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A climate in crisis

How climate change is making drought and humanitarian disaster worse in East Africa

Nearly eleven million people in Kenya, Ethiopia and Somalia are dangerously hungry and in need of humanitarian assistance. The worst drought-affected areas in Somalia are on the brink of famine.[1] The crisis could deteriorate significantly over the coming weeks, as rainfall in March and early April was very low in places and poor rainfall is forecast for April through June, which is the end of the rainy season.

There is growing scientific analysis suggesting that the impacts of current and recent droughts in East Africa are likely to have been aggravated by climate change.[2] Climate change is not a distant, future threat: it is helping fuel this emerging catastrophe in which poverty, chronic malnutrition, weak governance, conflict, drought and climate change have combined to create a perfect storm. While some still deny the severity of climate change and question the need to combat it, others are struggling for their lives as climate change makes a bad situation worse.

There could be no stronger call to take action on climate change than suffering on this scale. Governments across the region and around the world need to step up, take responsibility, and provide humanitarian assistance to save lives now. Short-term humanitarian aid needs to be coupled with support to promote the resilience of pastoralists and smallholder food producers. Without global efforts to reduce emissions and to help the world's poorest people cope with the effects of climate change, this crisis will continue to repeat itself.

Dry, hot, and getting hotter

For many in East Africa, this drought is the worst in living memory.[3] In a number of ways the situation today is worse than the 2010 to 2011 food crisis, which affected millions and resulted in a famine that killed more than 250,000 people. We are now in the third year of very low rainfall, coupled with high temperatures, which have exhausted people's ability to cope with another shock.[4]

Awad Ali, 87 years old, Somaliland. Photo: Petterik Wiggers/Oxfam

'I've seen many droughts in my lifetime but this is the worst one'

The last rainy season, from October to December 2016, brought severely low levels of rain. Since early January, much of East Africa has remained dry and much hotter than usual.[5] The current rains, from March to June, are forecast to be poor.[6] March rainfall has already been exceptionally low in Kenya and Somalia and is late in some areas in Ethiopia.

The prolonged drought over the past three years is part of a three-decade trend (see Box 3). Droughts are not new to this region, but they are increasing.[7]

The trends are deeply concerning:

- Seven of the last ten years have seen chronic droughts in East Africa due to poor or failed rains.[8]
- The long rains, which go from March to May/June, are failing much more frequently.[9] As of last year, in Eastern Kenya and Southern Somalia, 10 out of the last 16 have been dry compared with historic averages.[10]
- Temperatures across East Africa are rising, and have been much higher in recent years compared with historic averages *(see Box 1).*

Droughts do not have to be humanitarian catastrophes. Severe drought is undoubtedly contributing to the scale of this disaster, but the current crisis has also been caused by people and policies. Chronic poverty, slow international action, weak governance, have undermined people's ability to grow, gather or pay for food.

Pastoralists and smallholder farmers are most at risk. They lack the resources to cope with the inherent risks of farming, receive little support from governments, live on harsher lands, and rarely have access to economic safety nets when crops fail and livestock die. More frequent droughts are making it harder for people to recover between shocks, making them more vulnerable to the next crisis.

The climate change connection

Climate change is real and happening now. The past three years have been the hottest ever recorded. Average global temperatures are now one degree Celsius higher than pre-industrial levels, largely due to human activities.

Experts have long predicted that the frequency and intensity of droughts would increase as a result of climate change, especially in semi-arid areas.[11] Does the crisis in East Africa fit this trend? There are two main factors to look at.

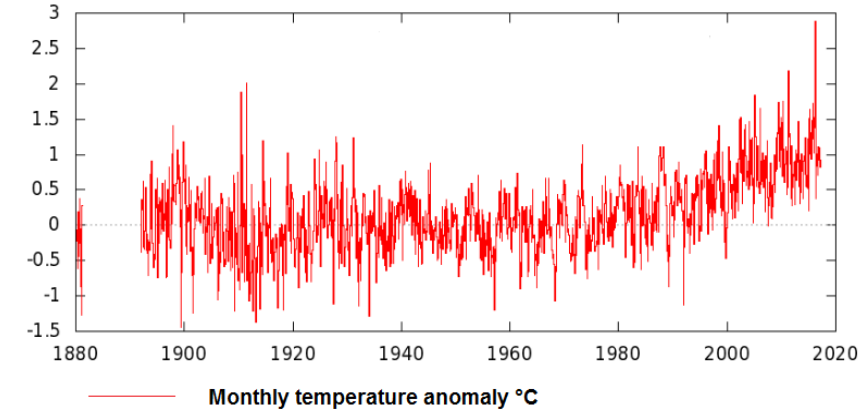
Rising temperatures

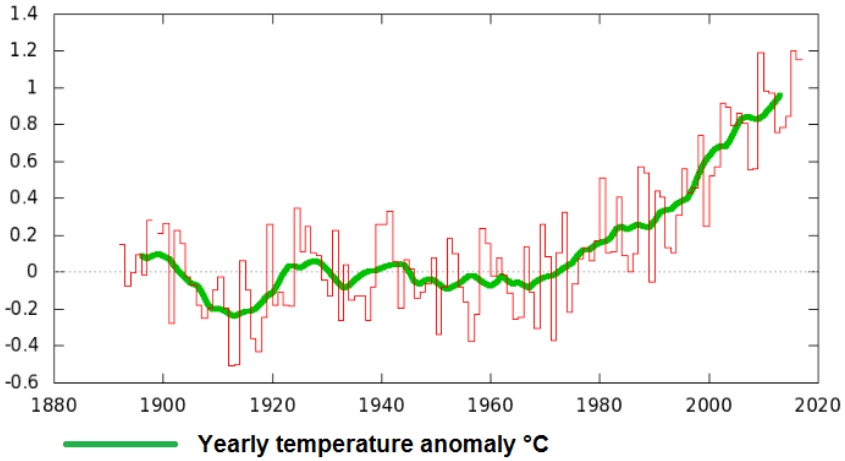
There is mounting evidence that climate change is likely to be contributing to higher temperatures in the region, and that increased temperatures are exacerbating the impacts of drought.[12] Temperatures have been consistently higher in East Africa in recent years, part of a trend seen in Africa and around the world *(see Box 1).*

Higher temperatures result in greater evaporation, meaning soil moisture is reduced, reinforcing drier conditions and intensifying the impacts of failed rains. Crops and pasture have less water, and the chance of failed harvests or lack of feed for livestock increases. In pastoral regions like northern Somalia, higher temperatures over the past six months have turned very low rainfall last year into a terrible loss of soil moisture – helping to desiccate all the available fodder for many of Somalia's pastoralists.

Box 1: Rising temperatures in East Africa

These charts show a clear trend of rising temperatures in East Africa, and particularly high temperatures over recent years compared with a historic average (over the period 1940 to1981).*





* Land temperature anomalies averaged over -4° – 12°N, 35°– 50°E using GISTEMP data https://data.giss.nasa.gov/gistemp/ . Time series produced using the KNMI Climate Explorer website https://climexp.knmi.nl/. Baseline average starts in 1940 due to observed discontinuities in station series data before then, and ends in 1981 when sign of anthropogenic influence are clearly evident.

Scarce and unpredictable rains

Scientific analysis of climate change's role in reducing rainfall during this and other droughts in the region is less definitive than the link to higher temperatures. But what is clear is that the decline in the long rains over the last three decades is 'unprecedented in its persistence and intensity from at least 1874'.[13] And it is easy to see in the data that during the March–June rainy seasons, droughts are becoming much more frequent.[14]

Farhia, 25, pastoralist living in Somaliland, Northern Somalia. Photo: Petterik Wiggers/Oxfam

"We have moved four times in the last four months. We were trying to follow the rain – moving according to where the rains were supposed to come. But they haven't. If the rains don't come, none of us will survive".

It seems likely climate change is playing a role, and there are an increasing number of studies of the physical processes that might be at play.[15] But attribution studies on recent droughts have tended not to indicate a strong influence of climate change on rainfall intensity *(see Table 1).* Given East Africa is already prone to droughts and has high year-to-year variability in its climate, there is disagreement over what is natural variability and what might be caused by climate change.[16]

Linking rainfall trends to climate change is a harder task than linking temperature, especially in Africa where historic data is limited. Lack of detection of a link in attribution studies of individual seasonal outcomes does not firmly indicate the fingerprint of climate change is not present.[17]

It should also be noted that most published research has focused on climate change's impact on the total amount of rain over a season, rather than changes in within-season rainfall patterns.[18] This is an important gap. Because the amount of total rainfall matters, but when looking at a region dominated by rain-fed agriculture, increasingly erratic rains are also a major problem. Shifts in the beginning and end of the rainy seasons, or dry spells during crucial periods during the growing season can all have serious consequences for crop and livestock production.[19]

What about El Niño and La Niña?

The 2015 to 2016 El Niño, one of the strongest ever recorded, played a significant role in the drought during that period.[20]

While a direct connection has not established by the International Panel on Climate Change, an increasing number of scientific assessments claim that climate change may make El Niño stronger and more frequent.[21]

That question aside, higher temperatures linked to climate change are weakening East Africa's ability to endure extremes in weather, such as El Niño and La Niña. When these events come amidst higher temperatures and drier conditions, their impacts are stronger.

Table 1: Climate change attribution studies on drought in East Africa

Climate change is increasing the risk of extreme weather events. Attribution studies use historical data and climate models to separate the effects of natural drivers from the influences of climate change, and set out the probability of an event being more likely or not to occur because of climate change. It should be noted that when attribution studies do not find climate change influence, this alone does not prove climate change did not have an effect, as in some instances it could be due to insufficient data or limited models. The African climate has historically received a lack of research attention, both in general and in the case of extreme event attribution, but this is changing.[22]

Study	Results: rainfall	Results: temperature
Attribution analysis of the Ethiopian drought of 2015[23] (April 2017) Focused on precipitation intensity in north-eastern Ethiopia over the period Feb–Sept 2015, looking at the b*elg* (Feb–May) and *kiremt* (June–Sept) rainy seasons.	The models and observations show mixed results on the influence of climate change, with climate change playing a pronounced role in the *kiremt* (June–Sept) rainy season, according to one model.	Not focus of study.
Kenya drought 2016[24] (March 2017) Focused on 2016 dry short *ond* rains (Oct–Dec) in north-west and south-east Kenya; as well as the particularly dry year Jan–Dec 2016 in south-east Kenya.	There is no detectable trend in rainfall, but the researchers do not exclude small changes in the risk of poor rains linked to climate change.	Trends indicate temperatures involved in this drought are hotter than they would have been without the influence of climate change.
The role of climate change and La Niña in the ongoing Somalia drought: A rapid analysis[25] (March 2017) Focused on the autumn *Deyr* Oct–Nov rains 2016 in Somalia and Somaliland.	Models suggest the effect of climate change on the autumn *Deyr* rains is small compared to natural variability. The strong La Niña that was active at the time explains about one-third of the precipitation deficit.	Not focus of study.
Assessing the contributions of local and east Pacific warming to the 2015 droughts in Ethiopia and Southern Africa[26] (December 2016) Focused on estimating climate change influence on the severe Ethiopian *kiremt* drought (and southern African droughts), including the relative influence of El Niño.	The 2015–16 El Niño was enhanced by climate change, and the El Niño enhancement made the rainfall deficits substantially greater, which translated into even higher reductions in stream flow.	Climate change made temperatures substantially warmer.
Concerns about the Kenya/Somalia short rains[27] (October 2016) While not a formal attribution study, this analysis looked at the historical relationship between East Africa *ond* rainfall and sea surface temperatures.	This analysis predicted the *ond* drought in October, based largely on exceptionally warm west Pacific sea surface temperatures.	
The 2014 drought in the Horn of Africa: Attribution of meteorological drivers[28] (December 2015) Whether climate change played a role in the 2014 East African long rain season in southern Ethiopia, northern Kenya and south-west Somalia (centre of the drought impact), that contributed the 2014 drought in East Africa.	Modelling shows no climate change influence on low rainfall.	Modelling shows clear signals of climate change influence on higher temperatures.

Can the 2011 East African drought be attributed to human-induced climate change?[29] (March 2013) Focused on regions of Kenya and Somalia looking at whether climate change affected the low rainfall that preceded the 2011 drought: 2010 short rains, and the 2011 long rains.	Climate change was found to increase the probability of long rains in 2011. But no evidence was found for climate change influence on the 2010 short rains, with their failure being affected by La Niña.	Not focus of study.

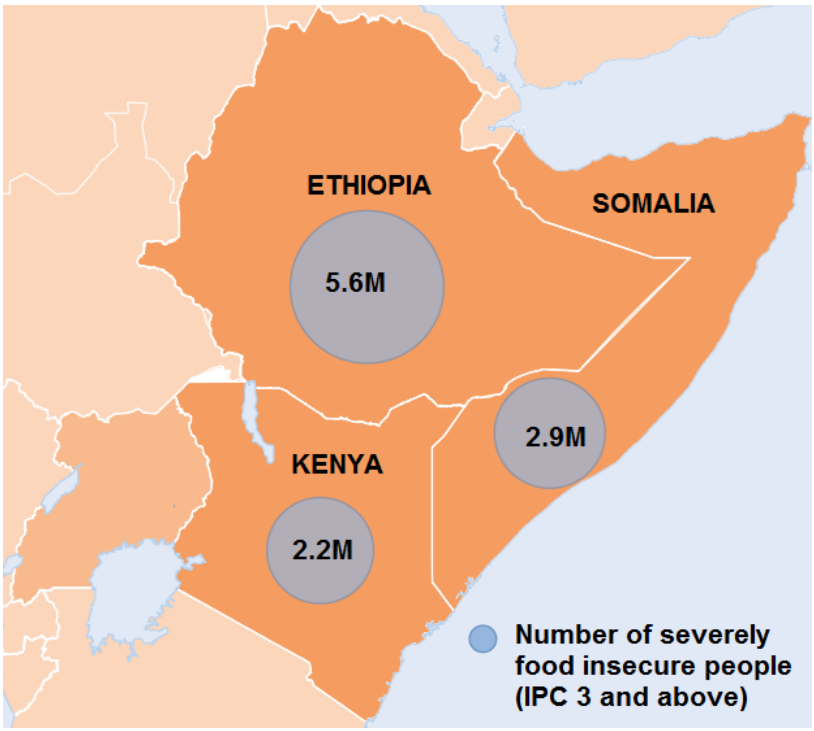
What is the current humanitarian situation?

Box 2: Humanitarian overview

Across the Horn of Africa, in Ethiopia, Kenya, Somalia, and the autonomous region of Somaliland, 10.7million people are facing severe hunger.[30] Additionally, it's expected that 15 million people will not have access to safe drinking water across these three countries in 2017.

There are increasing concerns that the situation will get much worse. The current rainy season has been slow to get underway. During March and early April, Kenya, Ethiopia and Somalia experienced low rainfall. The outlook for the rest of the rainy season which ends in May/June is forecast to be poor.

Somalia
Around 2.9 million people are facing severe hunger. And the number of people in need of emergency food aid has doubled in the last six months to more than 6.2 million people – more than half the population. Without a massive and urgent increase of humanitarian assistance, famine could soon be a reality in some of the worst affected areas. More than 365,000 acutely malnourished children are currently in need of help. About 3.2 million people are estimated to be in urgent need of water.[31] Somalia is currently experiencing its biggest cholera outbreak in recent times.



Ethiopia
Around 5.6 million people are facing severe hunger and 9.2 million people are expected to not have access to safe drinking water.[32] An estimated 300,000 children are expected to become severely acutely malnourished.

Kenya
The number of food insecure people recently doubled and currently stands at 2.2 million people. Malnutrition rates are above critical levels in five counties.

Box 3: Pastoralists in the Somali region of Ethiopia

The Somali region of southern Ethiopia is home to a large population of nomadic pastoralists who are among the hardest hit in the country by the current drought. Low rainfall across the region for two consecutive years has left rivers, *birkas* (water storage), and many other sources of water dry. Over 1.2 million people in the region are currently in urgent need of water.

Pastoralists can cope well with dry conditions. They can move their herds to find water and fresh pasture. However, they are also vulnerable to droughts. Pastoralists usually lose livestock during drought, which they normally recover in the years that follow. But this relentless drought has left exceptional numbers of people without most or all of their livestock, and the risk of no rain or heavy downpours killing those animals that have survived now looms.

Ismail**,** a pastoralist in Gashamo *woreda,* or district*,* tells of the livestock he has lost: 'Last year was bad. This year is worse. Livestock were not dying as they are dying now. Before people were still taking livestock to market. I had 150 goats and sheep and now I have 25. But not one of them is fit to sell. I cannot even eat their meat. The animals are not fit for slaughter.'

He is also deeply concerned by changes in the weather he has witnessed:
'I have never seen such hot weather before. In 24 months this area has not had rain. The trees used to have moisture in the stems. Now the trees have dried out. It will be a catastrophe if we don't get the rains on time'.

Ismail is not alone. Jama, a pastoralist living in Bodadere temporary settlement describes the extraordinary nature of the drought: 'There is nothing here. Nothing. This is an empty place without pasture or water in any direction you go. Even my parents did not tell stories of droughts like this.'

Bodadere temporary settlement is among the first to be established in Gashamo *woreda*. Due to the severity of this drought it was recently set up to provide people with assistance. Most of the people living there are nomads and have never lived in a settlement before, including Ibado, age 60, who lives with her nine grandchildren and their mother and father: 'In my lifetime I have never seen this. We used to have 700 sheep and goats, now we have seven. I have never lived in a settlement before – this drought has forced me. This drought is affecting everyone.'

Ibado, 60, pastoralist living in Bodadere temporary settlement, Gashamo woreda, Somali region, Ethiopia. Photo: Tracy Carty/Oxfam

What does the future look like?

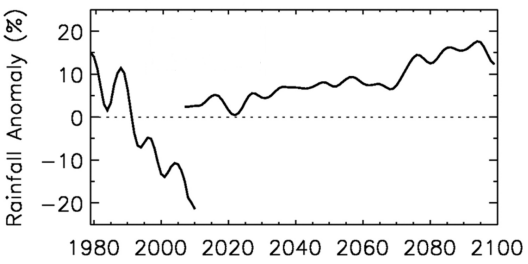
In a changing climate we can expect the unexpected – more extremes, more often. As David Carlson of the World Meteorological Organization said recently: 'Even without a strong El Niño in 2017, we are seeing other remarkable changes across the planet that are challenging the limits of our understanding of the climate system. We are now in truly uncharted territory'.[33]

Today global average temperatures are one degree above pre-industrial levels and the effects in the region appear to be profound.[34] Inertia in the climate system means that even if emissions are cut dramatically today, further increases in temperatures are still inevitable.

Even if global temperatures are limited to the 1.5 or well below 2 degrees set out in the Paris Agreement, it is highly plausible that this will still result in higher temperatures in East Africa.[35]

Temperatures are set to rise, but there is uncertainty on what long-term precipitation trends will be for the region.[36] Most climate models, as set out in the IPCC's last assessment, suggest the region will get wetter due to climate change.[37] Yet, in what is known as the 'East Africa Climate Paradox' observed trends show the opposite happening (see Box 4).[38]

Box 4: The East Africa climate paradox - past and future rainfall trends



The diagram contrasts the stark difference between observed declining rainfall patterns over recent decades and increasing rainfall over the coming decades projected by the majority of climate models. D. Rowell et al. (2015) 'Reconciling Past and Future Rainfall Trends over East Africa', *Journal of Climate*, Volume 28, AMS

Even if ultimately the drying trend goes into reverse, East Africa faces higher temperatures and decades of disruptive climate change. The impact that temperature increases alone will have on agriculture and livestock are likely to be significant, regardless of rainfall changes.[39]

What happens in the next two to three decades is a crucial question for science to study and governments to prepare for. Governments urgently need to help their communities to adapt to the possibility that the current devastating droughts will continue for years to come.

Box 5: Adaptation in action – long-term water solutions are helping families in Turkana, Kenya, cope in the drought

Years of higher temperatures and poor or no rain has left Turkana facing chronic water shortages. It is estimated that only 40 percent of boreholes in the area are currently functional.[40] The remaining sources such as hand-dug wells or Lake Turkana are unsafe, and bear the risk of deadly diseases such as typhoid and diarrhoea.

Since 2014, Oxfam has been helping families in Turkana gain access to sustainable sources of water. Through the installation of 15 new solar-powered boreholes and other durable technologies nearly 129,000 people have been provided with clean safe water.[41]

This long-term approach is helping people be better prepared for climatic shocks and stresses such as drought. Teresa from Lowareng'ak area compares her situation to those in communities without similar investments: 'It has not rained for over a year so water is a big problem for everyone. But because of this borehole, we do not lack water' she said. 'It is hard for those who don't have these (boreholes). Some walk for hours to come find water here. One woman told me that if she had known sooner that we had water here, her animals would still be alive today'.

Jennifer from Nasechabuin area said the pipeline installed by Oxfam to bring water to her village has been a reprieve: 'I have water right outside my door so in one way my family is safe. Even my goats can now stay alive'.

Other communities, such as Margaret's from Kapua village at least a hundred kilometres from Lowareng'ak, have to hope against hope that they too will see similar change: 'I have to walk four kilometres from my home to the well just to fill a twenty litre bucket. I have to make several trips to have enough water for my children. Some days I'm too weak to go so we either borrow from our neighbours, or wait until I'm strong enough'.

Action needed

The climate is changing, and East Africa faces a race against time. Severe drought should no longer be considered exceptional in this part of the world, but a new reality governments urgently need to be better prepared for and able to respond to. Climate change forces into sharp focus the need to address the underlying causes of vulnerability and poverty that make people's lives so precarious to changes in the weather; as well as political inertia which makes governments slow to respond to crisis and take necessary action to tackle climate change.

Catastrophic loss of life today is not inevitable: urgent and robust humanitarian and political action now will prevent the worst from happening. Widespread suffering and hunger tomorrow due to climate change is also not inevitable: we can still reduce emissions to avoid the worst impacts of climate change, and build resilience to climate extremes that cannot be avoided.

Urgent action by national governments, donors and the international community is needed:

Donors must fulfill the UN's $1.9bn appeal to urgently increase food and life-saving support.[42] The desperate need for money cannot be overstated. Money needs to come now to prevent this crisis becoming a catastrophe.

Governments, donors and the international community must commit to respond earlier to the warning signs of future crises before they escalate. Early action saves lives, reduces suffering and, like preventative healthcare, is more cost-effective than responding after a crisis has happened. This is not about *more* money but funding *earlier*.[43]

All actors should prioritize programmes targeting women and girls and protection programmes for children, who are hardest hit and most vulnerable.

Slash greenhouse gas emissions to avert devastating levels of warming this century. The total current pledges of emissions cuts amount to a catastrophic 3 degrees of warming, or even more. G7 and G20 leaders, and the international community, must reaffirm the Paris Agreement and commit to raising the ambition of current commitments, in order to keep the goal of limiting global temperature rises to 1.5 degrees and well below 2 degrees within reach.

National governments, donors and the international community should dramatically increase long-term investment to address the underlying causes of vulnerability of pastoralists and smallholder food producers, and to build their resilience and productivity so they are better able to cope with a changing climate.

Countries should meet their commitments under the Comprehensive African Agriculture Development Program to allocate 10 percent of their budgets to the agriculture sector.

This effort must be supported by a significant scaling up of international climate finance by donors to enable national governments to act.

Action needs to include:

- **National governments implementing risk reduction strategies** by accepting climate risk of future droughts and proactively managing that risk by working out

contingent liabilities and a plan for meeting them, including financial costs (some of which will be met by aid in extreme cases).

- **Disaster risk reduction**. Drought cycle management, for example, offers a useful approach which should be consistently implemented by governments in the region.
- **Climate change adaptation**. Building and maintaining sustainable water sources, drought-resistant and heat-tolerant seeds, providing weather insurance and other action all help vulnerable people cope with climate extremes.
- **Long-term investment in rural development and areas most at risk.** To reduce vulnerability of the hardest hit communities, especially those with livelihoods which depend on predictable rainfall.

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NOTES

1 The 10.7 million comprises of 2.9 million people in Somalia (including the autonomous region of Somaliland), 5.6 million people in Ethiopia and 2.2 million people in Kenya.

2 See Table 1

3 J. Firebrace (2016) *The Hidden Crisis in Eastern Somaliland: An assessment of the drought affected areas from ground observations and interviews* http://e-voice.org.uk/kingston-somali-community/files/view/JFA_Final_Report_on_Drought_in_Eastern_Somaliland_22_Dec_2016.pdf

4 OCHA (2017) *Horn of Africa: A call for action*, February 2017

5 *Seasonal Monitor:* Drought conditions exacerbated by above-average surface temperatures over Eastern Horn, January 31, 2017 http://www.fews.net/east-africa/seasonal-monitor/january-2017

6 See for example forecast by climate scientist Chris Funk 'Below normal long/Gu rains appears likely for Eastern Africa' 23 March 2017 http://blog.chg.ucsb.edu/?p=165. March rainfall performance has been extremely poor for Kenya and Somalia http://blog.chg.ucsb.edu/?p=194.

7 I. Masih et al. (2014) A review of droughts on the African continent: a geospatial and long-term perspective, *Hydrology Earth System Sciences,*18

8 2007, 2008, 2009, 2010, 2011, 2015, 2016 and to date drought conditions have continued in most parts of the region in 2017.

9 Despite the name, it should not be assumed that the long rains are the most important for all regions – the importance of the long rains and short rains for agriculture and pastorialism varies by region.

10 See blog by Chris Funk, 'Concerns about the Kenya/Somalia short rains, Climate Hazards Group', October 2016 http://blog.chg.ucsb.edu/?m=201610

11 T. Zhao et al. (2015) 'The Magnitude and Causes of Global Drought Changes in the Twenty-First Century under a Low–Moderate Emissions Scenario', *Journal of Climate,* 28

12 See Table 1 for studies linking high temperatures and climate change in drought-affected countries. And see the following for an assessment of how higher temperatures are currently making drought conditions worse: *Seasonal*

Monitor: 'Drought conditions exacerbated by above-average surface temperatures over Eastern Horn', January 31, 2017 http://www.fews.net/east-africa/seasonal-monitor/january-2017

13 D. Rowell (2015) 'Reconciling Past and Future Rainfall Trends over East Africa', *Journal of Climate*, Volume 28, AMS

14 Blog by Chris Funk, October 2016 op. cit.

15 Chris Funk, for example, suggests warming over the western Pacific (linked to climate change) is bringing more rain to South East Asia and drier air to East Africa. More dry air means more drought. Funk contends that as greenhouse gas emissions increase, these patterns are likely to continue, increasing drying. http://www.voanews.com/a/experts-say-climate-change-may-be-making-african-drought-worse/3783181.html The science underpinning this assertion and the Climate Hazards Group's predictions of East African drought can be found online at: http://www.hydrol-earth-syst-sci.net/18/4965/2014/ and http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-14-00334.1.

16 The high year-to-year variability of the climate means that in attribution studies the signal would have to be very large to be significantly different and thus detectable from natural variability. In the ongoing drought in Somalia for example research can exclude that climate change increased the risk of drought more than fivefold, but even if the risk only doubles, the impacts would be huge in a very vulnerable region.

17 But rather its influence was not detected. In some instances this could be due to missing data. E. Sarojini. et al (2016) Detection and attribution of human influence on regional precipitation. *Nature Climate Change*

18 New work suggests that warm west Pacific sea surface temperatures may increase sub-seasonal East African drought events. See N. Vigaud et al. (2016)'Sub-seasonal teleconnections between convection over the Indian Ocean, the East african long rains and tropical Pacific surface temperatures', *International Journal of Climatology*, 37

19 See the following Oxfam study setting out why timing of rain and intra-seasonal rainfall patterns are critical to smallholder farmers in developing countries S. Jennings and J. Magrath. (2009) *What Happened to the Seasons?: Changing seasonality may be one of the major impacts of climate change,* Oxfam Research Report, http://policy-practice.oxfam.org.uk/publications/what-happened-to-the-seasons-changing-seasonality-may-be-one-of-the-major-impac-112501

20 El Niño is a naturally occurring phenomenon that disrupts normal weather patterns and brings drought and wetter conditions to different parts of the world.

21 For example, this study concluded that anthropogenic warming contributed substantially to the very warm 2015/16 El Niño sea surface temperatures: Funk et al (2016) *Assessing the contributions of local and East Pacific warming to the 2015 droughts in Ethiopia and Southern Africa*, BAMS Dec 2016

But as yet the collective judgement of scientists on the relationship between El Niño and climate change is inconclusive, in part because observational data on El Niño only goes back a few decades and there have been natural variation in El Niño events over long periods of time.

The link between El Niño and La Niña is also not straightforward and modified by what the Indian Ocean is doing and impacts of increasing temperatures on it, which may change the teleconnection and make droughts in East Africa even harder to predict.

22 F. Otto et al (2015) 'Attribution of extreme weather events in Africa: a preliminary exploration of the science and policy implication', *Climate Change*, Vol 132, October 2015

23 Philip et al. (2016) 'Attribution analysis of the Ethiopian drought of 2015', submitted to *Journal of Climate* in April 2017

24 Scientists with World Weather Attribution carried out the attribution study:
https://wwa.climatecentral.org/analyses/kenya-drought-2016/

25 Scientists with World Weather Attribution carried out the attribution study:
https://wwa.climatecentral.org/analyses/somalia-drought-2016-2017/

26 C. Funk et al (2016) 'Assessing the contributions of local and east Pacific warming to the 2015 droughts in Ethiopia and Southern Africa', *Explaining Extreme Events in 2015 From A Climate Perspective, Special Supplement to the Bulletin of the American Meteorological Society* Vol 97, No12, December 2016
http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-16-0167.1

27 Blog by Chris Funk, October 2016 op. cit.

28 Marthews et al (2015) 'The 2014 drought in the Horn of Africa: Attribution of meteorological drivers', *Explaining Extreme Events in 2014 From A Climate Perspective, Special Supplement to the Bulletin of the American Meteorological Society* Vol. 96, No. 12, December 2015 http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-15-00115.1

29 F. Lott (2013) 'Can the 2011 East African drought be attributed to human-induced climate change?' *Geophysical Research Letters* 40(6) March 2013
https://www.researchgate.net/publication/258772331_Can_the_2011_East_African_drought_be_attributed_to_human-induced_climate_change

30 OCHA (2017) *op cit*

31 OCHA (2017) *op cit*

32 OCHA (2017) *op cit*

33 Quoted in article: 'Record-breaking climate change pushes world into 'uncharted territory', *The Guardian*, 21 March 2017 https://www.theguardian.com/environment/2017/mar/21/record-breaking-climate-change-world-uncharted-territory

34 Across Africa temperatures have increased dramatically over recent years, rising at more than twice the global rate in some places. Engelbrecht F. et al. (2015) 'Projections of rapidly rising surface temperatures over Africa under low mitigation', Environmental Research Letters, 10 http://iopscience.iop.org/article/10.1088/1748-9326/10/8/085004/pdf

See Box 2 for an indication of rising temperatures in East Africa's drought affected areas over recent years.

35 For an explaination of how higher temperatures increase the intensity of drought see K.E. Trenberth et al (2014) 'Global warming and changes in drought '.*Nature Climate Change*

36 Changes in rainfall are extremely hard to predict, and projections are offered with a lower level of certainty than temperature changes. Changes in future rainfall patterns are debated, see for example N. Souverijns et al (2016) 'Drivers of future changes in East African precipitation'*, Environmental Research Letters,* Vol 11

37 The Intergovernmental Panel on Climate Change's 5th assessment projected very likely increases in average temperatures by the mid and late 21st century under both high and low emission scenarios. Projections for rainfall were less certain than for temperature, but showed likely increases in annual average rainfall. http://www.ipcc.ch/report/ar5/wg1/

38 See for example D. Rowell (2015) 'Reconciling Past and Future Rainfall Trends over East Africa', *Journal of Climate*, Volume 28, AMS

While climate change models predict a transition to an El Niño-like climate, what we seem to see is the opposite – a more La Niña-like 'new normal' interspersed with more extreme El Niños.

39 P.K. Thornton et al. (2011) 'Agriculture and food systems in sub-Saharan Africa in a 4 °C+ world'. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*

40 According to the National Disaster Management Authority

41 Through the Oxfam-led consortium SWIFT program funded by DFID WASH Results Program. http://policy-practice.oxfam.org.uk/our-work/water-sanitation-and-hygiene/swift

42 This includes Ethiopia, Kenya, Somalia and Uganda. See OCHA (2017) *op cit*

43 See for example DfID study '*Multi-year Support to Emergency Preparedness and Rapid Response' (2013)* in Mozambique which shows significant savings to early action.