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The relationship between swamps and malaria: a review of the studies titled The Sanitary and Social Geography of Turkey

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Abstract

This study examines the multidimensional impact of infectious diseases on societies through the case of malaria, with particular emphasis on the anti-malaria campaigns implemented in Türkiye during the early Republican period within the framework of the studies titled The Sanitary and Social Geography of Turkey. These works constitute primary-source materials that systematically document the country's health conditions, social structure, and geographical characteristics during the early years of the Republic. In this study, data on swamps and malaria contained in these publications were analysed through a systematic document analysis and regional comparative approach. The findings demonstrate that the relationship between swamps and malaria varied considerably across provinces. While a strong positive association was identified along the Mediterranean and Aegean coasts and in the major river deltas, this relationship was substantially weaker in the high-altitude regions of Eastern Anatolia. Furthermore, the effectiveness of swamp-drainage programmes in controlling malaria remained limited due to factors such as fragmented implementation, recurrent flooding, and irrigation projects. The analysis also indicates that agricultural activities, particularly rice cultivation, contributed to the spread of malaria by creating artificial swamp environments. Consequently, malaria control emerged as a central policy domain during the early Republican period, becoming closely integrated with the state's broader strategies of nation-building and socio-economic development.

Keywords Malaria, Swamp reclamation, Public health, Infectious diseases, The Sanitary and Social Geography of Turkey

Introduction

Throughout history, epidemics have been multidimensional phenomena that have transformed human societies by shaping a wide range of domains, from politics and the economy to demographic structures and social life [1–3]. The degradation of environmental conditions,

the transition to settled life, and increasing human intervention in nature altered biological equilibria, creating conditions that facilitated the mutation of viruses and parasites and, ultimately, the emergence of global epidemics threatening large populations [4–7]. Among the endemic and pandemic diseases that have posed the greatest threat to human populations throughout history, malaria has been one of the most characteristic public health challenges, causing widespread mortality and undermining the social fabric of affected communities [8–10].

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Owing to its warm climatic conditions and the presence of wetlands and stagnant water bodies suitable for the breeding of *Anopheles* mosquitoes, Anatolia has been exposed to the devastating effects of malaria throughout its history [11]. In particular, the mass migration movements of the nineteenth century and the parasites carried by soldiers returning from endemic fronts of the First World War, such as the Hejaz and Iraq, transformed malaria from a local administrative concern into a matter of national survival [11–13]. This crisis, which the Ottoman Empire sought to contain through preventive measures such as quarantine and the free distribution of quinine from the Tanzimat period to the Constitutional Era, became one of the most severe socio-economic burdens inherited by the young Republic of Türkiye [11, 14].

Following the establishment of the Ministry of Health in 1920, the new government sought not only to build a modern institutional health system but also to adopt malaria control as a central component of its national development strategy, given the disease's devastating impact on the country's demographic structure [13, 15]. Nevertheless, the absence of comprehensive field surveys and reliable population data during this period made it impossible to determine the true extent of the epidemic on a scientific basis [13]. To address this deficiency, the government initiated large-scale field investigations in 1921, resulting in the creation of a unique body of publications that systematically documented the geographical, social, and medical conditions of the newly established Republic.

Primary analytical framework: the nature of *The Sanitary and Social Geography of Turkey* series

Produced as a result of the field surveys initiated by the Republican administration to formulate a comprehensive national public health policy, the *The Sanitary and Social Geography of Turkey* series constitutes not merely a collection of medical reports but also a body of official primary-source monographs reflecting the state's official ideology, population policies, and economic development strategies [16]. Prepared under the auspices of the Ministry of Health by provincial governors and directors of public health, these studies systematically documented the climatic conditions, water resources, population movements, social practices, and local economic potential of each province through a public health perspective [17, 18].

From the perspective of the global history of medicine and historical geography, the principal feature that distinguishes these publications is their attempt to establish, on the basis of empirical evidence, a causal relationship between the geographical characteristics of a state's sovereign territory and the distribution of diseases within society. In particular, the fifth chapter of each volume is

devoted to diseases endemic or epidemic to the respective province, providing detailed information on the regional distribution of malaria as well as the location and characteristics of swamps [19]. The volumes were prepared by provincial directors of public health and physicians of the period and were based on administrative records, clinical observations, and survey data. In the international context, this series represents one of the few systematic efforts undertaken in a post-war country to document the relationship between health and the environment, making it a significant primary source for the history of malaria control in the Mediterranean basin [20].

Objectives and methodological framework

The primary objective of this study is to analyse the spatial and societal relationship between the presence of swamps and the spread of malaria in Türkiye during the early Republican period, based on the primary data contained in the *The Sanitary and Social Geography of Turkey* series. To achieve this objective, the study seeks to address the following research questions:

1. What correlation existed between the geographical distribution of swamps and the areas in which malaria cases were concentrated during the period under examination?
2. How did the state's swamp reclamation and medical intervention policies, particularly the distribution of quinine, vary across provinces according to their socio-economic characteristics?

Methodologically, the study adopts a historical-geographical analytical approach combined with qualitative content analysis to examine the empirical data and official reports contained in this corpus. The provincial-level data are not presented merely in a descriptive manner, rather, they are comparatively classified and synthesised across coastal and inland regions, as well as agricultural basins and mountainous areas, thereby providing the basis for a broader analytical discussion.

Methodological limitations

Several of the monographs lack quantitative data concerning either the extent of swamp areas or the prevalence of malaria. In addition, the use of different criteria by individual authors to define the same concepts, together with variations in historical medical terminology, complicated comparative analysis. Furthermore, as these monographs were prepared as official administrative reports, they may reflect certain political or bureaucratic biases. Nevertheless, despite these limitations, the systematic structure of the series and its status as a body

of primary-source material provide a reliable basis for meaningful regional comparisons.

The origins, historical spread, and vector dynamics of malaria

According to the prevailing scholarly consensus, the origins of malaria can be traced to the African continent, from where it evolved into a global public health threat through successive waves of trade, migration, and military mobility [11]. Human intervention in the natural environment through agriculture, the modification of watercourses, and the domestication of animals facilitated contact between previously isolated parasite reservoirs and human populations [21–24]. Although malaria has not typically manifested itself in the form of large-scale explosive epidemics, it has nevertheless been responsible for substantial mortality. Documented across a broad historical continuum—from ancient Chinese medical texts to Mesopotamian tablets and Egyptian papyri—malaria has functioned less as a pandemic causing sudden mass fatalities than as an endemic disease that progressively eroded labour capacity, weakened immune systems, and reduced the reproductive potential of affected populations [22, 25, 26].

In medical terminology, malaria is a febrile infectious disease initiated when unicellular parasites of the genus *Plasmodium* are transmitted to humans through the bite of infected *Anopheles* mosquitoes, which serve as the disease vector [27, 28]. After entering the human body, the parasite causes pathological damage to the liver and red blood cells (erythrocytes), suppressing the immune system, increasing susceptibility to secondary infections, and, if left untreated, potentially resulting in multi-organ failure and death [29–31].

The global decline of malaria became possible only after the medicinal properties of cinchona bark, first learned from the Indigenous peoples of Peru in the seventeenth century and later refined through the isolation of quinine in the nineteenth century, were combined with systematic swamp drainage programmes [9, 16]. Breaking the epidemiological cycle of malaria requires not only the treatment of the parasite itself but also the elimination of stagnant water bodies and swamp ecosystems that serve as breeding and larval habitats for *Anopheles* mosquitoes [30, 31].

The socio-economic and legal dimensions of swamp reclamation in malaria control

The vector-borne transmission cycle of the malaria parasite necessitates placing environmental reclamation at the centre of public health policy. Swamps, river basins, and coastal zones provide ideal microclimatic breeding habitats for disease-carrying mosquitoes [11]. In Anatolia, the concentration of swamps in some of the country's

most agriculturally productive and economically valuable river valleys particularly the Büyük Menderes Plain prevented permanent settlement, leaving some of the most fertile lands underutilised. During the Ottoman period, the initiatives undertaken under the reign of Sultan Abdülhamid II to reclaim these areas for agricultural use and protect the population failed to achieve lasting success owing to financial constraints and successive wars, and the problem consequently persisted into the Republican era [32].

The Republican administration regarded malaria not merely as a clinical disease but as a structural macroeconomic obstacle that directly impeded regional development, labour productivity, and population growth. While the malaria-endemic coastal plains possessed considerable economic value, they experienced persistent demographic decline, by contrast, the inland regions were relatively less affected by malaria but exhibited more limited economic potential, resulting in a markedly uneven spatial pattern of development [13].

To overcome this structural challenge, the state launched a comprehensive legal and administrative mobilisation comprising several interrelated measures:

- **The First Turkish Medical Congress:** At this congress, malaria was officially recognised as a national threat, and securing a stable supply of quinine on which the country remained dependent through imports was identified as a strategic priority [28, 33, 34].
- **The 1924 Village Law:** This legislation imposed a legal and administrative obligation on local communities to drain small bodies of stagnant water within villages, thereby extending responsibility for public health to the local level [23].
- **The 1926 Law on the Control of Malaria:** Forming the legal foundation of the national anti-malaria campaign, this law authorised the quarantine of high-risk areas and mandated the rapid drainage of *Anopheles* breeding sites under state supervision. It also expanded the institutional framework through the establishment of specialised Malaria Control Centres in pilot provinces, including Ankara, Adana, and Afyon [29, 35].
- **Preparation of Malaria and Swamp Maps:** Rather than relying on indiscriminate interventions, the Ministry of Health adopted a spatial epidemiological strategy by mapping high-risk agricultural basins and swamp areas to guide malaria control measures [36].

Findings: The spatial distribution of swamps and malaria in the *The Sanitary and Social Geography of Turkey* series

Analysis of the empirical data presented in the *The Sanitary and Social Geography of Turkey* series reveals a clear geographical correlation between the presence of swamps and the distribution of endemic malaria in Anatolia during the early Republican period. The findings demonstrate that swamps were not merely topographical features but constituted a dynamic public health problem shaped by a combination of anthropogenic activities, such as rice cultivation; hydrological processes, including river flooding; demographic movements, particularly migration; and forms of cultural resistance rooted in traditional medical beliefs.

The integrated analytical matrix presented below (Table 1) synthesises the evidence from all seventeen provinces examined in this study by presenting the characteristics and extent of swamp areas alongside the clinical *Plasmodium* species identified and their associated socio-economic and demographic consequences.

Urban centres, human activities, and the typology of artificial swamps

Ankara province

As the administrative capital of the Republic, Ankara served as the first institutional pilot area for the implementation of organised malaria control measures [13]. An examination of the province's swamp ecology highlights the predominance of an artificial swamp typology created through human activities. In the city centre, irrigation channels opened by market gardeners along the Hatip Stream (Bentderesi) and İncesu Stream, together with inadequately managed wastewater and insufficient drainage around the railway station, transformed the areas surrounding the Grand National Assembly building and the principal urban thoroughfares into breeding grounds for *Anopheles* mosquitoes [17, 37].

The socio-demographic consequences of these environmental conditions were particularly severe in the rural districts. In the villages of Arkalı and Çongar in Keskin, situated between two swamp areas, the number of households declined from 60 to 70 to only 15, illustrating the extent to which malaria threatened demographic sustainability [37]. In Beypazarı and Nallıhan, rice cultivation along the Aladağ and Kırçu streams created a paradox between economic productivity and public health [37]. In Kalecik, seasonal malaria peaks associated with the Âmin Ağaç and Karahöyük swamps coincided with the harvest period, preventing villagers from collecting agricultural produce and thereby creating a regional economic bottleneck [37]. Furthermore, zoological investigations conducted by Dr Otto Kohler scientifically demonstrated that the underlying cause of the problem was

the presence of *Anopheles* mosquitoes as the disease vector [37].

Konya province

Konya represents one of the clearest examples of how agricultural modernisation practices could produce unintended adverse consequences for public health. As part of the Konya Plain Irrigation Project, the construction of uncontrolled irrigation canals and waterways rapidly transformed an otherwise arid landscape into an ideal breeding environment for *Anopheles* mosquitoes. As a result, approximately three-quarters of Ereğli, together with the areas surrounding Lake Çavuşçu in Ilgın and Lake Karaviran in Bozkır, became heavily malaria-endemic [4, 13]. In particular, the population of Ilgın was severely affected by malaria owing to the proliferation of mosquitoes breeding in the swampy areas around Lake Çavuşçu. Efforts to drain these wetlands dated back to the late Ottoman period. For example, in 1908, the reclamation of the Nane Lake marshes was entrusted to Haydar Beyzade Şükrü Bey of Akşehir after the marshes caused widespread illness among migrants during the summer months, with the work scheduled between January and March, when water levels were at their lowest [38].

During the early Republican period, the Yeniceoba subdistrict emerged as the principal source of malaria in Saiteli, while the southwestern part of Seydişehir and the villages of Kesecik, Taşağıl, Suyurdu, and Karayulak became major centres of malaria transmission because of their proximity to swamp areas [4]. As part of the drainage campaigns undertaken by the Republican administration, 200 decares of swampy land at Çayırpınar and additional areas of 50 and 20 decares near Aksaray were reclaimed in 1933 through the construction of drainage canals extending approximately 1,200 m [11]. By 1927, the prevalence of splenomegaly in the city centre had been reduced to 7.5%, representing a significant public health achievement. However, the principal analytical finding in the case of Konya is the detrimental effect of administrative disorganisation. The decision of the provincial governor, İzzet Bey, to open the marshy meadows for construction as a horse-racing track, together with the uncontrolled diversion of the Meram waters for livestock grazing, led to the reaccumulation of stagnant water in excavated depressions. These developments effectively undermined the gains achieved through the state's extensive malaria control efforts [13].

Kırşehir province

During the late nineteenth and early twentieth centuries, malaria was so widespread in Kırşehir Province that it affected a substantial proportion of the population at some point in their lives. The principal anthropogenic

Table 1 Macro-Analytical Matrix of Swamp Characteristics, Malaria Species, and Their Socio-Economic and Demographic Impacts at the Provincial Level

Province	Primary Swamp Locations and Surface Area	Typology of Swamp Formation	Malaria Parasite/Clinical Type	Identified Socio-Economic and Demographic Impacts
Ankara	Bentderesi, İncesu, Çubuk Stream, Keskin, Kalecik, Haymana, Beypazarı, Nallıhan	Anthropogenic (paddy cultivation, urban wastewater) and Natural (fluvial recession)	General endemicity / Anopheles vector transmission	Radical population decline (e.g., reduction from 60 to 15 households in a village), agricultural harvest losses.
Antep	Hayyam, Kereh, Merziman, Kara Soyuk, and surrounding areas of Sinab Stream	Natural (surface water spread and marshlands on flat terrain)	<i>Plasmodium vivax</i> (Tertian) and <i>P. falciparum</i> (Tropical)	Seasonal labor loss during summer and autumn; epidemic peaks.
Ağrı	Central Plain (40 km ²), Iğdır and Bayezid Plain (10 km ² and 35 km ²)	Natural (snow/rainwater runoff from mountainous areas and lacustrine flooding)	High endemicity rate	Seasonal avoidance strategies through transhumance/nomadism; localized use of marshlands as fuel.
Çankırı	Feslikan Swamp, Karatay, Alice, and Sazcığaz villages	Natural (riverbed dynamics and local depressions)	Endemicity associated with river water usage	Limited geographical spread; localized health deterioration.
Çatalca	Terkos, Balban, Deli Yunus, Podima, Istranca, Büyüçekmece	Natural (coastal lagoons and humid under-forest ecosystems)	(1) Tertian, (2) Quartan (<i>P. malariae</i>), rarely Tropical	High parasite prevalence confirmed by blood smears; risks along military and civilian logistics routes.
Denizli	Menderes Valley basin, Çivril, Sarayköy, Çal, Ballıbekoğlu (40 km ²)	Natural (large river basin and high groundwater table)	Widespread Regional Endemicity	Mass morbidity in the agricultural basin; collapse of production capacity of the rural population.
Çanakkale	Burgaz, Tayfur, vicinity of Lake Gala, Meriç and Ergene basins (İpsala, Enez)	Natural (river floods and alluvial lake beds)	Tropical in Enez; Tertian in other districts	Chronic anemia, splenomegaly (enlarged spleen), physical frailty in the population; inadequacy of quinine.
Isparta	Nudra Stream (18 km ²), Beyşehir shore (44 km ²), Eğirdir-Hoyran basin (200 km ²), Kuleönü	Natural (Sultan Mountains drainage, tectonic/karstic lake beds)	Tertian and Quartan (introduction of Tropical after 1920 migrations)	Completely devastated and abandoned settlements (e.g., Gencali Village), mass spatial migration/exodus.
Zonguldak	Ereğli (Alaplı 3 km ² , Gülüş 2 km ²)	Natural (river floods)	Tertian and Quartan	Medical resistance linked to superstitious beliefs (thread tying), splenomegaly.
Kayseri	Kayseri Marsh (98 km ²), Sultan Marshes (Develi, İncesu)	Natural (Erciyes drainage and flat plain floor) and Anthropogenic (garden pools)	Widespread Regional Endemicity (15% splenomegaly)	Stagnation of land reclamation efforts due to the utilization of reeds as fuel (berdi) in kilns.
Konya	Ilgın (Çavuşçu Lake, Nane Lake), Saiteli, Ereğli, Bozkır (Karaviran), Seydişehir, Beyşehir	Anthropogenic (irrigation project canals) and Natural (lake basins)	Multiple Endemicity / Wide Spread	Loss of gains due to administrative lack of coordination (governor's interventions), failures in civil land drainage.
Kırklareli	Midye (Kıyıköy- 20 dönüm), İğneada (Demirköy), Vize	Natural (obstruction of river mouths by wave action)	Severe Malaria Intoxication (High Prevalence)	Fatal effects on port workers and civil servants; labor force crisis in timber/firewood/coal exports.
Kırşehir	Vicinity of Lake Seyfe, Mucur (Kurugöl), Kızılırmak riverbed (Sıdıklı, Savcılı)	Natural (lake/river overflow) and Anthropogenic (irrigation basins)	Estimated 8.5% endemicity rate	Inadequacy of clinical diagnosis; transformation of agricultural irrigation basins into Anopheles breeding sites.
Muğla	Milas (60 km ²), Köyceğiz, Dalaman, Gökova (2000 dönüm), Fethiye coast (15 km)	Natural (karstic springs and coastal bay topography)	Deformed population structure (widespread splenomegaly)	Economic utilization of Sığla forests; historical reclamation (Abbas Hilmi Pasha) and eucalyptus afforestation.
Niğde	Yahyalı-Karahisar Plain marshes	Natural (extensive plain floor and insufficient drainage)	(1) Tertian, (2) Quartan, (3) Tropical	Complete dependence on quinine treatment due to the high cost of swamp reclamation; chronic geographical isolation.
Sinop	Coastal strip and Gökırmak basin	Anthropogenic (intensive rice/paddy cultivation)	Predominantly Tertian, rarely Tropical	Total abandonment of villages; socio-economic compulsions.
Urfa	Routes of the Sacur, Cullap, Nizip, and Suruç streams	Natural (riverbed pools and flooding)	Localized and Easily Remediable Endemicity	Resistance from the local peasantry to swamp reclamation initiatives, citing paddy cultivation and livestock irrigation as justifications.

factor contributing to the province's epidemiological situation was the presence of stagnant water in uncontrolled ponds and reservoirs constructed by local inhabitants to irrigate vineyards and gardens, which provided favourable breeding habitats for *Anopheles* mosquitoes. According to estimates based on field observations, the

prevalence of malaria across the province was approximately 8.5% [39].

Located approximately four hours from the provincial centre, the area surrounding Lake Seyfe became marshy during the rainy season, directly affecting the inhabitants of Seyfe village. Similarly, in Mucur District, Kurugöl,

situated along the Hacıbektaş road, constituted another important source of swamp formation [39]. In addition, small-scale swamp areas were identified in the vicinity of the villages of Sıdıklı, Gözler, and Savcılı, all located along the course of the Kızılırmak River. The monograph emphasises that these wetlands could be drained relatively easily through the construction of drainage channels. It also identifies Horla village, in the Mecidiye (Çiçekdağı) District, as one of the settlements where malaria was particularly prevalent [39].

Natural wetlands, karstic Basins, and macro-topographical barriers

Ağrı province

The swamp ecosystem of Ağrı Province was shaped almost entirely by macro-geographical and hydrological factors. Extensive wetland areas were formed by the overflow of Lake Balık and the accumulation of snowmelt from Mount Ağrı across the Central Plain (40 km²), the Bayezid Plain (35 km²), and the Iğdır Plain (10 km²), creating marshlands of such magnitude that effective drainage and reclamation were technically impracticable [40, 41].

The inability to reclaim these extensive swamp areas compelled the local population to adopt a strategy of climatic adaptation through seasonal migration. During the summer months, when temperatures rose and *Anopheles* mosquito populations increased, inhabitants moved to higher mountainous areas, where they lived in tents before returning to the plains during the winter [17, 40, 41]. This pattern illustrates that malaria not only affected public health but also reinforced traditional forms of seasonal mobility, making transhumant living practices an adaptive response to the environmental conditions created by the disease.

Isparta province

Isparta represents one of the most striking cases in the series in terms of both the spatial extent of its wetlands and their devastating social consequences. Vast marshlands associated with the Nudra Stream (18 km²), the shoreline of Lake Beyşehir (44 km²), and the Eğirdir, Afşar, Çaltı, and Akdağ basin (200 km²) developed because water was unable to drain from the tectonic and karstic depressions surrounding the Sultan Mountains [42]. In Eğirdir, the encroachment of lake waters into residential neighbourhoods created environmental conditions that continuously sustained *Anopheles* mosquito breeding by virtue of the area's topographical characteristics [42].

The most dramatic social consequence of this environmental setting occurred in Gencali Village in the Yalvaç district. Despite possessing approximately 28,000 decares of exceptionally fertile agricultural land, the settlement

was completely abandoned by its inhabitants and fell into ruin as a result of endemic malaria and the scarcity of clean water [42]. The evidence from Isparta also reveals a pattern of epidemiological continuity and change. Historically, the Quartan and Tertian forms of malaria predominated in the region; however, in 1920–1921, the more virulent Tropica form was introduced by soldiers returning from the war and by incoming migrants, thereby exacerbating the epidemiological situation. In contrast, districts such as Uluborlu, characterised by their higher elevation above sea level and windier climatic conditions, remained largely free from malaria, confirming the decisive influence of microclimatic and topographical barriers on disease transmission [42].

Kayseri province

In Kayseri Province, runoff originating from the slopes of Mount Erciyes was unable to find well-defined natural channels or adequate drainage across the flat plain, resulting in the formation of the Kayseri Marshes, which extended over approximately 98 km² to the west of the city, as well as the Sultan Marshes located between the Karahisar subdistrict and the districts of Develi and İncesu [43]. This geomorphological setting contributed to exceptionally high rates of splenomegaly, reaching as much as 15% in the surrounding villages [4, 43].

The most distinctive analytical feature of the Kayseri case lies in the economic dilemma that hindered swamp reclamation. Reeds harvested from the Kayseri Marshes were dried and used as a primary fuel source in the city's bakeries under the local name *berdi*, generating substantial commercial benefits for various segments of the local population. Consequently, these economic interests created significant local resistance to drainage initiatives, thereby obstructing efforts to reclaim the marshlands despite their well-documented role in sustaining malaria transmission [43].

Muğla province

In Muğla Province, the physical manifestations of malaria within the population most notably pallor and abdominal distension resulting from splenomegaly were so widespread that the government was compelled to provide quinine free of charge [44]. The province's swamp ecosystem was characterised by extensive wetlands sustained by karstic springs and coastal topography. The Milas Marsh, extending southwest of Milas towards the Gulf of Gölük, covered approximately 60 km², measuring 14 km in length and 5 km in width, and severely affected the villages of Horca, Koru, and Tekfur Ambarı. The wetland system surrounding Lake Köyceğiz stretched for approximately 12 km between the Namnam Stream, Tuzbaşı, and Yüksek Kum localities, reaching depths of up to 12 m in certain areas. At the mouth of the Yuvarlak Stream,

a seasonal marsh approximately 6 km in length dried out during the summer months; however, it also possessed economic value owing to the presence of sweetgum (*Liquidambar orientalis*) forests [44].

Extensive marshlands were also present within the Dalaman River basin, particularly between the Dalaman and Kapukargın streams. Prior to the First World War, however, comprehensive reclamation works undertaken by Abbas Hilmi Pasha, the Khedive of Egypt, together with the planting of thousands of eucalyptus trees, resulted in the drainage of approximately 70% of these wetlands and their subsequent conversion into agricultural land. The Gökabad Marsh, covering approximately 2,000 decares on the eastern side of the Gulf of Gökova, developed as spring waters accumulated in low-lying terrain. In Fethiye, the 15-km coastal strip extending from the harbour to Gökçe village became marshy during periods of heavy rainfall [44]. While drainage canals and road construction successfully eliminated reed beds and reclaimed land in the wetland areas east of Fethiye, proposals to relocate the villages of Karadere, Boğulçalı, Kum, and Atlı, which were affected by the 14 km² marsh at the mouth of the Eşen River, were considered by the provincial authorities but ultimately never implemented [44].

Niğde province

Malaria exerted a devastating impact not only on Niğde city centre, the town of Bor, and the villages of the central plain, but also on settlements in Yahyalı and the surrounding mountainous regions [45]. All three major *Plasmodium* species—Tertian, Quartan, and Tropica—were identified in the province, with the Tertian form being the most prevalent [4, 45]. Given the geomorphological conditions and severe financial constraints of the period, no comprehensive reclamation programme could be undertaken to drain the extensive reed beds and marshlands of the Yahyalı–Karahisar Plain. Taking into account the country's limited financial resources in the aftermath of the war, provincial administrators concluded that the most practical and economically feasible strategy for malaria control was the widespread use of quinine rather than costly engineering interventions aimed at large-scale swamp reclamation [45].

Antep and çankırı provinces

In Antep Province, the marshes of Hayyam, Kereh, Merziman, Kara Soyuk, and Sinab Suyu were formed where surface waters spread across the relatively flat terrain and became stagnant. These environmental conditions facilitated the establishment of both *Plasmodium vivax* (Tertian malaria) and *Plasmodium falciparum* (Tropica malaria) within the region [46, 47]. As a consequence, malaria severely reduced seasonal labour capacity,

particularly during the summer and autumn months when agricultural activities reached their peak.

In Çankırı Province, marshes that developed in the villages of Feslikan, Karatay, Alice, and Sazcıgaz were sustained by water accumulating in local depressions along the course of the Kızılırmak River. These wetlands gave rise to localised malaria foci associated with the utilisation of river water [4, 48].

Coastal zones, river mouths, and industrial basins

Kırklareli province

In Kırklareli Province, malaria was most prevalent in the subdistricts of Midye (Kıyıköy) and İğneada, together with their surrounding coastal villages [49, 50]. In Midye, the outlets of streams flowing through the town became obstructed by the powerful wave action of the Black Sea where they discharged into the coast, resulting in the formation of chronic marshes covering approximately 15–20 decares. These wetlands created highly favourable breeding conditions for *Anopheles* mosquitoes, and individuals living in the area developed severe malaria symptoms within a relatively short period, regardless of their physical condition [50].

İğneada, a subdistrict of Demirköy, served as the principal logistical port for the shipment of timber, firewood, and charcoal to Istanbul. Approximately half an hour inland from the harbour lay an extensive marsh system consisting of five separate ponds [49, 50]. The annual deaths of hundreds of labourers who travelled to the port for seasonal employment after contracting malaria profoundly disrupted both the transportation of industrial raw materials and the regional economy. Other significant mosquito breeding sites that remained unreclaimed included the lake adjoining Aksicim village in the Vize district and a marsh belt extending approximately 10 km in length and 50 m in width between the settlements of Münekkerat, Çakılı, and Örenli and the villages of Karabürçek and Yuvalı in Saray District [50].

Zonguldak province

Although the overall spatial distribution of malaria in Zonguldak Province was relatively limited, the disease was particularly severe in the districts of Bartın, Ereğli, and Devrek, which were administratively part of the province during the period under study [51]. In the Ereğli region, flooding of the Güllüç and Alaplı rivers, combined with the area's low-lying topography, gave rise to the Alaplı Marsh (3 km²) and the Güllüç Marsh (2 km²). The Alaplı Marsh created fragmented bodies of stagnant water in the villages of Çaycuma, Okçular, Karacaömer, Doğancılar, and Kevken, providing suitable breeding habitats for the Tertian and Quartan forms of malaria [51]. In the Güllüç area, drainage ditches and canals constructed in earlier periods gradually became blocked, while

the reduced flow velocity of the river led to the formation of malaria foci in the villages of Gülüş, Hamza, and Şeyhkişla [51].

In Bartın, temporary marshes developed approximately 15–20 km upstream from the point where the Filyos River reaches the sea, as the low-lying terrain prevented the effective drainage of seasonal floodwaters. A wetland extending over approximately 3 km² in winter and 1 km² in summer was situated between the town centre and İciler village [51]. One of the most significant analytical findings in the region is that many villagers relied on traditional folk practices such as tying thread as a form of healing instead of receiving medical treatment with quinine. This reliance on non-medical remedies contributed to the persistence of splenomegaly and chronic malaria carriage within the local population [51].

Sinop province

In Sinop Province, malaria was associated not only with the natural wetlands along the coastline but also, and more importantly, with the widespread and inadequately regulated cultivation of rice in the agricultural lands irrigated by the Gökırmak River, which constituted the principal source of disease transmission. Blood examinations revealed that the Tertian form of malaria predominated, while the Tropica form was identified only sporadically [52].

The demographic consequences of malaria were so severe that several villages along the coastal zone were completely abandoned, effectively becoming deserted settlements. Nevertheless, because rice cultivation represented an indispensable component of the regional economy and the reclamation of wetlands entailed costs that exceeded the socio-economic capacity of the period, the provincial administration prioritised the regular distribution of quinine rather than imposing far-reaching restrictions on agricultural production or undertaking extensive swamp-drainage projects [52].

Çatalca, denizli, and çanakkale provinces

In Çatalca Province, the coastal lakes of Terkos, Balban, Deli Yunus, Podima, and Büyükçekmece, together with the humid forest understorey ecosystem, created endemic conditions dominated by the Tertian and Quartan forms of malaria, posing a significant threat not only to the civilian population but also to military logistical networks [53]. In Denizli Province, the districts of Çivril, Sarayköy, and Çal, located along the Büyük Menderes Valley, together with the 40 km² Ballıbekoğlu Marsh, became centres of widespread malaria transmission owing to persistently high groundwater levels, which severely undermined the productive capacity of the local population [54]. In Çanakkale Province, the floodplains of the Meriç and Ergene rivers subjected the districts of

İpsala and Enez to intense malaria endemicity. In Enez, the most virulent form of the disease, *Plasmodium falciparum* (Tropica malaria), was particularly prevalent, resulting in chronic splenomegaly, general physical debility, anaemia, and population decline among the inhabitants [55].

Urfa province

In Urfa Province, wetlands consisted not of extensive reed marshes but rather of small ponds formed within river channels and temporary floodwater accumulations in low-lying depressions along the courses of the Sacur, Cullap, Nizip, and Suruç streams. Because the province lacked extensive marshlands, the provincial authorities concluded that malaria could be eliminated more readily than in many other provinces if protective embankments and drainage canals were constructed in the limited low-lying areas situated below river level. However, the principal obstacle was the socio-economic resistance of the local population. Rural communities depended on these wetland areas both for rice cultivation and as essential water sources for livestock, and this economic dependence generated considerable local opposition to proposals aimed at draining the wetlands [56, 57].

Discussion

The findings derived from the *The Sanitary and Social Geography of Turkey* series demonstrate that the relationship between malaria and swamps in the early Republican period was not merely an epidemiological phenomenon. Rather, it constituted a macro-political process shaped by the interplay of geographical determinism, economic imperatives, socio-cultural barriers, and the administrative capacity of the state.

The existing literature indicates that the global decline of malaria was achieved primarily through two complementary strategies: swamp drainage aimed at vector control and the provision of quinine for parasite control [9, 30]. However, the empirical evidence presented in this study demonstrates that, within the Anatolian context, these two universally recognised approaches were in continual tension with local economic priorities and geographical constraints. The cases of Sinop, Urfa, and Ankara (Beypazarı) clearly illustrate how rice cultivation created a structural contradiction between the state's objectives of national economic development and food security, on the one hand, and its commitment to protecting public health through malaria prevention, on the other [37, 52, 57]. The reluctance of local communities to support swamp drainage because these wetlands were indispensable for livestock watering and rice cultivation provides compelling empirical evidence that public health policies could not achieve lasting success without the cooperation of the communities they were intended

to serve. A comparable economic dilemma is evident in Kayseri, where reeds harvested from the marshes (*berdi*) acquired considerable commercial value as a primary fuel source for local bakeries, thereby discouraging reclamation efforts [43].

From a spatial perspective, the geographical characteristics of wetlands directly shaped the state's malaria control strategies. In extensive karstic and tectonic depressions such as those surrounding Lake Balık in Ağrı and the Eğirdir–Hoyran basin in Isparta, engineering limitations and financial constraints rendered comprehensive drainage technically and economically unfeasible. As a consequence, local populations either adopted traditional forms of seasonal migration as a climatic adaptation strategy or, as in the case of Gencali Village, abandoned their settlements altogether [40, 42]. The case of Niğde further demonstrates that the high costs associated with environmental reclamation compelled the early Republican administration to prioritise the importation and distribution of quinine as a short-term, palliative solution rather than pursuing long-term ecological transformation through large-scale drainage projects [45].

The relationship between the distribution of the principal *Plasmodium* species—*P. vivax* (Tertian malaria), *P. malariae* (Quartan malaria), and *P. falciparum* (Tropical malaria) and patterns of population mobility also reveals a significant historical continuity. In major endemic centres such as Isparta and Enez (Çanakkale), the spread of the highly virulent Tropical form was closely associated with infected soldiers returning from the First World War and the Turkish War of Independence, as well as with large-scale refugee movements [42, 55]. Malaria not only caused substantial mortality but also disrupted key sectors of the national economy. In Kırklareli, for example, the disease severely affected dockworkers engaged in the transport of timber, firewood, and other raw materials, thereby impairing industrial production and logistical networks [50]. Likewise, the persistence of traditional folk practices in Zonguldak, such as the ritual of tying thread instead of seeking medical treatment, created a significant cultural barrier to effective intervention and contributed to the chronic persistence of malaria within the population [51]. Finally, the administrative failures exemplified by the actions of Governor İzzet Bey in Konya demonstrate how centrally planned malaria control initiatives including the 1926 Law on the Control of Malaria and nationwide disease-mapping programmes could be undermined by inadequate coordination and short-sighted decision-making at the provincial level [13].

Conclusion and evaluation

Situated at the intersection of historical geography and public health, this study has examined malaria one of the most significant demographic and socio-economic crises inherited from the late Ottoman Empire by the early Republic of Türkiye through a spatial and analytical assessment of the *The Sanitary and Social Geography of Turkey* series. The findings demonstrate that the preventive public health measures and quarantine practices developed from the Tanzimat period onward created an important institutional legacy. However, the logistical collapse accompanying the Turkish War of Independence, together with large-scale military and civilian population movements and successive waves of migration, undermined this institutional capacity and transformed malaria into a major threat to national survival. The early Republican administration regarded malaria not merely as a clinical infectious disease but as a structural obstacle to the construction of a new social and economic order. This perception constituted the principal motivation for initiating the empirical and monographic field surveys published under the title *The Sanitary and Social Geography of Turkey*.

The analytical synthesis of the primary data from the seventeen provinces examined in this study reveals its most significant contribution: the existence of a strong geographical and socio-economic correlation between the typology of wetlands in Anatolia and the clinical as well as societal consequences of malaria. The first dimension of this causal relationship is manifested in the paradox created by human activity and economic necessity. In provinces such as Ankara, Konya, Kırşehir, and Sinop, the principal sources of malaria were found to be not natural wetlands but artificial swamps created through rice cultivation, uncontrolled irrigation canals, and irrigation ponds constructed for vineyards and orchards. This situation generated a structural contradiction between the state's objectives of national economic development and food security and its responsibility to protect public health. The inability of local communities to abandon rice cultivation, together with the commercial utilisation of marsh reeds as fuel in Kayseri, created significant social resistance to environmental reclamation, demonstrating that malaria control required not only medical intervention but also sustained socio-cultural persuasion and public cooperation.

The second dimension of this correlation concerns the interaction between macro-topography and demographic adaptation. In extensive karstic and tectonic basins such as those of Ağrı, Isparta, and Muğla, the financial and technical limitations of the period made permanent swamp reclamation impossible, fundamentally reshaping patterns of human settlement. The pressure exerted by malaria compelled communities to adopt traditional

strategies of seasonal migration to higher elevations, while, as observed in Gencali Village in Isparta and in the coastal settlements of Sinop, some communities abandoned their settlements entirely, leading to widespread depopulation and the emergence of deserted villages. The high costs of environmental reclamation also meant that, as exemplified by the case of Niğde, provincial administrations became dependent on short-term palliative measures most notably the distribution of quinine instead of implementing long-term ecological interventions.

The findings further highlight the spatial significance of logistical, industrial, and cultural barriers. In Çatalca, malaria endemicity threatened military transportation routes, while in Kırklareli the disease severely affected the workforce employed in the timber and coal export operations of the ports of İğneada and Midye, thereby disrupting the state's industrial logistics. The return of infected soldiers and the arrival of refugee populations from wartime fronts facilitated the spread of the highly virulent *Plasmodium falciparum* strain into the Anatolian interior, as demonstrated by the cases of Isparta and Çanakkale, contributing to greater epidemiological diversity within the parasite population. Meanwhile, traditional folk beliefs observed in provincial settings such as Zonguldak constituted important cultural barriers to medical treatment, thereby contributing to the persistence of splenomegaly and chronic malaria carriage.

In conclusion, it may be argued that the empirical evidence generated through these geographical monographs provided the scientific foundation for the 1926 Law on the Control of Malaria and the subsequent establishment of specialised Malaria Control Institutes. Although local administrative failures and a lack of bureaucratic coordination as exemplified by the case of Governor İzzet Bey in Konya occasionally undermined centrally planned policies, *The Sanitary and Social Geography of Turkey* series remains a remarkable historical testament to the positivist and rationalist efforts of the early Republican state to understand and govern its territory through systematic medical, demographic, and geographical investigation. From this perspective, the struggle against malaria in the early Republic should be understood not merely as a biological campaign against mosquitoes and swamps but as a strategic component of a broader nation-building project that sought to extend medical rationalism to the provinces, preserve the productive workforce, reorganise the physical environment, and ultimately establish the material foundations of a healthy nation-state.

Author contributions

The author confirms sole responsibility for the conception and design of the study, the analysis and interpretation of the results, and the preparation of the manuscript.

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Data availability

No datasets were generated or analyzed during the current study.

Declarations

Ethical approval

This study is a qualitative research article based on the systematic examination and analysis of published official monographs from the early Republican period (The Sanitary and Social Geography of Turkey series) together with relevant secondary historical literature. The research did not involve human participants or animals, nor did it include questionnaires, interviews, observational studies, or clinical interventions. Accordingly, ethics committee approval was not required. All primary sources examined are publicly available and accessible through library and archival collections.

Competing interests

The authors declare no competing interests.

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