Linking Environmental Degradation and Public Health in the Face of Climate Change: A Case Study of Mombasa County, Kenya

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Abstract

Climate change and degradation of the environment have served as the key drivers to posing the greatest public health risks in modern times. This occurrence is mostly witnessed in developed and developing urban centers like Mombasa, Kenya. This review aims to explore a range of health impacts arising from climatic hazards that are induced through a constant shift in the patterns of climate change. Among such common climatic incidences include, flooding, air and water pollution, and rising temperatures. It highlights how waterborne diseases, vector-borne illnesses, respiratory conditions, and malnutrition are exacerbated by environmental stressors, particularly affecting vulnerable populations including children, the elderly, informal settlement dwellers, and fisherfolk. The research also delves on the existing interlinkages between ecological degradation and the prevalence of diseases therefore highlighting the socioeconomic inequalities, gendered vulnerabilities, and systemic feedback loops that reduce community resilience. A critical review of Kenya's climate and public health policy landscape reveals existing gaps in enforcement, funding, and coordination. However, localized solutions-including community-based health initiatives, mangrove restoration, youth-led waste management, and digital health innovations-demonstrate potential for scalable and inclusive adaptation. The study concludes by recommending integrated climate-health strategies, improved intersectoral coordination, gender-sensitive planning, and enhanced public education to build long-term urban resilience. This paper provides actionable insights for policymakers, practitioners, and civil society actors committed to safeguarding public health in the face of environmental change.

Keywords

Climate change, Environment, Degradation, Public Health

1. Introduction

Climate change poses significant risks to human health globally, and its impacts are particularly severe in vulnerable regions such as Sub-Saharan Africa. The continent's rapidly urbanizing coastal cities are hotspots for environmental degradation and public health challenges resulting from climate-induced phenomena such as rising temperatures, sea level rise, and extreme weather events [1,2]. Kenya, situated along the equator and bordered by the Indian Ocean, faces diverse environmental and climatic stressors, particularly in urban coastal settings like Mombasa County.

Mombasa, Kenya's second-largest city and an economic hub due to its strategic port as shown in figure 1, is increasingly vulnerable to the adverse effects of climate change. Three factors contribute to Mombasa's high level of vulnerability to climate change: low altitude, and high temperatures and humidity levels [3]. This county experiences recurring floods, urban heat island effects, and ecological degradation due to rapid urbanization, poor infrastructure, and unregulated industrial activities [4]. These environmental challenges have a direct bearing on public health outcomes, including increased incidences of waterborne and vector-borne diseases, respiratory illnesses, and heat-related conditions.

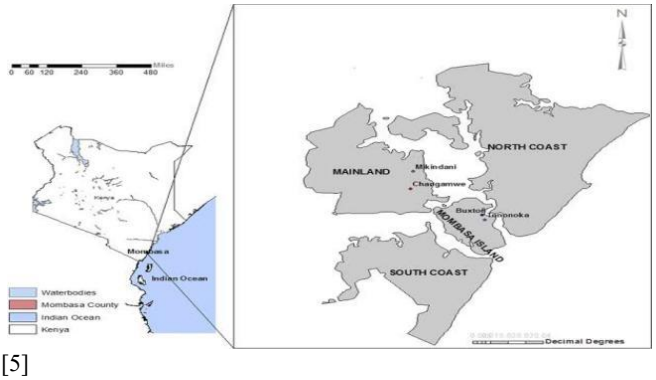

Figure 1 Mombasa County Map [5]

Environmental degradation, a process characterized by the deterioration of natural ecosystems due to anthropogenic and natural causes, has been accelerating in Mombasa. Coastal erosion, deforestation of mangrove ecosystems, poor waste management, and pollution from the maritime industry are critical concerns [3]. When these environmental stressors intersect with public health systems that are already under pressure, the outcome is a compound crisis that undermines human wellbeing and sustainable development goals.

This paper adopts a review approach to explore the intricate relationship between environmental degradation and public health in the context of Mombasa County under the influence of climate change. It draws from academic studies, government reports, and international literature to examine how environmental factors have influenced health burdens, impacted vulnerable populations, and challenged policy responses. The paper is organized into the following sections: a theoretical framework, an overview of environmental degradation in Mombasa, the public health impacts, linkages between environment and health, policy analysis, local initiatives, and recommendations for an integrated response.

1.1 Theoretical and Conceptual Framework

Understanding the relationship between environmental degradation and public health in the context of climate change requires a multi-dimensional analytical lens. This paper applies three key theoretical frameworks: the Ecological Model of Health, the "One Health" approach, and the Climate Change Vulnerability Framework.

The Ecological Model of Health posits that human health is not merely a product of individual behavior but is shaped by the physical and social environment in which people live. This model views health outcomes as a consequence of interactions across multiple levels: individual, interpersonal, community, and policy environments. In the case of Mombasa, this perspective is essential in recognizing how poorly managed urbanization, waste systems, and climate-induced hazards interact with local living conditions to affect health outcomes [6].

The "One Health" approach, endorsed by WHO and other international agencies, highlights the interconnectedness of human, animal, and ecosystem health. This model is particularly applicable in Mombasa, where marine ecosystems (such as mangroves and coral reefs) are under pressure, and degradation of these systems contributes to increased disease transmission. For example, the loss of mangroves reduces natural barriers against flooding and disrupts the breeding grounds of aquatic species, some of which may harbor pathogens [7]. One Health emphasizes the need for interdisciplinary responses that link environmental conservation with public health interventions.

Finally, the Climate Change Vulnerability Framework categorizes vulnerability into three components: exposure, sensitivity, and adaptive capacity. Mombasa is highly exposed to climate-related risks such as flooding and sea level rise [8]. Its population is sensitive due to factors like poverty, dense informal settlements, and inadequate healthcare infrastructure. The city's adaptive capacity is constrained by weak governance, limited disaster preparedness, and slow implementation of climate-resilient infrastructure. This framework helps assess the degree to which environmental and social factors combine to exacerbate public health risks.

Together, these frameworks offer a comprehensive lens for reviewing the current state of environmental degradation and its direct and indirect effects on public health in Mombasa

1.2 Environmental Degradation in Mombasa County

Mombasa County is experiencing rapid environmental degradation driven by urban expansion, industrialization, port development, and the impacts of climate change [9]. These processes have significantly altered the natural landscape, disrupted ecological balance, and increased exposure to health hazards [10].

One of the most pressing environmental issues is urban flooding, which has become increasingly frequent and severe. According to Oluchiri [8], Mombasa, along with Nairobi and Kisumu, experiences recurrent flooding due to a combination of heavy rainfall, inadequate drainage systems, and poor urban planning. These floods lead to the contamination of water sources and create breeding grounds for disease vectors, posing direct public health risks. In Mombasa, informal settlements are often built on flood-prone areas, exacerbating the problem and disproportionately affecting low-income residents [4].

The expansion of the Mombasa Port has brought significant socio-economic benefits but also environmental costs. As noted by Ogara, Akrofi & Gichuhi [7], the dredging and construction activities associated with port expansion have led to coastal erosion, habitat loss, and pollution of marine ecosystems. The increased maritime traffic contributes to oil spills and waste discharge, affecting both marine biodiversity and the livelihoods of fishing communities. Furthermore, air and noise pollution from port operations have been linked to respiratory issues among nearby residents [7].

Another critical issue is solid waste mismanagement, especially in densely populated urban centers. Otundo [11] highlights that Mombasa produces large volumes of uncollected waste, much of which ends up in open drains or is dumped in the ocean. This not only pollutes the environment but also clogs drainage systems, worsening the flooding situation. The burning of waste in open areas releases toxic gases, contributing to air pollution and increasing the risk of respiratory diseases.

The urban heat island effect is also becoming more pronounced in Mombasa as shown in figure 2 due to the loss of green spaces, high population density, and dense built-up areas [12]. Mutua [13] notes that this phenomenon leads to

elevated temperatures in the city, posing a health threat to the elderly and those with pre-existing conditions, especially during heatwaves.

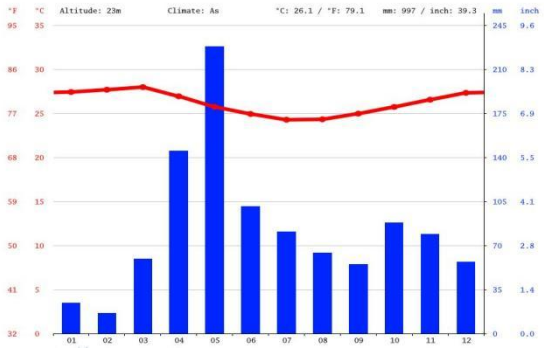

Figure 2 Mombasa Temperature Trend over a year [13]

These patterns of environmental degradation are not isolated-they are interlinked and amplified by climate change. As the environmental stress intensifies, the public health consequences become more severe, underscoring the need for urgent, multisectoral interventions.

1.3 Public Health Impacts in Mombasa

Mombasa County is experiencing a surge in climate-related public health challenges that stem directly from environmental degradation and poorly managed urban systems. One of the most pressing issues is the increase in waterborne diseases such as cholera, typhoid, and diarrheal illnesses [14]. Floodwaters frequently contaminate water sources, especially in informal settlements that lack proper sanitation infrastructure. Oluchiri [8] highlights how urban flooding in Mombasa has contributed to a rise in cholera outbreaks, particularly after heavy rainfall events that overwhelm the drainage system and spread human waste into drinking water supplies.

The spread of vector-borne diseases has also intensified due to environmental conditions favorable to disease-carrying insects. Stagnant water left behind by floods and blocked drainage systems provides ideal breeding grounds for mosquitoes. As a result, the incidence of malaria, dengue, and chikungunya has been rising in Mombasa [4]. Warmer temperatures linked to climate change further accelerate the reproduction cycles of these vectors, expanding the transmission window and geographic reach of these diseases.

Another growing health concern is the rise in respiratory illnesses, driven by increasing air pollution from industrial emissions, waste burning, and transport congestion near the Mombasa Port and industrial zones. Ogara, Akrofi & Muthoni [7] found a significant link between proximity to port operations and higher reported cases of asthma, bronchitis, and other respiratory ailments. Open waste burning and traffic-related emissions in densely populated areas also contribute to elevated particulate matter levels, especially in low-income neighbourhoods.

In addition, heat-related illnesses are becoming more prevalent due to the urban heat island effect, a phenomenon where city temperatures are higher than surrounding rural areas because of concrete infrastructure, reduced vegetation, and lack of green spaces. Mutua [13] notes that heatwaves in Mombasa have increasingly led to cases of dehydration, heat stroke, and aggravated cardiovascular conditions, particularly among the elderly and outdoor workers such as boda boda riders and vendors.

Mombasa's food security has also been compromised. Overfishing, coastal pollution, and the destruction of marine habitats have reduced fish stocks, a key source of protein for local communities [7] Declines in agricultural productivity from saltwater intrusion and unpredictable rainfall patterns further threaten local nutrition and livelihoods, leading to rising malnutrition rates among children.

Finally, the strain on the healthcare system is significant. Many public health facilities lack the capacity and infrastructure to respond to climate-induced disease outbreaks. Health inequalities are exacerbated by limited access to care in informal settlements and remote areas, disproportionately affecting vulnerable populations such as women, children, the elderly, and persons with disabilities [15].

1.4 Interlinkages Between Environmental Degradation and Public Health

The relationship between environmental degradation and public health outcomes in Mombasa is deeply interconnected and mutually reinforcing. Degraded ecosystems and poor environmental management practices directly exacerbate the prevalence of disease and contribute to new health vulnerabilities [14].

Flooding, for example, not only causes immediate physical injuries and displacement but also contaminates water sources, leading to waterborne disease outbreaks. This creates a cascading effect, where one environmental event triggers multiple public health crises. Similarly, coastal and marine degradation-through pollution and overexploitation-

impairs access to clean water and food sources, leading to long-term health risks such as malnutrition and stunted growth in children [11].

Vulnerable populations are disproportionately impacted by these environmental health risks. Informal settlements in Mombasa, often built on low-lying flood-prone land, suffer from poor drainage, lack of sanitation, and inadequate housing. These areas are frequently affected by floodwaters and pollution, compounding the risks of infectious disease and exposure to environmental toxins [4]. Children and the elderly are especially susceptible due to their reduced physiological resilience and dependence on others for care.

Fisherfolk and coastal communities face unique challenges. The decline in fish stocks from marine pollution and port development affects both income and dietary diversity, increasing nutritional deficiencies and psychosocial stress. Coastal erosion and rising sea levels also threaten their homes and cultural heritage, increasing mental health burdens and displacement risk [7].

Climate change also brings gendered health risks, as women often bear the burden of caregiving, water collection, and food preparation. During environmental crises, women may have less access to resources or healthcare, and they face increased risks of gender-based violence during displacement or in overcrowded health facilities [16]. In Mombasa, adaptation responsibilities-like sourcing clean water or protecting children from flood risks-disproportionately fall on women.

Finally, health vulnerabilities reduce resilience to future environmental shocks. Poor health, particularly chronic illnesses or malnutrition, weakens the body's ability to withstand environmental extremes. This creates feedback loops, where environmental degradation fuels poor health, and poor health in turn reduces the community's capacity to respond and adapt to climate threats.

1.5 Policy and Institutional Landscape

Kenya has developed a number of policy instruments to address climate change and environmental health risks, including the National Climate Change Response Strategy (NCCRS) and the National Climate Change Action Plan (NCCAP) [17]. These policies aim to promote climate adaptation and mitigation across sectors. Additionally, Mombasa County has incorporated environmental objectives into its County Integrated Development Plan (CIDP), focusing on sustainable waste management, disaster preparedness, and coastal ecosystem protection [11].

However, implementation remains inconsistent, and major gaps exist in enforcement, funding, and inter-agency coordination [18]. The environmental health mandates are often distributed across multiple agencies-such as the National Environment Management Authority (NEMA), the Ministry of Health, and the Mombasa County Government-with limited coordination, leading to inefficiencies and overlap. Funding for climate adaptation and health infrastructure remains insufficient, with many health facilities under-equipped to deal with vector control, water treatment, or climate disaster response [15].

Public health institutions in Mombasa are actively engaged in disease surveillance, health education, and disaster response, but they often operate reactively rather than proactively. There is limited integration of environmental data into public health planning, and many facilities lack climate-resilient infrastructure. Furthermore, few health policies in Mombasa explicitly incorporate climate adaptation or sustainability goals, limiting their long-term effectiveness.

Despite these challenges, community-based organizations and NGOs have played a critical role in filling policy and institutional gaps. Initiatives such as youth-led climate action, neighborhood clean-up campaigns, and mangrove restoration projects have increased public awareness and resilience at the grassroots level [4]. Faith-based organizations and women's groups have also been instrumental in promoting health education, especially during disease outbreaks and disaster events.

Moving forward, there is a need to strengthen local governance capacity to implement climate-health policies, improve cross-sectoral coordination, and enhance community engagement in planning processes. Integrating health indicators into climate adaptation strategies and vice versa will be crucial for achieving resilience in Mombasa's urban and coastal systems [18].

1.6 Localized Solutions and Initiatives

Localized and community-led solutions are playing a pivotal role in enhancing climate resilience and improving public health outcomes in Mombasa. While national frameworks provide direction, local action is essential for practical implementation and culturally appropriate responses.

One of the most promising areas of intervention is community-based water, sanitation, and hygiene (WASH) programs. In partnership with NGOs such as the Kenya Red Cross and WaterAid, local groups have established handwashing stations, distributed water purification tablets, and educated residents in informal settlements about safe water practices. These efforts have been particularly impactful in preventing cholera and diarrhoea diseases in high-risk areas like Bangladesh and Kaa Chonjo [19].

Urban greening and nature-based solutions have also gained traction. Organizations such as Big Ship and the Kenya Forest Service have collaborated on mangrove restoration projects in Tudor Creek and Mtwapa Creek, which not only

support coastal biodiversity but also serve as buffers against flooding and saline intrusion. Mangrove ecosystems act as carbon sinks and natural water filters, improving both environmental quality and public health [20].

Moreover, youth and women's groups in Mombasa are increasingly engaging in solid waste management and recycling initiatives. For instance, the Mombasa Women Empowerment Network has trained members on converting plastic waste into eco-bricks and reusable household items. These initiatives reduce the risk of flooding from clogged drainage systems and lower air pollution from open burning, thereby mitigating respiratory health risks [21].

In the health sector, community health volunteers (CHVs) have been instrumental in disease surveillance, early warning systems, and risk communication. CHVs often act as liaisons between formal healthcare systems and residents in informal settlements, especially during cholera outbreaks or heatwaves. They disseminate critical health information using local languages and culturally relevant approaches, thereby increasing trust and response rates [15].

Digital innovation is also emerging as a solution. Startups and civil society organizations are piloting mobile apps and SMS services to report flood risks, track disease symptoms, and access emergency health information. Platforms like AfyaWatch and DaktariSmart are examples of digital health tools that bridge the healthcare access gap in marginalized neighborhoods [22].

These localized initiatives demonstrate the power of grassroots resilience and underscore the need to scale and institutionalize such efforts through adequate funding, technical support, and inclusive policy frameworks

2. Recommendations

Addressing the public health challenges linked to climate change and environmental degradation in Mombasa requires a multidimensional and integrated strategy. The following recommendations focus on policy reform, institutional strengthening, and community engagement.

First, there is a need to mainstream climate adaptation into public health planning. This includes incorporating climate risk data into health surveillance systems, ensuring health infrastructure is climate-resilient, and training health professionals on the links between environmental changes and disease dynamics. The Ministry of Health, in collaboration with the Ministry of Environment and Mombasa County, should co-develop a Climate-Resilient Health Strategy that includes early warning systems for extreme weather events and climate-sensitive diseases [23].

Second, infrastructure investments must prioritize flood control, drainage systems, and sustainable housing in informal settlements. Green infrastructure solutions, such as bio-swales, rooftop gardens, and permeable pavements, can help manage stormwater and reduce the urban heat island effect [24,25]. Donor agencies and the National Treasury should support Mombasa County to access climate adaptation funds under mechanisms such as the Green Climate Fund (GCF).

Third, inter-agency coordination should be improved. A Climate and Health Task Force at the county level-bringing together NEMA, the Department of Public Health, Kenya Meteorological Department, and local NGOs-can improve data sharing, response coordination, and joint planning. A decentralized system that empowers ward-level committees to monitor and respond to localized environmental health threats would ensure a faster and context-specific response.

Fourth, gender-sensitive climate action is essential. Women should be involved in the design, implementation, and evaluation of environmental health programs. Gender-responsive budgeting and female-led community projects can address the unique vulnerabilities women face during climate shocks [16].

Fifth, education and behavioral change communication should be scaled up. Public awareness campaigns through radio, community theatre, and social media can improve knowledge on climate-related health risks and promote protective behaviors. Integrating climate literacy into school curriculums will also foster a generation that is informed and prepared to act.

Finally, monitoring and evaluation (M&E) systems must be strengthened to assess the effectiveness of interventions. Indicators such as reduced disease incidence, improved access to healthcare, and enhanced adaptive capacity should be tracked to inform policy refinements and funding priorities [22].

3. Conclusion

Mombasa's experience exemplifies how the impacts of climate change and environmental degradation are not only ecological but deeply intertwined with human health, particularly for vulnerable populations. From waterborne and vector-borne diseases to respiratory and heat-related illnesses, the city is at the frontline of a growing public health crisis exacerbated by unplanned urbanization, poor infrastructure, and systemic inequality.

However, the crisis also presents an opportunity to reimagine development through the lens of climate resilience and health equity. As highlighted, localized initiatives-from mangrove restoration and CHV networks to mobile health technologies-are already demonstrating innovative and impactful responses that can be scaled up with the right institutional support.

The interlinkages between environmental and health systems call for integrated governance, where climate adaptation is not treated in isolation but embedded within health, housing, water, and education planning. Mombasa must adopt a systems-thinking approach to break the cycle of vulnerability and build a healthier, more resilient urban future.

Key to this transformation is the empowerment of local communities, especially women, youth, and informal residents, whose lived experiences and adaptive practices can inform more inclusive and effective policy design. Building institutional capacity, securing sustainable financing, and fostering partnerships between government, civil society, and the private sector will be critical in ensuring lasting change.

Ultimately, Mombasa's path forward must balance ecological restoration with social justice, prioritizing both planetary and population health. If done right, this integrated approach can serve as a model for other coastal cities across Africa facing similar climate-health challenges.

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