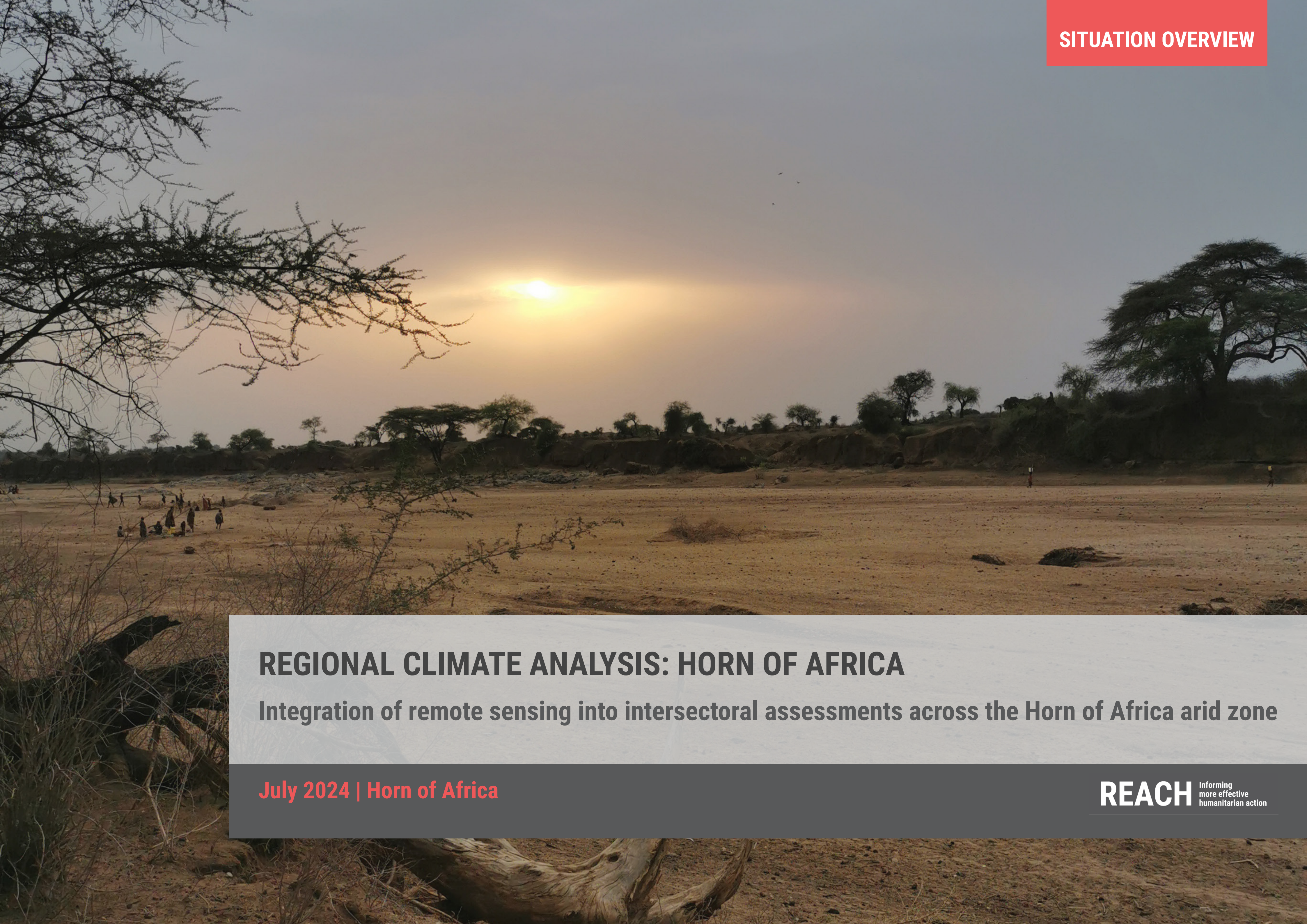

SITUATION OVERVIEW

REGIONAL CLIMATE ANALYSIS: HORN OF AFRICA

Integration of remote sensing into intersectoral assessments across the Horn of Africa arid zone

July 2024 | Horn of Africa

REACH Informing more effective humanitarian action

INTRODUCTION

Climate-related shocks are increasingly impacting communities in crisis-affected areas around the world. The rising frequency and severity of phenomena such as flooding, drought and extreme heat, intensified by climate change, are further undermining the coping capacities of already vulnerable communities.

REACH conducts intersectoral assessments in contexts of crisis to provide a clearer picture of humanitarian needs. Globally, REACH has a wider programmatic aim to explore and identify best practices for integration of remote sensing into these analyses to better measure the impact of climate shocks and climate change on communities. This aligns with REACH's broader objective to mainstream climate analysis in its research.

In addition, it is well known that environmental phenomena are transboundary. At the same time, the mechanisms through which REACH work are largely country-based, often confining the research extent to boundaries that present an incomplete picture from an environmental perspective. Therefore, this analysis takes advantage of the opportunity to conduct a regional analysis to highlight the value of providing an environmental lens at the appropriate scale. Through this, REACH hopes to advocate for more regional analysis in future and encourage more harmonised data collection and programming.

This report focusses on the Horn of Africa region, much of which has faced extreme climatic variability in the past few years, negatively affecting water access, as well as food security and livelihoods. From protracted drought between late 2020 and early 2023, extreme rainfall and flooding hit the region in late 2023. This report focusses specifically on the transboundary arid zones, which make up the majority of Somalia, northern Kenya and eastern Ethiopia, and share many similarities in environment, climate and livelihoods.

Using both remote sensing analysis and recent primary data from REACH's intersectoral assessments conducted across the region, this report aims to analyse climatic trends and impacts of climatic shocks. The subsequent section of the report explores correlations and comparisons between remote sensing indicators and household/key informant indicators to further understand what remote sensing can tell us about the potential humanitarian situation and triangulate information from primary data, particularly in hard-to-reach areas.

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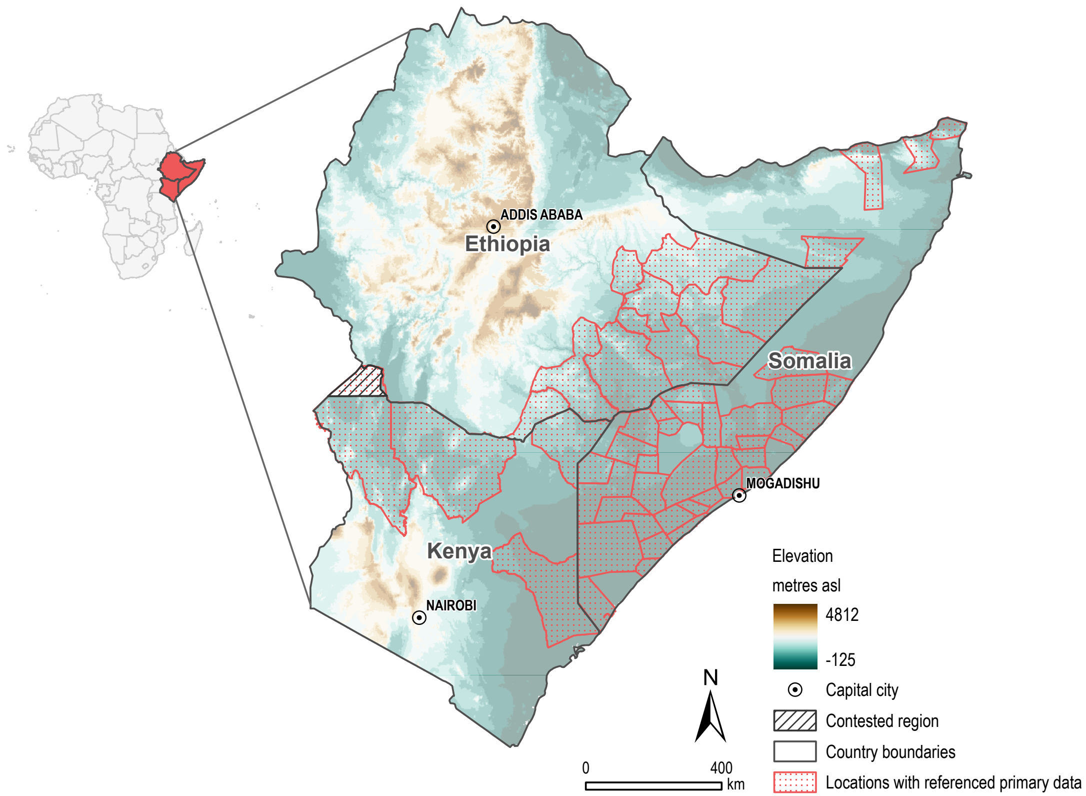
REGIONAL CLIMATE ANALYSIS

Integration of remote sensing into intersectoral assessments across the Horn of Africa arid zone

KEY MESSAGES

- Following protracted drought across the arid zone of the Horn of Africa between late 2020 and early 2023, much of the region was struck by heavy rains and flooding in 2023 and early 2024, driven by climate patterns such as El Niño, and further exacerbated by climate change. This extreme interannual climate variability highlights the importance of disaster risk reduction programming to reduce the risk to vulnerable communities arising from a disparate range of potential climate shocks in future.
- Similarities and connections can be observed between climatic shocks, livelihoods and impacts on communities across the arid zone of Kenya, Somalia and Ethiopia. This includes reports of similar shocks and impacts across this climatic zone, as well as heavy rainfall in one country (Ethiopia) affecting flooding downstream (in Somalia) for example. This highlights the importance of considering environmental and livelihood zones, which extend beyond individual country boundaries, under a regional lens to better prepare for and address the impacts of these phenomena.
- Climate shocks including droughts and floods were some of the most reported shocks across areas assessed by REACH in all three countries, often reported more frequently than conflict and insecurity, indicating the increasing impact of climatic shocks on the humanitarian situation across the region. Data also suggests long-term impacts of the 2020-23 drought on livelihoods, reducing coping capacity to subsequent shocks in the long-term.
- Correlations were identified between indicators from both household and key informant data collected by REACH, and remote sensing indicators in the locality. For example, borderline and poor Food Consumption Scores (FCS) were generally found to be related to poorer vegetation condition (VCI) and relatively lower rainfall (SPI) compared to acceptable FCS scores. This presents some interesting insights into how remote sensing can be used to flag potential shocks and triangulate information on the humanitarian situation, including in hard-to-reach areas. However, further research is required to further refine the analysis parameters and further consider additional contributing factors.

Fig. 1. Horn of Africa region, and locations where primary data referenced in this report was collected.



1.1 CLIMATE EXTREMES IN THE HORN OF AFRICA

Following protracted drought which saw up to six consecutive failed rainy seasons and left 23.4 million people acutely food insecure across the Horn of Africa (HoA) since late 2020,[1] exceptionally heavy rainfall hit parts of the region in 2023. This resulted in **flooding, displacement of over 1.6 million people, disease outbreaks, damaged infrastructure, and crop destruction**.[2] The recent (2024) *Gu* rains have also been above normal, with flooding once again widely reported.

The drought which began in late 2020 was **the longest and most severe experienced in recent history**, surpassing that of 2010-2011 and 2016-17.[3] Despite the increased rainfall in 2023, **the compounding shocks and long-term effects of the extended drought still appeared to be negatively impacting livelihoods** across much of the HoA in 2023. This includes through the erosion of coping strategies, reductions in livestock populations, poor harvests, reduced harvests, and high food prices, which primary data indicates were significant factors across the region.

From an environmental standpoint, **the effects of flash flooding in 2023 were likely exacerbated by the dry conditions in the preceding rainy seasons**, degrading topsoil and reducing the ability of the land to absorb water from heavy rainfall.[4]

Some scientists say that this **extreme climate variability has been intensified by climate change,[5] whilst seasonal drivers such as El Niño and Indian Ocean Dipole have further fuelled these events.** In Somalia, significant shifts have been observed in the annual distribution of rainfall, with a shift in heavy deluges towards the *Deyr* season, which historically only saw 25% of annual rainfall.[6] These changes in climate are having drastic impacts on populations, disrupting food access, livelihoods and access to water.

Impacts have been varied and widespread, but with many similarities across the region. As of February 2024, OCHA reported there were as many as 21M people in need of humanitarian assistance in Ethiopia and 8.3M in Somalia.[7] **Following the 2023 *Gu* rains, REACH assessments indicated that many people were still reporting drought as a shock, whilst flooding was also widely reported**, particularly in riverine areas. This reflects the mixed conditions at this time.

In Somalia, the most widely reported shocks according to REACH assessments conducted in August 2023, December 2023 and March 2024 were all climatic, showing a **shift from drought in August 2023 to floods in the subsequent two rounds.** The rains towards the end of 2023 were considerably above average across much of the region, reaching more than 130% above average in some areas. This resulted in further adverse impacts on livelihoods and erosion of coping strategies. In **Somali, Ethiopia, data suggests that many HHs experienced large decreases in income as of December 2023 compared to before the drought**, reportedly due to loss of livestock and lower agricultural output.

What can remote sensing tell us about potential humanitarian needs?

This report uses a combination of remote sensing, primary quantitative data, and secondary data review, to understand climatic patterns and shock severity at the local level across the HoA. Whilst remote sensing can provide an overview of potential shocks, it is necessary to compare this with additional data sources to contextualise the information and understand what it might tell us about the humanitarian situation and impacts on exposed communities.

REACH conducted various assessments in 2023-4 which have been referenced in this report. This includes the Multi-Sectoral Needs Assessment (MSNA) HH-based survey conducted in northern Kenya in mid-2023, and multiple rounds of the key informant (KI)-based Humanitarian Situation Monitoring (HSM) in hard-to-reach areas in Somalia. In addition, a HH-based livelihood assessment from Somali, Ethiopia following the 2023 *Deyr* rains has also been referenced.

This data has been compared with remote sensing analysis, both to triangulate information, and also to help extrapolate potential humanitarian conditions across areas where primary data has not been collected. This consolidated approach could support in targeting areas for further assessment and humanitarian intervention for drought-and flood-affected communities across the region. Detailed methodology is provided on page 21-22.

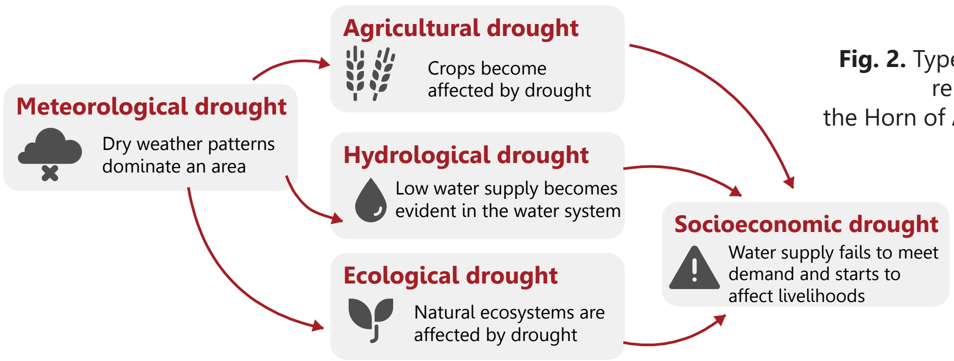


Fig. 2. Types of flooding reported across the Horn of Africa in 2023

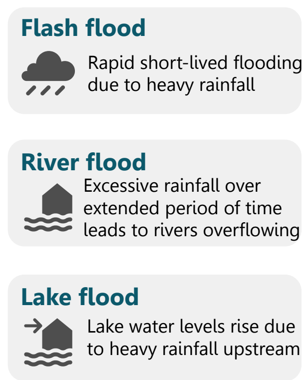
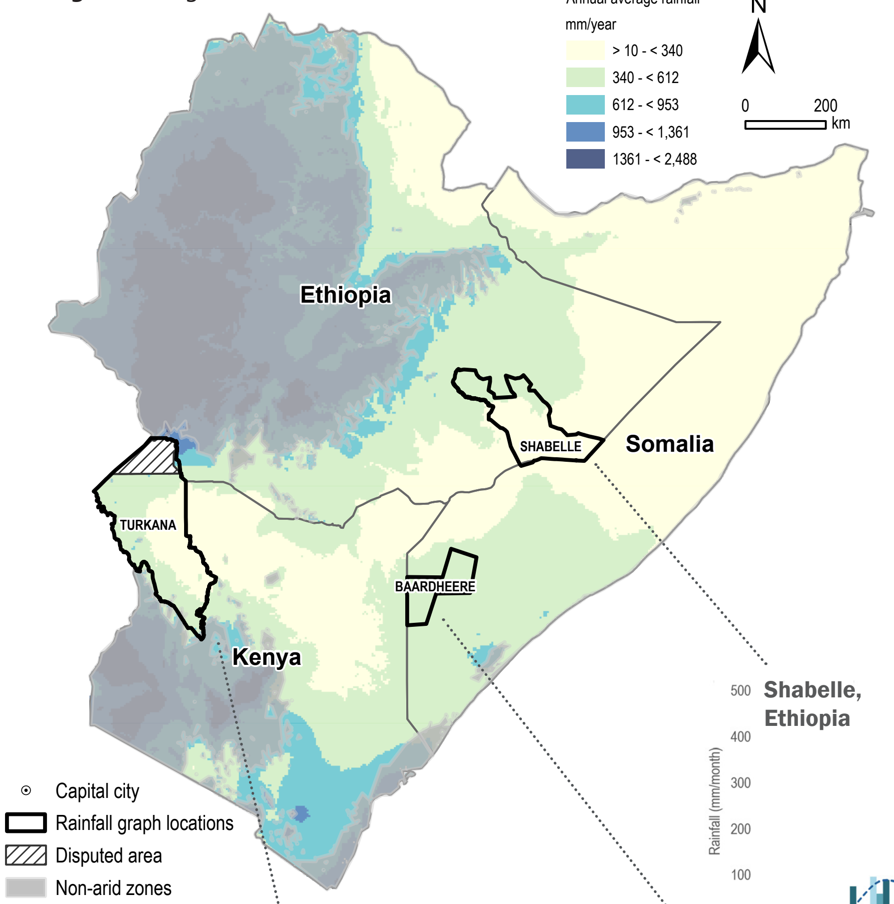
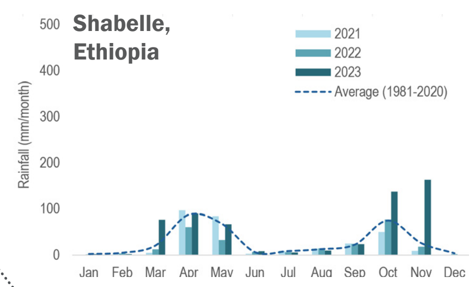


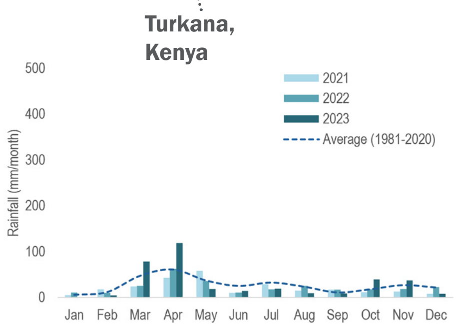
Fig. 3. Diagram indicating the various definitions of drought.[8] In general, meteorological drought can lead to agricultural drought, hydrological drought or/and ecological drought, whilst socioeconomic drought occurs when drought begins to affect livelihoods.

1.2. CLIMATIC CONTEXT

Fig. 4. Average annual rainfall. Source: CHIRPS.







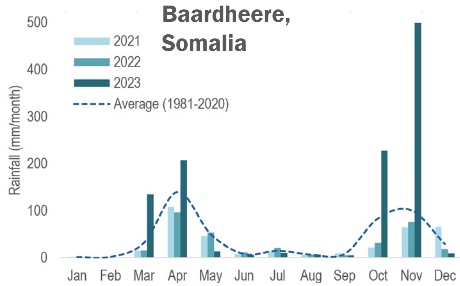
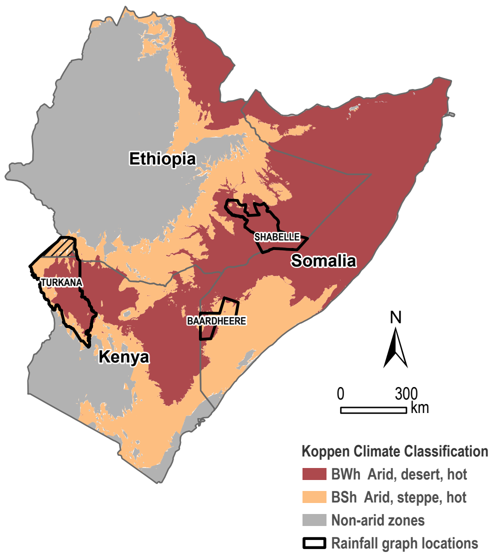


Fig. 5. Arid zones in the HoA - focus of this study. Locations of rainfall graphs below also shown.



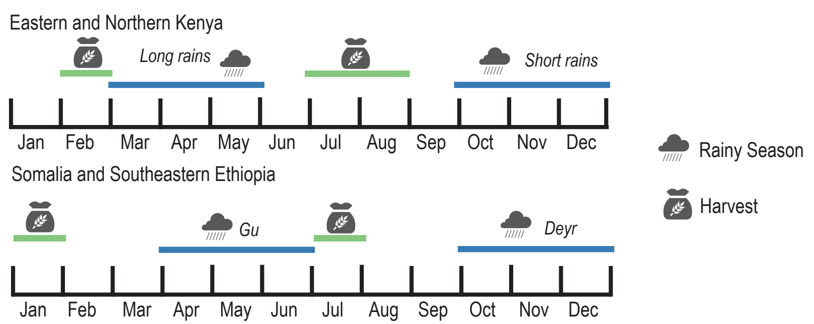
The Horn of Africa is characterised by a range of distinct climatic zones. As Fig. 4 indicates, the west of Ethiopia and southern Kenya receive the highest average annual rainfall, whilst Somalia receives the least, particularly the northeast of the country. Zones of higher rainfall broadly correlate with areas of higher elevation, and are an important determinant of livelihoods, with agricultural areas broadly aligned to areas of higher rainfall, and pastoralist livelihoods dominating in regions of lower rainfall, with agropastoral pockets (see following page).

The drier areas of the HoA fall within the *Bwh arid desert* and *BSh arid steppe* climate zones according to the Koppen climate classification (Fig. 5).[9] In general, rainfall patterns are similar across this region, with a longer rainy season falling between March and May, and another shorter one between October and December.

In Kenya, these are known as the *long rains* and *short rains* respectively. In Somalia and southeast Ethiopia, they are referred to as the *Gu* rains and the *Deyr* rains.[10] Simplified regional rainfall patterns and main harvests are summarised in Figure 6.

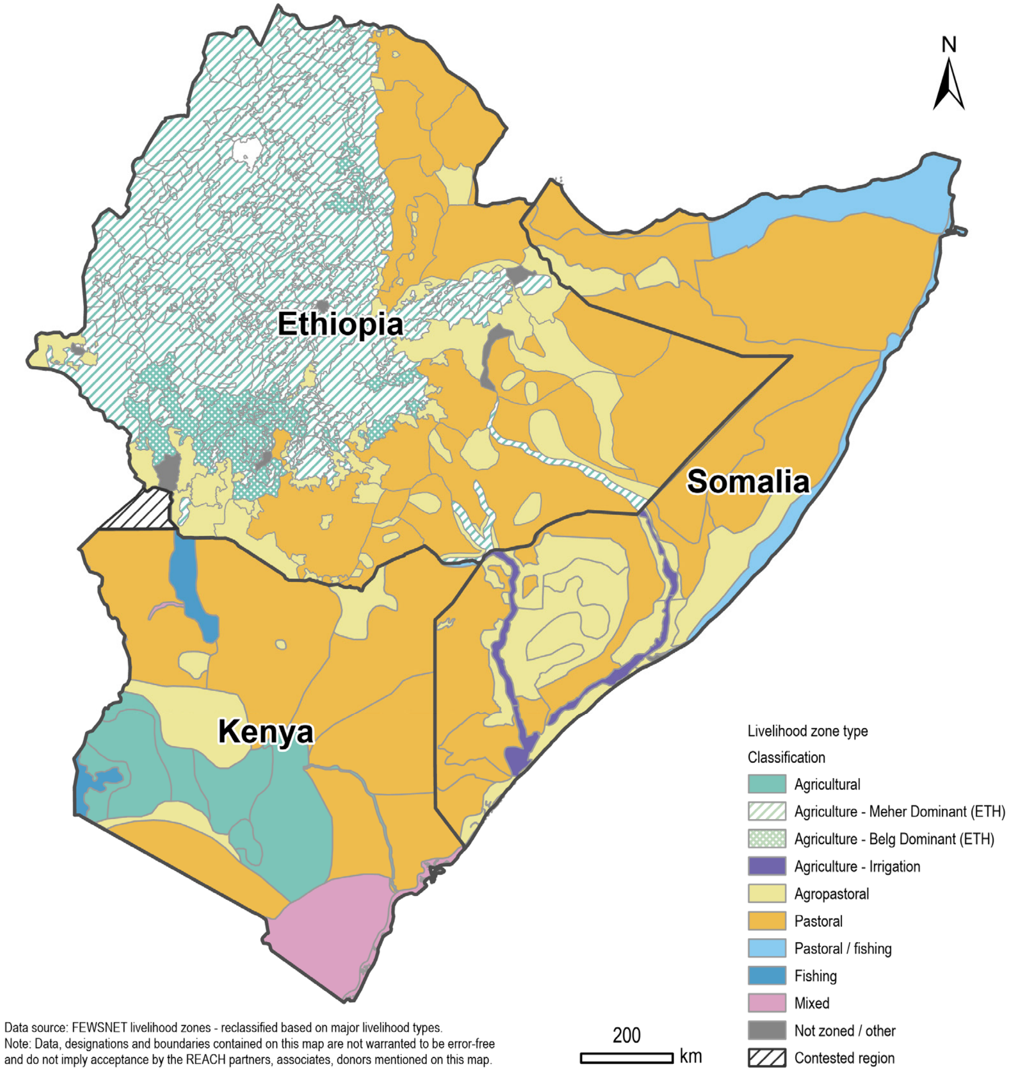
The graphs to the left show the long-term average rainfall in various locations across the HoA arid zone. Whilst the bimodal pattern is observed across all three locations, the quantity of rainfall varies significantly, with Turkana being the driest of the three areas. Rainfall in 2021, 2022 and 2023 is also shown, highlighting some of the extreme variability observed in recent years.

Fig. 6. simplified seasonal calendar for selected regions across the HoA[11]



1.3. LIVELIHOOD ZONES

Fig. 7. Livelihood zones across the Horn of Africa region, classified into broad livelihood types.



Data source: FEWSNET livelihood zones - reclassified based on major livelihood types.
Note: Data, designations and boundaries contained on this map are not warranted to be error-free and do not imply acceptance by the REACH partners, associates, donors mentioned on this map.

As defined by the Famine Early Warning Systems Network (FEWSNET),[12] there is a high diversity of livelihood zones across the Horn of Africa. The map shows generalised livelihood types, which can broadly be split into pastoralist, agro-pastoralist, and agricultural zones, with localised areas where other activities dominate. Comparing this map with mean annual rainfall (p.5), the dependency of livelihood activities on climate can be observed. Predominantly agricultural zones are concentrated in areas of higher rainfall, generally corresponding to highland areas of Kenya and Ethiopia.

Pastoralist-dominated livelihood zones are concentrated in the arid parts of the region, where rainfall is insufficient or too irregular for crop production. This includes most of Somalia, northern Kenya and eastern Ethiopia. Rainfall in these areas is lower and often localised, and rainfall deficiencies may limit pasture growth for livestock, as well as water availability for communities and livestock - particularly those relying on surface water.[13] There are small agropastoral pockets in this arid region, including along river basins such as in southern Somalia.

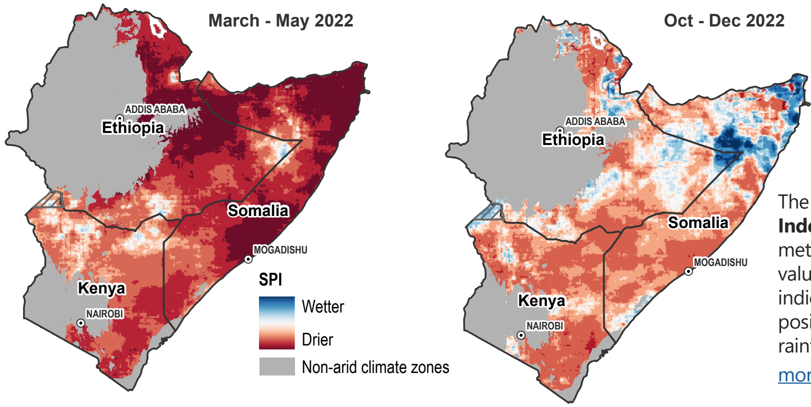
Livelihood zones involving fishing are located close to lakes such as Lake Turkana in Kenya, as well as coastal and riverine areas across the region. Riverine zones in southern Somalia are dependent on rains upstream in Ethiopia, where rainfall is higher.[14] Finally, some zones with mixed livelihoods are found in Kenya, such as along the Indian Ocean coastline, where in addition to crop and livestock production, livelihoods associated with casual labour and tourism are also common.[15]

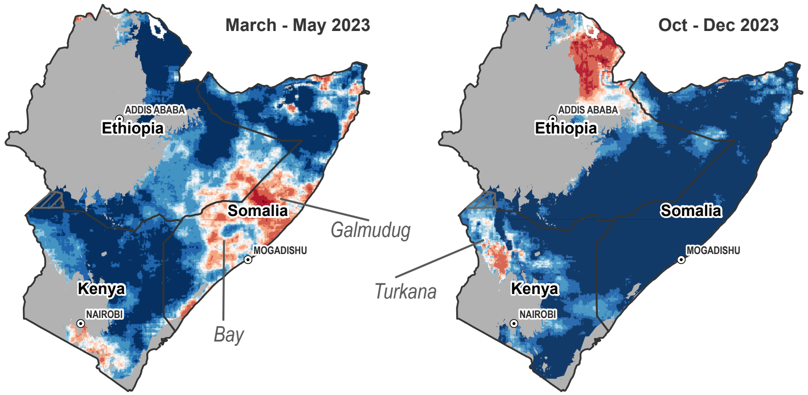
Both agricultural and pastoral livelihoods are particularly dependent on reliable rainfall patterns. Therefore, irregularity or insufficiency in rainfall due to dry spells and drought can result in devastating impacts on the livelihoods and resource access for all households relying on these livelihoods. Other factors, including diversification opportunities, and social and political capital, also affect the resilience of communities to drought.

For pastoral communities across the region, shifts in livelihood patterns have been observed as new opportunities for marketing and trade are opening up as a result of increased investment and improved infrastructure.[16] Pressures such as drought have also led to livelihood diversification and in Southern Kenya for example, diversification of livelihoods, which is seen as a climate change adaption strategy, has been observed at an increasing rate.[17] Much of the region has experienced a severe drought followed by flooding in recent years and is highly prone to climatic shocks, as outlined in the next section.

2.1. REGIONAL CLIMATE OVERVIEW: FROM DROUGHT TO FLOODS

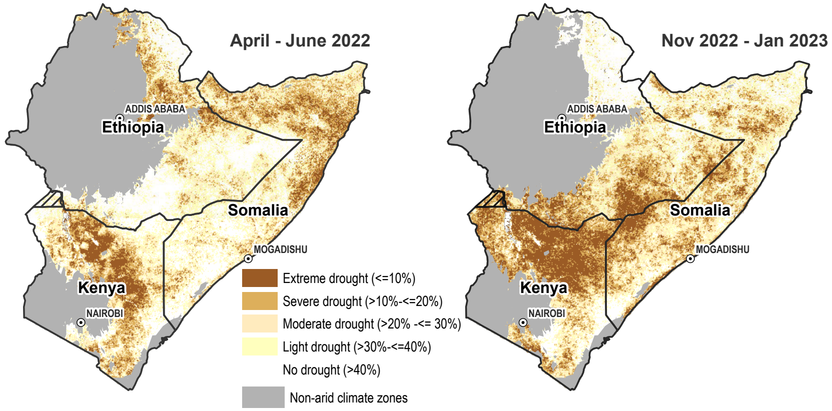
Fig. 8. SPI-3 in March-May (MAM) and October-December (OND) in 2022 and 2023. Highlights anomalously wetter and drier areas during the two rainy seasons in the HoA arid zone.

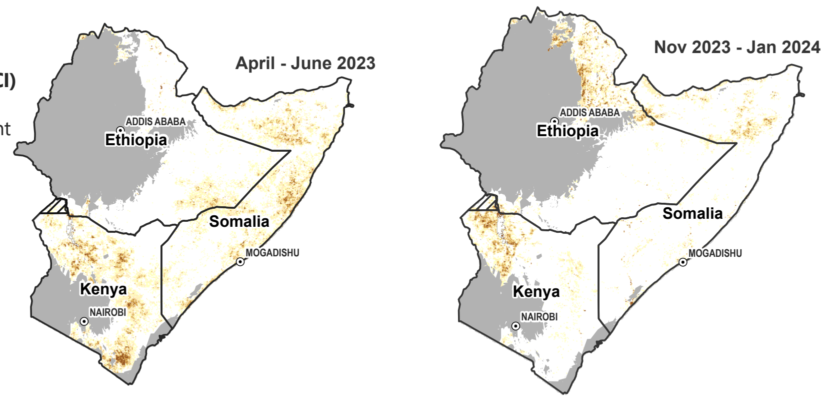




The **Standardised Precipitation Index (SPI)** highlights meteorological drought. Negative values (increasingly darker red) are indicative of drier conditions, whilst positive values indicate excess rainfall (increasingly darker blue). [See more info here.](#)

Fig. 9. VCI following the MAM and OND rainy seasons in 2022 & 2023 (April-June and Nov-Jan). Highlights impacts of rainfall performance on vegetation condition.





The **Vegetation Condition Index (VCI)** highlights agricultural or ecological drought (the latter would be important for pastoralists). The selected time periods account for the lag between rainfall and vegetation response. [See more info here.](#)

Fig. 8 shows the 3-month SPI (SPI-3) for March-May (MAM) and October-December (OND) in 2022 & 2023, the two main rainy seasons in the HoA arid zone (see p.5).[18] The maps indicate rainfall was mostly below average throughout 2022, when the region was still in the midst of the prolonged drought that had persisted since late 2020. Conditions were especially dry in the MAM season, but more mixed during the OND season.

Conditions shifted dramatically in 2023, when much of the region experienced above-average rainfall. However, rainfall in Somalia was mixed during the MAM season, with central areas including parts of Bay and Galmudug regions being relatively dry. Meanwhile, parts of Turkana and NE Ethiopia were relatively dry during the OND season.

As highlighted in the graphs on p.4, rainfall in selected locations was marginally higher during the 2023 MAM season, but significantly above average in the OND season. Graphs show rainfall was as much as 5 times above average in Baardheere during the OND season. Unusually high rainfall during the OND season exemplifies recent shifts observed in the HoA arid zone, with rainfall increasing in this season.[19]

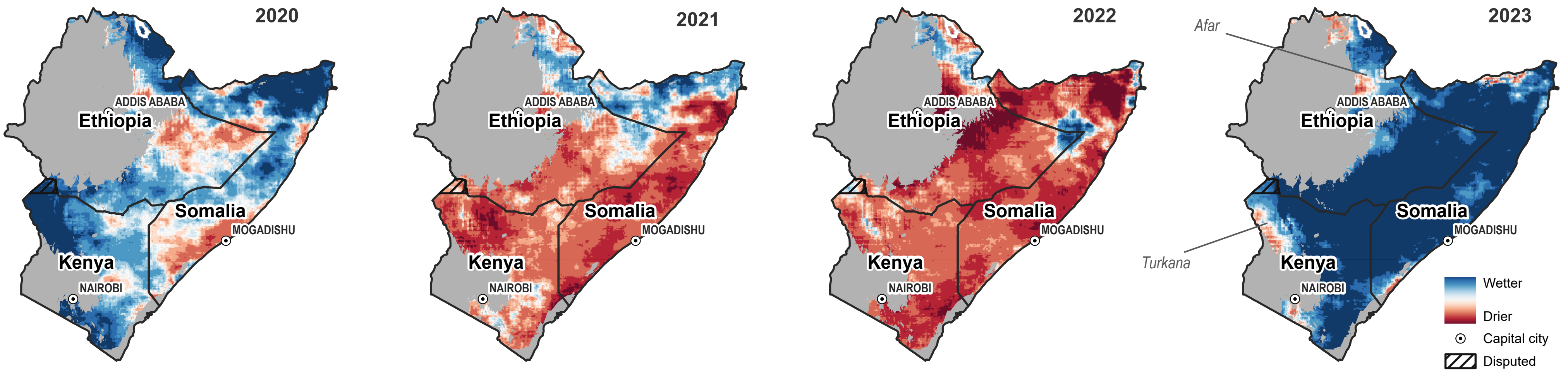
Whilst flooding occurred in both seasons in 2023, it was particularly severe in the OND season, when rainfall was excessively high. Flood severity was likely exacerbated by dry conditions in preceding years, degrading topsoil and reducing the land's ability to absorb water from heavy rains,[20] highlighting another impact of extreme climate variability.

Fig. 9 shows VCI following the two main rainy seasons in 2022 and 2023, providing insight into the impact of rainfall performance on vegetation condition. The data clearly shows large areas of the region were in severe and extreme drought in 2022, whilst conditions had improved following the high rainfall observed in 2023. However, parts of northwest Kenya and northern Somalia also remained in drought following both rainy seasons in 2023.

The majority of the region is inhabited by pastoralists and agropastoralists (see p.6). For agropastoral livelihoods, rainfall deficiencies during the growing season can be damaging to crop health, whilst floods can destroy crops. For pastoralists, rainfall deficits lead to lower water availability and may result in poor pasture, as well as atypical migratory movements, whilst floods may lead to livestock losses and increase disease risk. Impacts of climate shocks on livelihoods in areas assessed by REACH are explored from p.9-12.

2.2. REGIONAL CLIMATE OVERVIEW: LONG-TERM TRENDS

Fig. 10. SPI-12 in 2020, 2021, 2022 and 2023 across the HoA arid zone. Highlights medium to longer-term rainfall anomalies, which may have impacts on streamflow and groundwater storage.



Long-term rainfall anomalies

This page investigates longer-term trends, impacts, and potential causes of recent climate shocks in the HoA. In the long-term, extended droughts can impact soil moisture, as well as surface and groundwater availability, which can in turn have devastating effects on local livelihoods and drive displacement (see section 3.1).

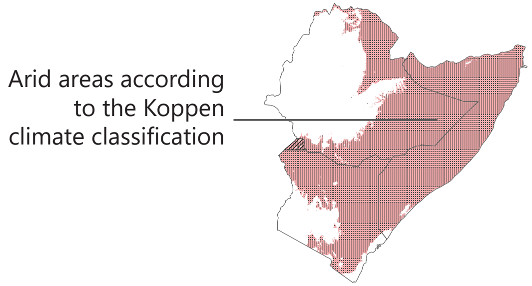
Fig. 10 shows the 12 month SPI (SPI-12) for the past 4 years, which is indicative of longer term rainfall anomalies. The maps show that very dry conditions prevailed across the majority of the HoA arid zone in 2021 and 2022, with the exception of northern areas of Ethiopia and pockets of northern Somalia.

As observed on p.7, patterns shifted to much wetter conditions in 2023 across much of the region. Fig. 10 shows that in the longer-term, only western Turkana and pockets of northern Ethiopia and Somalia remained drier than usual in 2023, despite the more extensive seasonal variability seen in the seasonal SPI maps (p.7). This shows that western Turkana (Kenya) and southwest Afar (Ethiopia) in particular remained in meteorological drought for 3 years or more, even following the main 2021-22 drought into 2023, potentially resulting in severe impacts on livelihoods and water access (more on the situation in Turkana on p.11).

Increasing climate variability

Research suggests that climate change has further exacerbated the likelihood, as well as the impact, of climate shocks and variability in the region. Conservative estimates suggest climate change has made droughts like the 2020-22 drought about 100 times more likely.[21]

Fig. 11 shows SPI-12 since 1980 and highlights recent drought and flood years. Inter-annual rainfall variability in the HoA is largely influenced by climate patterns such as the El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD).[22] ENSO is measured according to the Southern Oscillation Index (SOI), and years with a strong negative SOI (La Niña) correspond to the 3 most recent droughts. On the other hand, SOI entered a positive phase (El Niño) in 2023, coupled with a positive IOD, which correlate with the floods observed in 2023.



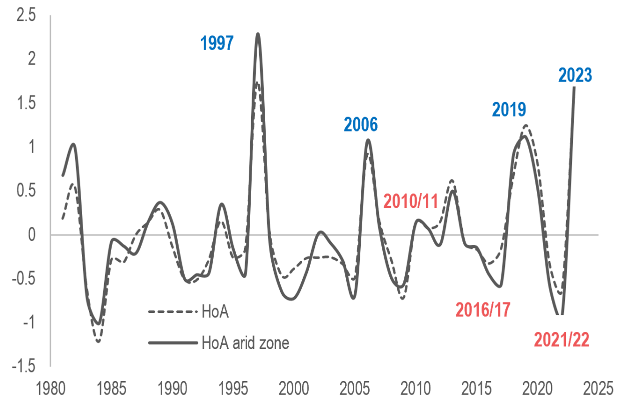


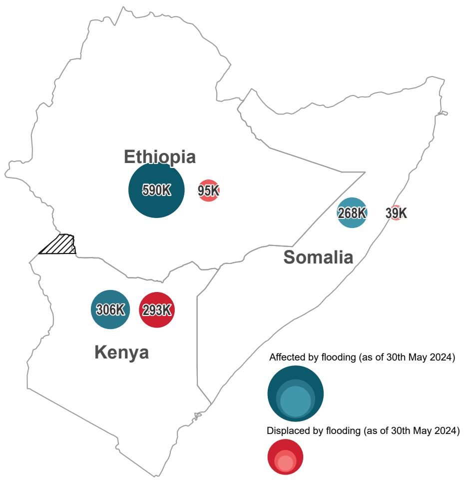
Fig. 11. Average SPI-12 across the Horn of Africa

2.3. FLOODING IN 2024 AND FUTURE OUTLOOK

2024 Gu /long rains flooding

According to OCHA, as of 30th May 2024, 1.16 million people had been affected by flooding across Kenya, Ethiopia and Somalia, including reports of over 500 deaths (Fig. 12).[23] Rainfall data also suggests that rainfall has been well above average in many areas of the region so far in 2024 (Fig. 13).

Fig. 12. Number of people affected / displaced by flooding as of May 30th, 2024.

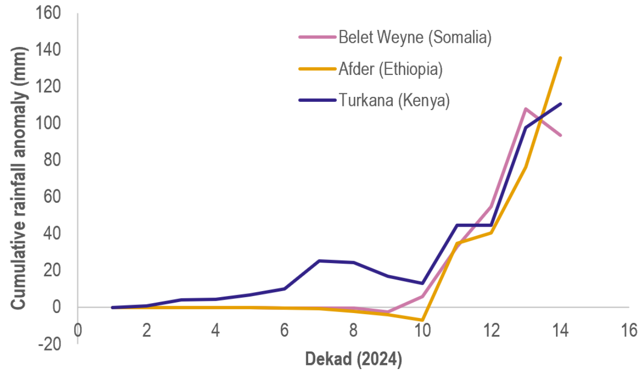


In Somalia, as of May 19th 2024, over 38K people had been displaced or relocated, and over 10.6K cholera cases had been recorded.[24] The worst affected districts were Belet Weyne (79K), Afmadow (60K) and Doolow (46K).[25] Much of the flooding, including in Belet Weyne was driven by high flow from upstream on the Shabelle river.

In Ethiopia, around 95K people had been displaced as of 24th May, with widespread crop damage and livestock deaths reported. The southeast of the country has been widely affected, including the southern areas of Somali along the Shabelle river, and the Dawa and Genale (which flow into the Juba river in Somalia).

The next pages investigate impacts of the 2023 flooding and longer-term impacts of the 2020-22 drought across the HoA, through the triangulation of primary data collection and remote sensing.

Fig. 13. Cumulative rainfall anomaly by dekad (10-day period) in selected areas of the HoA arid zone (1st Jan-20th May 2024)



How might climate change affect the likelihood and severity of climate shocks in future?

Rising temperatures, as indicated by climatic models,[30] will likely contribute to increased severity of droughts in future due to more rapid losses in surface water and soil moisture through evapotranspiration.[31]

Related to sea surface temperature anomalies in the Pacific and Indian oceans respectively, ENSO and IOD have global impacts on climate. Some research suggests that climate change may increase the intensity of La Niña and El Nino events in future,[32,33] which may influence the severity of future floods and droughts in the HoA.

Increases in quantity and intensity of rainfall during the OND season, as mentioned on p.7, may increase the likelihood of extreme flood events in future. On the other hand, increased rainfall intensity may benefit groundwater recharge across the region's drylands, providing potential opportunities for improved subsurface water access.[34]

Forecast

Fig. 14. Indian Ocean Dipole (IOD) forecast[26]

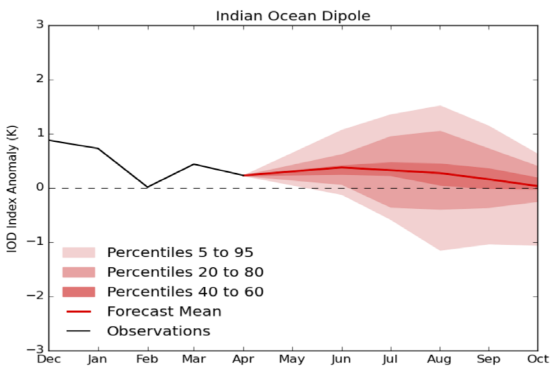
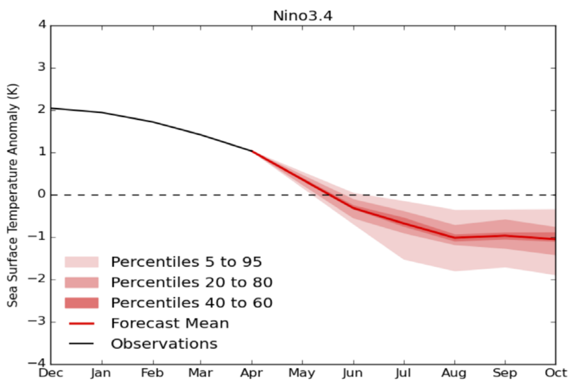


Fig. 15. Niño 3.4 forecast*[27]



At the time of writing in June 2024, the upcoming period corresponds to the dry season in much of the HoA arid zone. However, some areas of Eastern Africa, including central and northern Ethiopia, western and coastal Kenya are expected to receive above average rainfall between June and September.[28]

As mentioned, the high rainfall seen in 2023, as well as during the 2024 *Gu* season, was partly driven by the IOD and ENSO. As Fig. 14 shows, the IOD is expected to move towards a neutral state in the coming months, whilst Fig. 15 indicates that the ENSO is forecast to move towards a negative phase (La Niña) by the next rainy season (OND 2024). According to the Climate Hazards Center, La Niña has an 84% chance of developing by the OND season.[29] As mentioned, a strong La Niña has historically been associated with drought. Check ICPAC for seasonal forecasts for more updates.

*The Niño 3.4 is one of the most common indices used to define ENSO. Based on sea surface temperatures (SSTs), it represents the average equatorial SSTs across the Pacific from about the dateline to the South American coast.[35]

3.1 COUNTRY ZOOM-INS

This section zooms in to various locations within the Horn of Africa arid zone as defined by the Koppen climate classification. This zone, highlighted on p.5 has been the focus of this report. This zone is characterised by similar environmental and climatic conditions, as well as similar livelihoods (Fig 7), stretching across the three countries of Kenya, Somalia and Ethiopia.

Primary data was collected by REACH from various assessments in the three countries to help understand the occurrence, severity and impacts of climatic shocks in different parts of the region, as shown on Fig. 16. These assessments use both household and key informant (community-level) data collection techniques. This information has been triangulated with remote sensing data in this exploratory analysis. Case studies within this section show some relationships that can be drawn between primary data collection and remote sensing, highlighting some of the benefits (and limitations) of how these information sources can be triangulated to understand climatic shocks and impacts in the region.

In addition, by zooming into different locations across the three countries within this zone, which shares many climatic, environmental and socioeconomic characteristics, some of the similarities and differences in climatic conditions and potential impacts on communities across the region can be understood. This highlights the importance of considering climatic zones in programming, which in this case extend across multiple international boundaries.

The **Impact of Drought and Climate-Related Shocks on Livelihood Practices in Somali** assessment collected HH data on the impacts of the 2023 *Deyr* flooding and long term impacts of drought on livelihoods in 9 zones of Somali region. See [p.21 for more info on methodology.]

Photo: ACTED

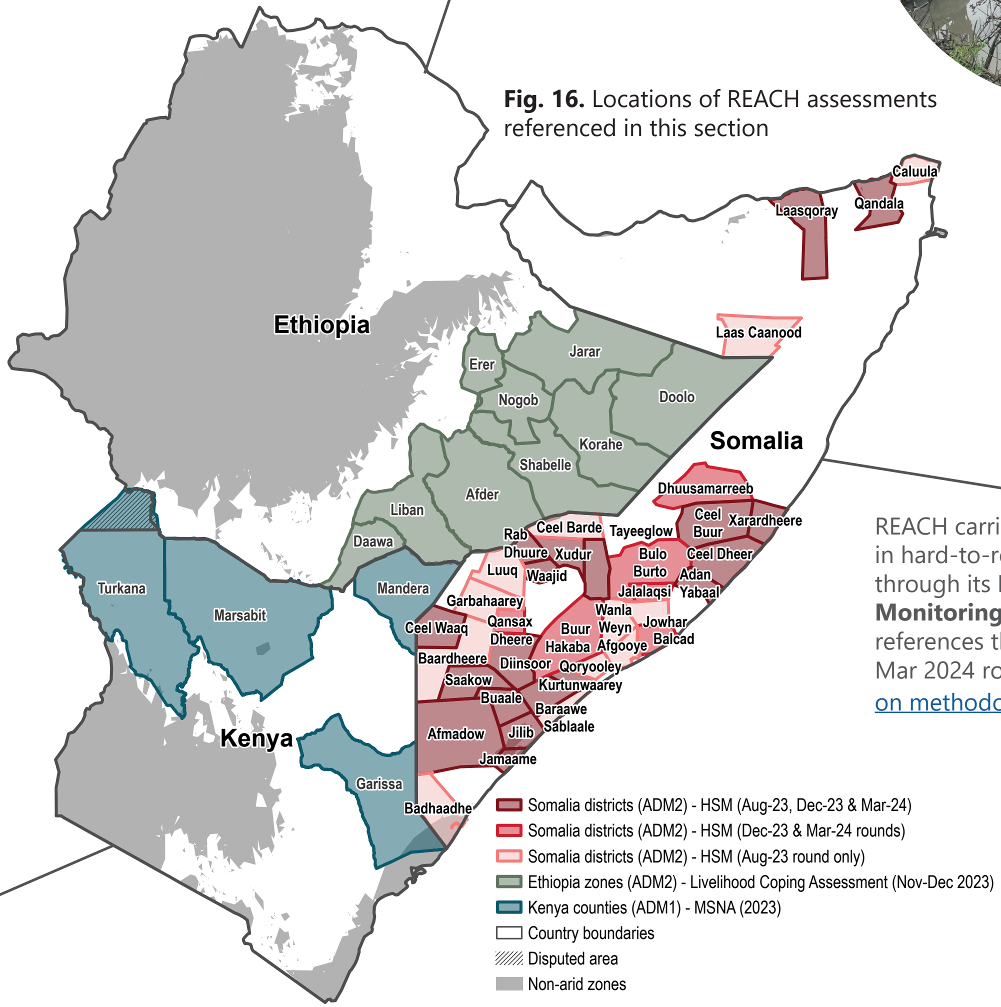


Fig. 16. Locations of REACH assessments referenced in this section

REACH carries out regular assessments in hard-to-reach districts of Somalia through its **Humanitarian Situation Monitoring (HSM)** activities. This report references the Aug & Dec 2023 plus the Mar 2024 rounds. See [p.21 for more info on methodology.]

REACH undertook a household-level **Multi-Sectoral Needs Assessment (MSNA)** in 4 counties within the arid and semi-arid lands (ASAL) of Kenya in May/June 2023 [p.21 for more info on methodology.]

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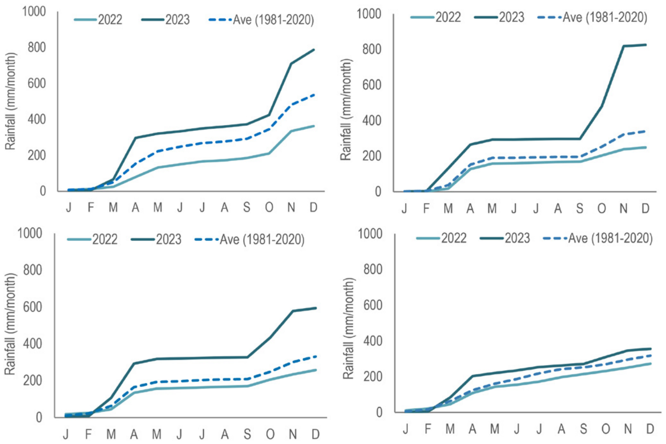
3.2 KENYA ZOOM-IN

On the following 3 pages, we zoom into the situation in Kenya, using remote sensing and primary household (HH) data from REACH's mid-2023 Multi-Sectoral Needs Assessment (MSNA) undertaken in Turkana, Marsabit, Garissa and Mandera counties, to correlate satellite-observed climatic patterns with the reported situation on the ground. As of May 2023, MSNA data suggested despite above-average rainfall during the 2023 long rains (Fig. 17), longer term impacts of the 2020-22 drought were still adversely affecting food security and livelihoods. This was reportedly driven by factors such as reductions in livestock, smaller cultivation areas due to lower purchasing power, and high food prices.

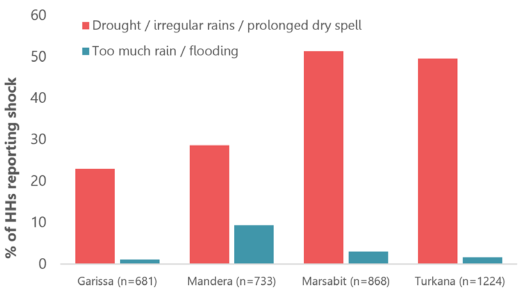
At the time of data collection, drought was most frequently reported in Marsabit and Turkana, including by 76% of HHs in Turkana South and 70% in Turkana East. Turkana was one of the worst affected areas by the 2020-22 drought, and was projected to reach Phase 4 for Acute Food Insecurity (AFI) as of March 2023.[36] Food consumption was also very poor in Turkana, with up to 17% having a poor food consumption score (FCS). In addition, large areas of the county, particularly in Turkana South and East, were significantly drier than average during the 2023 *short rains*, and overall the county was only slightly wetter than average in 2023 (Fig. 17d). Water insecurity was also poor in some areas, with Mandera having the highest proportion of water insecure HHs (27%).

Fig. 17: Rainfall trends by county: (a) Garissa, (b) Mandera, (c) Marsabit, (d) Turkana. Source: CHIRPS.



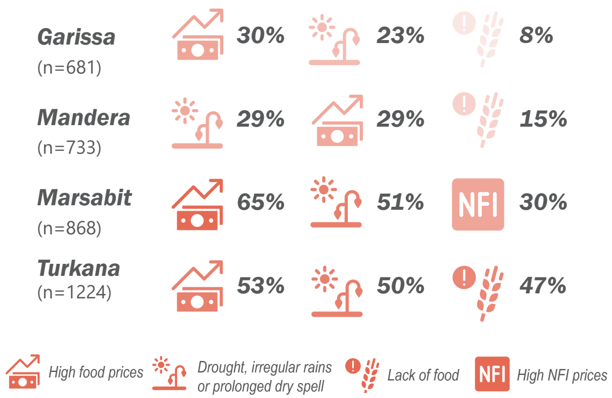
In general, the 2023 short rains performed well (Fig. 17). However, the March 2024 IPC AFI analysis suggested this was offset by widespread flooding (see right), and as such, much of the ASAL would remain in Phase 3 until March 2024,[37] after which food security was projected to improve to Phase 2.

Fig. 18: climatic shocks reported in past 3 months, as of May 2023 (REACH MSNA)*



*Values are % of those HHs reporting shocks (total #HHs reporting shocks indicated by "n=")

Fig. 19: most common shocks or challenges reported in past 3 months, as of May 2023 (REACH MSNA)*



Flooding in Kenya, 2023

Following five failed rainy seasons between 2020-22, rainfall was conversely well above average in 2023 (Fig. 17), particularly during the short rains when flooding was widespread. Floods in late 2023 resulted in over 170 fatalities, displaced half a million people, destroyed infrastructure, and led to livestock deaths and extensive cropland damage.[38] These impacts were compounded by the impacts of the protracted drought. The northeast of the country was worst affected, including Garissa and Mandera counties.

Some flash flooding occurred during the long rains in 2023, and was most frequently reported in Mandera (Fig. 18), although the most severe flooding was observed during the short rains (Fig. 20). As the graphs show (Fig. 17), rainfall was significantly higher than average during the short rains, exceeding 135% above average in Mandera by the end of 2023.

Fig 20: Flood extent in Kenya as of November 2023

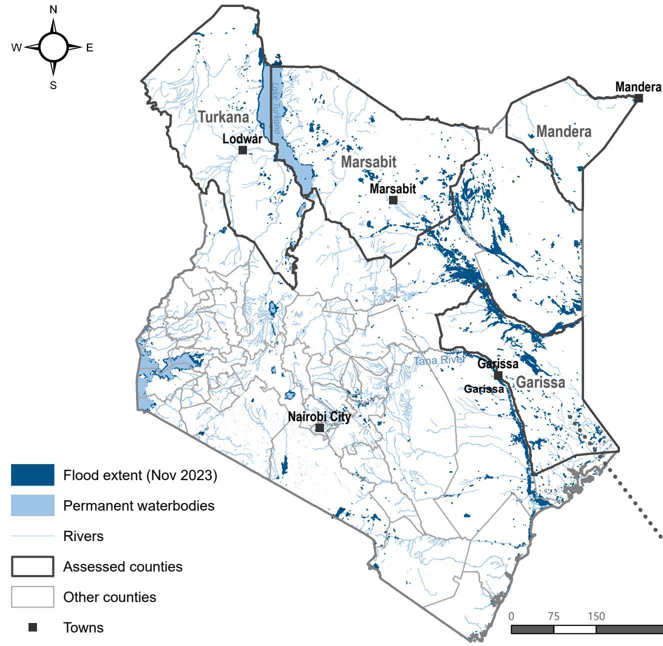
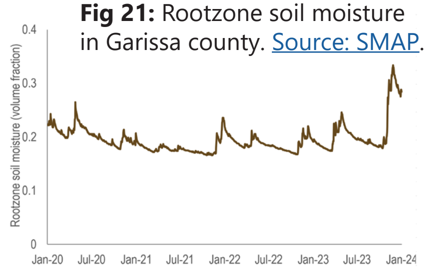


Fig. 21 shows that soil moisture was elevated in 2023, particularly around the Deyr season, increasing the susceptibility to flooding due to ground saturation.

Did the prolonged drought increase flood susceptibility in 2023?

The impacts of flooding were likely exacerbated by the years of drought, degrading the topsoil and increasing runoff.[39] For example, a high proportion of households in Mandera West and South widely reported both floods and drought as shocks affecting them in the past 3 months.

Fig 21: Rootzone soil moisture in Garissa county. Source: SMAP.



3.2 KENYA ZOOM-IN: TRIANGULATING HOUSEHOLD DATA AND REMOTE SENSING

The following 2 pages investigate what remote sensing can tell us about potential humanitarian conditions by comparing remote sensing indices with HH data (from the mid-2023 Kenya MSNA introduced previously) on reported climatic shocks, as well as the Food Consumption Score (FCS) and Household Water Insecurity Experiences Scale (HWISE), which indicate HH-level food and water security. This has been done separately for HHs within pastoral and agropastoral livelihood zones. These are the 2 main livelihood zones in the assessed counties (see p. 6). Locations and livelihood zones of assessed HHs are shown in Fig. 22. Note that livelihood zones are those as reported by the enumerator when conducting the survey.

Comparing remote sensing with reported climatic shocks

As previously mentioned, MSNA data indicated drought was widely reported as a shock affecting HHs in the 3 months prior to data collection in mid-2023 (38%), whilst 3.8% of assessed HHs reported flooding (up to 9.6% in Mandera). Flooding was more reported in pastoral livelihood zones.

When comparing agropastoral HHs who reported drought with the Vegetation Condition Index (VCI) in the 5km* around their HH (for the same period, accounting for a 1 month delay in vegetation response after the start of the rains), the median VCI around HHs reporting drought was 0.06 lower (Fig. 23b). This indicates that as might be expected, vegetation in the area surrounding agropastoralist HHs reporting drought was in poorer condition compared to those not reporting. There is not a strong relationship however for HHs within pastoral livelihood zones (Fig. 23a), which could be due to their nomadic lifestyle, whereby pastoralists may have moved within the 3-month recall period in search of pasture and water, meaning the 5km buffer used for RS analysis may not relate to the area they have utilised during this period (see p.22).

In terms of flooding, there are more limited data points, but the data shows that those HHs in pastoral livelihood zones reporting flooding have a median VCI that is 0.09 higher (Fig. 24a). Again this is the expected trend as it indicates healthier vegetation due to the excess moisture resulting from the flooding. This may be related to the fact that pastoral HHs are more likely to move to areas with more water, such as riverine areas. For agropastoralist HHs, flooding was not widely reported and there is no clear relationship with VCI (Fig. 24b).

Fig. 22. Assessed HHs by reported livelihood zone (REACH MSNA, Kenya, 2023)

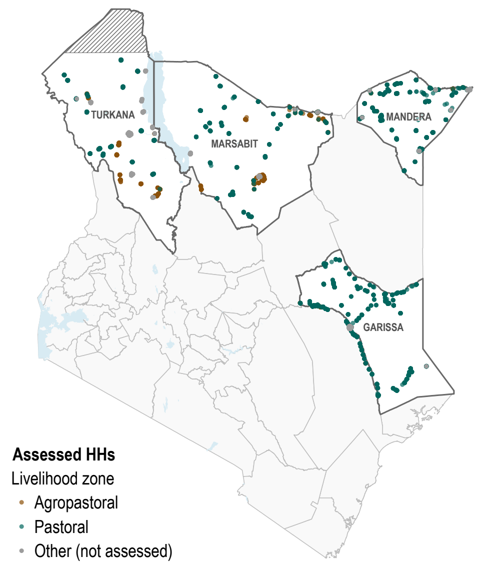


Fig. 23 - Drought: HHs mentioning drought as a shock affecting them in the three months prior to data collection (as of May/June 2023) vs VCI in AMJ 2023.

(a) Pastoral (n=2092) **(b) Agropastoral** (n=900)

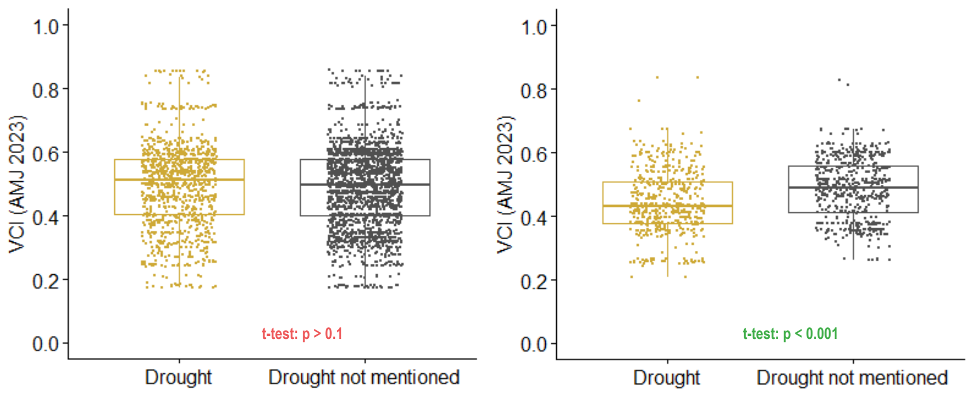
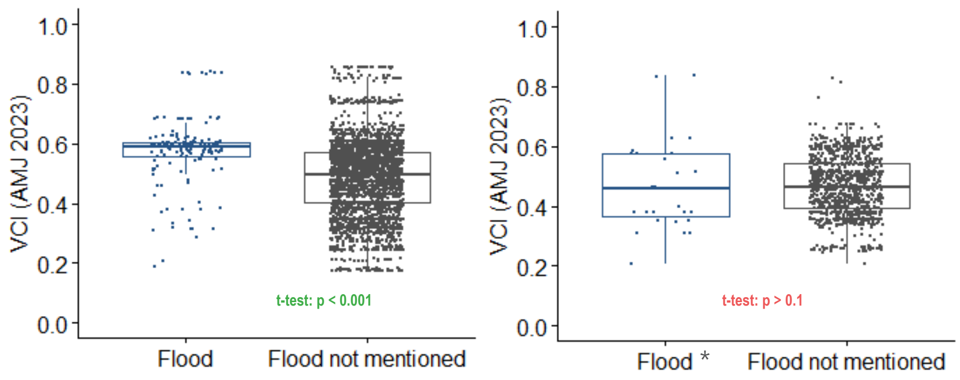
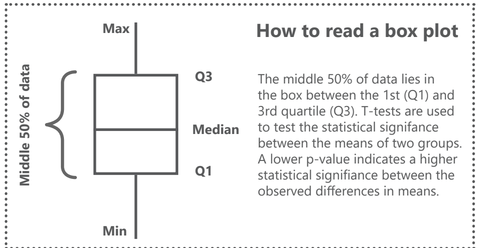


Fig. 24 - Flooding: HHs mentioning floods as a shock affecting them in the three months prior to data collection (as of May/June 2023) vs VCI in AMJ 2023.

(a) Pastoral (n=2092) **(b) Agropastoral** (n=900)



*Limited data points (n=17)



*Various buffer zones were tested. However, 5km was selected as most suitable due to the distance from HHs to nearby agricultural areas and other natural vegetation areas potentially used by pastoralists.

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3.2 KENYA ZOOM-IN: TRIANGULATING HOUSEHOLD DATA AND REMOTE SENSING (CONT.)

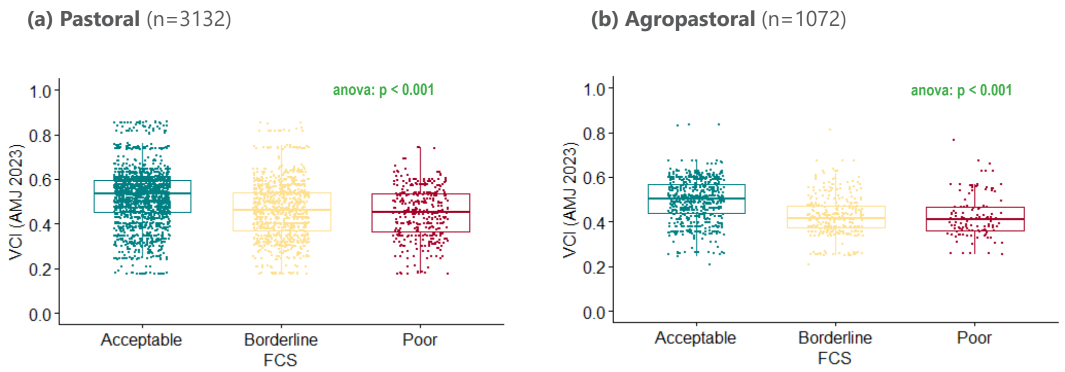
Food Consumption Score (FCS)

The FCS is a commonly used food consumption outcome indicator by food security actors. The score is calculated by asking questions about the frequency of consumption of various food groups in the past 7 days, and provides an estimate of dietary diversity and food consumption frequency, categorised as poor, borderline, or acceptable.[40]

Here, FCS category is plotted against VCI between April and June. The data indicates that for both pastoral and agropastoral HHs with acceptable FCS, the median VCI in the surrounding area is 0.08 and 0.09 higher than those with borderline FCS (indicating healthier vegetation around the HHs with acceptable FCS). Whilst the median VCI for HHs with poor FCS is lower than for borderline, although the difference is marginal.

Whilst there is more spread in the data for pastoral HHs, the trend is not too dissimilar to agropastoral areas, potentially indicating that the 7-day recall period used in calculating the FCS may mean that the 5km-buffer analysis area better represents movements of pastoralist HHs during this period, as compared with the longer (3-month) recall period used when asking about climatic shocks on the previous page. Note that these findings have not accounted for other potential contributing factors (more in Limitations, p.22).

Fig. 25: FCS category by HH (from REACH MSNA, May/June 2023) vs VCI in AMJ 2023.



HH Water Insecurity Experiences Scale (HWISE)

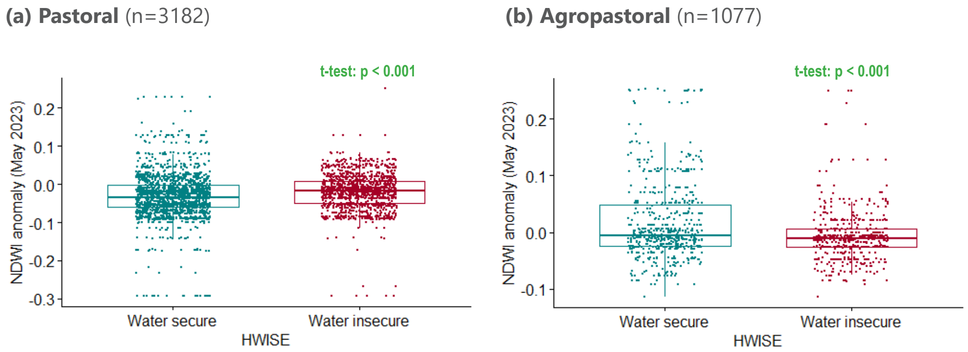
The HWISE scale quantifies experiences of HH water insecurity through a series of questions about frequency of experiences with common water-related disturbances. The index can be divided into water secure and water insecure HHs.[41]

Here, the HWISE for assessed HHs has been plotted against NDWI anomaly, which provides an estimation of vegetation water content and can give an indication of surface water availability. The graphs show that for pastoral HHs, there is a marginally higher NDWI anomaly for water insecure HHs (suggesting higher surface water availability / vegetation moisture content). This might suggest that pastoral HHs have moved to areas with more water access within the 4-week recall period, but the results should be interpreted with caution as we do not know the precise movement patterns of pastoral HHs during this period (more in Limitations, p.22).

For agropastoral HHs on the other hand, water insecure HHs clearly have a lower NDWI anomaly, indicating drier conditions with less surface water availability. This shows that HHs with lower NDWI anomaly in the surrounding area may be more likely to be water insecure. Note that these findings have not accounted for other potential contributing factors (more in Limitations, p.22).

The Normalised Difference Water Index (NDWI) highlights vegetation water content and gives an idea of moisture availability. A high NDWI anomaly may suggest environmental conditions indicative of high surface water availability or waterlogging, whilst a lower anomaly may suggest drought conditions.

Fig. 26: HWISE category by HH (from REACH MSNA, May/June 2023) vs NDWI anomaly in May 2023, at the end of the long rains season.



See more results in Appendix 1, which includes additional representations of this data, reinforcing these findings. In addition, indicators have been compared with SPI-3 and SPI-24.

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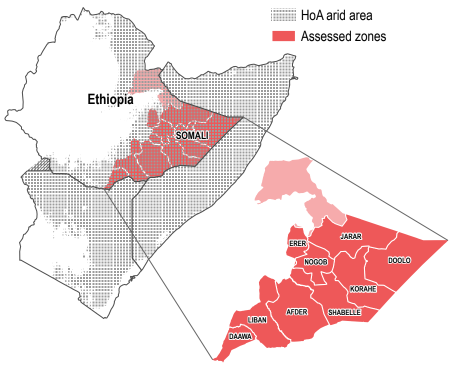
3.3. ETHIOPIA ZOOM-IN

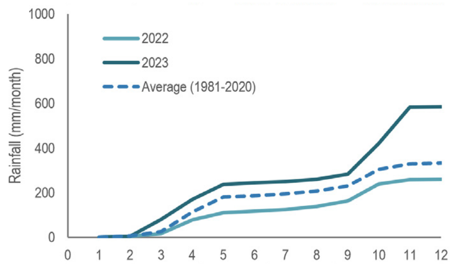
Eastern and southern Ethiopia, including the whole of the Somali region lies within the HoA arid zone (Fig. 5), which shares similar climatic conditions to adjoining areas of neighbouring Somalia and Kenya. This page focuses on 9 of the 11 zones of the Somali region that were assessed as part of REACH`s [Impact of Drought and Climate-Related Shocks on Livelihood Practices in Somali] assessment conducted at the end of the 2023 *Deyr** rainy season (Fig. 27).

Fig. 27: Assessed zones, Ethiopia. Shown within the HoA arid zone.



Recurrent droughts have had a devastating impact on livelihoods in the region in the past 4 years, with historically high acute food insecurity. Fig. 28 shows cumulative rainfall patterns in 2022 and 2023 against the long-term average, indicating below-average rainfall in 2022, and significantly above-average rainfall in 2023, particularly in the *Deyr* season. Overall, climate patterns in the Somali region broadly align to those in other parts of the HoA arid zone in neighbouring Kenya & Somalia (p.6).

Fig. 28: Rainfall trends in Somali, Ethiopia

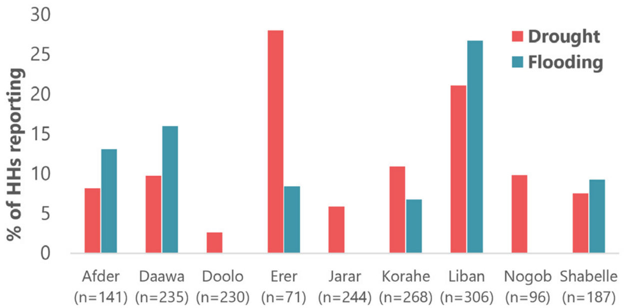


Reported climatic shocks

Across assessed zones, 41% of HHs reported experiencing a shock in the 3 months prior to data collection. Unusually high food prices were most frequently reported (18%), followed by loss/ reduced employment (13%), and too much rain/flooding (11%). Flooding was the most reported climatic shock, whilst drought/irregular rains/prolonged dry spell was reported by 10% of HHs. As Fig. 29 shows, flooding was most frequently reported in Liban, Daawa and Afder. A number of rivers flow through these zones, which flow into the Juba river downstream in Somalia. Flooding was also reported frequently in Shabelle, Erer and Korahe, which lie in the Shabelle basin and also flows downstream into Somalia. However, the lower frequency of reports here indicates flooding may have been less extensive on the Shabelle.

Whilst drought was only reported by 10% of HHs across all assessed zones, 28% reportedly experienced drought in Erer, followed by 21% in Liban. In the case of Liban, a similar proportion of respondents reported both drought and flooding. This was a similar situation in Afder, Dawaa, Korahe and Shabelle, and likely indicates mixed or uncertain climatic conditions during this period.

Fig. 29: % of HHs reporting different climatic shocks by assessed zone in Somali, Ethiopia, of those reporting shocks (indicated by "n=").



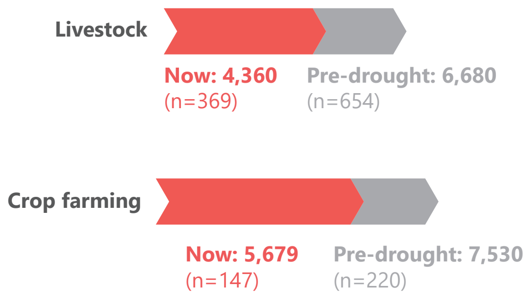
Impacts of Deyr floods on livelihoods

Heavy rainfall during the 2023 *Deyr* season resulted in flooding which significantly impacted food stocks, agricultural land, livestock, shelter and main water sources. Many of the pastoralists' herds reportedly died due to the lack of water and pasture, while agricultural production also declined, thus leading to reductions in households income up to 35% for pastoralists and 25% for crop farmers. Overall, 53% of HHs reported having lower income during the month prior to data collection compared to 2020, before the drought. Whilst drought may have been a contributing factor, other factors such as COVID-19 may have also had an influence.

Accumulation of shocks and long-term impacts of the drought

Fig. 30 indicates that HHs whose primary reported source of livelihoods was livestock, as well as those who reported crop farming, both experienced a reduction in income since the start of the drought in 2020. This may reflect long term impacts of the drought, as well as broader vulnerabilities of communities to climatic and economic fluctuations.

Fig. 30: Difference in income pre-drought (2020) and at time of data collection (Dec 2023), by primary reported source of livelihoods



Pastoralist livelihoods relying on livestock rearing as their primary income source are predominant in Somali, but findings indicate a significant decline in livestock ownership since the beginning of the drought, from 43% of HHs reported owning livestock in 2020 to just 18% in December 2023. *Deyr* floods also reportedly led to further livestock losses, and among the 23% of HHs who reported having been affected by the floods, 32% reported the loss of half or more of their herd, including 9% reporting the loss of their entire herd.

The accumulation of shocks further reduced the resilience and recovery of HHs, particularly in Daawa, Liban and Afder, as well as of displaced households. Whist in the past, Ethiopian pastoralist communities have employed various coping mechanisms to counteract the effects of drought, compounding challenges of conflict and extreme flooding triggered by El Niño are straining the resilience of communities. In addition, as of November 2022, at least 308K IDPs were registered in Somali region since the start of the prolonged drought in late 2020,[42] whilst food price inflation, and disease outbreaks such as cholera have further impacted communities.[43]

*In this region, the seasons are named the same as across the border in Somalia, with the *Gu* season roughly falling between March-May/early June and the *Deyr* season roughly falling between late September and early December.

3.3. ETHIOPIA ZOOM-IN: TRIANGULATING HH DATA AND REMOTE SENSING

As with the Kenya zoom-in, this page compares various indicators from primary data collected by REACH with relevant remote sensing indicators in a buffer zone surrounding these HHs.* Specifically, primary data from the REACH livelihood coping strategies assessment introduced on the previous page has been used in this analysis.

Whilst the Kenya example used primary data from the 2023 *Gu* season, this example uses data from the 2023 *Deyr* season. As outlined previously, this period was much wetter than average, with flooding reported in many areas, particularly in riverine areas. The data has again been disaggregated by livelihood zone, but in contrast to the Kenya analysis, where the reported livelihood zone was used for disaggregation, in this case the zone has been obtained from the 2018 livelihood zone shapefile from FEWSNET.

Comparing remote sensing with reported climatic shocks

Figs 31-32 compare HHs that reported being affected by climatic shocks, specifically flooding and drought, in the 3 months prior to data collection, with the 3-month SPI (SPI-3) in the HH vicinity for October-December 2023 (broadly aligning with the *Deyr* season and the approximate recall period of this HH indicator). Relationships between this indicator and other RS indices such as VCI were also explored (see Appendix 2), but in this case the 3-month Standardised Precipitation Index SPI-3 seemed to be the most promising. This may be because the assessment was undertaken during the height of the rainy season (November/December) and the timeframe of the SPI provides a more current snapshot of climatic conditions, whilst vegetation indices such as VCI require a lag to be accounted for to allow time for vegetation response, and therefore may not as adequately relate to the recall period of the question. There is quite a bit of spread in the SPI data, which could be attributed to the low resolution and uncertainty of the input rainfall data.

For drought, Fig. 31a shows that there is not a strong relationship with SPI3 for pastoral HHs. As with the Kenya example when comparing VCI, this is likely due to the difficulty in defining an analysis area for calculating RS indices due to the nomadic lifestyle of these communities (see p.22). For agropastoral HHs on the other hand, there is a clearer relationship whereby lower SPI is associated with reported drought conditions.

With flooding on the other hand, the relationships between reported flood shocks and SPI-3 are more significant (p<0.001). Agropastoral HHs reporting flooding have a median SPI3 0.44 higher than for those not reporting flooding, whilst the difference is 0.25 for pastoral HHs. However, because we do not have information on precise movements of pastoral HHs within this timeframe, this data should be interpreted with caution. In addition, in the case of flooding, other factors such as upstream rainfall may also be causal factors in riverine areas. This highlights the need to account for all contributory factors when assessing shocks using remote sensing.

Fig. 31. Drought: HHs mentioning drought as a shock affecting them in the three months prior to data collection (as of Nov/Dec 2023) vs SPI3 in OND 2023.

(a) Pastoral (n=1727) **(b) Agropastoral** (n=654)

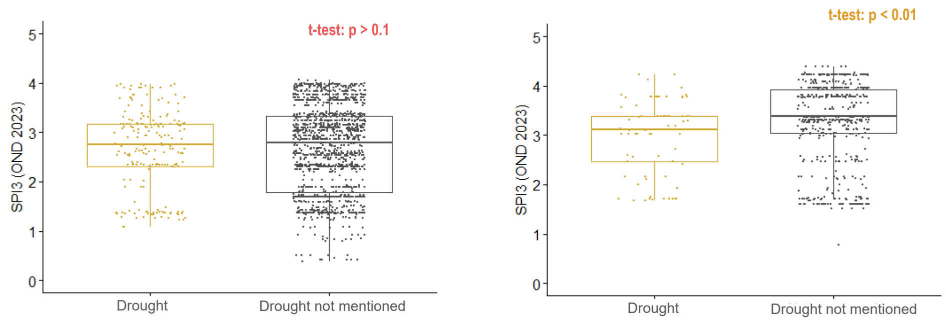
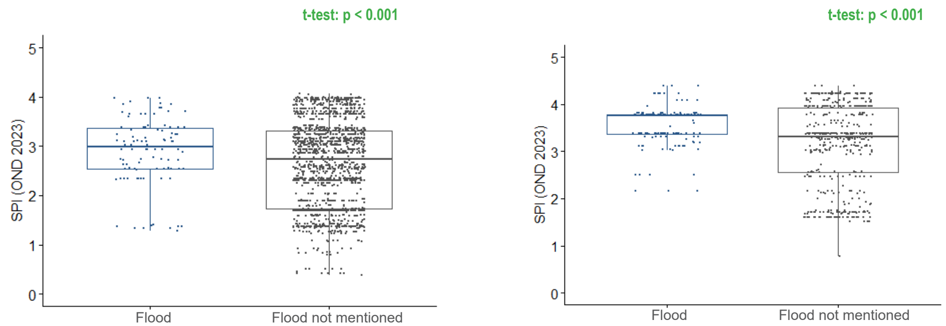
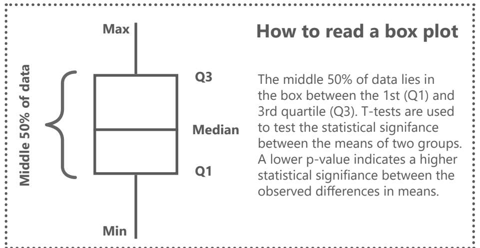


Fig. 32. Flooding: HHs mentioning flooding as a shock affecting them in the three months prior to data collection (as of Nov/Dec 2023) vs SPI3 in OND 2023.

(a) Pastoral (n=1727) **(b) Agropastoral** (n=654)





*A 5km buffer zone was selected for HHs, except for SPI, where a 10km buffer was selected to mitigate for the lower resolution of the CHIRPS dataset and lower accuracy of rainfall data compared to environmental indices.

3.3. ETHIOPIA ZOOM-IN: TRIANGULATING HH DATA AND REMOTE SENSING (CONT.)

Long-term impacts

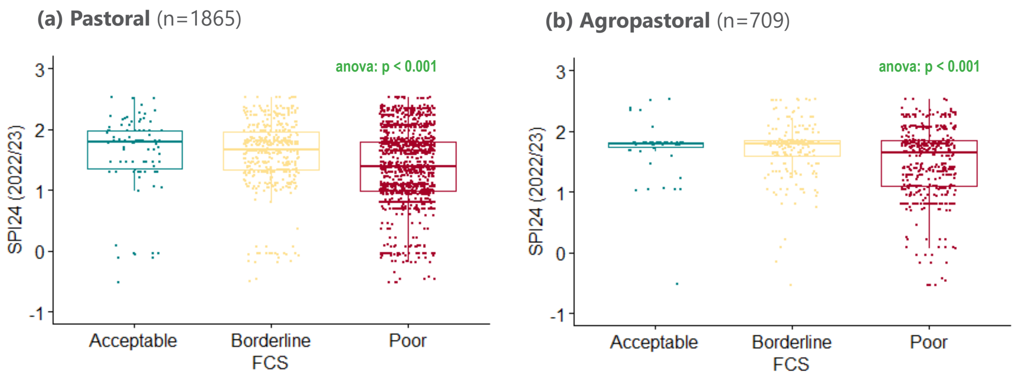
In addition to the short-term impacts of the 2023 *Deyr* floods, the preceding drought which extended from late 2020 to late 2022 and even early 2023 in some parts of the region had longer term impacts on livelihoods. For pastoralists, 28% of assessed households reported a reduction in livestock owned compared to prior to the drought in 2020, whilst for agropastoralists, 6% of the households reported primarily relying on this activity to sustain their livelihoods compared to 10% pre-drought.

Food Consumption Score

To help understand what long-term lack of rainfall might tell us about the current food consumption situation, FCS has been compared with the 24 month SPI (SPI-24) for the 2022-23 period. Over this timeframe, SPI is indicative of potential reductions in groundwater storage and streamflow.[44] You will notice that most HHs have a positive SPI value, indicating that rainfall has been above normal over much of the area over the past two years. Much of this could be attributed to the excess rainfall observed during the 2023 *Deyr* season, offsetting the lack of rainfall observed for the preceeding part of this period.

The data shows that poor FCS is generally associated with lower SPI, particularly for pastoral households, where the median SPI24 is 0.27 lower than for HHs with borderline FCS. This might suggest these HHs are located in areas of lower productivity, although it is important to note we do not know precise movements of pastoral HHs during the recall period. For agropastoral HHs, there is a narrower range in SPI values for HHs with borderline and acceptable FCS, but these are generally associated with areas that have received more rainfall over the 2-year period (higher median SPI-24), whilst HHs with poor FCS have marginally lower median SPI24, indicating drier conditions.

Fig. 33. Food Consumption Score (FCS): HHs by FCS category vs SPI-24 (2022-23) in 10km buffer around HH. Note the lower median SPI-24 for HHs with a poor FCS, potentially indicating long term impacts of lower rainfall in 2022-23 on food security for these HHs.

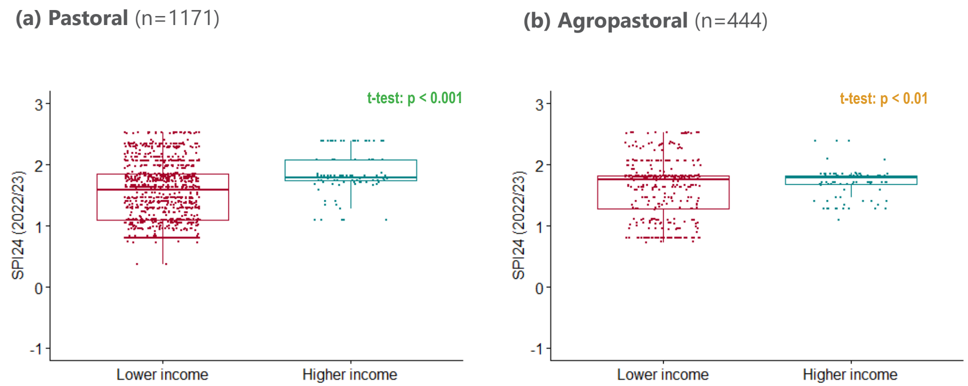


Income change

By comparing reported changes in income from before the drought with the SPI-24, the data suggests that a reduction in income is associated with a lower SPI-24, i.e. drier conditions over the last 2 years. Those reporting their income had increased on the other hand were generally associated with higher SPI-24, indicating their area had received comparatively more rainfall in the past 2 year period.

This trend can be observed for both pastoral and agropastoral HHs, but is particularly pronounced in pastoral livelihood zones, potentially indicating that poor rainfall performance had a greater impact on income for these HHs. Median SPI-24 is 0.2 higher for pastoral HHs reporting higher income. Considering that pastoral HHs may have moved during this period, it could also indicate a relationship between the higher productivity of the area they have moved to (indicated by the higher SPI) resulting in improvements in livestock condition and therefore income. However, it is again important to caveat that we do not know the precise movements of pastoral HHs within the recall period, which may have extended beyond the analysis buffer zone. For HHs in agropastoral livelihood zones, the data suggests that HHs in areas that have received comparatively more rainfall, likely resulting in improved productivity, have observed increases in income since the start of the drought.

Fig. 34. Income change: HHs who reported an increase or decrease in their income in December 2023 compared to before the drought in 2020 vs SPI-24 (2022-23) in 10km buffer zone around HH. Note the lower median SPI for HHs reporting their income was lower than since before the drought, indicating a potential relationship between rainfall performance and income change.



More results in Appendix 2, which includes additional representations of this data. Also note that these findings have not accounted for other potential contributing factors (more in Limitations, p.22).

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3.4. SOMALIA ZOOM-IN

According to the Notre Dame Global Adaption Initiative (ND-GAIN) index, Somalia is the second country in the world most vulnerable to climate change.[45] This zoom-in references data from [REACHs HSM assessments](), conducted with key informants on a quarterly basis in hard-to-reach districts of Somalia. As shown in Fig. 35, the most common shocks experienced in the past year, as reported in these assessments, were all climatic. This shifted from drought in August 2023 to flooding in both December 2023 and March 2024. However, drought also remained a considerable shock during these data collection cycles, being the third and second most reported shocks respectively in these months.

Somalia experiences two rainy seasons: the *Gu* season (mid-March to June), when around 75% of rainfall occurs; and the *Deyr* season (mid-September to November/December), when the remainder of rainfall occurs.[46]* However, in 2023, *Gu* rainfall was generally only a little over average, whilst the *Deyr* season experienced an exceptional amount of rainfall, reaching as much as 142% above average in Luuq by the end of 2023. This aligns with an observed trend in recent years where rainfall is increasing during the *Deyr* season and decreasing during the *Gu* season.[47] Flooding occurred during both seasons, with the most severe occurring during the *Deyr* season (see next page).

The August 2023 IPC AFI[48] analysis suggested that the prolonged drought across the Horn of Africa that hit in late 2020 was still adversely affecting livelihoods in early 2023, and milk availability remained low for pastoral livelihoods due to poor livestock body condition. Meanwhile, the erratically distributed rainfall during the 2023 *Gu* season adversely affected crops, whilst riverine flooding further affected crops and damaged irrigation pipes.

According to REACH's August 2023 HSM assessment, KIs in 70% of assessed settlements claimed that 2023 *Gu* crop yields were much lower than normal, primarily due to lack of surface water (65%), lack of rain (57%) and high temperatures (56%). However, in Luuq, flooding was reported as a cause by KIs in 69% of settlements.

As mentioned, during the *Deyr* season, rainfall was well above average, marking the end to the meteorological drought across the region. However, widespread flooding outweighed many of the potential benefits (see next page).

Fig. 35: most common shocks reported by KIs in past year, by % of settlements (REACH HSM)

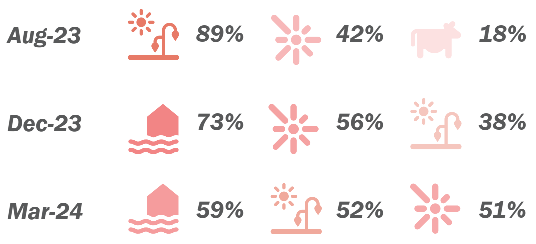
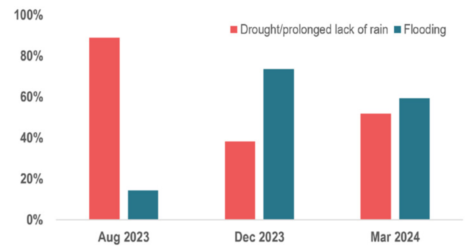


Fig. 36: % of assessed settlements in which KIs reported climatic shocks (REACH HSM)



REACH HSM, August 2023

KIs in 38% of assessed settlements claimed that there had been a large decrease in livestock for most HHs in the 3 months prior to data collection

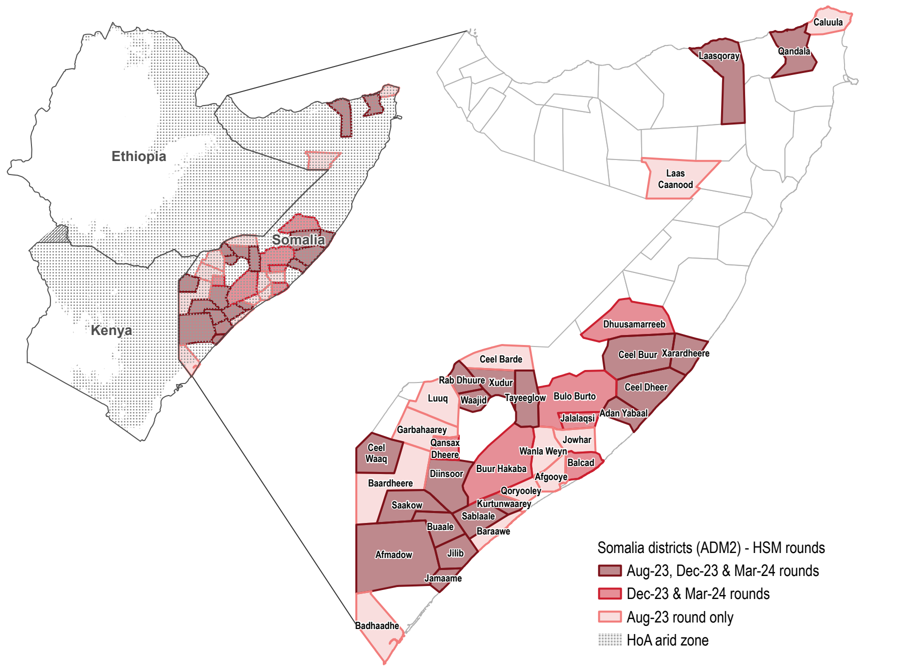
KIs in 70% of assessed settlements claimed that Gu crop yields were much lower than normal, with lack of sufficient water being the most commonly reported reason (65%)[49]

REACH HSM, December 2023

KIs in 23% of assessed settlements claimed that there had been a large decrease in livestock for most HHs in the 3 months prior to data collection

KIs in 17% of assessed settlements claimed that most HHs did not plant crops in the most recent harvest season, with the most reported reason being flooding (31%)

Fig. 37: Districts in Somalia covered by different rounds of REACH HSM data collection referenced in this report.



*Note: rainy seasons assumed to be March-May and October-December for comparability with the rest of the region.

3.4. SOMALIA ZOOM-IN: TRIANGULATING KI DATA & REMOTE SENSING

The following two pages investigate correlations between remote sensing and key informant data from REACHs recent HSM assessments, introduced on the previous page. In contrast to the HH data used for the Kenya analysis (p.11-13), which is representative at the admin 2 (county) level, HSM data is only considered indicative of the situation at admin 2 (district) level.

In countries with access and security constraints such as Somalia, KI data is often the only reliable source of primary data. This section investigates the integration of remote sensing to triangulate possible causes and impacts of climatic and environmental shocks, to support the assessment of humanitarian conditions in Somalia.

Flooding and long-term impacts of drought in 2023

As of November 2023, OCHA reported that floods in Somalia had temporarily affected over 700K people and left 113K people temporarily displaced.[50] Southwest and Jubaland states were the worst affected. Up to 14K families in Baardheere district and 2.4K people in Luuq became cut off by flooding.[51] Other impacts included flooding of shallow wells, increasing risk of disease outbreaks, crop damage, and livestock loss.

Fig. 38 shows the satellite-detected % of district area flooded as of December 2023. The map also shows the most frequently reported shocks according to the December 2023 HSM round. The data shows that flooding was most frequently reported in the districts on the downstream end of the Juba and Shablle rivers, where satellite data also shows flood extent was most extensive. However, there are a number of other districts further inland such as Ceel Waaq and Diinsoor where flooding was the most reported shock in the HSM data but remote sensing data did not capture flooding. This could be due to flash flooding, whereby floodwaters receded before they could be captured by satellite, and highlights the need to triangulate different sources of information on shocks wherever possible.

Whilst the most severe and extensive flooding occurred during the 2023 *Deyr* season, but flooding was also widely reported during the 2023 *Gu* season, primarily in the Juba and Shabelle basins, despite below average rainfall across parts of the country (see box below).

As shown on the previous page, during the March 2024 HSM data collection round, flooding was mentioned by KIs in 59% of settlements, whilst drought was reported in 52%. This shows the mixed and accumulated shocks that had occurred in the preceeding year. Fig. 39 shows there is a link between SPI-12 in 2023 and the most frequently reported shock by district in the year prior to data collection (as of March 2024), whereby SPI-12 is lower (indicating drier than normal conditions) for districts where drought was most frequently reported, and higher for those where flooding was reported. However, other factors which can also influence these climatic shocks, such as river flow in riverine areas (see below) and extended dry spells or temporal distribution of rainfall, should also be considered.

Fig. 38: Satellite-detected flood extent in Southern Somalia (UNOSAT, Dec 2023), and most reported shock (REACH HSM, Dec 2023).

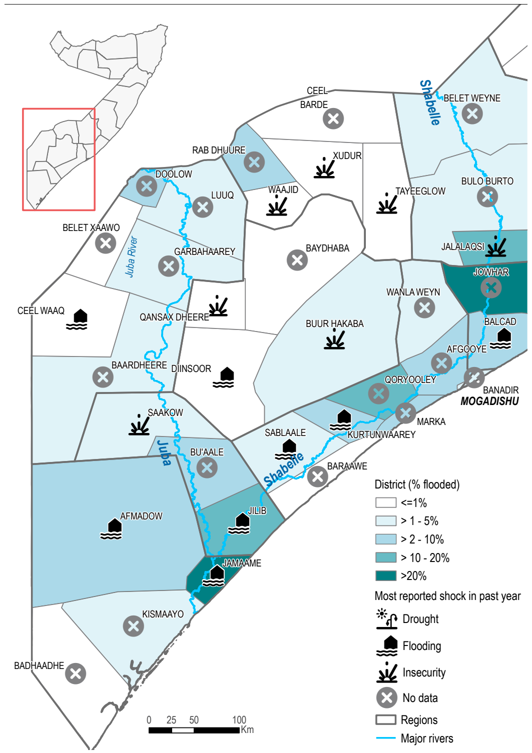
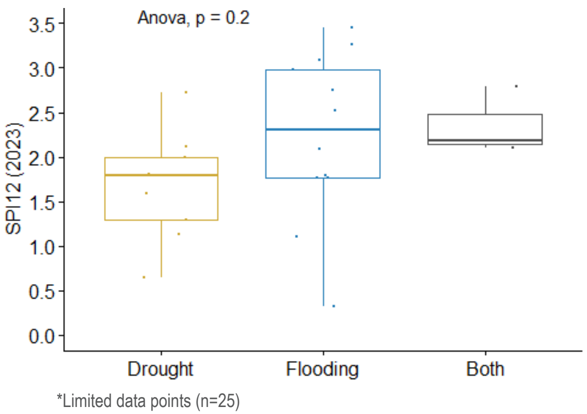


Fig. 39: Most frequent reported climatic shock vs SPI-12 for 2023.* Districts with lower SPI (comparatively drier conditions) most frequently reported drought.



Flooding drivers in riverine areas

As the maps to the right show (Fig. 40), rainfall was below average across much of Belet Weyne during the *Gu* season. However, flooding was reported by 38% of assessed HHs in the REACH MSNA conducted in mid-2023, and was mainly caused by upstream rainfall on the Shabelle in the Ethiopian highlands. This was also the case across much of the wider Juba and Shabelle basins. In the *Deyr* season on the other hand, when the most severe flooding occurred, rainfall was well above average in the district, as with most of the rest of the country.

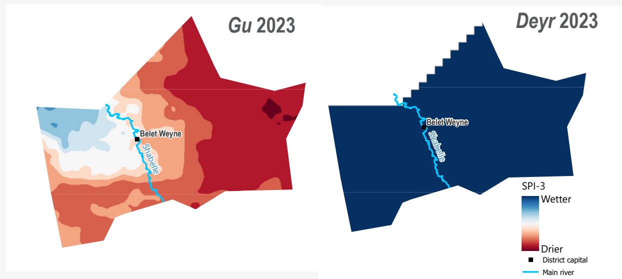


Fig 40: SPI-3 during the 2023 (a) *Gu* & (b) *Deyr* seasons.

3.4. SOMALIA ZOOM-IN: TRIANGULATING KI DATA & REMOTE SENSING (CONT.)

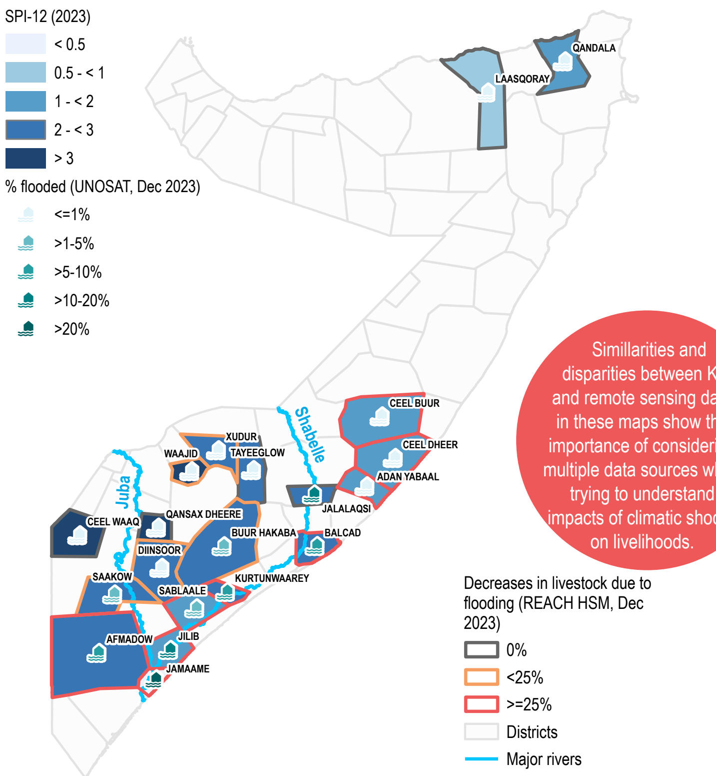
On this page, the impacts of the 2023 *Deyr* floods, as reported in the REACH HSM data, have been triangulated with RS data on flood extent and rainfall anomalies. Fig. 41 compares districts where KIs reported decreases in livestock due to flooding with both the SPI-12 for 2023, which indicates anomalous rainfall patterns, and the satellite-detected flood extent in December. The data shows that districts such as Jamaame, Jilib and Balcad, located along the Juba and Shabelle rivers, which had a higher proportion (>=25%) of assessed settlements where KIs reported decreases in livestock due to flooding (in the 3 months prior to data collection, as of December 2023) also had higher proportion of satellite-detected flooded area. However, SPI varied in these districts, indicating that upstream rainfall may have been a more important factor leading to flooding in these districts compared with local rainfall.

Conversely, those districts located further from these rivers that also had a higher proportion (>=25%) of assessed settlements where KIs reported decreases in livestock due to flooding, such as Ceel Buur, Ceel Dheer and Jalalaqsi, had negligible satellite-detected flood extent, although SPI was higher, indicating wetter than average conditions. This reinforces the point mentioned previously and suggests that these districts may have been affected by flash flooding that was not detected by satellite data.

Fig. 42 shows that riverine districts with a high proportion of crop loss reported by KIs in the most recent harvest period (from March 2024 HSM, referring to 2023 Deyr season) also had a higher satellite-detected flood extent, whilst SPI varied. As with impacts of flooding on livestock, this shows that upstream rainfall may have been a more important factor leading to flooding that affected crops than local rainfall. For example, SPI is only marginally above normal in Jamaame, yet detected flood extent is among the highest.

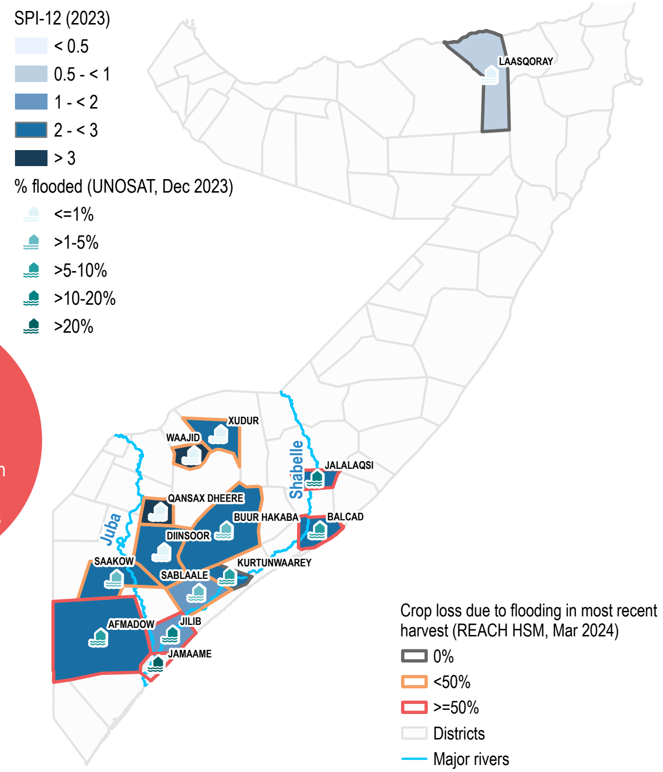
These findings show that remote sensing can be a useful tool to triangulate information on climatic and environmental shocks in hard-to-reach areas with limited access and data availability on community impacts. However, the use of multiple data sources, including from key informant data can provide further insights into the different drivers of climatic shocks and other contributory factors which may not be captured by one data source alone.

Fig 41: Pastoral livelihoods. Average SPI-12 (for 2023) by district and % district area flooded (Dec 2023), shown with % of settlements where KIs reported a large decrease in livestock due to flooding in the 3 months prior to data collection (REACH HSM, December 2023).



Simillarities and disparities between KI and remote sensing data in these maps show the importance of considering multiple data sources when trying to understand impacts of climatic shocks on livelihoods.

Fig 42: Agropastoral livelihoods. Average SPI-12 (for 2023) and % district area flooded (Dec 2023), shown with % crops lost due to flooding during most recent harvest (REACH HSM, March 2024).

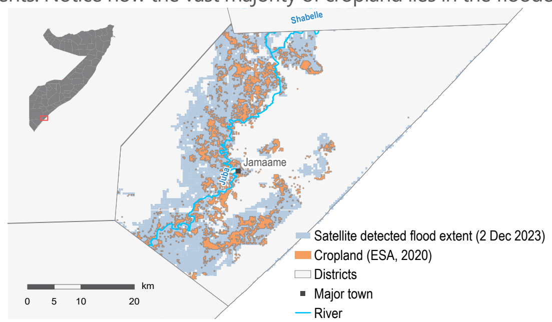


Deyr floods - a blessing and a curse

According to the December 2023 FEWSNET food security outlook update,[52] over 80K ha cropland was damaged due to *Deyr* flooding. As of December 2023, riverine agropastoral areas of southern Somalia were also among the worst affected by food insecurity, with many areas projected to be in IPC Phase 4 in December 2023.

Early-planted *Deyr* crops were largely destroyed by flooding, whilst in many areas, main season *Deyr* agricultural activities were delayed until the floodwaters receeded. It is projected that yields of these "recessional harvests" would be above average due to abundant moisture. Despite offering some respite, overall *Deyr* harvests were still projected to remain 13% below the long-term average.

Fig. 43: Satellite detected flood extent and cropland areas in Jamaame district, where all or almost all crops were reportedly destroyed in 88% of assessed settlements. Notice how the vast majority of cropland lies in the flooded area.



4.1. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

This analysis has taken advantage of an interesting opportunity to assess how remote sensing can be integrated with primary data to improve assessment of the potential humanitarian impact of climatic shocks on a regional scale. This aligns with a broader global objective of REACH to mainstream climate analysis within its intersectoral assessments.

Specifically, this report has focused on the arid zone of the Horn of Africa region. This zone includes the majority of Somalia, as well as contiguous parts of northern Kenya and eastern Ethiopia, and is characterised by similar climate patterns and livelihood systems. From protracted drought between late 2020 and early 2023, extreme rainfall and flooding hit the region in late 2023, affecting food security and livelihoods as well as water access, whilst also leading to disease outbreaks and displacement.

Remote sensing as well as REACH's primary data also indicated many similarities in the severity and impacts of climatic shocks across the arid zone of the entire region in recent years, and in particular the occurrence of severe droughts and floods. There are also many transboundary environmental interactions that should be considered, including for example heavy rainfall in the Ethiopian highlands being a key driver to riverine flooding in southern Somalia. These points highlight the importance of considering a regional lens in research and programming, to support early warning, preparedness and response to climatic shocks across the region.

REACH data from intersectoral assessments conducted across the three countries also indicated that climatic shocks were among the most reported shocks across the region, including in areas that are regularly affected by conflict and insecurity. The data also suggested long term impacts of the protracted drought, resulting in reduced coping capacity of communities to subsequent or compounding shocks. The inter-annual variability in climate patterns observed from remote sensing meanwhile, which is likely to increase in intensity with climate change, highlights the need for disaster risk reduction and resilience programming, particularly on a regional level.

This report has compared household and key informant indicators with remote sensing, highlighting some interesting linkages. For example, links between remote sensing indices indicating vegetation health, and household Food Consumption Score (FCS). Some of these relationships varied depending on the livelihood system, bringing attention to the importance of disaggregation of data by livelihood system. Note however that shifting livelihoods across the region due to economic and climatic drivers complicate this. The analysis should be further explored in different contexts and using different data collection methods, particularly with key informant data. In addition, whilst this analysis focused on climatic drivers, further analysis should also consider additional contributing factors. However, the results present an interesting opportunity to integrate remote sensing into assessments to provide additional layers of information on climatic shocks and the humanitarian situation, including in hard-to-reach areas.

Photos: ACTED

4.2. METHODOLOGY

This report uses a combination of remote sensing analysis, analysis of primary quantitative data collected from HH and KI surveys in selected locations across the region, and secondary data review. Please find details of the methodology below.

Remote sensing indicators

Precipitation trends (monthly total and cumulative)

Precipitation trends were calculated in Google Earth Engine (GEE) using the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) rainfall data for each of the focus counties. The long-term average was acquired by calculating the monthly average between 1981 and 2020 for comparison with monthly totals in 2021, 2022 and 2023.

Standard Precipitation Index (SPI)

The SPI calculates the rainfall anomaly for a specified period (usually 1, 2, 3, 6, 12 or 24 months) from a long-term average baseline for the same period. In this analysis, the full period of CHIRPS rainfall data availability, from 1981 to present, was used as a baseline. The index can be a useful indicator of potential drought conditions or excess rainfall. In this analysis, the SPI-3 was used to identify seasonal variations in rainfall across the region for the two main rainy seasons, which both last approximately 3 months. In addition, the SPI-12 was calculated to identify annual rainfall anomalies, as well as the SPI-24 to identify longer term rainfall anomalies, which are related to groundwater storage and reservoir storage. SPI was calculated in Google Earth Engine using the UN-SPIDER Recommended Practice.

Normalised Difference Vegetation Index (NDVI)

The NDVI is a widely used index to estimate chlorophyl content of vegetation, which is indicative of vegetation health and density. Because chlorophyl reflects more near-infrared light and absorbs more red light, the difference between the reflectance values in these two parts of the electromagnetic spectrum can be used to estimate vegetation health and density. In general, negative values relate to water, whilst low positive values are likely to relate to areas with no green leaves or a low concentration of greenery, such as urban areas or bare ground. Values closer to +1 relate to dense vegetation. In this analysis, the anomaly was calculated to identify trends straying from the usual seasonal conditions. NDVI anomaly was calculated from MODIS surface reflectance (SR) data in GEE.

Vegetation Condition Index (VCI)

The VCI highlights impacts of meteorological drought on vegetation condition through comparing vegetation greenness (from the NDVI or Enhanced Vegetation Index (EVI) vegetation indexes) in a specified time period (e.g. a month/season) with the average long-term value for that time period in that location. The lag between rainfall and vegetation response should be considered when selecting a time period to calculate VCI. The formula categorises areas into levels of drought severity between light and extreme. Note that here “drought” may refer to ecological or agricultural drought as the focus is on the impact of low rainfall on vegetation.

In this analysis, VCI was calculated in GEE using Moderate Resolution Imaging Spectroradiometer (MODIS) Enhanced Vegetation Index (EVI) data, using an adaption of the UNSPIDER Recommended Practice. Analysis was conducted to estimate the impact of the rainy seasons on vegetation condition, with the analysis being conducted 1 month later than the start of the relevant rainy season to account for the lag in vegetation response following the start of the rainy season.

Rootzone soil moisture

Soil moisture indicates the amount of water content within soils and can be measured at different depths. Rootzone soil moisture (RZSM) was selected for this analysis as it provides insights into the availability of water for plants and crops, and can support early warning of potential drought conditions, or in the case of over-saturation, potential waterlogging or increased susceptibility to flooding. RZSM was extracted from Soil Moisture Active / Passive (SMAP) data using GEE.

Normalised Difference Water Index (NDWI)

NDWI is an index used to highlight vegetation moisture content. This uses NIR and SWIR bands to determine moisture content of leaves. This is sometimes also referred to as the Normalised Difference Moisture Index (NDMI). Positive values generally indicate water content. In this analysis, the NDWI anomaly was calculated to understand variations away from the usual seasonal trends. Analysis was undertaken in GEE using MODIS SR data.

Additional sources

Satellite-detected flood extent data was downloaded from the United Nations Satellite Centre (UNOSAT) website for Somalia & Kenya. For Somalia, this data was aggregated to district level and % flooded area was calculated in ArcGIS Pro. Rainfall forecast data was requested directly from the ICPAC for the Horn of Africa region, whilst the IOD and ENSO forecasts were taken from the Met Office.

Primary data (indicators)

Food Consumption Score (FCS)

The FCS is an indicator used to measure dietary diversity, food frequency, and the relative nutritional importance of food groups at HH level. The index is calculated by asking questions about the frequency of consumption of various food groups in the past 7 days, and provides an estimate of dietary diversity and food consumption frequency, categorised as poor (0-21), borderline (21.5-35), or acceptable (>35). More info here.

Household Water Insecurity Experiences Scale (HWISE)

The HWISE scale quantifies experiences of HH water insecurity through a series of questions about frequency of experiences with common water-related disturbances. The index can be divided into water secure when the score is 12 or above, and water insecure HHs when below 12. More info here.

Primary data (sources)

Kenya: Multi-Sector Needs Assessment (MSNA)

The Kenya MSNA used a quantitative approach, involving face-to-face HH surveys from 22/05-02/06, 2023. In total, 4,951 HHs were sampled across the four counties. The sample size was calculated based on HH population figures from the Kenya National Bureau of Statistics (KNBS) 2019 census. Probability-stratified random sampling was used at the sub-county level to fulfill a 95% confidence level and 7% margin of error. At county level, a 95% confidence level and 10% margin of error was achieved, plus a 10% buffer to account for any non-responses and

4.2. METHODOLOGY (CONT.)

potential surveys to be deleted during data cleaning. More details can be found here. Data was disaggregated into pastoral and agropastoral livelihood zones, as reported by enumerators.

Somalia: Humanitarian Situation Monitoring (HSM)

REACH conducts HSM assessments in hard-to-reach districts of Somalia approximately on a quarterly basis. These assessments are based on an Area of Knowledge (AoK) methodology, which relies on key informant (KI) quantitative interviews to provide an indicative overview of hard-to-reach districts. Enumerators interviewed KIs living in hard-to-reach districts at the time of data collection by mobile phone, or face-to-face in accessible areas, such as Internally Displaced Persons (IDP) sites and markets.

KIs were selected if they were members of the assessed settlement and were knowledgeable enough to report on the settlement with regards to basic services, markets, livelihood, and protection. Respondents were identified via snowballing through the KIs interviewed. Data was collected at the settlement level, i.e., the questionnaire related to site level humanitarian needs, not individual needs. A target threshold of 15% of known settlements in each hard to-reach district was set. The KIIs were aggregated at the settlement level with a minimum of 2-3 KIs interviewed per settlement. When there was no consensus among the KIs from the same settlement, the results were not aggregated and thus no consensus is indicated in the response. The analysis and findings in this brief are indicative and not statistically representative of the assessed districts. Here is the Methodology Note for the March 2024 round. This report references the August 2023, December 2023 and March 2024 data collection rounds, which cover various hard-to-reach districts as indicated in Fig. 37.

Ethiopia: Livelihood Coping Assessment

This assessment aimed to examine the impact of drought and other shocks on host and IDP households, using structured HH surveys. It included 9 administrative zones in the Somali region selected based on FEWS NET Emergency (IPC Phase 4) outcomes zones as of September 2023. REACH conducted HH interviews with 2,633 HHs, including 1,245 host households and 1,388 IDP households, between 12/11 - 30/12/2023. Data from IOM's Displacement Tracking Matrix (DTM) was used to calculate the sample size of IDP population per zone. Selected HHs were randomly sampled using a two-stage stratified cluster technique. Findings are representative at admin 2 level, for both host and IDP communities, with a 95% confidence level and 10% margin of error. A spatial join was applied from the 2018 FEWSNET livelihood zones shapefile to each HH so the data could be disaggregated into pastoral and agropastoral livelihood zones. See full report here.

Comparative analysis

Aggregation of remote sensing data

For the HH-level comparisons between HH and RS indicators in Kenya and Ethiopia, buffer zones were generated around HH locations in ArcGIS Pro with radii of 2.5km, 5km and 10km. Remote sensing indices calculated in GEE were aggregated to these buffer zones to extract mean values for each RS indicator. This data was then joined back to the HH data.

Statistical analysis

Boxplots were created in R to compare RS indicators with HH indicators. Statistical tests were conducted to test the statistical significance of the comparisons. Specifically, t-tests were conducted for boxplots with two categories and the anova test was conducted for those with 3 categories. Additional statistical analyses were explored including regressions and empirical cumulative distribution functions, some of which are presented in the appendices below.

4.3. LIMITATIONS

Remote sensing (RS) is an invaluable tool allowing spatially and temporally extensive comparison of environmental and climatic conditions. This is important for humanitarian and disaster management actors, to support prioritisation of interventions and aid to most affected areas, including hard-to-reach areas. However, there are a number of limitations to this research. Firstly, there are limitations to the accuracy and Interpretability of RS data alone when investigating impacts of climatic shocks on livelihoods. This was seen in the Somalia zoom-in for example, whereby flash flooding reported by KIs in some districts was not directly detected by RS. However, this exemplifies the importance of triangulating different data sources, which is one of this report's key messages.

Note that RS/primary data comparisons presented here focused on climatic drivers. Whilst factors such as humanitarian food assistance, access to markets and remittances will also affect food consumption scores for example, they were not considered in this analysis. Future analyses should ideally consider these factors, which may help reduce noise in some of the analysis. In addition, data from the REACH HSM assessment in Somalia is not generalisable with a known level of precision and should be considered indicative of the situation only in the assessed hard-to-reach settlements. In addition, due to the non-representativeness of the data, HSM data may not cover settlements that have been affected by localised shocks such as flooding. Because settlement location data was missing or inaccurate for this data, the data had to be aggregated to admin 2 level.

Whilst HH data from Kenya and Ethiopia was representative at admin 2 level, findings have been disaggregated by livelihood system, which differs from the original sampling frame. In future rounds of the MSNA, REACH plans to pilot sampling by livelihood zone at the research design stage. Note that for Kenya, the livelihood zone as reported by enumerators at data collection was used for disaggregation, whilst for Ethiopia, the zone was taken from the 2018 FEWSNET livelihood zone classification. Both these methods have limitations and may not represent the most current or accurate livelihood zone. This is particularly true due to recent shifts in livelihoods in this region as a result of economic changes and investment, as well as droughts (see p.6). It may be useful to instead use reported current income source, or another determinant of livelihoods, in future research. In addition, there were limitations in conducting RS comparative analysis for pastoral HHs due to difficulty in definining analysis zones. In future, it could be interesting to use known movement routes when defining analysis zones.

The sampling, methods, and survey tools used in the three countries were inherently different, and findings can thus not be directly compared. Question formats and recall periods also differed. However, this again highlights a need for data harmonisation across similar environmental or livelihood zones areas. Overall, this analysis should be developed further to explore these relationships in different contexts using data collected by different methods, including further exploration of comparisons between RS and KI data in hard-to-reach areas.

Finally, in terms of the RS analysis conducted in this report, SPI is limited by the fact it does not account for temperature, which is important because rising temperatures due to climate change can increase evapotranspiration, which can further intensify drought. One alternative would be the Standardised Precipitation Evapotranspiration Index (SPEI), which also accounts for temperature variability and extremes,[53] although this is more complex to calculate. In addition, whilst analysis timeframes for RS indices such as SPI have been standardised to allow for regional comparison, exact timings of seasons vary, meaning local trends may not be fully captured across the whole region.

5.1. APPENDIX 1: MORE RESULTS FROM KENYA

Fig. 44. Drought vs SPI-3: HHs mentioning drought as a shock affecting them in the 3 months prior to data collection (as of May/June 2023) vs SPI-3 (MAM 2023) for (a) agropastoral, and (b) pastoral livelihood zones

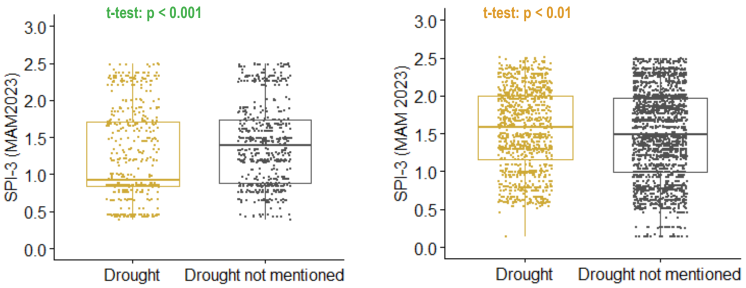


Fig. 45. Drought vs SPI-24: HHs mentioning drought as a shock affecting them in the 3 months prior to data collection (as of May/June 2023) vs SPI-24 (2021/22) for (a) agropastoral, and (b) pastoral livelihood zones. SPI-24 is lower for those reporting drought, indicating potential long-term impacts of the protracted drought.

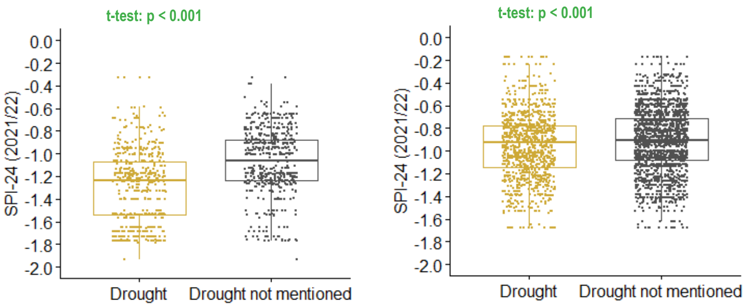
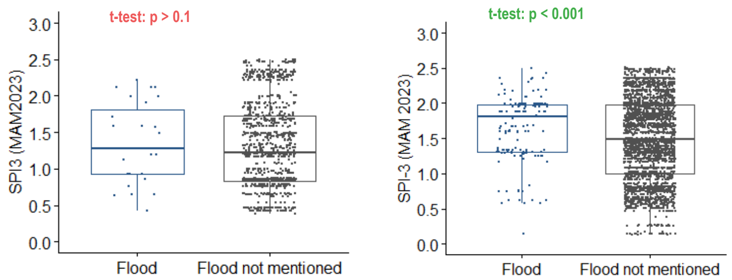


Fig. 46. Flood vs SPI-3: HHs mentioning flooding as a shock affecting them in the 3 months prior to data collection (as of May/June 2023) vs SPI-3 (MAM 2023) for (a) agropastoral, and (b) pastoral livelihood zones.*



*SPI-24 not calculated for flood shock as more recent rainfall performance assumed to be more relevant to flooding events.

Fig. 47. FCS vs SPI-3: HH FCS (as of May/June 2023) vs SPI-3 (MAM 2023) for (a) agropastoral, and (b) pastoral livelihood zones

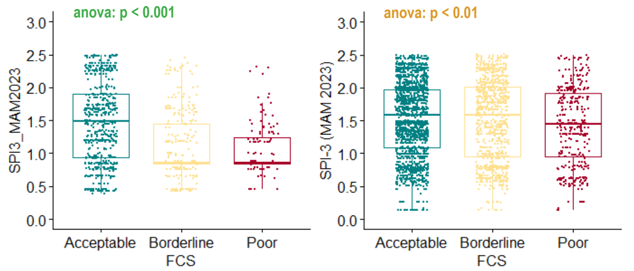


Fig. 48. FCS vs SPI-24: HH FCS (as of May/June 2023) vs SPI-24 (2021/22) for (a) agropastoral, and (b) pastoral livelihood zones. HHs with acceptable FCS have higher median SPI-24, particularly for agropastoral. May indicate longer-term impacts of protracted drought on current food security.

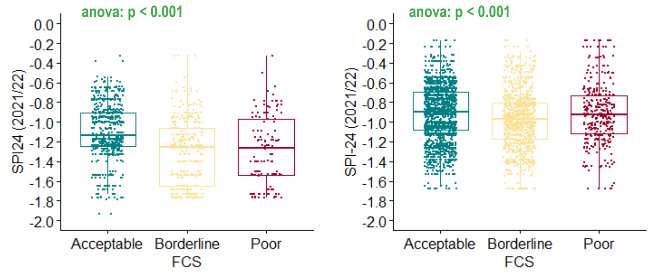
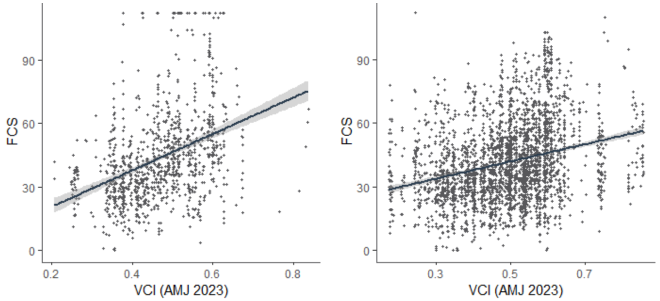


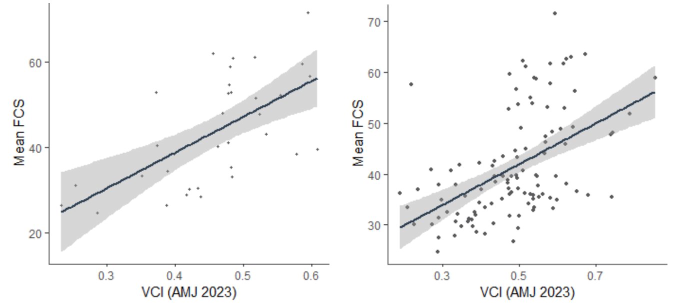
Fig. 49. FCS vs VCI (regression): HH FCS (as of May/June 2023) vs VCI (AMJ 2023) for (a) agropastoral, and (b) pastoral livelihood zones



R^2: 0.14. Slope coeff: 86.4. Std error: 6.5. FCS mean: 43.6 (std dev: 22.4)

R^2: 0.08. Slope coeff: 40.5. Std error: 2.5. FCS mean: 41.6 (std dev: 18.6)

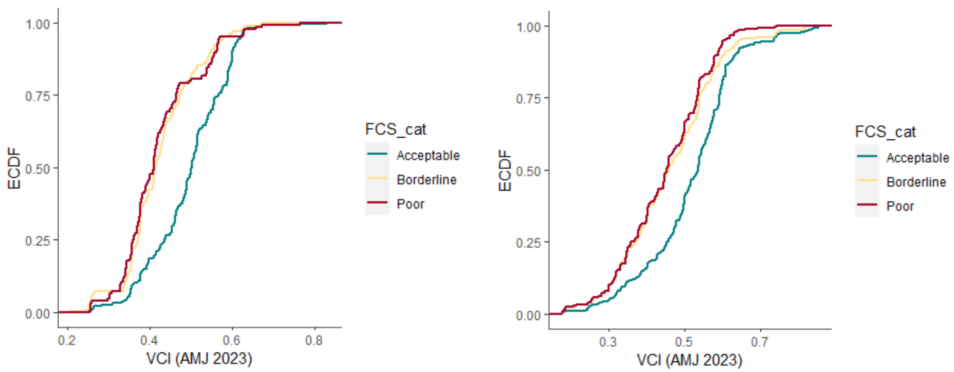
Fig. 50. FCS vs VCI (regression): HH FCS (as of May/June 2023) vs VCI (AMJ 2023) for (a) agropastoral, and (b) pastoral livelihood zones, aggregated to means within 10km-diameter hexagons. Reduces some of noise seen in Fig. 49.



R^2: 0.38. Slope coeff: 84.1. Std error: 19.0. FCS overall mean: 43.7 (std dev: 12.7)

R^2: 0.25. Slope coeff: 40.0. Std error: 6.6. FCS overall mean: 41.3 (std dev: 10.4)

Fig. 51. FCS vs VCI (empirical cumulative distribution function, ECDF): HH FCS category (as of May/June 2023) vs VCI (AMJ 2023) for (a) agropastoral, and (b) pastoral livelihood zones. Indicates that agropastoral HHs with acceptable FCS almost always have a higher VCI compared to borderline/poor. However, there is not a clear difference between borderline and poor categories.



5.1. APPENDIX 1: MORE RESULTS FROM KENYA (CONT.)

Fig. 52. HWISE vs SPI-3: HH HWISE (as of May/June 2023) vs SPI-3 (MAM 2023) for (a) agropastoral, and (b) pastoral livelihood zones. Shows that the median SPI-3 is lower (indicating comparatively less rainfall) for water insecure households.

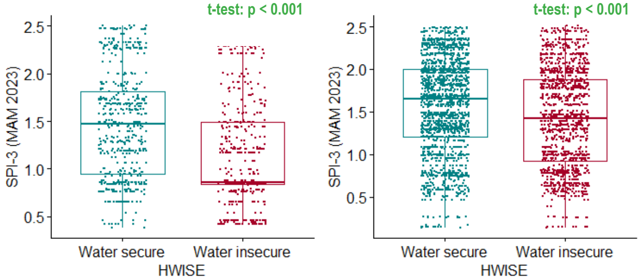


Fig. 53. HWISE vs SPI-24: HH HWISE (as of May/June 2023) vs SPI-24 (2021/22) for (a) agropastoral, and (b) pastoral livelihood zones. Indicates that the median SPI-24 is lower for water insecure HHs in agropastoral livelihood zones. No significant difference in pastoral livelihood zones.

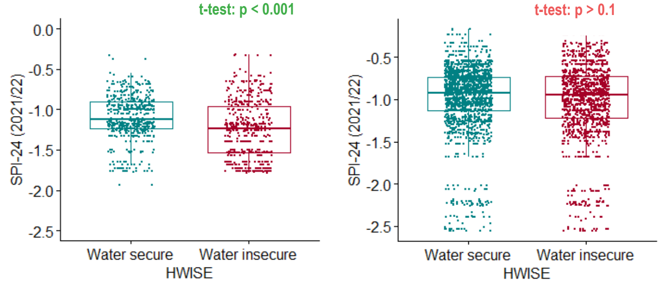
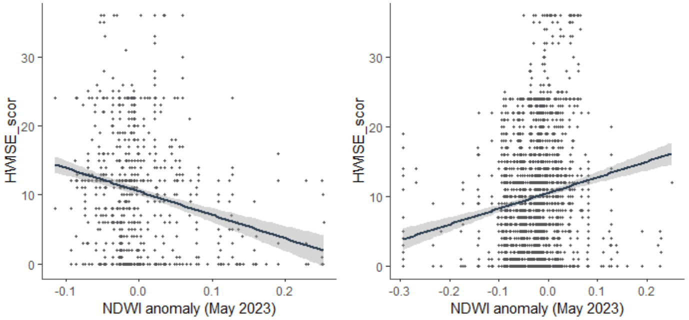


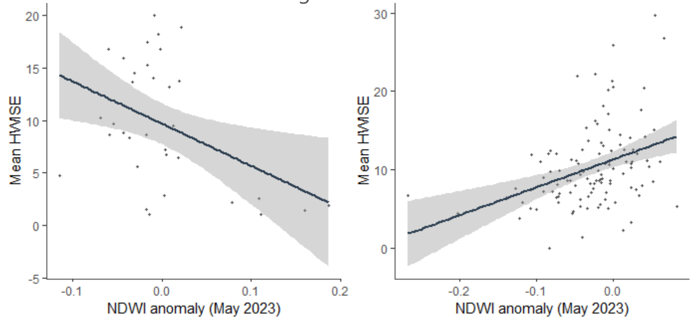
Fig. 54. HWISE vs NDWI anomaly (regression): HH HWISE (as of May/June 2023) vs NDWI anomaly (May 2023) for (a) agropastoral, and (b) pastoral livelihood zones.



***R^2: 0.05.** Slope coeff: -34.0. Std error: 4.5. HWISE mean: 10.3 (std dev: 9.3)*

***R^2: 0.02.** Slope coeff: 22.6. Std error: 2.9. HWISE anomaly mean: 9.9 (std dev: 8.8)*

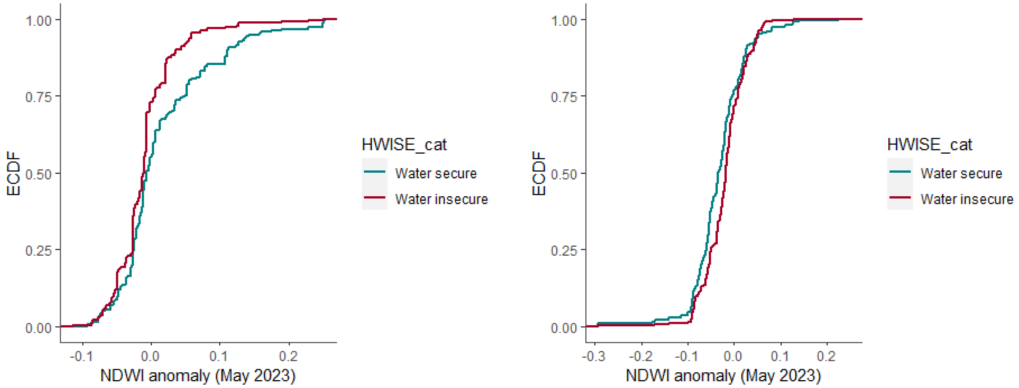
Fig. 55. HWISE vs NDWI anomaly (regression): HH HWISE (as of May/June 2023) vs NDWI anomaly (May 2023) for (a) agropastoral, and (b) pastoral livelihood zones, aggregated to means within 10km-diameter hexagons. Reduces some of noise seen in Fig. 54.



***R^2: 0.18.** Slope coeff: -40.2. Std error: 15.3. HWISE overall mean: 9.5 (std dev: 6.0)*

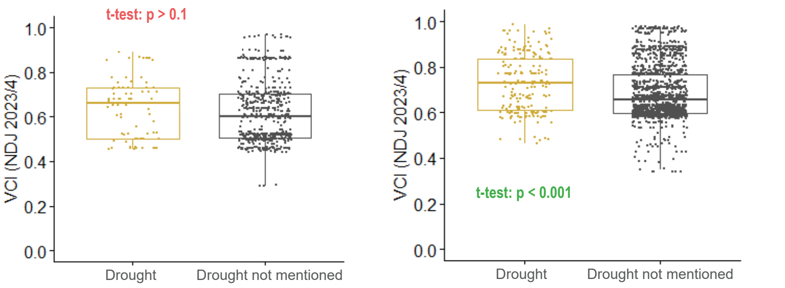
***R^2: 0.14.** Slope coeff: 35.7. Std error: 8.6. HWISE overall mean: 10.3 (std dev: 5.2)*

Fig. 56. HWISE vs NDWI anomaly (empirical cumulative distribution function, ECDF): HH HWISE category (as of May/June 2023) vs NDWI anomaly (May 2023) for (a) agropastoral, and (b) pastoral livelihood zones. Indicates that water secure agropastoral HHs usually have a higher NDWI anomaly, whilst the opposite trend is seen for pastoral HHs. This may be due to the fact water insecure pastoral HHs have moved to areas with more surface water availability, indicated by the higher NDWI anomaly observed for these HHs.



5.2. APPENDIX 2: MORE RESULTS FROM ETHIOPIA

Fig. 57. Drought vs VCI: HHs mentioning drought as a shock affecting them in the 3 months prior to data colection (as of Nov/Dec 2023) vs VCI (NDJ 2023/4) for (a) agropastoral, and (b) pastoral livelihood zones. See note to right.



__Note:__ as mentioned in the main report, because the HH survey was undertaken in Nov/Dec 2023, during the height of the rainy season, whilst VCI was analysed for November 2023 - January 2024 to cover the entire rainy season, accounting for a 1 month delay, the two variables were not necessarialy appropriate to compare. The analysis was done for drought and flood shocks for demonstration purposes (Fig. 57 & Fig. 59).

Fig. 60. FCS vs SPI-3: HH FCS (as of Nov/Dec 2023) vs SPI-3 (OND 2023) for (a) agropastoral, and (b) pastoral livelihood zones. As with comparing FCS with SPI-24 (p.16), median SPI-3 in agropastoral LZs is higher (indicating higher rainfall) for HHs with acceptable and borderline FCS compared with HHs with poor FCS. Interestingly however, for pastoral LZs, median SPI-3 is highest for borderline FCS, but remains lowest for poor FCS.

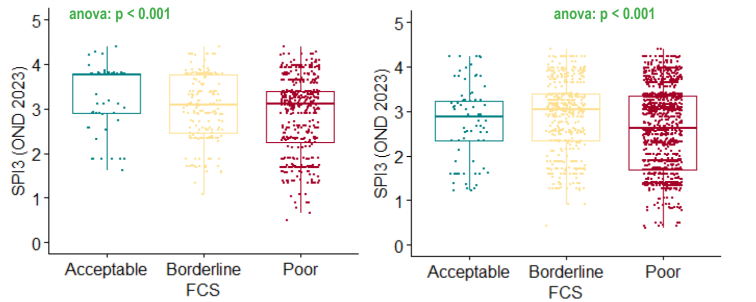


Fig. 58. Drought vs SPI-24: HHs mentioning drought as a shock affecting them in the 3 months prior to data colection (as of Nov/Dec 2023) vs SPI-24 (2022/23) for (a) agropastoral, and (b) pastoral livelihood zones. SPI-24 was analysed to identify any implications of long-term rainfall anomalies on short-term perception of drought. However, the data does not indicate a significant difference in mean SPI for agropastoral LZs, whilst the relationship is weak for pastoral LZs (p<0.1).

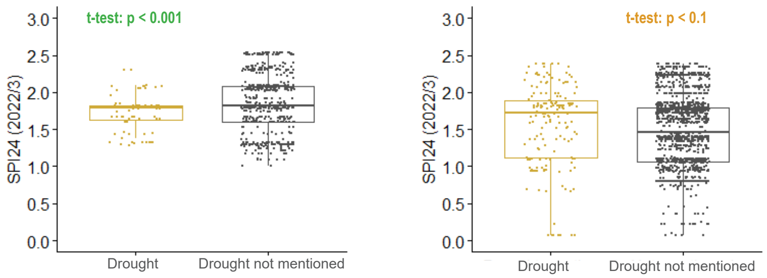
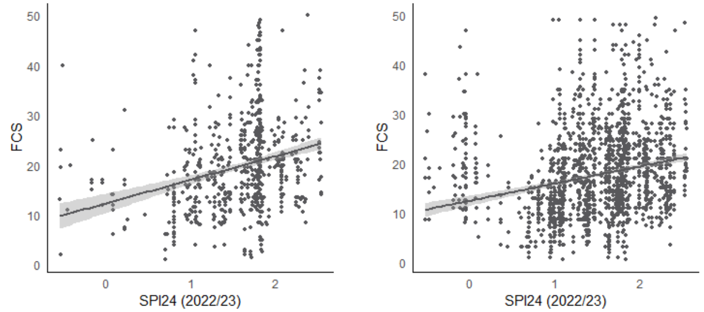


Fig. 61. FCS vs SPI24 (regression): HH FCS (as of Nov/Dec 2023) vs SPI24 (2022/23) for (a) agropastoral, and (b) pastoral livelihood zones. Whilst the trends still indicate a positive relationship between FCS and SPI, R2 values are lower compared to the Kenya results (p.23). This likely reflects the higher uncertainty related to investigating rainfall anomalies over this longer time period (SPI-24, as compared with SPI-3 for Kenya), and the additional potential factors that may have contributed to FCS scores over this timeframe.



R^2*: *0.08. *Slope coeff: 4.9. Std error: 0.6.*
SPI24 mean: 19.9 (std dev: 9.4)

R^2*: *0.02. *Slope coeff: 5.5. Std error: 0.8.*
SPI24 mean: 17.7 (std dev: 9.5)

__Note:__ hexagon-level analysis proved to show reduced noise and higher correlation compared with HH-level analysis (p.23). This was not conducted for Ethiopia but future analyses should further consider this method.

Fig. 59. Flood vs VCI: HHs mentioning floods as a shock affecting them in the 3 months prior to data colection (as of Nov/Dec 2023) vs VCI (NDJ 2023/4) for (a) agropastoral, and (b) pastoral livelihood zones. See note above.

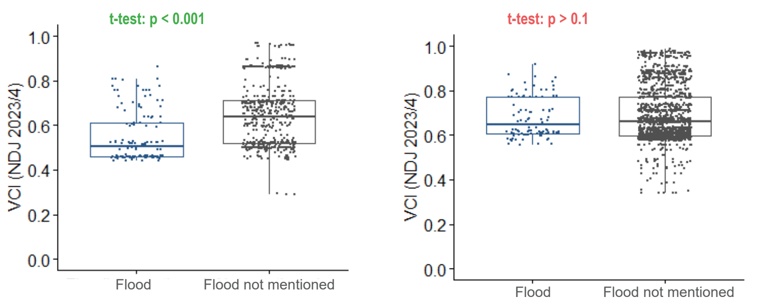
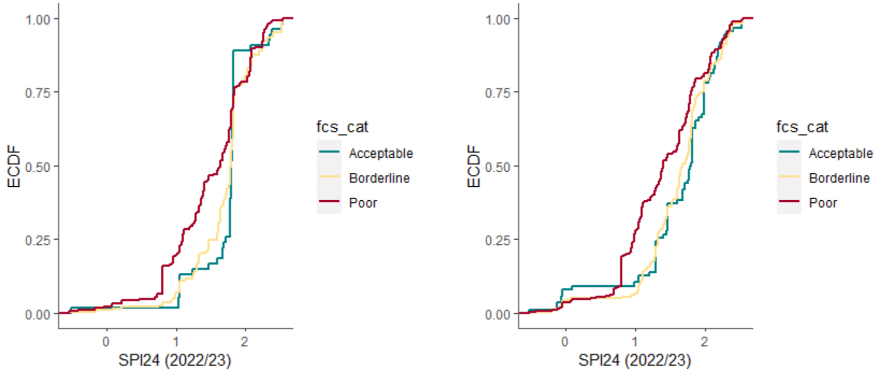


Fig. 62. FCS vs SPI-24 (empirical cumulative distribution function, ECDF): HH FCS category (as of Nov/Dec 2023) vs SPI-24 (2022/23) for (a) agropastoral, and (b) pastoral livelihood zones. In agreement with findings so far, these figures indicate that HHs with poor FCS are generally associated with lower SPI-24 (indicating relatively lower rainfall) compared to HHs with borderline and poor FCS, which have a similar trend. The data does however indicate higher uncertainty at the higher levels of SPI.



REFERENCES

1 United Nations World Food Programme (WFP), 2023. Drought in the Horn of Africa: Situation Update, July 2023.
2 Action against Hunger, 2023. Deadly climate-induced flooding displaces nearly 1.6 million people across the Horn of Africa.
3 United Nations Office for Coordination of Humanitarian Affairs (UN OCHA), September 2022. Horn of Africa Drought: Regional Humanitarian Overview & Call to Action (Revised 21 September 2022).
4 Climate Analytics, 2024. From droughts to floods: how Eastern African countries are responding to the rising El Niño and Indian Ocean Dipole.
5 AP News, December 2023. Scientists: Climate change intensified the rains devastating East Africa.
6 Ogallo, L., Omondi, P., Ouma, G. and Wayumba, G, 2018. Climate Change Projections and the Associated Potential Impacts for Somalia. American Journal of Climate Change, Vol. 7(02), pp. 153-170.
7 UN OCHA, February 2024. The Greater Horn of Africa: Humanitarian Key Messages (February 2024).
8 National Integrated Drought Information System, NIDIS. What is Drought?
9 GloH2O, 2024. Köppen-Geiger Global 1-km climate classification maps.
10 Famine Early Warning Systems Network (FEWSNET). Seasonal calendars for Ethiopia, Kenya and Somalia.
11 ibid.
12 ibid.
13 ibid.
14 ibid.
15 ibid.
16 Future Agricultures, 2012. Project: The politics of changing pastoral livelihoods in the Horn of Africa.
17 ibid.
18 ibid.
19 Ogallo, L., Omondi, P., Ouma, G. and Wayumba, G, 2018. Climate Change Projections and the Associated Potential Impacts for Somalia. American Journal of Climate Change, Vol. 7(02), pp. 153-170.
20 Climate Analytics, 2024. From droughts to floods: how Eastern African countries are responding to the rising El Niño and Indian Ocean Dipole.
21 World Weather Attribution, April 2023. Human-induced climate change increased drought severity in Horn of Africa
22 Palmer et al., 2023. Drivers and impacts of Eastern African rainfall variability. Nature Reviews Earth & Environment volume 4, pp. 254–270.
23 UN OCHA, 2024. Eastern Africa: Heavy rains and flooding Flash Update #4 (30 May 2024).
24 UN OCHA, 2024. Somalia: 2024 Gu (April to June) Season Floods Weekly Situation Report No. 2 - As of 19 May 2024.
25 UN OCHA, 2024. Somalia: Gu Floods - 2024: Situation and Response Dashboard (As of 16 May 2024).
26 Met Office, 2024. Tropical Atlantic and Indian Ocean sea surface temperature forecasts.
27 Met Office, 2024. El Niño Southern Oscillation (ENSO) region sea surface temperature forecasts.
28 Intergovernmental Authority for Development (IGAD) Climate Prediction and Applications Centre (ICPAC), 2024. Seasonal Forecasts.
29 Climate Hazards Centre, 2024. Exploring and Anticipating Extreme East African Short Rains in a Warming World with the Indo-Warm Pool Heating Gradient - with an OND 2024 Outlook.
30 WorldClim, 2022. Bioclimatic variables.
31 Ayugi, B., Eresanya, E., Onyango, A.O. et al. (2022). Review of Meteorological Drought in Africa: Historical Trends, Impacts, Mitigation Measures, and Prospects. Pure Appl. Geophys. 179, 1365–1386.
32 Imperial University, 2024. What is El Nino and how is it influenced by climate change?
33 Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2023. New study helps solve a 30-year-old puzzle: how is climate change affecting El Nino and La Niña?
34 Cardiff University, 2022. Rising groundwater offers hope for drought-stricken East Africa.
35 National Centre for Atmospheric Research (NCAR) Climate Data Guide, 2024. Nino SST Indices (Nino 1+2, 3, 3.4, 4; ONI and TNI).
36 Integrated Food Security Phase Classification (IPC), 2023. Kenya: Acute Food Insecurity Situation February 2023 and Projection for March - June 2023.
37 IPC, March 2024. IPC Acute Food Insecurity and Acute Malnutrition Analysis, February to June 2024, Kenya.
38 UN OCHA, December 2023. Heavy rains and floods impact and response.
39 Climate Analytics, 2024. From droughts to floods: how Eastern African countries are responding to the rising El Niño and Indian Ocean Dipole.
40 WFP Vulnerability Analysis and Mapping (VAM) Resource Centre, 2019. Food Consumption Score (FCS).
41 Young, S.L., Boateng, G.O., Jamaluddine, Z. (2019). On behalf of the HWISE Research Coordination Network, et al. The Household Water InSecurity Experiences (HWISE) Scale: development and validation of a household water insecurity measure for low-income and middle-income countries. BMJ Global Health, 4: e001750.
42 ACAPS, 2023. ACAPS Thematic Report: Impact of drought: Oromia and Somali regions (07 February 2023).
43 ibid.
44 NCAR Climate Data Guide, 2024. Standardised Precipitation Index (SPI).
45 University of Notre-Dame (ND-GAIN), 2021. Somalia.
46 United Nations Food and Agriculture Organisation (FAO) Somalia Water and Land Information Management (SWALIM), 2024. Climate.
47 Ogallo, L., Omondi, P., Ouma, G. and Wayumba, G, 2018. Climate Change Projections and the Associated Potential Impacts for Somalia. American Journal of Climate Change, Vol. 7(02), pp. 153-170.
48 IPC, 2023. Somalia: Acute Food Insecurity Situation for August - September 2023 and Projection for October - December 2023.
49 REACH, 2023. Humanitarian Situation Monitoring - Somalia, August 2023 round.
50 UN OCHA, 2024. Deyr Rainy Season 2023 Flash Update No.5.
51 ibid.
52 FEWS NET, December 2023. Somalia Food Security Outlook Update - Flood-affected riverine areas face Emergency (IPC Phase 4) outcomes.
53 NCAR Climate Data Guide, 2024. Standardized Precipitation Evapotranspiration Index (SPEI).

ACRONYMS

AMJ: April, May, June (period following short rains/Gu season)
ENSO: El Niño Southern Oscillation
EVI: Enhanced Vegetation Index
FCS: Food Consumption Score
HoA: Horn of Africa
HH: Household
HSM: Humanitarian Situation Monitoring
HWISE: Household Water Insecurity Experiences Scale
IDP: internally displaced person
IOD: Indian Ocean Dipole
IPC: Integrated Phase Classification
KI: Key Informant
MAM: March, April, May (referring to short rains/Gu rainy season)
MSNA: Multi-Sectoral Needs Assessment
NDJ: November, December, January (period following short rains/Deyr season)
NDVI: Normalised Difference Vegetation Index
NDWI: Normalised Difference Water Index
OND: October, November, December (referring to short rains/Deyr rainy season)
SPEI: Standardised Precipitation Evapotranspiration Index
SPI: Standardised Precipitation Index
VCI: Vegetation Condition index

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