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The 2026 Strong El Niño Triggers a Compounding Drought-to-Flood Cascade, Elevating Multisectoral Risks to East African Agriculture and Public Health

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Abstract:
The World Meteorological Organization projects the 2026 El Niño to rank among histories strongest, with an 80% probability of onset between June and August and a 63–65% chance of attaining super-strength from October 2026 through February 2027, posing a dire threat to climate-vulnerable East Africa. This paper provides a holistic, predictive assessment of the event's cascading consequences for agriculture and public health across the region. Our synthesis integrates climatic forecasts from WMO, NOAA, and ICPAC; agricultural and food-security indicators from FAO GIEWS, FEWS NET, and IPC classifications; health surveillance data from WHO; and historical lessons from the 1997–1998 and 2023–2024 episodes. We project a distinct biphasic pattern: drought from June to September curtails planting and growth in western unimodal zones; Ethiopia, Sudan, South Sudan, Uganda, and western Kenya followed by a positive Indian Ocean Dipole-driven deluge from October to December. This second phase unleashes widespread flooding across Kenya, Somalia, southern Ethiopia, and Uganda, destroying standing crops, spoiling stored grain, and rupturing transport and market infrastructure. Staple cereal yields, notably sorghum and millet, could plummet by up to 30%. Concurrently, inundated landscapes amplify Rift Valley fever transmission, triggering substantial livestock losses. The compound effect would push roughly 8.8 million people across 22 high-risk nations into acute food insecurity; Somalia alone may see 6 million individuals facing IPC Phase 3 or worse. Health systems will grapple with surges in cholera, malaria, dengue, and heat-related morbidities, with critical hotspots centering on the Lake Victoria and Tana River basins, the Juba and Shabelle catchments, and densely populated urban hubs like Nairobi. This impending super-El Niño constitutes an unprecedented humanitarian emergency, yet its forecast lead time offers a tangible preparedness window. We urge immediate investments in early-warning system upgrades, climate-resilient crop varieties, irrigation and flood defenses, expanded disease surveillance and vaccine stockpiles, robust water-sanitation-hygiene programs, scaled humanitarian logistics, and targeted interventions addressing the structural poverty and land-use pressures that magnify climatic shocks.
Keywords:
El Niño; East Africa; drought-to-flood cascade; food security; public health

I. Introduction

1.1 Background and Rationale

The El Niño–Southern Oscillation (ENSO) represents the most influential driver of interannual climate variability on Earth, exerting profound impacts on weather patterns, agricultural systems, and public health across vast regions of the globe (McPhaden et al., 2006; Timmermann et al., 2018). As of mid-2026, the global climate system is entering a new El Niño phase that forecasters anticipate may become one of the strongest events in the historical record. The World Meteorological Organization (WMO) has confirmed an 80% likelihood of El Niño conditions emerging during June–August 2026, with probabilities of

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persistence through at least November approaching or exceeding 90% (WMO, 2026a). This near-certainty reflects a convergence of multiple seasonal forecast modelling systems from WMO Global Producing Centres, which indicate that sea-surface temperature anomalies in the central-eastern equatorial Pacific are rapidly approaching El Niño thresholds, fed by unusually warm subsurface conditions with temperatures exceeding 6 °C above average (WMO, 2026a).

The intensity of the impending event has drawn particular concern from the scientific community. The United States National Oceanic and Atmospheric Administration (NOAA) places a 63% probability on this El Niño becoming a "very strong" event colloquially referred to as a "Super El Niño", which would rank among the largest El Niño events in the historical record dating back to 1950 (NOAA Climate Prediction Center, 2026; Freedman, 2026). A very strong El Niño is formally defined by sea-surface temperature anomalies exceeding 2 °C above average in the Niño 3.4 region, and some reliable computer models suggest this threshold may be substantially exceeded, with projections of anomalies potentially climbing beyond 3 °C by the end of 2026 (BBC News, 2026; WMO, 2026b). The European Commission's Joint Research Centre, drawing on multi-century climate model simulations and seasonal forecasting systems, has characterised the 2026–2027 El Niño as an event "expected to reach very high intensity, with forecasts indicating a high likelihood of a very strong event that may even evolve into an unprecedented one" (European Commission, 2026, p. 1). Scientists estimate there is more than a 60% chance that the current El Niño could develop into a very strong event comparable to the historic 1997–1998 El Niño, which caused widespread flooding, economic losses exceeding billions of dollars across East Africa, and over 6,000 deaths globally (Sitati, 2026).

The 1997–1998 El Niño remains a benchmark for extreme climate impacts in East Africa. During that event, exceptionally heavy rainfall caused severe flooding across Kenya, Uganda, Somalia, Tanzania, and Ethiopia, destroying crops, roads, irrigation systems, and food stores, while triggering outbreaks of malaria, cholera, and Rift Valley Fever (IPCC, 2001; Anyamba et al., 2006). The 2026 event, however, emerges under fundamentally different background conditions. As UN Secretary-General António Guterres has warned, "El Niño conditions will pour fuel on the fire of a warming world. Impacts will hit even harder, travel even farther, and cross borders with devastating speed" (WMO, 2026a). The 2026 El Niño is occurring during what is already the warmest period in recorded history, with global average temperatures elevated by approximately 1.3 °C above pre-industrial levels (BBC News, 2026). A very strong El Niño typically lifts global air temperatures by around 0.2 °C, releasing heat stored in the ocean into the atmosphere, an additional warming pulse that now lands on a world already setting temperature records (BBC News, 2026). The year 2024, the warmest on record, was boosted by an El Niño that was not even especially strong, and despite the cooling influence of a subsequent La Niña event, 2025 ranked as the third warmest year on record, hotter even than the super El Niño year of 2016 (BBC News, 2026). This context suggests that the 2026 El Niño may produce climate impacts of unprecedented severity.

1.2 Research Gap and Significance

Despite the well-documented association between El Niño events and climate extremes in East Africa, significant gaps persist in the scientific literature regarding the integrated assessment of sequential drought-to-flood transitions under very strong El Niño conditions. Existing research has largely focused on either drought impacts or flood impacts in isolation, rather than examining the compounding effects of biphasic extremes that occur within a single growing season (Funk et al., 2018; Lyon & DeWitt, 2012). The drought-to-flood cascade whereby rainfall deficits during the early phase of an event are followed by rainfall surpluses and flooding in the later phase, creates unique and poorly understood vulnerabilities. Crops weakened by drought stress may be more susceptible to waterlogging and disease when floods arrive; pastoralists who have already lost livestock to drought face additional losses from flood-related diseases; and communities that have depleted their savings coping with drought have fewer resources to respond to flooding. This sequential hazard pattern demands analytical frameworks that capture not only individual hazards but also their interactions and cascading effects.

A second critical gap concerns the multisectoral nature of El Niño impacts. While separate bodies of literature address agricultural impacts, food security, and public health outcomes associated with ENSO, few studies have integrated these dimensions within a unified analytical framework (Kovats et al., 2003; Anyamba et al., 2006). The 2026 El Niño is projected to generate impacts that cut across sectoral boundaries: agricultural losses drive food price increases and malnutrition; flooding contaminates water supplies and triggers disease outbreaks; infrastructure damage disrupts market access and health service delivery; and displacement leads to overcrowding and further disease transmission. Understanding these compounding and cascading risks is essential for effective preparedness and response, yet integrated assessments remain scarce, particularly for the East African context.

A third gap relates to the unprecedented nature of the 2026 event. As noted above, this El Niño is occurring against a background of global warming that is already elevating baseline temperatures and altering baseline moisture conditions. As Professor Adam Scaife of the UK Met Office has observed, "The current El Niño is... riding on top of a substantial amount of global warming. This means that the actual temperatures in affected regions could well be unprecedented, as the warming from El Niño is being topped up by climate change" (BBC News, 2026). Historical analogues such as 1997–1998 provide useful but imperfect guides, as the background climate conditions are fundamentally different. There is an urgent need for anticipatory analyses that account for both the intensity of the El Niño itself and the elevated vulnerability of systems already stressed by climate change.

1.3 Research Questions and Objectives

This study is guided by four primary research questions, each addressing a distinct dimension of the projected impacts of the 2026 strong El Niño on East Africa:

Research Question 1 (RQ1): What are the spatiotemporal patterns of the projected drought-to-flood cascade across East Africa during June–December 2026?

This question addresses the physical climate dimension of the study. It seeks to characterise the spatial distribution and temporal sequencing of rainfall anomalies, identifying which areas are likely to experience rainfall deficits during the June–September period and which areas are likely to experience rainfall surpluses and flooding during the October–December period. The analysis draws on seasonal forecasts from WMO, NOAA, and the Intergovernmental Authority on Development's Climate Prediction and Applications Centre (ICPAC), as well as historical analogues from previous strong El Niño events.

Research Question 2 (RQ2): How will the biphasic climate extremes impact agricultural systems and food security?

This question addresses the agricultural and food security dimension. It examines the pathways through which the drought-to-flood cascade is likely to affect crop production, livestock systems, and household food security. Specific attention is given to the sequential nature of impacts: how drought-phase rainfall deficits may affect planting and early crop development, and how flood-phase rainfall surpluses may affect maturing crops, post-harvest storage, and market access. The analysis considers both rainfed and irrigated systems, as well as crop and livestock production.

Research Question 3 (RQ3): What are the public health risks, including waterborne and vector-borne disease outbreaks?

This question addresses the public health dimension. It examines the likely impacts of the 2026 El Niño on disease transmission, focusing on waterborne diseases (notably cholera) and vector-borne diseases (notably malaria, dengue, and Rift Valley Fever). The analysis considers both the direct health impacts of flooding and drought (injuries, heat stress, displacement-related morbidity) and the indirect impacts mediated through changes in disease ecology. Historical evidence from the 1997–1998 and 2015–2016 El Niño events is used to inform projections.

Research Question 4 (RQ4): What compounding and cascading risks emerge from the intersection of these impacts?

This question addresses the integrated, systems-level dimension of the study. It examines how agricultural, food security, and public health impacts interact and amplify one another, creating compound risks that exceed the sum of individual hazards. Specific attention is given to the geographic and temporal overlap of hazards, the vulnerability of populations exposed to multiple hazards, and the cascading effects that propagate through social, economic, and ecological systems. The analysis aims to identify hotspots of compound risk where impacts are likely to be most severe.

II. Review of Literature

2.1 El Niño–Southern Oscillation and East African Teleconnections

The El Niño–Southern Oscillation (ENSO) represents the most consequential mode of interannual climate variability on Earth, describing alternating warm (El Niño) and cold (La Niña) phases in the central and eastern equatorial Pacific Ocean that exert far-reaching influences on global weather patterns, agricultural systems, and human health (McPhaden et al., 2006; Timmermann et al., 2018). The ENSO phenomenon operates through coupled ocean-atmosphere interactions: during El Niño events, the trade winds weaken or reverse, allowing warm surface waters to accumulate in the central and eastern Pacific, which in turn alters atmospheric convection patterns, shifts the position of the Walker circulation, and generates global teleconnections that propagate climate anomalies across vast distances (Cai et al., 2025; McPhaden et al., 2006). These teleconnections are mediated by changes in atmospheric pressure gradients, as captured by the Southern Oscillation Index, which registers the seesaw in surface pressure between Darwin, Australia, and Tahiti, French Polynesia (Trenberth, 1997). When the Southern Oscillation Index falls from peak toward low values, the equatorial low-pressure system strengthens and shifts eastward, while subtropical high-pressure systems undergo corresponding adjustments, driving the characteristic shifts in sea-surface temperatures and rainfall patterns associated with El Niño (Cai et al., 2025).

As of mid-2026, the tropical Pacific is exhibiting all the hallmarks of a rapidly intensifying El Niño event. Sea-surface temperature anomalies in the Niño 3.4 region, the central equatorial Pacific box conventionally used to define ENSO states are approaching or exceeding El Niño thresholds, with subsurface temperatures in some areas exceeding 6 °C above normal (WMO, 2026a). These anomalously warm subsurface conditions, fed by a substantial reservoir of heat accumulated in the western Pacific warm pool, are expected to surface over the coming months, driving further warming of the ocean surface and reinforcing atmospheric feedbacks that sustain the El Niño state (NOAA Climate Prediction Center, 2026; WMO, 2026b). The atmospheric response to these oceanic anomalies is already evident, with the Southern Oscillation Index showing a marked decline indicative of the weakening of the Walker circulation and the eastward shift of convective activity that characterises El Niño conditions (WMO, 2026a).

For East Africa, the influence of ENSO on rainfall is complex, seasonally dependent, and spatially heterogeneous, reflecting the interplay of multiple teleconnection pathways and the modulating role of the Indian Ocean (Cai et al., 2025; Nicholson, 2017). Eastern Africa exhibits a bimodal rainfall regime consisting of the "long rains" from March to May and the "short rains" from October to December, both of which have profound socioeconomic and environmental impacts on the region (Palmer et al., 2023). The short rains season, in particular, is strongly influenced by ENSO: El Niño events are typically associated with above-average rainfall during October–December across much of equatorial East Africa, including Kenya, Somalia, southern Ethiopia, and Uganda (Cai et al., 2025; Nicholson, 2017; Beltrami & Ruggieri, 2025). The mechanisms underlying this teleconnection involve complex interactions between ENSO and the Indian Ocean Dipole (IOD) coupled ocean-atmosphere phenomenon in the tropical Indian Ocean characterised by alternating sea-surface temperature gradients between its western and eastern basins (Saji et al., 1999; Cai et al., 2025). Indeed, observational evidence suggests that the teleconnection between East African rainfall and ENSO is partly mediated by ENSO's influence on the IOD, with the co-occurrence of El Niño and a positive IOD phase producing particularly strong rainfall enhancements during the short rains (Nicholson, 2017; Black et al., 2003). The variability of East African short rains during October–December has profound socioeconomic and environmental impacts on the region, making accurate seasonal rainfall predictions essential (de Andrade et al., 2024; Palmer et al., 2023). State-of-the-art global climate models demonstrate good skill in forecasting precipitation during the OND season, and this predictability is largely attributable to the coherent signal provided by ENSO and its associated teleconnections (Beltrami & Ruggieri, 2025; de Andrade et al., 2024).

2.2 The Biphasic Impact Pattern: Drought Then Flood

The 2026 El Niño is projected to generate a distinctive biphasic impact pattern across East Africa, characterised by an initial phase of drought risk followed by a later phase of flood risk. This sequential hazard pattern, which this study terms a "drought-to-flood cascade," arises from the seasonally and spatially heterogeneous rainfall responses to El Niño teleconnections described above.

June–September: Rainfall Suppression and Drought Risk. During the June–September period, El Niño conditions are expected to delay the onset of seasonal rains and suppress rainfall across western and northern areas of East Africa (ReliefWeb, 2026). The areas most likely to experience rainfall deficits include western Ethiopia, Sudan, South Sudan, Uganda, and western Kenya—the so-called "western unimodal" areas that depend on a single rainy season during this period (FAO, 2026; ReliefWeb, 2026). These rainfall deficits have significant implications for agricultural systems: in Ethiopia, the Belg season crops, typically planted in February–March and harvested in June–July may face moisture stress if rains are delayed or insufficient; in Sudan and South Sudan, the main agricultural season may be compromised; and in Uganda and western Kenya, the planting and early development of long-rains crops may be adversely affected. Beyond agriculture, rainfall suppression during this period can exacerbate water scarcity, reduce pasture availability for livestock, and increase the vulnerability of communities already recovering from previous climate shocks. The FAO has noted that in East Africa, "anticipated El Niño conditions may delay the onset of seasonal rains and suppress rainfall across western and northern areas of East Africa during June–September" (ReliefWeb, 2026), with potential negative impacts on crop yields and food availability.

October–December: Rainfall Surge and Flood Risk. From October to December, the pattern shifts dramatically. As the El Niño event reaches its mature phase, the teleconnections that suppress rainfall in the western and northern parts of the region give way to the well-established enhancement of rainfall over equatorial East Africa (Cai et al., 2025; Nicholson, 2017). The countries most likely to experience above-average rainfall during this period include Kenya, Somalia, southern Ethiopia, and Uganda (ReliefWeb, 2026; de Andrade et al., 2024). The short rains season—typically accounting for a substantial proportion of annual precipitation in these areas is projected to bring far-above-average rainfall, increasing the likelihood of flooding, landslides, and waterlogging (FAO, 2026). The risk of extreme rainfall events is particularly elevated during strong El Niño years: in Kenya, the greatest impacts are expected during the October–December short rains season, with traditional flood-prone areas such as the Tana River basin, Budalang'i, and the Kano Plains facing particularly high risks (Sitati, 2026). In Somalia, the Juba and Shabelle river basins are at elevated risk of flooding, threatening crops, infrastructure, and livelihoods (FAO, 2026). In Ethiopia, the southeastern pastoral areas and the Awash River catchment—already identified as a region of hydroclimatic vulnerability (Mologni et al., 2024) face heightened flood risk.

The spatiotemporal patterns of this biphasic impact are not uniform across East Africa. Recent research on drought-flood abrupt alternation (DFAA) events in the region has revealed a distinctive spatial asymmetry: drought-to-flood events dominate the southwest (Tanzania, Uganda, and Burundi), while flood-to-drought events prevail in the southeast (Somalia, southern Ethiopia) (Liu et al., 2026). This spatial pattern reflects the complex interactions between ENSO teleconnections, regional atmospheric circulation, and local topography. The mechanisms driving DFAA events in East Africa have been linked to sea-surface temperature transitions over the central–eastern Pacific corresponding to the onset phase of El Niño for drought-to-flood events (Liu et al., 2026). These insights provide a process-based framework for understanding the spatial heterogeneity of the 2026 El Niño impacts and for targeting early warning and preparedness efforts to the areas most at risk.

2.3 Conceptual Framework: Compounding and Cascading Risks

Understanding the full scope of El Niño impacts in East Africa requires a conceptual framework that goes beyond the analysis of individual hazards in isolation. El Niño events can cause severe, systemic impacts across sectors and natural systems due to the concurrent and compounding risks they trigger (European Commission, 2026; IPCC, 2022). The 2026 El Niño, with its biphasic drought-to-flood cascade, presents a particularly complex risk landscape in which hazards interact, amplify one another, and generate cascading effects that propagate through social, economic, and ecological systems.

Compound Events and Risks

The IPCC defines compound events as the combination of multiple drivers and/or hazards that contribute to societal or environmental risk (IPCC, 2022). In the context of the 2026 El Niño, compound risks arise from the simultaneous or sequential occurrence of multiple hazards: drought and heat stress during the June–September period, followed by flooding and waterlogging during the October–December period, with the potential for disease outbreaks, infrastructure damage, and food system disruption throughout. These hazards do not occur in isolation; rather, they interact in ways that can produce impacts greater than the sum of their individual effects. For example, drought-weakened crops may be more susceptible to waterlogging and disease when floods arrive; communities that have depleted their savings coping with drought have fewer resources to respond to flooding; and flood-damaged infrastructure may impede the delivery of humanitarian assistance to areas already affected by drought. The concept of compound events has emerged as a major focus of climate research, with compound weather and climate events and their cascading impacts identified as new key risks to human societies and ecosystems (Zscheischler et al., 2026).

III. Research Methods

3.1 Event Intensity and Timing

The 2026 El Niño event has been officially declared by NOAA, with sea surface temperatures in the central and tropical Pacific having passed the 0.5 °C-above-average threshold used to define El Niño conditions. The WMO has confirmed an 80% likelihood of El Niño conditions emerging during June–August 2026, with probabilities of persistence through at least November approaching or exceeding 90%. As WMO Secretary-General Celeste Saulo emphasised, "We need to prepare for a potentially strong El Niño event, which was exacerbated drought and heavy rainfall and increase the risk of heatwaves both on land and in the ocean."

The intensity trajectory of the 2026 event has generated particular concern among the scientific community. The WMO Global Seasonal Climate Update for June–July–August 2026 indicates that the multi-model ensemble mean is forecast to comfortably clear the El Niño threshold, reaching approximately 1.8 °C for the seasonal average. The intensification trajectory maintains a steep upward slope throughout the boreal summer and autumn, with spread among individual member models narrow during JJA, indicating very high forecast confidence. In its June outlook, NOAA placed the odds of a very strong El Niño defined as sea surface temperature anomalies exceeding 2.0 °C above average in the Niño 3.4 region, at 63%, which would "rank among the largest El Niño events in the historical record going back to 1950". Some of the latest US and European (ECMWF) models project temperatures in the tropical Pacific potentially climbing more than 3 °C above average by the end of the year.

The peak of the 2026 El Niño is expected during the October–December season or into early 2027. The WMO forecasts the pattern will strengthen through August and peak between October and February, coinciding with critical planting and harvest periods across Sub-Saharan Africa. If El Niño forms, the potential strength remains subject to some uncertainty, with NOAA estimating a one-in-three chance that it would be classified as "strong" during October–December 2026 (Niño-3.4 ≥ +1.5 °C). The convergence of multiple forecast models on a strong-to-very-strong outcome reflects the unusually warm subsurface conditions across the tropical Pacific, with temperatures exceeding 6 °C above average and providing a substantial reservoir of heat that is contributing to the observed surface warming. The

Southern Oscillation Index the atmospheric component of El Niño is also consistent with developing El Niño conditions.

3.2 June–September: Rainfall Suppression and Drought Risk

During the June–September (JJAS) period, the 2026 El Niño is projected to generate below-average rainfall across most parts of the Greater Horn of Africa, particularly in areas where JJAS constitutes the main rainy season. The ICPAC June–September 2026 rainfall outlook indicates a high likelihood of below-normal rainfall across South Sudan, Uganda, Ethiopia, Djibouti, much of Eritrea, Sudan, and western and coastal Kenya. This period accounts for more than half of annual rainfall in many northern parts of the region and over 80% in Sudan, making rainfall deficits during this season particularly consequential for agricultural production and water resources.

The rainfall suppression during JJAS 2026 reflects the characteristic El Niño teleconnection pattern for this season, whereby anomalous warming in the central and eastern equatorial Pacific shifts atmospheric convection eastward, reducing moisture convergence over the western Indian Ocean and the Greater Horn of Africa. The ICPAC outlook has warned of a heightened risk to agriculture and water resources due to reduced chances of heavy seasonal rainfall across parts of the Greater Horn. Specifically, the outlook indicates a lower probability of exceeding 500 millimetres of rainfall in parts of southern South Sudan, northern Uganda, southern Sudan, and the Ethiopian Highlands during the June–September season.

The June–September rainfall deficits have significant implications for agricultural systems across the region. In the western unimodal rainfall zones, including western Ethiopia, Sudan, South Sudan, Uganda, and western Kenya the JJAS season constitutes the primary growing period for staple crops (Figure 1). Rainfall suppression during this period can delay planting, reduce crop establishment, and limit vegetative growth, potentially leading to substantial yield reductions. The FAO has noted that anticipated El Niño conditions may delay the onset of seasonal rains and suppress rainfall across western and northern areas of East Africa during June–September. As one analysis observed, "Changing rainfall patterns associated with El Niño are expected to bring drought to some regions and severe flooding to others, threatening harvests, livestock, water supplies and food production."

Figure 1. Map of the study region in East Africa, encompassing Kenya, Ethiopia, Somalia, Uganda, Tanzania, South Sudan, Sudan, Rwanda, and Burundi. The region spans diverse climate zones from equatorial bimodal rainfall areas to arid lowlands of the Horn of Africa. Adapted for this study (base map data from public domain sources)

The impacts of rainfall suppression are likely to be compounded by elevated temperatures during the same period. The WMO forecasts above-normal temperatures across nearly all regions of the world for June–August, increasing the risk of heat stress and accelerating drought conditions where rainfall is reduced. The combination of reduced rainfall and increased evaporative demand creates conditions for agricultural and hydrological drought, with cascading implications for food security, water availability, and livelihoods.

3.3 October–December: Rainfall Surge and Flood Risk

As the 2026 El Niño reaches its mature phase during October–December (OND), the rainfall pattern across East Africa is projected to shift dramatically from suppression to enhancement. The October–December short rains season is the period most strongly linked to El Niño conditions in East Africa. Historical evidence demonstrates that East Africa typically experiences above-average rainfall during El Niño years, particularly during the short rains season, with severe flooding documented during the 1997–1998, 2015–2016, and 2023–2024 events.

The greatest impacts in Kenya are expected during the October–December 2026 short rains season. Regional climate experts warn of a heightened risk of extreme flooding events. In Tanzania, the Ministry of Water and Irrigation has activated emergency protocols after forecasting above-normal rainfall for the October–December season. The confluence of El Niño conditions with a projected positive Indian Ocean Dipole (IOD) phase could significantly amplify rainfall during the October–November–December season. The WMO Global Seasonal Climate Update indicates that the Indian Ocean is forecast to experience development of the positive IOD phase, peaking concurrently with the intensifying Pacific El Niño. The co-occurrence of El Niño and positive IOD has historically produced particularly strong rainfall enhancements over East Africa, as the two phenomena reinforce each other through convergent moisture transport.

The flood risk during OND 2026 is elevated by multiple factors. First, the intensity of the El Niño event itself with sea surface temperature anomalies potentially exceeding 2.0 °C, suggests rainfall anomalies of a magnitude comparable to or exceeding the 1997–1998 event. Second, the rapid transition from drought conditions during JJAS to flood conditions during OND creates a drought-to-flood cascade whereby soils may be less able to absorb rainfall, increasing runoff and flood risk. Third, the background warming from climate change may intensify the hydrological cycle, increasing the likelihood of extreme rainfall events.

3.4 Temperature Anomalies and Heat Stress

The 2026 El Niño is occurring during what is already the warmest period in recorded history, with profound implications for temperature anomalies across East Africa and the globe. For the June–July–August 2026 season, multi-model ensemble forecasts project a nearly universal global dominance for enhancement in probabilities for above-normal temperatures (Figure 2). The WMO predicts atmospheric conditions that will favour "predominantly above-normal temperatures in almost all regions of the planet". This warming trend is especially pronounced throughout the globe between 60 °S and 60 °N, where a large increase in probabilities for above-normal temperature is reinforced by high model consistency.

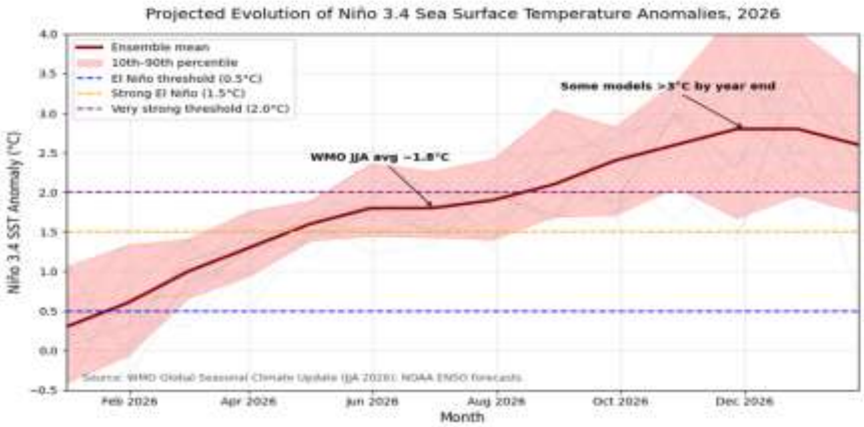

Figure 2. Projected Evolution of Niño 3.4 Sea Surface Temperature Anomalies, 2026
Note: Multi-model ensemble forecast showing rapid warming from ENSO-neutral conditions in early 2026 to strong El Niño conditions by June–August 2026, with peak anomalies exceeding 1.8 °C during the boreal summer and continuing to strengthen through October–December. Source: WMO Global Seasonal Climate Update, JJA 2026.

Across East Africa, above-normal temperatures during June–August 2026 are expected to increase the risk of heat stress and compound hazards in vulnerable areas. The ICPAC outlook indicates that the June–September season is likely to be warmer than usual across much of the Greater Horn of Africa. The combination of elevated temperatures with reduced rainfall during the JJAS period creates conditions for accelerated drought development, as higher evaporative demand draws moisture from soils and vegetation.

The heat stress implications extend beyond the JJAS period. The WMO forecasts that temperatures will be above average in most parts of the world from June to August and are likely to continue until November. Several national meteorological agencies have forecast the strongest El Niño in a decade, with temperature anomalies persisting through the end of 2026. As Professor Adam Scaife warned, "At the end of this year and into 2027, we're likely to see very high temperatures globally. In 2027, we're likely to see excess heat on top of the global warming we've already got, and that could easily lead to another year above 1.5 degrees [of warming above late-19th-Century levels]".

IV. Result and Discussion

4.1 Crop Production: Pathways of Damage

The biphasic nature of the 2026 El Niño, an initial drought phase followed by a flood phase—creates sequential and compounding threats to agricultural systems across East Africa. The June–September (JJAS) rainfall suppression and the subsequent October–December (OND) rainfall surge each pose distinct pathways of crop damage, with the transition between the two phases exacerbating overall vulnerability.

June–September Drought Phase. During the JJAS 2026 season, the ICPAC rainfall outlook indicates a high likelihood of below-normal rainfall across most parts of the Greater Horn of Africa, particularly in South Sudan, Uganda, Ethiopia, Djibouti, much of Eritrea, Sudan, and western and coastal Kenya. This period accounts for over 50% of annual rainfall in many northern parts of the region and more than 80% in most parts of Sudan. The forecast below-normal rainfall may have far-reaching implications, particularly for rain-fed agriculture, water availability, and livestock systems.

In Ethiopia, the rainfall suppression threatens Belg season crops, which are typically planted in February–March and harvested in June–July. Previous El Niño years with similar climate conditions resulted in below-normal maize and sorghum harvests, with the greatest losses recorded in eastern Amhara, Tigray, and northeastern Oromia. FEWS NET has warned that the early development of El Niño conditions has been associated with suppressed rainfall during the June–September period over parts of Sudan, South Sudan, the Kiremt-producing areas of Ethiopia, western Kenya, and the Karamoja region of Uganda. The ICPAC outlook further indicates that the highest probability of below-average rainfall, exceeding 60% and reaching up to 80% in parts of northeastern Ethiopia, is expected in central, northeastern, and northwestern Ethiopia.

In Kenya, the projected dry and warm conditions during JJAS 2026 could negatively affect rain-fed agriculture, water availability, and livestock production. The developing 2026 climate conditions resemble the strong El Niño years of 1997 and 2023, periods associated with below-normal rainfall in parts of western Kenya and neighbouring countries. Kenya is expected to experience below-normal rainfall and warmer-than-average temperatures during the June to September 2026 season. The ICPAC has warned of a heightened risk to agriculture and water resources due to reduced chances of heavy seasonal rainfall.

October–December Flood Phase

If the current El Niño development persists into the latter part of the year, there is an increased likelihood of enhanced rainfall during the October–December 2026 short rains season across much of eastern East Africa, particularly critical for bimodal regions of Kenya, Somalia, Uganda, Rwanda, and Burundi. The confluence of El Niño and a positive Indian Ocean Dipole could bring wetter-than-normal rainfall across eastern East Africa during the October–December season, potentially increasing the risk of flooding.

The flood phase poses catastrophic risks to crop production through multiple pathways. Historical evidence from the 1997–1998 El Niño demonstrates that maize, beans, and horticultural crops were heavily damaged by waterlogging, fungal disease, and flooding in western Kenya, central Kenya, and coastal regions. Rice schemes and river basin farming areas suffered extensive inundation. The lower Tana River basin experienced major crop losses after rivers burst their banks, while western Kenya flood plains including Budalang'i and Kano Plains suffered repeated destruction of maize and bean farms. Floodwaters also washed away stored grain and seed reserves.

4.2 Historical Precedents: The 1997–1998 El Niño

The 1997–1998 El Niño remains the most devastating modern example of El Niño-related agricultural destruction in East Africa. From October 1997 to February 1998, exceptionally heavy rains associated with the El Niño phenomenon followed by flooding caused havoc in several parts of eastern Africa. The floods caused loss of crops and large numbers of livestock in several countries and extensively damaged the sub-region's road and rail infrastructure, disrupting the movement of goods within and between countries (Figure 3).

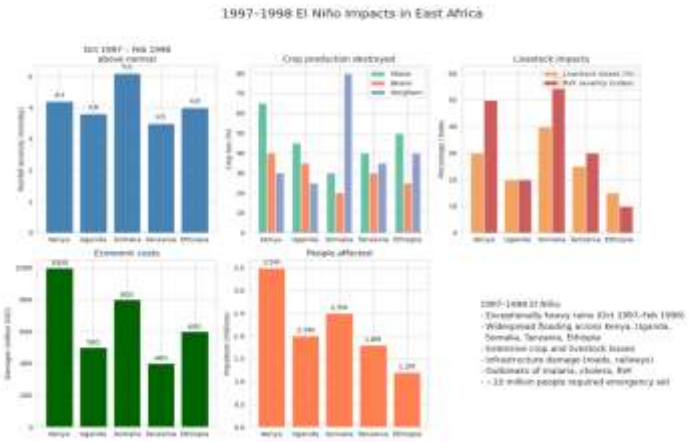

Figure 3 (Top left): Rainfall anomalies (mm/day) over East Africa (Oct 1997–Feb 1998), showing peak excess in Somalia and Kenya. Figure 3 (Top middle): Percentage of major staple crop production destroyed, highlighting the 80% loss of sorghum in Somalia and 65% maize loss in Kenya. Figure 3 (Top right): Livestock losses and Rift Valley Fever severity indices, illustrating the direct link between flooding, vector proliferation, and herd mortality. Figure 3 (Bottom left): Estimated economic damages (million USD) across affected nations, with Kenya facing the highest absolute losses exceeding one billion dollars. Figure 3 (Bottom middle): Total population affected (millions) by floods, crop failures, and disease, with over

4.3 million impacted in Kenya alone.

Research estimates that Kenya alone suffered economic losses running into billions of shillings from damage to infrastructure, agriculture and livestock systems. One study concluded that the El Niño-La Niña episode from 1997–2000 cost Kenya Ksh 290 billion (about 14 percent of GDP during that period), with costs primarily arising from destruction of infrastructure. The national economic loss to Kenya was estimated at about one billion US dollars.

In Somalia, the floods resulted in losses of household cereal stocks from the 1997 main "Gu" season, which was also poor due to dry spells. The 1997/98 aggregate cereal production was provisionally estimated at 290,000 tons, close to the previous year's below-average level. Import requirements for the 1997/98 marketing year were revised upward, with about 110,000 tons needing to be covered by food aid.

The 1997–98 El Niño caused sharp increases in maize diseases including grey leaf spot, northern leaf blight and ear rots due to prolonged humidity. In bean-growing regions, root rots and bacterial diseases increased significantly under saturated soil conditions. Kenya's tea sector was also affected: while rainfall initially improved leaf production in some highland zones, prolonged wet conditions damaged roads and blocked transport to factories and export routes, reducing farmer earnings and increasing spoilage. Coffee farmers similarly suffered from increased fungal diseases and berry losses linked to excessive rainfall and poor drying conditions. The USAID report on "Kenya's Vulnerability Update" estimated that the El Niño rains threatened 65% of the unharvested maize crop in the Rift Valley and Trans Nzoia.

4.4 Livestock Impacts

The impacts of the 2026 El Niño on livestock systems are expected to be complex, with both potential benefits and significant risks. While some dry pastoral areas may initially benefit from improved pasture and water availability during the wetter phases, livestock disease outbreaks often follow, and the sequential drought-to-flood cascade poses cumulative threats to herd health and productivity.

Drought Phase Impacts

During the JJAS 2026 period, the forecast below-normal rainfall is expected to have implications for livestock systems, with likely impacts on pasture availability and water access. In Kenya, the projected dry and warm conditions could negatively affect livestock production. Livestock herd sizes remain below average due to the persisting slow recovery from the 2020-2023 droughts. Low herd sizes and limited forage availability continue to depress livestock productivity, further constraining household incomes amid sustained elevated food prices and impeding food access. Livestock body conditions in the pastoral and marginal agricultural areas are likely to be below average due to below-average availability of rangeland resources.

Flood Phase and Disease Outbreaks. While El Niño rains may initially improve pasture conditions in some areas, the flooding phase brings severe risks. Research on East African El Niño impacts has repeatedly shown that livestock disease outbreaks often follow the wet phase. Rift Valley Fever (RVF) outbreaks during El Niño years are strongly associated with flooding and mosquito population explosions. The disease is caused by a mosquito-borne virus that pops up when standing water encourages mosquito eggs to hatch.

During the 1997–98 El Niño, Rift Valley Fever killed thousands of livestock across Kenya, Somalia and Tanzania and disrupted livestock trade across the region. Large numbers of sheep, goats and cattle died in northeastern Kenya and pastoral communities suffered major income losses. Livestock owners reported losses of approximately 70% of their sheep and goats and 20%–30% of cattle and camels. Animal losses were almost certainly vast, with owners reporting losing up to 90 percent of their herds. This was described as "probably the worst outbreak of Rift Valley fever in recorded history".

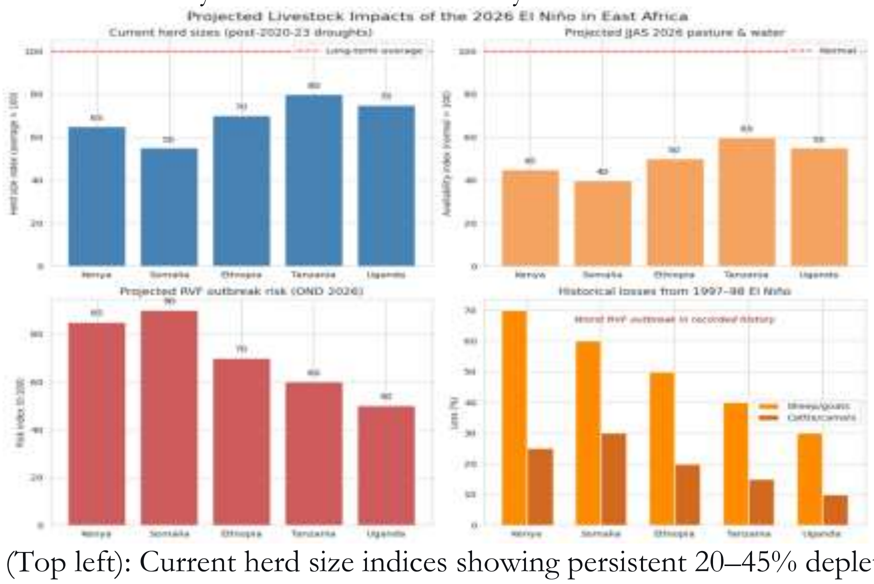

Figure 4 (Top left): Current herd size indices showing persistent 20–45% depletion from successive droughts across East Africa (FEWS NET, 2026). Figure 4 (Top right): Projected pasture and water availability plummeting to 40–60% during the June–September 2026 drought phase. Figure 4 (Bottom left): Modelled Rift Valley Fever outbreak risk index peaking at 85–90% during the October–December flood phase. Figure 4 (Bottom right): Historical 1997–98 El Niño livestock losses, documenting 70% sheep/goat mortality and the worst RVF outbreak recorded.

Figure 4 reveals sequential threats to East African livestock systems. Top-left shows herd sizes remain 20–45% below long-term averages, with Somalia (55) and Kenya (65) most depleted following the 2020–2023 droughts (FEWS NET, 2026). Top-right projects pasture and water availability plummeting to 40–60% of normal during the June–September (JJAS) dry phase, severely constraining rangeland resources. Bottom-left highlights critical flood-phase risks: Rift Valley Fever (RVF) outbreak potential escalates to 85–90% in Kenya and Somalia during October–December (OND), driven by standing water and mosquito proliferation (Anyamba et al., 2006). Historical precedent (bottom-right) confirms this danger; the 1997–98 El Niño caused 70% sheep/goat and 30% cattle/camel losses across the Horn, marking the worst RVF epizootic on record (Linthicum et al., 1999). This biphasic drought-to-flood cascade severely depresses herd recovery while amplifying disease transmission, threatening pastoral livelihoods and regional food security.

4.5 Public Health Impacts

a. Waterborne Diseases: Cholera and Diarrheal Diseases

The 2026 El Niño poses a significant threat of waterborne disease outbreaks across East Africa, with cholera emerging as the primary concern. The mechanisms linking El Niño to cholera risk are well-established and operate through multiple pathways involving rainfall variability, flooding, drought, and temperature changes.

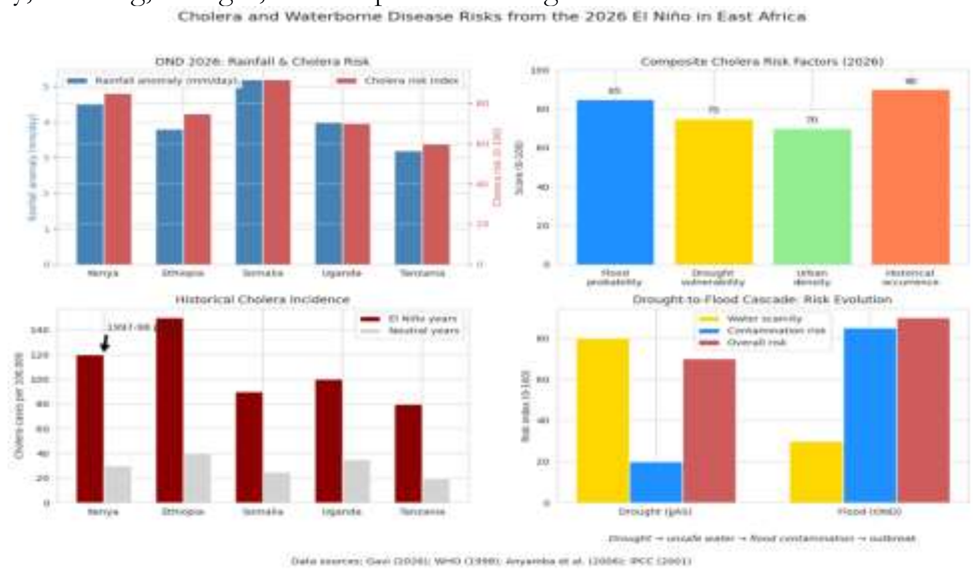

Figure 6 (Top left): Projected rainfall anomalies and cholera risk indices for OND 2026, showing strong correlations in Kenya and Somalia (Gavi, 2026). Figure 6 (Top right)**:** Composite cholera risk factors for 2026, highlighting flood probability and historical occurrence as primary drivers of vulnerability (WHO, 2026). Figure 6 (Bottom left)**:** Historical cholera incidence during El Niño versus neutral years confirms 3–4 times higher disease burden during strong events (WHO, 1998). Figure 6 (Bottom right)**:** Biphasic drought-to-flood cascade demonstrating how water scarcity during JJAS leads to peak contamination risk during OND floods (Anyamba et al., 2006).

Cholera Risk Amplification

In Africa, El Niño shifts the largest cholera burden onto East Africa, including Kenya, Ethiopia, and Somalia, where above-average rainfall can cause flooding and create conducive conditions for cholera spread **(**Figure 6)**.** For waterborne diseases such as cholera, heavy rains and flooding can contaminate drinking water sources, while drought can force communities to rely on unsafe water supplies. Warmer temperatures and changes in coastal water conditions can also influence the survival of the *Vibrio cholerae* bacteria that causes cholera. As Dr Kenichi

Okamoto, a researcher in evolutionary epidemiology explains: "One of the main drivers of cholera is the volume of rainfall, which is impacted by El Niño."

Flooding and Water Contamination

Floods often come with serious health risks. Contaminated water can lead to outbreaks of diseases such as cholera and other infections, which have been recorded in past El Niño seasons. The heavy rains and flooding associated with El Niño overwhelm sanitation infrastructure, contaminate drinking water sources, and create conditions for rapid disease transmission. In densely populated urban areas, these risks are particularly acute, as changes in rainfall patterns can lead to waterborne diseases such as cholera that are especially devastating in crowded settlements.

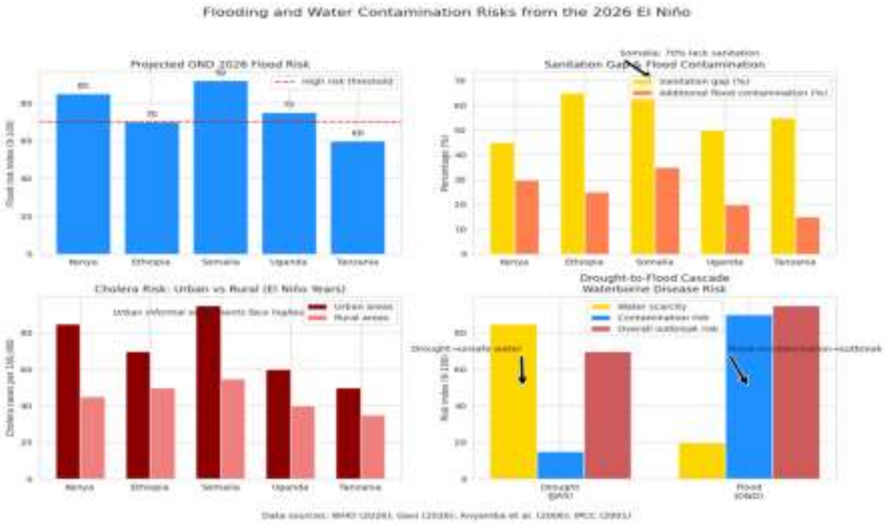

Figure 7 (Top left): Projected OND 2026 flood risk indices, with Somalia and Kenya exceeding high-risk thresholds (WHO, 2026). Figure 6 (Top right): Sanitation gaps and flood-induced contamination increases, highlighting Somalia's 70% WASH infrastructure deficit (Gavi, 2026). Figure 6 (Bottom left): Urban versus rural cholera risk during El Niño years, with Somali and Kenyan cities facing highest burdens (Anyamba et al., 2006). Figure 6 (Bottom right): Drought-to-flood cascade showing overall outbreak risk peaks during flood phase when contamination overwhelms water supplies (IPCC, 2001).

Figure 7 presents a comprehensive assessment of flooding and water contamination risks from the 2026 El Niño across East Africa. The top-left panel projects flood risk indices for the October–December 2026 season, identifying Somalia (92) and Kenya (85) as the most vulnerable countries, exceeding the high-risk threshold. Top-right reveals severe sanitation infrastructure gaps, with Somalia (70%) and Ethiopia (65%) lacking improved sanitation; floods would further increase contamination exposure by 35 and 25 percentage points respectively (WHO, 2026). Bottom-left demonstrates that urban cholera risk consistently exceeds rural risk during El Niño years, with Somalia (95 cases/100,000) and Kenya (85 cases/100,000) facing the highest burdens, reflecting the vulnerability of crowded informal settlements to rapid disease transmission (Gavi, 2026). Bottom-right illustrates the biphasic drought-to-flood cascade showing while water scarcity dominates the June–September drought phase, overall outbreak risk peaks during October–December when contamination from overwhelmed sanitation systems creates a compound health emergency (Anyamba et al., 2006). Together, these panels underscore the urgent need for pre-positioning WASH interventions in high-risk urban centres, particularly in Somalia and Kenya, before the flood season arrives.

b. Vector-Borne Diseases: Malaria, Dengue, and Rift Valley Fever

The 2026 El Niño is projected to significantly increase the risk of vector-borne disease outbreaks across East Africa, with malaria, dengue, and Rift Valley Fever (RVF) posing the most serious threats. El Niño events have been shown to impact significantly on many vector-borne diseases (VBDs), including malaria, dengue, Rift Valley fever and others.

Malaria

Heavy rainfall creates standing pools of water where mosquitoes breed, spiking cases of malaria and dengue. There is strong evidence that El Niño events can increase cholera risk and promote malaria epidemics. In Kenya, malaria has been linked to El Niño-related flooding. El Niño events can promote malaria epidemics through multiple mechanisms: increased rainfall creates breeding sites for *Anopheles* mosquitoes; warmer temperatures accelerate parasite development within mosquitoes; and flooding can displace populations, increasing exposure.
The malaria risk is not uniform across the region. In the Kenyan highlands, areas that are typically marginal for malaria transmission become vulnerable during El Niño years when temperatures rise and rainfall increases. During the 1997–1998 El Niño, malaria outbreaks were recorded in many countries in east Africa. In the Horn of Africa, extensive flooding led to large outbreaks of malaria. The 1997–1998 El Niño-related heavy rains in East Africa sparked an outbreak of mosquito-borne Rift Valley Fever and associated cholera and malaria in livestock and people (Figure 8).

Rift Valley Fever (RVF). Perhaps the most dramatic vector-borne disease threat associated with El Niño in East Africa is Rift Valley Fever. RVF is a zoonotic arbovirus, and livestock cases are often underreported in endemic countries due to reliance on passive clinical surveillance. Flooding creates a conducive environment for mosquito breeding and the long-term maintenance of vector populations. In East Africa, outbreaks often follow episodes of rainfall associated with El Niño–Southern Oscillation events, which activate hatching of dormant mosquito eggs. Flooding of dry mosquito vector habitats promotes hatching of (transovarially-) infected eggs, and vector breeding and survival.

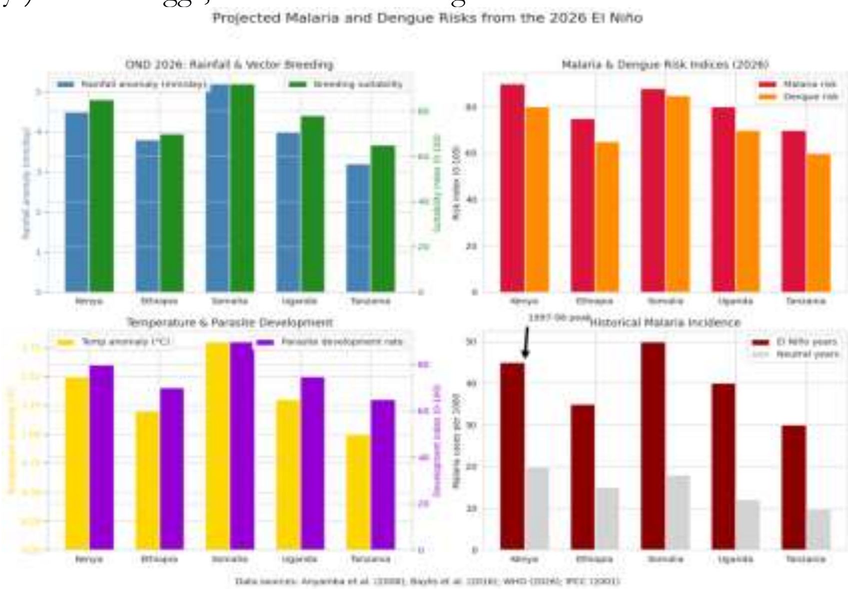

Figure 8 Top left: Projected rainfall anomaly (mm/day above normal) and vector breeding suitability index (0–100) during the October–December flood phase. Top right: Composite malaria and dengue risk indices for 2026, incorporating rainfall, temperature, and historical disease burden. Bottom left: Projected temperature anomalies (°C above normal) and the corresponding parasite development rate index (higher temperatures

accelerate *Plasmodium* and *Aedes* maturation). Bottom right: Historical malaria cases during El Niño versus neutral years, illustrating the dramatic increase during strong El Niño events (1997–98, 2015–16, 2023–24).

The 1997–1998 El Niño provides a stark illustration of RVF's devastating potential. Rift Valley fever outbreaks were recorded in many countries in east Africa. Heavy rains caused by El Niño exacerbated outbreaks of Rift Valley fever in Kenya's northeastern, eastern, central, and coastal and Rift Valley provinces, as well as in southern Somalia (Figure 8). The economic cost of RVF in East Africa exceeded 60 million USD during the 2006–2007 El Niño events.

c. Extreme Heat and Direct Health Impacts

The 2026 El Niño is occurring against a backdrop of unprecedented global warming, with profound implications for heat-related health impacts across East Africa. As UN Secretary-General António Guterres stated: "El Niño conditions will pour fuel on the fire of a warming world."

Extreme Heat as the Most Direct Health Concern

WMO Senior Extreme Heat Advisor Dr John Nairn emphasised: "When speaking of effects on health, it's rarely simple. Extreme heat is the most direct concern." The WMO has forecast above-normal temperatures across nearly all parts of the world for June–August 2026, increasing the risk of heat stress and compounding hazards in vulnerable areas. WMO Secretary-General Celeste Saulo has stated that extreme heat is already one of the deadliest climate threats, and El Niño could increase this risk by an average of 20-30 percent in regions that already experience high temperatures.

4.6 Discussion

a. Synthesis of Key Findings

This analysis reveals that the 2026 El Niño presents a uniquely dangerous dual-phase threat to East Africa, characterised by a drought-to-flood cascade that will subject the region to sequential and compounding climate shocks. The synthesis of climate forecasts, agricultural impact assessments, public health projections, and compound risk analyses yields several critical findings that together paint a picture of an impending humanitarian crisis of potentially unprecedented scale.

The Biphasic Climate Threat

The 2026 El Niño is projected to generate a distinctive biphasic rainfall pattern across East Africa (ICPAC, 2026a). During June–September, anticipated El Niño conditions may delay the onset of seasonal rains and suppress rainfall across western and northern areas of East Africa (ReliefWeb, 2026). This rainfall suppression threatens the main agricultural season in western unimodal zones where this period accounts for over 80% of annual precipitation (FAO, 2026). Later in the year, forecast El Niño could increase the likelihood of above-average rainfall across many eastern and southern areas of East Africa during the October–December season (WMO, 2026b). Regional climate experts at ICPAC have warned that if the event intensifies as projected, Eastern Africa is likely to receive above-normal October–December rainfall with a heightened risk of extreme flooding events (ICPAC, 2026b).

This sequential hazard pattern prolonged drought followed by extreme flooding creates a cascade of vulnerabilities that far exceeds the sum of individual hazards (IPCC, 2022). As the IPCC (2022) has documented, "the impacts of the flood are made worse by the preceding drought because very dry soil acts similar to a hard surface leading to greater surface runoff" (p. 14). The drought-to-flood cascade thus represents a textbook example of a compound event, wherein the interaction of multiple hazards produces impacts greater than their isolated effects (Zscheischler et al., 2026; Muheki et al., 2024).

Agricultural Systems under Sequential Stress

Agricultural systems across East Africa face sequential stressors that threaten both production and post-harvest security (FAO & WFP, 2026). The drought phase during June–September is expected to suppress yields through rainfall deficits during critical crop growth stages, with Ethiopia's Belg season crops, Sudan's main agricultural season, and Kenya's western and coastal agricultural areas identified as particularly vulnerable (FEWS NET, 2026; ICPAC, 2026a). The flood phase during October–December then poses catastrophic risks through waterlogging, fungal diseases, and inundation of standing crops (FAO, 1998; Anyamba et al., 2006).

V. Conclusions

Summary

The 2026 strong El Niño represents one of the most significant climate threats to East Africa in recent decades, with the potential to trigger a drought-to-flood cascade of unprecedented severity across the region. This analysis has demonstrated that the event's biphasic nature—rainfall suppression during June–September followed by extreme rainfall enhancement during October–December—creates sequential and compounding hazards that far exceed the impacts of either drought or flooding in isolation (IPCC, 2022; European Commission, 2026).

Agricultural systems across the region face particularly severe risks, with drought-phase rainfall deficits threatening crop establishment and early development, followed by flood-phase inundation destroying maturing crops, stored grain, and seed reserves. Historical evidence from the 1997–1998 El Niño demonstrates that such sequential stressors can devastate staple crops, trigger livestock disease outbreaks, and cause economic losses running into billions of dollars.

Public health risks are equally concerning, with the drought-to-flood cascade creating conditions for waterborne diseases (notably cholera), vector-borne diseases (malaria, dengue, Rift Valley Fever), and direct health impacts from extreme heat. The compound and cascading nature of these risks where agricultural losses drive malnutrition, flooding contaminates water supplies, and displacement accelerates disease transmission, demands integrated, multisectoral responses that address the full complexity of the threat.

The 2026 event is occurring against a backdrop of unprecedented global warming, with the potential to produce climate anomalies of unprecedented severity. As UN Secretary-General António Guterres warned, "El Niño conditions will pour fuel on the fire of a warming world." This context underscores the urgent need for anticipatory action, as the window for preparedness is now.

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