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1. Title

"GEOSPATIAL MONITORING OF MOSQUITOES OF EPIDEMIOLOGICAL IMPORTANCE IN THE MUNICIPALITY OF PINHEIRO, MARANHÃO, BRAZIL, TROUGH CITIZEN SCIENCE AND GLOBE PROGRAM PROTOCOLS"

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Abstract

In Brazil, diseases transmitted by arthropod vectors are considered a serious public health issue, particularly in tropical regions characterized by inadequate sanitation and unplanned urbanization. The municipality of Pinheiro, in the state of Maranhão, presents environmental conditions favorable to the proliferation of these vectors due to its climate and geographic characteristics. This study presents the results of a geospatial monitoring effort conducted in the municipality, using GLOBE Program guidelines to identify, analyze, and map mosquito breeding sites of epidemiological importance.This report aims to present the outcomes of geospatial monitoring of mosquitoes of epidemiological relevance carried out in Pinheiro, Maranhão, Brazil, using GLOBE Program protocols, with particular emphasis on the Mosquito Habitat Mapper. The study was conducted with guided student participation within a citizen science framework, integrating educational activities, field surveys, environmental data recording, and spatial analysis of the collected data.The methodology was based on the systematic identification of artificial breeding sites, the recording of environmental variables, and the georeferencing of monitored locations using the GLOBE Observer application. The collected data enabled the construction of thematic maps and heat maps, contributing to the visualization of the spatial distribution of breeding sites within the urban territory.The results revealed a heterogeneous distribution of mosquito breeding sites, with higher concentrations observed in areas characterized by high urban density, accumulation of solid waste, and inadequate water storage practices. Spatial analysis demonstrated the presence of critical zones for mosquito proliferation, reinforcing the relevance of geospatial tools in supporting environmental surveillance and vector control actions. The study highlights the strategic value of integrating community participation and scientific education with GLOBE protocols, consolidating this approach as an innovative tool for public health surveillance.

3. Introduction

The control of arboviral diseases represents one of the most persistent challenges in contemporary public health, particularly in tropical regions where urbanization has occurred rapidly and unevenly. The spread of Aedes aegypti is not a random event but rather a process directly linked to environmental, socioeconomic, and infrastructural factors within urban areas. Issues such as inadequate basic sanitation, improper solid waste disposal, and unplanned urban occupation create ideal conditions for vector reproduction (Costa & Natal, 1998; Flauzino et al., 2009; Silva & Machado, 2019).

In the context of the municipality of Pinheiro, located in the Maranhão lowlands, these conditions are intensified by the region's distinctive geographic characteristics. The local climate is marked by two well-defined seasons: a period of intense rainfall and a dry or low-precipitation season. The landscape is characterized by extensive flooded plains and high humidity, typical of tropical environments, which facilitate the persistence of both natural and artificial breeding sites for much of the year. This combination of high rainfall volumes and flood-prone areas favors the continuity of disease transmission cycles in the locality (Ferreira Filho, 2017; Valladares et al., 2019). As highlighted in the academic literature, the urban and geographic environment acts as a primary structuring factor in mosquito proliferation, making the incidence of diseases such as dengue a direct reflection of local social and environmental conditions (Lima-Camara, 2024).

To address this scenario, the use of geoprocessing technologies and spatial analysis has become an indispensable tool. These methodologies enable the mapping of disease dynamics across territories and the identification of critical areas, thereby supporting more targeted surveillance strategies and the efficient allocation of public health resources (Cavalcante et al., 2013; Masullo et al., 2011). In this context, citizen science emerges as an effective strategy for expanding environmental monitoring efforts. Beyond contributing to data collection, it promotes scientific education and empowers community members to become active agents in the stewardship of their local environment (Baixo et al., 2021; Silva & Witt, 2024).

4. Materials and Methods

The primary materials used in this study included mobile devices with access to the GLOBE Observer application, specifically the Mosquito Habitat Mapper protocol, electronic spreadsheets for data organization, geoprocessing tools for spatial analysis, and field equipment for photographic documentation and environmental observation. The use of the application enabled standardized data recording and integration into the global GLOBE Program database, as described by Baixo et al. (2021).

Data collection was conducted with the active participation of primary and higher education students who had received prior training, characterizing a citizen science approach in accordance with GLOBE Program guidelines and studies highlighting the educational and scientific value of this methodology (Silva & Witt, 2024). Students were involved in environmental site recognition, identification of water-holding containers with breeding potential, photographic documentation, and georeferencing of breeding sites.

Field procedures consisted of the systematic inspection of domestic and peridomestic environments, encompassing artificial containers such as tires, bottles, buckets, water storage tanks, disposable plastic containers, and other objects commonly found in the urban environment. For each identified breeding site, information was recorded regarding container type, presence or absence of water, associated environmental conditions, and geographic coordinates.

Following data collection, records were exported from the GLOBE platform and organized into electronic spreadsheets. Spatial analysis was subsequently performed, including the development of thematic maps and heat maps, enabling visualization of the spatial distribution of breeding sites and the identification of areas with higher concentration, in accordance with methodologies described by Cavalcante et al. (2013) and Bastos et al. (2019).

Study Area

The study was conducted in the municipality of Pinheiro, Maranhão, Brazil, located in the Maranhão Lowlands, a region characterized by extensive floodplains, high rainfall regimes, and environmental dynamics strongly influenced by water bodies. The municipality comprises urban and peri-urban areas with heterogeneous infrastructure, including sectors with inadequate drainage, irregular solid waste collection, and improper household water storage. These characteristics make the territory highly conducive to the formation of both artificial and natural mosquito breeding sites.

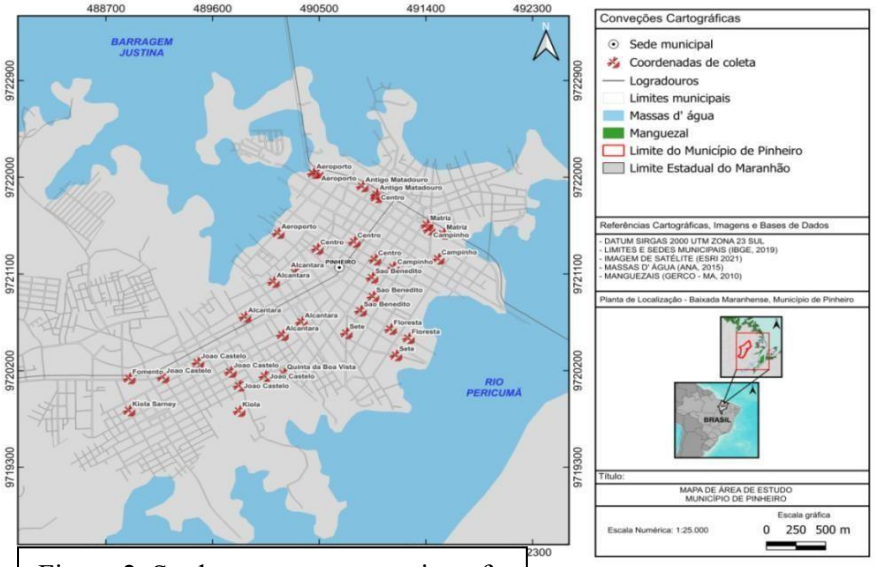

Figure 2. Study area: representation of the municipality of Pinheiro, Maranhão, Brazil, and the sampling sites.

Data Collection

Data collection for this study was conducted in accordance with the Mosquito Habitat Mapper protocol, a tool designed to identify and analyze different types of mosquito breeding sites. The selection of sampling locations was carried out strategically, based on information provided by the Municipal Health Department of Pinheiro. This criterion allowed the prioritization of areas with a higher risk of arbovirus vector occurrence within the municipality.

In total, 39 sites were surveyed in the municipality of Pinheiro during the period from September 2024 to March 2025. Based on this monitoring effort, 19 sites were subsequently identified as critical areas for vector presence. Field inspections were conducted by students within their own communities, where they completed detailed data sheets containing information on the type of site surveyed, the nature of the breeding habitat, the material of the container, and the presence of larvae and/or adult mosquitoes. When feasible, the mosquito genus was also identified.

The collected data were organized and categorized according to habitat type, classified as artificial, natural, or capture sites. Additionally, records were grouped based on container type and local environmental characteristics. This classification enabled a detailed analysis of breeding site distribution in the urban environment, integrating geospatial data with field conditions observed in the Maranhão lowlands.

5. Results and Discussion

The data collected during the monitoring period in the municipality of Pinheiro revealed a widespread and significant presence of mosquito breeding sites with potential to transmit diseases. A total of 39 sites were analyzed, showing a substantially higher occurrence of artificial breeding habitats, particularly in urban neighborhoods and transition areas. This pattern confirms that urban environments, when subjected to intense human modification and characterized by a high availability of water-holding objects, become highly favorable for mosquito reproduction. These findings are consistent with previous studies that describe mosquito proliferation as a direct consequence of urban expansion and the availability of artificial oviposition sites (Costa & Natal, 1998; Flauzino et al., 2009).

The application of the Mosquito Habitat Mapper protocol enabled the identification of multiple types of water-holding containers. Among the most frequently observed items in the communities of Pinheiro were improperly discarded tires, plastic bottles, packaging materials of various kinds, buckets, and, most notably, domestic water storage tanks and cisterns. The selection of 19 sites as critical areas was essential to demonstrate that inadequate waste disposal and the need for household water storage are key factors explaining the presence of Aedes aegypti in the region (Ferreira Filho, 2017; Valladares et al., 2019). Furthermore, the detection of larvae and adult mosquitoes at the same sites over different months suggests the persistent activity of breeding foci, indicating that current control measures require reinforcement through regular sanitation practices and increased community awareness.

The spatial distribution of breeding sites across Pinheiro was heterogeneous, with higher concentrations observed in densely populated neighborhoods lacking adequate basic services, such as proper drainage systems and efficient solid waste collection. The heat maps generated in this study highlighted critical zones where social vulnerabilities overlap with climatic conditions favorable to mosquito proliferation. Regarding taxonomic identification, the study revealed that the genus Aedes showed a preference for smaller containers with relatively clean water, whereas Culex mosquitoes were more frequently associated with environments containing high levels of organic matter, such as areas near open sewage systems. This distinction underscores how deficiencies in sanitation infrastructure in the Maranhão lowlands directly influence the composition and abundance of mosquito populations in different locations (Cavalcante et al., 2013; Masullo et al., 2011; Lima-Camara, 2024).

Student involvement in the investigative process was a key factor contributing to the success of the monitoring activities. Their participation not only expanded the spatial coverage of the survey—reaching locations often overlooked by conventional surveillance—but also functioned as an effective scientific learning experience. By applying GLOBE Program protocols, students were able to systematically organize records and upload data from Pinheiro to a globally accessible platform. This collaborative effort between students and researchers contributes to the development of robust databases, which are essential for supporting evidence-based decision-making by municipal authorities and public health agencies (Baixo et al., 2021; Silva & Witt, 2024).

Finally, the results reinforce that mosquito control in Pinheiro cannot rely solely on chemical interventions or waste removal. The observed scenario highlights the need for an integrated approach that combines improvements in urban infrastructure, the use of spatial mapping tools for neighborhood-level monitoring, and, most importantly, sustained investment in education. The integration of technological mapping with active community engagement emerges as the most effective strategy for reducing disease risks and promoting a healthier environment for local populations (Nascimento et al., 2023; Vasconcelos & Luna, 2020).5. Results and Discussion

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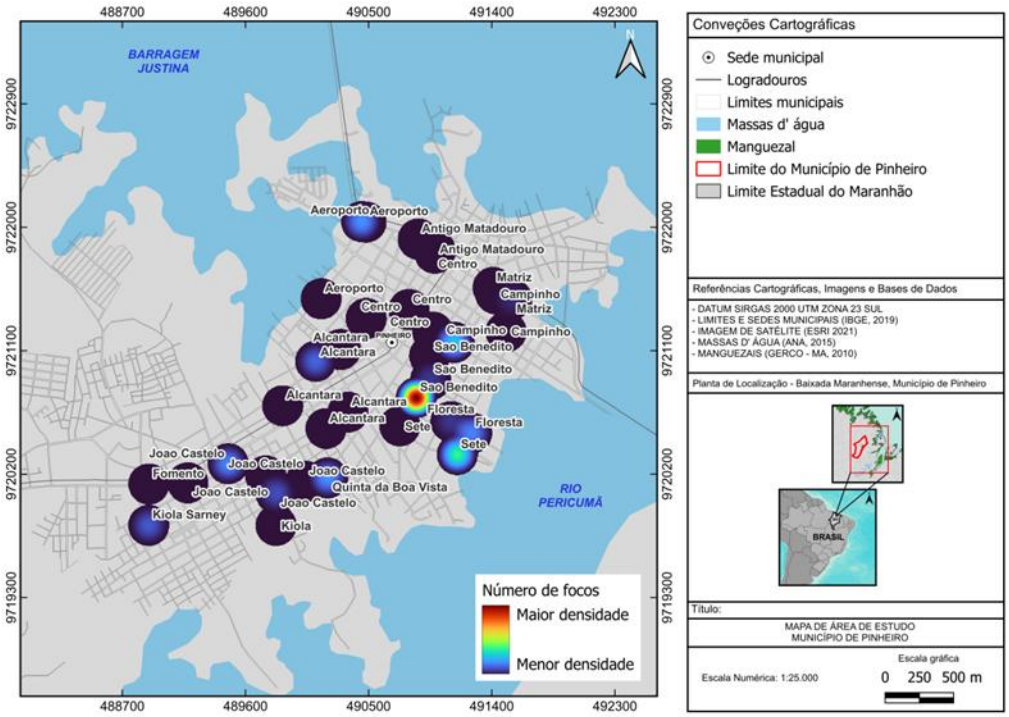

Figure 3. Percentage of breeding sites by container type in the municipalities of Pinheiro, Maranhão, and São Bento, Maranhão, Brazil.

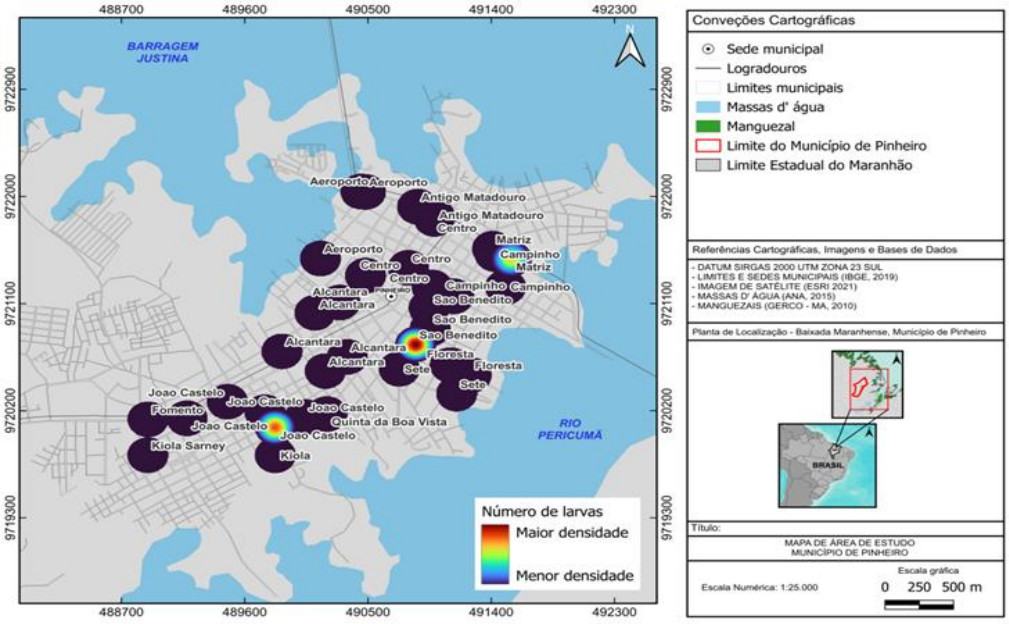

Figure 4. Percentage of breeding sites by locality type in the municipalities of Pinheiro, Maranhão, and São Bento, Maranhão, Brazil.

Table 1. Types of containers and indication of the presence of larvae and/or adult arbovirus vector mosquitoes

Container Type	Presence of Larvae and/or Adult Mosquitoes
Small pond; tires; bottles; packaging materials	Larvae and adult mosquitoes
Water storage tank	Larvae
Packaging materials; PET bottles	Larvae and adult mosquitoes
Animal drinking troughs; plastic containers; swimming pools; tires; buckets	Larvae and adult mosquitoes
Tires	Larvae and adult mosquitoes
Flower pots	Larvae and adult mosquitoes

Figure 5. Containers with mosquito breeding sites in the municipalities of Pinheiro, Maranhão, and São Bento, Maranhão, Brazil.

5. Conclusion

The monitoring conducted in the municipality of Pinheiro clearly demonstrated that the presence of disease-transmitting mosquitoes is directly associated with environmental conditions and population habits within the territory. The high number of artificial breeding sites identified—particularly containers related to improper solid waste disposal and domestic water storage—confirms that urban spaces and peri-urban areas play a central role in mosquito reproduction. This scenario is consistent with findings reported in several studies addressing the influence of urban occupation on public health (Costa & Natal, 1998; Flauzino et al., 2009; Ferreira Filho, 2017).

The analysis of the 39 monitored sites, supported by spatial mapping and geolocation tools, enabled the identification of 19 critical areas with higher concentrations of breeding sites. These locations correspond to zones of greater social vulnerability, where high population density and deficiencies in urban infrastructure facilitate the mosquito life cycle. Such results reinforce the importance of mapping and geoprocessing technologies as indispensable tools for planning surveillance and vector control actions in a more efficient and targeted manner, particularly in neighborhoods with greater needs (Cavalcante et al., 2013; Bastos et al., 2019).

The use of GLOBE Program protocols proved effective in organizing data from Pinheiro in a standardized format, allowing local records to be integrated into a broader research database. This integration strengthens environmental monitoring efforts and generates valuable scientific information for the municipality. Furthermore, citizen science emerged as a key strategy for expanding data collection, enabling research activities to reach areas that are often not routinely covered by conventional surveillance programs (Baixo et al., 2021; Silva & Witt, 2024).

Active student participation throughout the research process was one of the most notable strengths of the study. Beyond expanding the scope of field inspections, this approach enhanced students' understanding of the relationship between environmental stewardship and community health. Such engagement transforms young participants into informed agents and multipliers of good practices within their neighborhoods, which is essential for the success of preventive public health measures (Nascimento et al., 2023).

Finally, the results indicate that addressing mosquito-borne diseases in Pinheiro and across the Maranhão lowlands requires integrated actions that combine education, basic sanitation services, and continuous surveillance. The continuation of projects that integrate technological tools, community engagement, and environmental education represents the most reliable pathway to achieving long-term reduction of breeding sites and safeguarding local population health (Vasconcelos & Luna, 2020).

6. REFERENCES

BRASIL**.** Ministério da Saúde. *Aedes aegypti*. Disponível em: <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/a/aedes-aegypti>. Acesso em: 3 mar. 2025.

FIGUEREDO, Sara A. et al. Perfil epidemiológico de arboviroses no estado do Maranhão durante os anos de 2017 a 2021. *ResearchGate*, 2023. Disponível em: <https://www.researchgate.net/publication/372875811_PERFIL_EPIDEMIOLOGICO_DE_ARBOVIROSES_NO_ESTADO_DO_MARANHAO_DURANTE_OS_ANOS_DE_2017_A_2021>. Acesso em: 3 mar. 2025.

MINISTÉRIO DA SAÚDE. Mobilização nacional nas escolas reforça o enfrentamento às arboviroses por meio da educação. Disponível em: <https://www.gov.br/saude/pt-br/assuntos/noticias/2025/fevereiro/mobilizacao-nacional-nas-escolas-reforca-o-enfrentamento-as-arboviroses-por-meio-da-educacao>. Acesso em: 3 mar. 2025.

NASCIMENTO. Graciele N. et al**.** Educação em saúde como estratégia de enfrentamento às arboviroses. *Anais do Congresso Nacional de Saúde*, 2023. Disponível em: <https://ime.events/conasc2023/pdf/19773>. Acesso em: 4 mar. 2025.

VASCONCELOS, P. F. C.; LUNA, E. J. A. Arboviroses emergentes e desafios para a saúde pública no Brasil. *Revista de Saúde Pública*, 2020. Disponível em: <https://ime.events/conasc2023/pdf/19773>. Acesso em: 4 mar. 2025.

Zika no município de São Luís, Maranhão, Brasil. 2018. Dissertação (Mestrado) – Universidade Federal do Maranhão, São Luís, 2018. Disponível em: http://tedebc.ufma.br:8080/jspui/bitstream/tede/2299/2/AdrianaAraujo.pdf . Acesso em: 30 ago. 2025.

BAIXO, R.; BOGER, R.; NELSON, P.; KIMURA, M. Dados de ciência cidadã do GLOBE Mosquito Habitat Mapper 2017–2020. GeoHealth, v. 5, e2021GH000436, 2021. Disponível em: https://doi.org/10.1029/2021GH000436 . Acesso em: 27 jul. 2025.

BASTOS, Ismael Brioso et al. Georreferenciamento dos imóveis com foco positivo do mosquito Aedes aegypti no município de Sobral (CE). Revista de APS, v. 22, n. 1, 2019. BONIXE, Lucas. Geojornalismo no Brasil: produção de mapas na cobertura jornalística de desastres naturais. Revista Brasileira de Estudos de Jornalismo, v. 9, n. 2, p. 38-59, 2020. DOI: https://doi.org/10.21168/rebej.v9n2.p38-59.

BRASIL. Lei nº 11.445, de 05 de janeiro de 2007. Estabelece as diretrizes nacionais para o saneamento básico. Diário Oficial da União, Brasília, DF, 08 jan. 2007. Disponível em: https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/l11445 .htm. Acesso em: dez.2024.

CAVALCANTE, Micheline Pimentel Ribeiro et al. Análise geoespacial: um estudo sobre a dengue. Acta Paulista de Enfermagem, v. 26, p. 360–368, 2013.

COLOMBO, Tatiana Elias et al. Performance of CDC Trioplex qPCR during a dengue outbreak in Brazil. Journal of Clinical Virology, v. 121, p. 104208, 2019. DOI: https://doi.org/10.1016/j.jcv.2019 .104208. Acesso em: dez.2024.

COSTA, Antonio Ismael Paulino da; NATAL, Delsio. Distribuição espacial da dengue e

determinantes socioeconômicos em localidade urbana no Sudeste do Brasil. Revista de Saúde Pública, v. 32, n. 3, p. 232–236, 1998. Disponível em: https://www.scielosp.org/article/ssm/content/raw/?resource_ssm_path=/media/assets/rsp/v32n3/p232-236.pdf . Acesso em: 08 nov. 2025.

COSTA, Luana Dias da et al. Percepção da população sobre a atuação das autoridades e das comunidades no controle das arboviroses. Saúde em Debate, v. 46, p. 790-802, 2022. DOI: https://doi.org/10.1590/0103-1104202213414i. Acesso em: dez.2024.

DA SILVA COSTA, Diógenes Felix et al. Análise geoestatística aplicada na distribuição de arboviroses emergentes no município de Caicó–RN. In: Os desafios da Geografia Física na fronteira do conhecimento. v. 1, p. 5462–5474, 2017.

DONALISIO, Maria Rita; FREITAS, André Ricardo Ribas. Chikungunya no Brasil: um desafio emergente. Revista Brasileira de Epidemiologia, v. 18, n. 1, p. 283-285, 2015. DOI: https://doi.org/10.1590/1980-5497201500010022. Acesso em: dez.2024.
FEITOSA, Manuella Carvalho et al. Avaliação da qualidade metodológica de diretrizes de vigilância e manejo clínico de dengue e chikungunya. Cadernos de Saúde Pública, v. 36, n. 7, p. e00050919, 2020. DOI: https://doi.org/10.1590/0102-311x00050919. Acesso em: dez.2024.

FERNANDES, Maria da Conceição Rodrigues; MONTE, Washington Sales do; BEZERRA, Francisco Silvestre Brilhante. Avaliação do desenvolvimento tecnológico em saúde a partir da ocorrência das epidemias de zika e chikungunya no Brasil. Cadernos de Saúde Pública, v. 39, p. e00090022, 2023. DOI: https://doi.org/10.1590/0102-311xpt090022. Acesso em: dez.2024.

FERREIRA FILHO, David Figueiredo. Fatores ambientais que contribuem para a proliferação do mosquito da dengue no bairro praia grande no distrito de Mosqueiro, Belém–PA. In: VIII Congresso Brasileiro de Gestão Ambiental Campo Grande, MS. Instituto Brasileiro de Estudos Ambientais. 2017. Acesso: 30/10/2024 link: https://www.ibeas.org.br/congresso/Trabalhos2017/V-016.pdf

FIGUEIREDO, Luan Andrade de et al. Dengue, geoprocessamento e saúde: estudo de caso na zona urbana do município de Santa Helena (2022 a 2024). 2024. Trabalho acadêmico. Disponível em: https://revistas.uepg.br/index.php/conexao/article/download/23150/209209219338 . Acesso em: 03 set. 2025.

FLAUZINO, Regina Fernandes; SOUZA-SANTOS, Reinaldo; OLIVEIRA, Rosely Magalhães. Dengue, geoprocessamento e indicadores socioeconômicos e ambientais: um estudo de revisão. Revista Panamericana de Salud Pública, v. 25, n. 5, p. 456–461, 2009. Disponível em: https://www.scielosp.org/pdf/rpsp/2009.v25n5/456-461/pt . Acesso em: 02 dez. 2025.

JUSTINO, Renato Nunes et al. Análise descritiva e espacial dos casos de vírus Zika e Chikungunya nos municípios do estado de Goiás. Movimenta, v. 14, n. 2, p. 188–197, 2021 .

LIM, Ah-Young et al. Uma revisão sistemática dos dados, métodos e covariáveis ambientais usados para mapear o risco de transmissão de arbovírus transmitidos pelo Aedes. BMC Infectious Diseases, v. 23, n. 1, p. 708, 2023.

LIMA-CAMARA, T. N. Dengue is a product of the environment: an approach to the impacts of the environment on the Aedes aegypti mosquito and disease cases. Revista Brasileira de Epidemiologia, v. 27, p. e240048, 2024. DOI: https://doi.org/10.1590/1980-549720240048 .

MARQUES, Jonatan Marques Campos. Estações climáticas e sua relação com casos notificados de Dengue no Brasil: um estudo ecológico. Barbacena – MG: Faculdade de Medicina de Barbacena (FAME/FUNJOBE), 2024.

MASULLO, Yata Anderson Gonzaga; CARVALHO, Ana Carolina Coutinho; RANGEL, Mauricio Eduardo Salgado. Geotecnologias aplicadas ao monitoramento do vetor Aedes aegypti na área Itaqui-Bacanga, São Luís–MA. Revista Geográfica de América Central, v. 2, n. 47E, 2011. Disponível em: https://www.revistas.una.ac.cr/index.php/geografica/article/download/2009/1908 . Acesso em: 09 set. 2025.

MOTA, Suianne Letícia Antunes et al. Arboviroses no Brasil: desafios para a saúde pública e o papel crucial do saneamento básico. Aracê, v. 6, n. 4, p. 11997–12010, 2024. Disponível em: https://periodicos.newsciencepubl.com/arace/article/view/1980 . Acesso em: 19 out. 2025.

MOTA, Suianne Letícia Antunes et al. Arbovírus no Brasil: desafios para a saúde pública e o papel crucial do saneamento básico. Aracê, v. 4, p. 11997–12010, 2024. DOI: 10.56238/arev6n4-066. Disponível em: https://periodicos.newsciencepubl.com/arace/article/view/1980 . Acesso em: 21 abr. 2025.
NEVES, David Pereira; ALAIN, Lani; DI MÉRIO, Pedro; LINARES, Marcos; W., Ricardo; ALMEIDA, Victor. Parasitologia humana. 12. ed. Rio de Janeiro: Atheneu, 2011.

OLIVEIRA, Raiane Fontes de et al. Dimensões da vulnerabilidade à dengue a partir da Região Metropolitana do Rio de Janeiro: das escalas de produção do espaço à reprodução do processo saúde-doença-atenção. 2024. Tese (Doutorado) – Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 2024. Disponível em: https://www.bdtd.uerj.br:8443/bitstream/1/23230/2/Tese%20-%20Raiane%20Fontes%20de%20Oliveira%20-%202024%20-%20Completa.pdf . Acesso em: 21 nov. 2025.

ORGANIZAÇÃO MUNDIAL DA SAÚDE. Dengue: diretrizes para diagnóstico, tratamento, prevenção e controle: nova edição. Genebra: Organização Mundial da Saúde, 2009.

RIBEIRO, Marisa O. et al. Analytical and clinical performance of molecular assay used by the Brazilian public laboratory network to detect and discriminate Zika, Dengue and Chikungunya viruses in blood. Brazilian Journal of Infectious Diseases, v. 25, p. 101542, 2021. DOI: https://doi.org/10.1016/j.bjid.2021.101542 .

ROCHA, Adriano Moura da. Geotecnologias e educação ambiental como estratégia para o monitoramento da dengue no ambiente urbano: pesquisa participativa na Vila Cruzado, município de São Luís (MA). 2009. Dissertação (Mestrado) – Universidade Federal do Maranhão, São Luís, 2009. Disponível em: https://rosario.ufma.br/jspui/bitstream/123456789/2321/1/Adriano%20Moura%20da%20Rocha.pdf . Acesso em: 12 jul. 2025.

SENA, Brena F. et al. Advancing arbovirus diagnosis in Brazil: strengthening diagnostic strategies and public health data collection. Brazilian Journal of Infectious Diseases, v. 28, p. 103766, 2024. DOI: https://doi.org/10.1016/j .bjid.2024.103766.

SILVA, Fabiano Couto Corrêa da; WITT, Amanda Santos. Ciência Cidadã: Monitoramento Participativo da Dengue. Anais do Encontro Nacional de Pesquisa em Ciência da Informação, Vitória, ES, 2024.

SILVA, Júlio Cesar Barreto da; MACHADO, Carlos José Saldanha. Associações entre dengue

e variáveis socioambientais nas capitais do Nordeste brasileiro por análise de agrupamentos. Ambiente & Sociedade, v. 21, 2019.
SIQUEIRA, A. S. P. et al. ArboAlvo: stratification method for territorial receptivity to urban arboviruses. Revista de Saúde Pública, v. 56, p. 39, 2022. Disponível em: https://doi.org/10.11606/s1518-8787.2022056003546 . Acesso em: 05 nov. 2025.

SOUZA, Jessica Suzarte Carvalho de et al. Modelagem espaço-temporal das arboviroses nas regiões de saúde do estado da Bahia: uma abordagem epidemiológica e ambiental. 2022. Dissertação (Mestrado) – Universidade Federal da Bahia, Salvador, 2022. Disponível em: http://200.128.81.65:8080/bitstream/tede/1561/2/Dissertacao_v_15_versao_imprimir_e_encadernar.pdf . Acesso em: 18 ago. 2025.

TWIDDY, S. S.; HOLMES, E. C.; RAMBAUT, A. Inferring the Rate and Time-Scale of Dengue Virus Evolution. Molecular Biology and Evolution, v. 20, n. 1, p. 122–129, jan. 2003. DOI: https://doi.org/10.1093/molbev/msg010 .

VALLADARES, Gustavo Souza et al. Influência de variáveis ambientais na ocorrência da dengue utilizando geoprocessamento em Teresina, Piauí. Hygeia: Revista Brasileira de Geografia Médica e da Saúde, v. 15, n. 34, p. 102, 2019. Disponível em: https://seer.ufu.br/index.php/hygeia/article/download/47771/28541/222469 . Acesso em: 14 out. 2025.

WILDER-SMITH, A. et al. Dengue. The Lancet, v. 393, n. 10169, p. 350–363, 2019. DOI: https://doi.org/10.1016/S0140-6736(18)32560-1 .
YARI, Jiyan et al. MAPAEDES: sistema de mapeamento georreferenciado de focos de larvas e mosquitos Aedes aegypti L. e suas patologias. Revista Foco, v. 16, n. 8, p. e2614, 2023.

6. Emblem Descriptions

I Am a GLOBE Researcher

Students from participating schools were actively engaged throughout the study, collecting data in their neighborhoods and documenting detailed information on the surveyed sites. The research support team was responsible for conducting field surveys, data analysis, and the preparation of the results and discussion sections.

I Am an Earth System Scientist

During the execution of field activities, the climate–mosquito relationship was addressed, highlighting the climatic variables that optimize the vectors' life cycle and examining their interaction with the local geography of the study area.

I Make an Impact

The study had a significant societal impact, as students—through data collection, the exchange of information provided by the Municipal Health Department, which collaborated in selected field activities, and learning about disease-vector mosquitoes—shared this knowledge with their families. These family members reported changes in behaviors that could otherwise favor the proliferation of these insects. As a result, a positive impact on the community can be observed.