United Nations
Convention to Combat Desertification

COP-15 Côte d'Ivoire

DROUGHT IN NUMBERS 2022

- restoration for readiness and resilience -

COP-15 Côte d'Ivoire

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UNITED NATIONS DECADE ON
ECOSYSTEM
RESTORATION
2021-2030

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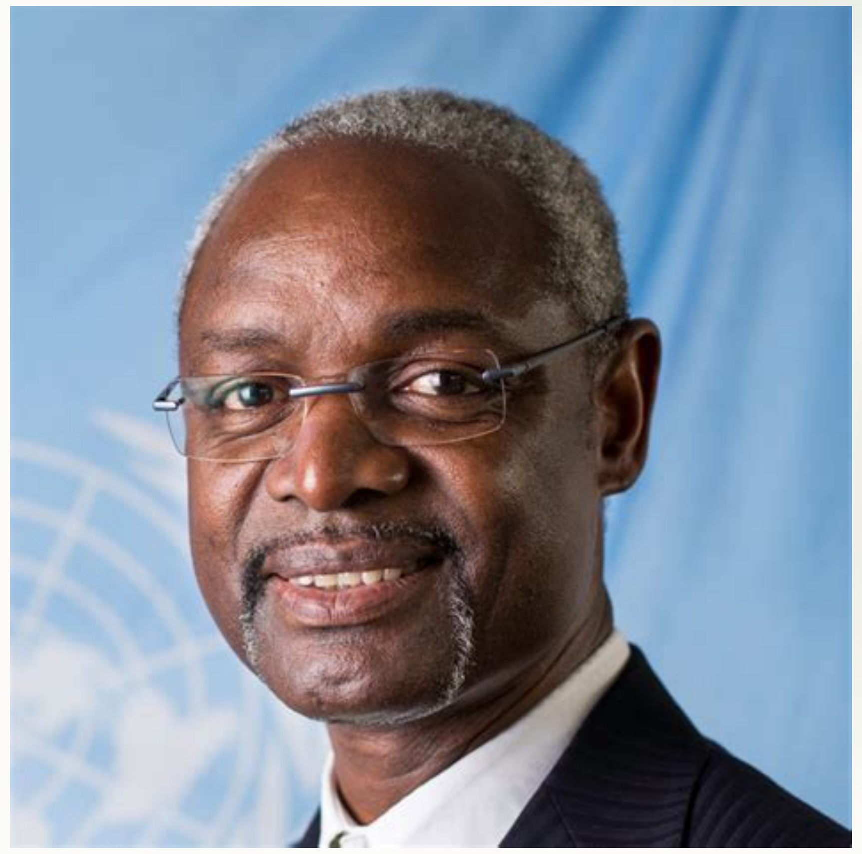
United Nations
Convention to Combat Desertification

United for land



Foreword by Ibrahim Thiaw

Throughout the world, people are feeling the impacts of the climate and environmental crises most strongly through water: the land is drying up, fertile grounds are turning to dust and drought is prevailing. In fact, since 1970, weather, climate and water hazards accounted for 50 percent of all disasters and 45 percent of all reported deaths. Tragically, 9 in 10 of these deaths occurred in developing countries, where drought led to the largest human losses during this period (WMO, 2021).

Droughts are among the greatest threats to sustainable development, especially in developing countries, but increasingly so in developed nations too. The number and duration of droughts has increased by 29 percent since 2000, as compared to the two previous decades (WMO, 2021). When more than 2.3 billion people already face water stress, this is a huge problem. More and more of us will be living in areas with extreme water shortages, including an estimated one in four children by 2040 (UNICEF). No country is immune to drought (UN-Water 2021).

The facts and figures of this publication all point in the same direction: an upward trajectory in the duration of droughts and the severity of impacts, not only affecting human societies but also the ecological systems upon which the survival of all life depends, including that of our own species.

We are standing at a crossroads, on top of a watershed, where we need to gain a new awareness and consciousness. We need to steer toward the solutions rather than continuing with destructive actions, believing that marginal change can heal systemic failure.

Rigorous scientific knowledge coupled with political will forms the pathway to impact and enable this urgently required planetary action, guided by empowering policies with clear targets and with environmental justice, commitment and willingness at its heart. We must deal with drought urgently, using every tool we can.

One of the best and most comprehensive ways to do so is through land restoration, which addresses many of the underlying factors of degraded water cycles and the loss of soil fertility. We must build and rebuild our landscapes better, mimicking nature wherever possible and creating functional ecological systems.

Restoration helps vulnerable communities adapt to droughts by, for example, increasing water infiltration and retention, which in turn increases agricultural production. Such measures would reduce the estimated 700 million people at risk of being displaced by drought by 2030.

Restoration is not enough, however. We need to protect and manage lands through improved consumption and production practices. On the agriculture side, this means sustainable and efficient management techniques that grow more food on less land and with less water. On the consumption side, this means changing our relationships with food, fodder and fiber, moving toward plant-based diets, reducing or stopping the consumption of animals.

We must also understand that drought is complex, with a range of causes and impacts. These should not be considered in isolation. We need coordination, communication and cooperation, driven by sufficient finance and political will.

Parties to the UNCCD and other stakeholders are radically shifting how they respond to water scarcity, desertification, land degradation and drought. To date, 128 countries have expressed political will to follow an approach to achieve or exceed Land Degradation Neutrality. Nearly 70 countries participated in the UNCCD's global drought initiative, which aims to shift from reactive approaches to drought to a proactive and risk-reducing approach. This is progress and a reason for hope, but so much more needs to be done.

We should commit to pursue concerted policy and partnerships at all levels. Developing and implementing integrated drought action plans is the first step. We should set up effective early-warning systems that could work across boundaries. New technologies, such as satellite monitoring and artificial intelligence, offer much-needed guidance and precision for informed decisions. Our strategic actions should be regularly reported so that we can monitor and ensure continuous improvement in our effectiveness in addressing droughts.

We should also mobilize sustainable finance to improve drought resilience at the local level. Investing in soil health makes business sense, while protecting our communities and ecosystems. According to recent economic analyses, every single dollar invested in land restoration can generate up to 30 dollars in ecosystem services.

Finally, we will only succeed if we work together – if we are inclusive and mobilize farmers, local communities, businesses, consumers, investors, entrepreneurs and, above all, young people, who are the engines of awareness and action.

Drought is daunting, as its effects on people's lives are devastating. But through ingenuity, commitment and solidarity, it can be successfully addressed. It can motivate action toward much-needed sustainable practices in land and water management, enabling us not only to survive, but to thrive.

PART I

United Nations
Convention to Combat
Desertification

Drought at a glance

Scientific consensus: There is strong evidence that human-induced climate change has led to an increased risk of drought (Hoegh-Guldberg et al, 2018)

Human activities, there is an increase in average surface temperatures around the world (IPCC, 2021)

Drought is deadly: From 1970 to 2019, drought was one of the hazards that led to the largest human losses, with a total of approximately 650,000 deaths

Among all the climate-related deaths during the period, more than 90 percent occurred in developing countries (WMO, 2021b)

Drought is costly: Economic losses due to drought have increased multifold in the past decades (WMO, 2021b)

Drought is devastating: An estimated 55 million people globally are directly affected by droughts every year, making it the most serious hazard to livestock and crops in nearly every part of the world (WHO, 2021)

Drought affects women and girls disproportionately: Greater burdens and suffering are inflicted on women and girls in emerging and developing countries in terms of education levels, nutrition, health, sanitation, and safety (Algur et al., 2021).

Almost 160 million children are exposed to severe and prolonged droughts - by 2040, it is estimated that one in four children will be living in areas with extreme water shortages (UNICEF, 2019)

Drought is underestimated: Droughts have deep, widespread and underestimated impacts on societies, ecosystems, and economies, with only a portion of the actual losses accounted for (UNDRR, 2021)

Drought preparedness polices make a difference: Proactive measures to reduce risks and increase resilience of ecosystems and communities can be achieved through sustainable land management and ecosystem restoration policies (King-Okumu, C. et al., 2019)

Land restoration is cost-effective: In Niger, farmers have substantially reduced drought risks by creating new agroforestry systems on 5 million hectares over 20 years, with average costs below USD20 per hectare (WRI, 2017)

Education instills readiness : Through a program of ecological restoration-based education, farmers in the Colombian Amazon set up 71 novel nursery gardens, producing 400,000 seedlings of 21 native forest species (Vizcarra, N. 2020)

Media matters: A case study of California in 2017 shows that an increase of about 100 drought stories over two months was associated with a reduction of 11 to 18 percent in typical household water-use (Quesnel, K. J., & Ajami, N. K., 2017)

Turning the tide: Limiting global warming to 1.5 degrees Celsius, along with regenerative land and improved water management practices, is expected to substantially reduce the probability of extreme drought events (Hoegh-Guldberg, O., 2018)

New horizons: A paradigm shift from ‘reactive’ and ‘crisis-based’ approaches to ‘proactive’ and ‘risk-based’ drought management approaches are indispensable (Tsegai, D. & Brüntrup, M., 2019)

fig. 1: Countries facing drought emergencies in the last two years (2020-2022)

(for UNCCD map disclaimer see page 45)

fig. 2: Countries affected by drought in 2020 - 2022

Drought around the world (1900-2022)

- More than 10 million people lost their lives due to major drought events in the past century, causing several hundred billion USD in economic losses worldwide, and the numbers are rising (Guha-Sapir, D. et al., 2021)

- Severe drought affects Africa more than any other continent, with more than 300 events recorded in the past 100 years, accounting for 44 percent of the global total. More recently, sub-Saharan Africa has experienced the dramatic consequences of climate disasters becoming more frequent and intense (Taylor et al., 2017; Guha-Sapir, D. et al., 2021)

- In the past century, 45 major drought events occurred in Europe, affecting millions of people and resulting in more than USD 27.8 billion in economic losses. Today, an annual average of 15 percent of the land area and 17 percent of the population within the European Union is affected by drought (Guha-Sapir, D. et al., 2021; European Environment Agency, 2017)

- In the U.S., crop failures and other economic losses due to drought have totaled several hundred billion USD over the last century – USD 249 billion alone since 1980 (NOAA-NCEI, 2021)

- Over the past century, the highest total number of humans affected by drought were in Asia (Guha-Sapir, D. et al., 2021)

fig. 3: Historic droughts, current trends and desertification hotspots

Drought impacts on human society

- Over 1.4 billion people were affected by drought in the period of 2000 to 2019. This makes drought the disaster affecting the second-highest number of people, after flooding. Africa suffered from drought more frequently than any other continent with 134 droughts, of which 70 occurred in East Africa (Wallemacq, P. et al., 2015)

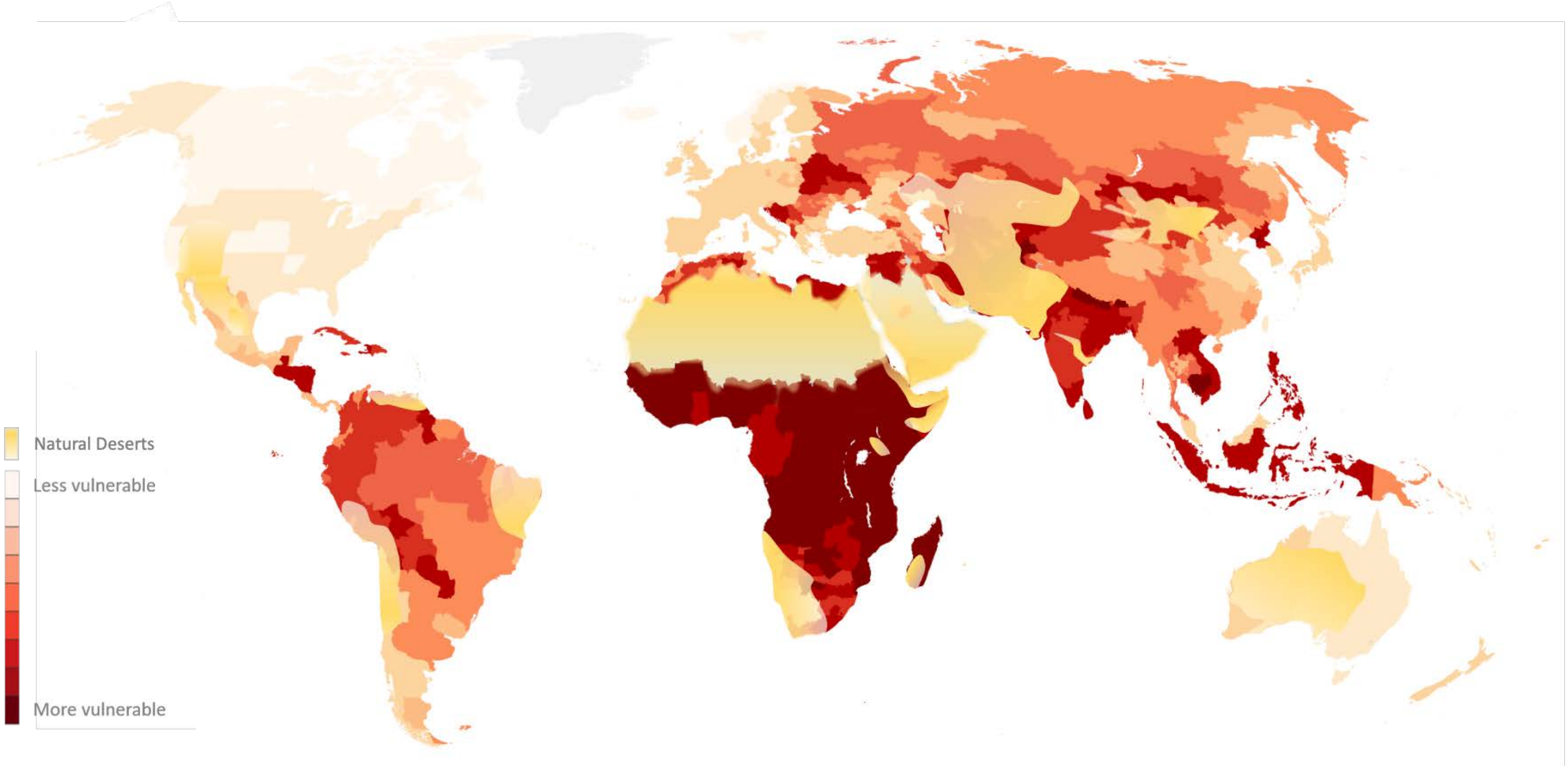
- The effect of severe droughts was estimated to have reduced India's gross domestic product by 2 to 5 percent over a period of 10 years (1998 to 2017) (UNDRR, 2021)

- As a result of the Australian Millennium Drought, total agricultural productivity fell by 18 percent in the period of 2002 to 2010 (WMO, 2021a)

- The burden of water collection – especially in drylands – falls disproportionately on women (72 percent) and girls (9 percent), who, in some cases, spend as much as 40 percent of their calorific intake carrying water (UNDRR, 2021)

- During the past two years (2020 and 2021), widespread precipitation deficits were recorded across the South American continent (Marinho Ferreira Barbosa et al, 2021)

- Drought is a major driver of crop yield volatility and, in particular, causes low yields that can lead to substantial financial losses (Bucheli, J. et al., 2021)



Global drought-vulnerability index 2022

Drought impacts on ecosystems

- The percentage of plants affected by drought has more than doubled in the last 40 years, with about 12 million hectares of land lost each year due to drought and desertification (FAO, 2017)

- Ecosystems progressively turn into carbon sources, especially during extreme drought events, detectable on five of six continents (Stocker, B. D. et al., 2019)

- One-third of global carbon dioxide emissions is offset by the carbon uptake of terrestrial ecosystems, yet their capacity to sequester carbon is highly sensitive to drought events (Chen, N. et al., 2020)

- The rapid increase in surface temperature correlates with declining biodiversity, including higher extinction rates (Nath, S. et al., 2021; Peace, N. 2020)

- Fourteen percent of all wetlands critical for migratory species, as listed by Ramsar, are located in drought-prone regions (WWF/RSIS, 2019)

- The megadrought in Australia contributed to 'megafires' in 2019 to 2020 that resulted in the most dramatic loss of habitat for threatened species in postcolonial history (Wintle, B. A. et al., 2020); about 3 billion animals were killed or displaced in the Australian wildfires (Eeden, van L. et al., 2020)

- Drought-induced peatland fires in Indonesia resulted in decreasing biodiversity, including both the number of individuals as well as plant species (Agus, C. et al., 2019)

- Photosynthesis in European ecosystems was reduced by 30 percent during the summer drought of 2003, which resulted in an estimated net carbon release of 0.5 gigatons (Schuldt, B. et al., 2020)

- North American scientists confirm that drought reduces vegetation and bird abundance, vegetation richness and diversity, and diversity of arthropods in semi-arid shortgrass prairie (Peterson, E. K. et al., 2021)

- Eighty-four percent of all terrestrial ecosystems are threatened by changing and intensifying wildfires (WWF, 2019)

- During the first two decades of the 21st century, the Amazon experienced 3 widespread droughts, all of which triggered massive forest fires (Brando, P.M.et al., 2020). Drought events are becoming increasingly common in the Amazon region due to land-use and climate change, which are interlinked (Aragão, L. E. et al., 2018). If Amazonian deforestation continues unabated, 16 percent of the region’s remaining forests will likely burn by 2050 (Boulton et al., 2022; Brando, P. M. et al., 2020)

- During one of the severest droughts in Costa Rica (2015), species-specific mortality rates reached up to 34 percent (Powers, J. S. et al., 2020)

- Drought has reduced the ecosystem productivity of Tibetan grasslands significantly in recent years, including soil drought, which now occurs more frequently and lasts for about 20 percent of the year (Xu, M. et al., 2021)

- Climate change is expected to increase the risk of droughts in many vulnerable regions of the world, particularly those with rapid population growth, vulnerable populations and challenges with food security (CRED & UNDRR, 2020)

- The World Bank estimates that up to 216 million people could be forced to migrate by 2050, largely due to drought, together with other factors such as water scarcity, declining crop productivity, sea-level rise and overpopulation (The World Bank, 2021)

- Within the next few decades, 129 countries will experience an increase in drought exposure mainly due to climate change alone – 23 primarily due to population growth and 38 mostly due to the interaction between climate change and population growth (Smirnov, O. et al., 2016)

- If global warming reaches 3 degrees Celsius by 2100, as has been predicted, drought losses could be five times higher than they are today, with the largest increase in drought losses projected in the Mediterranean and the Atlantic regions of Europe (Cammalleri, C. et al., 2020)

- In Angola, more than 40 percent of livestock, a significant livelihood source accounting for 31.4 percent of the agricultural GDP, is currently exposed to droughts and expected to rise to 70 percent under projected climate conditions (UNDRR, 2021)

- In the E.U. and U.K., annual losses from drought are currently estimated to be around EUR 9 billion and projected to rise to more than EUR 65 billion without meaningful climate action (Naumann et al., 2021)

- By 2050, between 4.8 and 5.7 billion people will live in areas that are water-scarce for at least one month each year, up from 3.6 billion today (UN Water, 2021)

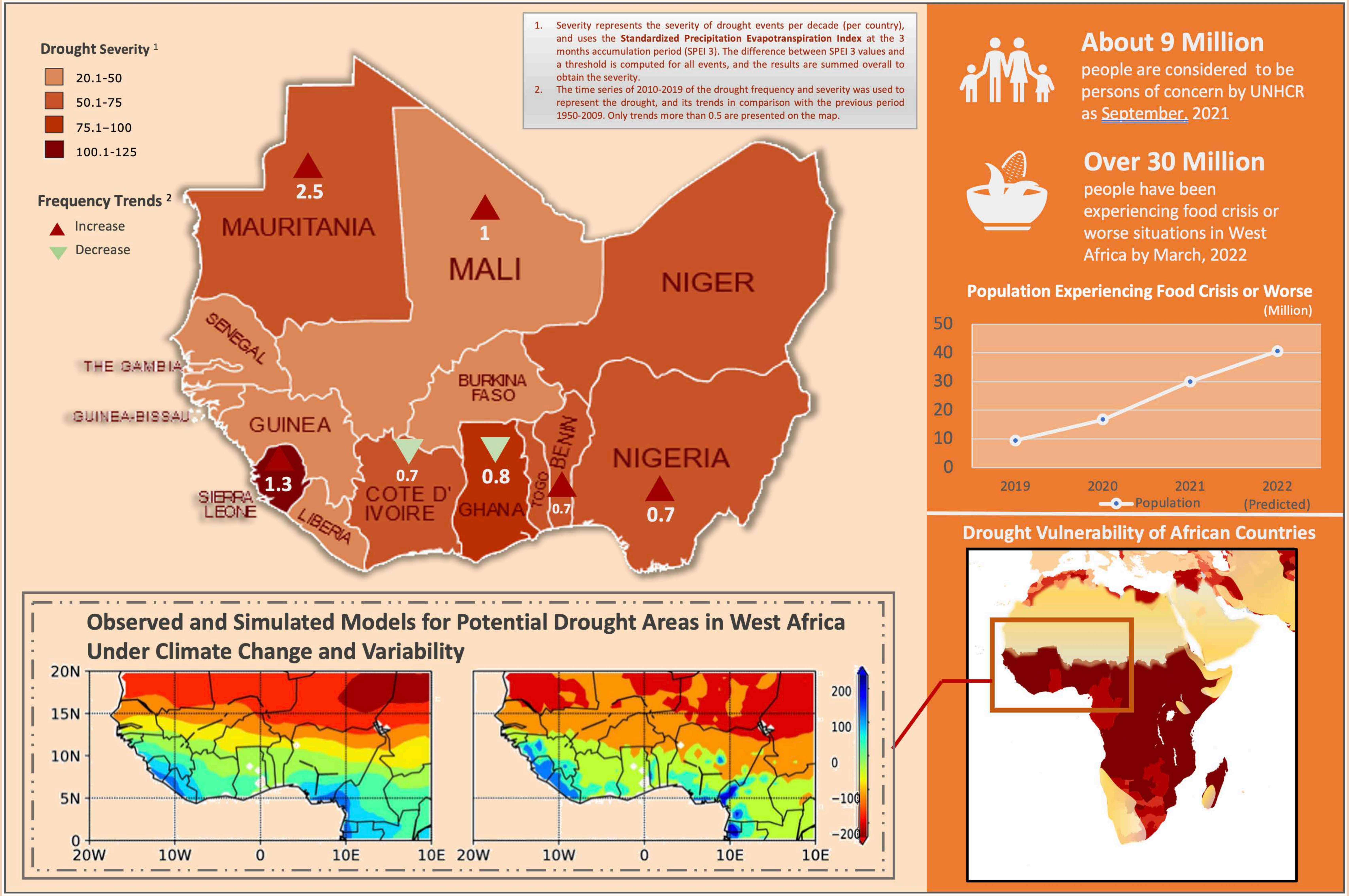
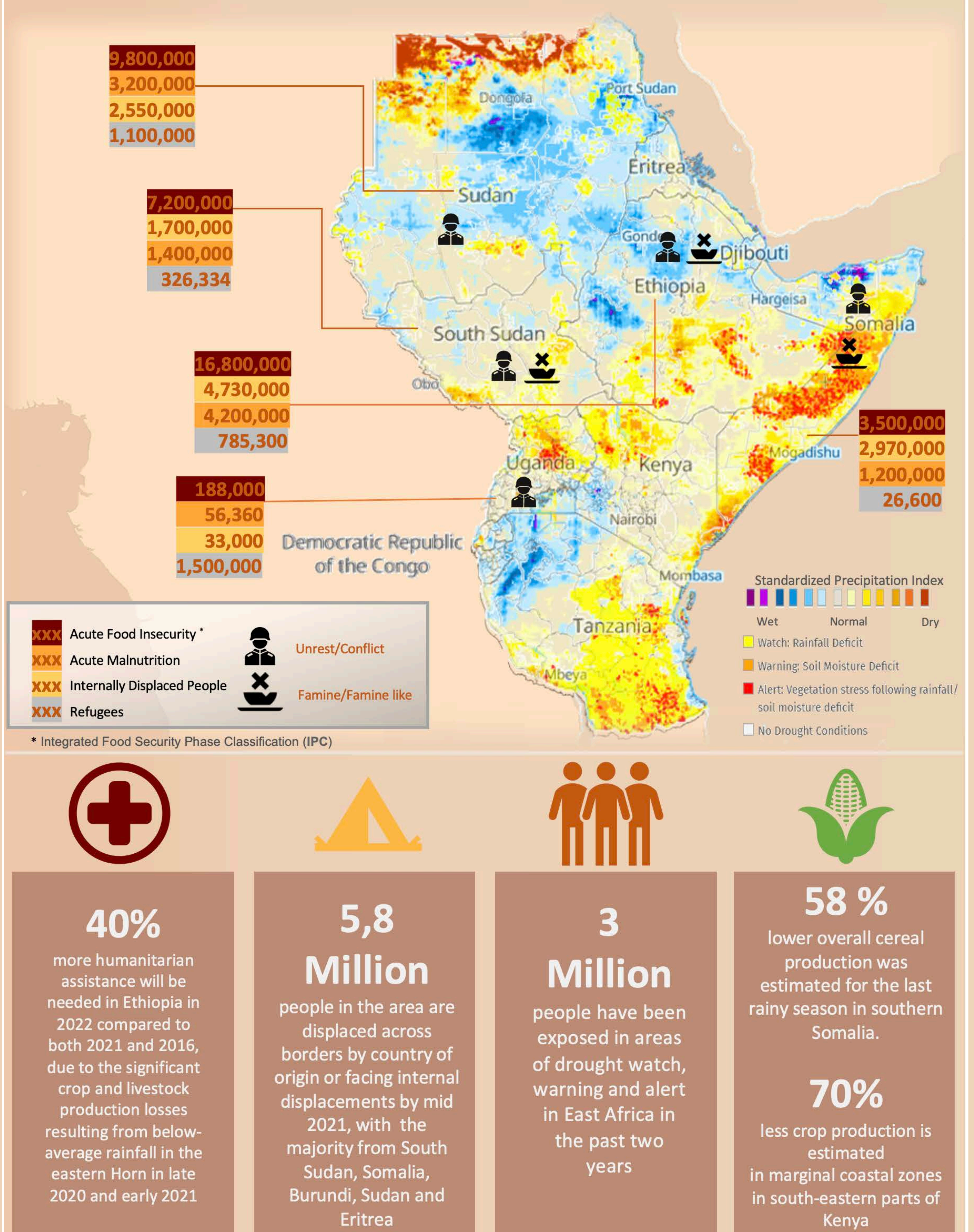


fig. 5: Drought infographic of West Africa

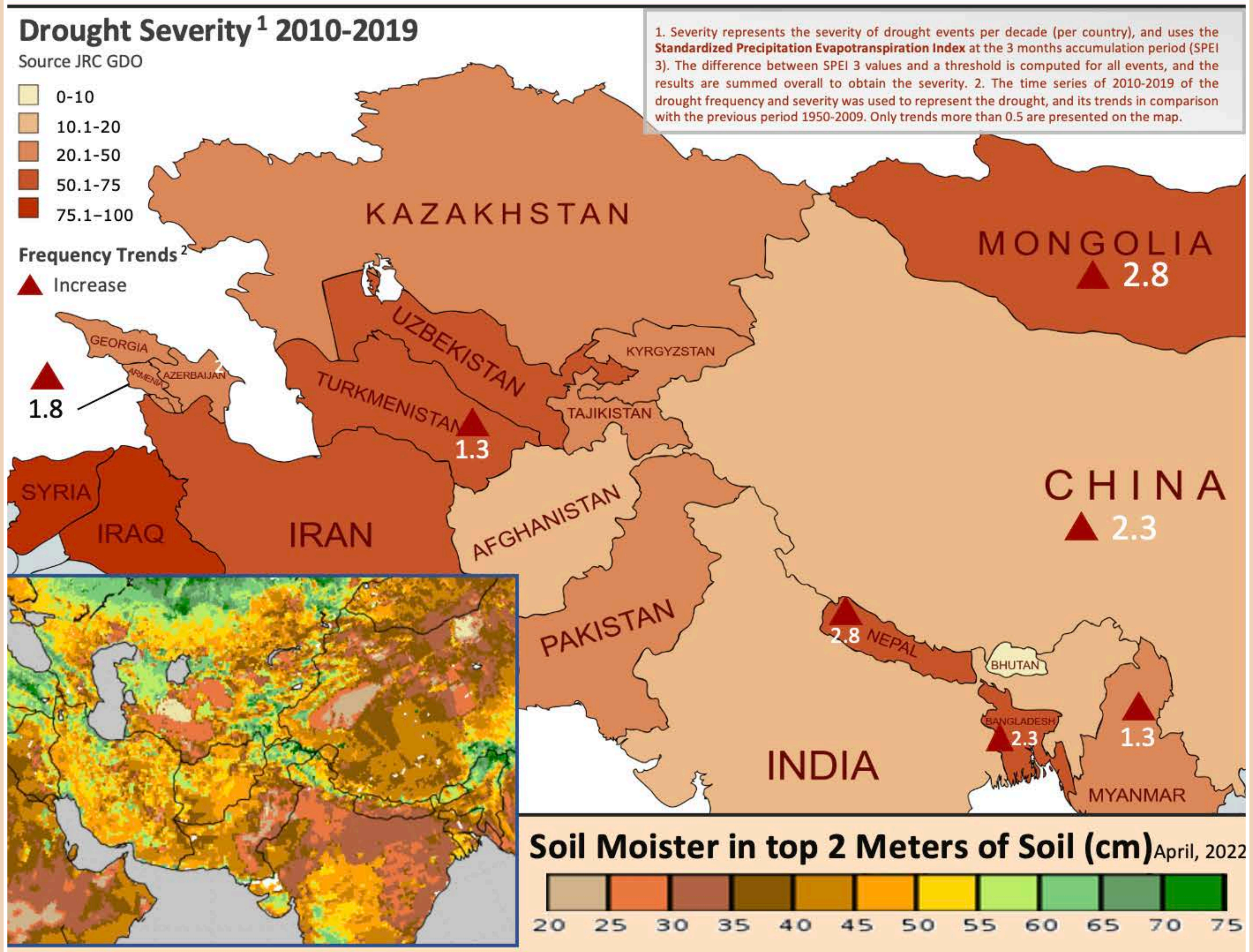
fig.6: Drought infographic of East Africa



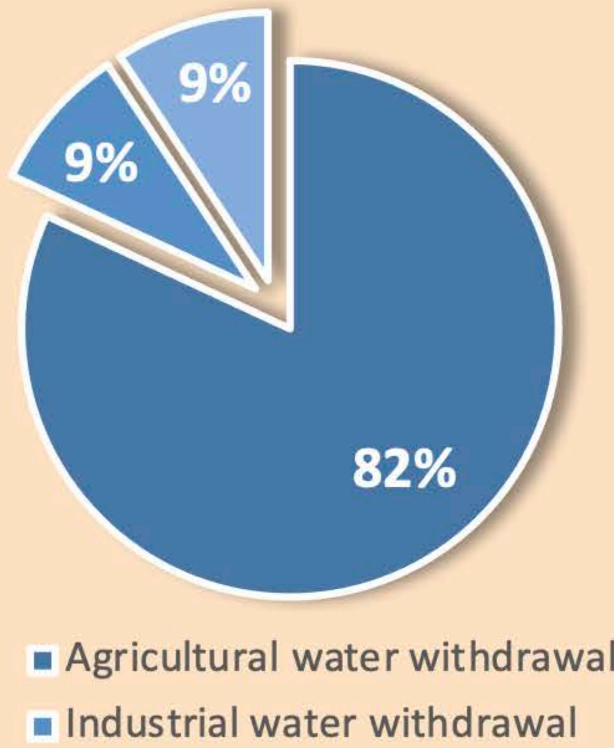
35%
countries from the map area have more drought events per decade between 2010 – 2019 compared to 1950 – 2009

90%
countries from the map area have experienced at least 2 drought events during the decade of 2011 – 2021

1,39 °C
mean temperature above the 1981 – 2010 average was detected in Asia in the year 2020



Water availability & withdrawals in Hindu Kush Himalayas countries (km³/year)



3500 km² in total is covered by the Hindu Kush Himalayas (HKH) across eight countries namely Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. The total renewable water availability in the eight countries from the HKH is **7745.5 km³**.

1,9 Billion
people living in major river basins originating in the Hindu Kush Himalaya

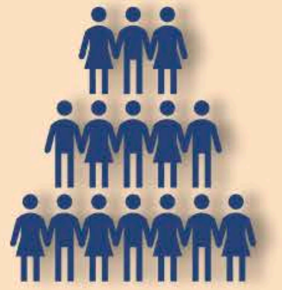


fig. 7: Drought infographic of Central and Southern Asia

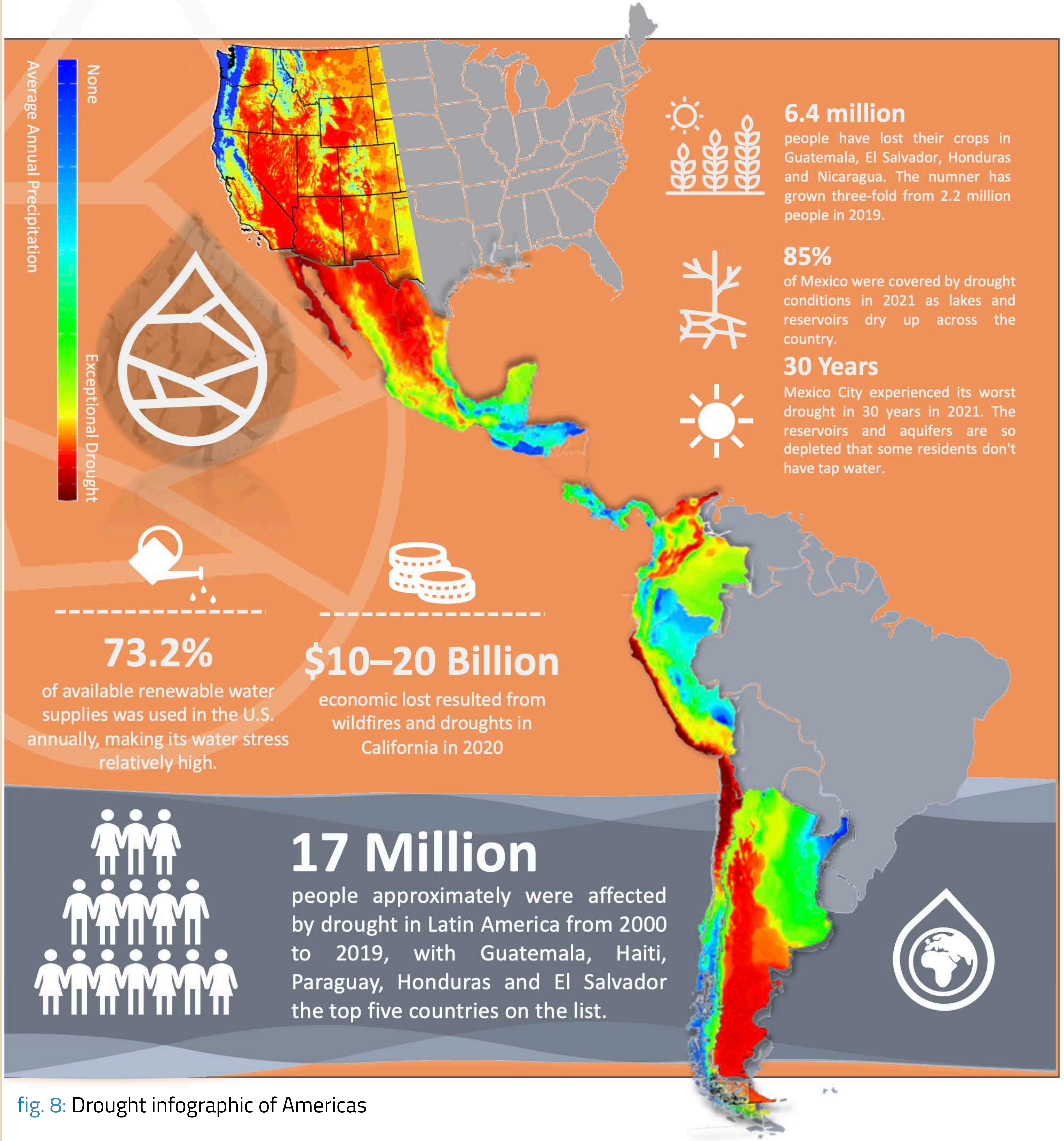


fig. 8: Drought infographic of Americas

PART II

- Launched in 2020, the conservation program of Reverte in Brazil aims to regenerate 1 million hectares of degraded pastureland by 2025 in the Cerrado, which covers 25 percent of the country's territory (UNDRR, 2021)

- The Australian government has invested USD 65.4 million in the Drought Community Support Initiative (DCSI) since 2019, assisting more than 25,000 drought-affected households in its first year (Department of Agriculture of Australian Government, 2019)

- Under the current Water Resources Management Plan and Drought Plans in the U.K., water companies are required to anticipate a minimum 25-year planning period as well as tactical and operational responses during a drought event (Water UK, 2016)

- Aiming to improve the productivity of agro- and silvo-pastoral systems through the expansion of sustainable management practices, the 3N Initiative (Nigerians Nourish Nigerians) has successfully reach almost all its 260,000 hectares of degraded lands targeted (UNCCD, 2019)

- The Integrated Resources Plan (IRP), adopted by the Southern California Metropolitan's Board of Directors, ensures supply reliability under various drought conditions through 23 local projects and 200 conservation programs that will yield more than 197 million cubic meters of water per year (The Metropolitan Water District of Southern California, 2021).

- The AFR100 initiative brings together 31 African governments and other partners to restore 100 million hectares of land by 2030 to promote food security, climate change resilience and rural prosperity, with the first 20 African restoration-focused organizations and businesses receiving USD 50,000 to USD 500,000 in the form of loans or grants (Hess, L. 2021).

We have the capacity to create a remarkably different economy: one that can restore ecosystems and protect the environment while bringing forth innovation, prosperity, meaningful work, and true security.

Paul Hawken

The need for proactive interventions

- Billions of dollars have been committed to international climate finance, expanding meteorological forecasting and its integration with remote Earth observation capabilities to observe drought risks (King-Okumu, C. et al., 2021)

- An overall drought vulnerability map based on a total of 14 drought-influencing criteria revealed that approximately 79 percent of Australia's Southern Queensland region in is moderately to extremely vulnerable to drought, helping decision makers to develop and apply proactive drought mitigation strategies (Hoque, M. et al., 2021)

- Full incorporation of proactive drought interventions in Central Asia alone could potentially avoid more than USD 4.5 billion in losses per year (Adelphi & CAREC, 2017)

- Pago por Servicios Ambientales (PSA), the Costa Rican programme for environmental services, has helped to protect 320,000 hectares at a cost of over USD 22 million and will benefit more than 33,000 people in the country, including Indigenous communities and women farm owners (UNCCD, 2021)

- In the short span of two years, Kings Subbasin Groundwater Sustainability Agencies in California's Central Valley have invested in hundreds of hectares of prime groundwater recharge land, anticipated to provide an average of over 18 million cubic meters of groundwater recharge per year on average, directly benefitting communities and agricultural land in the region (Kings River Conservation District, 2021)

- Information Technology and Indigenous Knowledge with Intelligence (ITIKI) is a drought early warning system that integrates Indigenous knowledge and drought forecasting to help small-scale farmers make more informed decisions, for example, on when and how to plant which crops. The support forecast models provides accuracy of 70 percent to 98 percent for lead-times of up to four years, as shown by trials in Mozambique, Kenya and South Africa (Masinde, 2020)

Successful business cases

- By adopting drip irrigation, small-scale vegetable farmers in drought-prone provinces of Viet Nam (Binh Phouc), Cambodia (Prey Veng and Svay Reing), the Philippines (Lantapan and Bukidnon) and Indonesia (Reing and Bogor, West Java; Rembang, East Java) were able to increase water use efficiency by up to 43 percent and yield by 8-15 percent (ESCAP, 2020)

- In Kazakhstan, financial assistance in the form of bank cards was distributed among 650 households in the Turkestan region and 500 in the Mangistau region to encourage greater local investments in drought resilience (IFRC, 2021)

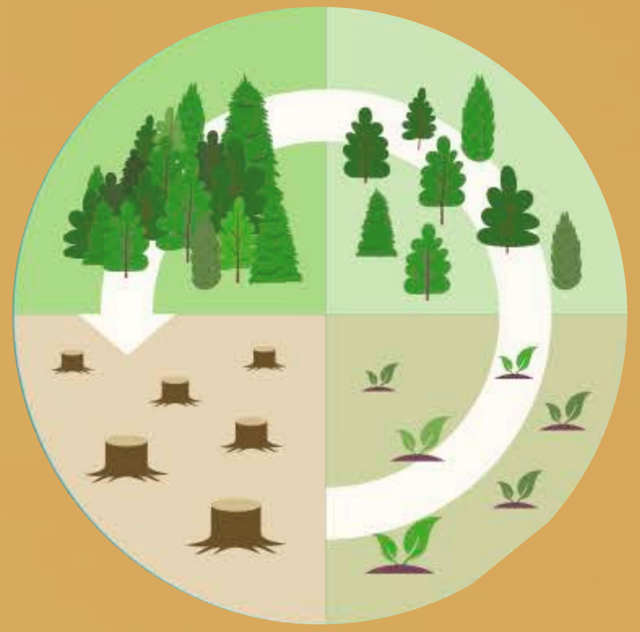
- To improve drinking water security in China's capital Beijing, a holistic restoration program was rolled out in the adjacent Miyun reservoir watershed (Jiali et al, 2018)

- With the highest water efficiency rate in agriculture, reaching a 70 to 80 percent rate, drip irrigation has helped to solve the problem of water scarcity in Israel (Megersa, G. & Abdulahi, J., 2015)

- The South African treasury invested over USD13 million in the Drought Relief Intervention Project, bringing 65% of the total 2,000 water tanks into serviceable use (Government of South Africa, 2020) fig.9: Restoration interventions and monetary returns

Natural Forest Regeneration

Extended Rotation Forestry



Agro-Forestry

Regenerative Agriculture

Grassland Regeneration

Energy Farming

Erosion Control

	Natural Forest Regeneration	Extended Rotation Forestry	Agro-Forestry	Regenerative Agriculture	Grassland Regeneration	Energy Farming	Erosion Control
Restoration fix costs:	0-500 USD/ha	300-3.500 USD/ha	450-1.500 USD/ha	50-800 USD/ha	100-1.500 USD/ha	50.000-4M USD/ha	200-1.500 USD/ha
Maintenance costs:	0-150 USD/ha/ya	100-600 USD/ha/ya	50-900 USD/ha/ya	150-1.500 USD/ha/ya	10-2.300 USD/ha/ya	2.000-0.1M USD/ha/ya	50-150 USD/ha/ya
Return range:	300-3.500 USD/ha/ya	1.000-6.500 USD/ha/ya	400-2.500 USD/ha/ya	250-3.500 USD/ha/ya	500-2.500 USD/ha/ya	4.000-0.3M USD/ha/ya	100-1.000 USD/ha/ya

* ranges are due to different levels of degradation, labor costs and market value fluctuations / erosion control estimates do not include coastal areas

- Soil organic matter (SOM) is a key factor contributing to the water-holding capacity of soil, up to 10,800 liters more of water per hectare can be retained with a 1 percent increase in SOM (Libohova, Z. et al., 2018)

- Soil coverage with mosses is characterized by high water absorption capacities. Some mosses can absorb water in amounts up to 1,400 percent of their dry mass, assisting land recovery and facilitating the establishment of higher plant growth in degraded environments (Adessi, A., 2021)

- Up to USD 1.4 trillion in production value can be generated globally by adopting sustainable land and water management practices (ELD Initiative, 2013)

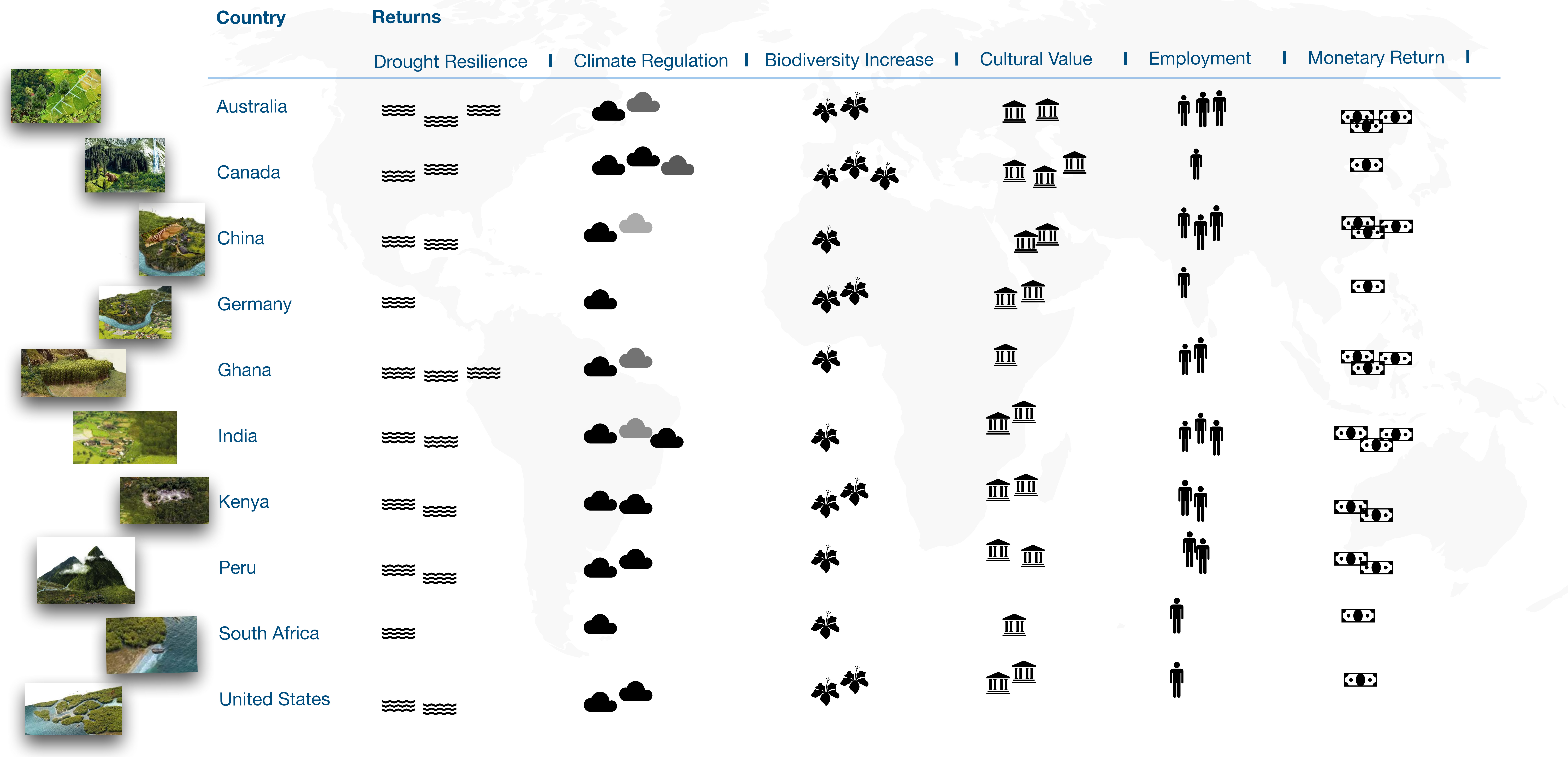
- Approximately 4 million hectares of degraded land within “strict intervention zones” have been rehabilitated under the framework of the African Union–led restoration initiative known as the Great Green Wall – 4 percent of the Wall’s ultimate target of restoring 100 million hectares, helping to reduce the immanent threats of desertification and drought (Vizcarra, N., 2020)

- Farmer-led land restoration innovations are key pathways to addressing severe land degradation that affects the livelihoods of the most vulnerable people living in drylands. Successful restoration efforts reaching a large number of farmers and covering vast areas must be taken to scale to regenerate hydrological cycles, reaching a large number of farmers and by covering large areas (Flintan, F. E., 2020)

- Seven million hectares of land in the Sahel has come under increased vegetation cover over the last 25 years after extensive droughts that ravaged the region in the 1970s and 1980s, driven by various factors including changes in tree tenure (Larbodière, L., 2020)

- In northern Shaanxi, China, bare lands decreased from 5,896 square kilometres in 1988 to 4,477 square kilometres due to active ecosystem restoration interventions over the past five years, holding more water in standing biomass and within soils (Wen, X., 2020)

fig. 10: Integrated landscape restoration and multiple returns


Country
Returns
Drought Resilience
Climate Regulation
Biodiversity Increase
Cultural Value
Employment
Monetary Return
Australia
Canada
China
Germany
Ghana
India
Kenya
Peru
South Africa
United States

EPILOGUE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United for land

The devastating impacts of drought reach much further than the dry regions of our planet. Droughts are becoming more frequent and severe across all continents – an omen of a world where freshwater and fertile soils are increasingly scarce. In extreme cases, drought triggers famine, forced migration and even conflicts.

Mortality related to droughts represents around 60 percent of the total deaths caused by extreme weather events, while droughts represent only 15 percent of natural disasters.[1] Between 1998 and 2017, droughts have led to global economic losses of approximately USD 124 billion.[2] Currently, forecasts estimate that by 2050, droughts may affect over three-quarters of the world's population. Heatwaves, sand and dust storms, and desertification are the symptoms of over-exploitation aimed at constant growth, material prosperity for some, uncurbed population development, and an economy that still heavily relies on non-renewable energy sources.

Drought is not just the absence of rain; it is fueled by land degradation and the climate crisis.

Recent scientific studies on drought point to a precarious future for the world and all nation-states, far beyond just those in arid regions. This wake-up call is louder and clearer than ever before.

The fifteenth session of the Conference of the Parties of the UNCCD (COP15) is taking place from 9 to 20 May 2022 Abidjan, Côte d'Ivoire, and among its top priorities should be a full global commitment to drought preparedness and resilience in all global regions. This can only be accomplished by promoting public awareness about desertification and drought, and by letting people know that desertification and drought can be effectively tackled. The solutions exist, and key tools are strengthening cooperation at all levels, managing drought risk proactively, and building an ecosystem restoration economy that aims to rejuvenate-water cycles, land fertility and people's livelihoods at the same time.

We all must live up to our responsibility to ensure the health of present and future generations, wholeheartedly and without delay.

"The atmosphere, the earth, the water and the water cycle - those things are good gifts.
The ecosystems, the ecosphere, those are good gifts.
We have to regard them as gifts because we couldn't make them.
We have to regard them as good gifts because we couldn't live without them."

Wendell, Berry

There's no radar image for a water crisis.
No storm surges, no debris fields -
the Tap-Out is as silent as cancer.
There's nothing to see,
and so the news is treating it like a sidebar.
Shusterman, Jarrod

List of references:

Adessi, A., De Philippis, R., & Rossi, F. (2021). Drought-tolerant cyanobacteria and mosses as biotechnological tools to attain land degradation neutrality. Web Ecology, 21(1), 65-78.

Adelphi & Central Asia Regional Economic Cooperation Program. (2017). RETHINKING WATER IN CENTRAL ASIA: The costs of inaction and benefits of water cooperation. https://carececo.org/Rethinking%20Water%20in%20Central%20Asia.pdf

Agus, C., Azmi, F. F., Ilfana, Z. R., Wulandari, D., Rachmanadi, D., Harun, M. K., & Yuwati, T. W. (2019). The impact of Forest fire on the biodiversity and the soil characteristics of tropical Peatland. In Handbook of Climate Change and Biodiversity (pp. 287-303). Springer, Cham.

Algur, K. D., Patel, S. K., & Chauhan, S. (2021). The impact of drought on the health and livelihoods of women and children in India: A systematic review. Children and Youth Services Review, 122, 105909.

Aragão, L.E., Anderson, L.O., Fonseca, M.G., Rosan, T.M., Vedovato, L.B., Wagner, F.H., et al., (2018). 21st Century drought-related fires counteract the decline of Amazon deforestation carbon emissions. Nat. Commun. 9, 1–12.

Brando, P.M., Soares-Filho, B., Rodrigues, L., Assunção, A., Morton, D., Tuchschneider, D., et al., (2020). The gathering firestorm in southern Amazonia. Sci. Adv. 6, eaay1632.

Boulton, C. A., Lenton, T. M., & Boers, N. (2022). Pronounced loss of Amazon rainforest resilience since the early 2000s. Nature Climate Change, 1-8.

Bucheli, J., Dalhaus, T., & Finger, R. (2021). The optimal drought index for designing weather index insurance. European Review of Agricultural Economics, 48(3), 573-597.

Burek, P., Satoh, Y., Fischer, G., Kahil, M.T., Scherzer, A., Tramberend, S., Nava, L.F., Wada, Y., et al. (2016). Water Futures and Solution - Fast Track Initiative (Final Report). http://pure.iiasa.ac.at/id/eprint/13008/1/WP-16-006.pdf

Cammalleri, C., Naumann, G., Mentaschi, L., Formetta, G., Forzieri, G., Gosling, S., Bisselink, B., De Roo, A. and Feyen, L.. (2020). Global warming and drought impacts in the EU. Publications Office of the European Union, Luxembourg.

Chavas, J. P., Di Falco, S., Adinolfi, F., & Capitanio, F. (2019). Weather effects and their long-term impact on the distribution of agricultural yields: evidence from Italy. European Review of Agricultural Economics, 46(1), 29-51.

Chen, N., Zhang, Y., Zu, J., Zhu, J., Zhang, T., Huang, K., & Chen, Y. (2020). The compensation effects of post-drought regrowth on earlier drought loss across the tibetan plateau grasslands. Agricultural and Forest Meteorology, 281, 107822.

CRED & UNDRR (2017). Economic losses, poverty & disasters: 1998-2017. Retrieved from https://www.preventionweb.net/files/61119_credeconomiclosses.pdf

CRED & UNDRR. (2020). The Human Cost of Disasters: an overview of the last. https://reliefweb.int/sites/reliefweb.int/files/resources/Human%20Cost%20of%20Disasters%202000-2019%20Report%20-%20UN%20Office%20for%20Disaster%20Risk%20Reduction.pdf

Department of Agriculture of Australian Government. (2019). Australian Government Drought Response, Resilience and Preparedness Plan. https://www.awe.gov.au/sites/default/files/documents/aust-govt-drought-response-plan_0.pdf

ELD Initiative (2013). Interim Report for the Economics of Land Degradation Initiative: A global strategy for sustainable land management. https://www.eld-initiative.org/fileadmin/pdf/ELD_interim_report_2015_web.pdf

ESCAP: ICT and Disaster Risk Reduction Division. (2020). Adaptation and Resilience to Drought: From know how to do how. https://www.droughtmanagement.info/literature/Adaptation_and_resilience_to_drought-from-Knowhow-to-dohow_final-report.pdf

European Environment Agency. (2017). Climate change adaptation and disaster risk reduction in Europe. https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster/at_download/file

FAO. (2017). Drought & Agriculture. http://www.fao.org/3/i7378e/i7378e.pdf

FAO & NEPAD. (2021). Review of forest and landscape restoration in Africa 2021.

Flintan, F. E. (2020). Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel. Summary of 2nd Webinar in the Land Tenure and Governance Webinar series, 13 October 2020.

Garzón, N. V., Rodríguez León, C. H., Ceccon, E., & Pérez, D. R. (2020). Ecological restoration-based education in the Colombian Amazon: toward a new society–nature relationship. Restoration Ecology, 28(5), 1053-1060.

Government of South Africa. (2020). Drought relief project bearing fruit in Free State. Reliefweb. https://reliefweb.int/report/south-africa/drought-relief-project-bearing-fruit-free-state

Guha-Sapir, D. & Below, R. & Hoyois, Ph. (2021). EM-DAT: The CRED/OFDA International Disaster Database. www.emdat.be

Hess, L. (2021, November 8). AFR100 initiative gets a boost as USD 2 billion funding goal before next COP set. Global Landscapes Forum: LANDSCAPE NEWS. https://news.globallandscapesforum.org/55716/afr100-initiative-gets-a-boost-as-usd-2-billion-funding-goal-before-next-cop-set/

Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., Diedhiou, A., Djalante, R., Ebi, K., Engelbrecht, F., Guiot, J., Hijioka, Y., Mehrotra, S., Payne, A., Seneviratne, S. I., Thomas, A., Warren, R., & Zhou, G. (2018). Impacts of 1.5°C Global Warming on Natural and Human Systems. In V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (Eds.), Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change World Meteorological Organization Technical Document.

Hoque, M., Pradhan, B., Ahmed, N., & Alamri, A. (2021). Drought Vulnerability Assessment Using Geospatial Techniques in Southern Queensland, Australia. Sensors, 21(20), 6896. doi:10.3390/s21206896

IFPRI - International Food Policy Research Institute. (2011). 2011 global food policy report. https://reliefweb.int/sites/reliefweb.int/files/resources/oc72.pdf

IFRC - International Federation of Red Cross And Red Crescent Societies. (2021). Operation Update Report Kazakhstan: Drought. https://reliefweb.int/sites/reliefweb.int/files/resources/MDRKZ010du1.pdf

IPCC (2022) AR6 Working Group II - Synthesis Report: Climate Change 2022. https://report.ipcc.ch/ar6wg2/ Kings River Conservation District. (2021, November 3). Fresno Area Groundwater Agencies Build for Drought Resilience at Record Pace. Association of California Water Agencies Newsroom. https://www.acwa.com/news/fresno-area-groundwater-agencies-build-for-drought-resilience-at-record-pace/

King-Okumu, C., Tsegai, D., Sanogo, D., Kiprop, J., Cheboiwo, J., Sarr, M. S., ... & Salman, M. (2021). How can we stop the slow-burning systemic fuse of loss and damage due to land degradation and drought in Africa?. Current Opinion in Environmental Sustainability, 50, 289-302.

Libohova, Z. & Seybold, C. & Wysocki, D. & Wills, S. & Schoeneberger, P. & Williams, C. & Lindbo, D. & Stott, D. & Owens, P.R.. (2018). Reevaluating the effects of soil organic matter and other properties on available water-holding capacity using the National Cooperative Soil Survey Characterization Database. Journal of Soil and Water Conservation. 73. 411-421. doi: 10.2489/jswc.73.4.411

Larbodière, L., Davies, J., Schmidt, R., Magero, C., Vidal, Arroyo Schnell, A., Bucher, P., Maginnis, S., Cox, N., Hasinger, O., Abhilash, P.C., Conner, N., Westerberg, V., Costa, L. (2020). Common ground: restoring land health for sustainable agriculture.

McCann, D. G., Moore, A., & Walker, M. E. (2011). The water/health nexus in disaster medicine: I. Drought versus flood. *Current Opinion in Environmental Sustainability*, *3*(6), 480-485.

Marinho Ferreira Barbosa, P., Masante, D., Arias-Muñoz, C., Cammalleri, C., De Jager, A., Magni, D., Mazzeschi, M., Mccormick, N., Naumann, G., Spinoni, J. and Vogt, J. (2021). Droughts in Europe and Worldwide 2019-2020. Publications Office of the European Union, Luxembourg.

Masinde, M. (2020). ITIKI Success Story: Classic Application of Design Thinking. In 2020 IST-Africa Conference (IST-Africa) 1-9.

Megersa, G. & Abdulahi, J. (2015). Irrigation system in Israel: A review. International Journal of Water Resources and Environmental Engineering, 7(3), 29-37.

Naumann, G. & Cammalleri, C. & Mentaschi, L. et al. (2021). Increased economic drought impacts in Europe with anthropogenic warming. Nat. Clim. Chang, 11, 485–491.

Nath, S., Shyanti, R. K., & Nath, Y. (2021). Influence of anthropocene climate change on biodiversity loss in different ecosystems. In Global Climate Change (pp. 63-78). Elsevier.

NOAA-NCEI. (2021). U.S. Billion-Dollar Weather and Climate Disasters. https://www.ncdc.noaa.gov/billions/, doi: 10.25921/stkw-7w73

Peace, N. (2020). Impact of climate change on insect, pest, disease, and animal biodiversity. International journal Environmental science & natural resources Review article, 23(5).

Peterson, E. K., Jones, C. D., Sandmeier, F. C., Rivas, A. P. A., Back, C. A., Canney, A., ... & Heuvel, B. V. (2021). Drought influences biodiversity in a semi-arid shortgrass prairie in southeastern Colorado. Journal of Arid Environments, 195, 104633.

Powers, J. S., Vargas G, G., Brodribb, T. J., Schwartz, N. B., Pérez-Aviles, D., Smith-Martin, C. M., & Medvigy, D. (2020). A catastrophic tropical drought kills hydraulically vulnerable tree species. Global Change Biology, 26(5), 3122-3133.

Qiu, J., Shen, Z., Huang, M., & Zhang, X. (2018). Exploring effective best management practices in the Miyun reservoir watershed, China. Ecological engineering, 123, 30-42.

Smirnov, O., Zhang, M., Xiao, T., Orbell, J., Lobben, A., & Gordon, J. (2016). The relative importance of climate change and population growth for exposure to future extreme droughts. Climatic Change, 138(1), 41-53.

Quesnel, K. J., & Ajami, N. K. (2017). Changes in water consumption linked to heavy news media coverage of extreme climatic events. Science advances, 3(10), e1700784. https://doi.org/10.1126/sciadv.1700784

Schuldt, B., Buras, A., Arend, M., Vitasse, Y., Beierkuhnlein, C., Damm, A., Kahmen, A. (2020). A first assessment of the impact of the extreme 2018 summer drought on Central European forests. Basic and Applied Ecology, 45, 86-103.

Smirnov, O. & Zhang, M. & Xiao, T. et al. (2016). The relative importance of climate change and population growth for exposure to future extreme droughts. Climatic Change, 138, 41–53. https://doi.org/10.1007/s10584-016-1716-z

Stocker, B. D., Zscheischler, J., Keenan, T. F., Prentice, I. C., Seneviratne, S. I., & Peñuelas, J. (2019). Drought impacts on terrestrial primary production underestimated by satellite monitoring. Nature Geoscience, 12(4), 264-270.

Taylor, C. & Belušić, D. & Guichard, F. et al. (2017) Frequency of extreme Sahelian storms tripled since 1982 in satellite observations. Nature 544, 475–478. https://doi.org/10.1038/nature220699

The Metropolitan Water District of Southern California. (2021). Water Shortage Contingency Plan. https://www.mwdh2o.com/media/21648/water-shortage-contingency-plan-june-2021.pdf

The World Bank. (2021). Groundswell Part 2 : Acting on Internal Climate Migration. https://openknowledge.worldbank.org/bitstream/handle/10986/36248/Groundswell%20Part%20II.pdf?sequence=8&isAllowed=y

Tsegai, D., & Brüntrup, M. (2019). Drought challenges and policy options: lessons drawn, and the way forward. In Current Directions in Water Scarcity Research (Vol. 2, pp. 325-336). Elsevier.

UNICEF (2019) FACT SHEET: 'The climate crisis is a child rights crisis' https://www.unicef.org/press-releases/fact-sheet-climate-crisis-child-rights-crisis

UNCCD. (2019). The Global Land Outlook, West Africa Thematic Report, Bonn, Germany. http://catalogue.unccd.int/1220_GLO_WEST_AFRICA_E.pdf

UNCCD. (2021, June 12). Costa Rica rallies up world leaders to act on land restoration. UNCCD News and Events. https://www.unccd.int/news-events/costa-rica-rallies-world-leaders-act-land-restoration-0

UNDRR. (2021). GAR Special Report on Drought 2021. https://www.undrr.org/media/49386/download

United Nations World Water Assessment Programme. (2017). The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource. Paris, UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000247153

UN Water. (2021) Water Facts – Scarcity. https://www.unwater.org/water-facts/scarcity/

Vizcarra, N. (2020). Africa's Great Green Wall is officially 4% – and unofficially 18% – complete. Global Landscapes Forum: Landscape News.

Wallemacq, P. & Guha-Sapir, D. & McClean, D. & CRED, & UNISDR. (2015). The Human Cost of Natural Disasters - A global perspective.

Water UK. (2016). Water Resources Long Term Planning Framework 2015-2065. https://www.water.org.uk/wp-content/uploads/2018/11/WaterUK-WRLTPF_Final-Report_FINAL-PUBLISHED-min.pdf

Webber, H., Ewert, F., Olesen, J. E., Müller, C., Fronzek, S., Ruane, A. C., ... & Wallach, D. (2018). Diverging importance of drought stress for maize and winter wheat in Europe. Nat Commun 9: 4249.

Wen, X. (2020). Temporal and spatial relationships between soil erosion and ecological restoration in semi-arid regions: a case study in northern Shaanxi, China. GIScience & Remote Sensing, 57:4, 572-590.

WHO. (2021). Drought Overview. WHO website. https://www.who.int/health-topics/drought#

WMO. (2021a). Drought report calls for new management approach. https://public.wmo.int/en/media/news/drought-report-calls-new-management-approach

WMO. (2021b). WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes 1970–2019. https://library.wmo.int/doc_num.php?explnum_id=10902

Wintle, B. A., Legge, S., & Woinarski, J. C. (2020). After the megafires: What next for Australian wildlife? Trends in Ecology & Evolution, 35(9), 753-757.

WRI (2017) Can We Restore 350 Million Hectares by 2030? https://www.wri.org/insights/can-we-restore-350-million-hectares-2030

WWF. (2019). Risiko Dürre – Der weltweite Durst nach Wasser in Zeiten der Klimakrise. WWF Deutschland. Berlin, Germany.

Xu, M., Zhang, T., Zhang, Y., Chen, N., Zhu, J., He, Y., & Yu, G. (2021). Drought limits alpine meadow productivity in northern Tibet. Agricultural and Forest Meteorology, 303, 108371.

Data sources for figures:

fig. 1

Guha-Sapir, D. & Below, R. & Hoyois, Ph. (2022). EM-DAT: The CRED/OFDA International Disaster Database. www.emdat.be

Relief Web. (2022). https://reliefweb.int/disasters?advanced-search=%28TY4672%29_%28DA20200101-%29

fig 2.

Guha-Sapir, D. & Below, R. & Hoyois, Ph. (2022). EM-DAT: The CRED/OFDA International Disaster Database. www.emdat.be

Relief Web. (2022). https://reliefweb.int/disasters?advanced-search=%28TY4672%29_%28DA20200101-%29

UNCCD. (2022). Drought Newsletter 2021 & 2022

fig 3.

Carrao, Hugo & Naumann, Gustavo & Barbosa, Paulo. (2016). Mapping global patterns of drought risk: An empirical framework based on sub-national estimates of hazard, exposure and vulnerability. Global Environmental Change. 39. 108 – 124. doi: 10.1016/j.gloenvcha.2016.04.012.

National Geographic. (2022). https://www.nationalgeographic.com/environment/article/desert-map

fig 4.

Guha-Sapir, D. & Below, R. & Hoyois, Ph. (2022). EM-DAT: The CRED/OFDA International Disaster Database. www.emdat.be

fig 5.

ACLED. (2022). The Armed Conflict Location & Event Data Project. https://acleddata.com/2022/03/10/regional-overview-africa-26-february-4-march-2022/

Al Jazeera. (2022). Drought crisis puts Horn of Africa 'on the brink of catastrophe'. https://www.aljazeera.com/economy/2022/2/15/on-the-brink-of-catastrophe-horn-of-africa-in-drought-crisis

East Africa Drought Watch. (2022). https://droughtwatch.icpac.net/mapviewer/

Famine Early Warning Systems Network. (2022). https://fews.net/

Relief Web. (2021). https://reliefweb.int/sites/reliefweb.int/files/resources/ECDM_20211013_Horn-of-Africa_Food-Insecurity.pdf

UNHCR. (2021). MID-YEAR TRENDS. https://www.unhcr.org/statistics/unhcrstats/618ae4694/mid-year-trends-2021.html

fig 6.

Quenum, G.M.L.D. & Klutse, N.A.B. & Dieng, D., et al. (2019). Identification of Potential Drought Areas in West Africa Under Climate Change and Variability. Earth Syst Environ 3, 429–444. doi: 10.1007/s41748-019-00133-w

Relief Web. (2021). https://reliefweb.int/sites/reliefweb.int/files/resources/ECDM_20210129_Africa_Drought_2010-2019.pdf

Relief Web. (2022). UNHCR West and Central Africa: Persons of Concern (September 2021). https://reliefweb.int/report/benin/unhcr-west-and-central-africa-persons-concern-september-2021

The Food Crisis Prevention Network. (2020). Sahel and West Africa: food and nutrition situation 2020-21. https://www.food-security.net/en/document/afrique-de-louest-et-sahel-situation-alimentaire-et-nutritionnelle-2020-21/

The Food Crisis Prevention Network. (2021). Sahel and West Africa: food and nutrition situation 2021-21. https://www.food-security.net/en/document/sahel-and-west-africa-food-and-nutrition-situation-2021-22/

The Food Crisis Prevention Network. (2019). Sahel and West Africa: food and nutrition situation 2019-20. https://www.food-security.net/en/document/sahel-and-west-africa-food-and-nutrition-situation-2019-20/

fig 7.

Alves, B. (2022). Number of people that were affected by drought in Latin America from 2000 to 2019, by country. Statista. https://www.statista.com/statistics/1140085/number-population-affected-draught-latin-america/

Sönnichsen, N. (2021). Estimated range of drought and wildfire-related economic costs in the United States in 2020, by select state. Statista. https://www.statista.com/statistics/1266247/us-drought-and-wildfire-economic-costs-by-state/

Tiseo, I. (2021). Baseline water stress score worldwide in 2020, by select country. Statista. https://www.statista.com/statistics/1097524/water-stress-levels-by-country/

Nuñez, J.H. & Verbist, K. & Wallis, J. & Schaeffer, M. & Morales, L. & Cornelis, W.M. (2011). Regional frequency analysis for mapping drought events in north-central Chile. Journal of Hydrology. 405: 352-366. https://www.climatedatalibrary.cl/CAZALAC/maproom/Historical/index.html

WFP. (2021). https://www.wfp.org/stories/central-america-meet-peoples-needs-and-tackle-root-causes-migration-says-report

Reitz, Meredith & Sanford, Ward & Senay, Gabriel & Cazenas, J.. (2017). Annual Estimates of Recharge, Quick-Flow Runoff, and Evapotranspiration for the Contiguous U.S. Using Empirical Regression Equations. JAWRA Journal of the American Water Resources Association. 53. doi: 10.1111/1752-1688.12546.

Our Daily Planet. (2021). Over 80% of Mexico Affected by Drought Conditions. https://worldwarzero.com/magazine/2021/04/over-80-of-mexico-affected-by-drought-conditions/

UNCCD/SEE-Intl' consultancy visit at all intervention sites (2008–2021) / (design: SEE-Intl' & One Big Robot)

Drought specific databases and portals

The United Nations Convention to Combat Desertification (UNCCD) – Drought Toolbox:
knowledge.unccd.int/drought-toolbox
The UNCCD developed the drought toolbox for providing drought stakeholders with easy access to resources to support action on drought preparedness to boost the resilience of people and ecosystems.

Drought Calculator:
www.nrcs.usda.gov/wps/portal/nrcs/detail/nd/technical/landuse/?cid=nrcs141p2_001670
The U.S. Department of Agriculture developed the drought calculator to assist ranchers and rangeland managers in assessing the impacts of drought on healthy rangelands and make informed decisions for drought preparedness strategies.

The International Disaster Database:
www.emdat.be/database
The Centre for Research on the Epidemiology of Disasters – CRED, Université Catholique de Louvain provides information on the human impact of disasters - such as the number of people killed, injured, or affected for vulnerability assessment and rational decision-making in disaster situations

United Nations Office for Disaster Risk Reduction (UNDDR) Preventionweb – Drought Solutions:
www.preventionweb.net/collections/drought-solutions
The UNDDR collected stories and research regarding different drainage solutions

EDO – European Drought Observatory/GDO – Global Drought Observatory:
edo.jrc.ec.europa.eu/gdo/php/index.php?id=2101
The EDO/GDO pages contain drought-relevant information such as maps of indicators derived from different data sources (e.g., precipitation measurements, satellite measurements, modeled soil moisture content).

The FAO Drought Portal:
www.fao.org/land-water/water/drought/drought-portal/en/
The FAO Drought Portal collates tools, methodologies, publications, and best practices from different disciplines to support informed decision-making and promote integrated drought management in agriculture.

Lead authors

Daniel Tsegai
Miriam Medel
Patrick Augenstein
Zhuojing Huang

Copy Editor
Sasha Alexander
Gabrielle Lipton

Contributing authors
Branislava Ilic
Caroline King-Okumu
Katya Arapnakova
Michael Brüntrup
Muhamma d Tukur Bayero
Robert Stefanski

Photos credits:
Page 1 - 50: Patrick Augenstein /
Society for Environmental Education - International (SEE-Intl')

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