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Assessment of the Influence of Flooding on Infectious Diseases Outbreak in Kenya

Isabella Kamanthi P.

Department of Public Administration Kampala International University Uganda

ABSTRACT

Flooding has become one of the leading disasters worldwide. In Kenya, the flooding events are influenced by a wide range of factors, including the overflow of rivers, flash floods, coastal floods, floods as a result of unprecedented amounts and intensity of rainfall, inadequate or lack of drainage systems and in some cases, human interference with drainage basins, riparian zone and watersheds. Flooding has a wide range of health consequences such as drowning, injury, outbreak of gastroenteritis, respiratory infections, poisoning, communicable diseases, epidemic diseases such as cholera, diarrhoea, and dengue fever, poor mental health, and disability, among others; however, the focus of this paper is on infectious diseases. Flooding alters the balance of the environment and often creates a conducive environment for the development of pathogens and vectors. The diseases that are most likely to be affected by flooding are those that require vehicular transfer from host to host (waterborne) and or a host/vector as part of its life cycle (vector-borne). In addition, flooding may hinder access and provision of urgent medical services to suppress the spread of infectious diseases leading to a wider spread. In light of the increased threat of flooding due to amplification by climate change, there is need for a better understanding of the association and underlying dynamics of outbreak of infectious diseases following flooding to inform policy.

Keywords: Flooding, Infectious disease, Vector, Consequence, Causes

INTRODUCTION

Flooding has become one of the leading disasters worldwide and is predicted to increase in frequency over the coming years as a result of climate change and other human-induced activities [1, 2]. Today, many countries in the globe suffer some kind of flooding, and Kenya is no exception. Since the first worst recorded floods in 1961-1962, Kenya has experienced some of the most intense and severely devastating flooding as exemplified by the 1997-1998 El Niño-induced floods that were the most widespread [3]. The financial losses associated with the El Niño floods were estimated at US$800m [4]. The problem of flooding has become perennial, every time taking back years of development and costing millions of dollars in reconstruction and recovery. In addition, hundreds of lives are lost. According to the United Nation Environment Program [5], flood-related fatalities constitute a whopping 60 per cent of disaster victims in Kenya. The flooding events in Kenya are influenced by a wide range of factors, including: the overflow of rivers, flash floods, coastal floods, floods as a result of unprecedented amounts and intensity of rainfall, inadequate or lack of drainage systems and in some cases, human interference with drainage basins, riparian zone and watersheds. Flooding affects both rural and urban Kenya, but in the recent past, it has become more frequent and severe in the urban areas. Many towns in Kenya are now faced with the problem of recurrent flooding as a result of factors such as climate change, high concentrations of buildings and people, but mainly due to poor planning and poor disposal of waste that clog the drainage system. Some towns are at a greater risk of flooding due to a combination of factors, most of all due to their location. Flooding has a wide range of health consequences such as drowning, injury, outbreak of gastroenteritis, respiratory infections, poisoning, communicable diseases, epidemic diseases such as cholera, diarrhoea, and dengue fever, poor mental health, and disability, among others [1]; however, the focus of this paper is on infectious diseases. According to [6], three components are essential for most infectious diseases: an agent (or pathogen), a host (or vector), and transmission environment. Flooding alters the balance of the environment and often creates a conducive environment (breeding ground) for the development of pathogens and vectors. The diseases that are most likely to be affected by flooding are those that require vehicular transfer from host to host (waterborne) and or a host/vector as part of its life cycle (vector-borne) [7]. In addition, flooding may hinder access and provision of urgent medical services to suppress the spread of infectious diseases leading to a wider spread. In light of the increased threat of flooding due to amplification by climate change, there is need for a better understanding of the association and underlying dynamics of outbreak of infectious diseases following flooding to inform policy [7]. This paper assesses the influence of flooding on infectious diseases in Kenya.

Human-related Causes of Flood in Kenya

Population Pressure and Settlement Patterns

Settlement patterns are partly influenced by population pressure. In urban areas, there is a tendency for the slums to develop in areas which have been designated as flood-prone zones. Settlement on steep slopes as well as cultivation on such lands also tends to increase the vulnerability of the community to landslides. This also increases possibility of increased rates of soil erosion particularly where overgrazing and deforestation have reduced vegetation cover. Modification of river channels through channel straightening can lead to rapid flow of water into streams, thus promoting rapid increase in water level in rivers. Flooding of the low-lying areas often follows this.

Poor Land-Use and Degradation of Catchment Areas

Poor land-use activities characterized by deforestation and clearance of bushes and other vegetation is the major cause of catchment degradation. Cultivation on steep slopes without applying soil conservation measures promotes soil erosion and rapid generation of surface runoff [8]. Vegetation cover is essential since it retards the flow of surface run-off, thus encouraging more water to infiltrate into the soil and replenish soil moisture. The recharge of ground-water aquifers also take place through infiltration and deep percolation of rainwater. Other causes of the degradation of catchment areas include poor construction of roads and footpaths, which are sources of sediments carried by the surface run-off to river channels. Lack of effective urban planning mechanisms promotes development of slums and other residential structures, which discharge sewage and domestic wastewater into river channels, thus degrading important water catchment areas.

Lack of Regulatory Systems

The enforcement of regulations governing settlement in zones designated as flood prone has been a major problem in Kenya in that the enforcement is weak, partly due to weak institutional capabilities to enforce regulations. Similarly, there is no effective coordination between different government departments and nongovernmental organizations, resulting into waste of resources and duplication of effort. The uneven development in the country particularly the huge difference in the living standard of urban and rural areas is encouraging the influx of rural poor into urban areas in search of better opportunities. This has led to overcrowding in urban areas, severely overstraining the existing housing, health, water supply, sewage and educational and recreational facilities.

Poverty

According to the 1997–2001 National Development Plan [9], out of the estimated population of 29 million people, 11 million people live below poverty line and 3 million are unemployed. This means that more than 40% of the population in Kenya lives below poverty line. The poverty in Kenya has increased in the recent past due to low productivity of the agricultural and industrial sectors. The dependency ratio is also extremely high. Studies show that areas prone to floods have high incidences of poverty. Poverty is encouraging people to dwell in slums located in flood-prone zones of the urban areas. It has also contributed to the limited application of better land-use practices and soil conservation methods in rural areas.

Limited Access to Proper Health Care and Social Services

Poverty has made it difficult for a large percentage of the urban and rural people who lack access to medical facilities. This has promoted high morbidity caused by waterborne and water-related diseases, which are otherwise treatable. This is made even worse by the inability of the government to provide highly subsidized access to public health facilities. Lack of an effective public health system is making people more liable to epidemics associated with the occurrence of extreme climatic events such as floods and droughts.

Poor Communication Infrastructure

Availability of good communication and transport network is essential in the management of disasters. These include telephone links, roads, railways, airports and airstrips. These are essential for evacuation of population during periods of emergencies. However, the current telephone network is poor and most rural areas are not linked to an efficient telephone system. In addition, road and railway network in most places is not in good condition and thus access to zones which are usually affected by droughts and floods is problematic. The problem of communication has been made even worse by the fact that the present telephone and road network was designed cater for a smaller population. Road traffic has increased tremendously in the recent past, leading to rapid deterioration of roads which were designed for much smaller loads. Thus, lack of access to a reliable communication network has increased the risks and vulnerability of the population to extreme climatic events since the affected population cannot be mobilized rapidly.

Diseases

Waterborne Diseases

The main cause of waterborne diseases during flooding is the contamination of drinking water supply. Floods transport bacteria, parasites, and viruses into the clean water system thus leading to the outbreak of waterborne diseases [7]. Many studies have revealed post flood increases in cholera, nonspecific diarrhoea, cryptosporidiosis,

rotavirus, and typhoid and paratyphoid [10]. In Kenya, research has shown association between cholera outbreak and flooding. [11], while looking at the interaction between climatic, environmental, and demographic factors on cholera outbreaks in Kenya found that flooding was associated with an increased risk of cholera. In an article describing the trend of cholera outbreak in Kenya, [12] report that the largest outbreak occurred during the 1997 El Niño rains that caused massive flooding, with 17, 200 cases (annual incidence, 60.7 cases per 100,000 population) and an estimated 555 deaths (CFR, 3.2%). ,is trend continued throughout 1998. In overall, during the El Niño period, their study indicates that 33,137 cholera cases were reported with an estimated 1,549 deaths [12]. In 2009, during the October floods, another major cholera outbreak was reported with a total of 11,769 cases and 274 deaths, which was exceptionally high compared to other outbreaks reported during nonflood periods. In a study on the dynamics of cholera outbreaks in the Great Lakes region (which includes the Lake Victoria basin) [13] using a multiscale geographic information system-based approach found that cholera greatly increased during El Niño events accompanied by massive flooding. Similar associations were arrived at in an earlier study by [14] in the Lake Victoria basin. They noted that cholera peaks coincide with high-flow peaks during El Niño years in the months of September, October, November, and December.

Vector-Borne Diseases

Incidences of mosquito-borne infections are higher with increase in the rainfall amount [7]. For example, flood provides new breeding grounds for mosquitoes, and this leads to an increase in the number of mosquito-borne diseases such as Rift Valley fever, malaria, and West Nile fever. In Kenya, a number of studies have linked above the average rainfall and associated flooding to increase in malaria epidemics. For example, malaria parasite prevalence data assembled by [15] over 40 years between 1974 and 2014 along the Kenya coast show that malaria parasite prevalence peaks during periods of abnormally high rainfall accompanied by flooding such as in 1982, 1994, and 1997/98; during these periods, incidences of malaria disease peaks. Other studies that have linked flooding to explosive epidemic malaria outbreak are those by [16, 17]. In their study, [17] noted that the unprecedented virtually uninterrupted rainfall arising from the El Niño in 1997/98 led to massive flooding in the North Eastern region of Kenya and provided ideal breeding conditions for Anopheles mosquitoes (malaria vectors). This led to a large increase in the vector population leading to an explosive epidemic of Malaria.

Rodent-Borne Diseases

Rodent-borne diseases are also known to increase during periods of heavy rainfall and associated flooding because of altered patterns of humanpathogen-rodent contact. A study by [18] on the link between flooding and rodent-borne infectious disease outbreak indicates that heavy rainfall encourages excessive wild grass seed production that support increased outdoor rodent population; at the same time, flooding forces rodents from their burrows into built environment and closer to human population, thus increasing the risk of infectious rodent-borne disease outbreak such as leptospirosis. Leptospirosis is a systemic zoonotic disease [19]. High prevalence of the disease was observed in Garisa Kenya following the 1997/8 El Niño rains. The rains increased rodent population and offered contaminated flood waters for transmission of the disease.

Possible Health Interventions

Public health interventions are very important in reducing vulnerability to infections as a result of flooding. The interventions range from those made before, during and after flooding [7]. One of the most effective health interventions to avoid the outbreak of infectious diseases resulting from flooding is to develop Early Warning Systems (EWSs) for infectious diseases by considering flooding trends [20]. This allows those at risk to either evacuate or take precautionary measures and the public health sector to sufficiently prepare for the eventualities.

Emergency response planning is another health intervention. [21], explain that this should entail well planned emergency procedures for health systems designed and established well in advance of the flooding hazard in order to provide a basis for effective health care during and after flooding. According to [22], "emergency response plans should include training in identifying and management of specific potentially threatening diseases, preparing needed equipment, supplies and materials, making local backups of supplies and tools for diagnosis and treatment, and environmental health measures for disease outbreaks. During and after flooding, surveillance plays an important role in early identification and consequent control of infectious disease outbreaks as well as in timely management of other health issues. [23], equate surveillance to the early warning system for infectious outbreaks. The surveillance should involve systematic collection and analysis of data on infectious disease. [24], observe that disease surveillance can provide precise knowledge of incidence rates of infectious diseases arising from flooding across population and geographic region. This will help in managing and control of disease as it generates information on frequency, trend, affected population, and location. Another intervention is the rapid disease risk assessment. It should be set up by public health responders at the onset of flooding disaster in order to take note of its impacts and health needs and risks as well as to identify appropriate interventions to put in place. According to [25], the risk assessment should focus on risks such as interruption and contamination of safe water, sanitation and cooking facilities, inhabitable shelter facilities and resultant population displacement with overcrowding,

increased exposure to disease vector and poor access to health services. Risks assessment informs decisions to protect health and wellbeing.

CONCLUSION

Flooding in Kenya poses significant risks for infectious disease outbreaks, exacerbated by factors such as population pressure, poor land-use practices, poverty, and inadequate infrastructure. The resulting contamination of water sources and proliferation of disease vectors create a conducive environment for the spread of waterborne, vector-borne, and rodent-borne diseases. To mitigate these risks, proactive public health interventions are crucial. Early warning systems tailored to flooding trends can help communities prepare and respond effectively. Emergency response planning should be comprehensive, encompassing disease management protocols, supply chain readiness, and environmental health measures. Surveillance systems play a vital role in early detection and control of outbreaks, providing essential data for targeted interventions. Rapid disease risk assessments conducted at the onset of flooding disasters inform immediate health interventions and resource allocation, prioritizing the protection of vulnerable populations. In light of the increasing frequency and severity of flooding events, implementing and strengthening these interventions is imperative to safeguard public health and mitigate the impact of infectious disease outbreaks in Kenya.

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