

# Kenya Meteorological Department

## EXTREME WEATHER EVENTS IN KENYA BETWEEN 2011 AND 2020.

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## 1.0 FLOODS AND DROUGHTS

Floods and droughts are the main extreme weather events that ravage Sub-Saharan Africa bringing with them complex challenges to an already hard-hit continent. Kenya has not been an exception, as it has had its fair share of disasters resulting from these hazards. While floods have been associated with loss of lives, landslides, damaged property and infrastructure over vast areas, frequent droughts have led to food insecurity, especially in the arid and semi-arid lands of Kenya. Over 80% of the Kenyan landmass falls under arid and semi-arid climates where droughts and floods are the predominant extreme events. This makes Kenya prone to climate vagaries. The effects of droughts and floods have been devastating in Kenya. Whereas floods inundate large parts of arable land destroying crops, killing livestock and destroying property, droughts on the other hand cause decline in water levels affecting agricultural activities, livestock keeping and in worst cases causing loss of lives [Huho & Kosonei, 2014]

Hazard	Areas most affected (hotspots)
Droughts	Counties in Eastern, North Eastern, coast, and parts of Rift Valley
Floods	Budalangi, Nyando, Homa Bay areas (all within the Lake Victoria Basin) and Tana River county in the lower Tana River catchment
Flash floods	Mainly in urban centers like Nairobi and Mombasa due to poor drainage and uncontrolled urban settlements. This type of flooding is also experienced in Arid and semi-arid areas particularly northern and north-eastern parts of the country
Landslides	Central Kenya and around Mount Kenya region mainly in Muranga and parts of Meru counties
Hailstones	Localised areas countrywide but with highest concentration within the Lake Victoria Basin
Thunderstorms and lightning strikes	Localised areas countrywide but with highest concentration in Kisii and Kakamega counties in Western Kenya
Strong winds	Localised areas countrywide but with highest concentration in northern Kenya counties
Frost	Vary rare phenomenon but occasionally experienced around Nyahururu area within the slopes of the Aberdare mountain Range
Extreme temperatures	Northern Kenya counties
Fog	Localised areas countrywide but with highest concentration around Limuru, Kinungi and Timbora, all along the Nairobi to Eldoret Highway

**Figure 1:** Hazards in Kenya and affected regions (Adapted from Marigi S. N (2017))

**Figure 1** highlights the various hazards Kenya faces. This report focuses primarily on droughts and floods and associated landslides and includes a few strong wind cases. It seeks to investigate the flood and drought occurrences in the last decade i.e., January 2011 to December 2020.

## 2.0 FLOODS IN KENYA

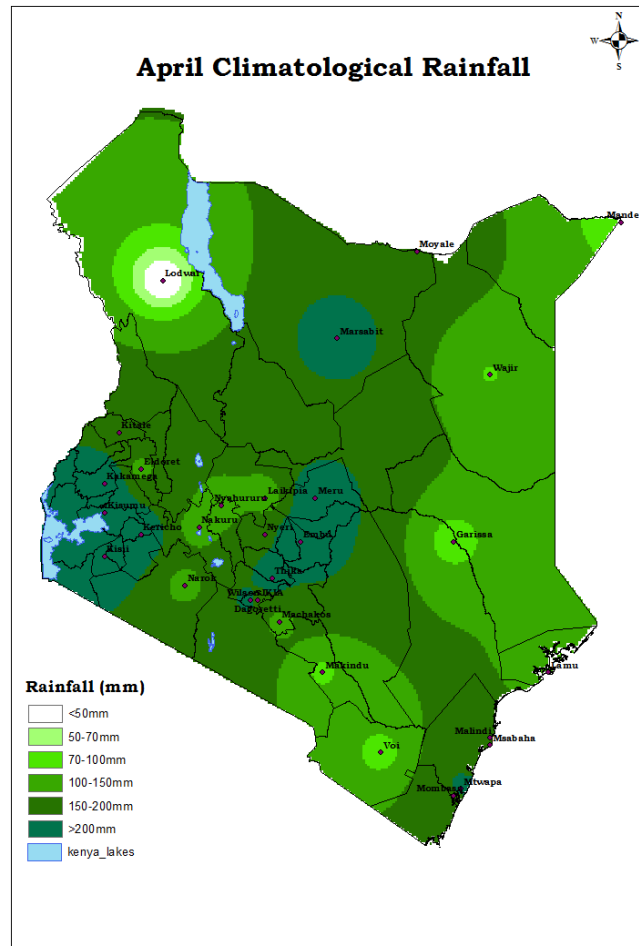
Ideally, floods can occur anywhere particularly after a period of heavy precipitation. All flood plains and urban areas (increased paved surfaces and clogged drainage systems) have a high vulnerability to flooding mostly caused by heavy storms due to reduced infiltration. On the other hand, flash floods occur after a period of prolonged drought that renders the ground very compact followed by rainfall falling on this now hard surface having much lower-than-normal infiltration capacity.

Severe flooding in Kenya has been observed to be triggered by severe thunderstorms, tropical cyclones, as well as heavy rainfall over consecutive days. The El Nino Southern Oscillation, Madden Julian oscillations and other phenomena have been observed to exacerbate the flood situation in the country.

Other non-climatic factors play a role in determining the impacts that flooding will have on a region. Urban flooding, for example, is precipitated by increase in paved surfaces thus reducing infiltration and increasing downstream flow of rainwater.

Most flooding in the country occurs during the March to May (MAM) long rainfall season and particularly during the month of April which is the peak of the rainfall season.

**Figure 2** depicts the climatological rainfall for the month of April. Regions within the Lake Victoria Basin and western Kenya receive more than 200mm of rainfall during this month. The same is observed in parts of the Central highlands of Kenya including Murang'a County that is frequently ravaged by mudslides associated with flooding.



**Figure 2:** April Climatological rainfall

## 2.1 Year by Year cases of floods

- (i). In April **2012** floods were experienced in Kenya that resulted in some deaths reported at Hell’s Gate National Park, a region perennially impacted by flash floods.

Analysis at the end of the month of April indicated that the station closest to the park recorded 274.3mm against a monthly average of 120.2mm. This was 228% of the rainfall normally received. Most stations recorded very high rainfall during this particular short rain season which resulted in floods in various parts of the country and landslides in central Kenya.

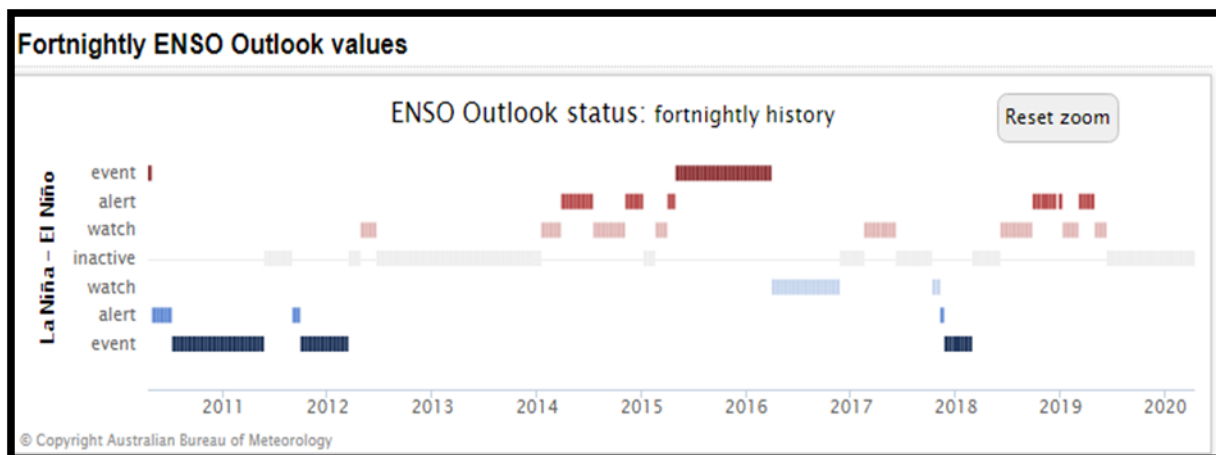
- (ii). In April **2013**, 10 people were reported dead in Narok County, following flooding while one person was swept away in Nyamira County. By the end of the short rains season, it was reported by the Kenya Red Cross Society that about 50 people had lost their lives and about 4,000 families had been evacuated from their homes. Widespread loss and destruction of property associated with the flooding was also recorded.

The persistent heavy rains received during MAM 2013 caused flooding in several parts of Kenya. The worst affected areas included the Coastal strip, western region and parts of central Kenya, where the heavy rains

triggered floods leading to loss of lives and destruction of property, including damage to infrastructure that rendered most roads impassable. Various rivers in the country, including Rivers Tana, Nyando, Nzoia and Ewaso Nyiro burst their banks as a result of the pounding rains, leading to the displacement of thousands of people in the flood plains. Landslides were also experienced in various parts of the country. Narok recorded over 100% more rainfall this month than its normal rainfall amounts for April.

- (iii). During the October to December (OND) **2013** rainfall season, flooding associated with heavy rainfall was reported. At least 12 people died between December 14<sup>th</sup> and 15<sup>th</sup> in Kajiado County after seasonal rivers burst their banks following the heavy rains in the region. On 14<sup>th</sup> December two women travelling from Isinya along the Pipeline road were swept away by raging floods at Oltepes area near Kiserian. The two were flashed into a raging seasonal river and their bodies were recovered on 15<sup>th</sup> December in the evening trapped in their car. On 15<sup>th</sup> December 10 people perished after floods swept away a car downstream at Inkirgir at Isinya, Kajiado County. Other counties affected by floods include during this OND rainfall season were Makueni, Laikipia and Narok.
- (iv). During the March to May (MAM) **2014** rainfall season, flooding was once again experienced in various parts of the country. At the beginning of the rainfall season, flooding was reported in Narok county, particularly in Narok south, resulting in fatalities. In April, Kisumu and Nairobi both reported losses of lives and damaged property attributed to the extensive flooding.
- (v). In April **2015**, flooding was reported in Southwestern Kenya, specifically in Bondo, Siaya County. This was mainly driven by bursting of dams in the region following two consecutive days of heavy rainfall. Lives were lost and families were displaced. Kajiado was also affected by the flooding during this month, resulting in the death of six people. A bus was swept away by flood waters in Mandera resulting in the death of 40 of the passengers. In May 2015 a building collapsed in Nairobi due to heavy rainfall and flooding resulting in the death of nine people.
- (vi). The Short Rains (October, November, December - OND) 2015 season was also characterised by flooding in parts of Kenya including Talek in Narok, where three people lost their lives after being swept away by raging flood waters. In Migori County, the Ntimaru – Gitungi bridge was swept away due to heavy rains. Heavy rains and flooding were also reported in North Horr, Laisamis and Chalbi desert in Marsabit County as well as parts of Kisii County. During OND 2015, a tally revealed that at least 112 people had died and over 100,000 people were displaced. It is worth noting that

the heavy rainfall experienced in OND 2015 was driven by a strong positive El Niño index (see **Figure 3** below).



**Figure 3:** El Niño History for the past 10 years (Adapted from Australian Bureau of Meteorology)

- (vii). Several parts of Turkana County recorded intense rainfall during the afternoon of 10<sup>th</sup> March **2016** which led to overflowing of the Turkwel and Kawalase Rivers. At least three people died in the floods and more than 1,000 others were displaced from their homes. Large numbers of livestock were also reported to have been swept away by the flood waters. In April 2016, at the peak of the rainfall season, Nairobi received heavy rainfall (>50mm/24hrs) that resulted in widespread flooding. Buildings collapsed trapping and killing people, traffic was brought to a standstill as most city roads had been rendered impassable.
- (viii). In May **2017** the coastal counties of Mombasa, Kilifi, Kwale as well as parts of south-eastern lowlands of Taita Taveta County received very heavy rainfall (>50mm/24hrs) resulting in flooding that unfortunately once again killed people and destroyed property. Most residents of these regions had to be evacuated to further safeguard their lives. Garissa County also reported flooding extending to Dadaab during the same period. Parts of the central highlands, including Nyeri County, likewise reported flooding and associated mud and landslides.
- (ix). In late October to November **2017**, once again heavy rainfall was reported across most parts of the country resulting in flooding. Counties affected included Turkana, Marsabit, Tharaka Nithi and Meru, with reports of loss of human life, displacement of families and damaged bridges and roads.
- (x). During MAM **2018** flooding was witnessed over most parts of the country following heavy rainfall. Deaths were reported in Kisumu Turkana and Taita Taveta counties and people were forced to evacuate their homes.

Families were marooned in Nyeri County after heavy rains rendered most roads impassable.

- (xi). The heavy rainfall of the OND **2019** rainfall season resulted in widespread flooding that led to the displacement of many families, especially near the Kenyan border with Ethiopia. In November 2019, consecutive days of heavy rain (>20mm/24hrs) in western Kenya triggered massive landslides and flash floods in West Pokot County. During the same month, residents of the lower parts of Tana River County were affected by floods as a result of River Tana bursting its banks following heavy rainfall.

Generally, all heavy rainfall events in Kenya almost always lead to flood conditions in one place or another. These flood events may occur in some regions within a given rainfall season while simultaneously, during the same season, other regions experience low rainfall amounts or drought conditions.

### **3.0 DROUGHTS IN KENYA**

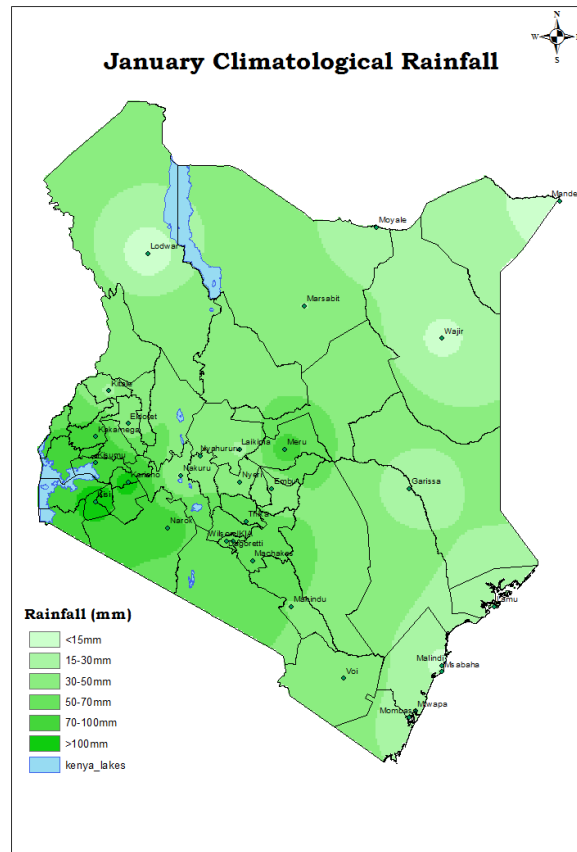
Drought is characterized by a lack of precipitation—such as rain, snow, or sleet—for a protracted period of time, resulting in a water shortage. While droughts occur naturally, human activity, such as water use and management, can exacerbate dry conditions. What is considered a drought varies from region to region and is based largely on an area's climatology.

In Kenya most of the regions that regularly experience drought lie within the Arid and semi-arid regions of the country largely within the Northern parts. These regions are characterized by low annual rainfall, low population density, high livestock population, pastoralism (largely driven by rainfall patterns), poor physical and social infrastructure, resource conflicts and generally low literacy levels. All these issues make for a very complex situation to deal with and reduce the adaptive capacity of the people to droughts.

Droughts in Kenya are exacerbated by La Nina conditions, the opposite of El Nino conditions. **Figure 3** shows La Nina years in the past 10 years and most droughts correspond to those years. Drought in Kenya is also cyclic, having even shorter return periods as the climate changes. The months mostly associated with drought in Kenya are the ones following a poor rainfall season. The climatology of Kenya depicts January, February, June, July, August and September as the most common drought months, especially in the northern parts of the country.

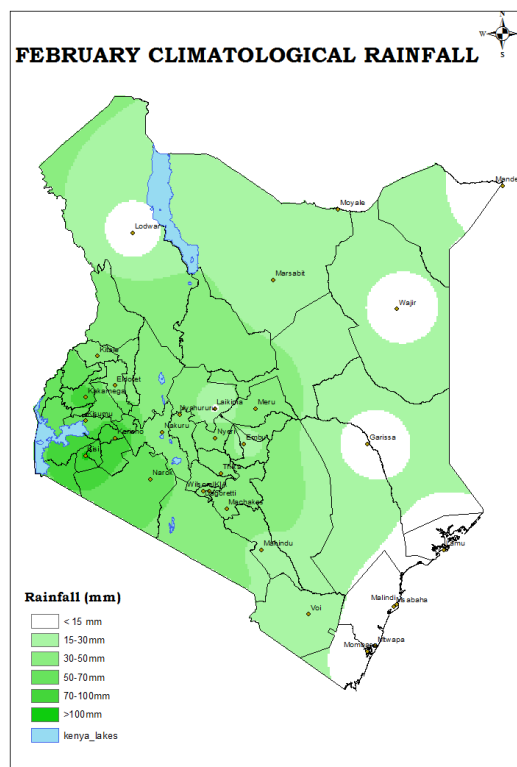
**Examples of Figures 4 and 5** show regions within the country that are especially prone to droughts based on long-term data analysis. These regions receive, on average, very little rainfall amounts (<15mm – 30mm) for the months of January and February two months. The data used to

calculate climatology for the country for this month is data for the 30-years period of 1971 – 2000.



**Figure 4:** Climatology of rainfall in Kenya in January





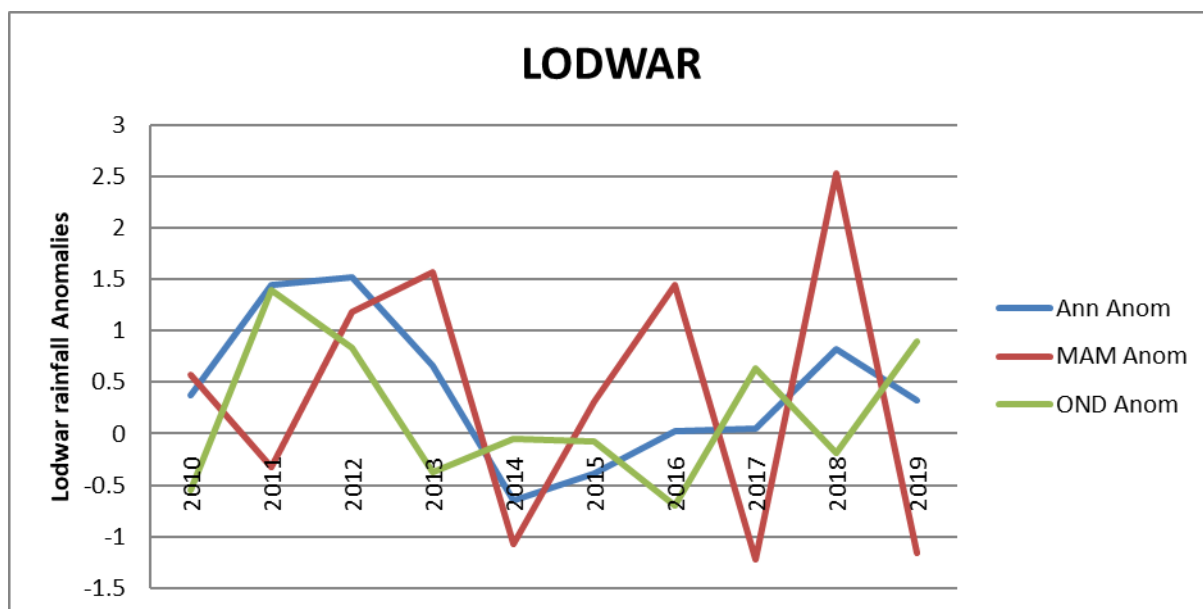
**Figure 5:** Climatology of rainfall in Kenya in February

### 3.1 Year by Year Drought Cases

- (i). Between July **2011** and mid-**2012**, a severe drought affected the entire East African region. Considered to be "the worst in 60 years", [Wooldridge, 2011] the drought caused a severe food crisis across Somalia, Djibouti, Ethiopia and Kenya that threatened the livelihoods of 9.5 million people.
- (ii). In January **2014**, the Government of Kenya declared an impending drought with an estimated 1.6 million people affected. This followed poor rainfall performance over the arid and semi-arid counties during OND 2013. Thereafter, there was also poor performance of the long rains between March and May 2014 in the arid and semi-arid zones. The drought situation continued to affect both pastoral and marginal agriculture livelihood zones (the North Western, Northern, North Eastern, South Eastern and parts of Coast) with adverse impact on households' food security as well as livestock productivity. The situation continued to worsen due to the increase in food prices.
- (iii). At the end of **2016**, from around late November and into early **2017**, Kenya was once again in the grip of a drought. This followed two consecutive seasons (MAM 2016 and OND 2016) of poor rainfall, resulting in depletion of critical pasture and water resources. The drought also occasioned water and electricity rationing, affecting even areas that are not widely known dry-lands such as Elgeyo-Marakwet, Bomet, Kisumu, Busia, Kakamega, Homa Bay and parts of central Kenya. It was during this drought season that Ndakaini Dam which

holds 70 million m<sup>3</sup> was reported to have gone below the 50% water level mark. Migration in search of pasture and water in northern Kenya, coastal and eastern regions was widely reported, with increasing cases of livestock succumbing due to lack of forage and water. This drought extended into early **2018**. Examples are Lamu and Voi Counties both of which received no rainfall at all in January and February, whereas normally these regions receive up to 50mm of rainfall during these months. Lodwar, Marsabit, Moyale, Garisa, Wajir and Mandera likewise received no rainfall in January. Most other stations received very dismal amounts in comparison to their average rainfall for the months of January and February

- (iv). At the beginning of **2019**, parts of the country experienced drought conditions due to prolonged failure of rainfall, prominent among these cases were West Pokot, Turkana and Baringo Counties. These regions required food aid due to reduced food availability. The OND 2018 rainfall was below normal followed by below normal rainfall in MAM 2019 in Northwestern Kenya and this precipitated the drought conditions witnessed as highlighted in **Figure 6**.
- (v). In **2020**, due to the below normal rainfall during the OND 2020 season, some Counties experienced drought conditions with trends indicating worsening conditions. By October **2020**, Garissa, Mandera and Wajir Counties were in the alert level of drought status. Attributed to the drought were reports of acute malnutrition across the Arid and Semi-Arid Lands (ASAL) Counties. The food security situation in the ASAL Counties was reportedly at one of the lowest levels in the last 15 years (UNOCHA, 20th October 2020)



**Figure 6:** Lodwar rainfall Anomalies at annual and seasonal level

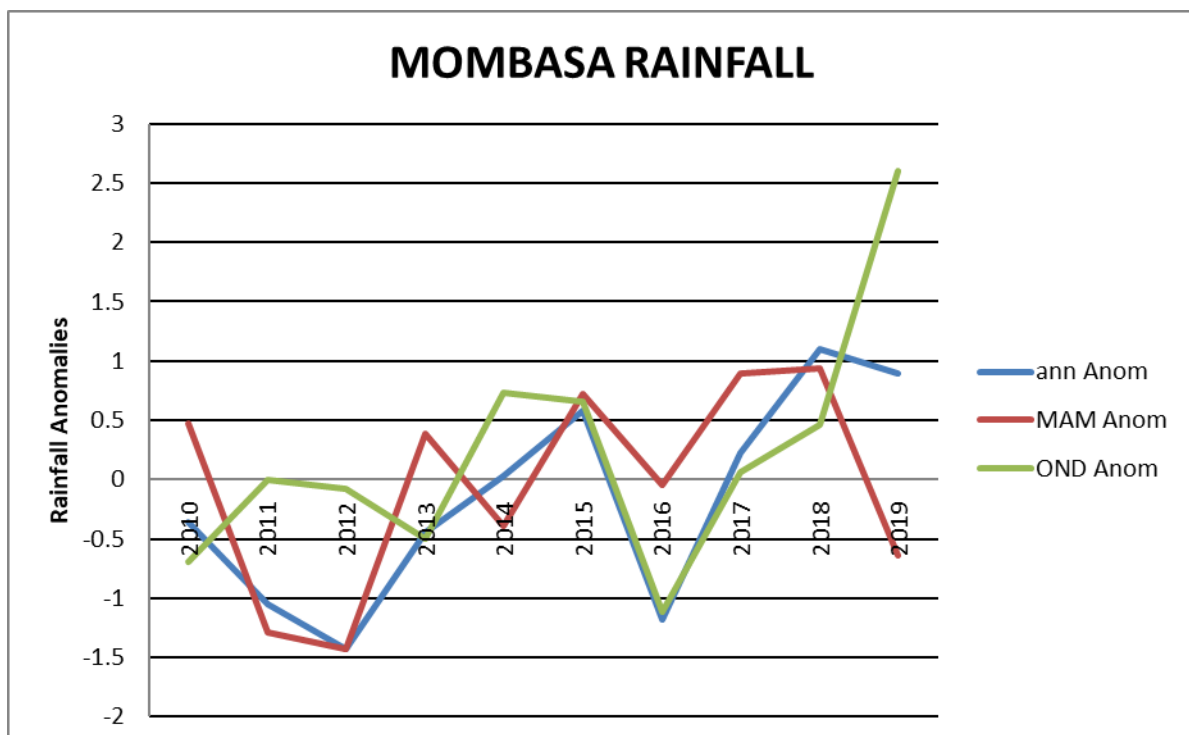
**Figure 6** depicts rainfall anomalies for Lodwar, representing the North Eastern region, of the country. Data analysis shows that Lodwar exhibits very high variations in rainfall from year to year and this in turn results in

flood years followed by drought years. At the annual level (blue line), there has been a steady decline in rainfall amounts, however 2015 and 2016 were the only years with below average rainfall in the region. During MAM season (red line), the greatest variability is observed. The year 2017 had a negative anomaly of -1.2 and witnessed drought conditions that spread into early 2018. This was followed by a positive anomaly of 2.5 in 2018 resulting in flooding and leading to loss of lives in the region. During OND season (green line) the prevailing conditions for the region were below average rainfall which then spread into the beginning of the following year bringing with it drought conditions in the region.

#### 4.0 RAINFALL ANOMALIES

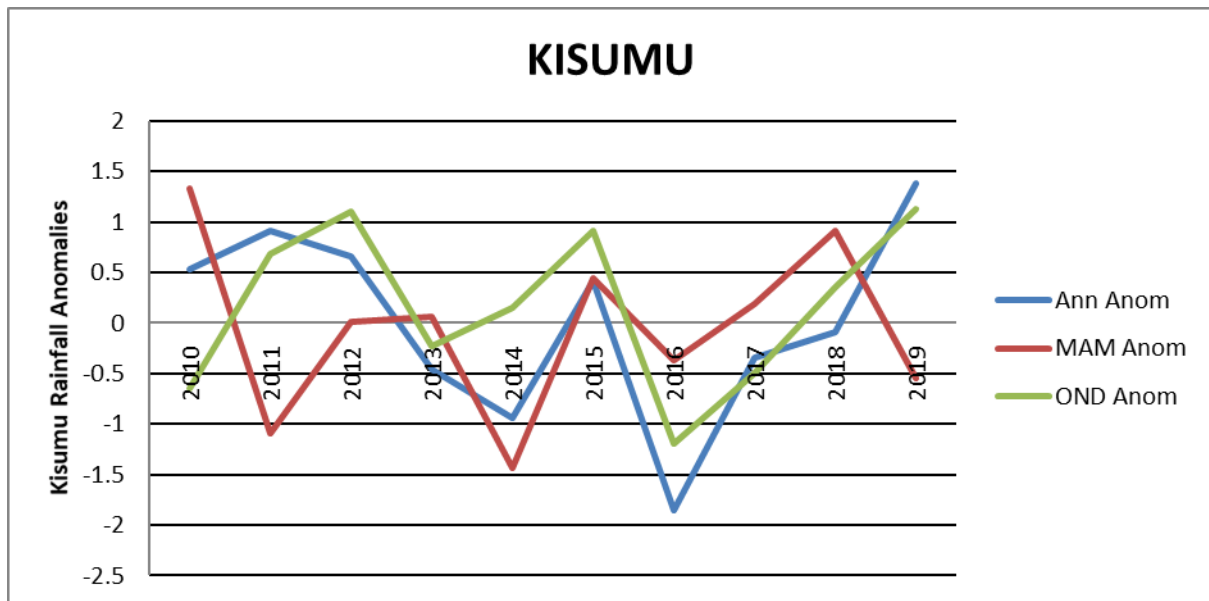
In this section the rainfall anomalies are examined and from data of a few stations sampled it is clear that there have been more years with flooding than droughts within Kenya.

**Figure 7** below depicts rainfall anomalies for Mombasa station. The zero line represents the normal rainfall while the variations highlight the variability of rainfall about the mean. At the annual level (blue line) there's an equal number of years with below average rainfall while the years with above average rainfall varied across the years. The same scenario is replicated during MAM season (Red line). However, during the OND season (green line) there are fewer years with below average rainfall compared to above average rainfall in the past 10 years.



**Figure 7:** Mombasa rainfall Anomalies at annual and seasonal level

**Figure 8** likewise highlights rainfall anomalies for Kisumu station. Kisumu station represents the Lake Victoria basin region that is prone to flooding almost every year. The data analysis shows that at the annual level (blue line) there are an equal number of years with below average rainfall while the years with above average rainfall varied across the years. However, during the MAM season (Red line) as well as the OND season (green line) there are fewer years with below average rainfall compared to above average rainfall in the past 10 years.



**Figure 8:** Kisumu rainfall Anomalies at annual and seasonal level

This analysis clearly shows that there have been more years with flooding events than droughts within Kenya.

## 5.0 STRONG WINDS & DUST STORMS

1. The 1<sup>st</sup> of October 2019 saw strong gusts of wind experienced over Nairobi, raising concern among city dwellers. Dagoretti Meteorological Station reported over 5 consecutive hours of strong winds of up to 28 knots (14.4m/s). The winds extended all the way to Arusha in Tanzania indicating that it was not simply a localised system and was recorded as a 'Haboob'. This resulted in electric power disruption, damage to infrastructure in the form of billboards and others and drastically reduced visibility in the region for hours.
2. Another case of strong winds was reported during the month of July 2020 as a result of strong pressure gradients. The areas affected were in the North-eastern parts of Kenya and the strongest winds in knots were 30knots (15.4m/s)

## **6.0 OTHER EXTREME EVENTS KENYA**

Desert locust's invasion in Kenya spilled over from 2019 into 2020, with large swarms spreading across 14 Kenyan Counties and gradually invading neighbouring countries - influenced by both wind and rainfall occurrences within the region.

## **7.0 SOCIO-ECONOMIC IMPLICATIONS**

The socio-economic implications of the impacts of floods and droughts as well as the cost implications will be the next step in this analysis.

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