DROUGHT, WATER STRESS AND FOOD SECURITY ISSUES: A REVIEW FROM GLOBAL PERSPECTIVE

Chizoba Chinweze; Chemtek Associates Limited, Nigeria; ud2001ng@yahoo.com; +234(0)8033015717

Abstract:

Droughts and water stress are intimately linked to food insecurity and have clear negative impacts on lives, livelihoods, health, ecosystem, economies, societies; often leading ultimately to conflicts, migration, and national security hazards. Drought is defined as a period of abnormally dry weather long enough to cause a serious hydrological imbalance. Water scarcity impacts 40% of the world's population and 700million people are at-risk of being displaced as a result of drought by 2030. Under the climate change scenario, nearly half of the world's population in 2030 will be living in areas of high-water stress[1]

In the USA 37.9% of the land area is experiencing drought which affects 67.1million people. In Europe 17% of the land area have been affected by water scarcity impacting 11% of the European population. Central Europe already suffered from droughts in 2018 and 2019, with relevant crop damages, water supply restrictions and industrial slowdown due to low river levels. Most of France and Germany are worst hit by soil moisture and rainfall deficits. In South-East Asia where people depend heavily in agriculture for subsistence drought impacts can be disastrous, this is true for Lao PDR, Viet Nam, Indonesia, Cambodia, Philippines. Drought in Africa, especially in Eastern Africa, Southern Africa and Horn of Africa leaves more than 45million people food insecure.

Agricultural production is closely linked with water availability, as water is required for crop growth and animal husbandry; invariably food production will be hampered in water scarce regions. Currently, about two-third of the global population experience some level of water scarcity and 815million of the world population are food insecure.

There is therefore the need to build coping capacities in these regions with water stresses and incidences of droughts, to enhance food production, end hunger and improve well-being. The coping strategies include both institutional approaches and traditional knowledge applications.

It is worthy to note that spikes in food prices arising from low agricultural yield, will make many people within low-income cadre to go hungry and eat only what they can afford and not necessarily what is nutritious. Undernourishment and hunger which is prevalent in low-income countries is related to drought, water imbalance and low food production. Furthermore COVID-19 pandemic and climate variabilities are factors that exacerbate vulnerabilities to drought impacts and food insecurity. Except urgent measures are put in place, the SDG Zero Hunger target by 2030 may not be met.

Keywords: Drought risk, water stress, drylands, food security, impacts, climate change and Sustainable Development Goals (SDG)

[1] UNCCD: https://www.unccd.int/un-decade-deserts-and-fight-against-desertification-impact-and-role-drylands

2.1 Introduction

Drought is defined as a sustained and spatially extensive period of below-average natural water availability[2], with possible long-term socio-ecological consequences. Drought originates from a deficiency of precipitation that results in a water shortage for some activity (e.g., crop production or users of water resources[3]. Drought conditions also arise from changes in atmospheric conditions; the El Niño Southern Oscillation, the Pacific Decadal Oscillation and the Interdecadal Pacific Oscillation are key indicators of low-frequency changes in persistent atmospheric circulation patterns associated with drought conditions over large areas of the world[4].

There are four different classes of droughts which define the hierarchal set of water deficit characterization, these include "Meteorological drought" (reduction in rainfall leading to excessive heat and heightened evapotranspiration[5]), "Agricultural drought" (low soil moisture content with its impacts on crop yield), "Hydrological drought" (conditions of reduction in streamflows and groundwater storage) and "socio-economic droughts" (impact of deficit in water supply on the economies of the affected population). The newest class of drought is the "ecological drought", which emphasizes the vulnerability of ecosystems to intense water shortages[6].

Clearly water shortages impact directly on food system and food security. Many regions in the world have been affected by drought-related challenges as deficiency of precipitation, lack of irrigation water, and severe water stress. Water stress occurs when demand for water (total water withdrawals) in a given area exceeds the supply (surface waters - rivers, lakes, and reservoirs - and groundwater). Roughly 70 percent of the world's freshwater is used for agriculture, and the rest for industrial (19 percent) and domestic uses (11 percent).

---

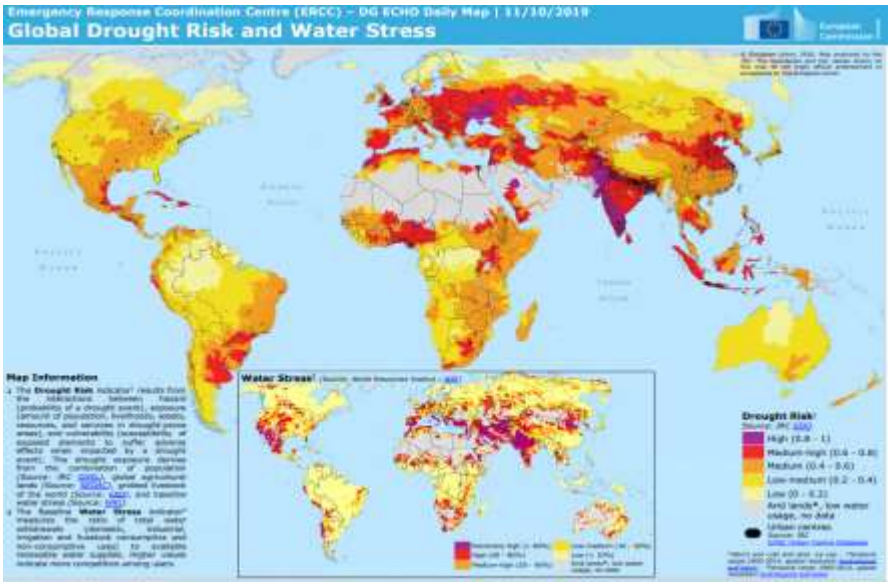
[2] Tallaksen, L. M., and H. A. J. Van Lanen (Eds.) (2004), Hydrological Drought: Processes and Estimation Methods for Streamflow and Groundwater, Developments in water science, 48, Elsevier Sxci. B.V., Amsterdam, Netherlands

[3] Wilhite, D.A. and M.H. Glantz. 1985. Understanding the drought phenomenon: The role of definitions. Water International 10:111–120.

[4] : United Nations Office for Disaster Risk Reduction (2021). GAR Special Report on Drought 2021. Geneva.

[5] Vicente-Serrano, S.M., Van der Schrier, G., Beguería, S., Azorin-Molina, C., Lopez-Moreno, J.I., 2015. Contribution of precipitation and reference evapotranspiration to drought indices under different climates. J. Hydrol. 526, 42–54.

[6] Types of Droughts: National Drought Mitigation Center. https://www.drought.unl.edu/Education/DroughtIn-depth/TypesofDrought.aspx. Accessed 14/06/2021; 3.19a.m



Map 2.1: Global Drought Risk and Water Stress (Source: European Commission's Directorate-General for European Civil Protection and Humanitarian Aid Operations 2019)

Droughts and water stress affect large areas and populations, with widespread impacts on agricultural production and food security; with its toll on society, economy, the environment (e.g., forests, wildfires, wetlands, biodiversity) and achieving sustainable development goals; often leading to conflict and migration. The impacts of drought on agricultural yields often expressed in higher food prices has its ripples felt globally; with the poorer population in distance places from the drought-prone food zone being most vulnerable. But reducing the impacts of drought will contribute to the achieving the SDGs, in particular zero hunger, poverty reduction, good health and well-being, gender equality, clean water and sanitation, and sustainable cities and communities[20].

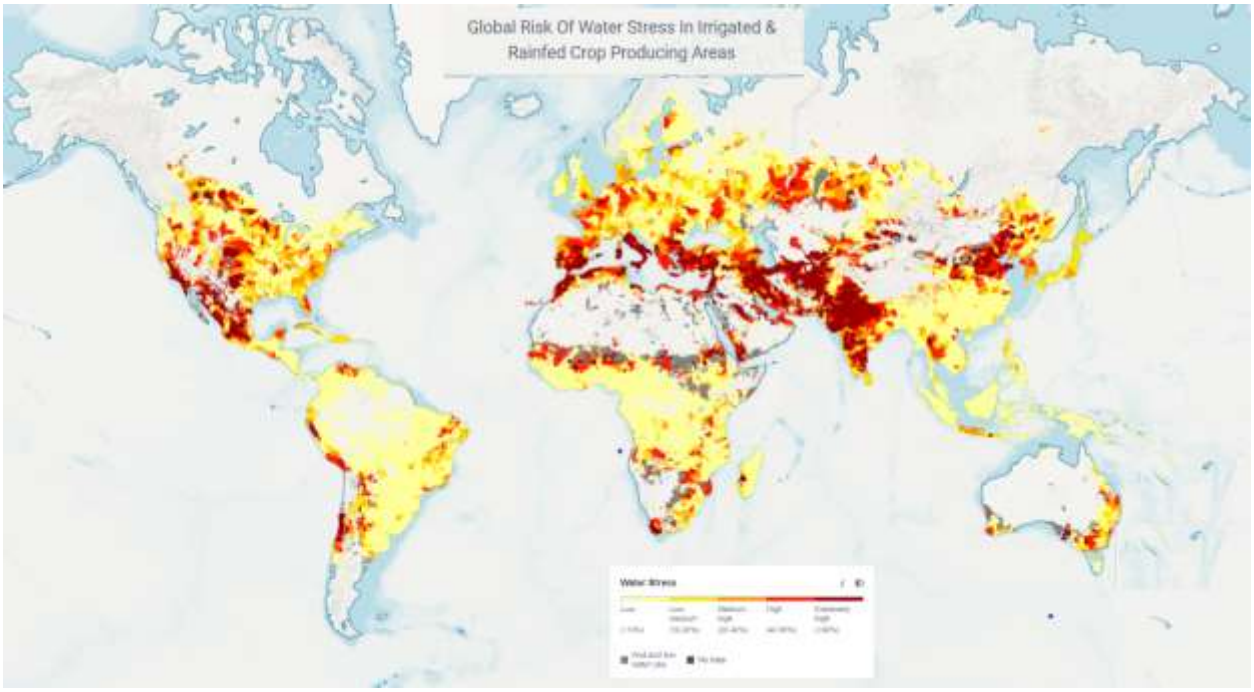
A proactive rather than a reactive approach to drought risk management will make for a resilient socio-ecological system. The proactive approach entails implementing necessary measures to prevent or minimize drought impacts in advance.[20]. These measures include drought monitoring, forecasting, early warning and vulnerability reduction, coupled with adaptation to a changing climate and actions to increase societal and environmental resilience.

2.2 Global Drought Risk and Water Stress by Region

Risks associated with drought events are multifaceted, sectorial and geographic (affecting different regions of the world differently). Drought hazards exposes the affected population and the ecosystem to the risk of hunger, famine, poverty, water supply shortages, migration, conflicts, degradation, loss and even death. Assessing the risk to drought involves knowing who and what is at risk, the degree of exposure/vulnerability and the coping capacity. Although drought affects many sectors, but the most susceptible sector is the agricultural sector because of it's water requirement. Water defects results in water stress in plants leading to low agricultural yields; with respect to the society water stress depicts insufficient water supply in relation to the demand. Global water stress from agricultural systems perspective in irrigated

and rainfed agriculture as presented in Map 2.2 gives an indication of where drought risk is high to elicit intervention.

A country or region is considered to be water stressed when an individual get less than 1,700 cubic metres per annum; statistically one in every six persons, according to the United Nations[7], experiences water-stress. By 2050, it is projected that about 52 percent of the world's population will be vulnerable to the impacts of water shortages.



Map 2.2: Global Water Stress in Irrigated and Rainfed Agriculture (Source: WRI Aqueduct 2019)

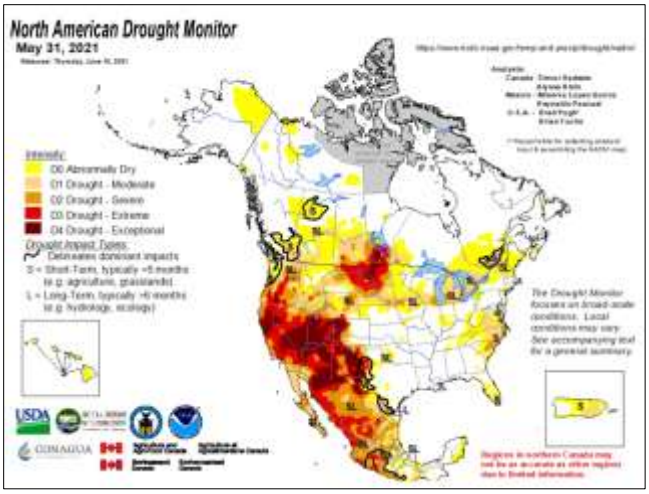
2.2.1 Middle East and North Africa

The most water stressed region on earth is the Middle East and North Africa (MENA). 12 out of the 17 most water-stressed countries are in the MEAN (Map 2.3). The region is hot (high temperature) and dry (very little rainfall), with low water supply (very few rivers flow all year round) and using more than 80 percent of their available water supply every year, put the region in water stress, again the growing water demands have pushed the countries further into extreme stress and Climate change is set to complicate matters further[8], this has implication for agriculture production. The affected countries according to WRI are Qatar, Israel, Lebanon, Libya, Iran, Jordan, Kuwait, Saudi Arabia, United Arab Emirates, Bahrain, Palestine, Turkmenistan and Oman,

[7] https://www.activesustainability.com/water/ranking-countries-highest-water-stress/ (accessed 14/06.2021)
[8] World Resource Institute (Hofste,R.W, Reig P and Schleifer L) 17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress. 2019. https://www.wri.org/insights/17-countries-home-one-quarter-worlds-population-face-extremely-high-water-stress (accessed 14/06/2021).

Map 2.2: Middle East and North Africa Water Stress (Source: WRI, 2019)

2.2.2 North America



Map 2.3: Drought and Water Stress in North America

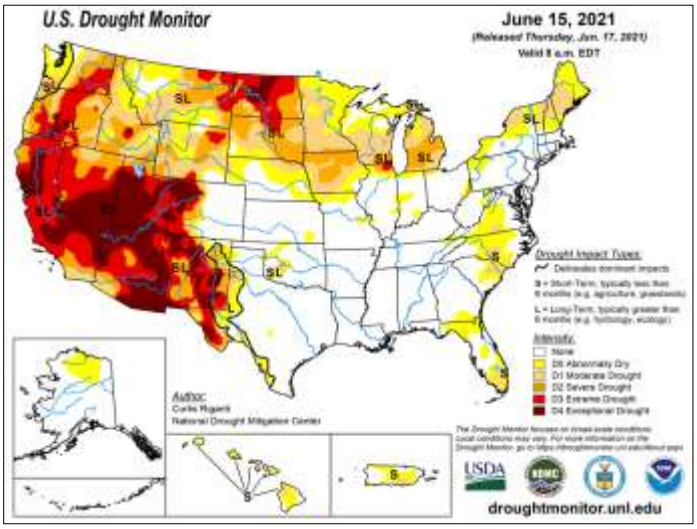
In North America drought extends from Mexico through all of the western United States (except the Pacific Northwest) to eastern portions of Canada's Prairies. The North American drought is most serious in the west-central and southwestern Plains through the central and southern Rocky Mountain region to California, and it extends southward into northern Mexico[9].

- USA

In the US 37.9% of the land area is experiencing drought which affects 67.1million people. These dry regions also show high level of water stress; they include such areas as parts of California, Oklahoma, Minnesota and Colorado (Map 2.3). Also in the Southwest, western Great Plains, and parts of the Northwest water demands outstrip supplies creating water stresses in

[9] https://www.bakingbusiness.com/articles/52875-drought-in-north-america-remains (accessed 20/06/2021)

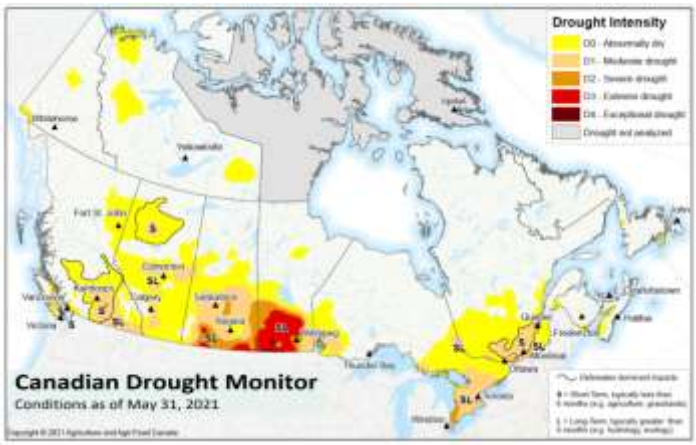
the region. Watersheds are considered stressed when water demand (from power plants, agriculture, and municipalities) exceeds 40% (water supply stress index of 0.4) of available supply[10]. These water stress clearly impacts on agricultural production and food supply.



Map 2.4: Drought monitor USA

- Canada

Canada continued to receive below-normal precipitation, causing an increase to drought conditions across the country; Abnormally Dry (D0) and Moderate to Exceptional Drought (D1-D4) conditions affected twenty-seven percent of the National landscape. Eighty-five percent of the agricultural extent was affected by dry and drought conditions with the most significant concerns persisting in southern Manitoba and Saskatchewan[11].



Map 2.5: Canada Drought Status (Source: Canadian Drought Monitor)

[10] https://www.globalchange.gov/browse/multimedia/water-stress-us (accessed 14/06/2021)
[11] https://www.agr.gc.ca/atlas/maps_cartes/canadianDroughtMonitor/monthlyAssessments/en/2021/cdm_2105_mn_en.pdf (accessed 20/06/2021)

- Mexico

Nearly 85% of Mexico is experiencing one of its most widespread and intense droughts in decades[12]; with dwindling water sources, exposing nearly its 125 million population to water stresses. Moderate to severe drought (D1 to D2) occurred in Veracruz, Oaxaca and the Yucatan Peninsula, while the western part of the country experienced extreme drought (D3)[13]. The northwest and northeast regions have recently moved from severe to extreme drought, which will affect some agricultural crop production, such as corn production in Sinaloa (Mexico's largest corn producer)[27].

Map 2.6: Mexico Drought

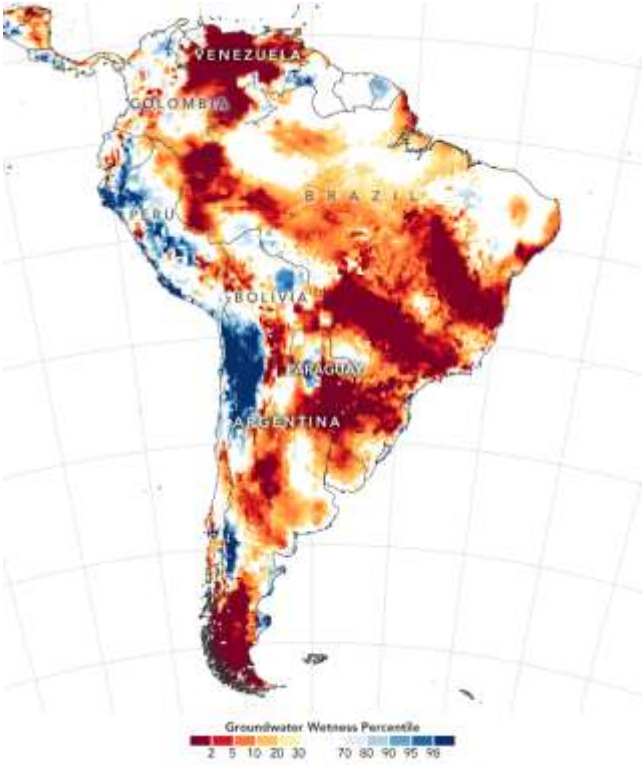
2.2.3 South America

Drought conditions occur in almost all the regions of South America, particularly in Argentina, Venezuela, Brazil, Columbia, and Paraguay. The ENSO (El Niño Southern Oscillation) determines the climatic conditions of the LAC[14], creating extreme and irregular weather events. In Argentina over 60 per cent of the territory is classified as drylands. The impacts of the drought are felt in all parts of the region, ranging from low agricultural yields to economic and social stresses. Rain-fed agriculture practiced by small farmers and indigenous groups is threatened in times of inadequate rain[14], affecting livelihoods and overall human well-being.

[12] https://earthobservatory.nasa.gov/images/148270/widespread-drought-in-mexico

[13] https://smn.conagua.gob.mx/tools/DATA/Climatolog%C3%ADa/Sequ%C3%ADa/Monitor%20de%20sequ%C3%ADa%20en%20M%C3%A9xico/Seguimiento%20de%20Sequ%C3%ADa/MSM20210615.pdf (accessed 20/06.2021)

[14] UNCCD (2018) Towards National Drought Policies In Latin America And The Caribbean Region



Map 2.8: Drought in South America (Source: NASA Earth Observatory)

Drought or dryness in the region has been reported to be exacerbated by increasingly frequent and intense fires[15]; the combined impact of the heat, droughts and fires affect local crop yields (food insecurity), resulting in diminishing export capabilities which severely impact on local livelihoods and economies[16].

2.2.4 Europe

In Europe 17% of the land area have been affected by water scarcity impacting 11% of the European population. Central Europe already suffered from droughts in 2018 and 2019, with relevant crop damages, water supply restrictions and industrial slowdown due to low river levels. Most of France and Germany are worst hit by soil moisture and rainfall deficits. The drought hotspots in the region give an indication of areas of water stresses and reduced crop yields (for such crops as soybeans, rice, sugar cane, cotton, almonds, etc. cultivated within the area), as well as supplies and demand for those crops.

About half of the EU population will experience shortages in water supply which is an indication of water stress. The water exploitation index (WEI) an expression of percentage of water abstraction per annum, has countries such as Cyprus, Bulgaria, Belgium, Spain, Italy and Malta with a WEI of 20% (an indication of water stress). Cyprus, which has been suffering severe drought, consumed much more than 40% of its renewable supplies. Climate change will add to the problems of water scarcity and droughts[17].

---

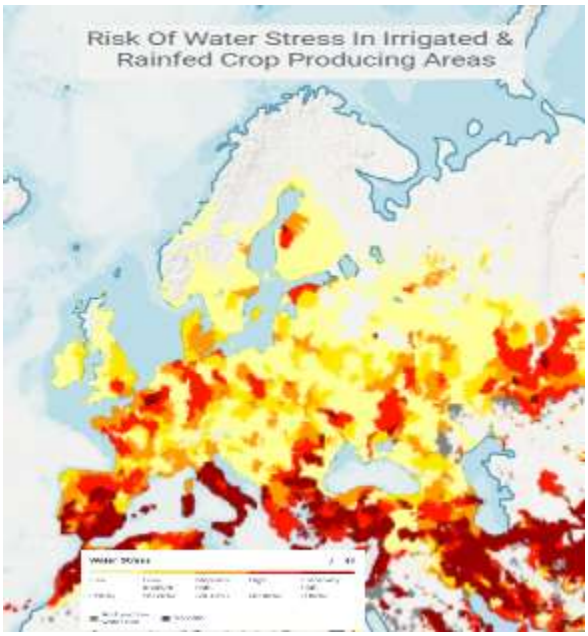
[15] https://earth.org/data_visualization/severe-drought-in-south-america/ (accessed 22/06/2021)

[16] ibid

[17] EU 2010. Water Scarcity and Drought in the European Union

The central Europe for three years in a roll is experiencing dry spells; with July 2020 being drier than usual in France, Belgium and southern Germany. Combined with the spring rainfall totals, relevant deficits of precipitation and soil moisture persist mainly over north-east France and through northern Germany. Dry conditions also persist in central Scandainavia and Icland around August 2020. Around the western Black Sea coast there is increasing soil moisture deficit. The recurring dryness in central Europe determined a reduction of crop yield prospects. Water supply shortages has been reported for both consumption and industrial cooling. Forests in France are under stress due to dry conditions.

New technologies, improved irrigation management, drought resistant crops and water recycling in factories could save up to 40% in the agricultural and industrial sectors.



Map 2.4: European Water Stress in Irrigated and Rainfed Crop Production

2.2.5 Australia

Australia experiences recurring droughts, which has its toll on the livelihoods of the farmers and rural communities as water is required for agricultural production[18]. Incidences of climate change in the region will not only heighten the frequency of droughts but will extend its duration and coverage with its consequences of water scarcity, impacting the agricultural system and farmers income farms.[19]; as well as other sectors of the economy such as energy, businesses,

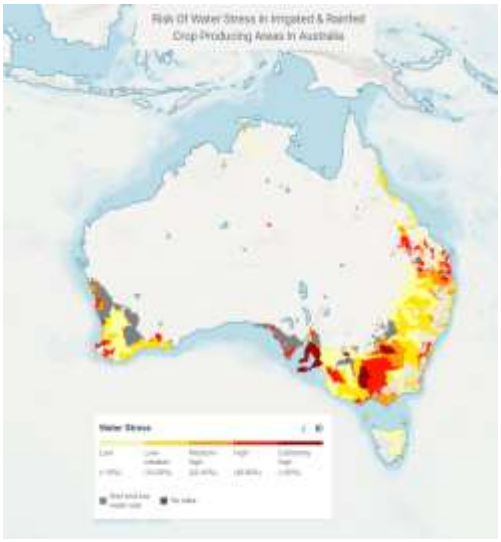
[18] Australian Government 2019, *Drought in Australia: Coordinator-General for Drought's advice on a Strategy for Drought Preparedness and Resilience*, Canberra, October. CC BY 4.0.

[19] Australian Bureau of Agricultural Resource Economics and Sciences 2018, Analysis of 2018 drought, report prepared by S Hatfield-Dodds, N Hughes, A Cameron, M Miller & T Jackson, Department of Agriculture and Water Resources, ABARES, Canberra, ABARES Insights 2018;2.

industrial activities, etc. in Australia[20]. Furthermore, it is projected that with increases in population; the national water demand is expected to double by 2050[21] and water required for agricultural system to increase by 80 per cent by 2050[22]. Therefore, there is a severe water stress in the future in the region, especially for farmers with the likelihood of reduced crop yield and possibilities of increases in the prices of food crops/ farm production[23].

Long term drought resilience requires both institutional and individual input in managing the natural resource.[24] This involves reducing the exposure of topsoils to external interferences by using appropriate vegetation cover, treating soil acidification, controlled pastural and efficient water use. Putting pressure on the water resource comes at a cost to the national economy and regional communities.[25].

The City Resilience Framework[26] is focused on achieving resilience by enhancing the coping capacities of all the stakeholders.[27] Community resilience is all about building a stronger group.

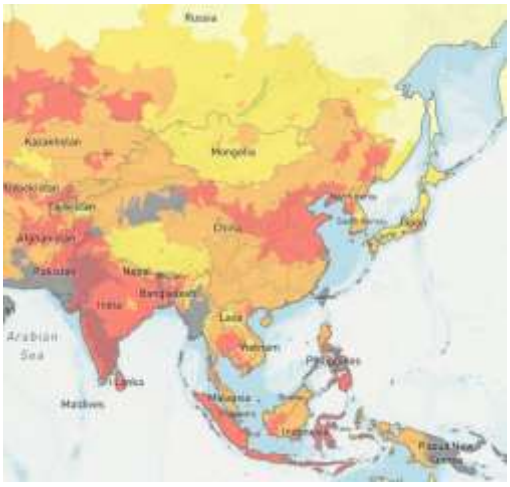


Map 2.5: Australian water stress

[20] Debelle, G 2019, 'Climate Change and the Economy'. Speech by Deputy Governor, Reserve Bank of Australia, delivered at a public forum hosted by the Centre for Policy Development, Sydney, 12 March 2019, viewed 28 March 2019, <https://www.rba.gov.au/speeches/2019/sp-dg-2019-03-12.html>.
[21] CSIRO 2015, Australian National Outlook 2015, CSIRO, Australia.
[22] CSIRO 2015, Australian National Outlook 2015, CSIRO, Australia.
[23] Kelly, S., R. Cunningham, R., Plant, Maras K., (2019) Water Scarcity Risk for Australian Farms and the Implications for the Financial Sector. Institute for Sustainable Futures, UTS
[24] Brown & Schrimer.
[25] Department of the Environment and Energy, Impact of weeds, Department of the Environment and Energy, Canberra, viewed 28 March 2019 <http://www.environment.gov.au/biodiversity/invasive/weeds/index.html>.
[26] The Rockefeller Foundation and ARUP 2014, City Resilience Framework, ARUP, London, viewed 28 March 2019 <https://www.rockefellerfoundation.org/report/city-resilience-framework/>.
[27] Shocks are typically considered single event disasters, such as fires, earthquakes, and floods. Stresses are factors that pressure a community on a daily or reoccurring basis, such as drought, chronic food and water shortages, an overtaxed transportation system, or high unemployment.

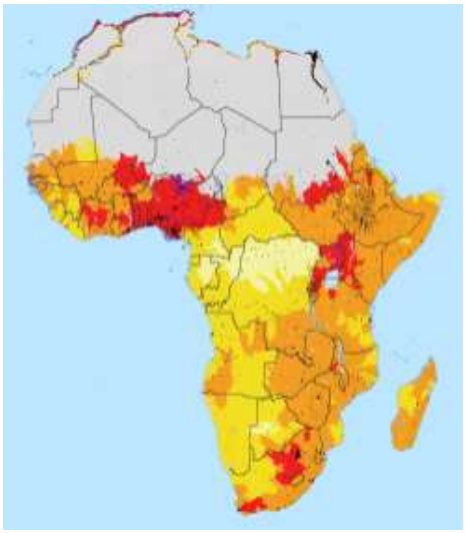
2.2.6 Asia

In Asia, the southern countries are most drought-prone; these include Afghanistan, India, Pakistan and Sri Lanka as well as Bangladesh, Vietnam and Nepal. The WRI identified India as the most water stressed region in Asia, abstracting more than 80% of their available supply on average every year; noting that the Reservoirs in Chennai, India's sixth-largest city, are nearly dry[28]. The country is undergoing its worst water crisis in history, impacting livelihoods and food production.



Map 2.6: Asian Drought Risk

2.2.7 Sub-Saharan Africa



Map 2.7: Drought Risk and Water Stress in Sub-Saharan Africa (Source: EU-ERCC ECHO/WRI)

[28] https://www.wri.org/insights/17-countries-home-one-quarter-worlds-population-face-extremely-high-water-stress (accessed 23/06/2021 5.28a.m

The regions mostly hit by drought in the sub-Saharan Africa are the West Africa, the Greater Horn part of Eastern and Southern Africa. These regions experience frequent and sometimes prolonged droughts that lead to famine[29]. Eastern and southern Africa regions are characterized mainly by semi-arid and sub-humid climates with a pronounced dry season in most part of the year[30] and it has a direct connection with global processes such as [31]El Niño/La Niña-Southern Oscillation (ENSO)[32].

Sub-Saharan Africa is drought-prone, and this has negative implications for agricultural production/crop yield as over 95% of the agricultural production is rainfed and 90% of the rural population depend on agriculture as their main source of income[33]. Rising temperatures and unpredictable rainfall caused by climate change are expected to lower crop yields and raise food prices.

2.3 Food Security and SDG2

According to United Nations Food and Agricultural Organization "food security exists when all people, at all times, have physical, economic and social access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life"[34]. At the end of 2020, the world seems to be off the track in achieving the mandate of Zero Hunger by 2030 (SDG1) taking into consideration the global food security status. One of the reasons for undernourishment and hunger is drought, which reduces agricultural production leading to food insecurity situation[35].

The GRFC Report reveals that at least 155 million people experienced acute food insecurity at Crisis or worse levels (IPC/CH Phase 3-5) across 55 countries/territories in 2020 - an increase of around 20 million people from the previous year 2019[36]. The status hit a 5-year high in 2020; probably escalated by the COVID-19 pandemic and extreme weather events.

---

[29] Hansen, J.W., Dilley, M., Goddard, L., Ebrahimian, E., Ericksen, P., 2004. Climate Variability and the Millennium Development Goal Hunger Target. IRI Technical Report No. 04-04.

[30] Shiferaw B et al (2014) Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options. Elssevier; Weather and Climate Extremes Vol.3, pp.67-79.

[31] El Niño and La Niña refer to the warming and cooling of sea-surface temperatures (SST) in the equatorial Pacific Ocean, respectively which influence atmospheric circulation and consequently rainfall and temperature in specific areas around the world. Since the changes in the Pacific Ocean (represented by "El Niño/La Niña") and the changes in the atmosphere (represented by "Southern Oscillation") cannot be separated, the term ENSO is often used to describe the ocean-atmosphere changes. (ingh, M., 2006. Identifying and Assessing Drought Hazard and Risk in Africa. Regional Conference on Insurance and Reinsurance for Natural Catastrophe Risk in Africa, Casablanca, Morocco, November 12–14, 2006).

[32] Nicholson S.E (2001): Climatic and environmental change in Africa during the last two centuries. Clim. Res., 17 (2001), pp. 123-144

[33] https://www.wri.org/insights/climate-change-hurting-africas-water-sector-investing-water-can-pay (accessed 23/06/2021)

[34] FAO, 1996. Rome Declaration on World Food Security and World Food Summit Plan of Action

[35] Kogan. F, Guo. W, and Yang W 2019: Drought and food security prediction from NOAA new generation of operational satellites. Geomatics, Natural Hazards and Risk, Volume 10, 2019 - Issue 1 Taylor ^ Francis.

[36] FAO 2021: Global Report on Food Crisis. Joint Analysis For Better Decisions FSIN & GNAFC

Nearly 690 million people were reported hungry in 2020, or 8.9 percent of the world population – up by 10 million people in one year and by nearly 60 million in five years. If recent trends continue, the number of people to be affected by hunger would surpass 840 million by 2030s[37].

As more millions of people slip into food insecurity, they opt for low quality diet, thus being exposed to the risk of malnutrition (undernutrition, overweight and obesity) leading to various form of health challenges. Children are the most vulnerable group to malnutrition. Globally, in 2019, 21.3 percent (144.0 million) of children under 5 years of age were stunted, 6.9 percent (47.0 million) wasted and 5.6 percent (38.3 million) overweight[35]. The prevalence of child wasting is above the 5 percent target for 2025, putting the lives of tens of millions of children at risk in the immediate term.

From a regional perspective Africa (Sub-Saharan Africa) and Asia are experiencing severe to acute food challenges.

- Africa

In Africa over 100 million people faced crisis, emergency, or catastrophic levels of food insecurity in 2020 which is expected to worsen further in 2021. In sub-Saharan Africa, hunger measured as Perveance of Undernourishment (PoU)[38] is on the increase; in 2017 there were 232 million undernourished people, which grew to 239 million (22.8 percent) in 2018[39], and more than 250 million in 2019. This prevalence is more than twice the world average (8.9 percent) and is the highest among all regions. If recent rates of increase persist, its PoU will rise to 25.7 percent by 2030.

In West Africa, 23.6 million people are projected to face crisis-levels of food insecurity—an increase of 40 percent from already record levels[40]. This is due in part to extrem weather events affecting local food production in addition to pockets of conflicts within the subregion which increases insecurity (food and otherwise) thus heightening the prevalence of malnutrition in the subregion. According to FAO the latest estimates that refer to the period between October 2020 and May 2021, urgent food assistance is needed for 9.2 million people in Nigeria, 1.2 million in the Niger, 2 million in Burkina Faso, 850 000 in Sierra Leone and 430 000 in Mali[41].

In East Africa, rains are expected at below-average levels over northern and eastern Ethiopia and in areas of western South Sudan according to the latest weather forecast by the Greater Horn of Africa Climate Outlook Forum (GHACOF), while average amounts is expected over the other areas. In the subregion about 33million people located mainly in Ethiopia, South Sudan and the Sudan are food insecure. In Ethiopia, according to the latest FAO Integrated Food Security Classification (IPC) analysis, about 12.9 million people are estimated to be severely food insecure; while in South Sudan, about 5.8 million people (about 48 percent of the total

[37] FAO, IFAD, UNICEF, WFP and WHO. 2020. The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. Rome, FAO.

[38] The Prevalence of Undernourishment (PoU) is the share of the population with a caloric intake which is insufficient to meet minimum requirements for a healthy life. Minimum requirements vary by individual based on age, gender, weight, activity levels and so vary by country depending on the demographics of its population. Distributions for individuals are taken into account for this measure. PoU is Indicator 2.1.1 under SDG 2 – "End hunger" by 2030. This means eliminating undernourishment for all (https://sdg-tracker.org/zero-hunger).

[39] FAO, ECA and AUC. 2020. Africa Regional Overview of Food Security and Nutrition 2019. Accra.

[40] Food Insecurity Crisis Mounting in Africa – Africa Center for Strategic Studies (accessed 25/06/2021

[41] FAO 2021: Crop Prospects and Food Situation. Quarterly Global Report. No. 1, March 2021. Rome

population) are estimated to face crisis or worse levels of acute food insecurity between December 2020 and March 2021. In the Sudan, about 7.1 million people, Somalia 1.6 million and Uganda 2 million people were estimated to be severely food insecure between December 2020 and March 2021. In United Republic of Tanzania, a significant shortfall in cereal production due to prolonged dry spell left the local population in hunger.

In Central Africa about 24.2 million people are estimated to be severely food insecure in early 2021, which is 45 percent higher year on year.

Southern Africa is also experiencing widespread shortfall in aggregate food production/supplies, especially in Lesotho, Madagascar, Malawi, Mozambique, Zambia and Zimbabwe due to conflict and extreme weather events. High levels of food insecurity are expected to persist in southern parts of Madagascar and Angola due to the impact of rainfall deficits on agricultural production in 2021 as well as in northern Mozambique due to both the impact of the conflict and poor weather conditions[38].

40% of stunted children in the world live in Africa. In sub-Saharan Africa there is an increase in the number of stunted children from 51.2 million in 2012 to 52.4 million in 2019.

- Middle East and North Africa

In the Middle East drought (representing water stress) is one of the factors exacerbating food insecurity in the region. According to FAO[42] the 2019 estimates show that about 51.4 million people were hungry or 12.2 percent of the population – an increase of 1.1 million people from the previous period. The numbers affected by moderate or severe food insecurity also showed an upward trend with an estimated 137 million people in 2019 who do not have regular access to sufficient and nutritious food. The trend is mostly driven by an increase in moderate food insecurity. About 22.5 percent of children under 5 years of age were stunted, 9.2 percent wasted, and 9.9 percent were overweight. The burden of malnutrition (undernutrition, overweight and obesity) and micronutrient deficiencies (often linked to poor diets) continue to increase at an alarming speed in the Arab region, particularly among school-age children and adults[39].

In Palestine, around 2 million people – or 38 percent of the population – were moderately or severely food insecure. In Iraq, 0.7 million people representing 12 percent of the conflict-affected population, were food insecure (WFP CARI methodology) in 2020. In Yemen, between January and June 2021, the number of food insecure people is estimated to have increased from 13.5 million to 16.2 million while in the Syrian Arab Republic, a nationwide food security assessment indicates that about 12.4 million people (60 percent of the overall population) are food insecure, 5.4 million more than at the end of 2019.

- Asia

Available data showed that in 2019 about 381million people in Asia which represent more than half of the population are undernosished[35].

In Afghanistan, between November 2020 and March 2021, about 13.15 million people (over two-fifths of the total population) are estimated be in severe acute food insecurity, due to poor crop production arising. In Bangladesh, official estimates indicate that, as of June 2020,

[42] FAO, IFAD, UNICEF, WFP, WHO and ESCWA. 2021. Regional Overview of Food Security and Nutrition in the Near East and North Africa 2020

30 percent of the total population was poor, compared to 21 percent in June 2019, invariably affecting their food purchasing power. In Pakistan's areas bordering Afghanistan, more than 1.2 million people were in food crisis or worse, representing 25 percent of the inhabitants of this area,

- Latin America and the Caribbean

In Latin America and the Caribbean, the PoU was 7.4 percent in 2019, The region has seen a rise in hunger in the past few years, with the number of undernourished people increasing by 9 million between 2015 and 2019. With respect to achieving the Zero Hunger target for 2030, Latin America and the Caribbean is off track, although to a much lower degree than Africa[38].

The number of food insecure people the region are 4.4 million in Haiti, 3 million in Honduras, nearly 1 million in El Salvador and 3.7 million people in Guatemala[38].

- South America

Food security in the drylands of the semiarid region of Northeast Brazil (NEB) is under severe risk due to extreme drought conditions. The prolonged drought that started in 2012 has heightened the vulnerability of the local population and increasing the area under water stress[43]. In Brazil, 2021 first quarter crop yields (maize) in the key producing southern areas were reportedly low, reflecting unfavourable weather conditions.

In the 2017-2019 period, the prevalence of undernourishment was estimated at 31.4 percent in the Bolivarian Republic of Venezuela, a significant increase compared to 8.6 percent in the pre-crisis 2013-2015.

- Australia

Although Australia produces more food than it can consume and exports 70% of its production, yet an estimated 3.5% of its population are food insecure by 2017 estimates[44]. In the last year, more than one in five Australians (21%) are food insecure. That is the equivalent of five million people[45]. However, the PoU rate in Australia is <2.5%.

- Europe

Europe is the second-best food secured region in the world, the PoU in the region is <2.5 for all the countries in region except in Bulgaria where the value is 3.1% and Ukraine with a value of 3.8% by 2017 data[46]. According to World Bank the prevalence of undernourishment (PoU) in EU is 3.0%[47], on the average putting into consideration higher values in countries like Bulgaria, Ukraine, Sebia, Slovakia, Greece and Hungary.

About 88 million people in Northern America and Europe are food insecure.

- North America

In the United States of America and Canada the Prevalence of Undernourishment (PoU) between 2005 – 2019 is rated <2.5%. Although, the United States is classified as a food secured nation, there are pockets of food insecure households rated as 10.5% (13.7 million) of

---

[43] Marengo, J.A., Cunha, A.P.M.A., Nobre, C.A. *et al.* 2020 Assessing drought in the drylands of northeast Brazil under regional warming exceeding 4 °C. *Nat Hazards* **103,** 2589–2611

[44] https://ourworldindata.org/grapher/share-of-population-with-severe-food-insecurity (accessed 26/06/2021)

[45] Foodbank Hunger Report 2019

[46] https://sdg-tracker.org/zero-hunger (accessed 27/06/2021)

[47] https://data.worldbank.org/indicator/SN.ITK.DEFC.ZS?locations=EU (accessed 26/06/2021)

U.S. households in 2019, which is down from 11.1% in 2018[48]. The cumulative decline prevalence of food insecurity from 2011 (14.9 percent) to 2019 (10.0 percent) was statistically significant.

2.4 Conclusion

According to FAO[38], the world is off track to achieve the SDG targets for hunger and malnutrition by 2030. The FAO expects that food production will need to more than double by 2050 to meet the demand of projected world population and economic growth. Expanding food production to meet future demand will substantially increase demands on water for irrigation, particularly in regions where water availability is already limited. An increase in water scarcity under climate change presents its own challenges, including cross-border water conflicts as well as competing demands for water for agriculture, industry, and residential use[49]. It is important to note that there are possibilities of overlap in stresses of water and food production/supplies that might lead up to instability and conflicts.

For instance, in Africa water conflicts around Lake Chad, between Nigeria, Chad and Niger natives; there is also Nile River-related conflicts between Egypt, Ethiopia and Sudan. In the Middle East there are disputes with respect to Euphrates-Tigris Basin among Turkey, Syria and Iraq; as well as between Israel, Lebanon and Palestine over River Jordan. In Asia, there are issues over China damming the Mekong basin for hydropower projects thus, reducing water flow to the downstream countries Vietnam, Laos, Cambodia and Thailand. In central Asia, there are conflicts between Kazakhstan, Uzbekistan, Turkmenistan, Tajikistan and Kyrgyzstan over Aral Sea. Therefore, there is need for institutional strategies (nationally and transboundary), through policy formulations and implementations geared towards reducing vulnerability to drought and water/climate-related shocks to enhance resilience and urgent adaptive actions. It is worthy to note that more than 200 river basins in the world that are shared by countries are relevant for food production; so, it is imperative that policies and political agreements are in place to avert conflicts and agitations.

Furthermore, to boost agri-food production systems, smart and innovative agricultural (SIA) techniques both at local and global scales need to be upheld. Smart/Sustainable Innovative Agriculture (SIA) is an integrated approach aimed at enhancing water/land use in agricultural practices to effectively address water scarcity, irrigation and seedlings, to foster food security and income/livelihoods. It also assists in attaining internationally agreed goals, such as SDGs, Paris Agreement, etc.

[48] https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx (accessed 28/06/2012)

[49] Lienhard V. J.H, Madramootoo, C. Monier E, Robins R.J and Sixt J (Eds) 2018 Climate Change, Agriculture, Water, and Food Security: What We Know and Don't Know MIT