**INOSR Scientific Research 12(3):108-112, 2025.** **ISSN: 2705-1706**
**©INOSR PUBLICATIONS** **INOSRSR12300000**
**International Network Organization for Scientific Research**
**https://doi.org/10.59298/INOSRSR/2025/123108112**

# Wetlands and Malaria Transmission: Exploring the Relationship in West African Ecosystems

**Kibibi Wairimu H.**

**School of Natural and Applied Sciences Kampala International University Uganda**

## ABSTRACT

Wetlands in West Africa are critical to the region's ecological health and socioeconomic stability, providing essential services such as water filtration, flood control, and biodiversity conservation. However, they also serve as breeding grounds for Anopheles mosquitoes, the primary vectors of malaria, exacerbating the disease burden in nearby communities. Malaria remains a leading cause of morbidity and mortality, particularly in wetland-dependent areas. This review explores the complex relationship between wetlands and malaria transmission, investigating how ecological factors such as hydrology, vegetation, and human activities influence mosquito populations. It examines existing wetland management practices and their impact on malaria control, highlighting the need for integrated strategies that balance environmental conservation with public health objectives. The review also evaluates the socioeconomic consequences of malaria in wetland regions, particularly on vulnerable populations. Finally, it proposes integrated approaches for sustainable wetland management and malaria control, emphasizing community engagement, eco-friendly interventions, and policy recommendations aimed at achieving long-term, effective solutions.

**Keywords**: West Africa, wetlands, malaria transmission, Anopheles mosquitoes, integrated malaria control.

## INTRODUCTION

Wetlands are among the most productive ecosystems in the world, offering essential ecosystem services such as water filtration, flood control, carbon sequestration, and biodiversity conservation [1]. These ecosystems support a diverse range of flora and fauna, playing a crucial role in maintaining environmental stability and human livelihoods. In West Africa, wetlands serve as vital sources of water for agriculture, fishing, and domestic use, making them indispensable to local communities [2]. However, despite their ecological and economic benefits, wetlands also present significant public health challenges. One of the most critical concerns is their role as breeding sites for Anopheles mosquitoes, the primary vectors of malaria. Malaria remains one of the most prevalent and deadly infectious diseases in West Africa, disproportionately affecting rural populations that rely heavily on wetland ecosystems [3]. The persistence of malaria in the region is influenced by multiple factors, including climate variability, land use patterns, and socio-economic conditions. Given that wetlands provide a conducive environment for mosquito breeding, there is a growing need to investigate the complex interactions between wetland ecosystems and malaria transmission [4]. A deeper understanding of this relationship can inform more effective malaria control strategies that balance public health objectives with environmental conservation goals. Malaria is a significant public health challenge in West Africa, accounting for a substantial proportion of global malaria cases and deaths. The region's climatic conditions, characterized by high humidity and seasonal rainfall, create ideal breeding environments for Anopheles mosquitoes [5]. Wetlands, in particular, provide standing water and abundant vegetation, making them highly suitable for mosquito proliferation. As a result, communities living near wetlands are at increased risk of malaria transmission, especially during peak transmission seasons [6]. Over the years, efforts to combat malaria have focused on various interventions, including insecticide-treated bed nets (ITNs), indoor residual spraying (IRS), and antimalarial medications [7]. While these measures have led to a decline in malaria incidence in some areas, the persistence of the disease indicates that additional strategies are needed. In particular, environmental management approaches that target mosquito breeding sites, such as wetland modification or larval source management, have gained attention as complementary strategies for malaria control [8].

Despite the recognized link between wetlands and malaria transmission, there is limited research on how specific wetland characteristics, such as hydrology, vegetation cover, and human activities, influence mosquito populations [9]. Furthermore, there is a need to examine how wetland conservation efforts can be integrated with malaria control programs to achieve sustainable outcomes. Understanding these dynamics is essential for developing holistic strategies that address both environmental and public health concerns. Malaria remains a leading cause of morbidity and mortality in West Africa, with wetlands playing a significant role in sustaining mosquito populations [10]. While wetlands provide crucial ecological services, their function as mosquito breeding sites presents a dilemma for public health and environmental management. Efforts to drain or modify wetlands for malaria control can have unintended consequences, such as biodiversity loss and disruption of local livelihoods [11]. Conversely, conservation-focused approaches may inadvertently contribute to increased malaria risk if mosquito populations are not effectively managed. There is a need for an integrated approach that balances wetland conservation with malaria control efforts. However, achieving this balance requires a deeper understanding of the specific interactions between wetland ecosystems and malaria transmission dynamics [12]. Limited research on this topic has resulted in fragmented and sometimes conflicting strategies, highlighting the need for comprehensive studies that explore the ecological, epidemiological, and socio-economic dimensions of the issue [13]. This study aims to examine the ecological characteristics of wetlands in West Africa that influence Anopheles mosquito breeding and malaria transmission. It assesses the impact of wetland management practices on mosquito population dynamics and malaria risk, analyzes the socio-economic and health implications of malaria transmission in wetland-dependent communities, explores integrated approaches that combine wetland conservation and malaria control for sustainable health and environmental outcomes, and provides policy recommendations for mitigating malaria risk while preserving the ecological integrity of wetlands. The study addresses several research questions, including the key ecological factors within wetland ecosystems that contribute to Anopheles mosquito breeding and malaria transmission, the impact of current wetland management practices on mosquito populations and malaria prevalence in West Africa, the socio-economic and health burdens of malaria on communities living near wetlands, how malaria control measures can be integrated with wetland conservation strategies for more effective and sustainable outcomes, and what policy interventions can be proposed to address the dual challenge of malaria control and wetland conservation in West Africa. The findings have practical implications for malaria control programs in West Africa, as understanding how wetland management practices affect mosquito populations can help refine existing interventions and promote more effective strategies. The study also sheds light on the socio-economic and health challenges faced by communities living near wetlands, as malaria imposes a significant economic burden on households, affecting productivity, healthcare costs, and overall well-being. The study promotes an integrated approach to malaria control and wetland conservation, bridging traditional malaria interventions with wetland conservation efforts, leading to more holistic and sustainable solutions that benefit both human populations and the environment. Policy recommendations derived from this study can guide governments, environmental agencies, and health organizations in designing evidence-based interventions, incorporating malaria risk reduction strategies and supporting wetland conservation. Understanding the complex interactions between wetland ecosystems and malaria transmission is crucial for developing effective and sustainable interventions. By integrating wetland conservation with malaria control strategies, the study aims to contribute to improving public health while maintaining ecological integrity, ultimately guiding policies and interventions that address both environmental and public health challenges in West Africa.

## Wetland Ecosystems in West Africa

Wetland ecosystems in West Africa are crucial for the region's ecological health and economic activities. These ecosystems, including mangroves, floodplains, swamps, and inland deltas, are characterized by their high biodiversity, productivity, and essential services to the environment and local communities [14]. Mangroves, found along the coastal regions, provide habitat for fish, shellfish, and bird species, protecting coastal areas from erosion and reducing storm surge impacts. Floodplains, low-lying areas adjacent to rivers, support a variety of plant and animal species and are important for agriculture, particularly rice farming. Swamps, found in both coastal and inland regions, are highly productive environments providing habitat for amphibians, birds, and aquatic organisms. Inland deltas, such as the Inner Niger Delta in Mali and the Niger Delta in Nigeria, are large areas of seasonal or permanent flooding caused by river systems, supporting complex networks of water channels and islands [15]. Wetlands provide a wide range of ecosystem services, including biodiversity support, water filtration, flood regulation, and climate change mitigation. However, challenges such as malaria transmission pose significant challenges to these ecosystems. Wetland ecosystems in West Africa face significant threats, including agricultural expansion, pollution, overfishing, and climate change. The growing population pressures wetlands for crop production, leading to habitat loss, soil degradation, and altered hydrology. Pollution from industrial, agricultural, and domestic sources degrades water quality, harms aquatic life, and disrupts local ecosystems. Overfishing threatens the sustainability of fish stocks in areas like the Niger Delta. Climate change affects wetlands' hydrological cycles, leading to droughts or flooding. Wetlands also play a role in malaria transmission, as they provide breeding grounds for mosquitoes. Staggered

water bodies and increased mosquito populations create favorable conditions for malaria transmission. Mitigation strategies include drainage and water management, insecticide-treated nets and indoor spraying, and integrated vector management. Balancing the ecological value of wetlands with the need to mitigate malaria transmission requires integrated approaches considering both environmental health and human health factors [16].

**Malaria Transmission Dynamics in Wetland Areas**

Malaria transmission in wetland regions is influenced by various factors, including the availability of suitable breeding sites for mosquitoes, particularly the Anopheles species responsible for transmitting the malaria parasite (Plasmodium) [17]. Wetlands, with their abundant sources of stagnant water, provide ideal breeding conditions for these mosquitoes. Climate conditions, such as temperature, humidity, and rainfall patterns, play a significant role in malaria transmission dynamics. Warmer temperatures accelerate the incubation period of the malaria parasite inside the mosquito, while humidity affects the parasite's survival. Malaria transmission tends to peak in wetland regions during or immediately after the rainy season, as water levels are highest and new mosquito breeding sites are abundant. Human activities in and around wetland regions can significantly influence malaria transmission by creating more breeding sites or increasing the likelihood of human-mosquito contact. Irrigation practices for farming, fishing, and settlements near wetlands can increase mosquito populations and exposure to malaria [18]. Urbanization, lack of sanitation infrastructure, and untreated waste in wetland ecosystems also contribute to the problem. Malaria transmission in wetland regions is exacerbated by factors such as lack of effective vector control measures, environmental degradation, and human activities. Mitigation strategies include integrated vector management (IVM), sustainable agricultural practices, and community education. Controlling malaria transmission in wetland regions requires a multifaceted approach considering wetland ecosystem characteristics and sustainable practices.

**Socioeconomic and Environmental Impacts**

Malaria in wetland areas is a major public health issue, affecting community well-being, economic stability, and environmental sustainability. It is a leading cause of morbidity and mortality, particularly among vulnerable groups like children under five, pregnant women, and the elderly [19]. The disease's persistence places immense pressure on healthcare systems, reducing the capacity of local clinics and hospitals to respond to other health crises. The high demand for antimalarial drugs, diagnostics, and vector control measures can lead to shortages, inadequate treatment, and the potential emergence of drug-resistant strains. Health inequities exist in wetland-dependent regions, particularly rural areas with poor infrastructure, contributing to higher rates of malaria-related illness and mortality among marginalized populations. The high health burden disproportionately affects women and children, exacerbating gender and age-related disparities in health outcomes. The economic consequences of malaria in wetland areas are substantial, affecting individual households and the broader economy. The disease leads to decreased productivity, higher medical costs, and reduced economic opportunities for individuals and communities. Land-use modifications, such as wetland drainage, urban expansion, and agricultural intensification, can disrupt natural ecosystems and influence malaria transmission patterns [20]. Climate change and environmental stressors can alter malaria transmission patterns, affecting water availability, flooding regimes, and seasonal variations. Effective malaria control in wetland areas requires a holistic approach that includes health interventions and environmental management strategies.

**Strategies for Malaria Control in Wetland Regions**

Malaria control in wetland regions requires a comprehensive approach that considers the unique environmental and socioeconomic contexts of the region. Strategies include vector control methods, sustainable wetland management, and community engagement [21]. Vector control methods, such as insecticide-treated nets (ITNs) and indoor residual spraying (IRS), disrupt the mosquito life cycle and minimize human-mosquito contact. LSM targets mosquito breeding sites through biological and environmental control methods. Sustainable wetland management practices balance malaria control with wetland conservation, protecting wetland ecosystems from over-exploitation and degradation while minimizing the creation of mosquito breeding habitats. Controlled water management and flood control and drainage systems are essential for controlling mosquito populations and preserving wetland ecosystems. To combat malaria, an integrated approach involving natural wetland hydrology restoration, ecosystem-based approaches, eco-friendly interventions, and biodiversity conservation is crucial [22]. Restoring natural hydrological processes, integrating ecosystem-based approaches, and focusing on vulnerable populations can improve ecosystem health and reduce malaria transmission. Eco-friendly interventions, such as planting vegetation around water bodies, can prevent mosquito breeding without disrupting the ecosystem. Community engagement and education are essential in wetland regions where local populations rely on natural resources for livelihoods.

**CONCLUSION**

The relationship between wetlands and malaria transmission in West Africa is complex, as they provide essential services to local communities but also serve as breeding grounds for Anopheles mosquitoes, increasing the risk of malaria transmission. To mitigate malaria, integrated and sustainable approaches must be adopted, going beyond traditional methods like insecticide-treated nets and indoor residual spraying. Environmental management practices

targeting mosquito breeding sites, such as larval source management and controlled water management, are also crucial. Restoring natural wetland hydrology and promoting eco-friendly interventions are also essential. Sustainable wetland management is crucial in striking a balance between conservation and public health objectives. An ecosystem-based approach can integrate wetland conservation with malaria control strategies, leading to more effective and long-term solutions. Community engagement is essential, as local populations must be educated on malaria prevention and the importance of preserving wetland ecosystems. A comprehensive and integrated approach to malaria control in wetland regions is needed, considering the unique ecological, socio-economic, and cultural contexts of wetland-dependent communities. Policy interventions promoting malaria risk reduction and wetland conservation are essential for improving public health while safeguarding the region's critical environmental resources.

## REFERENCES


1. Ferreira, C.S.S., Kašanin-Grubin, M., Solomun, M.K., Sushkova, S., Minkina, T., Zhao, W., Kalantari, Z.: Wetlands as nature-based solutions for water management in different environments. Current Opinion in Environmental Science & Health. 33, 100476 (2023). https://doi.org/10.1016/j.coesh.2023.100476
2. Alum, E.U., Ugwu, O.P.C., Egba, S.I., Uti, D.E., Alum, B.N. (2024). Climate Variability and Malaria Transmission: Unraveling the Complex Relationship. INOSR Scientific Research 11(2):16-22. https://doi.org/10.59298/INOSRSR/2024/1.1.21622
3. Egwu, C. O., Aloke, C., Chukwu, J., Agwu, A., Alum, E., Tsamesidis, I, et al. A world free of malaria: It is time for Africa to actively champion and take leadership of elimination and eradication strategies. Afr Health Sci. 2022 Dec;22(4):627-640. doi: 10.4314/ahs.v22i4.68
4. Waheb B, Uzair S, Onur M, Ting-Wei S, Oguzhan Y, Shirley L, Aydogan O (2011). Handheld, lensless microscope identifies malaria parasites. *SPIE newsroom, 10-12. 10.1117/2.1201107.003812*
5. Alum, E. U., Tufail, T., Agu, P. C., Akinloye, D. I., & Obaroh, I. O. (2024). Malaria pervasiveness in Sub-Saharan Africa: Overcoming the scuffle. *Medicine, 103*(49), e40241. doi: 10.1097/MD.0000000000040241. PMID: 39654176
6. Ebele J. I, Emeka E. N., Nnenna C. A., Ignatius C. M., Emeka G. A. (2010). Malaria parasitaemia: effect on serum sodium and potassium levels. Biol Med, 2, 2, 20-25.
7. Pryce, J., Medley, N., Choi, L.: Indoor residual spraying for preventing malaria in communities using insecticide-treated nets. Cochrane Database Syst Rev. 2022, CD012688 (2022). https://doi.org/10.1002/14651858.CD012688.pub3
8. Obeagu, E., Obeagu, G.: Malaria's Silent Partner: Anemia in Children. 2, 1–7 (2024)
9. Olubunmi A., Faoziyat A. S, Abdulmumeen A. H, Azeezat A., Abraham C A., Oloriegbe S, Basheer A. B., Olatunji G. A, Kambizi L (2021). In pursuit of new anti-malarial candidates: novel synthesized and characterized pyrano-benzodioxepin analogues attenuated Plasmodium berghei replication in malaria-infected mice. Heliyon, 7, (12), 8523.DOI:https://doi.org/10.1016/j.heliyon.2021.e08517
10. Li, J., Docile, H.J., Fisher, D., Pronyuk, K., Zhao, L.: Current Status of Malaria Control and Elimination in Africa: Epidemiology, Diagnosis, Treatment, Progress and Challenges. J Epidemiol Glob Health. 14, 561–579 (2024). https://doi.org/10.1007/s44197-024-00228-2
11. Armin R., Michele R. R., (2013). Malaria during pregnancy with parasite sequestration in the villous chamber. *Blood, the Journal of the American Society of Hematology, 121, (12), 2173-2173. https://doi.org/10.1182/blood-2012-10-465096*
12. Ugwu, O. P. C., Alum, E. U. and Uhama, K. C. (2024). Dual Burden of Diabetes Mellitus and Malaria: Exploring the Role of Phytochemicals and Vitamins in Disease Management. Research Invention Journal of Research in Medical Sciences. 3(2):38-49.
13. Gebrekidan, T.K., Weldemariam, N.G., Hidru, H.D., Gebremedhin, G.G., Weldemariam, A.K.: Impact of improper municipal solid waste management on fostering One Health approach in Ethiopia — challenges and opportunities: a systematic review. Science in One Health. 3, 100081 (2024). https://doi.org/10.1016/j.soh.2024.100081
14. Géant, C.B., Wellens, J., Gustave, M.N., Schmitz, S.: How Rural Communities Relate to Nature in Sub-Saharan Regions: Perception of Ecosystem Services Provided by Wetlands in South-Kivu. Sustainability. 16, 7073 (2024). https://doi.org/10.3390/su16167073
15. Dasgupta, R.R., Mao, W., Ogbuoji, O.: Addressing child health inequity through case management of under-five malaria in Nigeria: an extended cost-effectiveness analysis. Malaria Journal. 21, 81 (2022). https://doi.org/10.1186/s12936-022-04113-w
16. Obeagu E. I, Obeagu G, U, Egba S. I, Emeka-Obi O. R, (2023) Combatting Anaemia in Paediatric Malaria: Effective management strategies Int. J. Curr. Res. Med. Sci. (2023). 9(11): 1-7

17. Koffi, A.A., Camara, S., Ahoua Alou, L.P., Oumbouke, W.A., Wolie, R.Z., Tia, I.Z., Sternberg, E.D., Yapo, F.H.A., Koffi, F.M., Assi, S.B., Cook, J., Thomas, M.B., N'Guessan, R.: Anopheles vector distribution and malaria transmission dynamics in Gbêkê region, central Côte d'Ivoire. Malaria Journal. 22, 192 (2023). https://doi.org/10.1186/s12936-023-04623-1
18. Emmanuel I. N., Ani. O. C., Ugwu F. J., Egba S. I., Aguzie I. O., Okeke O. P., Dialoke C. E., Asogwa L. O., Odo S. I. (2020) Malaria Prevalence in Rice Farm Settlements South East Nigeria. IJTDH, 41(9): 64-74
19. Liu, Q., Jing, W., Kang, L., Liu, J., Liu, M.: Trends of the global, regional and national incidence of malaria in 204 countries from 1990 to 2019 and implications for malaria prevention. J Travel Med. 28, taab046 (2021). https://doi.org/10.1093/jtm/taab046
20. Alum, E. U. (2024). Phytochemicals in Malaria Treatment: Mechanisms of Action and Clinical Efficacy. KIU J. Health Sci., 4(2):71-84. https://doi.org/10.59568/KJHS-2024-4-2-06.
21. Okumu, F., Moore, S.J., Selvaraj, P., Yafin, A.H., Juma, E.O., Shirima, G.G., Majambere, S., Hardy, A., Knols, B.G.J., Msugupakulya, B.J., Finda, M., Kahamba, N., Thomsen, E., Ahmed, A., Zohdy, S., Chaki, P., DeChant, P., Fornace, K., Govella, N., Gowelo, S., Hakizimana, E., Hamainza, B., Ijumba, J.N., Jany, W., Kafy, H.T., Kaindoa, E.W., Kariuki, L., Kiware, S., Kweka, E.J., Lobo, N.F., Marrenjo, D., Matoke-Muhia, D., Mbogo, C., McCann, R.S., Monroe, A., Ndenga, B.A., Ngowo, H.S., Ochomo, E., Opiyo, M., Reithinger, R., Sikaala, C.H., Tatarsky, A., Takudzwa, D., Trujillano, F., Sherrard-Smith, E.: Elevating larval source management as a key strategy for controlling malaria and other vector-borne diseases in Africa. Parasites & Vectors. 18, 45 (2025). https://doi.org/10.1186/s13071-024-06621-x
22. Nabukenya I, Kaddu-Mulindwa D, Nasinyama G W (2013). Survey of *Brucella*infection and malaria among Abattoir workers in Kampala and Mbarara Districts, Uganda. *BMC public health*, *13*, *1-6*.

**CITE AS: Kibibi Wairimu H. (2025). Wetlands and Malaria Transmission: Exploring the Relationship in West African Ecosystems. INOSR Scientific Research 12(3):108-112.**
**https://doi.org/10.59298/INOSRSR/2025/123108112**