inform the development of evidence-based vector control strategies to protect public health.

2. Materials and methods

2.1 Study site

In January 2025, Walailak University in Nakhon Si Thammarat, in the southern region of Thailand (8.6538° N, 99.9017° E), surveyed mosquito larvae. Nakhonsithammarat Province has three seasons: summer (mid-February to mid-May), rainy (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 study sites at 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 water's pH and temperature 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 into 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 obtained from the GLOBE database and through field observations conducted by students at Walailak University in Nakhon Si Thammarat, Thailand. The GLOBE mosquito data provided an initial dataset supplemented by field data from various regional locations. Students were involved in collecting data on mosquito larvae, environmental factors such as water temperature and pH, and the identification of 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 assess the differences between the GLOBE mosquito data in Asian countries and locally collected field data. We used the GLOBE observer: MHM app to find the latitude and longitude coordinates where mosquito larvae were found.

2.4 Entomological studies

This study integrates mosquito larval data collected directly from the Walailak University area with data from the GLOBE Mosquito Habitat Mapper for the Asian region. Larval collection followed a standardized protocol: smaller containers were emptied and filtered, while larger containers were sampled using nets, ensuring 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 involved a total of 360 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. The GLOBE data, contributing broader spatial coverage, were used to analyze mosquito species distribution, 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

The data analysis involved calculating the Container Index (CI) to assess mosquito breeding prevalence, defined as the percentage of water-holding containers infested with larvae.

$$CI = \left(\frac{\text{Number of containers with larvae or pupae}}{\text{Total number of containers inspected}} \right) \times 100$$

Descriptive statistics summarized species diversity and breeding site data, categorizing findings by region and habitat type. Tables organized species distribution and breeding site frequencies. At the same time, graphical representations, including bar charts, pie charts, and heatmaps, visualized trends in species diversity, breeding site preferences, and regional variations in the Container Index. This approach enabled a comprehensive examination of mosquito data across Asia, highlighting key patterns and correlations.

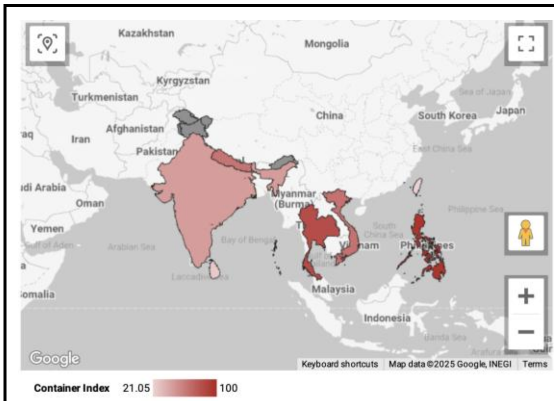
3. Results

Table 1. Distribution of Mosquito Species by Country in Asia

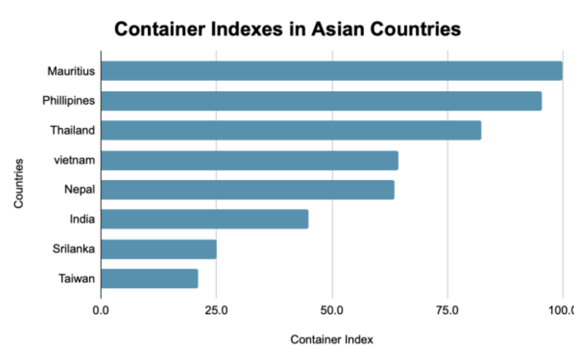
Country	*Ae. aegypti*	*Culex* spp	*Anopheles* spp
India	60	0	0
Nepal	105	0	0
Thailand	1034	80	257
Taiwan	0	52	0
Vietnam	100	0	5
Philippines	529	70	664

Distribution of Mosquito Species by Country in Asia

The table presents the distribution of key mosquito species—*Aedes aegypti*, *Culex spp*, and *Anopheles spp*—across selected Asian countries. **India** reported a high count of *Aedes aegypti* (60), with no presence of *Culex* spp or *Anopheles spp*. Similarly, **Nepal** recorded many *Aedes aegypti* (105) but no observations of the other two species. **Thailand** showed the highest diversity, with many *Aedes aegypti* (1034) and moderate counts of *Culex* spp. (80), and *Anopheles* spp. (257). In contrast, **Taiwan** reported only *Culex* spp. (52), with no *Aedes aegypti* or *Anopheles* spp. **Vietnam** had a notable presence of *Aedes aegypti* (100) and a small count of *Anopheles spp* (5), but no *Culex* spp. Finally, the **Philippines** recorded high numbers of *Aedes aegypti* (529) and *Anopheles* spp. (664), along with a moderate count of *Culex* spp. (70). These results highlight distinct regional patterns in mosquito species distribution, reflecting variations in ecological and environmental factors across Asia.



(a)



(b)

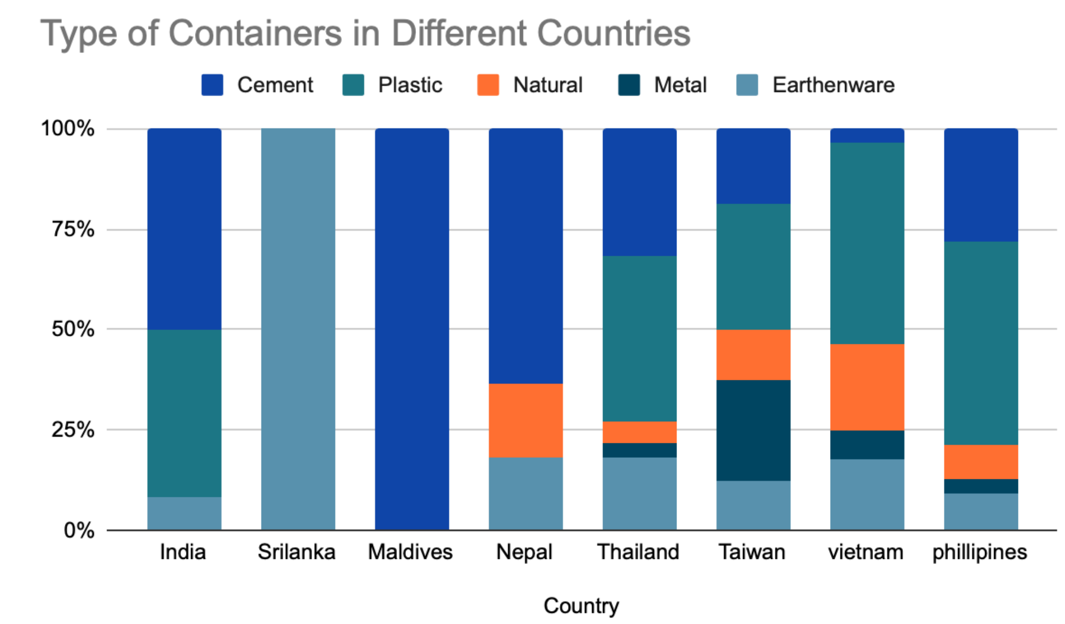
(c)	

Figure 3 (a) Geographic distribution of the Container Index in Asia, with darker shades indicating higher mosquito breeding prevalence, (b) Comparison of Container Index across Asian countries, and (c) Type of water containers across Asia

Container Index (CI) by Country in Asia

The Container Index (CI) measured the percentage of water-holding containers infested with mosquito larvae across selected Asian countries (Figure 3a,b). Mauritius had the highest CI at 100%, indicating that all inspected containers were favorable for mosquito breeding. The Philippines followed closely with a CI of 95.4%, while Thailand reported a CI of 82.3%. Vietnam and Nepal showed moderate CIs of 64.3% and 63.6%, respectively. India had a lower CI of 45%, and Sri Lanka and Taiwan reported the lowest CIs at 25% and 21.1%, respectively. These results reveal significant regional variations in mosquito breeding prevalence, with higher CIs in countries with greater urbanization, poor water management, or tropical climates, underscoring the need for targeted vector control measures in high-risk areas.

Distribution of Mosquito Breeding Containers by Type and Country in Asia

The table in the collected data (Figure 3c) highlights the types of containers infested with mosquito larvae across selected Asian countries, categorized into earthenware, metal, natural, plastic, and cement containers. India reported most breeding sites in cement containers (50%), followed by plastic (5). Sri Lanka showed 100% of breeding sites in earthenware containers, while Maldives had all breeding sites in cement containers. Nepal had a significant proportion of breeding sites in cement containers (63.3%), with some in earthenware and natural containers. Thailand had the highest diversity, with plastic containers being the most common (41.3%), followed by cement and earthenware. Taiwan reported a relatively even distribution, with plastic containers slightly more prevalent (31.3%). Vietnam showed 50% of breeding sites in plastic containers, while the Philippines also had a majority in plastic containers (51%), followed by cement and earthenware. These findings indicate regional preferences for specific container types, with plastic and cement containers being the most common breeding sites in urbanized areas. In contrast, earthenware and natural containers dominate in less urbanized regions. This underscores the need for targeted interventions based on local breeding site preferences.

4. Discussion

This study investigated mosquito species composition, abundance, breeding site preferences, and container indices across six Asian countries (India, Thailand, Maldives, Taiwan, Vietnam, and the Philippines) using local larval collections and GLOBE Mosquito Habitat Mapper data. The findings provide valuable insights into mosquito ecology and potential risk factors for vector-borne disease transmission in the region.

The Dominance of Plastic and Cement Containers and Implications for Disease Transmission

Our results highlight the widespread use of plastic and cement containers as primary breeding sites for mosquito larvae across several Asian countries. Plastic containers were the most common breeding habitat in Thailand, Vietnam, and the Philippines, accounting for 41.3%, 50%, and 51% of infested containers. This aligns with previous studies that emphasize the role of improperly discarded plastic waste in urban and semi-urban areas as a significant contributor to the proliferation of Aedes aegypti, the primary vector for dengue, chikungunya, and Zika viruses (Bhatt et al., 2013; WHO, 2020). Cement containers, on the other hand, were dominant in India (50%) and Maldives (100%), reflecting the reliance on cement tanks for water storage in these regions. The high prevalence of these container types underscores the ongoing risk of arboviral diseases in areas with inadequate waste management and water storage practices. Targeted interventions, such as community clean-up drives, proper waste disposal, and larvicides in water storage containers, are critical to reducing mosquito breeding in these high-risk areas.

Variation in Container Indices and Breeding Site Preferences

The container index (CI) varied significantly across countries, with Thailand, Vietnam, and the Philippines reporting a high index due to the abundance of plastic containers. In contrast, Sri Lanka and Maldives preferred earthenware and cement containers. These variations can be attributed to differences in cultural practices, levels of urbanization, and environmental conditions. For instance, rapid urbanization in Thailand and the Philippines has increased plastic waste, creating ideal breeding conditions for mosquitoes (Gubler, 2011). In rural areas, such as Nepal and Sri Lanka, traditional water storage practices using earthenware and natural containers contribute to mosquito breeding. Understanding these regional preferences is crucial for designing effective, context-specific vector control strategies. For example, in urban areas, public health campaigns should focus on reducing plastic waste, while in rural areas, improving water storage practices and covering containers should be prioritized.

High-Risk Areas for Mosquito-Borne Diseases

Dengue and Chikungunya: Countries with high plastic container indices, such as Thailand, Vietnam, and the Philippines, are at elevated risk for dengue and chikungunya due to abundant Aedes aegypti breeding sites. These areas require urgent interventions to reduce plastic waste and improve waste management systems.

Malaria: Regions with natural and earthenware containers, such as Nepal and Sri Lanka, may face higher malaria risks due to the presence of Anopheles species. Environmental management and community education on eliminating stagnant water sources are essential.

Zika Virus: Urbanized areas with high plastic container usage, such as Thailand and the Philippines, are also at risk for Zika virus transmission. Public health efforts should focus on reducing Aedes aegypti populations through integrated vector management strategies.

Conclusion

This study provides critical insights into the distribution of mosquito breeding containers and their implications for disease transmission in Asia. The dominance of plastic and cement containers in urban and rural areas highlights the need for region-specific vector control strategies. High-risk areas for dengue, chikungunya, and Zika require targeted interventions to reduce breeding sites, while regions at risk for malaria need environmental management and community engagement. These findings contribute to a better understanding of mosquito ecology in Asia. They can inform the development of evidence-based public health interventions to mitigate the burden of mosquito-borne diseases.

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-samples 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: MHM App.

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