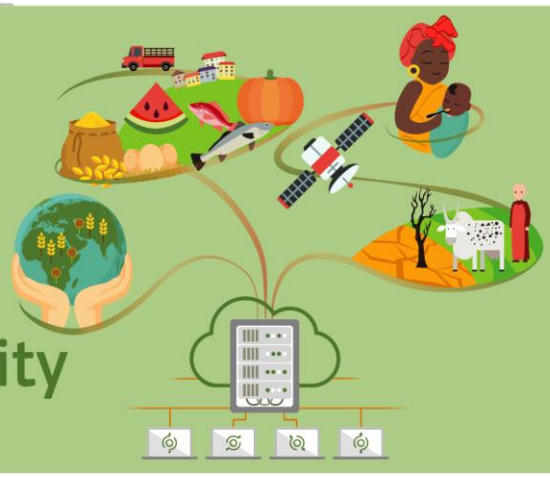
European Commission

The European Commission's Knowledge Centre for Global Food and Nutrition Security



About the rapidly increasing impact of weather and climate extremes on food security and the need for accelerated adaptation and mitigation action

Headlines

- There is high confidence that increasing weather and climate extreme events have exposed millions of people to acute food insecurity and reduced water security, with the largest impacts observed in many locations in Africa, Asia, Central and South America, Small Islands and the Arctic.
- The cumulative scientific evidence is unequivocal: Climate change is a threat to human well-being and planetary health. Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a rapidly closing window of opportunity to secure a liveable and sustainable future for all.
- Climate variability and extremes are a major driver of food insecurity and malnutrition, are closely interlinked with other major drivers such as conflicts and economic slowdowns and as shown by the ongoing global food crisis, can create cascading negative impacts on food security.
- They continue to increase in both frequency and intensity, which leads also to more simultaneous or back to back occurrence.
- All dimensions of food security can be negatively impacted by weather and climate extremes, which often lead to livelihoods erosion for the poorest and in particular in countries with high dependence on agriculture and high percentage of income spent on food.
- Reducing risks due to weather and climate extremes on food security is one of the major challenges of the 21st century and requires inter-sectoral approaches and action, international collaboration and increased levels of policy coherence and synergy.
- In the agricultural sector, the main emphasis for mitigation should be on healthy and sustainable diets on the demand side and on reduced food loss and waste on the production side. Plant-based diets could reduce agricultural GHG emission by 80%, while food production practices only by 10%.
- Agroecological practices and climate-smart agricultural practices show high potential to support climate change adaptation. The costs for adaptation action is a fraction of the cost of inaction.

Climate change and extremes

As compared with the previous version of this brief published in 2020, the evidence about the impact of climate change has continued to increase, as has the perception of the urgency of adaptation and mitigation action. In its Summary Report for Policy Makers on *Climate Change – Impacts, Adaptation and Vulnerability,* the Intergovernmental Panel on Climate Change (IPCC) concluded in 2022 that: "*Widespread, pervasive impacts to ecosystems, people, settlements, and infrastructure have resulted from observed increases in the frequency and intensity of climate and weather extremes, including hot extremes on land and in the ocean, heavy precipitation events, drought and fire weather*" (1).

Changes in the precipitation regime, increasing temperatures and extremes have been projected for the coming decades all around the world (2) (3) (4). Global surface temperature will continue to increase until at least mid-century under all emission scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO2 and other greenhouse gas emissions occur in the coming decades.

Many changes in the climate system become larger in direct relation to increasing global warming. They include increases in the frequency and intensity of hot extremes, marine heatwaves, heavy precipitation, and, in some regions, agricultural and ecological droughts; an increase in the proportion of intense tropical cyclones (5).

Recent climate model outputs also show that the frequency of both high intensity rainfall events and of dry spells is expected to increase

markedly across different climatic zones of the African continent (3) (4) and significant negative impacts on crop growth season timing and length have been estimated (6) (Figure 1).

With the uncertainty still inherent to climate change predictions it remains difficult to attribute single extreme weather events to climate change. However, while the frequency of such events is increasing, exposure to multiple types of events progressively becomes more challenging (e.g. droughts followed by floods) (7).

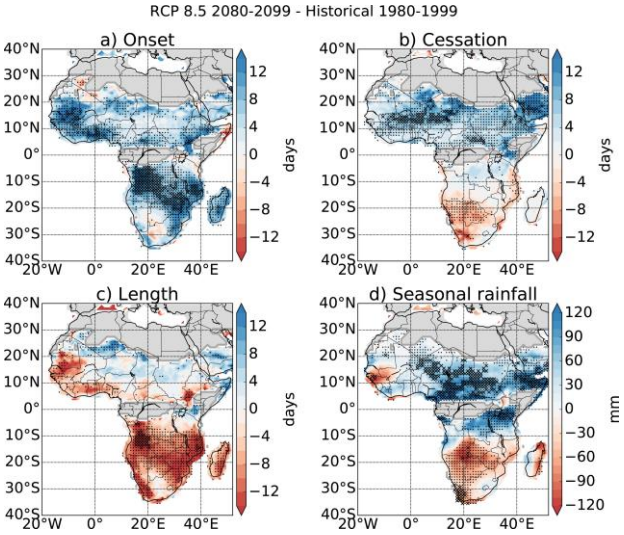


Figure 1 Median change in (a) onset, (b) cessation, (c) season length, and (d) wet season rainfall in 29 CMIP5 simulations from 1980–99 (historical simulation) to 2080–99 (RCP8.5 scenario). Blue colours indicate the onset/cessation getting later while red colours indicate onset/cessation getting earlier (6).

In most African countries, precipitations will be concentrated in a shorter period.

Why focus on the impact of weather and climate extremes on food security?

Extreme weather and climate events are among the leading causes of global hunger and malnutrition. This effect is particularly evident in low and middle income countries, where the economy is often highly dependent on agriculture (8). Also, according to the Global Network against food crises, weather extremes are one of the main factors leading to food crises, together with conflict and socio-economic aspects. Recent research by Oxfam confirms that although the causes of global hunger are deeply complex and conflict and economic disruptions, including those from COVID-19, remain key drivers, worsening weather extremes are increasingly peeling away the abilities of poor people, particularly in low-income countries, to stave off hunger and cope with next shock (8).

A 3°C temperature increase trajectory will cause catastrophic disruption to African food systems within the next 30 years. A 1.5°C trajectory provides more options for adaptation of African food systems, but still demands urgent action (9).

Climate-related disasters are progressively dominating disaster risk to a point that they account for 80 % of all major internationally reported disasters. Floods, droughts and tropical storms alone affect food production more than any other factor (10).

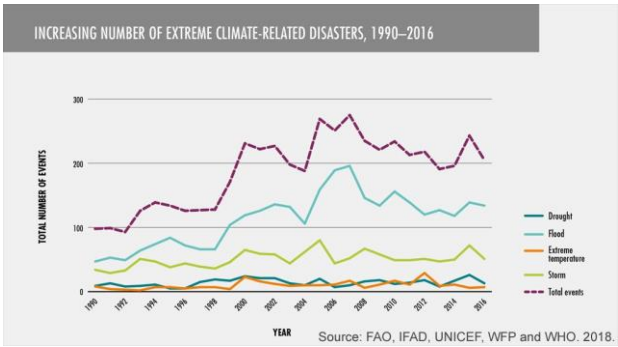


Figure 2 depicts the increasing number of extreme climate-related disasters in the time period 1990 – 2016 for low and middle-income countries, as reported in the State of Food Security and Nutrition of the World 2018 (7).

Extreme weather during the 2020/21 la Niña altered rainfall seasons, disrupting livelihoods and agricultural campaigns across the world. Extremes in both 2021 and 2022 have compounded shocks from previous year(s), making it increasingly difficult to quantify impacts resulting from one single event.
Consecutive droughts across large parts of Africa, Asia, and Latin America have coincided with severe storms, cyclones and hurricanes, significantly affecting livelihoods and the ability to recover from recurrent weather shocks (11).

At the same time, food systems are estimated to contribute more than a third of global greenhouse gas (GHG) emissions responsible for climate change, placing food production at the centre of attention as both a contributor to global warming and a critical sector for mounting an adaptive response to climate change. As was made clear in 2021 at both the UN Food Systems Summit (UNFSS) and UNFCCC COP26, food systems must play a central role in achieving multiple sustainable development and climate goals, from the local to the global level. These aspirations envision food systems that are far more nature-positive, deliver improved and more resilient livelihoods, empower disadvantaged groups, and produce a healthy mix of foods at affordable prices[1].

Weather and dimate extremes have an impact on all four dimensions of food security, namely on food availability, food accessibility, food utilisation and food stability. Also, recent expert group assessments conclude that increased demand for water will be the first threat to food security in the coming 20 years, followed closely by heat waves, droughts, income inequality and political instability (12).

Impact of Weather Extremes and Climate Change on Food Availability

Food availability is defined as the availability of sufficient quantities of food having an adequate quality supplied via domestic production or import. The foremost impact of extreme weather on food availability is due to crop failure and reductions in crop yield. For instance, in Sub-Saharan Africa, food availability has been reported as being affected by change in precipitation amount and variability patterns, increase in temperature, sea water level rises and increase

[1] https://unfss.org/

in atmospheric CO2 concentrations (13). In semi-arid climate regions it is not unusual to have 80% or more of the inter-annual crop production variability explained by climate (7).

Weather extremes may not always affect aggregate national food production but can significantly affect subnational areas with devastating impacts on the food security and nutrition of their populations (14). This is particularly the case of areas dominated by small scale farmers and pastoralists, whose livelihoods largely depend on their own crop and livestock production. Food availability is also impacted by the availability of water which in turn is extremely responsive to climate change (15).

Fisheries are expected to be significantly affected by climate change, as a result of changes in abiotic (sea temperature, oxygen levels, salinity and acidity) and biotic conditions (primary production, and food webs) of the sea affecting aquatic species in terms of their distributional patterns, growth and size, catch potential, etc. (16) (17).

Several global and regional quantitative studies project that fisheries productivity will increase in high latitudes and decrease in mid- and low latitudes (18), primarily due to species shift. This has important implications for developing countries, which are generally located in the tropics (17).

Inland fisheries and aquaculture may face higher mortality due to heat waves, water scarcity and competition for water.

Impacts of extreme events are increasing, with more risks of damage or loss of infrastructure and housing. Sea level rise might lead to the relocation of communities (17) (19).

Impact of Weather Extremes and Climate Change on Food Accessibility

Food access is ensured when individuals, communities and countries are able to obtain food in appropriate quantity and quality. Food price spikes and volatility, often combined with losses of agricultural income, follow weather extremes, reducing food access and negatively affecting the quantity, quality and dietary diversity of food consumed (20).

Where weather extremes damage occurs with an increased frequency, it can also lead to long term negative effects on food access including increased poverty, negative coping strategies and erosion of livelihoods. Additionally, weather extremes can directly impact physical access to food by the disruption of food supply to markets and access to markets by people due to dysfunctional or blocked transport routes and physical wellbeing issues due to the weather and climate extremes themselves (21).

Large scale crises such as the COVID19 pandemic and even more Russia's war against Ukraine conflict have the potential to disrupt trade and impact countries or regions relying on imports for essential food supply, adding on the impact of climate and weather extremes (22). Food price inflation as the one driven by the recent global crises have a particularly strong effect on poor populations who spend a large share of their income on food. Also, weather and climate extremes disproportionately increase the vulnerability of women and worsen their access to food in the immediate aftermaths of climate shocks.

Impact of Weather Extremes and Climate Change on Food Utilisation

Food utilisation refers to the capacity to consume and benefit from food. It depends on what manner food is exploited, and whether a balanced and nutritious diet can be maintained. Food utilisation is affected by climate change and extremes if the micronutrient and nutritional content of the crops is altered, or possibly if other crops of a different nutritional value are substituted due to negative climate effects (e.g. higher CO2 concentration reduces protein contents in grains, crop and livestock losses caused by extreme events reduce nutrient rich food production at the household level).

Also, coping strategies used to face climate shock impacts may lead to a reduction of the quantity, diversity and quality of the food consumed. Studies have shown for example, that the nutritional status of children and women is especially vulnerable to climate related disasters both in the aftermath of the event and in the long run (23) (24).

Also, food safety issues are involved via the supply chain (21). Food safety is commonly decreased by climate change and extremes owing to higher rates of microbial growth at increased temperatures (7) (13).

Impact of Weather Extremes and Climate Change on Food Stability

The stability of food security is impacted in the short and medium term by the potential strong fluctuations of food supply, access and utilisation induced by extreme climate events. In the longer run, climate change, through pressure on agriculture, ecosystems, water and soil, possible environmental degradation and decrease in productivity, is threatening the resilience of food systems and livelihoods (13) (21). In agriculture-dependent communities in low income contexts, droughts have been found to increase the likelihood of violence and prolonged conflict at the local level, which can eventually pose a threat to societal stability and peace [8].

Climate change adaptation and mitigation: urgent action for increased climate resilience

Food system resilience is defined as the "capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate and accessible food to all, in the face of various and even unforeseen disturbances" (25).

Determining and implementing measures to reduce risk and impact of increased climate variability and extreme weather events implies major challenges for policy development and implementation (7) (12) (13). Scaled up actions across sectors are needed to strengthen the resilience of livelihoods and food systems to climate variability and extremes and such actions need to be accelerated as compared with the current speed of implementation (12) (25).

Main actions include integrated disaster risk reduction and management, climate change adaptation policies and programmes as well as more sustainable agricultural practices. Implementation of climate resilience policies and programmes means strengthening and adopting tools and interventions including: risk monitoring and early warning systems, emergency preparedness and response, vulnerability reduction measures among others (12).

In the agricultural sector, the focus is on sustainable integrated agricultural systems including mainly: agroecology, climate-smart agriculture, conservation agriculture and sustainable intensification. These systems are complementary and partially overlapping but tend to follow different narratives (26).

Efforts in the agricultural sector to adapt to and mitigate climate change are crucial and the main emphasis for mitigation should be on healthy and sustainable diets on the demand side and on reduced food loss and waste on the production side. It is estimated that plant-based diets could reduce agricultural GHG emission by 80%, while food production practices only by 10% (27).

At the farm level, adaptation must address changing growing conditions, water scarcity, droughts and floods, increased risks of destructive weather events, and related risks of disease and pests. Along value chains, storage and logistics will also be affected by

climate change, and price volatility will increase, with implications for processors, traders, and consumers as well as farmers.

Many technical innovations show high potential to support climate change adaptation. Examples are agroecological practices and climate-smart agricultural practices, including improved water management, which can increase resilience to climate change and contribute to mitigation efforts. Adaptation efforts need to focus on sustainable farming practices which involve local communities including agroforestry, crop diversification and use of endemic species (28). Digital solutions also bear clear potential for adaptation in agriculture, provided that these solutions take into consideration local needs, are inclusive and over the longer term scalable and sustainable (29).

The introduction and adaptation of such innovations require enabling environments, including appropriate international and national policy frameworks and attractive conditions for private investment in agrifood sector innovations (30).

All indications are that financing adaptation to climate change will be more cost-effective than financing increasingly frequent and severe crisis response, disaster relief, and recovery pathways. In fact, the costs for adaptation action in Africa are about $15 billion (0.93 percent of regional GDP). This number is a fraction of the cost of inaction, which could rise to more than $201 billion (12 percent of GDP) (9). In a nutshell, building more resilient food systems that can manage several climate hazards is more cost effective strategy than trying to deal with individual shocks in isolation (12).

References

1. IPCC. Summary for Policy Makers - Climate Change 2022: Impacts, adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Internet]. Cambridge University Press; 2022 p. 3–33. Available from: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

2. Knutti R, Sedláček J. Robustness and uncertainties in the new CMIP5 climate model projections. Nat Clim Change. 2013 Apr;3(4):369–73.

3. Toreti A, Naveau P, Zampieri M, Schindler A, Scoccimarro E, Xoplaki E, et al. Projections of global changes in precipitation extremes from Coupled Model Intercomparison Project Phase 5 models. Geophys Res Lett. 2013 Sep 28;40(18):4887–92.

4. Carrão H, Naumann G, Barbosa P. Global projections of drought hazard in a warming climate: a prime for disaster risk management. Clim Dyn. 2018 Mar;50(5–6):2137–55.

5. IPCC. IPCC 2021 Summary for Policymakers. [Internet]. United Kingdom and New York: Cambridge University Press; 2021. (Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change). Available from: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

6. Dunning CM, Black E, Allan RP. Later Wet Seasons with More Intense Rainfall over Africa under Future Climate Change. J Clim. 2018 Dec;31(23):9719–38.

7. FAO, editor. Building climate resilience for food security and nutrition. Rome: FAO; 2018. 181 p. (The state of food security and nutrition in the world).

8. OXFAM MEDIA. HUNGER IN A HEATING WORLD - How the climate crisis is fuelling hunger in an already hungry world [Internet]. OXFAM MEDIA; 2022. Available from: https://oi-files-d8-prod.s3.eu-west-2.amazonaws.com/s3fs-public/2022-09/ENG%20Climate%20Hunger%20BRIEF_16%20Sept%2022.pdf

9. Global Center on Adaptation. State and Trends in Adaptation Report 2021 - How Adaptation Can Make Africa Safer, Greener and More Prosperous in a Warming World [Internet]. Global Center on Adaptation; 2021. Available from: https://gca.org/wp-content/uploads/2022/07/GCA_STA_2021_Complete_low-res.pdf

10. FAO. The impact of disasters on agriculture - Addressing the information gap [Internet]. Rome, Italy; 2017. Available from: https://www.fao.org/3/i7279e/i7279e.pdf

11. World Meteorological Organization. State of Global Climate 2021 - WMO provisional report [Internet]. 2021. Available from: https://library.wmo.int/doc_num.php?explnum_id=10859

12. Mehrabi Z, Delzeit R, Ignaciuk A, Levers C, Braich G, Bajaj K, et al. Research priorities for global food security under extreme events. One Earth. 2022 Jul;5(7):756–66.

13. WFP, M. O. H. C. Climate impacts on food security and nutrition [Internet]. 2013. Available from: https://documents.wfp.org/stellent/groups/public/documents/communications/wfp258981.pdf?_ga=2.68026900.486826177.1516349963-1383206686.1516349963

14. Lewis K. Understanding climate as a driver of food insecurity in Ethiopia. Clim Change. 2017 Sep;144(2):317–28.

15. Misra AK. Climate change and challenges of water and food security. Int J Sustain Built Environ. 2014 Jun;3(1):153–65.

16. Manuel Barange, Tarûb Bahri, Malcolm C.M. Beveridge, Kevern L. Cochrane, Simon Funge-Smith, Florence Poulain. Impacts of climate change on fisheries and aquaculture - Synthesis of current knowledge, adaptation and mitigation options [Internet]. Vol. 627. FAO; 654 p. Available from: https://www.fao.org/3/i9705en/I9705EN.pdf

17. The State of World Fisheries and Aquaculture 2020 [Internet]. FAO; 2020 [cited 2022 Nov 17]. Available from: http://www.fao.org/documents/card/en/c/ca9229en

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18. John R. Porter et al. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. In IPCC; 2014. p. 485–533.

19. HLPE. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security [Internet]. Rome; 2014. Available from: https://www.fao.org/3/i3844e/i3844e.pdf

20. Research Institute (IFPRI) IFP. Climate change: Impact on agriculture and costs of adaptation [Internet]. 0 ed. Washington, DC: International Food Policy Research Institute; 2009 [cited 2022 Nov 17]. Available from: https://ebrary.ifpri.org/digital/collection/p15738coll2/id/130648

21. Campbell BM, Vermeulen SJ, Aggarwal PK, Corner-Dolloff C, Girvetz E, Loboguerrero AM, et al. Reducing risks to food security from climate change. Glob Food Secur. 2016 Dec;11:34–43.

22. World Food Program. Impact of the Russia-Ukraine Conflict on WFP Operations in Eastern Africa [Internet]. World Food Program; 2022 Jul p. 5. Available from: https://reliefweb.int/report/world/impact-russia-ukraine-conflict-wfp-operations-eastern-africa-july-2022

23. Rodriguez-Llanes JM, Ranjan-Dash S, Degomme O, Mukhopadhyay A, Guha-Sapir D. Child malnutrition and recurrent flooding in rural eastern India: a community-based survey. BMJ Open. 2011 Nov 1;1(2):e000109–e000109.

24. Rodriguez-Llanes J, Ranjan-Dash S, Mukhopadhyay A, Guha-Sapir D. Flood-Exposure is Associated with Higher Prevalence of Child Undernutrition in Rural Eastern India. Int J Environ Res Public Health. 2016 Feb 6;13(2):210.

25. Tendall DM, Joerin J, Kopainsky B, Edwards P, Shreck A, Le QB, et al. Food system resilience: Defining the concept. Glob Food Secur. 2015 Oct;6:17–23.

26. IPCC. Food security. In: Climate Change and Land - An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [Internet]. IPCC; 2019. p. 437–550. Available from: https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf

27. Lipper L, Thornton P, Campbell BM, Baedeker T, Braimoh A, Bwalya M, et al. Climate-smart agriculture for food security. Nat Clim Change. 2014 Dec;4(12):1068–72.

28. HLPE. Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome; 2019.

29. Knowledge Centre for Global Food and Nutrition Security. Knowledge Review: Digital technology for agriculture: What's in it for smallholder farmers? [Internet]. Knowledge4policy; 2022. Available from: https://knowledge4policy.ec.europa.eu/publication/knowledge-review-digital-technology-agriculture-whats-it-smallholder-farmers-0_en

30. Policy Institute IF. 2022 Global food policy report: Climate change and food systems [Internet]. 0 ed. Washington, DC: International Food Policy Research Institute; 2022 [cited 2022 Nov 17]. Available from: https://ebrary.ifpri.org/digital/collection/p15738coll2/id/135889