



Submitted:
29 April 2026
Revised:
12 May 2026
Published:
30 May 2026

CONTACT

Correspondence Email:
merrenogimagasin@mail.ugm.ac.id

Address: Ngestiharjo,
Kec. Kasihan. Kab.
Bantul, D.I. Yogyakarta.
55799.

KEYWORDS

Ekologi, penyakit,
mobilitas masyarakat,
malaria.

COLONIAL FRONTIER AND THE PRODUCTION OF VULNERABILITY: POPULATION MOBILITY AS AN ECOLOGICAL FACTOR IN EARLY 20TH-CENTURY MALARIA ENDEMICITY IN BANYUWANGI

MERREN OGI MAGASIN

Universitas Gadjah Mada

ABSTRACT

Malaria in Banyuwangi is conceptualized in this study not solely as a medico-biological phenomenon, but rather as a product of historical processes encompassing human mobility, landscape transformation, and colonial economic expansion. Consequently, the primary focus is directed toward the mechanisms by which migration and colonial landscape alterations generated the socio-ecological conditions that enabled malaria to become endemic. Rather than treating malaria as a purely biological phenomenon, as conventional medical perspectives often do, this study situates the disease within a broader framework of environmental history and colonial dynamics. Drawing upon the 1930 Population Census (*Volkstelling*), colonial reports, and a diachronic historical approach, this paper argues that large-scale migration to frontier regions like Banyuwangi not only altered demographic structures but also engineered novel ecological conditions conducive to malaria transmission. Deforestation, the proliferation of artificial water bodies, and the expansion of unsanitary temporary settlements played pivotal roles in creating breeding sites for vectors. Furthermore, the colonial economic system, particularly estate expansion, exacerbated environmental disruption while failing to provide adequate health infrastructure. Ultimately, malaria must be understood as a socially and historically produced vulnerability rather than an inevitable tropical malady. This study highlights the importance of integrating environmental and social perspectives into historical analyses of disease in colonial contexts.

I. INTRODUCTION

Studies of malaria in colonial historiography have generally been situated within medical and geographical frameworks that emphasize natural factors as the primary cause of disease outbreaks. From this perspective, malaria is frequently framed as a tropical disease inherently linked to warm, humid environments, swamps, and stagnant water. While not entirely incorrect, this view oversimplifies the complexity of the issue by ignoring the historical and social dimensions that shaped these ecological conditions. With the evolution of historiography, particularly in environmental history and the history of medicine, there has emerged a growing recognition that diseases cannot be detached from their surrounding social, economic, and political dynamics (Crosby, 2004; McNeill, 1976). In other words, disease is not merely a biological phenomenon; it is the product of historical interactions between humans and their environments.

Within this analytical framework, early 20th-century Banyuwangi presents a compelling case study. As part of the Besuki Residency, Banyuwangi possessed distinct geographical characteristics and underwent intense socio-economic dynamics driven by colonial expansion. The region operated as a colonial frontier: a sparsely populated yet resource-rich area that became a primary target for economic expansion via land clearing and plantation development. In this context, the frontier represents more than a geographical boundary; it is a historical space undergoing rapid and profound transformation, wherein relations between humans, nature, and power are continuously reshaped.

To date, historical scholarship on malaria in the Dutch East Indies has largely followed two main tracks. The first views malaria as a biological and medical problem linked to tropical conditions, sanitation, and epidemiological patterns. The second focuses on colonial health policy and institutional responses to tropical diseases. While both approaches provide valuable insights, a critical gap remains regarding how population mobility, environmental alteration, and the creation of disease-vulnerable spaces intersected in colonial territories. This article offers a fresh perspective by examining Banyuwangi as a locus of significant social and ecological shifts driven by economic expansion and labor migration.

In analyzing frontier dynamics, Igor Kopytoff (1987) conceptualizes the frontier as an arena of internal colonization characterized by population movements, social reorganization, and resource extraction. A frontier is not merely a borderland, but a space of transformation merging migration, community formation, and shifts in human-environment relationships. In Banyuwangi, the surge of migration to estate regions during the 1920s illustrates this frontier process. Population movement did not simply yield demographic growth; it reorganized space through deforestation, the construction of new settlements, and the expansion of colonial production grounds. Thus, migration in Banyuwangi can be understood as an integral component of colonial frontier building that directly altered the region's ecological matrix.

Similarly, Anna Tsing (2005) defines the frontier as a zone of ecological instability produced by the intrusion of capitalism into peripheral areas. Tsing argues that frontiers are not empty spaces, but arenas of "friction", the collisions between economic growth, human mobility, and local ecological conditions. This process renders the frontier a site of heightened socio-ecological inequality. This approach is vital for analyzing early 20th-century Banyuwangi, where plantation expansion triggered landscape disruptions and heightened health risks for migrant laborers. Deforestation, irrigation canal construction, and the rise of labor settlements established novel ecological niches conducive to vector proliferation. Thus, malaria in Banyuwangi was not a natural condition of the tropics, but a consequence of colonial friction between economic expansion and environmental change.

Building upon these theoretical foundations, this article treats the frontier not merely as a physical backdrop for malaria, but as a historical process that concurrently generated social and ecological transformations. The contribution of this research lies in bridging frontier studies with colonial environmental and health histories. Migration is interpreted here as an agent of environmental change that shaped habitats for disease, while malaria is analyzed as an outcome of vulnerability produced within colonial frontier spaces. In doing so, this study enriches the historiography of malaria in Indonesia by showing how the disease evolved through interactions among population movements, landscape alterations, and colonial power relations.

One of the most striking features of Banyuwangi's dynamics during this era was rapid demographic growth, particularly between 1920 and 1930. This growth cannot be attributed solely to natural increase (birth rates); it was heavily driven by inbound migration from other areas of Java and Madura (*Volkstelling*, 1930). This migration was propelled by push-and-pull factors ranging from demographic pressure in origin regions to economic opportunities offered by Banyuwangi's plantation sector. In the colonial context, this mobility was far from spontaneous, it aligned with a broader economic logic in which labor supply was crucial for production.

However, migration studies in Indonesian historiography frequently focus on demographic or economic metrics while neglecting their environmental and public health ramifications. Yet, population mobility carries profound implications within a colonial frontier. Beyond relocating people, migration introduces new social practices, technologies, and environmental management strategies. Thus, population movement can be conceptualized as an agent of ecological change with direct impacts on ecosystems and landscapes (Packard, 2007).

In recent decades, international scholarship has increasingly explored the nexus of environmental change and disease in colonial contexts. These studies demonstrate that colonial economic expansion, especially through plantation agriculture and commercial farming, frequently entailed drastic landscape alterations, including deforestation, altered hydrological systems, and biodiversity loss. These ecological disruptions created conditions that favored vector-

borne diseases like malaria. Disease, therefore, was not an isolated event, but a collateral consequence of human intervention in nature.

Nevertheless, research specifically connecting population mobility, environmental transformation, and malaria endemicity in East Java, particularly Banyuwangi, remains sparse. Most existing literature treats environmental factors as primary variables without explicitly linking them to migration patterns and colonial policies. This article addresses that analytical gap. By integrating environmental and social history, this study provides a holistic account of how malaria flourished within a colonial frontier environment.

This paper operates on the premise that malaria in Banyuwangi was not a random natural occurrence, but the product of interacting historical processes. Population mobility served as a catalyst, altering demographic profiles while simultaneously driving landscape transformations that impacted ecological stability. Forest clearing, agricultural expansion, and the establishment of new settlements disrupted existing ecological balances, altering vegetation structures and water dynamics. These changes created optimal breeding grounds for malaria vectors, notably *Anopheles* mosquitoes.

Furthermore, the socio-economic conditions of migrant workers heightened their vulnerability. Unplanned settlements, limited access to clean water and sanitation, and a lack of health infrastructure rendered worker communities susceptible to disease transmission. In this environment, malaria emerged not only as an environmental issue, but also as a social problem tied to resource allocation and public infrastructure.

Accordingly, this article argues that malaria in Banyuwangi from 1920 to 1930 was the product of a "production of vulnerability", a condition in which structural factors (demographics, environment, and colonial policies) intersected to generate severe health risks. This framework moves past strictly biological explanations to reveal disease as an outcome of broader socio-historical processes.

Ultimately, malaria in Banyuwangi cannot be understood solely through a medical or biological lens. The disease emerged from the intersection of colonial economic exploitation, human movement, and environmental change. This study challenges colonial narratives that reduced malaria to a byproduct of tropical climates, demonstrating instead how disease distribution was shaped by socio-ecological inequalities. Applying an environmental history framework reveals public health as an arena shaped by interactions among humans, ecosystems, and state power.

Extensive land clearing in Banyuwangi during the late 19th and early 20th centuries was part of Dutch colonial economic expansion across eastern Java. This endeavor aimed to expand export crop production, such as coffee and cinchona, in the mountainous zones of Ijen and Merapi, as well as southern Banyuwangi. Forests were cleared and converted into plantation estates through *ontginning* concessions granted by the colonial government to private enterprises and individuals.

As noted in a 1930 issue of *De Locomotief*, land concession practices were frequently marred by irregularities, including the use of front men (*strooman*) and the influx of external laborers specifically brought in to clear land (*De Locomotief*, 1930).

This agrarian transformation reshaped the local ecology. Forests that once acted as ecological buffers were cleared for plantations and worker housing. These land clearance activities altered hydrological flows, created stagnant pools, left irrigation channels unmanaged, and exposed open wetlands. These conditions formed ideal habitats for *Anopheles* mosquitoes, the primary vectors of malaria. Thus, colonial plantation development did not merely restructure Banyuwangi's economy; it engineered an environment tailored for malaria transmission.

Colonial health records frequently identified Banyuwangi as a primary endemic hotspot for malaria in East Java. The early 20th-century resurgence of malaria in the region was fundamentally bound to colonial land development and estate expansion. Policies focused on resource exploitation altered both ecology and demographics: forests were cleared, hydrological systems were disrupted, migrant populations were introduced, and plantations expanded without accompanying public health infrastructure. In this light, malaria was not simply a medical issue, but a historical outcome of colonial transformations across Banyuwangi's landscape.

In conclusion, this research aims to provide a comprehensive understanding of how population mobility contributed to environmental transformations and how these dynamics fostered malaria endemicity. In doing so, this article contributes to the historiography of health in Indonesia while offering a broader perspective on the historical interplay between human activity, environmental alteration, and disease under colonial rule.

II. METHODS

The methodology applied in this research is the historical research method. This approach consists of four steps. The first step is heuristics, or source collection, followed by source criticism and verification. Subsequently, there is the data interpretation phase, which aims to synthesize facts into a coherent whole. The final phase is historiography, namely the writing of the comprehensive narrative (Kartodirdjo, 1992; Kuntowijoyo, 2018). In this research process, the author utilized various primary sources, such as contemporaneous medical journals including *Mededeelingen Van Den Dienst Der Volksgezondheid en Van Den Burgelijken Geneeskundigen Dienst*, *Geneeskundig Tijdschrift Voor Nederlandsch Indië Uitgegeven*, and *Jaarcijfers voor het Koninkrijk der Nederlanden*; newspapers such as *De Locomotief*, *De Avondpost*, *De Nieuwe Courant*, *Preangerbode*, *De Nieuwe Vorstenlanden*, *Bataviaasch Nieuwsblad*, and *De Indische Courant*; as well as archival records from ANRI (National Archives of the Republic of Indonesia) and the *Nationaal Archief*, among others.

Drawing from Dutch East Indies newspapers, for instance, environmental transformations occurred concurrently with mass population movements. Articles regarding F. L. Bresser indicate that since the 1890s, the Ijen and Southern Banyuwangi regions were intensively opened up by plantation companies. This land expansion demanded a large labor force that could not be supplied solely by the local population. Consequently, the colonial government, alongside plantation entities, recruited workers from various regions across Java, particularly from densely populated areas such as Madiun, Kediri, Kedu, and Madura. This influx of labor migration triggered the emergence of new settlements surrounding the plantations, which were generally characterized by poor sanitation conditions and a lack of health facilities (*De Avondpost*, 1932).

The high density of migrant workers in plantation areas accelerated the spread of malaria. Many plantation laborers resided in rudimentary barracks situated near forests, swamps, or waterways that served as breeding sites for mosquitoes. Furthermore, workers originating from non-endemic malaria regions generally lacked immunity to the disease. As a result, morbidity and mortality rates due to malaria in Banyuwangi increased drastically in the early 20th century.

The migration process to Banyuwangi exerted a substantial ecological impact. Migrants working as plantation laborers cleared new forest areas for agricultural land and residential settlements. These activities led to alterations in local vegetation structures and hydrological systems. Forests that previously functioned as natural buffers were cleared and replaced by open land, which was more vulnerable to flooding. Additionally, the construction of rudimentary drainage and irrigation channels that were uncoordinated with the broader water management system resulted in water stagnation in various locations. This condition created an environment highly conducive to the proliferation of *Anopheles* mosquito larvae. Consequently, migration influenced not only population composition but also created new ecological niches that facilitated the transmission of malaria.

The source evaluation process was conducted through both internal and external criticism, ensuring the validity of the data used in this study. External evaluation aimed to establish the authenticity of the documents. For instance, regarding the January 15, 1908 edition of *De Locomotief*, the researcher verified publisher information, publication year, digital reproduction conditions at the *Koninklijke Bibliotheek*, and edition number consistency within archival catalogs to ensure that the document was authentic and chronologically relevant. Internal evaluation was conducted by analyzing the textual content and credibility. For example, in the November 2, 1921 edition of *De Nieuwe Courant*, under the column regarding the suspension of health services, the author noted that due to funding shortages, local health services in Banyuwangi were suspended starting October 1. Subsequently, the government urgently allocated funds via telegram for local health services, allowing operations to resume; however, malaria eradication activities had to be temporarily halted.

During the interpretation phase, the production of malaria vulnerability in Banyuwangi emerged through the interplay between the Dutch colonial economic structure, the social conditions of migrants, and environmental transformations. Migrant laborers in the plantation sector received minimal wages and lived under unstable economic conditions. Consequently, they were only able to construct makeshift dwellings made of bamboo and thatch around plantation perimeters or accessible wetland areas. Simultaneously, land clearing and drainage system development in plantations created numerous stagnant pools of water that served as mosquito breeding grounds. Therefore, vulnerability to malaria was not an inherent natural condition of tropical communities, but rather the outcome of social and economic structures generated by the colonial system. In this context, disease progression was driven not only by the presence of vectors, but also by power relations that placed migrant groups in ecologically and socially vulnerable conditions.

To synthesize the validated data into a coherent understanding, the researcher correlated reports from *De Locomotief* concerning public health conditions in Banyuwangi with information from other sources, such as *Geneeskundig Tijdschrift Voor Nederlandsch Indië Uitgegeven* and *Jaarcijfers voor het Koninkrijk der Nederlanden*. This cross-referencing was conducted to gain broader perspectives on demographics, ecology, epidemiology, environment, and social mobility. This process enabled the researcher to identify temporal interconnections, such as how regional development and colonial government policies influenced public health service demands, and to reveal underlying patterns of continuity and change.

III. RESULT AND DISCUSSION

Banyuwangi as a Colonial Frontier and Migration Space

In the early 20th century, Banyuwangi occupied a unique position within the colonial landscape of the Dutch East Indies. It was not merely an administrative territory at the eastern tip of Java, but a frontier space simultaneously undergoing economic penetration, human movement, and environmental transformation. Within this framework, a frontier is understood not just as an undeveloped geographical area, but as an ever-shifting historical space where relations between humans, power, and nature are intensively reshaped.

The frontier character of Banyuwangi was clearly reflected in its demographic paradox. On the one hand, its population density was relatively low compared to other regions in East Java. On the other hand, its population growth rate was remarkably high, particularly during the 1920–1930 decade (*Volkstelling*, 1930). This growth cannot be attributed solely to natural factors such as birth rates, but relied heavily on population mobility, specifically the influx of immigrants from other parts of Java and Madura (Boomgaard, 2001; Nawiyanto, 2010). Consequently, Banyuwangi became a destination for those pushed out of their home regions by demographic pressure, land scarcity, and structural poverty. This migration was not random; it followed the logic of the colonial

economy. Plantation expansion demanded a massive workforce, while Banyuwangi offered vast, relatively available land from a colonial perspective. In this context, migration served as a crucial instrument in integrating Banyuwangi into the global economic system. Migrants moved not only as individuals, but as agents carrying social and ecological changes into the spaces they entered.

A key characteristic of migration to Banyuwangi was its gender imbalance. The dominance of male migrants created an uneven demographic structure, which subsequently influenced settlement patterns and social organization. This masculine migration indicated that early-stage population movement was oriented toward labor rather than permanent settlement. Migrants arrived to work, clear land, or serve as plantation laborers without bringing families in large numbers.

This condition resulted in a distinct settlement form: temporary or semi-permanent settlements that developed around worksites. Unlike agrarian villages with relatively stable social structures and spatial organization, these frontier settlements were fluid, unplanned, and often situated in ecologically vulnerable locations. Thus, from the outset, population mobility engendered social conditions distinct from traditional settlement patterns in Java. Furthermore, spatial distribution was uneven. Certain districts, such as Genteng, became centers of extraordinarily high growth, while other areas experienced more moderate growth. This demonstrates that migration was driven not only by land availability, but also by factors such as transportation access, proximity to plantations, and economic opportunities. In other words, population mobility followed a spatial logic tightly bound to colonial infrastructure and production networks.

Tabel 1.
Population Growth Data in East Java, Early 20th Century
Processed from Volkstelling 1930.

District	Population Growth / Accres (%)
Genteng	132.9
Banyuwangi (City)	± 41
Rogojampi	± 38
Bangorejo	± 35
Glagah	± 28

From an environmental history perspective, it is essential to emphasize that migration was not merely a demographic phenomenon, but an ecological process. The Genteng district offers one of the clearest examples of the link between colonial expansion and environmental change. In the 1920s, this region emerged as a plantation hub attracting thousands of migrant workers. Massive deforestation resulted in irregular terrain depressions and drainage channels. Following the rainy season, standing water accumulated in various places, creating breeding grounds for *Anopheles* mosquitoes. A similar situation unfolded in Rogojampi and Cluring, where the rapid expansion of migrant settlements occurred without adequate sanitation development. Consequently, the spread

of malaria in Banyuwangi was inextricably linked to the geography of colonial economic expansion. Every human movement bore consequences for the inhabited landscape. Migrants cleared forests, cultivated soil, built settlements, and constructed rudimentary water systems. In doing so, they did not merely fill empty spaces; they actively reshaped the environment.

Banyuwangi as a colonial frontier must therefore be understood as a space undergoing a simultaneous process of spatial production. The colonial state, plantation companies, and migrants each played distinct roles driven by different interests: the state sought administrative control, companies pursued economic profit, and migrants strived for survival. This produced a complex and often unstable socio-ecological landscape. Colonial health reports indicate that areas undergoing recent deforestation exhibited a higher prevalence of malaria compared to locations without significant ecological changes. Official administrative reports revealed that standing water near agricultural areas served as breeding grounds for malaria-carrying mosquitoes. Moreover, seasonal surges in malaria cases frequently followed land clearing and the construction of new irrigation canals. This demonstrates a direct correlation between human-induced environmental alterations and disease proliferation. Thus, malaria in Banyuwangi can be understood as an ecological consequence of colonial expansion (De Indische Courant, 1925; Het Nieuws van den Dag voor Nederlandsch-Indië, 1930; Geneeskundig Tijdschrift voor Nederlandsch-Indië, 1932).

Within this context, the conditions emerging in Banyuwangi were not the product of a single isolated factor, but of interactions among diverse historical forces. Migration, as a primary force, serves as a gateway to understanding how demographic shifts can trigger broader changes, including those in environment and health. Consequently, an analysis of malaria in Banyuwangi cannot be detached from an understanding of population mobility as the foundational driver of these transformations.

Tabel 2.
Female Population in Selected East Java Regions, Early 20th Century
Processed from Volkstelling 1930.

Region	Females per 1,000 Males
East Java Average	± 1,010
Banyuwangi	935
Jember	948
Kediri	1,020

As shown in Tables 1 and 2, migration to Banyuwangi in the early 1900s exhibited striking characteristics typical of labor movements in the colonial era. The vast majority of newcomers were productive-age men recruited for plantation labor, infrastructure development, and land clearing. This male dominance indicates that population movement in its initial stages was driven primarily by colonial economic interests rather than settled family formation. As a result, the resulting settlements were temporary, overcrowded, and poorly planned. Migrant workers typically resided in basic barracks or semi-permanent housing erected near worksites. These conditions created

environments highly vulnerable to disease transmission due to high population density, poor residential ventilation, and inadequate access to sanitation facilities. Thus, the colonial migration pattern not only altered Banyuwangi's demographic composition, but also forged settlement patterns that heightened the risk of malaria transmission.

In addition, high labor mobility led to rapid population circulation. Many migrants arrived and departed according to seasonal demands on plantations. This fluidity hindered the establishment of a stable public health system, as the population along the colonial frontier remained dynamic and transient. In epidemiological terms, high mobility also heightened the risk of spreading malaria to other regions, as infected workers relocated across different districts. Consequently, migration not only drove local ecological changes, but also expanded the spatial range of disease transmission on a broader colonial scale.

Landscape Transformation and the Ecology of Malaria

The transformation of Banyuwangi's landscape in the early 20th century represents one of the most tangible consequences of population mobility and colonial economic expansion. A landscape previously dominated by forests, natural wetlands, and relatively stable ecosystems was gradually converted into production spaces governed by economic imperatives. This transformation was not merely physical, but deeply ecological, as it fundamentally altered the relationships between humans, land, water, and other living organisms within the ecosystem.

One of the most critical aspects of this transformation was mass deforestation to clear land for plantations and agriculture. In this process, forests that previously functioned as ecological buffers, absorbing rainwater, maintaining soil moisture, and regulating water runoff, were cleared. Banyuwangi underwent integration into the global capitalist economic system through the expansion of the plantation sector and the extraction of natural resources, including coffee, copra, bananas, coconuts, and tea. In this context, the frontier was not simply a peripheral geographical area, but a zone undergoing profound social and ecological shifts. The colonial government viewed frontier regions as economically valuable areas ripe for expansion and exploitation through deforestation, infrastructure development, and labor mobilization. However, these actions resulted in significant ecological repercussions.

The opening of colonial territories in Banyuwangi fundamentally transformed public interaction with the environment. Forests, which had once served as relatively stable ecological spaces, were transformed into production zones dominated by commercial agriculture and plantations. Throughout this process, the hydrological balance was disrupted, natural vegetation declined, and new habitats for disease vector propagation emerged. Consequently, the colonial frontier not only drove economic growth but also created ecological conditions highly vulnerable to tropical diseases such as malaria. Furthermore, the colonial frontier became a locus of inequality. While the colonial government and plantation companies reaped economic profits from

resource extraction and labor, migrant groups lived under precarious socio-economic conditions. This disparity laid the groundwork for the "production of vulnerability," wherein disease risks were unevenly distributed among specific population groups. As a result, the previously stable hydrological system was disrupted; water that would normally be absorbed by vegetation flowed freely across the surface, creating stagnant pools in various locations.

Public health conditions from 1899 to the present day could be described as reasonably satisfactory, although certain parts of the region, particularly coastal areas, continue to experience frequent cases of fever and malaria. Several areas that were previously difficult to drain have now been filled in. Efforts to land-fill swamps and stagnant water pools across various districts in Banyuwangi must continue. However, due to the frequent rotation of local government medical officers (four different doctors were rotated during my tenure), few public health improvement recommendations were formally submitted. A similar pattern occurred among *Anopheles* mosquito researchers appointed to investigate malaria transmission, whose outcomes fell short of expectations.

A First-Class Health Officer, Dr. F. H. ter Poorten, drafted a document regarding the spread of malaria in Banyuwangi. This document was forwarded to me via a letter dated October 27, 1921 (No. 139/13A), representing the Inspector of the Civil Health Service. The contents offer little cause for optimism. Dr. ter Poorten noted that while a sanitation initiative targeting the breeding grounds of *Anopheles ludlowi* might still be feasible, and financially viable, it appeared nearly impossible to permanently eradicate *Anopheles aconita* larvae from the region's numerous small streams. Therefore, even if *ludlowi* breeding sites were successfully cleared, malaria in Banyuwangi would likely persist at a relatively high prevalence rate. (nationaalarchief.nl/onderzoeken/archief/2.10.39)

In the Resident of Besuki's report, overall public health was declared "satisfactory" from 1899 through the early 1920s. This statement initially appears to contradict the reality that coastal regions, particularly Banyuwangi, were identified as high-incidence areas for fever and malaria. In the epidemiological vocabulary of the colonial era, the term "fever" was often used broadly to encompass several tropical diseases; in practice, however, it frequently referred to malaria. It is therefore evident that malaria was a prominent endemic disease in the region, particularly along the coast and low-lying plains.

Banyuwangi's geographical characteristics were exceptionally conducive to malaria proliferation. The region was dotted with swamps, stagnant water bodies, small streams, and highly humid coastal areas. The combination of these environmental elements formed ideal habitats for *Anopheles* mosquitoes, specifically the species known as primary malaria vectors in tropical regions. The report explicitly highlights two species: *Anopheles ludlowi* and *Anopheles aconita*. The identification of these two species indicates that by the early 20th century, colonial health experts possessed a sophisticated understanding of the linkage between malaria and specific

mosquito vectors. This was closely aligned with advancements in tropical medicine following Ronald Ross's discovery of the mosquito's role in malaria transmission in the late 19th century.

Stagnant water pools were a key element in understanding malaria ecology. Under natural conditions, these pools might have been temporary and dispersed. However, within a human-modified landscape, they became more permanent and localized (Worster, 1994). Logging pits, ground depressions, and poorly managed water channels created small, sheltered water bodies protected from currents. These micro-environments provided ideal conditions for the development of *Anopheles* larvae (Packard, 2007). Beyond deforestation, alterations in vegetation also played a critical role. Monoculture crops such as coffee and rubber replaced forest biodiversity. This shift not only reduced biodiversity but also altered the local microclimate. Surface soil temperatures rose while humidity remained high, creating micro-environments that accelerated the mosquito life cycle. Consequently, vegetative changes directly contributed to vector population dynamics.

Landscape transformation also encompassed the construction of colonial infrastructure, such as roads and railways. While this infrastructure enhanced economic mobility and efficiency, it accelerated environmental fragmentation. Transportation corridors cut through forests and wetlands, granting access to previously isolated areas. This facilitated human expansion into undisturbed ecosystems while expanding the geographical footprint of ecological modification (Nawiyanto, 2010). Furthermore, irrigation and water management systems engineered for plantations were rarely designed with long-term ecological impacts in mind. Waterways constructed to irrigate plantation lands frequently became clogged or disconnected from broader drainage networks, resulting in water retention and persistent pool formation. In this context, stagnant water was no longer merely a natural phenomenon, but a direct artifact of human intervention (Crosby, 2004).

Crucially, this landscape transformation did not occur uniformly. Certain areas underwent more intensive modification, particularly those serving as hubs of economic activity. This created spatial variations in ecological conditions, rendering specific areas significantly more vulnerable to malaria than others. Thus, disease distribution was determined not only by natural factors, but also by land-use patterns and anthropogenic activities. Spatial variations in malaria across Banyuwangi during the 1920s and 1930s demonstrate that disease spread was not uniform; rather, it tracked colonial development, population movement, and land-use changes. Consequently, malaria cannot be viewed solely as a tropical disease driven by natural climate factors, but must be understood as a socio-ecological phenomenon tied to the transformation of colonial space. Spatial analysis is vital here, as it demonstrates that areas characterized by high migration rates, intensive plantation growth, and inadequate drainage systems exhibited far higher malaria vulnerability than ecologically stable administrative regions.

Data from the 1930 *Volkstelling* (Census) indicates that regions such as Genteng, Rogojampi, and Cluring experienced rapid population growth due to waves of incoming plantation laborers.

This demographic surge was driven less by natural birth rates and primarily by the influx of laborers from other parts of Java and Madura. Within the colonial framework, this migration was directly linked to deforestation and plantation expansion, both of which required substantial labor forces. As a result, these districts underwent rapid landscape transformations compared to the administrative center of Banyuwangi town. (*Volkstelling 1930*)

Land-use change was a pivotal factor explaining spatial variations in malaria transmission. In Genteng and Rogojampi, forest clearing for plantations and commercial agriculture resulted in extensive open land, ground depressions, and water channels unintegrated with permanent drainage systems. During the rainy season, water pooled in numerous locations, creating optimal habitats for *Anopheles* mosquitoes. Additionally, the expansion of coastal aquaculture ponds and irrigated rice paddies in southern Banyuwangi generated shallow-water environments that further supported larval development.

Colonial health reports indicate that villages (*kampungs*) adjacent to aquaculture ponds, railway lines (*spoorbaan*), and plantation estates exhibited significantly higher malaria rates than urban administrative areas. Splenic index data from 1926 revealed exceptionally high spleen rates (*miltindex*): 90% in Kampung Kertosari opposite the railway line, 80% in Mandar, 80.5% in Karangredjo opposite the railway line, and 80.4% in Toekangkajoe. These high figures highlight that areas developing along colonial economic corridors bore the highest exposure to malaria. Conversely, administrative districts with superior drainage infrastructure and better healthcare access demonstrated lower levels of vulnerability. (*Mededeelingen Van Den Dienst Der Volksgezondheid 1932*)

This spatial pattern underscores a close correlation between migrant density and malaria prevalence. Settlements around railway tracks and plantations evolved into dense hubs for colonial labor, characterized by overcrowded living conditions. Semi-permanent housing was constructed in close proximity without adequate sanitation systems. Domestic wastewater was discharged directly into open ditches or channels, which subsequently became primary breeding sites for mosquitoes. In this context, migrant density not only increased human-vector contact rates but also placed severe ecological stress on the surrounding environment. To illustrate these spatial variations, colonial health and census data can be tabulated as follows:

Tabel 3
Data compiled from Mededeelingen Van Den Dienst Der Volksgezondheid en Van Den Burgelijken Geneeskundigen Dienst, Geneeskundig Tijdschrift Voor Nederlandsch Indië.

District/Kampun g	Territorial Character	Migrant Density	Drainage Condition	Splenic Index/Malaria
Genteng	Frontier plantation	High	Poor	High
Rogojampi	Migration route & plantation	High	Poor	High
Cluring	New land clearing	Moderate– high	Poor	High

Mandar	Fishponds & spoorbaan (railway tracks)	High	Very poor	80%
Kertosari t/O spoorbaan	Railway labor settlement	High	Poor	90%
Karangredjo t/O spoorbaan	Railway migrant area	High	Poor	80.5%
Banyuwangi Kota	Administrative	Moderate	Relatively good	Lower

This tabulation demonstrates that areas with the most intensive colonial economic activities were precisely those with the highest levels of malaria vulnerability. In other words, colonial economic development did not automatically translate into improved public health. On the contrary, the expansion of plantations and colonial infrastructure created an ecological landscape conducive to the proliferation of malaria. This spatial analysis also reveals that malaria risk was closely linked to drainage infrastructure. Following the implementation of environmental sanitation programs, in the form of draining stagnant water, normalizing water channels, and improving drainage in several villages near the fishponds, the splenic index dropped drastically. In Mandar village, the malaria rate decreased from 80% to 19% after two years of sanitation efforts, eventually reaching 0% three years later. In Karangredjo t/O *spoorbaan*, the malaria rate dropped from 80.5% to 12% and ultimately to 0%. This evidence underscores that malaria in Banyuwangi was heavily influenced by man-made environmental changes.

In a broader perspective, the transformation of Banyuwangi's landscape can be understood as part of a larger colonial process: the integration of the region into the global capitalist economy. In this process, nature was treated as a resource to be exploited, while its ecological impacts were frequently ignored. In this context, malaria emerged as one of the consequences of this process, a hidden cost of colonial economic development. Consequently, the ecology of malaria in Banyuwangi cannot be understood without examining the landscape changes that occurred. *Anopheles* mosquitoes did not appear spontaneously; rather, they thrived under conditions created by human activity. A landscape that transformed into one that was wetter, fragmented, and prone to standing water became an ideal habitat for disease vectors. Therefore, malaria must be viewed as an ecological phenomenon intrinsically tied to the history of environmental change.

Migrant Settlements and the Production of Vulnerability

One of the most crucial aspects of understanding malaria dynamics in Banyuwangi is the condition of migrant settlements. As previously noted, migration to this region in the early 20th century was dominated by males of productive age working as plantation laborers or land clearers. This migration pattern generated a form of settlement that differed radically from established agrarian villages.

Migrant settlements were generally temporary or semi-permanent. Dwellings were constructed with crude materials, often lacking clear spatial planning. Population density within these settlements was relatively high, while sanitation facilities were severely limited. Access to clean water was scarce, and domestic waste was frequently mismanaged. Under such conditions, the boundary between human living spaces and the natural environment became blurred. These settlements functioned not only as temporary residences for plantation workers but also as socio-ecological spaces that directly impacted the population's vulnerability to malaria. In this regard, the daily environmental conditions of migrants served as an essential element in the production of vulnerability, wherein the physical state of the residential area, sanitation standards, and the availability of clean water directly influenced the degree of human exposure to *Anopheles* mosquitoes.

Genteng District serves as one of the most salient examples of how the growth of migrant settlements in colonial borderlands created environments vulnerable to malaria. Since the early 1920s, Genteng developed as both a plantation center and a labor mobility hub, attracting migrants from various regions across Java and Madura. The population grew rapidly, whereas residential infrastructure development failed to keep pace with the velocity of migration. As a result, labor villages (*kampungs*) emerged organically around plantation lands, railway lines, and areas with poor drainage.

Colonial health documents and local sanitation archives indicate that the majority of migrant workers' homes in Genteng were built using simple materials such as bamboo, light timber, and thatched roofs made of *rumbia* (sago palm) or *ilang-ilang* grass. These homes were generally semi-permanent, featuring inadequate ventilation and damp earthen floors, particularly during the rainy season. In many cases, houses were built in close proximity without a coherent spatial layout, resulting in high density within labor residential environments. This situation heightened the risk of malaria transmission, as mosquitoes could easily breed in damp places with minimal air circulation.

Beyond poor structural quality, the primary issue facing migrant settlements in Genteng lay in sanitation systems and water management. Most residents obtained water from shallow wells, small streams, or plantation irrigation channels with extremely poor hygiene standards. Colonial reports noted that water sources for residents were frequently situated near drainage ditches, stagnant pools, and household waste outlets. This situation kept the residential environment perpetually damp, turning it into an ideal breeding ground for *Anopheles* larvae.

Waste disposal systems in migrant communities were similarly appalling. Most households discharged domestic waste directly into open ditches or vacant plots surrounding their homes. During the rainy season, these small channels overflowed, creating stagnant pools across various settlement locations. Ecologically, these pools served as primary breeding sites for malaria-

carrying mosquitoes. Poor sanitation, therefore, reflected not only the poverty of the migrant community but also directly contributed to the formation of disease habitats.

Settlement location was another vital factor. Many migrant settlements were built near water sources, such as small rivers, swamps, or stagnant water bodies. This choice was driven by practical needs, such as access to water for drinking and daily activities. However, these locations were also ideal mosquito habitats. Thus, migrant settlements inadvertently placed their residents under high-risk conditions for malaria. Social conditions within these settlements further contributed to vulnerability. Migrants were frequently in a weak economic position, facing low wages and arduous working conditions. Access to healthcare services was severely constrained by both geographical and social factors. In many instances, colonial healthcare services prioritized economic interests, specifically maintaining labor productivity, over the overall welfare of the population.

In this context, the concept of the "production of vulnerability" becomes highly relevant. Vulnerability to malaria did not emerge naturally; rather, it was produced by a combination of social, economic, and environmental factors. Migration created specific demographic conditions, landscape transformations generated specific ecological conditions, and infrastructure limitations produced specific social conditions. Malaria vulnerability resulted from a confluence of labor movement, poor housing quality, lack of healthcare access, and environmental shifts brought about by colonial plantation expansion. In other words, the threat of this disease was not a natural occurrence, but was shaped by the social and ecological conditions experienced by migrant groups in their everyday lives.

The majority of migrant workers in Banyuwangi during the 1920s resided in semi-permanent dwellings constructed near plantation areas, railway lines, and fishpond regions. Their homes were generally made of bamboo with thatched roofs and lacked adequate ventilation. The proximity of these settlements to water channels, stagnant pools, and fishponds heightened the probability of human contact with *Anopheles* mosquitoes. Water for daily needs was drawn from open sources such as small streams, ditches, or irrigation canals, which were often contaminated and served as larval breeding sites. Under these circumstances, migrant communities inhabited an environment that generated daily malaria risks.

This production of vulnerability can be clearly observed through the *miltindex* (spleen index) data of children in villages surrounding the fishponds and the *spoorbaan* (railway track) areas in Banyuwangi between 1926 and 1930. These data are critical because splenomegaly (spleen enlargement) in children serves as a primary indicator of high, chronic malaria exposure within a community. Colonial health tables show that several villages with high numbers of migrant laborers exhibited extremely elevated *miltindex* rates prior to the implementation of sanitation improvements.

Data recorded by Dr. Overbeek in February 1930 revealed a similar pattern. In the village of Melajoe, children under two years of age exhibited a *miltindex* of 19%, while the group over two

years reached 10%. In Mandar, the *miltindex* for children under two years also reached 19%, whereas for those above two years, it stood at 17%. Even in several villages near the *spoorbaan*, such as Kertosari above the railway tracks, the *miltindex* for children over two years reached 30%. These high malaria rates among children indicate that the daily living environment of the community functioned as an extraordinarily active transmission zone (Mededeelingen Van Den Dienst Der Volksgezondheid, 1932).

Historically, this condition was inseparable from the colonial frontier character of Banyuwangi. Migrant villages expanded rapidly alongside the expansion of plantations and colonial transportation networks, devoid of adequate sanitation planning. Poor drainage, stagnant water around fishponds, and pits resulting from land clearing created ideal habitats for *Anopheles* mosquitoes. In this regard, vulnerability to malaria was driven not merely by the presence of mosquitoes, but by a colonial economic system that subjected migrant communities to unhealthy living conditions. A lack of healthcare access further compounded the situation. Colonial medical facilities were typically concentrated in administrative and urban centers, whereas labor villages in frontier regions rarely received medical care. Malaria treatment was generally provided only when a patient's condition became severe or when an outbreak began to disrupt labor productivity on the plantations. Consequently, migrant communities confronted malaria amid severe constraints: they lived in environments with a high risk of disease, yet possessed severely restricted access to healthcare.

Furthermore, it is crucial to recognize that this vulnerability was not evenly distributed. Certain groups, particularly migrant laborers, occupied far more vulnerable positions than others. This points to an inequality in the distribution of health risks. Malaria was not merely an environmental problem, but also a social issue intertwined with power structures and resource distribution (White, 2011). Within this framework, the colonial state played an ambivalent role. On one hand, it drove migration and economic expansion, the very sources of ecological change. On the other hand, it failed to provide adequate infrastructure to mitigate the consequences of those changes. As a result, local and migrant populations were forced to endure the repercussions of processes over which they exercised no control. Thus, migrant settlements in Banyuwangi can be understood as spaces where multiple forms of vulnerability intersected. Ecological, social, and economic vulnerabilities overlapped, creating conditions highly favorable for the spread of malaria. In this context, the disease was not merely the result of interactions between humans and mosquitoes, but also the product of interactions among humans, the environment, and power structures.

Dutch colonial authorities were, in fact, aware of the high malaria rates in Banyuwangi, particularly in plantation zones. However, the health policies implemented were often merely temporary and unsustainable. In the early 1920s, several local health services suffered shortages due to minimal funding from the colonial government. In a number of cases, malaria control

programs were temporarily suspended despite high infection rates remaining. This situation illustrates that the colonial government prioritized economic stability over public health. Medical intervention was typically undertaken only when the disease began to impair labor productivity on plantations. Consequently, public health during the colonial era was treated more as an economic tool than as a social right for the populace. Additionally, health programs executed by colonial authorities were generally top-down and failed to address underlying environmental issues. The government favored individual medical treatment over improving living environments and drainage systems. As a result, the primary ecological factors driving the proliferation of malaria remained unaddressed.

Malaria as a Social-Ecological Product

When the three aspects mentioned above, population mobility, landscape transformation, and settlement conditions, are examined together, a clear pattern emerges. Malaria in Banyuwangi did not appear by chance, but rather as the result of a complex historical process. Migration brought humans to the frontier region, their activities altered the landscape, and their settlement conditions created vulnerable social environments.

Tabel 4.
Periodization of malaria in Banyuwangi.
Data compiled from Mededeelingen Van Den Dienst Der Volksgezondheid en Van Den Burgelijke Geneeskundigen Dienst, Geneeskundig Tijdschrift Voor Nederlandsch Indië Uitgegeven.

Period	General Condition	Main Response
1921	Severely endemic, minimal health services	Press criticism, preliminary research
1921–1927	Identification of malaria vectors	Medical studies, no major actions taken yet
1927–1928	Drastic decline in malaria	Cleaning & connecting ponds to the sea
1930–1933	Malaria nearly eradicated	Drainage infrastructure
1934	Local outbreaks in villages	Quinine distribution, emergency relief
1935–1936	Sporadic cases	Intensive surveillance

The colonial health tabulation above demonstrates that malaria patterns in Banyuwangi were closely linked to environmental changes and spatial management efforts. In several areas that underwent drainage improvements and standing water reduction, malaria rates dropped significantly. This indicates that malaria did not occur randomly or solely due to the tropical climate, but was intimately tied to ecological conditions shaped by human activity. Studies on malaria data show that areas with higher rates of land clearing frequently exhibited higher disease incidence. Agricultural areas such as Genteng and Rogojampi illustrate a connection between the growth of migrant housing, changes to irrigation systems, and rising malaria cases. This reinforces the argument that economic development during the colonial era triggered landscape transformations that directly influenced disease transmission.

Furthermore, statistical data reveals that malaria treatment efforts focusing solely on individuals yielded negligible results if environmental conditions remained unaddressed. A decline in malaria rates only became observable following drainage improvements, the draining of stagnant water, and more structured environmental management. Thus, colonial-era data demonstrates that ecological factors strongly influenced the establishment of malaria endemicity. Moreover, statistical tables from the colonial era highlight inequalities in disease distribution. Regions serving as economic hubs during the colonial period actually experienced high levels of malaria vulnerability. This condition indicates that modernization in the colonial era did not necessarily correlate with an improved quality of life for the population. In the context of Banyuwangi, colonial economic development instead produced a social-ecological landscape vulnerable to tropical diseases.

Consequently, malaria can be understood as a social-ecological product. It is not merely a disease caused by parasites and mosquitoes, but also by the social and environmental conditions that enable those parasites to thrive. Within this framework, health cannot be separated from history, as public health conditions are the outcome of a long historical process. This approach opens a new perspective on understanding disease. Instead of viewing malaria strictly as a medical issue, we can see it as an indicator of the relationship between humans and their environment. In the context of Banyuwangi, malaria reflects how colonialism, migration, and environmental change interacted to shape the living conditions of the population.

An analysis of malaria offers insight not only into the disease itself, but also into broader social and ecological dynamics. Banyuwangi serves as an example of how a frontier region can become a historical laboratory where various global and local processes intersect and produce complex consequences. It developed through an intricate interplay between population movement, environmental change, and colonial power structures. The relocation of labor to the colonial frontier drove the clearing of new land for commercial agriculture and plantations. This process altered environmental structures through deforestation, water system modification, and the formation of stagnant pools that served as ideal breeding grounds for *Anopheles* mosquitoes. Concurrently, low-wage migrant workers resided in semi-permanent settlements characterized by poor sanitation and limited access to healthcare facilities.

Tabel 4.
Data compiled from Mededeelingen Van Den Dienst Der Volksgezondheid en Van Den Burgelijken Geneeskundigen Dienst, Geneeskundig Tijdschrift Voor Nederlandsch Indië Uitgegeven.

Location	Number of Ponds	Cost (f)	Method
Banjoewangi	40	>23,000	Pond elimination
Probolinggo	273	Lower	Hygienic sanitation
Pasoeroean	–	±2,000 (10 ponds)	Hygienic management

Under these circumstances, malaria emerged not simply due to the presence of vector mosquitoes, but because of socio-economic structures that placed migrant populations in precarious living conditions. The colonial state and plantation companies reaped economic profits from the exploitation of labor and natural resources, while the ecological and health burdens were borne by the workers. Therefore, malaria in Banyuwangi can be viewed as the result of the "creation of vulnerability", a historical process wherein disease risks were generated and inequitably distributed through colonial power relations. This synthesis demonstrates that social and environmental dimensions are inextricably linked. Environmental changes that created habitats for malaria occurred simultaneously with the formation of disease-vulnerable social structures. Consequently, malaria in Banyuwangi must be understood as a social-ecological phenomenon arising from the interactions between humans, the environment, and colonialism. Such a comprehensive framework also allows this study to challenge reductionist views that historically attributed malaria primarily to the tropical climate. In reality, environments conducive to disease transmission were heavily shaped by human agency and colonial policy. Thus, malaria was not merely an issue tied to the tropical environment, but a direct historical outcome of colonial economic expansion along the frontier.

IV. CONCLUSION

This article demonstrates that malaria in early 20th-century Banyuwangi was the product of a complex historical process rather than a purely biological phenomenon. Population mobility played a crucial role in altering the ecological landscape through deforestation, the creation of stagnant water bodies, and the emergence of temporary settlements lacking adequate infrastructure. As a colonial frontier region, Banyuwangi became a space of intensive interaction between humans and the environment. Within this context, malaria emerged as a consequence of ecological transformations driven by human activity and colonial policies. This study underscores the importance of an environmental history approach to understanding disease dynamics. By conceptualizing malaria as a socio-ecological product, we can recognize that public health is inextricably linked to broader historical and environmental contexts. Early 20th-century Banyuwangi cannot be understood solely through a medical and biological lens that views disease as a natural occurrence in tropical regions. Rather, malaria proliferated through historical processes involving population movements, environmental shifts, and colonial economic structures. Thus, the disease was the outcome of socio-ecological interactions shaped by the nexus of human activity, the environment, and colonial power.

Labor migration to Banyuwangi as a colonial borderland played a vital role in generating ecological changes that facilitated the spread of malaria. Deforestation, plantation development, drainage modifications, and the growth of migrant settlements created a novel landscape that served as an ideal habitat for *Anopheles* mosquitoes. In this regard, the environment was not a

static arena, but a historical space continuously transformed by human action. Furthermore, this article illustrates that vulnerability to malaria was unevenly distributed. Economically vulnerable migrant groups faced a heightened risk of infection due to substandard living conditions, inadequate sanitation, and limited access to healthcare facilities. This situation reveals that malaria emerged within an exploitative colonial socio-economic framework. In other words, the disease was not merely a biological issue, but one deeply intertwined with social inequality and the distribution of power.

Historiographically, this article makes a significant contribution to the study of health and environmental history in Indonesia. First, it challenges long-held views that attribute malaria solely to tropical geography. Second, it demonstrates that population displacement and colonial landscape transformations had a direct impact on the formation of disease habitats. Third, it expands the application of environmental history methodologies to the study of colonial public health. Moreover, the framework discussed in this article reveals that diseases develop through historical processes driven by the interplay of economics, the environment, and power dynamics. In the context of Banyuwangi, malaria was the product of colonial expansion that exploited natural resources and labor without regard for environmental and public health consequences. Consequently, this article not only examines the history of a disease, but also explores how colonialism induced social and ecological injustices that directly affected human lives.

The findings of this study remain highly relevant today. Environmental alterations stemming from economic expansion, urbanization, and human mobility persist worldwide, frequently giving rise to new health crises. Thus, the history of malaria in Banyuwangi offers a vital lesson: public health cannot be decoupled from environmental conditions or prevailing socio-economic structures. An environmental history approach enables us to recognize that disease is not an isolated phenomenon, but an integral part of the dynamic relationship between humanity and nature within specific historical contexts.

REFERENCES

- ANRI .Massive aan de secretaris van staat, gouverneur generaal over nederlandsch indië, 27 julij 1824 betreffende jaarliksch verslag dienst jaar 1823. Arsip tekstual redien Besuki no.20.
- ANRI. Algemeen Beknopt Verslag den 31 juli 1838 verslag van den resident ter gelegenheid der inspectie van den gouverneur generaal in de maand augustus 1838. Arsip tekstual Residen Besuki no.28.
- ANRI. Algemeen Verslag der Residentie Besoeki over het jaar 1834. Arsip tekstual Residen Besuki no.117.
- ANRI. Algemeen Verslag Over het jaar 1847. Arsip tekstual Residen Besuki no.42.
- ANRI. Algemeen verslag van de residentie besoeki van den jar 1835. Arsip tekstual Residen Besuki no.25.

- ANRI. Arsip Memori Residen Jawa timur 1921. Jakarta.
- ANRI. Gewestelijk bestuur. afdeeling secretarie no:3501.bezoeki 13 augustus 1870. Arsip tekstual Residen Besuki no.116.
- ANRI.Arsip tekstual Residen Besuki no.1030. Besuki 1874.
- ANRI.Resident Besoeki Algemeen Verslag Over het jaar 1883. Arsip tekstual Residen Besuki no.78.
- ANRI.Resident Besoeki Algemeen Verslag Over het jaar 1888. Arsip tekstual Residen Besuki no.83.
- Bonne C. De ontwikkeling der geneeskundige wetenschappen in Nederlandsch-Indie in de periode 1891-1935. In: Feestbundel 1936, Geneeskundig Tijdschrift voor Nederlandsch-Indie. Batavia:Kolff, 1936:16-44.
- Boomgaard, P. (2001). *Frontiers of fear: Tigers and people in the Malay world*. Yale University Press.
- Boomgaard, P. (2003). *Southeast Asia: An environmental history*.
- Crosby, A. W. (2004). *Ecological imperialism: The biological expansion of Europe, 900–1900*. Cambridge University Press.
- de Langen CD. Het geneeskundig onderwijs in Indonesie. *Ned Tijdschr Geneesk* 1948;92: 1582-8.
- de Waart A. Het Indisch geneeskundig onderwijs in de laatste 25 jaren. In: Feestbundel 1936, Geneeskundig Tijdschrift voor Nederlandsch-Indie. Batavia: Kolff, 1936:246-74.
- de Waart A. Vijf-en-zeventig jaren medisch onderwijs te Weltevreden, 1851-1926. In: de Waart A, Radsma W, de Visser Smits D, Kayadoe I, Taroenodibroto RG, eds. *Ontwikkeling van het geneeskundig onderwijs te Weltevreden, 1851-1926*. Weltevreden: Kolff, 1926:1-93.
- Departemen Kesehatan RI. *Sejarah kesehatan Nasional*. Jilid I. Jakarta : Departemen Kesehatan RI, 1978: 29-76.
- Dinger JE. In memoriam Professor Cornelis Bonne. *Ned Tijdschr Geneesk* 1948;92:1290-2.
- Geneeskundig Tijdschrift Voor Nederlandsch Indië Uitgegeven 1932.
- Hanafiah MA. 125 Tahun pendidikan dokter: 75 tahun peretama. In: 125 Tahun pendidikan dokter di Indonesia 1851-1976.-Jakarta : Panitia Peringatan 125 Tahun pendidikan Dokter di Indonesia, 1976:1-14.
- Hoffman MS, ed. *The world almanac and book of facts*. New York : Pharos Books, 1992:763-4.
- Kirschner L, De Landskoepkinrichting en het Instituut Pasteur 1890-1935. In: Feestbundel 1936, Geneeskundig Tijdschrift voor Nederlandsch-Indie. Batavia:Kolff, 1936:258-74.
- Kouwenaar W. De gezondheidszorg ter Oostkust van Sumatra 1891-1935. In: Feestbundel 1936, Geneeskundig Tijdschrift voor Nederlandsch-Indie. Batavia:Kolff, 1936:286-302.
- Kouwenaar W. Geneeskundige voorziening op Sumatra's Oostkust. *Ned Tijdschr Geneesk* 1948 ;92: 1293 -300.
- Kouwenaar W. Het Pathologisch laboratorium te Medan 3 October 1906-1931. *Geneesk Tijdschr Ned Indie* 1931;11:1218-27.

- Mackie, J.A.C. 1985. "The Changing Political Economy of an Export Crop: The Case of Jember's Tobacco Industry". *Bulletin of Indonesian Economic Studies*, 21.
- Mangkoewinoto, R.M.M.1923. "Assaineering der Tjiheavlakte", *Mededeelingen van den Burgerlijken Geneeskundigen Dienst in Nederlandsch-Indië*, 12.
- Margana, Sri. 2012. *Ujung Timur Jawa 1763- 1818: Perebutan Hegemoni Blambangan*. Yogyakarta: Pustaka Infada.
- McNeill, W. H. (1976). *Plagues and peoples*. Anchor Press.
- Mededeelingen Van Den Burgelijken Geneeskundigen Dienst 1922.
- Mededeelingen Van Den Burgelijken Geneeskundigen Dienst 1924.
- Mededeelingen Van Den Dienst Der Volksgezondheid 1922.
- Mededeelingen Van Den Dienst Der Volksgezondheid 1928.
- Mededeelingen Van Den Dienst Der Volksgezondheid 1932.
- Mededeelingen Van Den Dienst Der Volksgezondheid 1933.
- Nawiyanto, S. 2005. *The Rising Sun in a Javanese Rice Granary: Change and the Impact of Japanese Occupation on the Agricultural Economy of Besuki Residency, 1942-1945*. Yogyakarta: Galang Press.
- Nawiyanto. (2010). *Migrasi dan perubahan sosial di Jawa Timur*. Jember University Press.
- Nawiyanto. 2008. *The Development of Plantations in Jember during the Late Colonial Period*. Yogyakarta: Lembah Manah.
- Nyland AH. De ontwikkeling van het bedrijf der Landskoepokinrichting te Weltevreden. In: *Geneeskundig Tijdschrift voor Nederlandsch-Indie*. Feestbundel ter herinnering uitgegeven bij het verschijnen van het 50ste deel. Batavia: Javasche Boekhandel & Drukkerij,lg Ll:324-31.
- Onderzoek. 1909. *Onderzoek naar de Mindere Welvaart der Inlandsche Bevolking op Java en Madoera*, Vol. 9 (14): *Samentrekking van de Afdeelingsverslagen over de Uitkomsten der Onderzoekingen naar de Economie van de Desa in de Residentie Běsoeki*. Weltevreden: Visser.
- Overbeek J.G. and W.J. Stoker. 1938. "Malaria in Nederlandsch-Indie and Hare Bestrijding", *Mededeelingen van den Burgerlijken Geneeskundigen Dienst in Nederlandsch-Indië*.
- Overbeek, J.G., and W.J. Stoker. 1937. *Malaria in the Netherlands Indies and Its Control*. Batavia-Centrum: G. Kolff.
- Packard, R. M. (2007). *The making of a tropical disease: A short history of malaria*. Johns Hopkins University Press.
- Padmo, Soegijanto. 1994. *The Cultivation of Vorstenlands Tobacco in Surakarta Residency and Besuki Tobacco in Besuki Residency and Its Impact on the Peasant Economy and Society: 1860-1960*. Yogyakarta: Aditya Media.
- Penris, P.W.L. s.n. "The Part Played by Plantations in Java in the Medical Care of the Population". Swellengrebel, N.H. (ed.), *Indonesia Before the War*. S.l.

- Rapport. 1914. Rapport der Commissie van Enquête in Zake Werkvolkkwestie te Banjoewangi.
- Rapport. 1916. Rapport in Zake Werkvolkkwestie in Banjoewangi. Weltevreden: Visser. Regentschapsversla gen behorende bij het Eindverslag over het Desa-Autonomie Onderzoek: Regentschap Panaroekan (Sitoebondo).
- Reijntjes, E.W. 1926. "De Vischteelt in Zoutwatervischvijvers". Mededeelingen van de Afdeeling Landbouw, Departement van Landbouw, Nijverheid en Handel, 10.
- Reijntjes, E.J. 1922. "Vischvijvers en Malariabestrijding". Teysmannia, 33.
- Reijntjes, E.J. 1938. "Zoutwatervischvijvers en Malaria-gevaar". Onze Gezondheid, 3(6).
- Ross, R and M. Watson. 1930. A Summary of Facts Regarding Malaria. London: John Murray.
- Savage, V.A. 1984. Western Impressions of the Nature and Landscape in Southeast Asia. Singapore: Singapore University Press.
- Schoute, D. 1937. Occidental Therapeutics in the Netherlands East Indies During Three Centuries of Netherlands Settlement (1600- 1900). Batavia: The Netherlands Indian Public Health Service.
- Snapper, I. 1945. "Medical Contributions from the Netherlands Indies". In P. Honig and F. Verdoorn (Ed.). 1945. Science and Scientists in the Netherlands Indies. New York City: Board for the Netherlands Indies, Surinam and Cura-çao.
- Soesilo, R. 1936. "Malariabestrijding in den Oost-Indischen Archipel". Geneeskundig Tijdschrift voor Nederlandsch-Indië, Feest bundel.
- Soesilo, R. 1938. "Sanitation of Fresh-Water Fish-Ponds". Acta Conventus Tertii de Tropicis Atque Malariae Morbis, Pars II: Acta Conventus Tertii de Malariae Morbis. Amstelodami: Societas Neerlandica Medicinae Tropicae.
- Swellengrebel, N.H. 1921. De Anophelinen van Nederlandsch Oost-Indië. Amsterdam: De Bussy.
- Takken, W. and W.B. Snellen (Ed). 1991. Environmental Measures for Malaria Control in Indonesia: An Historical Review on Species Sanitation. Wageningen: Wageningen Agriculture University.
- Taylor, N. 1945. Cinchona in Java: The Story of Quinine. New York: Greenberg.
- Tennekes, J. 1963. "De Bevolkingspreiding der Residentie Besoeki in 1930". Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap, 80.
- Terburgh. 1902. "Malaria-Aetiologie". Tijdschrift voor Inlandsche Geneeskundigen, 10 (1).
- Volkstelling. (1930). Population census of the Netherlands Indies. Batavia: Landsdrukkerij.
- Wellington JS. Plantations and parasites: fifty yeas of Indonesian pathology. Malaysian J Pathol 1978;1:27-31.
- White, S. (2011). The climate of rebellion in the early modern Ottoman Empire. Cambridge University Press.
- Winckel CWF. De geschiedenis van het Geneeskundig Tijdschrift voor Nederlandsch-Indië. In: Feestbundel 1936, Geneeskundig Tijdschrift voor Nederlandsch-Indië. Batavia: Kolff, 1936: 1-15.

Worster, D. (1994). *Nature's economy: A history of ecological ideas* (2nd ed.). Cambridge University Press.