HSBC Global Research

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ESG Summer Series 2024

Flash droughts: dry in a flash

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- The frequency of flash droughts (FDs) is rising globally; their unique traits call for new forecasting tools & mitigation strategies
- Frequent FDs pose high risks to the agriculture sector, in particular, and could intensify further with climate change
- Various other sectors are also vulnerable to FDs; raising awareness and use of monitoring tools could help mitigate risks

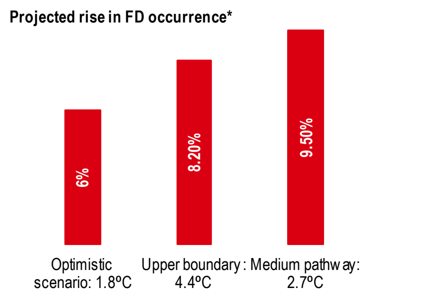
This is the second report in our ***ESG Summer Series 2024*** *– looking at sustainability issues in less obvious places. These issues could grow to become bigger trends in the future.*

Out of nowhere: Imagine you are on a holiday on a *warmer than usual* beach and wish to take a shower after a day soaking in the sun. However, you are left sticky and confused when you find that the water for tourists is rationed by the local authorities due to a sudden onset of a drought-like situation in the region. Welcome to the new world of ***flash droughts (FDs)***, the sneaky version of *slow* drought, known for its rapid onset and strong intensity, and which usually take administrators by surprise.

On the rise: The recorded instances of FDs are rising globally, particularly in regions with high humidity and low aridity. Geographically, they are concentrated in (but not limited to) the tropical and sub-tropical regions. Climate change could further worsen the FD situation (Fig 1) by adding a layer of variability in precipitation and intensification of heatwaves. Current tools used to monitor conventional droughts are largely inadequate for FDs, and efforts to identify a unified set of indicators remain inconclusive due to seasonal and regional variability. Nevertheless, advancements, such as using increased *solar-induced fluorescence* as a potential indicator of severe soil water loss due to FDs, look promising.

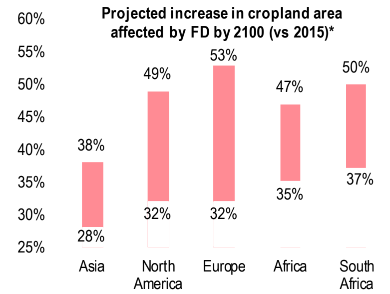
Far-reaching impacts: Flash droughts pose significant risks to various sectors, particularly *Food & Agriculture*, due to a potential drop in cropland yields (Fig 2). Whereas a sudden decline in hydroelectric power output could adversely affect the *Energy* sector, FDs could also impact *Tourism*, among other things. Given that developing countries are more prone to FDs, investments in monitoring tools and adaptation, as well as raising FD awareness, are critical to mitigate the impacts and build resilience, in our view.

1. FD frequency to rise in all climate scenarios…



Source: Nature - Global projections of FD show increased risk in a warming climate; *mean change in FD frequency over 2066-2100 vs 1980-2014; scenarios represent estimated warming by 2081-2100 (as per the IPCC Sixth Assessment Report)

2. …impacting croplands across all major regions



Source: Nature - Global projections of FD show increased risk in a warming climate; *based on 30Y mean values in SSP585 scenario

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Amit Shrivastava*
ESG Analyst, European Equity Strategist
HSBC Bank Middle East Ltd, DIFC

Anushua Chowdhury
Associate, Climate Change & ESG Research
HSBC Securities and Capital Markets (India) Private Limited

Jawahar Hingorani
Analyst, Climate Change & ESG Research
HSBC Bank plc

Wai-Shin Chan, CFA
Head, Climate Change Centre; Head, ESG Research
The Hongkong and Shanghai Banking Corporation Limited

James Rydge
Head, ESG Research, EMEA
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What is a flash drought?

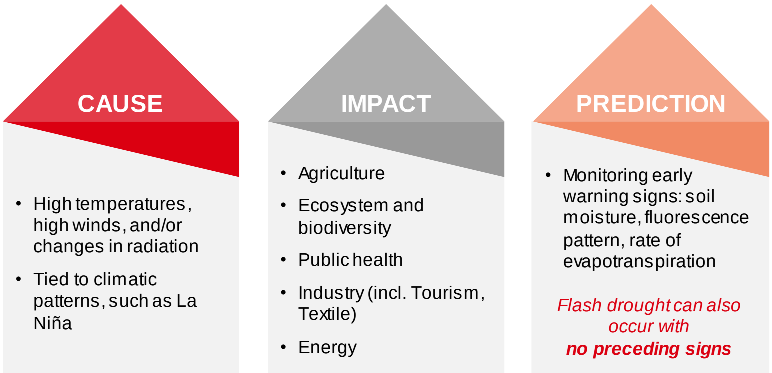
Swift and intense…

Droughts are usually defined as periods of time with a persistent water deficit. Unlike *conventional* or *slow* droughts, which are caused by prolonged periods of below-normal rainfall, and which can persist for months or even years, **flash droughts (FDs)** are a result of lower-than-normal rates of rainfall, accompanied by abnormally high temperatures, winds, and radiation. This special category of drought, FD, develops suddenly – often over days or weeks – and intensifies rapidly. In contrast to slow droughts that may occur at any location throughout the year, FD are more common during warmer seasons.

...hence more damaging in the short term

Most flash droughts are short-lived, and might not persist long enough to become conventional droughts. A research study focused on FDs in the US between 1979 and 2016 indicated that about 5-10% of all FDs transitioned to the highest drought category[1]. However, unlike conventional droughts, which unfold slowly, allowing more time for preparation and implementation of mitigation strategies, FDs can be *more damaging* in the short term due to their sudden onset and rapid intensification, often requiring a rapid response.

3. Flash droughts: cause, impact and potential prediction metrics



Source: HSBC (based on National Integrated Drought Information System, NASA)

Did you know? *The term "flash drought" is fairly new. It can only be found in the scientific literature as early as 2002, though research on the topic grew considerably after the 2012 drought in the US.* Currently, FD impacts are most widely studied in developed parts of the world, but the risks for the developing and under-developed countries remain notably high.

FD hotspots: flashes around the world

Tropical & sub-tropical regions are most impacted…

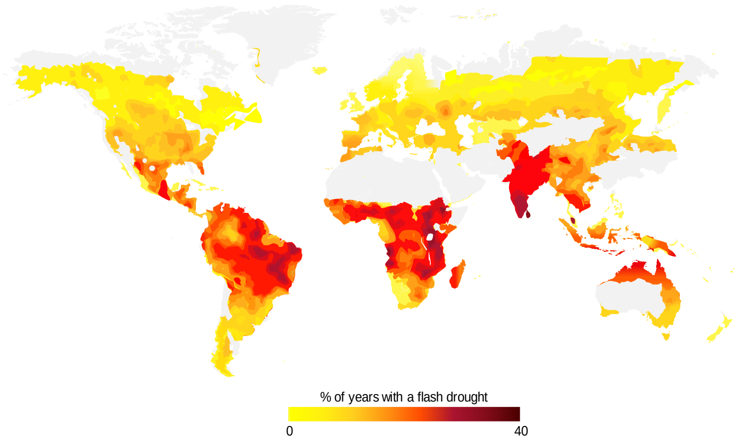
By geographical zones, the areas experiencing the highest frequency of FDs are usually concentrated in the tropical and sub-tropical regions. Economically, large areas across major developing countries and the least developed parts of the world are the worst impacted, including areas in Brazil, India, China, and Central & Equatorial Africa (Fig 4)[2]. However, there are many other FD hotspots that are spread around the world, including some parts of the US, Mexico and Eastern & Southern Europe, among others. In Spain, for instance, FDs have become more frequent, accounting for nearly 40% of all droughts[3].

...but wet regions are also not spared

The recorded instances of FDs are rising globally, particularly over the humid regions with lower aridity, where the frequency of their occurrence is 2x-3x higher than the other regions[3]. FD in the south-eastern United States in 2016 is a good example: despite the region's reputation for being water rich and receiving ample rainfall, 92% of the area within Georgia, Alabama, Mississippi, and Tennessee was known to be in a state of "severe drought" or worse[4].

1 IOP Science, Regional characteristics of flash droughts across the United States, 4 November 2019
2 Nat. Commun. Christian, J. I, R. M. Global distribution, trends, and drivers of flash drought occurrence, 03 November 2021
3 Data in Brief, Near-real time flash drought monitoring system and dataset for Spain, 17 January 2023
4 The 2016 Southeastern U.S. Drought: An Extreme Departure From Centennial Wetting and Cooling, 04 October 2017

4. Tropics and sub-tropics are most prone to flash droughts



Source: HSBC (recreated based on Nature, Global distribution, trends, and drivers of flash drought occurrence, 03 November 2021)

Challenges and emerging monitoring tools

Climate change is likely to increase the risk of FDs

FDs present a unique challenge for risk management. Given they often develop with limited or no warning, FDs are not only difficult to monitor and forecast, but mitigation strategies are often challenging to implement. Climate-induced rainfall variability adds a further layer of risk. Studies[5] have found that climate change has led to an increase in the frequency of FDs in many regions across the globe. In fact, over 74% of all global regions have recorded an increase in drought intensification rates and a transition towards more FDs[6]. Looking ahead, FDs could become more prevalent: another study predicts a rise in the FD occurrence across all climate scenarios[7] (Fig 1).

Difficult to forecast and mitigate using existing tools

As per the National Integrated Drought Information System (NIDIS), the existing tools used to monitor and forecast droughts are insufficient to provide adequate early warnings for FDs. Moreover, studies focused on identifying an integrated set of leading indicators for FD are not conclusive due to variability in their occurrence across seasons and regions[8].

> **"As flash droughts intensify rapidly, they need different early warning systems and mitigation methods than those typically used for slower evolving conventional droughts**

Emerging tools to monitor FDs

Advancements in FD monitoring technologies

However, some progress has been made in this space, particularly in developed parts of the world. For instance, scientists can now predict possible FDs through increased *solar-induced fluorescence* (SIF), where an unusual boost in plant productivity is an early sign of severe soil water loss[9]. Another open-source tool, *FLASH*, uses NASA's SMAP (Soil Moisture Active Passive) satellite to monitor near-real-time FDs. Owing to the high frequency of FDs, Spain has also developed an *FD monitor* based on the Standardized Precipitation Evapotranspiration Index[10]. Likewise, the *Rapid Drought Intensification Risk Tool*, developed by the Midwestern Regional Climate Centre in the US, uses artificial intelligence to forecast the likelihood of rapid drought intensification.

***Did you know?** Faster than normal rate of growth of crops could be a sign of an imminent FD.*

5 Cooperative Institute for Meteorological Satellite Studies, Space Science and Engineering Center, University of Wisconsin–Madison
6 Xing Yuan et al. ,A global transition to flash droughts under climate change.
7 Christian, J. I.,et al. (2023). Global projections of flash drought show increased risk in a warming climate
8 Flash Drought: Current understanding & future priorities, NOAA/NIDIS
9 NASA, How 'Glowing' Plants Could Help Scientists Predict Flash Drought
10 Noguera, I., Domínguez-Castro, F., Vicente-Serrano, S. M., & Reig, F,Near-real time flash drought monitoring system and dataset for Spain, April 2023

Most impacted sectors

The swift onset and high intensity of FDs can cause extensive damage to the agriculture sector, in particular, with studies[11] suggesting heightened risk on croplands across all major regions in the future (*chart 2*). Additionally, FDs could also impact the overall ecosystem and livelihoods in the affected regions due to its knock-on impacts on other sectors, including tourism, food & beverages, and textiles (natural fibres such as cotton), among others. Below, we explore a few sectors that may be left vulnerable, in the future, as frequency and intensity of FDs increase:

Agriculture is the worst impacted; knock-on impact on many other sectors

Agriculture: FDs occurring during the critical growth stages of crops can result in significant agricultural losses. Corn, for instance, is the most vulnerable during its flowering phase and an intense FD during this stage of its growth could severely impact the harvest. As per estimates[12], the 2017 FD impacting the US Northern Plains caused USD2.6bn in agricultural losses in the US alone. Similarly, FDs in western Russia in 2010 resulted in c11,000 deaths and led to a 70% fall in the regional wheat yield, leading to a ban on wheat exports and resulting in a surge in global prices[13].

The drying tale of Californian almonds and remedial measures

Almond cultivation is a water-intensive process, requiring an average of 10,240L of water to produce a kilogram of kernels[14]. However, scarcity of water due to frequent droughts in **California**, which accounts for c80% of the world's almond supply, forced several farmers in the region to explore alternative crops[15]. Nonetheless, despite increasing risks of droughts and water scarcity, farmers have taken many remedial measures and set a target in 2018 to reduce water use by 20% by 2025. Several steps have been taken, which include the use of micro-irrigation by 80% of California almond farms, on-farm groundwater recharge, and precision scheduling[16]. As a result, c75% of the target was already met by 2022.

Energy: FDs could disrupt the energy sector. They could lower the hydropower generation due to a fall in the availability of water required for power plant operations. A flash drought in China's Yangtze River basin in 2022, for example, not only triggered wildfires, but the subsequent drying up of the river led to an energy shortage in southern China, as hydropower stations couldn't operate at desired capacity. Likewise, FDs could also lead to a fall in crop yields for biofuel production.

Waterways and aquatic ecosystems: FDs can also severely impact rivers and waterways, resulting in increased stress on aquatic ecosystems and disruption of navigation. Water levels in the Mississippi River, for instance, reached a record low in October 2022, owing to FD in Memphis that year. The river is a key waterway to move grain by barge to domestic and export markets. Therefore, lower-than-usual water levels in the river not only disrupted transportation of shipments, but also led to an increase in transportation costs[17].

Wildfires: FDs can have a cascading impact leading to wildfires. Wildfires not only destroy landscapes, vegetation and wildlife habitats, but also pose threat to human lives and property, compounding the challenges for the communities already reeling under the impacts of FDs. The 2017 FD in the Canadian Prairies resulted in high number of wildfires in the rangelands of Alberta and Saskatchewan[18]. The more recent 2023 wildfire, caused by FDs, in Hawaii caused enormous losses, resulting in nearly 100 fatalities and destruction of over 2000 buildings[19].

11 Christian, J. I.,et al. (2023). Global projections of flash drought show increased risk in a warming climate
12 NOAA/NIDIS, Flash Drought: Lessons Learned From the 2017 Drought Across the U.S. Northern Plains and Canadian Prairies, 29 May 2019
13 Jordan I Christian et al 2020; Flash drought development and cascading impacts associated with the 2010 Russian heatwave
14 Fulton, J., Norton, M., & Shilling, F. Water-indexed benefits and impacts of California almonds, 2019
15 Politico, Have we reached 'peak almond'?, 31 May 2022
16 California Almonds, Do almonds use a lot of water?
17 The Conversation, Record low water levels on the Mississippi River in 2022 show how climate change is altering large rivers, 14 December 2022
18 Global Assessment Report on Disaster Risk Reduction, Special Report on Drought 2021
19 'Flash drought' in Hawai'i fuels deadliest U.S. wildfires in 100 years, 13 August 2023

Biodiversity: The Amazon basin has experienced severe drought events this century, leading to a significant loss of biodiversity. The drought in 2015/16, for instance, resulted in devastating wildfires, burning an estimated 9,246km^2 of the Amazon rainforest[20]. While the biodiversity loss in the region was not a direct result of FD, it indicates the inherent vulnerability of the region. Several regions of biodiversity-rich South America are facing an increased risk of FDs, which can trigger biodiversity loss due to increased competition for dwindling resources and habitat loss due to wildfires.

Tourism: The tourism sector also faces major risks due to FDs. Given tourists consume 2-3x more water than local residents[21], the water-intensive nature of the sector makes it vulnerable to water scarcity due to FDs. Key risks include decreased water availability for tourists' recreational activities (eg, pools and golf) and reduced attractiveness of affected landscapes which usually draw tourists. Furthermore, FDs can significantly alter natural scenery and lower agricultural productivity, thus negatively impacting agri-tourism (eg, farm tours) and eco-tourism.

Did you know?: Catalonia in Spain declared a ***drought emergency*** earlier this year, wherein the worsening water situation forced authorities to consider imposing water-related restrictions on tourists[22]. Likewise, the 2017 FD in the US Northern Great Plains region disrupted the local tourism industry, resulting in a decline in the number of tourists and loss of revenue[23].

The tourism sector has already been affected by long, slow droughts, and the rising occurrences of FDs around the world could only make the situation worse, in our view. Last year, low water levels in rivers due to persistent drought in large parts of Europe, for instance, forced authorities to take preventive measures, such as transporting cruise passengers by bus at some stretches of the river Rhine[24]. Similarly, approaching 'day zero' in Cape Town in 2017 (a point when the city would run out of water), which was driven by a long drought in the region, led to a considerable decline in tourist arrivals, significantly impacting the overall tourism sector[25]

Conclusion

FDs could become a major issue in the future; raising awareness could help the most vulnerable regions

Given its significant impact on critical sectors such as food and agriculture, among others, there is a growing urgency to raise awareness about FDs, which are becoming more frequent and intense. Since the least developed parts of the world appear to be the most vulnerable, there is a need to deploy more investments into systems and processes for effective monitoring and forecasting of FDs, and facilitate a shift in the deployment of mitigation measures to prevent loss of lives, ecosystem and preserve biodiversity.

20 NewScientist, Major 2015 wildfires in central Amazon killed a quarter of vegetation, 19 May 2021
21 Impacts of tourism development on water demand and beach degradation on the island of Mallorca (Spain). Garcia C., Servera J. 2003
22 AP News: Don't let it flow: Tourists to Spain's Catalonia may soon see water restrictions in the dry season, 16 April 2024
23 Lessons Learned from the 2017 Flash Drought across the U.S. Northern Great Plains and Canadian Prairies, 2020
24 How Europe's droughts are affecting tourism, 2023, dw.com
25 What the tourism sector can learn from Cape Town's drought, 22 Sep 2020

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