



**United Nations**  
Convention to Combat  
Desertification

# THE BLUE PAPER

- Drought Risks, Resilience and Restoration -





# THE BLUE PAPER

Intergovernmental Working Group on Drought

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## Drought at a glance

**Dry land:** Land degradation enhances drought and vice versa (Mishra et al. 2021; Aguilos, 2021)

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

**Increasing temperatures:** Due to human activities, there is an increase in average surface temperatures around the world. Atmospheric CO<sup>2</sup> concentrations are higher than at any time in at least 2 million years (*high confidence*) (IPCC, 2021)

**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 is disproportional:** 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, 91 percent of them occurred in developing countries (WMO, 2021b)

**Drought hits children:** 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)

**Polices make a difference:** Proactive reversal of the slower onset ecological and hydrological degradation affecting ecosystems and communities can be achieved through land management and ecosystem restoration policies (King-Okumu, C. et al., 2019)

**Land restoration works:** In Niger, farmers have built new agroforestry systems on 5 million hectares in 20 years, at costs below \$20 per hectare, substantially reducing drought risks (WRI, 2017)

**Education brings change:** Through a program of ecological restoration-based education, farmers in the Columbian Amazon created 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 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 degree Celsius is expected to substantially reduce the probability of extreme drought (Hoegh-Guldberg, O., 2018)

**New horizons:** A paradigm shift from “reactive” and “crisis-based” approach toward a more “proactive” and “risk-based” drought management approach is indispensable (Tsegai, D. & Brüntrup, M., 2019)

## Predictable futures: we are at crossroads

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

It is estimated that up to 216 million people could be **forced to migrate** by 2050, which is due to a great extent 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 countries primarily due to population growth, and 38 countries primarily due to the interaction between climate change and population growth (Smirnov, O. et al., 2016)

By 2050, between 4.8 billion 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)

With the threat of 3°C global warming by 2100, **drought losses** could be 5 times higher compared to today (Cammalleri, C. et al., 2020)





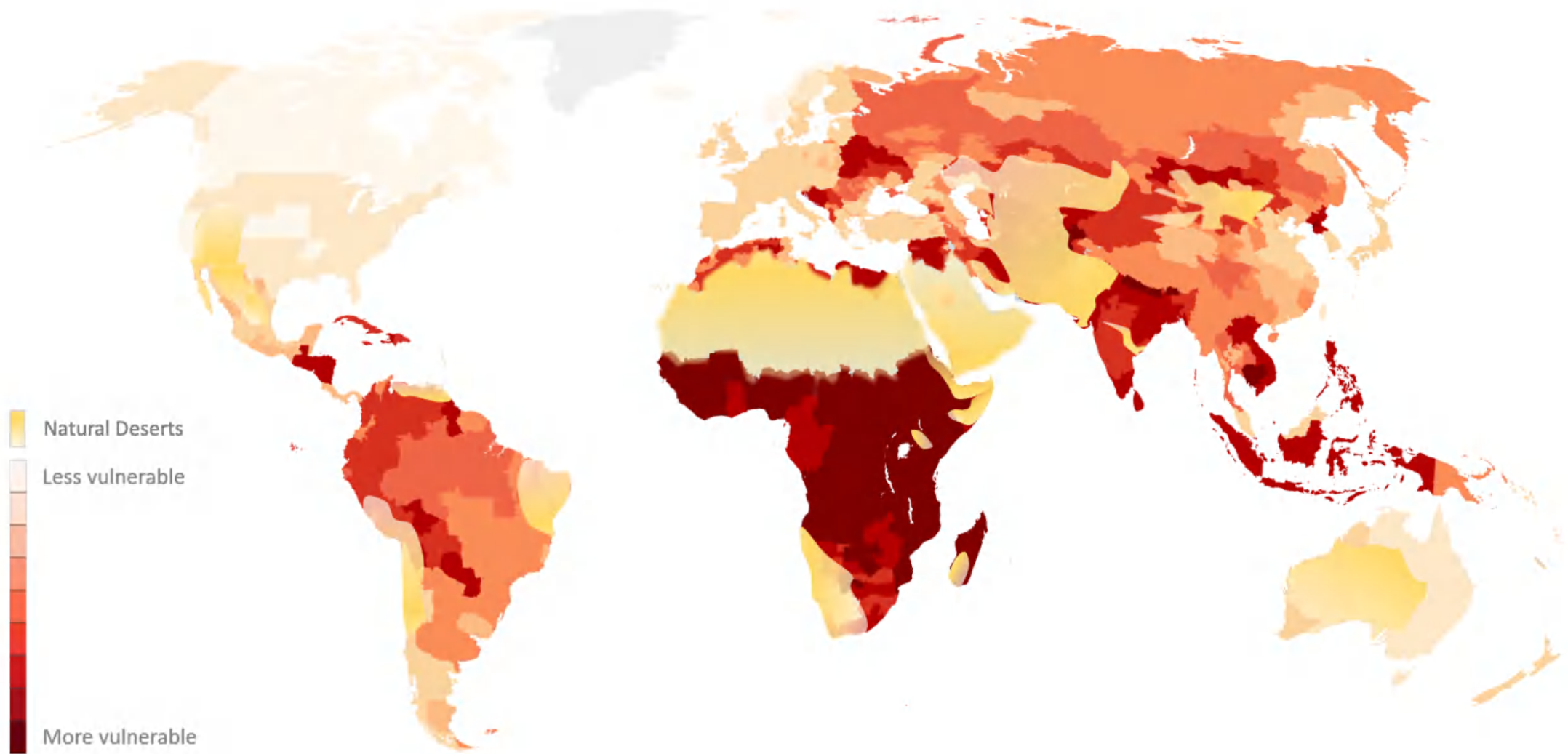


|              |            |               |
|--------------|------------|---------------|
| Afghanistan  | Kazakhstan | Niger         |
| Angola       | Kenya      | Somalia       |
| Brazil       | Lesotho    | South Sudan   |
| Burkina Faso | Mali       | Syria         |
| Chile        | Mauritania | Pakistan      |
| Ethiopia     | Madagascar | United States |
| Iraq         | Malawi     | Zambia        |
| Iran         | Mozambique |               |

*fig. 1: Countries declaring drought emergencies in the last two years (2020-2022) (own)  
for UNCCD map disclaimer see page 4*



fig. 2: Countries affected by drought in 2020 – 2022 (own)



*fig. 3: Global drought-vulnerability index 2022 (own)*

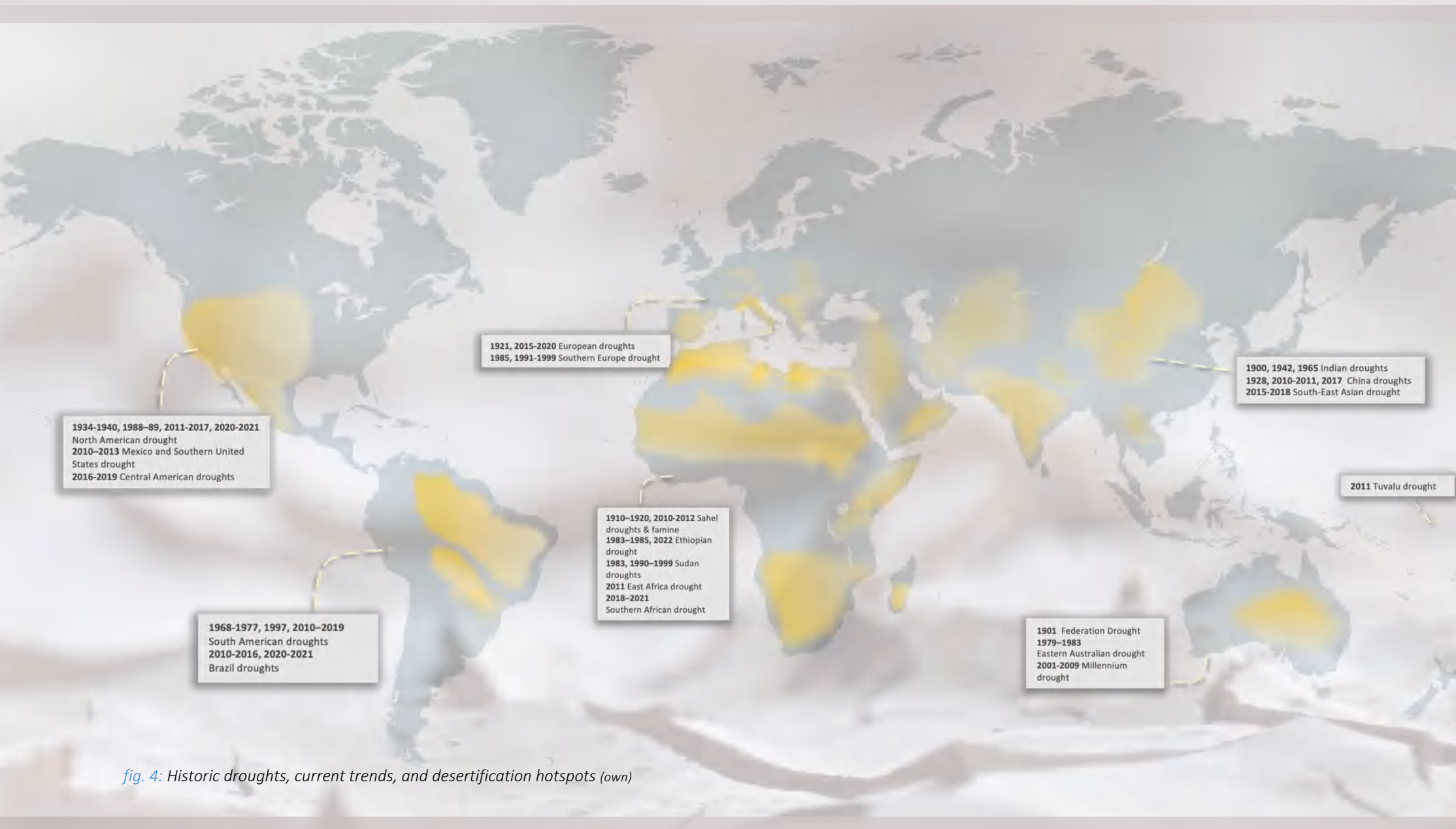


fig. 4: Historic droughts, current trends, and desertification hotspots (own)



## Foreword

Drought cannot be defined by geographic boundaries or technical specifications. Cause and effect relationships with climate change, food security, and other global threats require an examination of interrelationships. With an ambition to link land to life and sustainability, attention to drought must deepen.

Drought has attracted increasing attention, however, action towards comprehensive drought management has not evolved in scope and activity commensurate to other disasters. Increased projected occurrence and exposure requires equivalent responses to enhancing resilience at scale through the implementation of approaches under the drought management pillars. The *Intergovernmental Working Group on Drought*, short IWG, worked to unravel drought complexities to facilitate this global transition.

Hydrological drought has impacts on ecosystems, societies, and populations across the globe. This, in terms, means that droughts also have a strong, negative impact across many economic activities. It is devastating to food production, to agriculture, to industry, and of course to poor households. Reduced amount of water, which means increased drought, is thus a very important aspect of the whole socio-ecologic and -economic system. In the broadest sense, sustainable development refers to the capacity for socio-ecological systems to persist unimpaired into the future. That means that how we are combatting droughts has a crucial aspect on to what extent we will meet the SDGs.



The *Intergovernmental Working Group on Drought* presents its outcomes at COP 15, outcomes building on a policy framework where implementation and partnerships as well as effectiveness under the Convention, should result in reduced disaster risks and enhanced resilience. This Blue Paper brings extra dimensions to the IWG document in deepening several aspects such as: “Policies make a difference”, “Land restoration works”, “Education brings change”, “Media matters”, “Turning the tide” and “New horizons”.

The Blue Paper provides context and depth across drought management dimensions, building on existing frameworks at national, regional and global levels. It presents an analysis of existing systems and their applicability, appropriateness and accessibility. An evaluative methodology is used to produce critical inferences consolidating diversified perspectives and alternatives. The authors were challenged in bridging the science-policy divide, examining technical considerations and shaping meaningful recommendations. In recognising sustainability as iterative, the use of signals and trends add to the reader’s depth of exposure.

While we have gained significant knowledge and understanding, the collective effort remains a priority and this publication, timely and relevant, can contribute to catalysing needed global action on drought.

Dr. Gunilla Bjorklund, IWG-Chair

Dr. Gaius Eudoxie, IWG-Chair





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## Table of acronyms

**CBD** Convention on Biological Diversity

**DRM** Disaster Risk Management

**DRR** Disaster Risk Reduction

**EU** European Union

**FAO** United Nations Food and Agricultural Organisation

**IPBES** Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

**IPCC** Intergovernmental Panel on Climate Change

**LDN** Land Degradation Neutrality

**NOAA** US National Oceanic and Atmospheric Administration

**REDD** Reducing Emissions from Deforestation and Degradation

**SDG** Sustainable Development Goals

**SFM** Sustainable Forest Management

**SFM** Sustainable Land Management

**UNCCD** United Nations Convention to Combat Desertification

**UNFCCC** United Nations Framework Convention on Climate Change

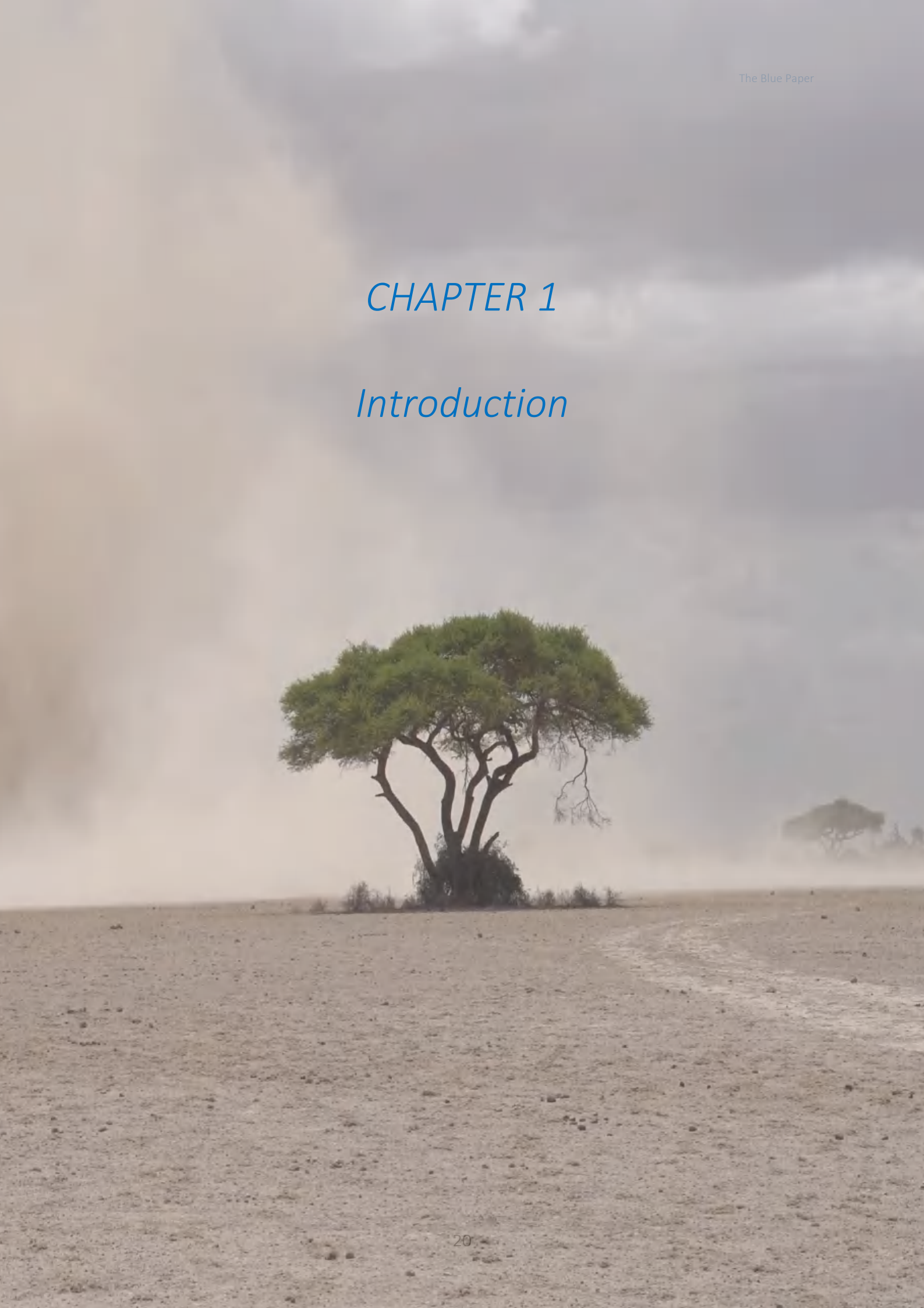
**UNICEF** United Nations Children's Fund

**UNISDR** United Nations Sendai Framework for Disaster Risk Reduction



# *CHAPTER 1*

## *Introduction*





## 1.1 The Intergovernmental Working Group

### 1.1.1 Mission and aims

The United Nations Convention to Combat Desertification (UNCCD) is the sole legally binding international agreement on land issues. Established in 1994, the secretariat aims to implement the Convention and to achieve the Sustainable Development Goals through partnerships with its 197 nation state parties. The goal is to protect land surface from over-use, drought, further uncontrolled conversion, and to restore it wherever possible and feasible.

Droughts are one of the most far-reaching disasters impacting land, ecosystems, and the livelihoods of billions that depend on it, causing short- and long-term economic and ecological losses. To reduce vulnerability to droughts holistically, there is an urgent need to overcome the prevailing structures of reactive, post-hazard management and to move toward proactive risk management approaches.

Against this backdrop, the Conference of the Parties at its thirteenth session (COP 13) adopted the UNCCD 2018–2030 Strategic Framework, comprising the following five objectives:

Strategic objective 1: To improve the condition of affected ecosystems, combat desertification/land degradation, promote sustainable land management and contribute to land degradation neutrality

Strategic objective 2: To improve the living conditions of affected populations

Strategic objective 3: To mitigate, adapt to, and manage the effects of drought in order to enhance resilience of vulnerable populations and ecosystems

Strategic objective 4: To generate global environmental benefits through effective implementation of the UNCCD

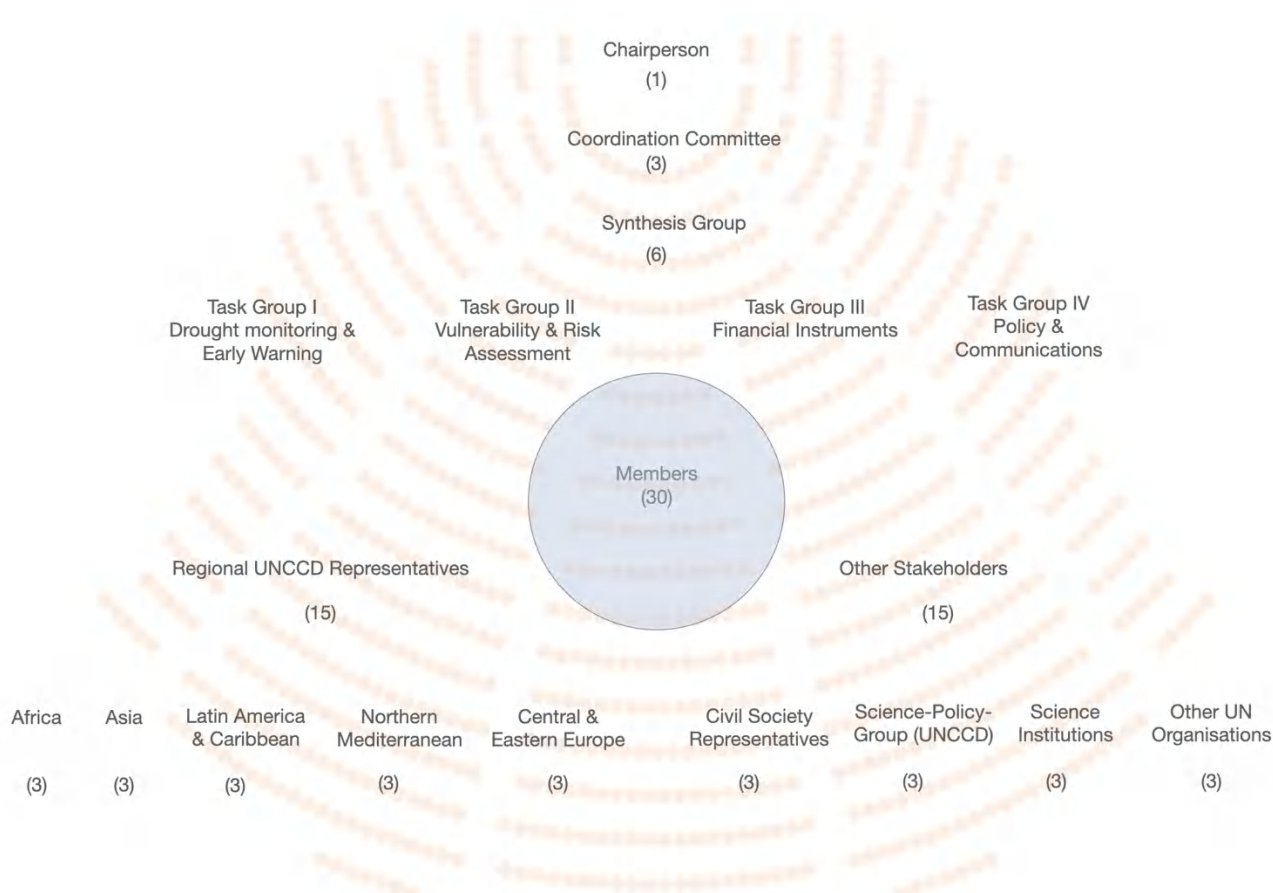
Strategic objective 5: To mobilize substantial and additional financial and non-financial resources to support the implementation of the Convention by building effective partnerships at global and national level

At its fourteenth session (COP 14), the Conference of Parties decided to establish an Intergovernmental Working Group (IWG) on effective policy and implementation measures for addressing drought under the UNCCD.

Its aim is, on the one hand, to take stock of and review the existing policy, implementation, and institutional coordination frameworks, including partnerships on drought preparedness and response. On the other, it is to consider options for appropriate policy, advocacy, and implementation measures at all levels for addressing drought effectively under the Convention, in the context of a holistic and integrated approach to disaster risk reduction and enhancing the resilience of human societies and ecosystems.

The IWG is composed of 30 members (<https://www.unccd.int/issuesland-drought/intergovernmental-working-group-drought>). They consist of 15 Party representatives,

nominated by the five regional UNCCD groups. The additional 15 members are drawn from key stakeholders and include United Nations organizations, the Science-Policy Interface, other scientific organizations, and regional and civil society organizations.



*fig. 5: Structure of the Intergovernmental Working Group (IWG) (own)*

The working structure of the IWG consists of a Coordination Committee and four task groups, whose work has focused on the following topics: (1) Implementing drought monitoring and early warning systems, (2) Assessing the risk and impacts of and the vulnerability to drought, (3) Finance instruments for drought risk management, and (4) Policies for drought risk management. As part of this work, the IWG conducted a survey with the national focal points (NFPs), to take stock of the member states' drought risk assessments, drought impacts, drought policies and practical measures, and related needs, barriers, and challenges. The questionnaire was administered through the UNCCD's regional liaison offices across the five UNCCD regions. Forty NFPs and five civil society organizations took part in the survey.

This report comprises a synthesis of this work of the IWG, as well as of related reports and additional literature.



### 1.1.2 Composition, bias, and constraints

The IWG consists of 15 Party representatives nominated by national governments and 15 additional experts from key stakeholder groups including UN organizations, the Science-Policy Interface, scientific organizations, regional organizations, and civil society organizations. The following is a critical reflection of contextual and internal working conditions of the IWG, taking into consideration set standardized evaluation criteria (Harrison-Bernard et al, 2020; Benson, 2021).

In terms of group composition, there is great heterogeneity, both in terms of drought-related working fields as well as regional expertise. All major regional hotspots of drought found their representation, as did the wide spectrum of fields, be it through academia, independent consultants, NGOs, UN institutions, policymakers, or employees of national drought mitigation centers. A slight misrepresentation was given in the field of Indigenous rights groups or First Nation advocates, which were not part of the working group, and neither were financial experts. The shortfall of the latter was compensated through an OECD-based consultant in one of the Task Groups. A specific gender parity expert was not appointed, given that a balanced representation was not a goal. About 25% of all members were female.

Given this was the first time such a working group on drought was established under the UNCCD mandate, one of the biggest constraints was the comprehensiveness in which stock-take and science literature review could be undertaken. While there were no distorting monetary incentives for the actual members, the limited availability of funds to conduct primary or synthesizing research needs to be taken into account. Sources outside of anglophone, francophone and germanophone journals could not be considered, and a graded language was not employed in the final report.

Sampling size, framing effects, and layering are dimensions that require critical reflection for the chosen stock-taking mechanisms but have to also be seen in the context of the available resources. In addition, almost exclusively anthropocentric conceptual frameworks were chosen, putting humans front-and-center, often leading to positivistic and technocratic lines of argumentation, while avoiding recognition of non-human worlds, sentients, beings. The term “biodiversity” is employed once, “nature” is absent, and ecological functions are framed as anthropocentric services. A theory of change remains underdefined and a road map, based on similar negotiation processes and voting histories in the UN’s sister conventions, remains missing at this stage. This leaves some sections anchored in idealism rather than in the recognition of process-oriented target settings guided by adaptive management.

Various forms of consensus mechanisms were employed at various stages of the different workflows. These were constantly re-evaluated for their effectiveness, discussed openly, and adjusted where necessary, ensuring an inclusive environment and helping to reduce group-think, ingroup, and courtesy bias. All members were able to express ideas and concerns throughout the entire process and raise critical remarks on the work of a synthesis group that was elected and tasked to crystalize the options and recommendations. The final report also gave representation to internal group differences, weighted these, and did not mask nuances and differences that were articulated.

## 1.2 Understanding drought and drought risk

### 1.2.1 Definition and dimensions of drought

Drought often still is described as a ‘natural’ hazard, ignoring the findings of 40 years of climate science that clearly attribute anthropogenic factors to its increase in severity, frequency, and expanding geographic scope across the globe (IPCC 2021). In comparison to other hazards, drought is challenging to clearly define, due to its gradual onset and end, its diffuse occurrence over spatial and temporal scales, and the large heterogeneity of direct short-term and indirect long-term impacts. Drought often unfolds slowly over weeks, months, or even years, and yet it can also occur as a rapidly intensifying flash drought, a phenomenon that has gained attention in the past few years (Lisonbee et al. 2021).

Drought occurs not only in geographic zones traditionally marked by low rainfall, but in almost all climate regimes. As such, it must be considered a relative condition, a temporary aberration from the average climate of a specific region (Heim 2002, WMO 2006, IPCC 2019). It must be distinguished from aridity, a long-term climatic feature of low rainfall areas that limits vegetation, as well as from water scarcity, an imbalance between water supply and demand (Tallaksen & van Lanen 2004, Belal et al. 2014).

A broad range of drought definitions and indicators have been put forward over time (Heim 2002, Mishra & Singh 2010), complicating drought recognition, debate, and management. Yet, as Wilhite (2000) put it, “a universal definition of drought is an unrealistic expectation” (p. 8), as the varying characteristics, courses, and diverse impacts of drought require region-, impact-, and subject- or sector-specific definitions. The bottom line is: the designation of changes in an area's weather as “drought” is a social act. Drought is a relative term, set by a human standard. In short, we reach an agreement of what drought means when we speak of it.

In its founding document, the UNCCD defined drought as “a phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems” (UNGA 1994, p.5). This definition is broadly consistent with that of the IPCC (2019, p. 811), which describes drought as “a period of abnormally dry weather long enough to cause a serious hydrological imbalance.” Similarly, the World Meteorological Organization (WMO) defines drought as a hazard “characterized by lower than expected or lower than normal precipitation that, when extended over a season or longer period of time, is insufficient to meet the demands of human activities and the environment” (WMO 2006, p. 4).

Building on the classification put forward by Wilhite & Glantz (1985) and Wilhite (2000), four ‘types’ of drought, which should be rather labelled as ‘dimensions’ or ‘progression stages’ of a drought, were commonly distinguished: meteorological, agricultural, hydrological, and socioeconomic drought. Because of the considerable impacts of drought on ecosystems, a debate on ecological drought has emerged over the past years (Crausbay et al. 2017, p. 2544). He defined ecological drought as “an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability, impacts ecosystem services, and triggers feedbacks in natural and/or human systems.” We thus distinguish five dimensions or progression stages of drought:



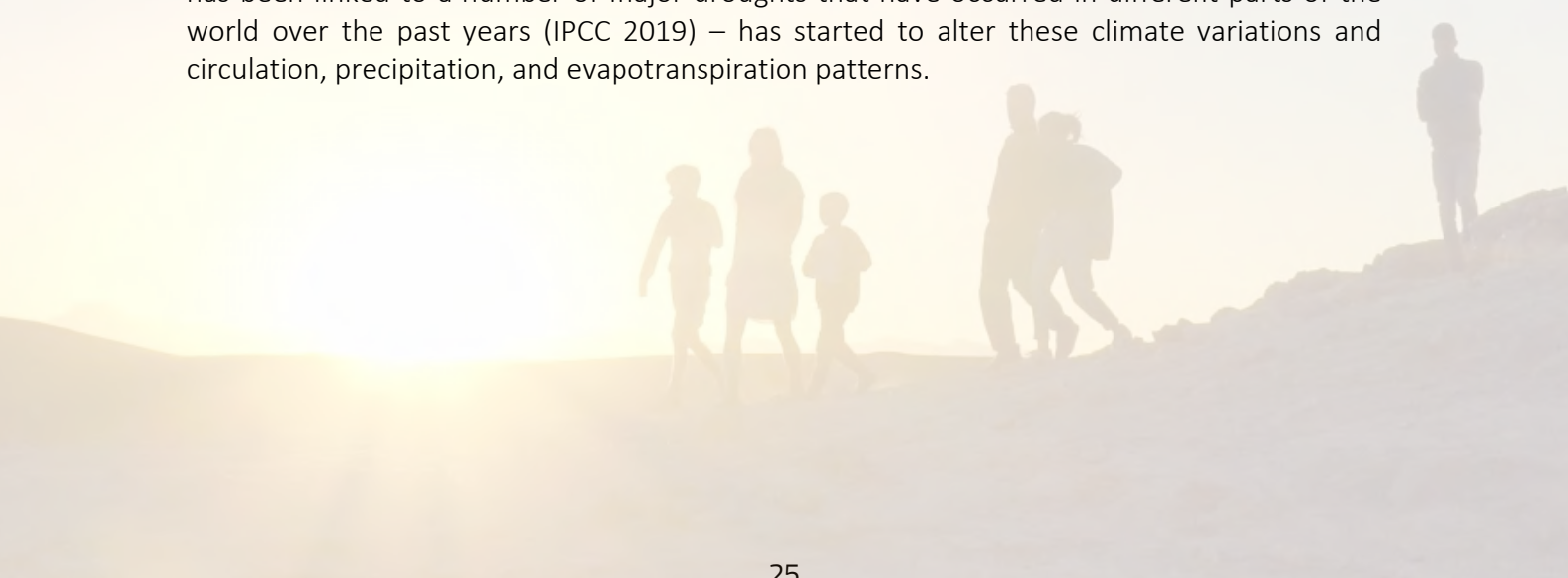
- Meteorological drought: a deficiency of precipitation compared to average region-specific conditions.
- Agricultural drought: soil water deficits resulting from precipitation shortages and evapotranspiration cause agricultural losses.
- Hydrological drought: the effects of periods of precipitation shortfall on surface or subsurface water supply, i.e. streamflow, reservoir and lake levels, and groundwater.
- Socioeconomic drought: the effects of meteorological, agricultural, and hydrological drought on human activities.
- Ecological drought: “an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability, impacts ecosystem services, and triggers feedbacks in natural and/or human systems” (Crausbay et al. 2017, p. 2544).

The different ‘types’ or ‘dimensions’ of drought usually develop in a sequence from meteorological drought to agricultural, ecological, and hydrological drought, with increasing impacts on humans and societies over time (socioeconomic drought).

It recognizes that humans are not only affected by meteorological, ecological, agricultural, and hydrological drought, but actively contribute and condition all four stages through land use change, hydrological modifications, and a socioeconomic system with fossil-fuel-based activities that closes the circle. Thus, climate change mitigation in all its forms is crucial to limiting the measurable increase in the frequency and severity of droughts; and proactive drought risk management can, to some extent, prevent a meteorological drought from turning into an ecological, agricultural, hydrological, and socioeconomic drought.

### 1.2.2 Drivers of drought

Drought in the Anthropocene is in fact no longer adequately described as a ‘natural’ hazard. In traditional understandings, drought is solely caused by climatic variations – regional or larger-scale changes of atmospheric circulation patterns or extended persistence of anticyclones. The El Niño-Southern Oscillation (ENSO) is a major driver of drought in various parts of the world (Mason & Goddard 2001, Vicente-Serrano 2011). Yet Anthropogenic climate change – which has been linked to a number of major droughts that have occurred in different parts of the world over the past years (IPCC 2019) – has started to alter these climate variations and circulation, precipitation, and evapotranspiration patterns.



Furthermore, humans have substantially altered much of the Earth's surface, and this has had and continues to have profound effects on evapotranspiration, micro-climates, surface and groundwater flows, and the resilience of ecosystems to climatic variations. For example, the rising water demands of California's growing population have considerably aggravated hydrological drought in parts of the state (He et al. 2017). In the Brazilian Amazon, deforestation, micro-climatic changes, rainfall, drought, and fires, combined with changes in the global climate, are causally entangled in mutually reinforcing cycles, driving the system toward a new, drought-prone state (Brando et al. 2020, Staal et al. 2020).

While meteorological drought plays its role, human water withdrawals can also be a major cause for irreversible negative impacts on ecosystems, land use and land stability, food security, and water availability (Madani et al. 2016). Groundwater, a crucial water source and buffer during droughts, has been severely depleted in many parts of the world. Globally, the doubling of human water-use between 1960 and 2010 substantially intensified the frequency and magnitude of hydrological drought (Wada et al. 2013), and the population increase of 80 million people being added to the planet every year continues to fuel this trend.

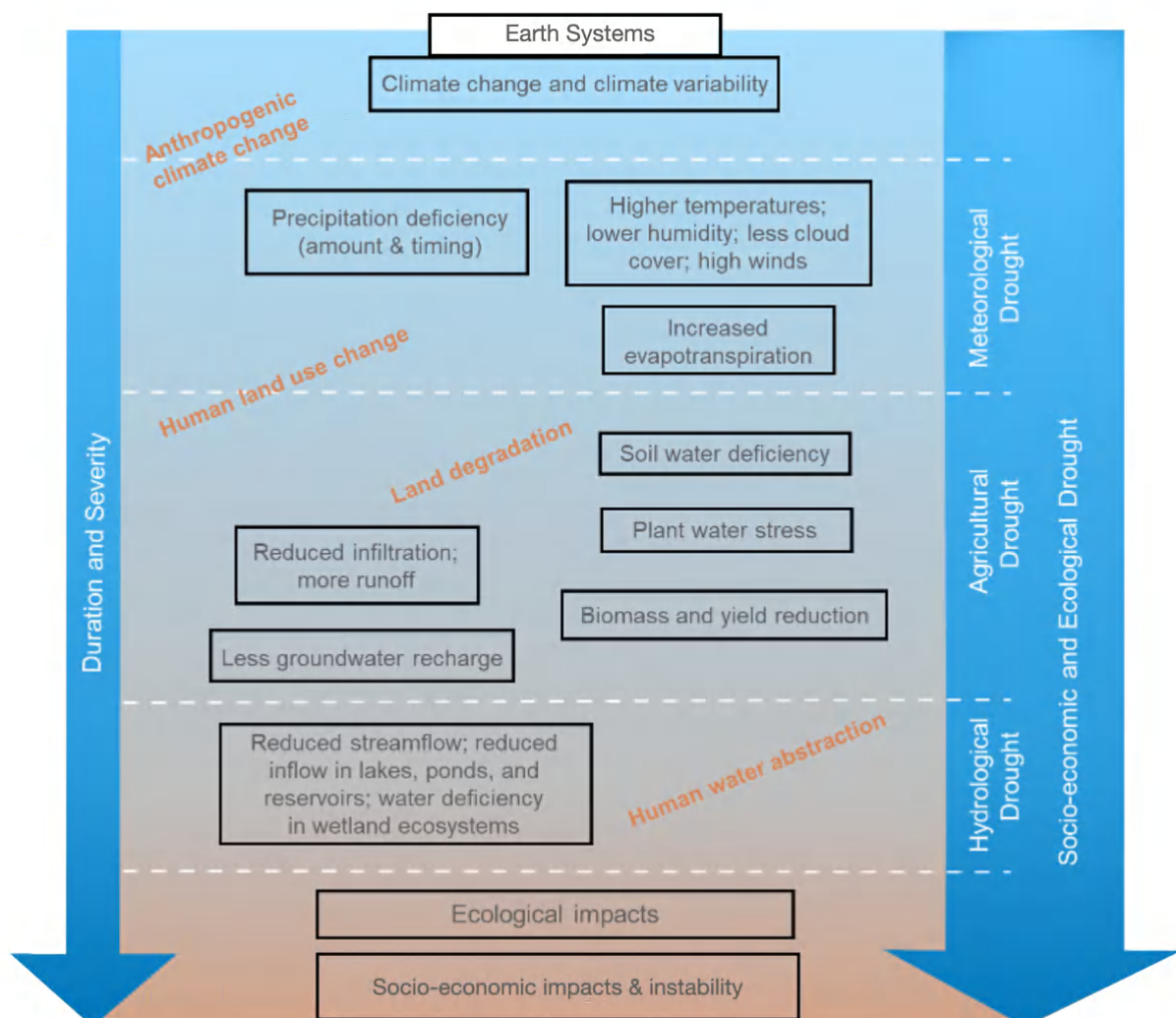


fig. 6: Drivers and progression of drought (own)



Acknowledging the fact that the occurrence and severity of many droughts are substantially influenced by humans, AghaKouchak and colleagues have conceptualized the term ‘anthropogenic drought’ (AghaKouchak et al. 2015, 2021). Similarly, van Loon et al. (2016 a, b) called for new frameworks for drought definitions and research, consequently integrating the multifaceted human processes affecting soil moisture and hydrological drought development. To foster this, they proposed to differentiate between “climate-induced,” “human-induced,” and “human-modified” drought. Disentangling and quantifying the roles of the various interwoven factors is challenging and the subject of increasing research interest. Yet, even without quantification, awareness of the interwoven anthropogenic and quasi-natural drivers of drought and their complex interactions is key to effective drought risk mitigation.

### 1.2.3 Hazard, risk, and vulnerability

Drought risk, as commonly seen within the disaster risk reduction community, is defined in an anthropocentric way as a function of drought hazard, exposure, and vulnerability:

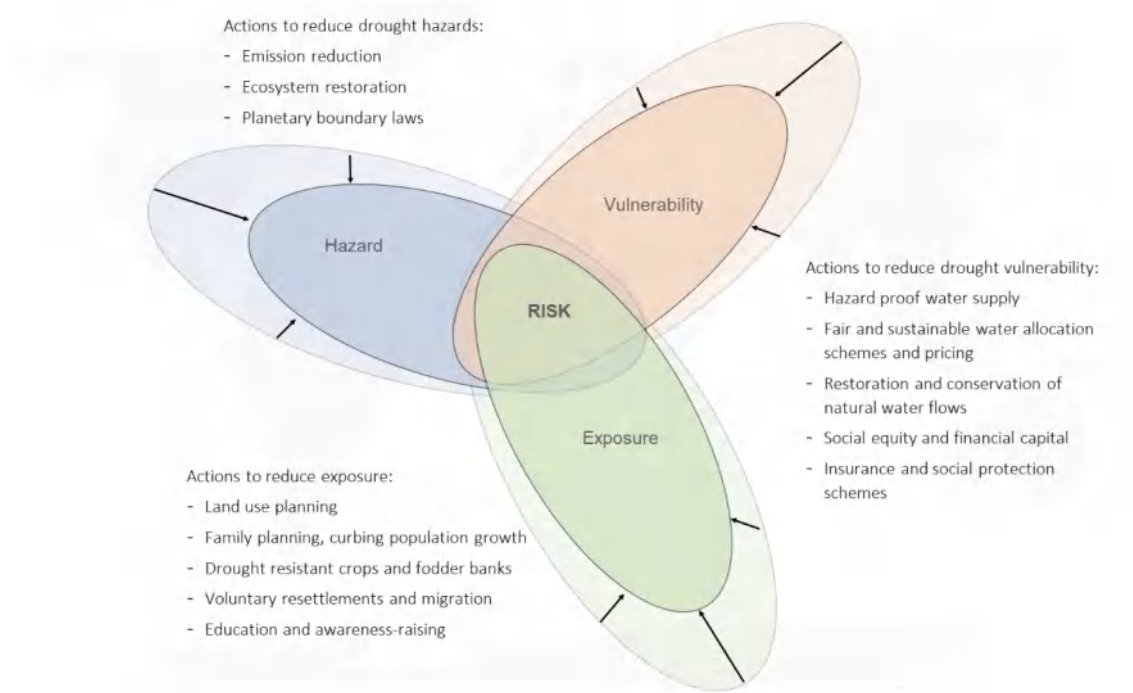
$$Risk = f(Hazard, Exposure, Vulnerability)$$

Accordingly, the risk to incur negative effects from a drought (e.g. health impacts, loss of life, economic losses) depends on the severity and probability of drought occurrence (the hazard), the exposed people and/or assets, and the vulnerability of those people or their capacity to cope with the hazard (Voigt et al. 2018). The Global Drought Observatory, developed by Voigt et al. (2018) for the European Commission’s Joint Research Centre (JRC), is based on a version of this formula and assessable via the UNCCD Drought Toolbox: (<https://maps.unccd.int/drought/>).

The climate change adaptation community as well as the IPCC define vulnerability in a different way than does the risk reduction community. Taking a systems- rather than people-centered approach, it defines vulnerability as a function of exposure, sensitivity, and adaptive capacity. Following this manner, the UNCCD guidelines for developing a national drought plan and the UNCCD Drought Resilience, Adaptation and Management Policy (DRAMP) report comprise indicators and guidance for carrying out drought vulnerability analyses using this approach (UNCCD 2018, 2019):

$$Vulnerability (V) = Exposure (E) + Sensitivity (S) - Adaptive Capacity (AC)$$

Taking the perspective of the disaster risk reduction community, drought risk mitigation includes actions targeting all three determinants of drought risk: drought hazard, exposure, and vulnerability.



*fig. 7: Options for reducing drought hazards, exposure, and vulnerability* (own/based on IPCC risk framework and adapted from Salman, Tsegai & King-Okumu 2021).

### 1.3 Global overview of drought patterns and trends

Drought has been a threat to civilizations since the early days of human life on Earth. Paleoclimatic reconstructions, based on sediment core and tree-ring analyses, have linked the decline, weakening, de-urbanization, and migration of early civilizations to drought events. Examples include the Indus Valley Civilization about 4,000 years ago (Dixit et al. 2014), the Maya civilization about 2,800-3,000 years ago (Medina-Elizalde & Rohling 2012), and the western Roman Empire and various population groups across Europe between 113 B.C. and 600 A.D. (Büntgen et al. 2011, Drake 2017). More evidence is available for the last about 1,000 years, showing recurrent droughts, for example, in North America, Mexico, Asia, Africa, and Australia (see Dai 2011 for a review).

Since the 19th century, rapid population growth, considerable increase in agricultural land, industrialization, and changing lifestyles have increased water demand, exposure to droughts, and drought costs (AghaKouchak et al. 2021). While irrigation, water storage capacities, inter-basin transfers, and ground water extraction have helped human development and its coping with droughts (at least temporally), unsustainable water extraction, resulting in falling ground water levels and declining water flows downstream have in some regions exacerbated drought risk. In Africa, which is presently the continent with the highest level of vulnerability to drought, numerous drought events throughout the 20th and early 21st centuries have affected hundreds of millions of people, and in combination with conflicts, caused starvation and killed hundreds of thousands (see Tsegai 2006 for a documentation of drought events and corresponding literature).

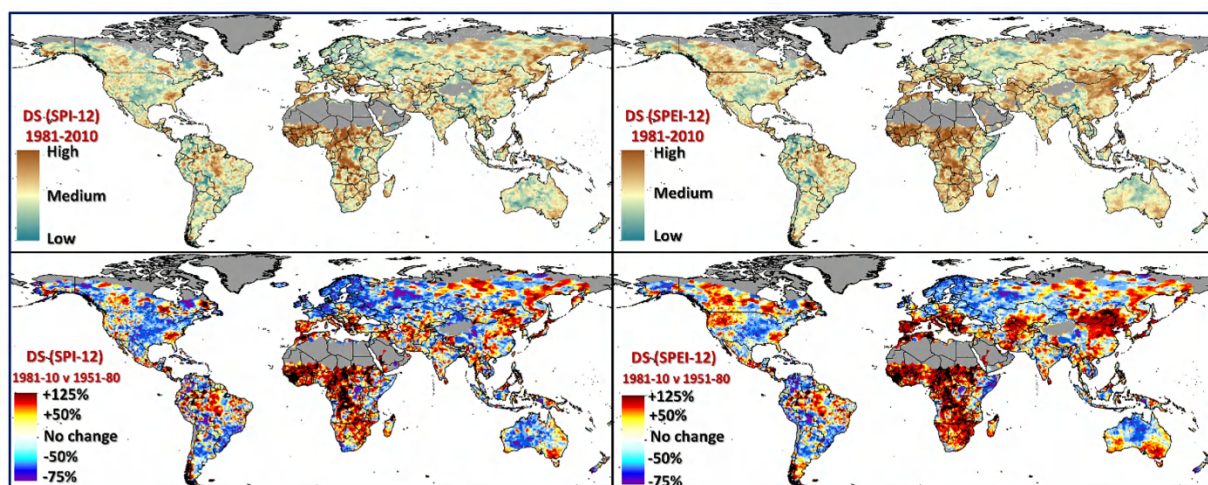
The increasing amount of instrumental records from the 1950s onward allows for the analyzing of changes in the probability of meteorological drought occurrence over time. Rising temperatures in almost all areas of the world, combined with decreasing precipitation in most



of Africa, southern Europe, South and East Asia, eastern Australia, Central America, the central Pacific, the coasts of North America, and some parts of South America have resulted in drying and decreasing runoff in these regions (Dai 2011). Global warming and the increasing frequency of El Niño have been the major causes for the global increase in dry areas (Dai 2011). The warming between the 1980s and 2010 alone is estimated to have resulted in an increase in the areas under meteorological drought by about 8 percent globally (Dai 2013). Warming increases both evaporation and the atmosphere's water-holding capacity, supporting a trend of low-precipitation areas getting drier and high-precipitation areas getting wetter (Trenberth 2010).

In addition to the increasing level of meteorological drought occurrence, population growth considerably raises drought exposure. The combined effect of both has resulted in an increase of the global population under drought from 0.7 billion in 1960 to 2.2 billion in 2010 (Wada et al. 2013). The effect of population growth is particularly pronounced in Africa, where the population affected by drought increased tenfold from 50 million in 1960 to 500 million in 2010 (Wada et al. 2013). This trend is projected to continue. The population in drylands is projected to rise about twice as rapidly as compared to non-drylands (van der Esch et al. 2017).

The SPEI Global Drought Monitor (<https://spei.csic.es/index.html>) provides global information on meteorological drought conditions and trends with a 1-degree spatial resolution and a monthly time resolution from 1955 onwards. The standardized precipitation evapotranspiration index (SPEI) is based on precipitation and temperature data (see Vicente-Serrano et al. 2010). Figure 1.4 shows changes in meteorological drought conditions based on the SPEI over time since 1955.

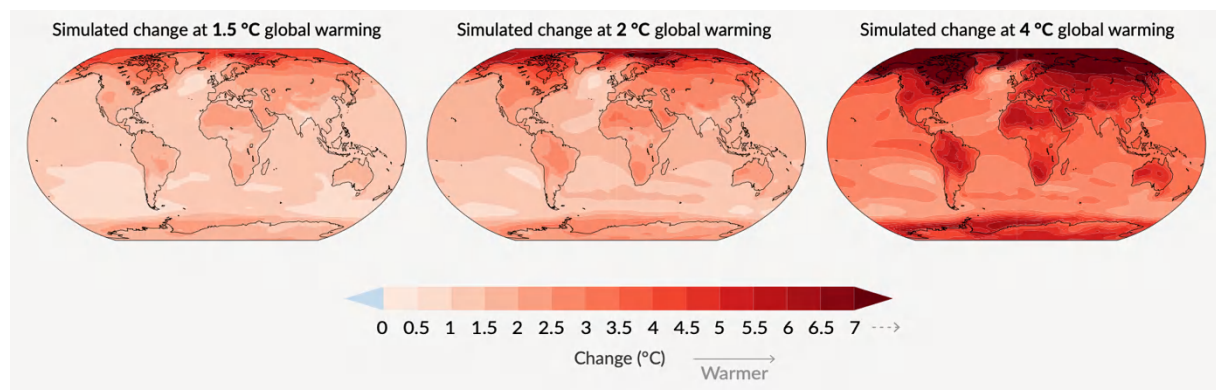


*fig. 8: Changes in meteorological drought occurrence according to the SPEI-12 (Standardized Precipitation Evapotranspiration Index) and SPI (Standardized Precipitation Index) from 1951-1980 to 1981-2010 (Voigt et al. 2018)*

Spioni et al. (2019) built a new global database of 4,500 meteorological drought events during the period of 1951 to 2016, based on the SPEI and SPI (Standardized Precipitation Index). The Mediterranean region, most of Africa, Amazonia, southern South America, and northeastern China stand out as drought hotspots therein. The authors detected the following as drought hotspots that experienced a robust increase in meteorological drought frequency and severity between the periods 1951 to 1980 and 1981 to 2016: Patagonia, the Mediterranean region, the Sahel, the Congo River basin, northeastern China, and (though not unanimously agreed upon by all indicators) central Asia and southern Australia. North America, central Europe, and

central Asia also experienced more frequent and more severe droughts during that period, mainly as a result of rising temperature (Spioni et al. 2019).

The Sixth IPCC Assessment Report (2021) projects a further increase of the global land area subject to drought and an increase in the frequency and severeness of drought with high confidence. It projects an increase in the frequency and/or severity of agricultural and ecological droughts for parts of Africa, South America, and Europe with medium to high confidence, and for Australasia, Central and North America, and the Caribbean with medium confidence. The subtropical and Mediterranean regions will be most affected. In the Mediterranean, southwestern South America, and western North America, future aridification will far exceed the magnitude of change seen in the last millennium (high confidence). Increasing evapotranspiration will decrease soil moisture also in South Africa and southwestern Australia (high confidence). Some tropical regions are also projected to experience increased aridity, including the Amazon basin and Central America (high confidence).



*fig. 9: Annual mean temperature change (°C) relative to 1850-1900 (IPCC 2021, TS-126)*

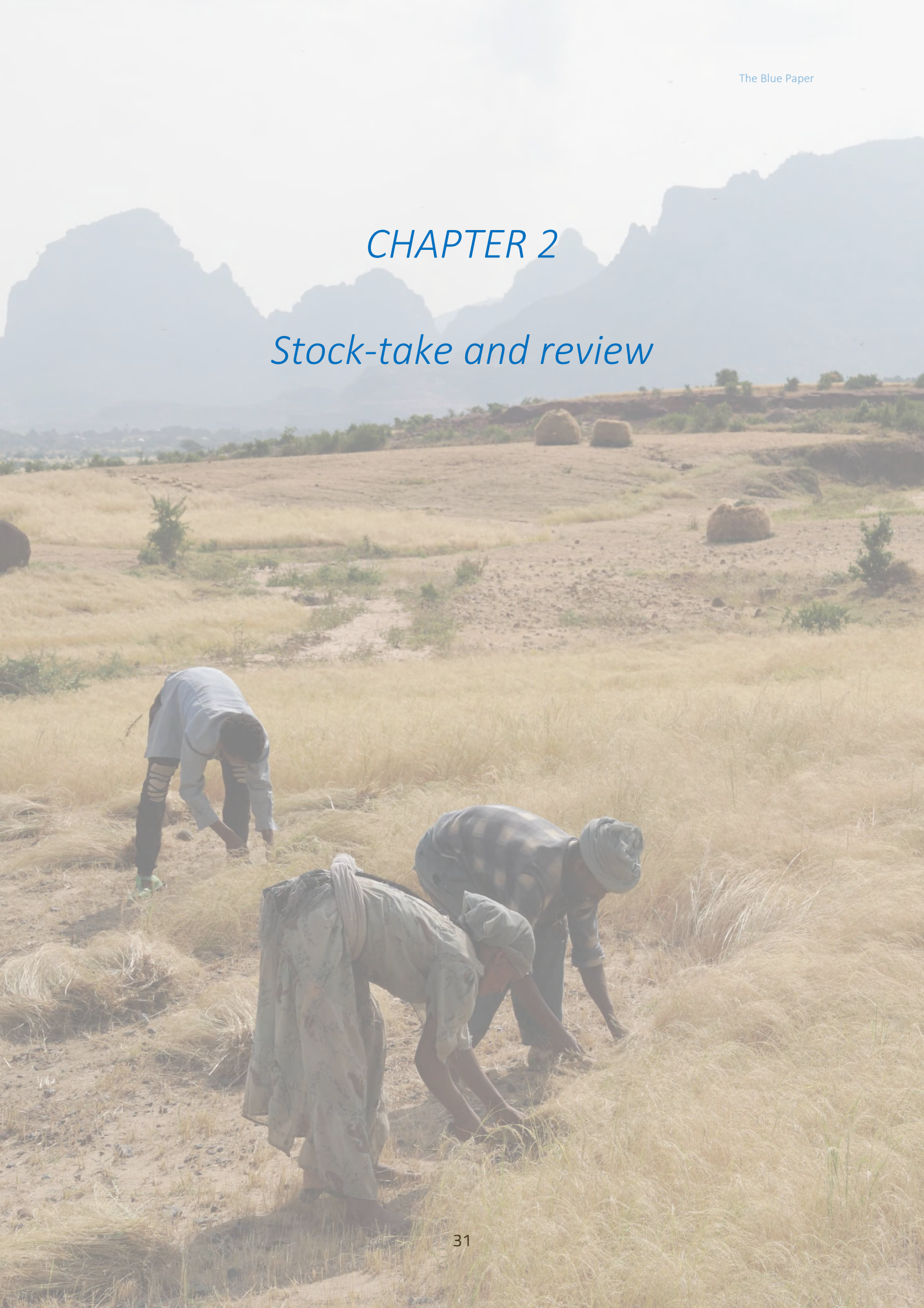
Many uncertainties remain for regional changes in precipitation. Extra-tropical precipitation patterns, for example, depend on storm tracks and quasi-stationary highs and lows. The effects of global warming on these stationary highs and lows and on storm tracks and their temporary persistence are still uncertain (Simpson et al. 2016). Yet, temperature increases alone push drought risk. In the U.S. southwest, for example, regional warming simulated for RCP 8.5 (4.5°C) would make megadroughts (drought events that once occurred only once or twice per millennium) very likely (>90% probability) until the end of the 21st century; with a 10% increase in precipitation, the probability would still be about 70% (Ault et al. 2016).

Notwithstanding remaining uncertainties in projections, the severe droughts in parts of Africa, Australia, Europe, and the western parts of North America in the past four years, and the unprecedented fires they triggered, are clearly in line with the projections summarized above. There is a high confidence that the frequency and severity of drought will increase in the coming decades. This poses serious challenges to humanity, undermines efforts toward several of the Sustainable Development Goals, and is an urgent call for proactive drought management. The ways and severity in which meteorological drought impacts ecological, hydrological, agricultural, and socio-economic systems depends on how land and water resources are being used and managed and on the kinds and ways of implementation of drought risk mitigation and preparation measures.



## CHAPTER 2

### *Stock-take and review*





## 2.1 Drought impacts

### 2.1.1 Ecosystems

Life on the surface of the earth became possible through the evolution of plants in the oceans and on land, which remove excess carbon in the air through photosynthesis while simultaneously releasing oxygen. It is their existence that enables ours.

On a warming planet, record-breaking droughts have caused enormous reductions in the gross primary production capacity of ecosystems, especially in the past two decades. In other words, green turned brown, and water in all its forms diminished, be that as soil moisture amongst the roots of a plant, vapor underneath a leaf, precipitation above a closed canopy, or the free-flowing form in creeks and rivers. Examples of devastating droughts with severe impacts on the natural ecosystems that all life depends upon are, e.g., Europe's 2003 drought (Ciais et al., 2005; Reichstein et al., 2007), the U.S.'s 2012 drought (Wolf et al., 2016), China's 2013 drought (Xie et al., 2016; Yuan et al., 2016), Southern Africa's 2015 to 2016 drought (Yuan et al., 2017), or Australia's 2017 to 2019 drought (Holgate et al., 2020).

Species diversity primarily correlates with temperature and water availability. Regions that are warm and wet support more species than those that are arid, cold, or very warm (Humboldt & Bonpland, 1807; Wulf, 2015). Those biomes with highest diversity levels are those with an abundance of water, be that in soil moisture, humidity, or precipitation. A drying world, under the influence of intensifying drought events, will experience a continuous decline in its diversity of life. Where local adaptation capacities are exceeded, rapid increase of surface temperature correlates with declining biodiversity, up to the level of extinction (Nath et al., 2021; Peace, 2020).

Furthermore, with droughts expanding their intensity and duration due to human activities, one additional consequence is the increase of wildfires, which take form in smoldering peatlands, intensive grassland burns, and raging forest fires, all of which profoundly impact habitat, species, and genetic diversity. The year 2019 stands out as one of the most extreme years for biodiversity loss and impact since 2009, writes Feng et al. (2020) about the forest fires in Brazil. Novel future simulations of North American ecosystems show that by 2100, between 28% and 59% of the forested area is likely to fail to regenerate, indicating considerable loss of biodiversity, and therefore, resilience to other threats (Rammer et al., 2021). The megadrought in Australia in 2019 to 2020, also resulted in 'megafires' that caused "the most dramatic loss of habitat for threatened species and devastation of ecological communities in postcolonial history" (Wintle, 2020). And a study for peatland fires in Indonesia by Tri W. Yuwati (2018) revealed that "the severe peat fire extremely decreased diversity, number of individuals as well as number of plant species."

Yet too often the media fails to make visible these (potentially) irreversible losses of biodiversity while instead focusing on the tragedies surrounding human harm – from lives to business properties to vacation homes. "About 3 billion animals were killed or displaced in the recent Australian wildfires," according to van Eeden (2020), marking a rare occasion in which mainstream media (BBC, Reuters, DW) noted such dimensions.



This makes clear that we have only started to see where our blind spots are at the interface of media coverage, drought, and biodiversity loss (Rutledge & Beggs, 2021; Quesnel & Ajami, 2017; Thompson et al., 2020; Church et al., 2020). Hardly any systematic analysis has been done in this field until today.

What is more widely recognized is that terrestrial ecosystems play a key role in the global carbon cycle, having absorbed about 30% of anthropogenic carbon dioxide emissions during the past five decades (Le Quéré et al., 2018). But these ecosystems progressively turn into carbon sources, especially during extreme drought events (Ciais et al., 2005; Stocker et al., 2018, 2019). It is a vicious cycle, when the drying of the land due to a drought reduces the carbon uptake capacity of the aboveground and belowground biomass, while at the same time releases greenhouse gases through the decomposition of existing vegetation (Zheng et al., 2021; Chapin & Díaz, 2020). Droughts triggers a strong negative ecosystem response by decreasing soil moisture and respiration capacity along with the carbon storage potential within plant biomass, be it aboveground or belowground.

### 2.1.2 Societies

Humans are both the driver of increasing drought impacts, as well as the recipients. By removing protective vegetation cover, converting natural systems on a massive scale, sealing soils, and expanding habitation into water-short regions, we have “achieved progress and development,” while creating new instabilities, leading sociologists to define our existence as that of a ‘risk society’ (Ulrich Beck, 1986). In combination with the release of fossil fuels (ancient forms of photosynthesis stored in the Earth’s crust), the large-scale alteration to the Earth’s vegetative cover has led to massive hydrological disruptions changing atmospheric and soil compositions.

The following illustrative watershed gives a comprehensive overview of human activities that altered the terrestrial systems, all contributing to increasing drought incidences and associated risks, reaching from deforestation to wetland destruction, and from overpopulation to urban sprawl.



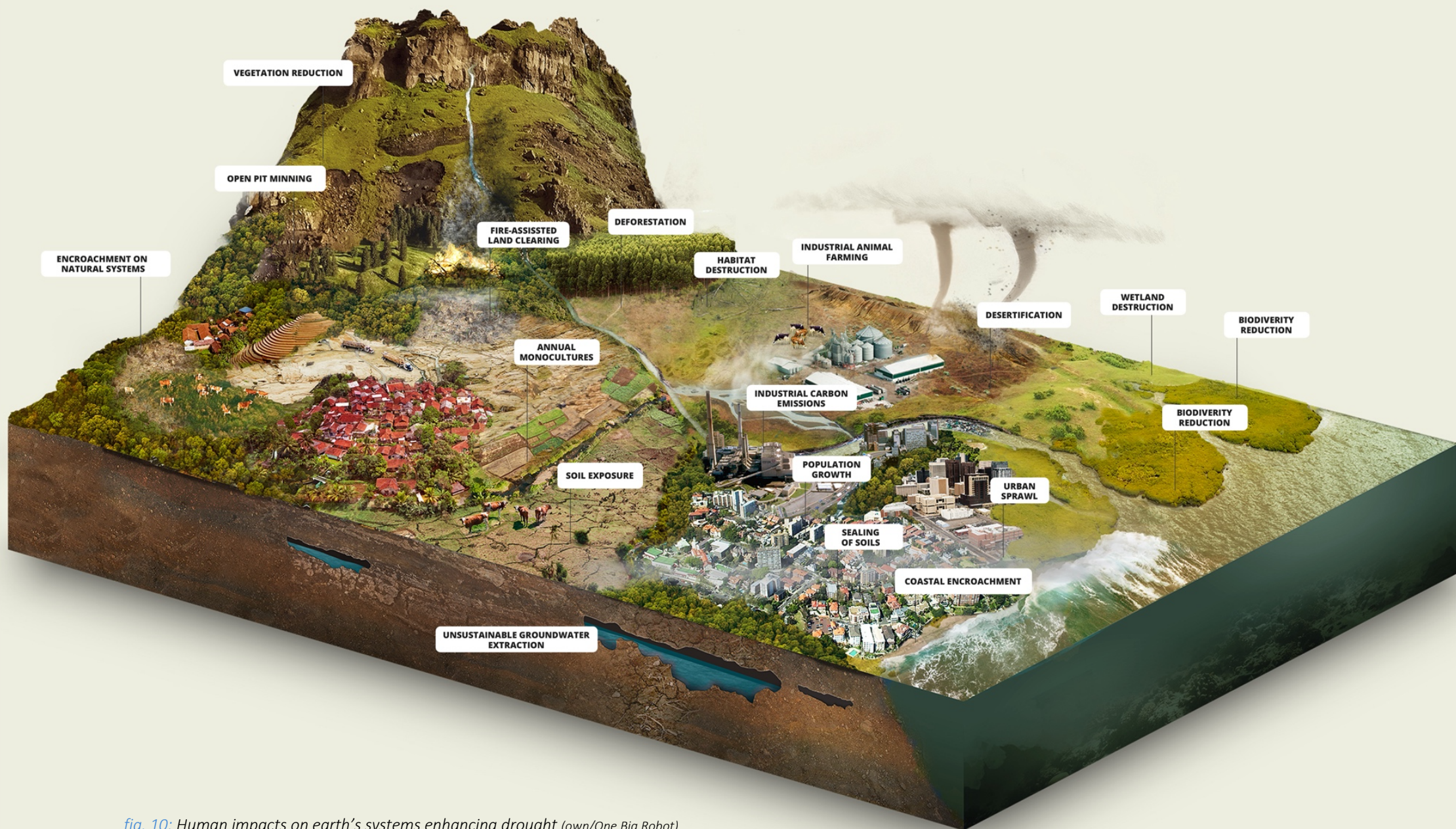


fig. 10: Human impacts on earth's systems enhancing drought (own/One Big Robot)



For the human species, drought has been the deadliest of all hazards in the last 50 years, also affecting the greatest number of people globally in 2019 (IFRC, 2020) with disproportionately severe impacts on marginalized and poor communities in low-income countries. While famines caused by a lack of rainfall (meteorological famines) have been superseded by political famines – famines as a result of state failure, war, and conflicts – drought often remains the most aggravating factor when it comes to the loss of human lives. While at the turn of the millennia signs looked favorable, seeing famines recede into history, 20 years on, we face new and harsh realities (de Waal, 2017). Yet, it is not only humanitarian crises unfolding in places bettered by conflict and dry climatic conditions, like Afghanistan, Ethiopia, South Sudan, Syria, or Yemen; we have also witnessed a resurgence in extreme levels of hunger in countries like India, Cambodia, and Brazil, along with drought (Oxfam, 2021).

Going beyond food security, estimates of the overall economic losses should be interpreted with care. This is because, on the one hand, the non-monetizable dimensions of social and environmental losses for economic performance are often not accounted for (so called “externalities”); and on the other hand, there is usually a significant gap between reported and actual impacts. “Droughts and their associated social and economic impacts are occurring with increasing frequency and magnitude across most parts of the world. Their costs are underestimated, particularly in the less developed countries where assessment capacities and drought management systems are the weakest and drought hazards interact with other threats to global, national and local security” (UNCCD, 2019). According to United Nations Office for Disaster Risk Reduction Global Assessment Report (UNDRR), the past 20 years have seen at least 1.5 billion people affected by drought, leading to economic losses of at least USD 124 billion across the world. However, these are most likely partial accounts and grossly underestimate. Cost estimates based on case studies suggest that impacts differentiate much further than these estimates and therefore result in multiplying costs (GAR, 2021, 168).

A set of accumulated findings from the UNCCD task group reports point into a similar direction. As the most lethal hazard to livestock, drought is responsible for nearly nine out of ten disaster-related livestock losses. In Serbia, for example, losses related to the droughts after 2000 exceed EUR 5 billion, and more than 70% of material loss and damage resulting from the impact of climate change is associated with droughts. The 2014 and 2015 droughts in El Salvador caused losses in agriculture of almost 4% of the gross domestic product and affected 3.5 million people. The Western Cape in South Africa, with Cape Town as its capital, lost about USD 400 million to 1 billion, including 37,000 jobs and 13 to 20% of export revenues as a consequence of three consecutive years (2016-2018) of below-average rainfall in combination with government failure (FAO, 2018; TG2; Ziervogel, 2019;). Since drought goes far beyond primary effects on agricultural and the water-provision sector, exact numbers remain difficult to calculate.

On a global level, a database has been established for aggregating the various impacts of drought, sourced from national governments, United Nations agencies (UNCCD, OCHA, IRIN, WFP, FAO), other international organizations (for example WB or IFRC), as well as reinsurance companies and media outlets. The platform is called The International Disaster Database (EM-DAT), hosted at the Centre for Research on the Epidemiology of Disasters

(CRED) in Brussels. Three Additional databases with a slightly narrower scope or specific geographical range exist, such as NDMC for North America ([www.droughtreporter.unl.edu/map/](http://www.droughtreporter.unl.edu/map/)), EDC for Europe ([www.geo.uio.no/edc/droughtdb/](http://www.geo.uio.no/edc/droughtdb/)), and UNISDR ([www.desinventar.net/](http://www.desinventar.net/)) as part of the SENDAI Framework. For a detailed analysis of different approaches of how to assess drought impacts on societies, please see the UNCCD publication, *“Drought Impact and Vulnerability Assessment - A Rapid Review of Practices and Policy Recommendations (2019).”*

We can see in the summarizing figure on the next page that the consequences of a drought reach almost all sectors of a society. Agrarian production is usually the most vulnerable, especially if relying on rain-fed agriculture, as drought reduces water availability, reduces soil organic matter, and consequently lowest soil fertility, triggering sheet erosion and decreased productivity. These effects are more imminently felt with annual crops, but are felt with perennial too, especially if not endemic or otherwise well adapted to altering hydrological conditions.





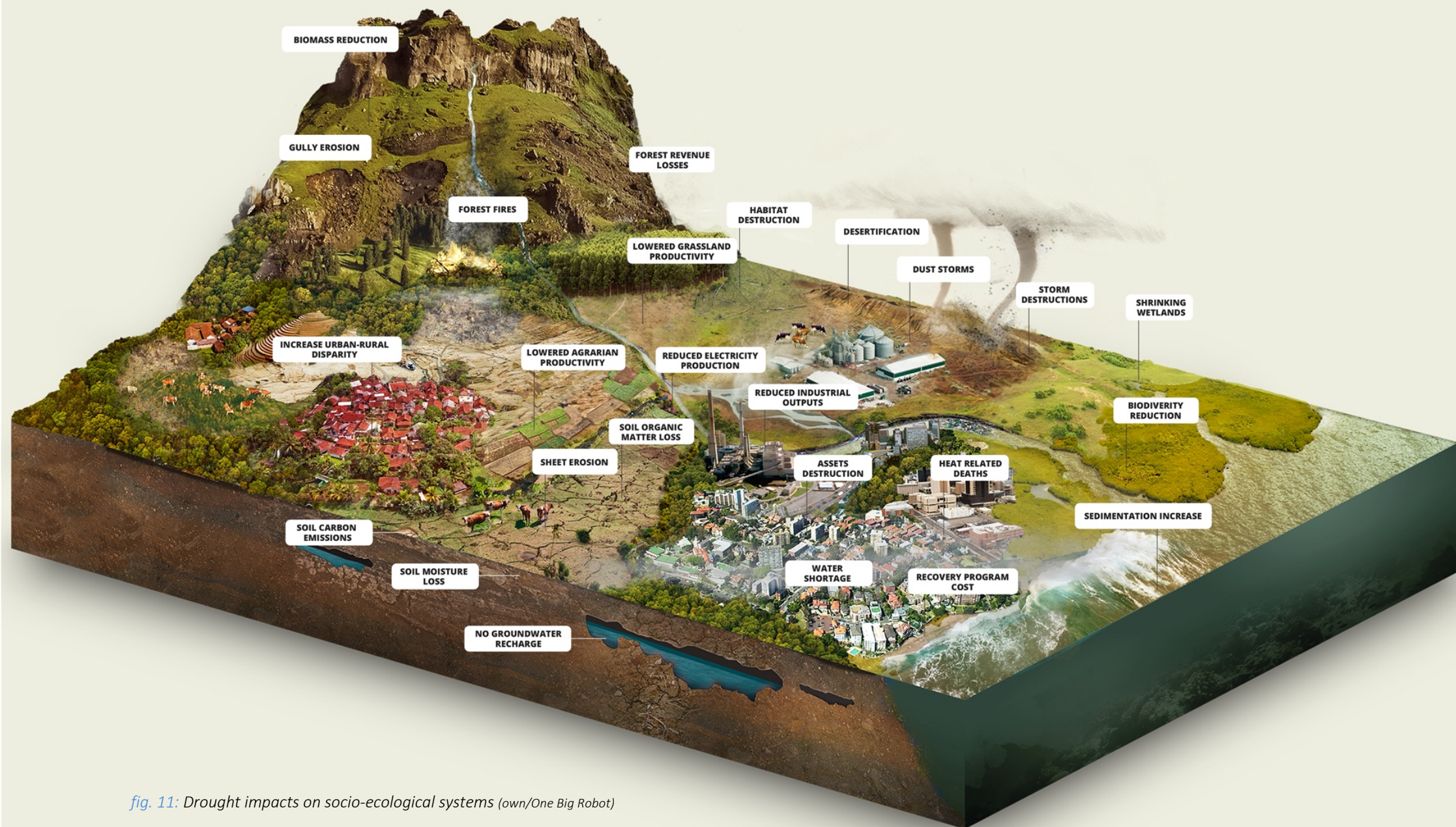


fig. 11: Drought impacts on socio-ecological systems (own/One Big Robot)

When vegetation dries up, run-off increases, sediment loads in rivers surge, and groundwater levels reduce due to limited rainwater infiltration. Subsequent problems are created along waterways, reducing navigation routes or the water-cooling capacities of power plants, resulting in a decrease of electricity production. Forests, and especially monocultural plantations, that are not adequately adapted to withstand higher temperatures are also susceptible to loss or even complete stand failure (Schuldt, 2020). These cascading (sequentially) or compounding (simultaneously) impacts are distributed across sectors, from local shipping to international trade disruptions, and from forced migration to food insecurity. In the worst cases, droughts potentially have multiplying effects on existing conflict risks, triggering social instability or even war. Droughts therefore pose a major challenge to achieving all of the Sustainable Development Goals (SDGs) (Prudhomme et al., 2014; IPCC, 2018; Lu et al., 2019; Spinoni et al., 2020), necessitating a comprehensive and coordinated policy framework to proactively address these risks.

## 2.2 Existing policies

What are the existing policy frameworks meant to govern the intersectoral risks deriving from drought? Do we have the necessary global and regional regulations mechanisms, and are nation states adequately prepared with the necessary legislation to proactively combat droughts? The following section will give review this on three scales: global, regional, and national.

### 2.2.1 Global

On the global level, the UNCCD is the sole legally binding convention that addresses issues surrounding land management, desertification, and drought. When the secretariat was established in 1994, it had a specific focus on arid, semi-arid, and sub-humid regions, but with the impacts of heat-related climate phenomena progressively expanding across the globe and landscape degradation affecting more and more countries, UNCCD's mandate has concurrently expanded its geographic and thematic scope. The UNCCD Strategic Framework (2018-2030) marks the most comprehensive global commitment to achieve Land Degradation Neutrality (LDN) by halting destruction and restoring damage done to socio-ecological systems wherever possible. With 197 Parties working together to achieve these goals, the UNCCD works in close collaboration with the two other Rio Conventions, UNFCCC and CBD, on a global level.

A set of other United Nations agencies work with global mandates on topics related to drought risk management. The four most prominent ones, all without non-binding legal mechanisms, are the FAO, the WMO, the UNDRR, and the WFP. In regard to monitoring drought globally, NOAA's Global Drought Information System along with the SPEI Global Drought Monitor, hosted in Spain, provide biophysical parameter measurements with resolution of up to 0.5° in a nearly real-time environment. Furthermore, the Global Water Partnership (GWP) and the World Meteorological Organization (WMO) launched a joint Integrated Drought Management Programme (IDMP) in 2013 to improve monitoring and prevention of drought in various parts of the world.



### 2.2.2 Regional

A number of drought-related collaborations with regional focus have been emerging in recent decades, primarily focusing particularly on early warning as well as vulnerability assessment and monitoring. Increasingly, they focus on sharing good practices on mitigation measures too.

The Global Water Partnership (GWP) launched the regional Integrated Drought Management Programme (IDMP) in 2013 as part of the global joint World Meteorological Organization (WMO)/GWP IDMP and the Drought Management Centre for Southeastern Europe (DMCSEE). A European Drought Observatory (EDO) was also inaugurated the same year as a joint effort of the EU Joint Research Centre, the United Nations Economic Commission for Europe (UNECE), and the European Drought Centre. It is a purely virtual platform serving as knowledge center with the aim “to coordinate drought related activities in Europe to better mitigate the environmental, social and economic impact of droughts.” It involves more than 40 organizations from 9 CEE countries (Bokal, 2014).

Following the Nairobi Summit of 2011, the Heads of State and Government resolved to embark on the Drought Disaster Resilience and Sustainability Initiative for Africa, led by the Inter-Governmental Authority on Development (IGAD). Subsequently the African Risk Capacity Network was founded as a Specialized Agency of the African Union “established to help African governments improve their capacities to better plan, prepare, and respond to extreme weather events and natural disasters” (ARC, 2021). This African-led initiative, which was also co-created together with the UN World Food Programme (WFP) the so called AfricaRiskView, a regional satellite-based weather forecast and surveillance program. The first African Drought Conference, held in Windhoek, Namibia in August 2016, brought together African Member States and Parties to the UNCCD, Ministers, Heads of Delegation, and experts to discuss ways to enhance drought resilience in Africa. The two major outcomes of the Conference were the Windhoek Declaration and the White Paper on Drought Resilience and Prepared Africa (DRAPA) (Duguma et al., 2017).

As for Latin America, there is an EU-financed drought preparedness program encompassing 18 countries called EUROCLIMA+, which functions off the synergistic work of seven agencies: the Spanish Agency for International Development Cooperation (AECID), the French Development Agency (AFD), the Economic Commission for Latin America and the Caribbean (ECLAC), Expertise France (EF), the International and Ibero-American Foundation for Public Administration and Policy (FIIAPP), the German Society for International Cooperation (GIZ), and UN Environment. In the Caribbean region, the Caribbean Disaster Emergency Management Agency (CDEMA), and Caribbean Institute of Meteorology and Hydrology (CIMH) together developed into hubs of knowledge and early warning. The CAPRA initiative was created in partnership with the Center for Coordination of Natural Disaster Prevention in Central America (CEPRENAC), the United Nations International Strategy for Disaster Reduction (UN ISDR), the Inter-American Development Bank (IADB), and the World Bank.

In North America, there is the National Drought Information System, a national integrated drought early warning information system that aims to create a higher level of drought resilience in the U.S. Close regional collaboration exists with the Canadian Drought Monitor (CDM). Both institutions, along with their Mexican counterpart, are also closely linked through

the North American Drought Monitor, hosted at the National Drought Mitigation Center at the University of Nebraska-Lincoln, sharing real-time data and analysis capacities.

Several regional drought monitoring and assessment centers also established themselves as collaborative bodies in Asia, such as The South Asia Drought Monitor (SADM) in 2014, the APEC Climate Center (APCC) in 2005, and the Asia-Pacific Regional Drought Mechanism as part of the ESCAP's Regional Drought Mechanism in support of UN-Spider or the Regional Drought Monitoring and Outlook System (RDMOS) for South Asia.

Finally, there are also transcontinental collaborations, like the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) and an ever-growing number of commercially oriented services that make forecasting their business.

### 2.2.3 National

Many nation states have National Drought Management Plans in place, but they are often called by different names, such as Land Care Acts, Extension Programs, Climate Change Adaptation Plans, or Risk Management Strategies.

Two independent UNCCD surveys were conducted in the years 2019 and 2020 in order to stock-take policies on the national level, and they revealed that siloed approaches are still highly prevalent, in which different institutions lack cross-sectorial coordination and solely focus on their own line functions without taking a more holistic view. Therefore, the need for a coordinating committee or commission is essential, equipped with the necessary advisory and steering capacities to translate policies into action. More in this is found in the "Recommendations & Options" sections of chapters 3 to 5.

The two surveys have also observed that up until today, the majority of countries still engage in reactive and crisis-driven approaches toward drought rather than proactively managing risks. The UNCCD puts its premise on proactive, coordinated, and holistic approaches that are based on the following three pillars:

1. Early warning and monitoring systems,
2. Vulnerability and impact assessments, and
3. Drought risk mitigation measures.

The first of the two surveys, which had responses from a total of 36 drought-affected countries (2020), including 50% of all African countries, revealed that only 39% of the countries have national policies in place, of which one-fourth were established in the last five years. While the progress seems to point in the right direction, it is also likely more than 50% of all those countries do not have the necessary legal instruments in place.

The majority of countries, despite acknowledging the growing drought threats in their respective territories, defines drought management and DRR measures through sectoral policies and law provisions. To this point, it must be highlighted that the lack of strategic national drought plans is rarely the result of a lack of understanding or underestimation of drought phenomenon. Rather, it is the plethora of law provisions in place and authorities in



charge that increases the difficulty to establish effective coordination mechanisms and, ultimately, hampers national efforts to develop successful policies. The graph below gives a comprehensive overview on interlinked approaches of drought policy, measured from the responding countries.

| Country            | Plans of action<br>(National/Local) | Policy embedded | National drought<br>strategies |
|--------------------|-------------------------------------|-----------------|--------------------------------|
| Algeria            |                                     |                 |                                |
| Angola             |                                     |                 |                                |
| Bosnia-Herzegovina |                                     | ✓               |                                |
| Botswana           | ✓                                   |                 | ✓                              |
| Burkina Faso       | ✓                                   |                 | ✓                              |
| Cambodia           | ✓                                   |                 | ✓                              |
| Central Afr. Rep.  |                                     | ✓               |                                |
| Chad               |                                     | ✓               |                                |
| China              |                                     |                 | ✓                              |
| Ivory Coast        |                                     | ✓               |                                |
| Ecuador            | ✓                                   | ✓               | ✓                              |
| El Salvador        |                                     |                 |                                |
| Eritrea            | ✓                                   |                 |                                |
| Ghana              |                                     | ✓               | ✓                              |
| Greece             |                                     | ✓               |                                |
| Guinea             | ✓                                   | ✓               |                                |
| Hungary            | ✓                                   |                 |                                |
| Kenya              | ✓                                   |                 | ✓                              |
| Macedonia          |                                     | ✓               |                                |
| Mali               | ✓                                   | ✓               | ✓                              |
| Malta              |                                     |                 |                                |
| Montenegro         | ✓                                   |                 | ✓                              |
| Myanmar            |                                     |                 |                                |
| Nicaragua          |                                     | ✓               |                                |
| Nigeria            |                                     | ✓               |                                |
| Panama             | ✓                                   |                 | ✓                              |
| South Africa       |                                     | ✓               |                                |
| Spain              | ✓                                   |                 | ✓                              |
| Sudan              |                                     | ✓               |                                |
| Suriname           |                                     | ✓               |                                |
| Swaziland          | ✓                                   |                 |                                |
| Togo               |                                     |                 |                                |
| Turkey             | ✓                                   | ✓               |                                |
| Ukraine            |                                     |                 |                                |
| Uzbekistan         |                                     | ✓               |                                |
| Venezuela          |                                     | ✓               |                                |
| Zimbabwe           |                                     | ✓               |                                |

fig. 12: Country overview on drought approaches (own)

It should be noted that in those cases where national drought plans are missing, coping strategies are often formulated more generally under the UNFCCC Paris Agreement, are part of specific climate change adaptation policies or, in a third case, are part of complementary sectorial legislation, such as forestry, agriculture or water management.

The survey also revealed that in many countries where strategic frameworks are not yet established, civil society organizations often promote mechanisms on a local or district level, with the potential to be cast in a legislative mold in the near future. Here a direct link to international actors can often be found, which can help stimulate and inspire the drafting of frameworks on a sub-national level. Therefore, outlining a novel possibility by scaling-up local and regional initiatives, rather than solely working with a top-down approach. Building on existing experiences, local interventions should be further investigated to evaluate their relevance and effectiveness at a larger scale, and, in such cases, could be considered as

reference tools for elaboration in national measures. The following section gives a comprehensive overview on mechanisms, both anchored in policies and not.

The second survey conducted by UNCCD one year later among their national focal points in 190 countries brought a response rate of almost 50%, exceeding the return rate of the earlier one, but only having two focus areas: the existence of national drought plans or that of similar legally binding documents, and the target plans for Land Degradation Neutrality or similar national guidelines. The results of this survey are summarized in the graph below and interpreted in the next paragraphs.

|                     |                 |                 | National Drought Plan |              |             |             | LDN Target Plan |              |             |             |
|---------------------|-----------------|-----------------|-----------------------|--------------|-------------|-------------|-----------------|--------------|-------------|-------------|
|                     | Total countries | Total responses | existing              | similar doc. | in progress | nonexistent | existing        | similar doc. | in progress | nonexistent |
| Africa              | 54              | 41              | 24                    | 10           | 1           | 6           | 20              | 3            | 0           | 18          |
| Asia                | 48              | 12              | 7                     | 1            | 3           | 1           | 0               | 0            | 0           | 12          |
| CEE & NMED          | 27              | 15              | 5                     | 7            | 1           | 2           | 0               | 0            | 0           | 15          |
| LAC                 | 33              | 11              | 4                     | 5            | 2           | 0           | 1               | 0            | 0           | 10          |
| Non Annex Countries | 28              | 4               | 0                     | 3            | 0           | 1           | 0               | 0            | 0           | 4           |
| Total number        | 190 / (194)     | 83              | 40                    | 26           | 7           | 10          | 21              | 3            | 0           | 59          |

|                     |                   |                 | National Drought Plan |              |             |             | LDN Target Plan |              |             |             |
|---------------------|-------------------|-----------------|-----------------------|--------------|-------------|-------------|-----------------|--------------|-------------|-------------|
|                     | Total countries * | total responses | existing              | similar doc. | in progress | nonexistent | existing        | similar doc. | in progress | nonexistent |
| Africa              | 54                | 41              | 59%                   | 24%          | 2%          | 15%         | 49%             | 7%           | 0%          | 44%         |
| Asia                | 48                | 12              | 58%                   | 8%           | 25%         | 8%          | 0%              | 0%           | 0%          | 100%        |
| CEE                 | 18                | 15              | 33%                   | 47%          | 7%          | 13%         | 0%              | 0%           | 0%          | 100%        |
| LAC                 | 33                | 11              | 36%                   | 45%          | 18%         | 0%          | 9%              | 0%           | 0%          | 91%         |
| Non Annex Countries | 28                | 4               | 0%                    | 75%          | 0%          | 25%         | 0%              | 0%           | 0%          | 100%        |
| Percentage          | 153 / (194)       | 83              | 48%                   | 31%          | 8%          | 12%         | 25%             | 4%           | 0%          | 71%         |

fig. 13: Overview of countries with drought management plans and LDN Targets (own)

Once again, African countries had the highest response rate, with 41 out of 54 countries, revealing that 59% have a national drought plan in place and additional 24% a similar legal document. Asian countries have the highest proportion of countries that are currently in the process of developing a national drought plan, with 25% of those 12 that responded. This is more than double the global average, where currently about 8% of responding countries are in the process of preparing such plans. The survey revealed that almost 90% of the responding countries do have legal instruments in place that deal with droughts in one way or another. It will be interesting to see and analyze in future evaluations about the effectiveness of the existing frameworks and what kind of adaptive revision functions were put in place, enabling improvements through lessons learned.

One indication of the countries primary reactive function can be indirectly seen through the low rate of Land Degradation Neutrality Plans in place by the responding countries. 71% do not have such long-term planning instruments for resilience. Great regional differences exist with Europe and Asia having zero responses, and Latin American and the Caribbean only 9%. African countries, on the contrary, seem to have adapted well to this unifying UNCCD strategy and measurement tool with about 50% of all responding countries having such plans established. When comparing these numbers against global assessment on land degradation reports such as ISRIC's GLADA (2011) or UNCCD's Global Land Outlook (2019), however, it becomes also clear that measurable results as a direct consequence are as of yet hard to assess. Nevertheless, with more countries ascribing to the principles and reporting structures, comparability across countries and individual sectors will greatly improve in times to come, as will, hopefully, data robustness and resolution.

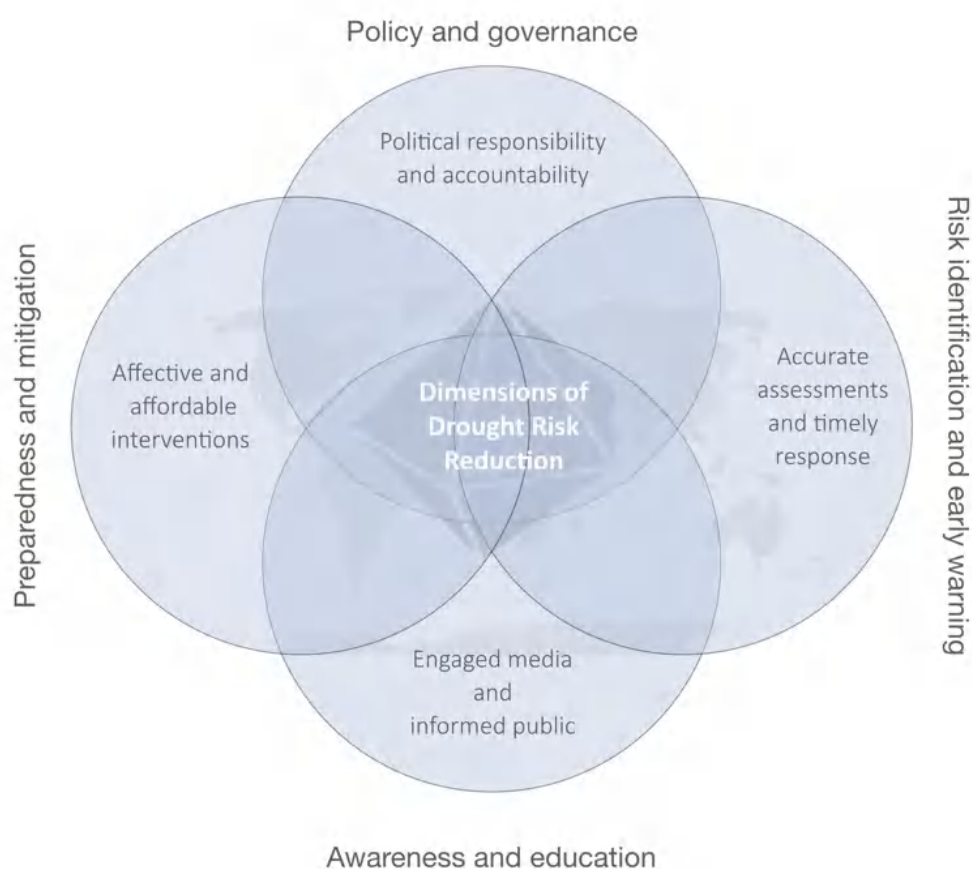


## 2.3 Existing mechanisms

### 2.3.1 Country-level preparedness and responses

At the national level, action on drought can be generically described in two main categories: proactively managing the risk of drought and reactively managing the drought crisis. Proactive drought risk management refers mainly to pre-drought or protection actions: mitigation, preparedness, prediction, and early warning of drought. Related actions might include structural measures, such as planting drought-resistant crops, building infrastructure that supports water conservation and use regulation, or facilitating income generation that is not dependent on water availability; or non-structural measures such as drought-related knowledge development, risk and vulnerability assessments, capacity building on monitoring and forecasting, and establishment of drought policies and plans. (UNCCD 2019)

The second category involves the reactive capacities that deal with the intensity of any given shock, engaging traditional emergency mechanisms, but also insurance schemes, awareness, and education campaigns to mitigate the worst effects. Both dimensions often overlap due to the cascading nature of risks and compounding scenarios. The graph below gives an integrated overview of the interconnectedness of preparedness and response measures.



*fig. 14: An overview of interconnected drought management dimension (own)*

Counter-measures that address the root causes of hydrological dysfunction – at the level of deep adaption – always involve the restoration of landscapes and their endemic diversity, meaning the reconstruction of functional ecological systems on a large-scale, based on local conditions.

If this is being achieved by (assisted) natural regeneration or active rehabilitation and restoration is a question that can only be answered on a landscape level and in consultation with ecologists and those stakeholders that remain dependent on specific functions of a particular biome or ecosystem. In parallel, fundamental changes in societal patterns of resource consumption, landscape conversion, and energy are required if current trends in drought-amplifying actions are to be curtailed and future degradation avoided.

The following table gives a comprehensive overview of intervention mechanisms currently in use and practice-proven by various countries. One sample good practice is listed in the right column.

| Scale               | Land use type                   | Socio-ecological management measure                                                                                                                                                          | Good practise examples                                                                                                                                                                                                                                                                                           |
|---------------------|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Plot Level          | Water body                      | Water infiltration and retention in-situ / fair water extraction and provision / proper water treatment                                                                                      | Netherlands: even though located at the end of major European rivers, the country ranks highest in terms of waste-water treatment (99.5%)                                                                                                                                                                        |
|                     | Soil body                       | ensuring soil-coverage and high organic matter content                                                                                                                                       | Uruguay: an innovative legislation links property taxes to the potential of soils, not to their use                                                                                                                                                                                                              |
| Watershed Landscape | Natural Systems                 | Restoration, conservation and protection                                                                                                                                                     | Costa Rica: The country decided to not have an army and instead put priority on education, health, ecosystem restoration and conservation.                                                                                                                                                                       |
|                     | Forestry systems                | Afforestation and reforestation / selective extraction / agroforestry systems                                                                                                                | Finland: forest stocks have increased from 1,500 million m <sup>3</sup> in 1970 to 2,500 million m <sup>3</sup> in 2015, due to effectiveness of legislation, and certification in regenerating forests.                                                                                                         |
|                     | Agrarian systems                | Regenerative agriculture / sustainable land management                                                                                                                                       | Denmark: since the 80s, the gov. put a lot of effort into supporting organic farming, incl. a free certification scheme. Today it has the highest national market share in the world at 14%.                                                                                                                     |
|                     | Rangeland systems               | Grassland                                                                                                                                                                                    | Durban, South Africa: invested in participatory processes, took a regional and system-wide approach to build new levels of resilience.                                                                                                                                                                           |
|                     | Built environments              | Urban greening/gardening and bio mimicking                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                  |
| National            | Various of the above categories | National drought planning committee / pro-active drought incentives / removal of counterproductive subsidies / functional early warning system based on system-wide Vulnerability assessment | Australia: water used has halved over a period of 20 years in its capital Melbourne. The national government passed legislation that allocates power to a regional water manager to force cooperation between water utilities, city agencies and reservoir managers.                                             |
| Regional            | All categories                  | Regional early warning systems, linked with national and global levels / trans-regional capacity building and exchange / regional collaboration centres                                      | SEVIR-Himalaya-Hindukusch: an regional drought monitoring and outlook system predicting droughts (up to 3 months) and providing real-time data to government entities, including capacity building in seven countries, coordinated through the International Centre for Integrated Mountain Development (ICIMOD) |
| Global              | All categories                  | Global policy frameworks and monitoring / catalytic financial mechanism and penalty system / coordination of global agencies / preparation of scientific task group reports                  | UNFCCC: The only Rio Convention that was successful in developing binding policy mechanism and having differentiated IWG on various key aspects of the climate crises.                                                                                                                                           |

fig. 15: Intervention mechanisms on various scales  
(own/King-Okumu et al., 2021; WOCAT; SER; SEE-Intl'; UNCCD Global Outlook Report)

### 2.3.2 Drought risk management capacities

UNCCD's survey also included a section evaluating the role of various capacities for drought risk management to succeed. The results are as following: Seventeen countries (42.5%) expressed there is a need of having, making, or improving drought vulnerability and impact assessments. Thirteen countries specifically referred to the need to either install, rehabilitate, or improve the network of climate and hydrological stations that would allow effective and reliable drought monitoring. Regularly mentioned was the need to provide assistance to the institutions in terms of material, financial, human, and technological resources, and improve capacities also at the



community level and of the stakeholders. The policy level itself was also identified as a field where capacity building is required.

The following graph tries to summarize the lessons-learned on why drought management interventions can fail, based on limited capacities of various kinds.

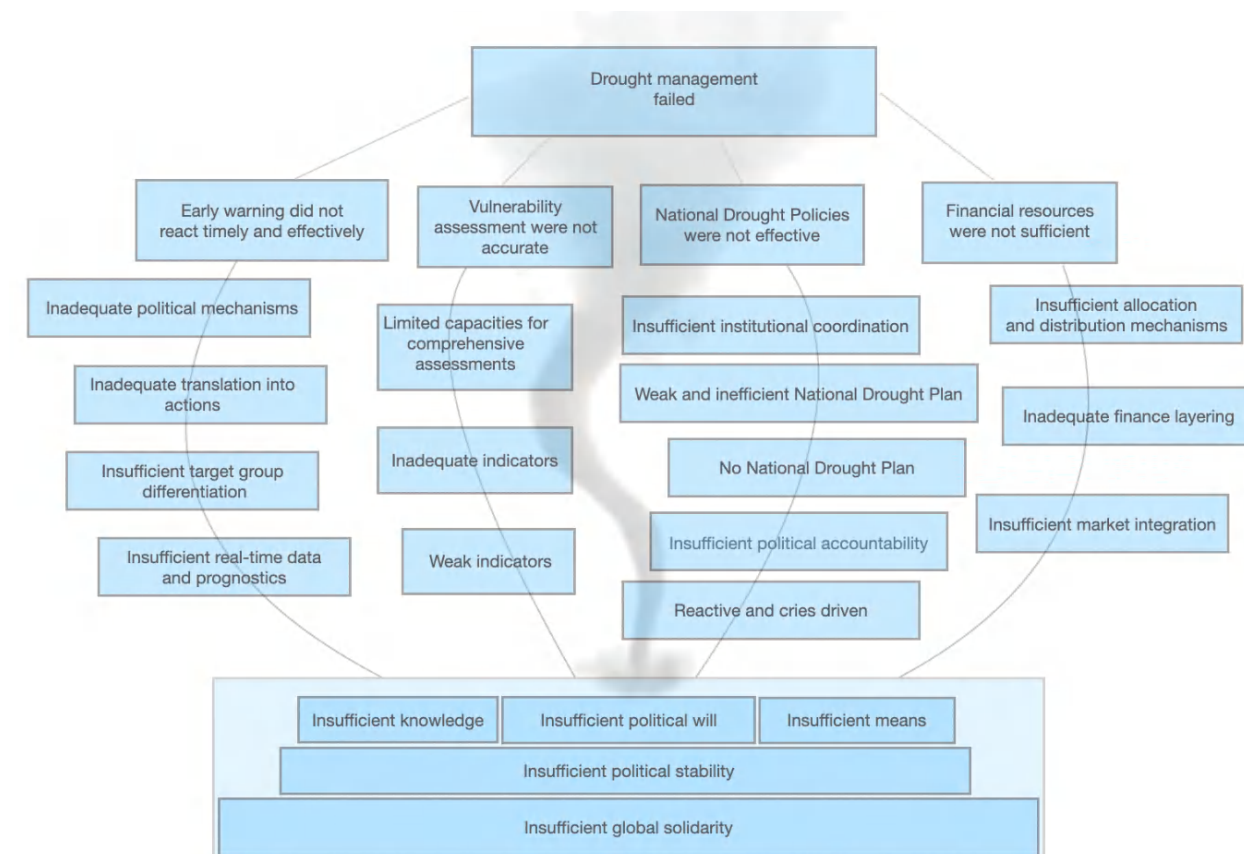


fig. 16: Reasons for drought management failure (own)

## CHAPTER 3

### *Options & recommendations: Multiscale assessments and resilience monitoring*



Drought has traditionally been and often still is addressed through reactive crisis management approaches, with high levels of political attention when drought causes a crisis and limited attention before and thereafter. Reactive crisis management focuses on drought response, providing relief and emergency assistance (Wilhite 1997). This ad-hoc crisis action is costly, often poorly coordinated, fragmented, and shaped by politics (Sainath 1996, Wilhite 1997, Clarke & Dercon 2016, Sivakumar et al. 2017). It usually fails to reduce future drought vulnerability. Crisis-driven relief rather creates a culture of dependency and serves as a disincentive for sustainable drought risk mitigation (Wilhite 1997, Raschky & Weck-Hannemann 2007, Cohen & Werker, 2008, Crossmann 2017, WMO & GWP 2017). Therefore, drought policies and management need to move to proactive approaches, reducing vulnerability and increasing resilience.

Drought monitoring together with vulnerability and resilience assessments are key to moving from reactive to proactive management. This is reflected in the Drought Resilience, Adaptation and Management Policy Framework (DRAMP), developed by UNCCD as a guidance for proactive drought management (Crossman 2017, UNCCD 2019). The DRAMP framework builds on the Sendai Framework for Disaster Risk Reduction (UNISDR 2015) and a series of workshops on capacity development for national drought management policies held in multiple regions between 2013 and 2015 (Tsegai et al. 2015). It comprises three pillars (UNCCD 2019):

Key pillar 1: Implement drought monitoring and early warning systems

Key pillar 2: Assess drought vulnerability and risk

Key pillar 3: Implement measures to limit drought impacts and to better respond to drought

These pillars are intended to serve as a basis for national drought policy and management plans and to support the development of various drought management activities in a structured way. With key pillars 1 and 2, the DRAMP framework puts considerable emphasis on monitoring, assessment, and early warning systems – together a crucial basis for effective drought risk mitigation. The IWG has therefore invested considerable effort into analyzing the status quo and major challenges, and into compiling overviews of indicators, indices, and methodologies. Following a brief summary of the present situation and major challenges, this chapter presents an overview and discussion of assessment frameworks, indicators, and methodologies, introduces the UNCCD's Drought Tool-Box, discusses guiding principles, and identifies priorities for further action.

### 3.1 Status quo and challenges

The survey with the national focal points, conducted by the IWG, indicated varying levels of implementation of drought monitoring, early warning systems, and vulnerability assessments in the member countries.

Of 40 national focal points that provided feedback on this question, 31 stated that their country conducts climate or drought monitoring. Twenty-one said that they have drought early warning systems in place. Fourteen said that their countries conduct some kind of drought impact assessment. Their approaches ranged from networks of local reporters observing soil and vegetation conditions and yield losses to remote sensing-based impact assessments. Drought effects on crops was the aspect most commonly monitored. Four countries noted that they

conduct drought risk assessments. Ten countries explicitly stated that they conduct drought vulnerability and diagnostic assessments. A literature review by the IWG identified drought vulnerability studies carried out in countries that did not participate in the survey as well as in some countries that participated but did not report those studies. Combining the survey data and the literature review, a total of 48 countries were identified to conduct drought vulnerability assessments.

Asked about major needs of action to reduce drought impacts and vulnerability, 18 of the 40 countries pointed to drought monitoring, forecast, and early warning. Thirteen specifically referenced the need to install, rehabilitate, or improve the network of climate and hydrological stations, to strengthen related institutional, technical, and human capacities and the coordination between relevant authorities, and/or to improve the access to and use of remote sensing data for effective and reliable drought monitoring. Eleven countries expressed the need to establish or strengthen early warning systems. The feedback to the survey reflects a common understanding that monitoring and early warning play a key role in drought preparedness. Timely information on drought onset and extent could help, for example, to limit agricultural drought costs. It could allow timely decision making, for example, by farmers to reduce livestock numbers in time.

A similar number of countries (17 of 40) pointed to improved drought vulnerability and impact assessments as major needs of action. The breadth of relevant meteorological, physical-geographic, and socioeconomic aspects was thereby noted as a major challenge. The aspects that different respondents viewed as necessary but challenging to better integrate range from land degradation, (wind) erosion, water supply, soil types, crop-specific water needs, water supply, human health, nutrition, and land and water conflicts, to the identification of the most vulnerable ecosystems and population groups across rural and urban areas. Improved knowledge and further development of holistic or easily applicable, and of region-specific indicators, indices, and methods were also expressed as needs.

The IWG survey revealed widespread confusion of the concepts of vulnerability and risk, and of risk assessments and drought monitoring. This is broadly in line with a comprehensive, systematic literature review conducted by Hagenlocher et al. (2019). The fact that 60% of the 1,141 articles on drought risk and vulnerability assessment published between 1970 and 2018 that the authors identified were published during the last four years of this period reflects the calls of the WMO and UNCCD (Sivakumar et al. 2014), the UNISDR, and others for proactive drought management. The authors identified substantial scope for further advancement in research and practice. They found that of the reviewed assessments, more than 60% did not explicitly specify the type of drought hazard addressed, 42% provided no clear definitions of drought risk, and only about 40% of the assessments established direct links to drought risk mitigation strategies. Both the IWG survey with the national focal points and the review by Hagenlocher et al. (2019) underline the importance of the UNCCD's work in this field.

### 3.2 Concepts and indicators

Given the spatial-temporal fuzziness of drought, its multiple dimensions, and its multifaceted impacts, it is no surprise that a large range of concepts and indicators have been developed to monitor drought, and to assess drought risk, vulnerability, and resilience.



## Drought monitoring

The gradual onset of drought makes it easy to neglect until it turns to disaster. On the other hand, it is their gradual onset that makes drought hazards easier to monitor and detect before they turn to disaster than other, more suddenly occurring hazards, like floods or earthquakes. Monitoring and forecasting the onset and duration of drought is a crucial basis for timely response actions. Comprehensive sets of drought monitoring indicators and indices and corresponding references are contained in WMO & GWP (2016) and UNCCD (2019). Table 3.1 lists a selection of some of the most commonly used or most applicable indicators and indices for the different drought dimensions, based on the review contained in UNCCD (2019).

| Drought dimension                   | Indicator/Index                                            | Data input                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------|------------------------------------------------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Meteorological drought              | Standardized Precipitation Index (SPI)                     | Precipitation              | <ul style="list-style-type: none"> <li>Simple, normalized index that summarizes temporal anomalies in precipitation</li> <li>“Starting point” for meteorological drought monitoring</li> <li>Quantifies precipitation deficits for different timescales (1, 3, 6, 12, 24, and 48 months)</li> <li>Four SPI drought categories (mild, moderate, severe, and extreme dryness) can be used as triggers for response actions</li> </ul>                                    |
|                                     | Standardized Precipitation Evapotranspiration Index (SPEI) | Precipitation, temperature | <ul style="list-style-type: none"> <li>Captures evapotranspiration and thereby accounts for the influence of temperature variability and increasing temperature under climate change</li> <li>Better performance than SPI for capturing streamflow, soil moisture, forest growth, and crop yield impacts during summer droughts (Vicente-Serrano et al. 2012)</li> </ul>                                                                                               |
|                                     | Effective Drought Index (EDI)                              | Precipitation              | <ul style="list-style-type: none"> <li>Can be used to assess drought severity with daily precipitation as the major input</li> <li>More sensitive than SPI to shorter drought periods and to detecting the onset and end of a drought (Jain et al. 2015)</li> </ul>                                                                                                                                                                                                    |
| Hydrological drought                | Streamflow Drought Index (SDI)                             | Streamflow                 | <ul style="list-style-type: none"> <li>Simple to calculate indices of streamflow</li> <li>Important when surface water flow, storage, and diversions become critical components for agricultural production, urban and industrial water supply, and freshwater ecology</li> <li>Yet, in addition to streamflow, a robust assessment of hydrological drought requires hydro-dynamic models of land systems, which require high levels of technical expertise</li> </ul> |
|                                     | Standardized Streamflow Index (SSFI)                       | Streamflow                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Ecological and Agricultural drought | Vegetation Health Index (VHI)                              | Satellite data             | <ul style="list-style-type: none"> <li>Robust measures of drought-induced crop stress</li> <li>Combines measure of vegetation moisture stress (NDVI) and temperature stress (BT) with timing of different stages of plant phenology over the growing season</li> </ul>                                                                                                                                                                                                 |

| Drought dimension       | Indicator/Index                                                    | Data input                                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------|--------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | Water Requirement Satisfaction Index (WRSI)                        | Satellite data, modelling data, crop coefficient | <ul style="list-style-type: none"> <li>Robust measures of drought-induced crop stress</li> <li>Combines remotely sensed precipitation and potential evapotranspiration data with soil water holding capacity and crop coefficients to provide early warning estimates of crop yields and potential failures</li> <li>Percentage of total crop water requirement satisfied by rainfall or available soil moisture</li> </ul> |
|                         | Agricultural Stress Index (ASI)                                    | VHI                                              | <ul style="list-style-type: none"> <li>Developed by the FAO, based on high spatial and temporal resolution time-series interpretations of VHI</li> </ul>                                                                                                                                                                                                                                                                    |
|                         | Normalized Difference Vegetation Index (NDVI)                      | Satellite data                                   | <ul style="list-style-type: none"> <li>Useful and practical methods for identifying early drought impacts to agriculture and to monitor impacts to natural ecosystems and forests</li> </ul>                                                                                                                                                                                                                                |
| (Socioeconomic drought) | Multivariate Standardized Reliability and Resilience Index (MSRRI) | WSRI, multiple                                   | <ul style="list-style-type: none"> <li>MSRRI evaluates the supply and storage of water in relation to demand; its calculation requires data on water demand, water storage capacity and levels and water inflows</li> <li>Given the multifaceted impacts of drought on societies, specific indicators for socioeconomic drought are uncommon</li> </ul>                                                                     |
| Composite indicators    | US Drought Monitor (USDM)                                          | Multiple indicators                              | <ul style="list-style-type: none"> <li>Combines six indicators of drought (PDSI, soil moisture, daily streamflow, rainfall deciles, SPI and VHI)</li> <li>Five USDM drought categories (D0-D4: abnormally dry, moderate, severe, extreme, and exceptional drought) can be used as triggers for response actions</li> </ul>                                                                                                  |
|                         | African Flood and Drought Monitor (ADFM)                           | Satellite data                                   | <ul style="list-style-type: none"> <li>Uses numerous remotely sensed datasets and streamflow data to calculate high resolution spatially continuous indicators describing meteorological, agricultural, ecological, and hydrological drought (<a href="http://stream.princeton.edu/">http://stream.princeton.edu/</a>)</li> </ul>                                                                                           |

fig. 17: Commonly used or most applicable indicators

The choice of indicators is influenced by climatic, physical-geographic, and social-economic circumstances, the type of drought, the availability of data, and institutional, human, and technical capacities. Taking into consideration more than one drought index helps to better characterize droughts and to examine the sensitivity and accuracy of different indicators (Dogan et al. 2012). Indicator selection is a location-specific trial-and-error process (WMO & GWP 2016). The selection of indicators and triggers should be done in a transparent, scientific way to ensure validity (UNCCD 2019). Steinemann & Cavalcanti (2006) proposed a 12-step method for designing and applying drought indicators and triggers for drought monitoring and early warning, which national and sub-national authorities are encouraged to follow (UNCCD 2019).



## Drought risk and vulnerability assessment

Risk and vulnerability assessments are the basis for targeted drought mitigation and response. A good knowledge of drought hazards and their effects on the various ecosystems and components of society and of the varying vulnerabilities of different areas, population groups, and sectors is the starting point for developing effective and sustainable drought mitigation measures and policies. It also guides the selection of monitoring and early warning indicators and triggers (UNCCD 2019).

Vulnerability assessments “attempt to understand who is vulnerable to what, when and why, and what can be done to reduce vulnerability” (UNCCD 2019, 19). Drought risk assessments expand the vulnerability assessment by the likelihood of drought hazard occurrence. Different conceptual understandings of drought risk and vulnerability (see Section 1.2.3) and the large range of different approaches and possible variables, combined with the diversity of region, country, and location-specific circumstances limit the transferability and comparability of the results of different risk and vulnerability assessment across world regions. The various sets of methodologies and variables need to be seen as a toolbox, from which the most suitable ones should be chosen in the context of region, country, and location-specific drought characteristics, vulnerabilities, and circumstances. The choice of approaches also depends on the scale of analysis, e.g., local, national, global, and the scope of assessment, e.g., understanding root causes, or identifying spatial and temporal patterns of risk (Hagenlocher et al. 2019).

Quantitative assessments usually apply indicators to calculate often spatially varying vulnerability scores. Qualitative assessments can be based, for example, on interviews, focus groups, and the integration of various types of information. Integrating different approaches provides complementary information supporting a better understanding of drought risk and vulnerability (Hagenlocher et al. 2019).

UNCCD (2019) provides guidance for a vulnerability assessment that builds on an understanding of vulnerability as a function of exposure, sensitivity, and adaptive capacity:

$$\text{Vulnerability (V)} = \text{Exposure (E)} + \text{Sensitivity (S)} - \text{Adaptive Capacity (AC)}$$

This definition, which is derived from the climate change adaptation community, takes a holistic view of drought impacting the entire system, not only people. The majority of the vulnerability assessments reviewed by Hagenlocher et al. (2019) take such an approach. Exposure can be estimated using variables and indicators capturing the probability, spatial extent, duration, and intensity of drought. Sensitivity can be framed using indicators describing, for example, the dependency on water resources, soil characteristics, the extent of land degradation, and population densities. Adaptive capacity can be seen as a combination of natural, social, human, financial, and manufactured capital, which can be captured by a breadth of different variables and indicators. Figure 3.1 visualizes this approach of a vulnerability assessment and provides examples of the breadth of possible variables that can be used.

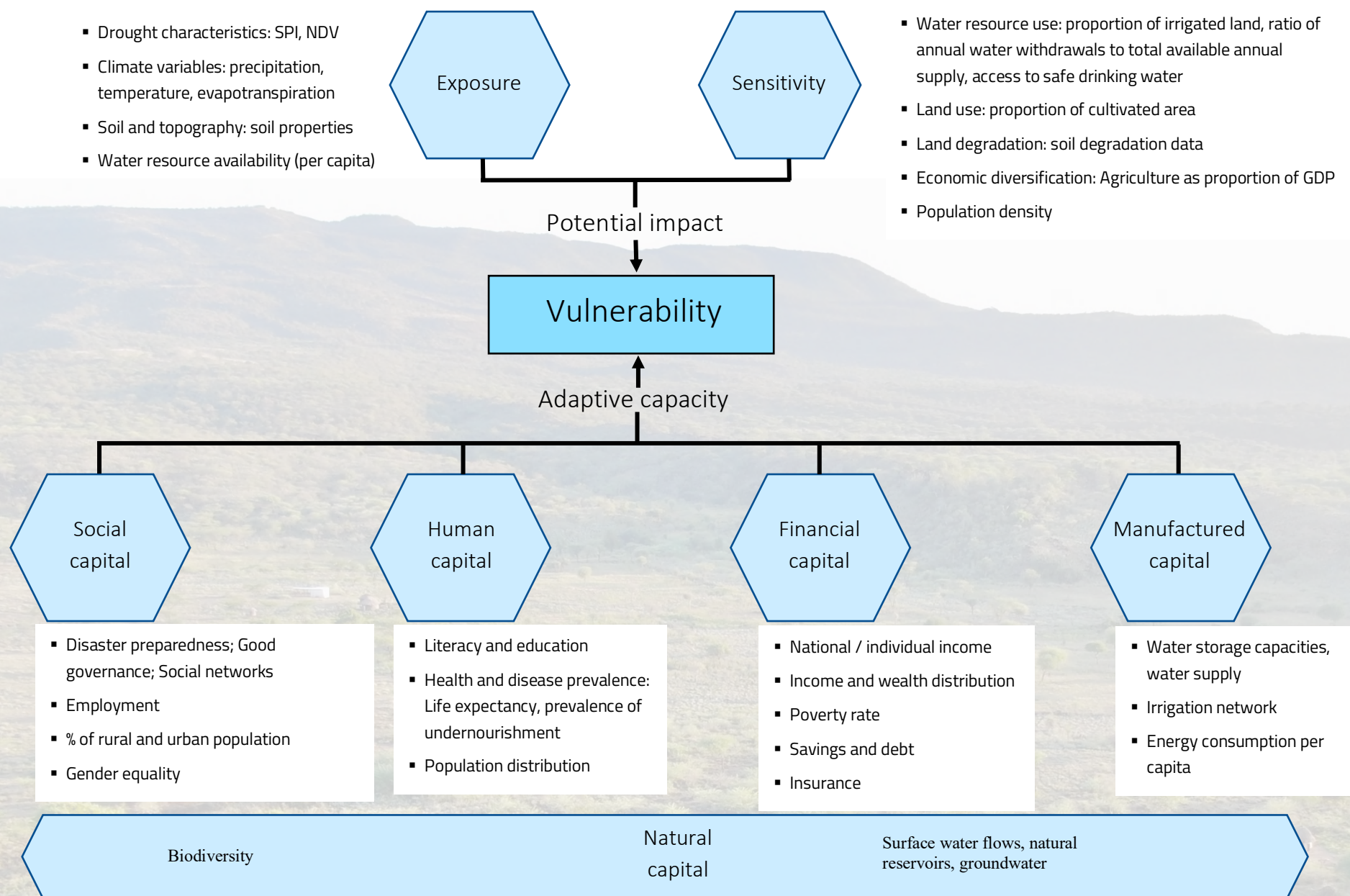


fig. 18: Framework and examples of variables and indicators for a drought vulnerability assessment (own/adapted from Gbetibouo et al. 2010 and building on UNCCD 2019 and Hagenlocher et al. 2019). Further work is required to identify and structure various aspects neglected in such frameworks.

In quantitative analyses, a weighting scheme, representing varying levels of importance, can be applied to connect the various variables in the calculation of overall vulnerability scores. Many steps in quantitative assessments, such as data imputation, outlier treatment, normalization, indicator weighting, and aggregation introduce uncertainty, rendering validations of the vulnerability assessment crucial (Hagenlocher et al. 2019, UNCCD 2019). The methodological steps, including the weighting scheme and validation, need to be transparently communicated. Hagenlocher et al. (2019) found that 57% of the indicator-based vulnerability assessments did not specify their weighting methods, and only 11% conducted any form of validation.

In addition to building on sets of factors seen as causes of drought vulnerability, assessments can and should also consider likely drought impacts and the ways in which they unfold. This is often retrospective, drawing on the experience of past droughts, but may also include probabilistic impact predictions (Blauhut et al. 2016). Analyses of past trends through repeated risk and impact assessments can also support the monitoring and evaluation of risk mitigation measures (Hagenlocher et al. 2019).

Vulnerability assessments should include ecosystems, the various land uses, and all population groups and sectors impacted by drought. Hagenlocher et al. (2019) found in their review that the majority of the assessments focused on social dimensions, without an integrative social-ecological view. Only 13 to 14% of their reviewed articles considered soil conditions or the quality and protection of ecosystems, though this is often crucial to understanding the causes of drought risk. This was also reflected in the risk mitigation strategies: of the studies that made links to mitigation strategies, only very few considered ecosystem-based approaches.

Hagenlocher et al. (2019) also critically noted that assessments often used the same sets of vulnerability indicators across different sectors, contexts, and scales and called for further work on sector, context, and scale-specific indicators and the development of an ‘indicator library’ that could be flexibly used for different contexts.

The framework depicted in Figure 3.1 is one way to structure such an ‘indicator library’, to simplify complex realities into simple categories. It provides some guidance and illustrates the breadth of themes to be taken into account. Yet, it poses the danger of encouraging inflexible, mechanistic assessment approaches, with practitioners working through the boxes and lists without open-ended inquiry into the complexities of actor, location, region, and country-specific real-world situations. Quantitative and broader-scale assessments should therefore be combined with and build upon qualitative inquiry across scales, from the local to the national. This allows for the identification of important factors not previously considered and not comprised in the ‘boxes’ of the framework.

Further work is needed to identify factors determining drought vulnerability and resilience and to develop a good structure of an ‘indicator library’. There are numerous factors that do not fit into the simplified ‘boxes’ of existing frameworks. The framework depicted in Figure 3.1, for example, lacks a very crucial dimension: the characteristics of the political system. Governance and corruption indicators are sometimes muddled into the category of ‘social capital,’ where they are not well-placed and hidden from the attention they require. A large range of political-economic factors do not fit into the ‘boxes’ of the framework and have often been neglected in drought risk and vulnerability analyses. This range of political-economic factors includes, for example:



- Possibilities and levels of political participation
- Participation of the most drought-affected actors and population groups in drought assessments and the development and implementation of mitigation strategies
- Corruption and law enforcement
- Financial accountability and transparency
- Political and legal accountability of those in charge of drought management decisions
- Human capacities and the quality of institutions in charge of drought monitoring and management
- Patterns of, inequities in, and conflicts over the access and control of land, water, and other resources
- Perverse market forces, such as rising water prices during droughts, benefiting wealthy actors and excluding the most marginal population groups from the resource

Neglecting these crucial factors in drought vulnerability assessments leaves them unaddressed in drought mitigation policies and strategies, rendering them less or ineffective.

### Drought resilience assessment

In addition to the real-world complexity and context-dependent variability of factors determining drought risk and drought resilience, the diversity of definitions, concepts, and frameworks complicates debates and practice. This also applies to the specificities and overlaps between vulnerability and resilience concepts.

While vulnerability assessments focus on the issues, weaknesses, and dysfunctions, resilience assessments reversely focus on strengths and on factors reducing drought risk – the goal of drought risk mitigation. Increasing ecosystems' and communities' drought resilience is the aim of the UNCCD's strategic framework, laid out in Decision 7/COP 13. Following the definition of the United Nations Office for Disaster Risk Reduction (UNDRR 2021), resilience is "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management." Increasing drought resilience refers to any actions that reduce drought exposure, drought vulnerability, or drought hazard.

There is substantial overlap between the factors covered in drought vulnerability and in resilience assessments; many of the factors are simply framed conversely. Yet, the debate on drought resilience and resilience assessment has directed attention to factors often neglected or not adequately developed in debates on vulnerability assessment. It is therefore briefly summarized in the following.

The concept of resilience has been widely embraced by scholars, development organizations, and NGOs, leading to a blossoming of literature, concepts, approaches, and indicators (Bahadur et al. 2015, Schipper & Langston 2015). The multi-faceted, context-dependent nature of

resilience makes it challenging to measure. Like in the case of vulnerability, any indicators simplify complex, interconnected, dynamic phenomena, rendering them contentious and calling for care in their selection and use (Hinkel 2011).

The following is a synthesis of a review of studies specifically applying or evaluating drought resilience indicators for various biophysical and socioeconomic dimensions.

### Ecological drought resilience

As noted above, vulnerability assessments have, to date, neglected ecosystems and ecological processes. The literature on ecosystem resilience to drought is also rather limited and very uneven across different biomes, such as forests, shrublands, grasslands, wetlands, croplands, urban land, and mixed land uses. Forests, grasslands, and croplands have been studied the most.

The speed of recovery in the Normalized Difference Vegetation Index (NDVI) is commonly used to measure a vegetation-based proxy for resilience. This and other vegetation indices that can be obtained by satellite image analysis together cover all scales and vast areas (from local to global) at various granularities and frequencies (Dorman et. al. 2015). The NDVI combined with field data, such as dendro-ecological data and climate data, can provide in-depth insights into ecosystem conditions and their resilience to droughts (Miranda et. al. 2020; Brodrick et. al. 2019; Yu et. al. 2017). Soil organic matter levels could be an important drought resilience indicator because of the crucial role they play in soil moisture retention capacity (Lal 2020). Key sources of data for ecosystem drought resilience assessments are satellite data, such as Landsat and MODIS, weather and climate variables, and assessments of soils, ecosystems, and their characteristics on the ground.

Based on the literature review, three types of indicators appear suitable for measuring ecosystem resilience to drought, though further research is needed: (1) Ecosystem recovery time after droughts, (2) Soil moisture holding capacity, and (3) Biodiversity.

The first indicator, ecosystem recovery time after droughts, captures drought resilience ex post and mainly relates to spatial and temporal analysis using vegetation indices and weather/climate variables. The second indicator, soil moisture holding capacity, plays a key role in ecosystem recovery (Redmond et al. 2017, Yu et al. 2017). In this regard, the key soil characteristic relevant for ecosystem drought resilience is considered to be soil organic matter levels (Ifejika Speranza 2010, Osman 2012, Liu et al. 2013, Lal 2020), a fact that has been neglected in drought management strategies to date. This moves organic agriculture, which puts major emphasis on maintaining and increasing soil organic matter content, into the spotlight of drought risk mitigation strategies. The third indicator, biodiversity, is based on the tendency of ecosystems containing larger numbers of species to be more resilient or at least to exhibit higher levels of resistance in the short-term to climate extremes, including droughts (Isbell et al. 2015, Pretzsch et al. 2013). Soil moisture holding capacity and biodiversity could serve as ex ante indicators of ecosystem drought resilience.

| Indicator                              | Scales of analysis                                                         | Complexity           | References                                                                                               |
|----------------------------------------|----------------------------------------------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------|
| Ecosystem recovery time after droughts | Local, landscape, global                                                   | Moderate to advanced | Dorman et. al. 2015, Miranda et. al. 2020, Yu et.al. 2017, Na-U-Dom et. al., 2017, Brodrick et. al. 2019 |
| Soil moisture holding capacity         | Local (with soil sample analysis and modelling) to global (with modelling) | Moderate             | Jacobi et al. 2013                                                                                       |
| Biodiversity                           | Local                                                                      | Moderate             | Isbell et al. 2015                                                                                       |

fig. 19: Possible indicators for ecosystem resilience to drought (own)

### Social drought resilience

Compared to the work on drought vulnerability, the literature on drought resilience tends to focus more (though not exclusively) on the local level and on qualitative approaches. It thereby contributes to filling a gap identified in the work on vulnerability assessments above. Contextual details, for example, about people's livelihoods, socio-cultural characteristics, household composition, and resource access have received more attention than in vulnerability assessments. Table 3.3 lists some of those factors that deserve to be included in 'indicator libraries.'

| Factor / indicator                                                                                                                                                                                                                                          | Data types and sources                                                                                                        | References                                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| Proportion of people (gender-disaggregated) with secure rights to land, property, and natural resources. Possible indicators: (a) % of legally documented or recognized evidence of tenure, or (b) % who perceive their rights are recognized and protected | Quantitative and qualitative; Statistical agency, land registries, census data, household surveys                             | Fernald et al. 2015, Columbia Basin Trust 2014                |
| Presence of decentralized climate change, natural resource, or land use commissions, and of disaster and adaptation plans                                                                                                                                   | Quantitative and qualitative; Review of policies and reports, expert and community interviews                                 | Luh et al 2015, Columbia Basin Trust 2014                     |
| Stakeholder empowerment and degree of inclusion/autonomy in decision-making processes; Possible indicators: (gender-specific) inclusion and consensus, Number of consultation meetings and workshops, attendance of multiple stakeholders                   | Mainly qualitative; Interviews with community leaders, household surveys                                                      | Fernald et al. 2015, Arup ACCCRN 2014, TAMD 2014, BRACED 2013 |
| Ability to self-organize; Possible indicators: number and strength of grassroots networks, community, cooperative, or self-help groups in an area                                                                                                           | Qualitative and quantitative; Interviews with community leaders, local administrative registries, authorities, and households | FAO 2015, SHARP framework                                     |



| Factor / indicator                                                                                                                                                                                                                                                     | Data types and sources                                                                                                                          | References                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| Percentage of farmers with access to extension and advisory services; quality of these services; degree of collaboration with technical support institutions                                                                                                           | Qualitative and quantitative;<br>Interviews with local authorities, community leaders, or farmers;<br>Review of local budgets and plans         | FAO 2015, SHARP framework                                          |
| Local knowledge: presence of traditional and local forms of drought mitigation and adaptation mechanisms and practices                                                                                                                                                 | Qualitative;<br>Interviews and surveys with households, communities, and local leaders                                                          | Fernald et al. 2015, Twigg 2009                                    |
| Savings and ability to diversify income generation; Possible indicators: % of households/men/women having enough cash to meet their survival or livelihood protection threshold; #/% of able to stabilize/improve their net income by [kind of alternative livelihood] | Quantitative and qualitative;<br>Household surveys, focus groups, information from clusters or local government, secondary data, income records | Fernald et al. 2015, Columbia Basin Trust 2014, Livelihoods Centre |
| Availability and kind of adaptation technologies and innovations; Possible indicators: #/% of target population able to protect, replace, increase, or improve their productive assets above pre-disaster or baseline level through [...]                              | Quantitative and qualitative;<br>Clusters or government, expert interviews and focus groups, reference to a 'normal' or baseline situation      | Columbia Basin Trust 2014, Livelihoods Center                      |
| Connection/access to drought resistant acequia landscape, water reservoirs, and irrigation mechanisms                                                                                                                                                                  | Quantitative and spatial;<br>Land use land cover maps, government records, focus groups                                                         | Fernald et al. 2015, UNESCAP 2020                                  |
| Percentage and extent of crop insurance coverage within target area/population                                                                                                                                                                                         | Quantitative;<br>Reports from insurance providers, local authorities, farmer groups and associations, focus groups                              | Mohammed et al 2018, DFID 2014                                     |

*fig. 20: Selection of factors and indicators to measure social resilience to drought (own)*

### 3.3 Global UNCCD indicators and frameworks

To develop a basic global monitoring and assessment approach for comparable results across regions and to monitor trends, the UNCCD member states adopted by decision 11/COP.14 a tiered indicator and monitoring framework, including three indicators to report on drought hazard, drought exposure, and drought vulnerability:

- Level 1 Simple drought hazard indicator  
Trends in the proportion of land under drought over the total land area
- Level 2 Simple drought exposure indicator  
Trends in the proportion of the total population exposed to drought
- Level 3 Comprehensive drought vulnerability indicator  
Trends in the degree of drought vulnerability

The country Parties are requested to report on these three indicators for a baseline period of 2000 to 2015 and regularly every four years individually or in combination, as deemed appropriate to national and sub-national conditions and circumstances. Details and guidance are contained in the Good Practice Guidance for National Reporting on UNCCD Strategic Objective 3 (Barker 2021). This global reporting framework is intended to complement, not to replace national drought assessments. As drought vulnerability indicator (Level 3), Barker (2021) propose a composite of indicators grouped in three components:

- ‘Social component’: literacy rate, proportion of rural population, life expectancy, proportion of population aged 15-64, government effectiveness, and proportion of refugee population.
- ‘Economic component’: proportion of population below poverty line, GDP per capita, GDP share of agriculture, and energy consumption per capita.
- ‘Infrastructural component’: proportion of the population using safely managed drinking water services, total renewable water resources per capita, and proportion of cultivated area equipped with irrigation.

### 3.3 Guiding principles and recommendations

To support national and sub-national authorities and all other stakeholders engaged in drought management, UNCCD has developed a Drought Toolbox (<https://knowledge.unccd.int/drought-toolbox>). It comprises practical information, guidance, and training materials in the form of manuals, publications, case study material, decision trees, and video tutorials, as well as databases. The toolbox is organized in three modules: (1) Drought monitoring and early warning, (2) Drought vulnerability assessment, and (3) Drought risk mitigation. The breadth of materials contained in Module 2 ranges from drought impact databases and various monitoring and assessment guidelines to the Drought Risk Assessment Visualization Tool, comprising interactive global drought risk maps.

Figure 3.2 depicts how the process of a resilience or vulnerability assessment might look. It starts with the definition of the aims and scope of the assessment. They basically determine the breadth, scale, and approach (e.g. qualitative, quantitative, or mixed-methods) of the assessment. Following reviews of literature and other materials to gather existing knowledge on drought risk and all relevant contextual factors, a self-assessment of capacities and priorities in light of the scope of the assessment’s aims is useful. In case the available evidence allows, key factors determining vulnerability / resilience in the context of the study area can be identified and selection criteria and existing indicators chosen. Otherwise, additional assessments, for example in the form of qualitative interviews or focus groups with experts, community representatives, and other relevant stakeholders, or perception studies, may be conducted. Depending on the aims, scope, key factors and existing evidence, existing indicators may be chosen, or new indicators be developed.

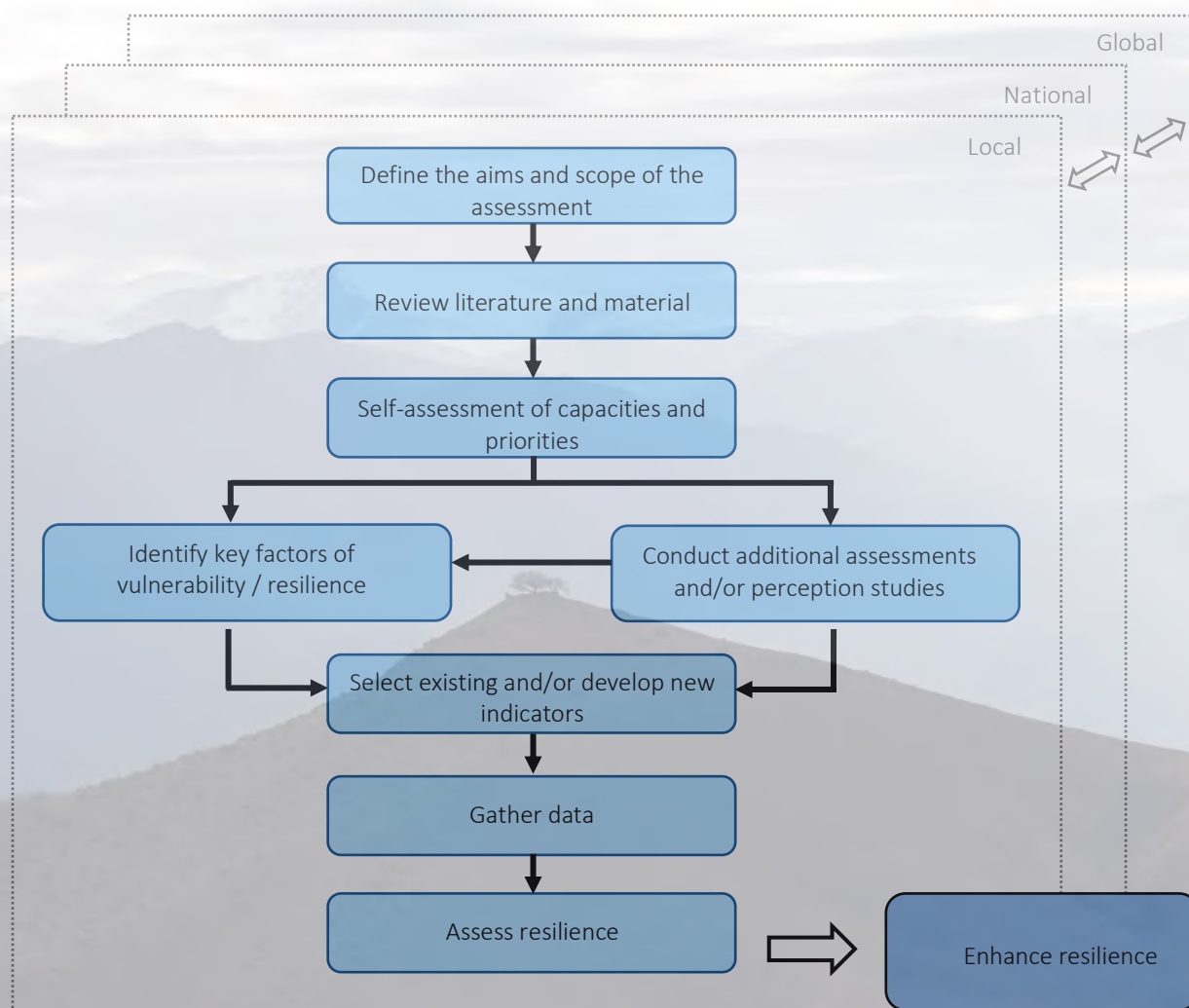


fig. 21: Workflow of a resilience or vulnerability assessment (own)

As the basis for effective drought risk mitigation policies, vulnerability and resilience assessments need to be conducted across and ideally integrate scales, from the local to the national (and the global).

For a thorough understanding of drought vulnerability and resilience, the local level is of key importance. Local-level assessments, including qualitative, open-ended approaches and involving local authorities and different social groups provide the necessary understanding of drought risk factors and impacts, disaggregated across social groups and within the real-world complexity on the ground. Such participatory, inductive local-level assessments are crucial also because they involve local actors in the process of developing proactive drought management policies from the beginning and foster awareness and initiative on the ground – where it as much needed as at the national level. Individuals and communities initiating drought risk management measures locally, from sustainable water use and storage to drought-resilient land management. Local associations, cooperatives, labour unions, NGOs and others can serve as organizational hubs and multipliers of such activities and connect them to government administrations (King-Okumu et al. 2021). This also helps to overcome common disconnections and discrepancies between national authorities' views and plans and the realities, challenges, and needs on the ground. It also helps to better represent the multifaceted determinants of



drought risk and the breadth of potential drought impacts and affected groups and actors across sectors and scales – an important requirement and challenge of vulnerability and resilience assessments.

The aggregated insight from local-level assessments feeds into vulnerability and resilience assessments for larger regions, from districts or sub-watersheds to watersheds and provinces, and for national-level assessments, which are needed for identifying priority areas. This linking of local and broader-scale assessments is crucial. It helps to avoid the common problem of quantitative, broader-scale analyses that mechanistically apply deductively selected sets of indicators that may not be a good reflection of the real drought risk factors on the ground. What is the value, for example, of a quantitative broader-scale analysis, based on indicators like meteorological parameters, average income scores, and the number of wells, when the most vulnerable population groups, whose characteristics have even not found their way into statistical data, have no access to water from these wells or have to buy it at inflated prices from wealthy well owners, whose drought-related income hikes statistically contribute to increasing income in the region?

In broader-level and quantitative analyses, variables and indicators have to be carefully identified and selected, ideally based on aggregated insight from local assessments. Thus, indicators must not be understood as a ‘plug-and-play’ methodology but rather as a way of quantifying, monitoring, and spatializing factual evidence gathered beforehand and, if well-designed, as a tool to monitor and evaluate the effects of drought risk mitigation strategies. The pitfalls of selecting the wrong indicators based on inaccurate assumptions for any given context include the creation of unintended consequences and counterproductive incentives (Hallegatte & Engle 2019).

The checklist adapted from Spearman & McGray (2011, adapted from CIDA 2004) may support indicator selection – the more (ideally all) of these questions are answered with ‘yes,’ the better an indicator may be suited:

- Validity: Does the indicator measure a change in drought resilience or vulnerability?
- Precise meaning: Do stakeholders agree on exactly what the indicator measures in this context?
- Practical, affordable, and simple: Are the required data available or reasonable to gather?
- Reliability: Can the indicator be consistently measured against the drought resilience baseline over the short-, medium-, and long-term?
- Sensitivity: When drought vulnerability or resilience change, is the indicator susceptible to those changes?
- Clear direction: Are we sure whether a change in the indicator value is positive or negative, for whom and for which dimensions?
- Utility: Will the information collected be useful for drought management and foster accountability and learning?
- Owned: Do stakeholders agree that this indicator makes sense for describing resilience?

The breadth of ecological and societal factors, of impacted sectors, and of the kinds of information to be considered in holistic assessments, calls for multi-disciplinary teams with interdisciplinary leadership.

Finally, the results of drought vulnerability and resilience assessments must be used to identify priority areas, spatially and actor-specific, to inform the selection of drought monitoring indicators and triggers, and to develop and improve drought risk mitigation strategies and early warning systems across political levels, from the local to the national, and internationally.

Drought early warning systems “aim to track, assess and deliver relevant information concerning climatic, hydrologic and water supply conditions and trends [...] to provide timely information in advance of, or during, the early onset of drought to prompt action (via threshold triggers) within a drought risk management plan as a means of reducing potential impacts” (WMO & GWP 2016). Timely, clear, and reliable communication to all relevant authorities, stakeholders, and population groups is crucial. The global spread of digital communication technologies, social media, and mobile phones facilitates the broad, timely, and cost-effective spreading of drought warnings.

Based on the stocktake of present practices and challenges and the synthesis and discussion of frameworks, indicators, and guiding principles above, the following options and recommendations appear as a priority:

#### Conceptual

- Further develop flexible conceptual frameworks of drought vulnerability and resilience
- Foster improved and more holistic understanding of drought vulnerability and resilience factors across scales, sectors, and actor-groups
- Foster the knowledge of and the integration of political-economic factors in drought vulnerability and resilience frameworks
- Foster work for an enhanced understanding of ecosystem resilience and of the roles of ecological factors and processes for social drought resilience

#### Capacity

- Disseminate knowledge and strengthen interdisciplinary human capacities for vulnerability and resilience assessments
- Strengthen human, institutional, and technical capacities for drought monitoring and early warning systems

## Policy and practice

- Promote participatory and actor-oriented vulnerability and resilience assessments bottom-up, from the local level across scales to the national, regional (and global)
- Promote the integration of open-ended qualitative methods and quantitative methods
- Promote multi-sectoral, interdisciplinary assessment approaches
- Promote the integration of ecological factors and processes in vulnerability and resilience assessments and corresponding mitigation strategies
- Link participatory assessments with drought mitigation strategies and policies across levels, from the local to the national
- Strengthen dissemination and response mechanisms of early warning systems





## CHAPTER 4

### *Options & recommendations: Policies and communications*

Drought is one of the most complex of human-amplified risks today. The lack of progress in drought preparedness planning and the development of national drought policies is partially a reflection of this complexity, but it is also a sign and *alarming* signal that we haven't fully comprehended the wide array of systems effected by human-aggravated drought impacts.

The amount of drought-induced damage is increasing worldwide. Therefore, there is an urgent need to move from crisis management to drought risk reduction policies. Managing drought needs to be reconceptualized in the light of the climate crisis, of which the upsurge in droughts is one of the severest symptoms (Crossman, 2018; Duguma et al, 2017; Tsegai & Brüntrup, 2019)

In this following chapter, the term “policy” is used in a broad sense here to refer to governance body decisions, leading to the formulations of laws, the creation of institutions or agencies, or the development of strategic plans, regulations, or guidelines. The following chapter reviews and proposes policy instruments from a global to a regional, national and sub-national level, with special attention on one crucial policy planning instrument, called the national drought plan.

The chapter also analyzes and highlights the role of policies regarding communication, education, and media as part of a holistic management framework prior, during, and after a drought period.

#### 4.1 Global mandates and frameworks

Given that impact areas of a drought reaching across socio-ecological zones, industries, and governance fields, related drought risk management policies are similarly heterogeneous (Costa, 2020; HDMP, 2013 Hurlbert & Gupta, 2016; Jedd et al, 2021). The following figure gives an overview of institutions, stakeholders, and frame-setting conditions involved in policy formulations.

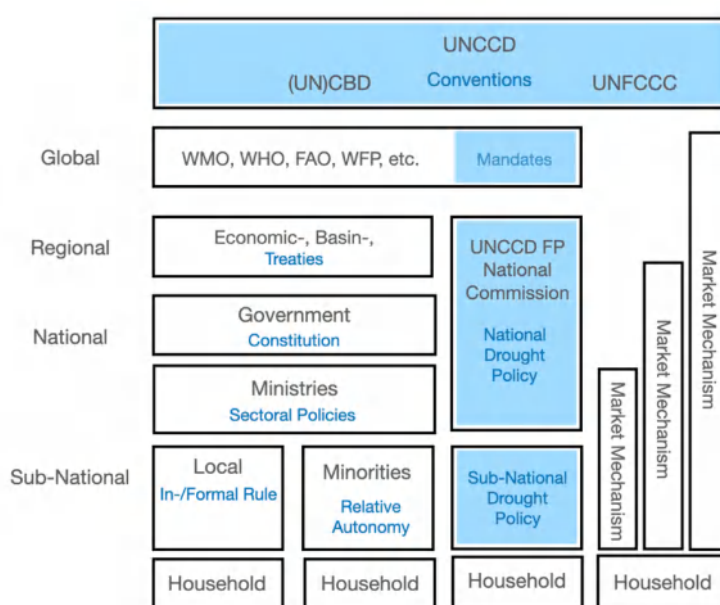


fig. 22: Policies and institutions related to DRM (own/based on Brüntrup)

Even though the Rio Conventions stretch across all scales, this does not necessarily equate to a higher form of governmentality, per se. The lack or total absence of non-binding mechanisms within these conventions limits their role and effectiveness.

As for UNCCD, the latter is currently the case. The convention text contains five annexes, each concerned with one world region (Africa, Asia, Latin America and the Caribbean, Northern Mediterranean, and Central and Eastern Europe)<sup>1</sup>. Implementation is organized around these five geographical regions, setting the focus of regional and subregional programs. These action programs provide a framework for regional coordination and collaboration. Though the country Parties of the regions together define how the UNCCD will be implemented, most action takes place at the national level.

At global level, UNCCD is the most legitimized institution to comprehensively deal with drought issues, but the secretariat is surrounded by other global players. Up until now, there exists a range of different drought risk management (DRM) initiatives at an international level, including those of the UNCCD, along with the two other Rio Conventions, (UN)CBD and UNFCCC, as well as the following UN organizations: WMO, FAO, UNDRR, WFP plus IFAD, IMF, (WBG), IOM and WMO.

UNCCD's status and more recent developments include a general mandate for DRM, the drought initiative with the drought toolbox, and various activities in support of DRM of member states, all combining into a first step towards global drought monitoring and several other decisions concerning drought.

However, this was deemed insufficient by its members and hence the "decision 23/COP.14 established an Intergovernmental Working Group (IWG) on effective policy and implementation measures for addressing drought under the UNCCD" (IWG Interim Report, 2021). Options of how to design policies and legal instruments through a strengthened mandate of UNCCD are outlined in the graph below, including coordination and implementation frameworks ranked according to levels of ambition. These rankings are the result of a discussion process within the IWG, several rounds of revision, and a final consensus-finding mechanism. The majority of the IWG members (XY%) recommends implementing those actions outlined under the highest level of ambition.

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<sup>1</sup> List of countries currently not belonging to a regional implementation annex: Andorra, Austria, Belgium, Brunei Darussalam, Canada, Czechia, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Japan, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Rep. of Korea, San Marino, Sweden, Switzerland, United Kingdom of Great Britain and Northern Ireland, United States of America.



|                        | least ambitious                                                                              | moderately ambitious                                                                                                                                                              | ambitious                                                                                                                               |
|------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Coordination Framework | - expand the Drought Toolbox into an interactive exchange and communication tool             | - arrange seed funding to develop national DRM policies                                                                                                                           | - arrange funding streams for national focal points and risk coordination centres                                                       |
| Policy Level           | - review national DRM policies                                                               | - evaluate DRM policy impacts<br>- devise, underpin, coordinate data provision and other cooperation with the private sector                                                      | - establish a binding agreement (amendment, annex or protocol) to develop national drought plans and to measure effectiveness           |
| Institutional Level    | - develop and disseminate comprehensive DRM strategies for other international organisations | - establish a leading role for the UNCCD in coordinating international organisation drought policies<br>- support or organise advice for integrated funding strategies of parties | - establish acceptance of UNCCD evaluation schemes for international organisation drought policies<br>- establishing a binding protocol |
| Advocacy Level         | - creating a competence centre under the UNCCD                                               | - create regional competence centre under the UNCCD                                                                                                                               | - create national inter-sectorial competence centers                                                                                    |
| Communication Level    | - provide good practise examples and guidelines                                              | - evaluate communication protocols<br>- evaluate educational curricula                                                                                                            | - evaluate communication protocols of risk management centres according to established standards                                        |
| Obligation Level       | voluntarily                                                                                  | unenforceable                                                                                                                                                                     | legally binding                                                                                                                         |

fig. 23: DRM-related adjustments on the UNCCD mandate/global governance levels (own)

## 4.2 National drought plans and recommendations

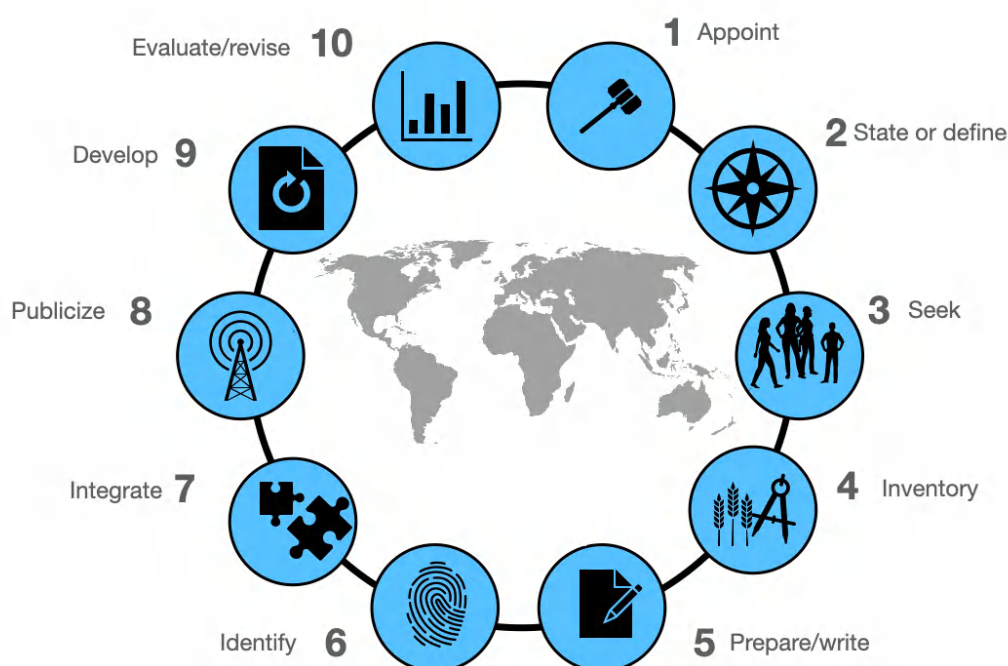
Because drought is a complex phenomenon that is temporally and spatially diffused, therefore requiring multiple temporal-spatial measures on different scales, no single global policy adjustment or sectoral approach can achieve substantial drought risk reduction on its own. Therefore, reducing drought risk requires a multi-pronged approach and supporting policy framework, especially on the national level. This is where the bulk of the policies are anchored, management frameworks are laid out, specialized responsibilities are assigned, and vertical and horizontal coordination mechanisms are formulated (Brüntrup, 2019; Global Water Partnership, 2020; Grobicki).

Early reviews identify a number of national challenges such as inadequate inter-sectoral and inter-ministerial coordination mechanisms; insufficient data; challenges of communicating DEWS information; and inconsistent application of the three-pillar approach, to name the most prominent ones (Bedran-Martins & Lemons, 2017; Gies et al, 2014; Mapedza, 2019; Müller & Kruse, 2021).

National-level policy formulation, coordination, and implementation can be strengthened through national commitments to global policy standards and reporting processes to track implementation, and also through regional and global partnerships to support these (Wilhite et al, 2014; Sivakumar et al, 2014). To some extent, the UNCCD reporting process already offers countries a systematic global protocol for bi-annual national inventory.

To address the most fundamental land-based levels of dysfunction, the Bonn Challenge was initiated (amongst other regional efforts such as AFR-100, ECCA30, the GGW, or Initiative 20x20), setting restoration goals for nation states, which in turn proactively rehydrates landscapes. By re-establishing a permanent vegetative cover, rainwater infiltration, storage, and conversion into biomass is enabled, which in turn re-builds functional hydrological cycles. Depending on the size and scope of such restoration interventions, this can rebuild microclimatic conditions as well as a trans-regional hydrological regimes, eventually leading to a globally measurable reversion of negative trends (Aronson et al, 2020).

In order to transparently define and plan these fundamental – or any other proactive or reactive – measures, a National Drought Plan has proven to be the central policy instrument (Stone, 2014; Wilhite et al, 2014; Wendt et al, 2021). The process of how to establish such a legally-binding document is shown in the diagram below. Its overall intent is to move from reactive to prospective measures, taking into consideration local and regional differences in terms of socio-ecological conditions as well as legislative frameworks. It provides a dynamic framework that evolves over time, including periodic reviews of achievements and priorities.



*fig. 24: Drought policy preparedness process*  
(own/based on: IDMP, 2014; Wilhite et al, 1999; Wilhite 2011)

The process of developing such a holistic policy framework on a national level starts with the following steps (IDMP, 2014):

1. The appointment of a national drought policy commission, which in turn has to
2. State and define the objectives of risk-based management approaches, including
3. Consultation with key stakeholders within the water use sector as well as beyond, including forestry, energy, finance, etc.
4. An inventory of financial resources and groups of risks is taken
5. The key tenets of the plan are spelled out, following a three-pillar approach
6. Institutional needs and research gaps and are to be identified, and
7. The science and policy interface must be integrated
8. Public awareness must be created, followed by a debate and consensus-finding process; at this point, earlier steps of stakeholder engagement and conflict resolution might need to be repeated
9. Education campaigns for all citizen groups and stakeholders must developed, spreading awareness enabling participation processes
10. Regular evaluation and revision of policy plans compose the final stage

The following guideline recommendations for a National Drought Plan are based on the Drought Resilience, Adaptation and Management Policy (DRAMP) Framework as developed by UNCCD, as well as the task group of the Intergovernmental Working Group on Drought, and a literature review of those sources listed in the annex.



#### Proactive long-term measures:

- Implement the 10-step process to develop a National Drought Plan
- Apply UNCCD's Drought Toolbox
- Create a preventive, long-term risk management culture supported by drought prevention, mitigation, and adaptation strategies
- Take an integrated, trans-boundary, participatory, and gender-sensitive approach to water management
- Design and implement intelligent, risk-reducing financial strategies that finance relief, reconstruction, and livelihood recovery – such as micro-insurance, insurance, and reinsurance, along with national, regional, and global risk pools;
- Move away from short-term reactionary, crisis, post-impact drought policy and a culture of dependency on government and donor drought hardship payments
- Create enabling policies for holistic watershed restoration mechanisms
- Reward preventive measures and remove perverse incentives
- Incorporate local and Indigenous knowledge on drought characteristics, impacts and risks wherever feasible
- Create competence centers
- Create policy frameworks to enshrine LDN as a national development priority in support of SLM practices
- Develop comprehensive public awareness and education strategies and plans to effectively promote and communicate drought issues with all stakeholders

#### Drought preparedness measures:

- Build multi-sectoral, interdisciplinary, inter-country, and regional-scale collaborations at each stage in the drought monitoring and early warning process
- Empower government institutions to assume coordinated and strategic leadership and implement drought risk management policies
- Take a multi-hazard approach to drought by aligning drought policy with other disaster risk management policies
- Improve communication and information-sharing processes to increase awareness of risks associated with drought.
- Develop weather index insurance and safety nets
- Anticipate and communicate drought risk

#### Response measures:

- Implement pre-defined threshold measures, including emergency trade regulations
- Mobilize financial resources for emergency relief measures
- Design “build back better” approaches based on the assessed damage
- Assess managerial mistakes and enable investigative journalism and scientific studies
- Prosecute and trial those in power who are responsible for avoidable losses, including human lives
- Transparently communicate and exchange the lessons learned

The following chart gives an overview of National Drought Plans, agencies, and strategy plans, in order to create a better understanding of the possible and desirable succession of legal frameworks. Individual member states of the UNCCD are at different stages along the scale, reaching from nascent to engaged, and from capable to effective.

| Dimensions      | Nascent                                                                               | Engaged                                                                                                                                                                                                                                | Capable                                                                                                                                                 | Effective                                                                                                                                                                                                                                           |
|-----------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Legal Framework | No specific legal framework on drought is in place. No drought law or policy adopted. | The government and its various ministries/sectors recognise the need for a legal framework and regulations. The creation of meteorological laws has started. No drought law is in place, but sector laws incorporate drought mandates. | Regulations for the provision of meteorological services is established. National drought law are formulated and adopted. Law adopted.                  | Well-established drought law or policy with evolutionary amendments are in place. Meteorological law has been adopted, defining roles and responsibilities of various actors. Regulations related to the provision of services follow from the law. |
| Agencies        | No drought committee is in place.                                                     | Ad hoc drought coordination committees convene during drought events.                                                                                                                                                                  | Multi-disciplinary and multi-sectorial drought committee is established.                                                                                | A drought committee is functioning well, with effective working groups, interagency cooperation and an institutionalised science-policy interface.                                                                                                  |
| Strategic Plan  | No strategic plan is in place.                                                        | Drought emergency response plans are only in place.                                                                                                                                                                                    | Basic drought preparedness and response plan are in place but primary focus is on monitoring and response. Limited coordination and low implementation. | Comprehensive and adaptive management plan covering all sectors and drought phases are in place. High levels of effectiveness and implementation rates are confirmed through an independent evaluation committee.                                   |

fig. 25: Evolution of the DRM Sector Framework (own/based on Browder et al, 2021)

### 4.3 Local platforms and expertise

In accordance with the principle of subsidiarity, which states that policy issues should be dealt with at the most immediate (or local) level consistent with their resolution, local mechanisms and platforms are paramount, regarding all levels of holistic drought risk management. Therefore, adaptation of drought resilient practices is most often implemented at the household and community level (GWP, 2015; Tsegai & Brüntrup, 2019). This is also true for many national policies that need local implementation, taking into account that the term “local” can only be understood as a placeholder for the many governance forms – be they formal or informal – that stretch from the national down to the household level.

It is crucial to provide an enabling policy environment that anchors early warning agencies on the ground while connecting them with the national centers that receive information from various scales, including regional and global. Furthermore, any land-based interventions, be they forest restoration, SLM, or holistic watershed rehabilitation, must receive the necessary policy support to be conducted in a decentralized manner that’s appropriate to scale of the endeavor and harvest local expertise, creating ownership and acceptance. Local expertise is also a precious resource for the various forms of vulnerability assessment to ensure that water, tenure, and usage rights are negotiated in the most inclusive manner with all those affected by change (Crossmann, 2018).

In addition, there is a need for policies that cover the range of various financial instruments, including insurance schemes and microfinance, supporting capital and asset building as well as income diversification.

After a drought hazard has become a disaster, it is at the local level where emergency schemes are rolled out, asking for local administrative structure to take a crucial role, be it in identifying affected households or by coordinating emergency monetary transfers and insurances schemes. Policy must be in place prior to a drought to ensure and control such operations.

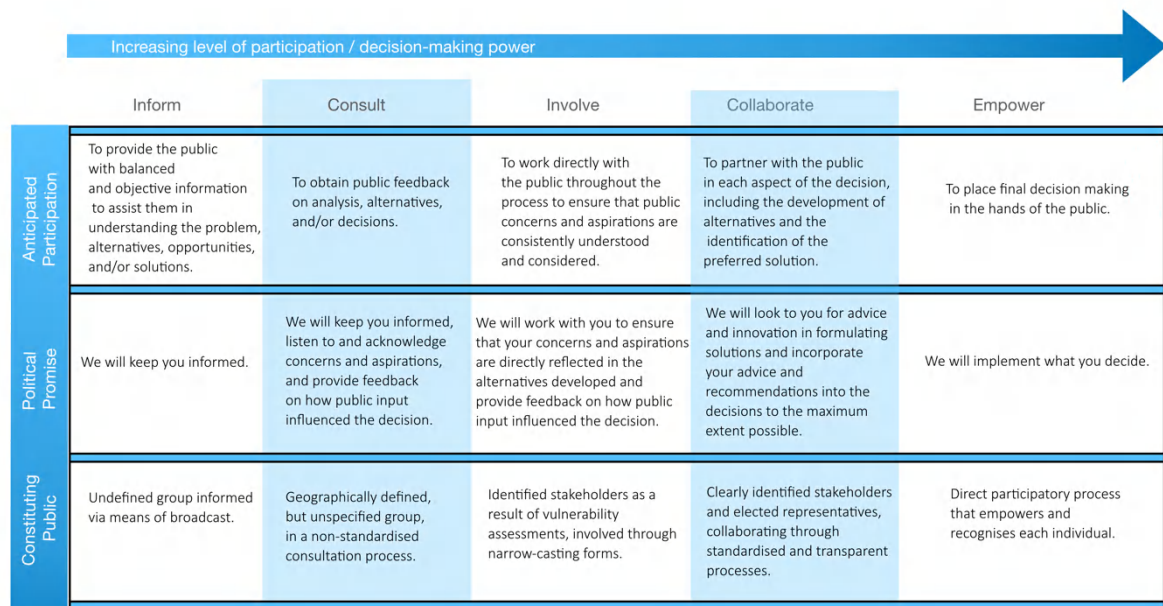


fig. 26: Spectrum of participation and understandings of what forms the public  
(own/based on Browder et al, 2021)

The graph above shows the various degrees of public participation that can be achieved on a local level, as well as different conceptualization modes of what “public” means and entails.

#### 4.4 Knowledge platforms, media and recommendations

When changes in an area's weather are deemed as "drought," this is a social act. Drought is a relative term, set by a human standard. This earlier stated circumstance is complicated further by various perceptions of media-transmitted realities. The various forms of modern communication are pre-conditioned through different levels of education, spheres of knowledge, and diverse interest, leading to different levels of sensitization (or ignorance) and awareness about risks (Toussaint, 2020).

It seems self-evident that policies are in place to disseminate information about hazards that are rapid-onset disasters, such as an earthquake or a tsunami. The same doesn't seem to be true for the most economically devastating but slowly onsetting one, drought. However, when it comes to the topic of saving water during a drought, evidence from various countries suggests that there is a correlation between media coverage and personal behavior, even before strict rationalization might be imposed (IDMP, 2019, 17). Yet, other research also suggests that commercially oriented mediascapes adhere to a different logic than does independent public broadcasting in terms of knowledge/content creation, alerts, and social responsibility, suggesting that crucial information dissemination and content programming cannot be left to market forces alone but requires regulations and state policies. Research on the California drought, e.g., suggests that an increase of about 100 drought stories over two months was associated with a reduction of 11 to 18% in typical household water-use. State-independent public broadcasters covered most of the programming (Quesnel & Ajami 2017).

To improve public engagement with water usage and other pro-socio-ecological behaviors prior to and during a drought, the IWG calls for holistic communication policies that adopt an evidence-based



approach, informed by empirical research. The following options are based on the finding of IWG's task group, literature research, and the findings of a five-year interdisciplinary research project called DRY – *Drought Risk and You*, which explored the interface between narrative construction and science to better support multi-stakeholder decision-making processes, including policies (IDMP, 2019; Liang et al. 2018; Weitkamp et al, 2021).

The described interface involves the National Drought Planning Committee, as well as training and education facilities and media agencies.

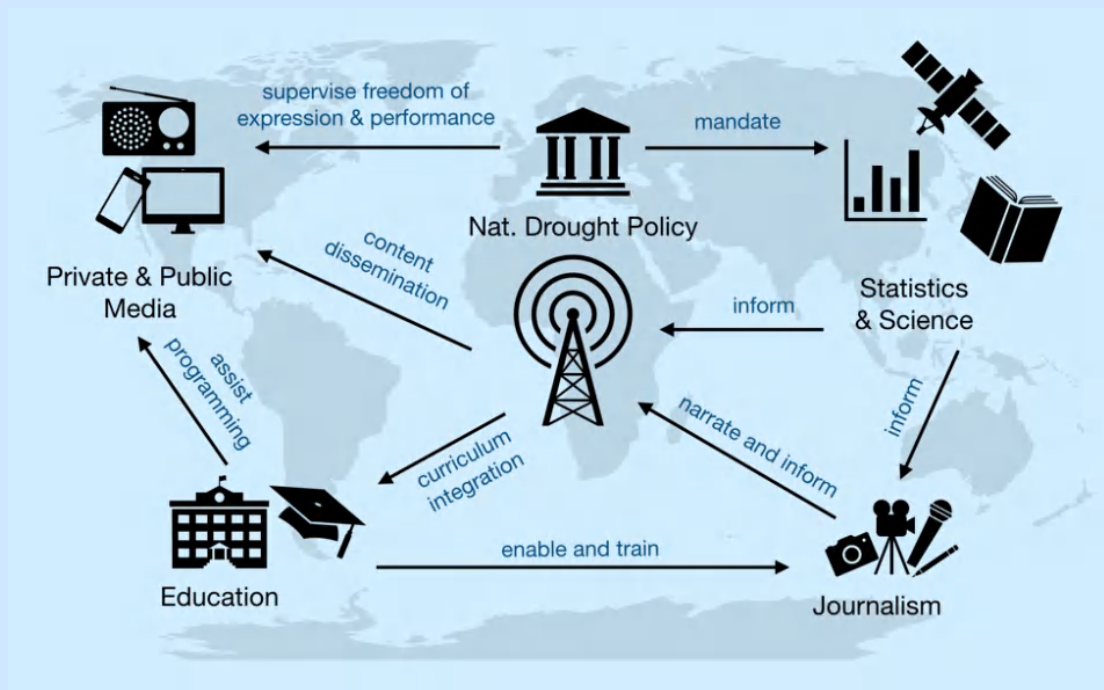


fig. 27: National Drought Policy, media and education (own)

#### Recommendations on a policy level:

- Institutionalized forms of drought management need to include capacity-building for media communication.
- Sectorial experts (be it a water specialist, an agronomist or others) are to be obliged to present factual information in straightforward manners to stimulate uptake by media and the public.
- Policies that protect free and investigative journalism are crucial for fact-finding missions on the socio-political and resource justice dimensions of a drought as well as for knowledge dissemination.
- Holistic drought management needs to be embedded at various educational curricula, including that of media/journalism schools.

#### INFOBOX: Recommendations on a narrative level:

- People are more aware of climate change than drought; linking the two closes a causal link and increases media traction.
- Timing of news dissemination is crucial (with attention to the hydrological cycle, see glossary).
- Perceptions about drought are shaped by past events. Therefore, it is important to relate to existing (local) experiences or trans-local similarities.
- Different audiences have the need for different information. Therefore, different content formats are needed, focusing on agriculturalists, urban dwellers, or others
- Media coverage of a drought benefits from beginning with what is known rather than identifying the unknowns and parts of prediction models.
- Clear and simple messaging is needed (e.g., when explaining to affected people that restrictions remain in place even if rains have started).
- Narratives are needed that show costs-benefit ratios, tied to the SDGs.
- The dissemination and exchange of experiences, good practices, and lessons learned is crucial.
- The World Day to Combat Desertification (or similar occasions) can be utilized to generate highly visible events.
- Informing people about options of proactive actions should take priority over sensationalizing.



## CHAPTER 5

### *Options & recommendations: Finance sources and mechanisms*



Commitment and financial resources for proactive drought management have been limited. The common approach has mostly been reactive: waiting until drought reaches a crisis state and then providing immediate relief to impacted sectors and individuals. The human, social, ecological, and economic costs of this approach are high and set to continue to rise under climate change. To save lives and prevent the costs from rising, drought management and financing must move from reactive emergency response to a proactive approach. Investments into drought mitigation and preparedness can reduce the costs of drought and provide substantial co-benefits. However, inadequate financing is a major barrier to moving from a reactive to a proactive approach (UNCCD 2020). Raising funds when a drought reaches the crisis stage is often easier than mobilizing resources for mitigation and preparedness in advance.

To move to a proactive approach to drought management and to spread the burden of risks, countries need to creatively tap and combine different finance sources and instruments. A drought finance strategy, developed as part of a national drought plan, defines the mix of financial instruments needed by governments, households, and the economy to mitigate and manage drought risk, and it ensures these financial instruments are available when needed. It arranges in advance which and whose drought costs are covered, in what way, and by whom, in turn ensuring coordinated, predictable disaster response instead of fragmented, ad-hoc crisis action, shaped by politics and donors (Sainath 1996, Clarke & Dercon 2016).

The first section of this chapter discusses the business case for proactive drought management. It sheds light on the increasing costs of drought and presents findings supporting the argument that the costs of proactive drought management action are lower than the costs of inaction. It also points to the substantial co-benefits of drought mitigation. The next section briefly documents the limited financing for ex ante disaster risk reduction and sketches the need for countries to creatively tap and combine new resources. The following three sections present a comprehensive toolbox of finance sources and instruments that deserve consideration as components of a national drought management strategy, showing how governments and drought management bodies can and should combine a range of instruments from this toolbox to best fit to their needs and circumstances, using a risk layering approach. The chapter closes with key questions to keep in mind when developing drought finance strategies as well as a set of recommendations.

## 5.1 The business case for proactive drought management

In addition to the inherent value of the lives, livelihoods, and ecosystems saved, there is a strong business case for political and financial investment into proactive drought management. The cost of responding once agricultural and socioeconomic drought has triggered a crisis is likely to be higher than the cost of investing in measures to mitigate drought risks on the front-end, provided that these measures are in line with sustainability principles. The latter does not comply, for example, to the construction of irrigation infrastructure and wells extracting water resources unsustainably.

Drought has been the deadliest of all natural hazards, killing over 2 million people since the 1960s and affecting an average of 46 million people every year (IFRC 2020). The full cost of droughts globally is not known. Compared to other natural hazards, like floods, storms, or earthquakes, droughts often unfold silently and slowly, affect large, spatially diffuse areas, and

have multifaceted impacts across sectors for longer periods of time, while they cause little suddenly visible physical damage. This impedes political action and causes the costs of droughts to be underreported and difficult to quantify (Wilhite 2000, Ding et al. 2011, Naumann et al. 2021). Thus, data on drought costs does not exist for large parts of the world and is highly variable for others.

Drought losses for the EU and U.K. have been estimated to grow from EUR 9 billion to 31 billion per year at 2°C global warming level, and to EUR 65 billion per year at 4°C global warming level (Naumann et al. 2021). The many indirect and longer-term costs of droughts are not included in such assessments (García-León et al. 2021, Naumann et al. 2021). In the U.S., the 28 most cost-intensive droughts (with damages over USD 1 billion) between 1980 and 2020 caused an estimated USD 268 billion in total inflation-adjusted costs (NOAA 2021). For the Global South, which is particularly vulnerable to drought impacts, data is scarce, and longer-term impacts are more pronounced. Food insecurity has long-term impacts on human health and human capital development. A single drought reduces growth of the agricultural sector by three percentage points over the following five years, as a review of nearly 50 years of economic data has shown (Loayza 2009).

With the massive human, social, and economic costs of drought, even reactive measures can have returns on investment. Yet, crisis management usually fails to reduce vulnerability, and drought relief may even incentivize activities vulnerable to drought (Raschky & Weck-Hannemann 2007, Cohen & Werker, 2008, WMO & GWP 2017). Hence, the business case for a proactive approach, with ex ante measures to mitigate and prepare for drought, is stronger. It has been estimated that USD 1 of federal U.S. government grants for mitigation and preparedness across other natural hazards results in USD 6 in cost savings (Multi-Hazard Mitigation Council 2019). Another estimate for the U.S. by Healy and Malhotra (2009) noted that a USD 1 increase in disaster preparedness spending reduced future disaster damage by about USD 15. Investments to bring hydro-meteorological capacities and early warning systems in developing countries to levels similar to those in high-income countries is estimated to yield annual benefits of USD 4 to 36 billion, with benefit-cost ratios between 4 and 35 (Hallegatte 2012). A study of drought impacts in Iran quantified the direct costs of a major drought at USD 1.6 billion, equivalent to 30.3% of the total value added by the cropping sector. Mitigation through water-efficient technologies, saving 10% of the water input, could reduce drought costs by 17.5% or USD 282 million (Salami et al. 2009). There are ongoing efforts to provide more data on the benefits of investing in proactive drought management and the costs of inaction (WMO & GWP 2017, Venton et al. 2019).

Many drought risk mitigation measures not only lower drought costs and drought relief costs; they also have substantial additional social, economic, and environmental co-benefits. For example, rehabilitating degraded lands and enhancing tenure security may improve dry season water flows and ground water levels, increase agricultural yields and rural incomes, and thereby both mitigate drought risk and enhance livelihoods and ecosystems.

#### *Limited financing for ex ante disaster risk reduction*

Despite the business case for proactive drought management, financing for disaster risk reduction in the most drought-affected regions has been limited. While comprehensive data on respective national funds is lacking, an analysis of international development assistance

funds draws a revealing picture. Of the total of USD 3 trillion of international development funds committed between 1991 and 2010, USD 106.7 billion was allocated to disasters. Of those USD 106.7 billion, 65.5% was for disaster response, 21.8% was for reconstruction and rehabilitation, and only 12.7% (0.4% of the total amount of development funds) was for ex ante disaster risk reduction (Kellet & Caravani 2013). A large proportion of the funds were for sudden-onset disasters and concentrated in a small number of middle-income countries, while development assistance for drought mitigation was miniscule. Among the 10 countries with the highest proportion of their population affected by drought – all of which are low-income sub-Saharan African countries with very low levels of government revenue – international disaster risk reduction funds for all natural hazards, of which drought is only one component, were only between USD .04 and 4.68 per person per year (Kellet & Caravani 2013).

There is certainly a need to raise the profile of drought and proactive disaster risk reduction within international development assistance. Yet, limited international funds are and will continue to be confined to a few spots and projects only, and development assistance is a decreasing portion of many developing countries' budgets. Thus, governments must think creatively on how to reorient existing funds and use their domestic resources and other financial mechanisms for proactive drought management.

## 5.2 Drought finance sources and instruments

Drought finance spans multiple types of finance and focuses on how governments, households, and the private sector acquire and use financial resources to invest in assets and transfer risk to mitigate, prepare, respond to, and recover from drought.

### *Government funding, credit, savings, and insurance*

Government funding, which is mainly based on taxes, user fees, and transfers, usually covers regular drought management measures, such as operational expenses for early warning systems or training on drought-resistant crops to farmers. Fiscal year government funding may also cover emergency expenses, such as food aid programs or cash transfers for farmers, especially in case of minor drought events.

By contrast, the cost of larger capital investments, such as the deployment of a national network of hydrometeorological sensors or expansion of irrigation canals, is typically spread across multiple fiscal years through government borrowing, also referred to as financing. Credits to fund drought investments or emergency response in the present impacts the future. To justify borrowing, the future benefits from a drought mitigation investment should be greater than the future costs of paying back the loan.

In addition to credit, savings can also be used to pay for drought mitigation, response, and recovery. Government savings, in the form of contingency budgets or disaster reserves held over multiple fiscal years, provide a way for governments to set aside current funding in case it is needed in the future. Households generally save in either one of two ways: formally through savings accounts in financial institutions such as banks or credit unions; or informally, either in the form of tangible property, cash, or informal group savings cooperatives. Like borrowing,



saving has an opportunity cost as well. The money set aside for the future could have been used for another, potentially more productive purpose in the present. A key barrier to effective savings is limited fiscal discipline – the temptation to spend the funds in the present for other purposes, rather than keeping them in reserve for when they are needed, a concept referred to in behavioral economics as time inconsistent preferences. The slow-moving and less immediately dramatic nature of drought make it even more difficult to save and allocate funding than for other natural disasters. To avoid the risk of funding being diverted for other purposes, drought reserve funds should have clear and ideally objective measures for determining when they can be tapped, as well as a strong legal structure to ensure these measures are followed.

The costs of drought recovery can also be managed through insurance programs that share and transfer risk. Insurance also incurs costs in the present in the form of premiums, which are typically paid through current funding. As insurance payouts are made available once a disaster occurs, they are typically used to fund response and recovery efforts.

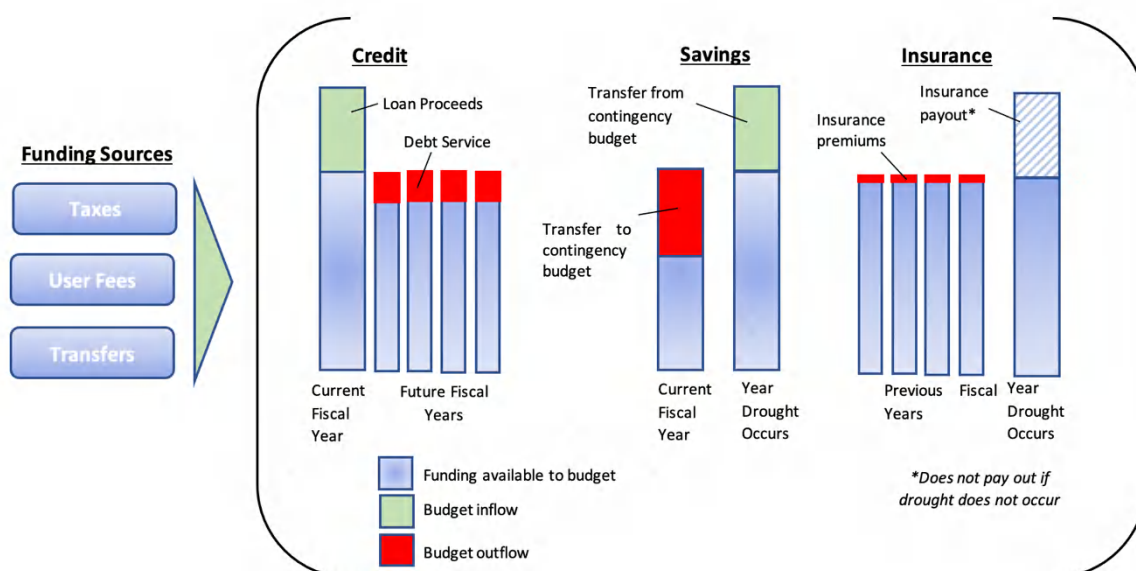


fig. 28: Links between government funding, credit, savings, and insurance (TG Report 3)

Borrowing, saving, and insuring each offer benefits and trade-offs, and all three can be part of an effective approach to drought finance. Balancing these trade-offs and securing resources for drought management is part of a drought finance strategy. A drought finance strategy can build on a broad range of financial sources and instruments. It should carefully consider the varying potentials, advantages, and disadvantages of the various sources and instruments in the light of the specific drought management measures to be implemented, the levels and scales of implementation, and the specific national and local social-political contexts, needs, and actor constellations. The next section presents an overview of major building blocks of drought finance and the broad range of sources and instruments that deserve consideration. Drawing on these building blocks and the menu of finance sources and instruments, national drought coordinating bodies can use a risk layering approach to develop a drought finance strategy that addresses all pillars of the drought management cycle. This approach and the way of

incorporating a finance strategy into national drought plans will be presented in Sections 5.4 and 5.5.

### *Sources and instruments of drought finance*

Drought finance spans multiple types of finance, echoing the complex and cross-sectoral nature of drought. While disaster risk financing has been the core framing for drought finance, other types of finance can serve as useful building blocks to provide financial instruments and sources of financing, particularly for proactive drought management:

*Climate adaptation finance* has become an important resource for drought finance strategy. It is a focus of the Green Climate Fund, the Adaptation Fund, The Global Environment Facility's Least Developed Countries Fund, and development banks, all of which provide grants, loans, guarantees, equity investments, and other instruments. To access climate finance, drought planning should be closely linked to National Adaptation Plans (NAP) and Nationally Determined Contributions (NDC) to incorporate drought mitigation into the country's climate strategy.

*Agricultural finance* is another important component of a proactive drought management strategy, as the agricultural sector is particularly vulnerable to drought risks. Agricultural finance comprises a diverse range of instruments, including loans and credits tailored to farmers' needs.

*Infrastructure finance* for drought management may support, for example, investments in water supply, water storage, and irrigation infrastructure. Investments in land restoration and rehabilitation may also fall under the category of infrastructure finance, though it is less common.

Payments for Environmental Services (PES) have been enthusiastically promoted as a way to incentivize changes in land and resource uses deemed to have positive environmental effects. Notwithstanding their potential, they are no panacea and pose risks, such as leakage and crowding out intrinsic motivation (Engel & Muller 2016, Jack & Cardona Santos 2017, Ezzine-de-Blas et al. 2019). PES in drought risk management have received limited attention, and their scope with environmental service 'buyers' in their classical sense appears rather limited. Yet, publicly funded rewards, for example, in form of food, cash, or resource use rights, for land restoration, digging wells, constructing bunds, and other activities have a potential for drought risk mitigation (Okumu et al. 2021).

*Financial inclusion* provides vulnerable households and businesses with tools to manage risk, such as microinsurance linked to rainfall for farmers and savings accounts for them to self-insure, or ways to invest in resilience, such as through microfinance programs. It also includes remittances, which can support both drought mitigation and response. Financial inclusion also directs attention to gender impacts, for them to be considered in exploring drought finance options at the household level.

*Disaster risk finance*, the type of finance most closely associated with drought management, comprises ex ante financial instruments such as contingent financing, insurance, savings, dedicated reserves, or budget reallocations to fund drought response.

Each of these types of finance offer different financial instruments relevant for drought management. The following table provides an overview of finance instruments that deserve consideration as components of a drought management strategy. Such a strategy is likely to combine elements from all categories for multiple stakeholders. It may include, for example, direct government borrowing for water storage reservoirs, agricultural credits for drip irrigation and solar pumps, as well as strategies to support micro-savings and microinsurance for vulnerable households.

The following table provides a comprehensive toolbox of finance sources and instruments for drought management.





|                                                           |                                                                                                                                                                                   |                                                                                                                                                                  | Primary Users |                   |            |            | Sources              |                         |                                 |                                  |                     |                  |       | Purpose    |             |          |          | Relevance                     |                               |                           |                 |                                  |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------|------------|------------|----------------------|-------------------------|---------------------------------|----------------------------------|---------------------|------------------|-------|------------|-------------|----------|----------|-------------------------------|-------------------------------|---------------------------|-----------------|----------------------------------|
| Instrument                                                | Description                                                                                                                                                                       | Illustrative Applications in Drought Finance                                                                                                                     | National Govt | Sub-national Govt | Businesses | Households | Development Partners | Global Commercial Banks | Local Commercial Banks and MFIs | Local and Global Capital Markets | Insurance Companies | Impact Investors | Other | Mitigation | Preparation | Response | Recovery | Upper-Middle Income Countries | Lower-Middle Income Countries | Least-Developed Countries | Conflict States | Fragile and Post-Conflict States |
| Credit                                                    |                                                                                                                                                                                   |                                                                                                                                                                  |               |                   |            |            |                      |                         |                                 |                                  |                     |                  |       |            |             |          |          |                               |                               |                           |                 |                                  |
| Concessional loan                                         | Below-market loans to developing country governments                                                                                                                              | Financing infrastructure and social programs to build drought resilience                                                                                         | •             | •                 |            |            | •                    |                         |                                 |                                  |                     | •                |       | •          | •           |          | •        | •                             | •                             | •                         | •               | •                                |
| Bonds and commercial lending                              | Debt financing from domestic or global capital markets                                                                                                                            | Financing infrastructure with high productive potential                                                                                                          | •             |                   |            |            |                      | •                       | •                               | •                                |                     |                  |       | •          | •           |          |          | •                             | •                             |                           |                 |                                  |
| Green bonds, blue bonds, and climate bonds                | Bonds with proceeds earmarked for projects with positive environmental or climate impact; often comparably low costs of borrowing due to high demand from investors               | Financing green-gray infrastructure for water storage                                                                                                            | •             |                   |            |            |                      |                         |                                 | •                                |                     |                  |       | •          | •           |          |          | •                             | •                             |                           |                 |                                  |
| Impact bonds and resilience bonds                         | Bonds with a portion of the principal and/or interest payments linked to the environmental or social outcomes generated by the investment (e.g. reduced losses caused by drought) | Financing a program to help farmers invest in drought resilience; Financing a national drought preparedness program                                              | •             | •                 | •          |            | •                    |                         |                                 |                                  |                     | •                |       | •          | •           |          |          | •                             | •                             |                           |                 |                                  |
| Blended finance                                           | Combining concessional and commercial finance to support projects with strong social impacts that are not commercially bankable                                                   | Financing an irrigation project expected to generate near-market-rate returns; financing the expansion of piped water service into low-income neighborhoods      | •             | •                 |            |            | •                    | •                       | •                               | •                                |                     | •                |       | •          | •           |          |          | •                             | •                             | •                         |                 |                                  |
| Microcredit and small and medium enterprise (SME) finance | Small-scale loans for businesses and households                                                                                                                                   | Financing for cisterns and rainwater harvesting equipment; loan program to fund off-farm businesses for income diversification, increasing household resilience. |               |                   | •          | •          |                      |                         | •                               |                                  |                     |                  |       | •          | •           |          |          | •                             | •                             | •                         | •               | •                                |
| Revolving loan funds                                      | Publicly managed funds to support a specific policy goal                                                                                                                          | Concessional loans to municipalities to invest in drought resilience                                                                                             |               | •                 | •          | •          |                      |                         |                                 |                                  |                     |                  | •     | •          | •           |          |          | •                             | •                             | •                         |                 |                                  |
| Agricultural credit                                       | Loans for agricultural inputs and equipment                                                                                                                                       | Loans for drip irrigation and solar pumps                                                                                                                        |               |                   | •          | •          |                      |                         | •                               |                                  |                     |                  |       | •          | •           |          |          | •                             | •                             | •                         | •               | •                                |
| Agricultural value chain finance                          | Loans and other instruments to support the marketing, processing, and export of agricultural products                                                                             | Investments in post-harvest processing to increase farmer incomes and resilience to drought                                                                      |               |                   | •          |            | •                    | •                       | •                               |                                  |                     |                  |       | •          | •           |          |          | •                             | •                             |                           |                 |                                  |
| Concessional loan                                         | Below-market loans to developing country governments                                                                                                                              | Financing infrastructure and social programs to build drought resilience                                                                                         | •             | •                 |            |            | •                    |                         |                                 |                                  |                     | •                |       | •          | •           |          | •        | •                             | •                             | •                         | •               | •                                |
| Savings                                                   |                                                                                                                                                                                   |                                                                                                                                                                  |               |                   |            |            |                      |                         |                                 |                                  |                     |                  |       |            |             |          |          |                               |                               |                           |                 |                                  |

|                                                         |                                                                                                                                              |                                                                                                                                 | Primary Users |                   |            |            | Sources              |                         |                                 |                                  |                     |                  |       | Purpose    |             |          |          | Relevance                     |                               |                           |                                  |
|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------|------------|------------|----------------------|-------------------------|---------------------------------|----------------------------------|---------------------|------------------|-------|------------|-------------|----------|----------|-------------------------------|-------------------------------|---------------------------|----------------------------------|
| Instrument                                              | Description                                                                                                                                  | Illustrative Applications in Drought Finance                                                                                    | National Govt | Sub-national Govt | Businesses | Households | Development Partners | Global Commercial Banks | Local Commercial Banks and MFIs | Local and Global Capital Markets | Insurance Companies | Impact Investors | Other | Mitigation | Preparation | Response | Recovery | Upper-Middle Income Countries | Lower-Middle Income Countries | Least-Developed Countries | Fragile and Post-Conflict States |
| Contingency budgets and reserve funds                   | Public money set aside for disaster mitigation and response                                                                                  | Emergency fund for disaster response                                                                                            | ●             | ●                 |            |            |                      |                         |                                 |                                  |                     |                  | ●     |            |             | ●        | ●        | ●                             | ●                             |                           |                                  |
| Microsavings                                            | Small-scale savings accounts for poor and vulnerable households                                                                              | Savings for smallholder farmers to provide tools for self-insurance                                                             |               |                   |            | ●          |                      |                         |                                 |                                  |                     |                  | ●     |            |             | ●        | ●        | ●                             | ●                             | ●                         | ●                                |
| Savings groups                                          | Informal savings tool                                                                                                                        | Groups of farmers saving as a form of self-insurance                                                                            |               |                   |            | ●          |                      |                         |                                 |                                  |                     |                  | ●     |            |             | ●        | ●        |                               |                               | ●                         | ●                                |
| Insurance                                               |                                                                                                                                              |                                                                                                                                 |               |                   |            |            |                      |                         |                                 |                                  |                     |                  |       |            |             |          |          |                               |                               |                           |                                  |
| Agricultural insurance                                  | Insurance to manage risks related to crop and livestock losses                                                                               | Compensate farmers post-drought                                                                                                 |               |                   | ●          |            |                      |                         |                                 |                                  |                     | ●                |       |            |             | ●        | ●        | ●                             | ●                             | ●                         | ●                                |
| Microinsurance                                          | Small-scale insurance products for poor and vulnerable households                                                                            | Compensate farmers post-drought                                                                                                 |               |                   |            | ●          |                      |                         |                                 |                                  |                     | ●                |       |            |             | ●        | ●        | ●                             | ●                             | ●                         | ●                                |
| Informal risk management                                | Traditional community-based tools for risk management                                                                                        | Self-insurance against drought risks, for example, through kin support networks or reciprocal grazing and planting arrangements |               |                   |            | ●          |                      |                         |                                 |                                  |                     |                  | ●     |            |             | ●        | ●        |                               |                               | ●                         | ●                                |
| Business interruption insurance                         | Insurance to compensate businesses for lost income if they are forced to close due to natural disaster                                       | Compensate businesses post-drought                                                                                              |               |                   | ●          |            |                      |                         |                                 |                                  |                     | ●                |       |            |             | ●        | ●        | ●                             |                               |                           |                                  |
| Sovereign risk insurance                                | Disaster risk insurance for national governments                                                                                             | Fund post-drought emergency response                                                                                            | ●             |                   |            |            | ●                    |                         |                                 |                                  |                     | ●                |       |            |             | ●        | ●        | ●                             |                               |                           |                                  |
| Risk pools                                              | Groups of countries jointly insuring disaster risk                                                                                           | Fund post-drought emergency response                                                                                            | ●             |                   |            |            | ●                    |                         |                                 |                                  |                     |                  |       |            |             | ●        | ●        | ●                             | ●                             |                           |                                  |
| Catastrophe bonds                                       | Insurance-like product to support national governments' disaster risk management                                                             | Fund post-drought emergency response                                                                                            | ●             |                   |            |            | ●                    |                         |                                 |                                  |                     |                  |       |            |             | ●        | ●        | ●                             |                               |                           |                                  |
| Other Instruments                                       |                                                                                                                                              |                                                                                                                                 |               |                   |            |            |                      |                         |                                 |                                  |                     |                  |       |            |             |          |          |                               |                               |                           |                                  |
| Grants                                                  | Non-repayable funding provided for development or relief purposes by, e.g., development partners, philanthropic foundations, and individuals | Funding early warning systems or social programs for drought resilience                                                         | ●             | ●                 | ●          | ●          | ●                    |                         |                                 |                                  |                     |                  |       |            | ●           | ●        | ●        | ●                             | ●                             | ●                         | ●                                |
| Matching grants, challenge funds and recoverable grants | Grants with a specific additional requirement attached                                                                                       | Matching grants to water utilities to invest in drought resilience                                                              | ●             | ●                 | ●          | ●          | ●                    |                         |                                 |                                  |                     | ●                |       | ●          | ●           |          |          | ●                             | ●                             |                           |                                  |

|                                                |                                                                                                       |                                                                                               | Primary Users |                   |            |            | Sources              |                         |                                 |                                  |                     |                  |       |            | Purpose     |          |          |                               | Relevance                     |                           |                                  |  |  |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------|-------------------|------------|------------|----------------------|-------------------------|---------------------------------|----------------------------------|---------------------|------------------|-------|------------|-------------|----------|----------|-------------------------------|-------------------------------|---------------------------|----------------------------------|--|--|
| Instrument                                     | Description                                                                                           | Illustrative Applications in Drought Finance                                                  | National Govt | Sub-national Govt | Businesses | Households | Development Partners | Global Commercial Banks | Local Commercial Banks and MFIs | Local and Global Capital Markets | Insurance Companies | Impact Investors | Other | Mitigation | Preparation | Response | Recovery | Upper-Middle Income Countries | Lower-Middle Income Countries | Least-Developed Countries | Fragile and Post-Conflict States |  |  |
| Subsidies and tax incentives                   | Grants provided to support a specific policy goal                                                     | Tax incentives for farmers to invest in rainwater harvesting and water-efficient technologies |               | ●                 | ●          | ●          |                      |                         |                                 |                                  |                     |                  | ●     | ●          | ●           |          |          | ●                             | ●                             | ●                         |                                  |  |  |
| Budget reallocation                            | The ability to shift public budgets in response to natural disasters                                  | Reallocating funds for drought disaster response and recovery                                 | ●             | ●                 |            |            |                      |                         |                                 |                                  |                     |                  | ●     |            |             | ●        | ●        | ●                             | ●                             | ●                         | ●                                |  |  |
| Remittances                                    | Money transfers from migrant workers to family members                                                | Informal post-drought income support                                                          |               |                   |            | ●          |                      |                         |                                 |                                  |                     |                  | ●     |            |             | ●        | ●        | ●                             | ●                             | ●                         | ●                                |  |  |
| Payment for ecosystems services                | Paying landowners to use their land in a way that generates positive externalities                    | Compensation to upstream landowners to improve availability of water downstream               |               |                   | ●          | ●          | ●                    | ●                       | ●                               | ●                                |                     | ●                |       | ●          |             |          |          | ●                             | ●                             |                           |                                  |  |  |
| Environmental markets and water rights trading | Developing markets for trading credits related to a specific natural resource or negative externality | Encouraging more efficient use of water resources                                             |               |                   | ●          | ●          |                      |                         |                                 |                                  |                     |                  | ●     | ●          |             |          |          | ●                             |                               |                           |                                  |  |  |
| Equity                                         | Sale of partial ownership in a firm                                                                   | Venture capital investment in a drought-focused startup                                       |               |                   | ●          |            | ●                    |                         |                                 | ●                                |                     | ●                | ●     |            |             |          |          | ●                             |                               |                           |                                  |  |  |
| Public-private partnerships                    | Contractual relationship between government and a firm to finance and operate infrastructure          | Expanding irrigation infrastructure                                                           | ●             |                   | ●          | ●          | ●                    | ●                       |                                 |                                  |                     |                  |       | ●          |             |          |          | ●                             | ●                             |                           |                                  |  |  |

fig. 29: Drought finance instruments (TG Report 3)



The various finance sources and instruments listed in Table 5.1 are applicable to a broad range of drought risk management measures and are tailored to various stakeholder groups. The applicability and the advantages and disadvantages of the various instruments need to be critically evaluated in light of the measures to be implemented and within their socioeconomic and political contexts. To illustrate the breadth of finance instruments listed in Table 5.1 and their application in drought risk management strategies for diverse stakeholders, a few selected instruments are briefly elucidated in the following:

#### *Green bonds and climate bonds*

Various national governments, including of Indonesia, Thailand, Egypt, and Mexico, have begun to issue green bonds. Drought resilience investments are strong candidates for green bonds and climate bonds, particularly if a link to climate adaptation can be shown. Following an unprecedented drought, the city of Cape Town in South Africa issued its first green bond, accredited by the Climate Bonds Initiative. The US\$ 72 million bond has a tenor of 10 years and is being used to finance the upgrading of reservoirs, water efficiency investments and wastewater reuse.

#### *Microsavings*

Saving allows low-income households to smooth fluctuating incomes and to buffer shocks, such as drought, without being forced to borrow – often from moneylenders at extremely high rates. Minimum deposit requirements, fees, or other barriers discourage low-income households from opening formal savings accounts. New microsavings products can make their savings safe and convenient. With commitment savings, the saver deposits money, but is not able to withdraw it until a specific date or savings goal has been met. Drought coordinating agencies could explore microsavings withdrawable in the case of a drought as part of a drought finance strategy.

#### *Contingency budgets and reserve funds*

Drought is a constant and enduring challenge across most of Australia. To provide long-term support for drought resilience and response across fiscal years, the Government of Australia capitalized the US\$ 3 billion Future Drought Fund in 2020. In addition to supporting drought response, the fund will provide annual support for drought resilience, including support for climate risk analysis, agricultural investments and local government planning.

#### *Agricultural and microinsurance*

Agricultural insurance for crops and livestock has long been used as risk management tool but is still less widespread in developing countries. New parametric insurance products are reducing costs and increasing the speed of payouts to farmers, although they are not a panacea and need critical assessment before application in specific contexts (Jensen & Barrett 2017). Parametric insurance is usually linked to rainfall, vegetation, or soil moisture indices to trigger payouts. In contrast to indemnity-based insurance, this does not disincentivize drought mitigation. Yet, measurement challenges can resemble political tensions of drought declaration, though this challenge is being addressed through satellite data and machine learning algorithms. Agricultural microinsurance is tailored to the requirements of low-income households and mostly parametric. Fintech has reduced transaction costs and time to payout. National drought management bodies can critically evaluate the potential and risks of different insurance options in their specific contexts and regulate and support their use.

#### *Drought and Climate Finance:*

##### *The Great Green Wall*

Spanning 11 countries across Africa, the Great Green Wall is a massive initiative to restore degraded land and create green jobs. In 2020, the International Fund for Agricultural Development (IFAD) and the Green Climate Fund announced a plan to invest over US\$ 1 billion into the Great Green Wall Umbrella Program (GGW Up) to expand financing for this continent-spanning initiative. Working closely with UNCCD, the program will support the sustainable management of natural resources, improve livelihoods for smallholder farmers and develop climate-resilient infrastructure – all of which will strengthen the drought resilience of participating countries.

#### *Risk pools*

Instead of working with traditional insurance providers, national governments can cooperate with other countries in the region to purchase insurance together, creating a risk pool. Risk pools reduce costs through economies of scale and through reducing the costs of reserves and reinsuring the portfolio. Risk pools can also reduce what is known as “uncertainty loading” – the tendency for insurers to mark up costs when risk data is missing or low quality. Examples of risk pools related to drought include the African Risk Capacity and the Caribbean Catastrophe Risk Insurance Facility. A recent drought in Zimbabwe, causing a drop in grain yields in 2020, triggered a payout of US\$ 1.4 million through the African Risk Capacity. The Government of Zimbabwe used the payout to provide direct mobile money disbursements to over 155,000 households in highly vulnerable districts.

## 5.4 Incorporating a drought finance strategy into national drought plans

Each of the financial instruments above can address specific drought-related challenges for specific stakeholders or provide the financial means for different drought management measures. A drought finance strategy developed as part of a national drought plan combines various of these instruments that are best fit to the specific challenges, stakeholders, and social-political and institutional contexts. To ensure the financial resources are in place for effective drought management, the development of a drought finance strategy should be integrated within the broader drought planning process.

Hence, the process of developing national drought plans (see UNCCD 2018 for a generic 10-step process) should involve the finance ministry and comprise an assessment of the state of financial resources and the macro-economic environment. This, and the drought risks and drought management activities described in a national drought plan inform a review of the above and of additional, new finance sources and instruments and the identification of the most feasible sources and instruments that can be used by national and sub-national governments, households, and firms. A national drought planning task force can then develop a risk layering approach to financing that draws on a mix of the most suited sources and instruments. It should also carefully explore risks and constraints associated with the specific finance instruments, adapt or re-combine them accordingly, and identify where additional capacity building, support for marginalized groups, subsidies, or regulatory reforms might be needed in order to ensure these instruments unfold their potential and are used in the right way that avoids negative effects, for example, with regard to equity and debt overload. The task force should also coordinate with the relevant stakeholders to ensure the financial instruments are coordinated and accessible for mitigation and preparedness measures and in advance of a drought event.

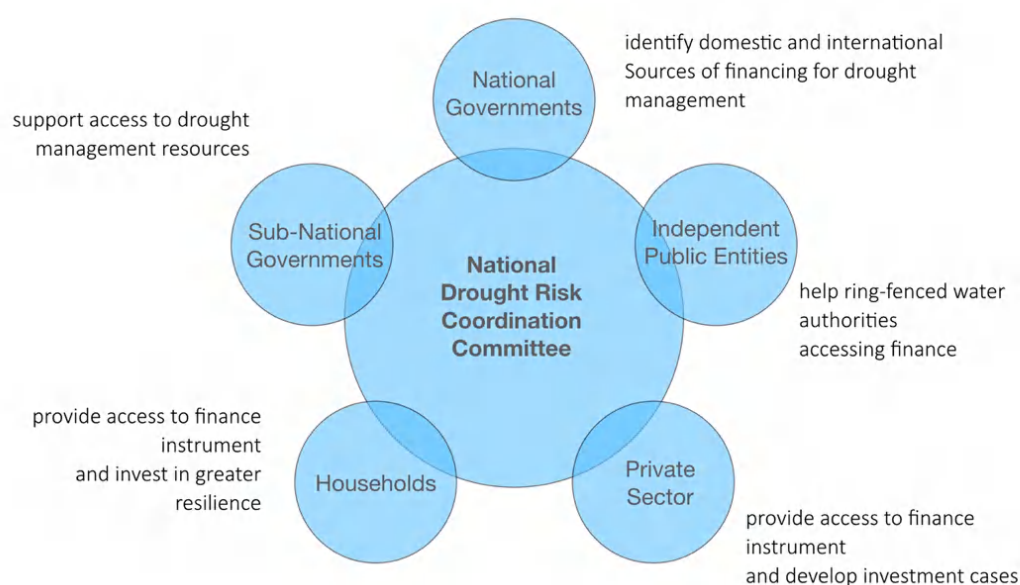


fig. 30: Coordinating role of a national drought planning task force (own)

Drawing on the building blocks and menu of financial instruments outlined above, drought planning bodies can use a risk layering approach to develop a drought finance strategy that combines multiple instruments for mitigation and preparedness and for responding to droughts of varying severity and frequency. Risk layering is the process of dividing disaster risk by potential impact and likelihood, and then mapping the right financial instrument to each layer (Figure 5.3).

Above the risk layers, investments in mitigation and preparation can push the curve downward, reducing the frequency of droughts through mitigation efforts and their severity through better preparation. These investments can be financed through government funding and through credits and savings by various stakeholders. To push sub-national governments to invest in drought resilience, the national coordinating body can explore the use of revolving funds and subsidies. To encourage households and firms, grants and tax incentives are a powerful tool to encourage investment, in addition to efforts to expand access to microcredit (where feasible), agricultural credit, or agricultural value chain finance.

At the lower risk layers (small, localized drought events), individual savings, contingency budgets, and reserve funds can be arranged in advance of a drought and provide the resources needed for response and recovery. To help households build savings in advance of drought, national coordinating bodies can also work with partners to expand access to formal micro-savings, informal savings groups, and remittances. For the higher risk layers (severe drought in large areas), budget reallocation, sovereign risk insurance, risk pools, and needed. Catastrophe bonds can help to close finance gaps. Across all risk layers, insurance for households and firms provides a way to transfer risk.

An effective drought finance strategy aligns the most appropriate financial instruments with the risk layers and identifies mitigation and preparation investments with the highest potential for reducing risk while maximizing co-benefits. Such an approach helps to reduce both drought impacts and finance gaps at the crisis stage.



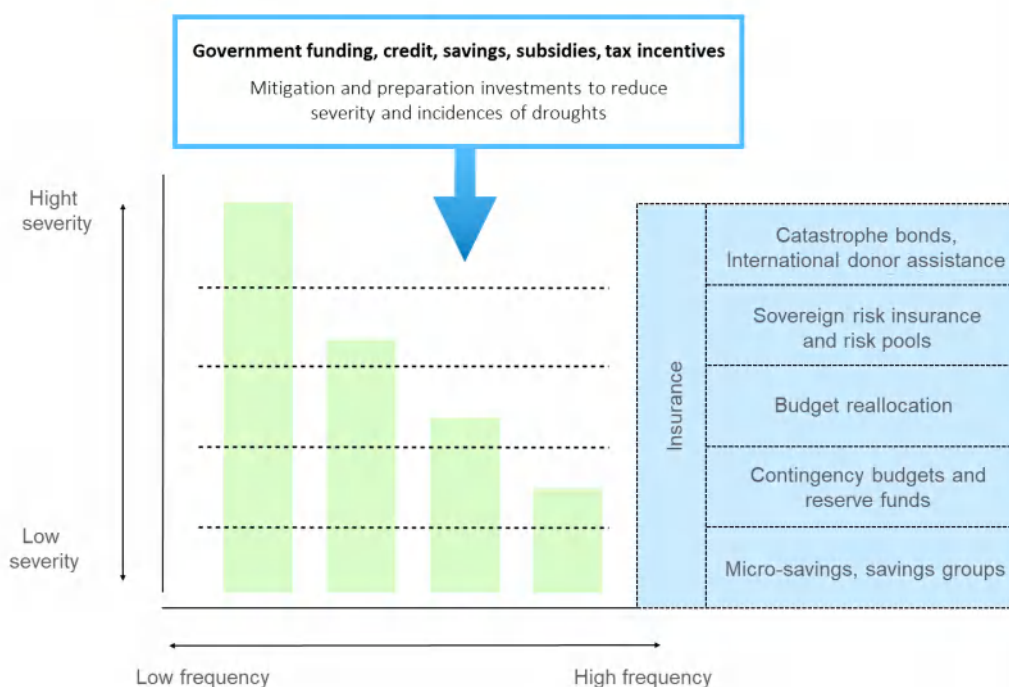


fig. 31: Risk layering as part of a drought finance strategy

## 5.5 Remarks and recommendations

A solid drought finance plan that arranges whose and which drought costs are covered by whom ensures coordinated, predictable disaster response and avoids ill-conceived, fragmented, ad-hoc crisis action shaped by politics, the media, and donors (Sainath 1996, Clarke & Dercon 2016). The latter model of ad-hoc crisis action creates avoidable human hardships, injustices, and uncertainties. As explored above, it is also less cost-effective than proactive drought management. Furthermore, this model of crisis response can be self-perpetuating by reducing incentives of both individuals and governments to pro-actively invest in drought risk mitigation, an issue known as ‘charity hazard’ (Raschky & Weck-Hannemann 2007). As Cohen & Werker (2008) put it with regard to governments who get rewarded when disasters happen: “additional payments come during ‘bad times’ while nothing happens during ‘good times’.” Shifting to a proactive drought management approach with solid drought finance plans might mean that governments get rewarded for good governance, though voters sometimes tend to reward politicians more for disaster relief spending than for disaster preparedness spending (Healy & Malhotra 2009). Rational consideration of the business case of proactive drought management in political decision-making and public debates thus seems to be a key.

Developing a drought finance strategy forces governments and the other stakeholders involved to realistic drought management planning to debate the trade-offs of different drought management measures, to consider the business case of proactive drought management, and to tap new, previously unconsidered financial resources and instruments. This process of developing a drought finance strategy should involve debate on questions, like the following:

- Which mitigation measures reduce drought costs most efficiently in the longer term?
- Which mitigation measures produce which additional social, economic, and environmental co-benefits and for whom? Do the most vulnerable actors and population groups benefit?
- What are the most suitable combinations of finance instruments for which mitigation measures?
- Whose drought costs will be covered by whom and by which finance instruments?
- Which finance instruments are best suited and used in what way to foster equity and financial inclusion?
- How can potential negative effects of finance instruments, such as debt overload, be avoided?
- Which measures and institutional arrangements best ensure fiscal discipline and avoid the diversion of drought funds for other purposes or prior to specified drought events?
- In what ways can those who benefit from droughts (e.g. wealthier farmers owning the deepest wells or water traders) be engaged in mechanisms supporting the most vulnerable? Can their revenues be tapped to support drought mitigation and response for the most vulnerable?
- Which finance sources and instruments are in line with the goal of a drought finance strategy that is consistent with the goals of the Paris Agreement? Involving finance and insurance institutions contributing to high levels of “finance-based emissions” (Manyach et al. 2021), for example through financing coal industries, clearly runs counter to the goal of drought risk mitigation.

Various stakeholders have a role in supporting and developing solid, equitable, and consistent drought finance strategies enabling the urgent move from reactive to proactive drought management. The following recommendations can contribute to this goal:

| Stakeholder group                     | Recommendations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| UNCCD                                 | <ul style="list-style-type: none"> <li>▪ Raise the profile of financing proactive drought management</li> <li>▪ Support further research on the economics of proactive drought management</li> <li>▪ Encourage and support critical evaluation of the above and of further drought finance options, including their potentials, advantages, disadvantages, and further development</li> <li>▪ Provide assistance to countries for developing solid drought finance strategies that consistently take into account the needs of the most vulnerable groups</li> <li>▪ Foster awareness on the links between drought finance and finance-based emissions and other activities undermining drought risk (including climate) mitigation goals</li> </ul> |
| National and sub-national governments | <ul style="list-style-type: none"> <li>▪ Carefully explore the potential, risk, and constraints of the various finance sources and instruments in the context of national and local needs and circumstances and considering the above questions.</li> <li>▪ Adapt and combine multiple finance sources and instruments, addressing all pillars of the drought management cycle, covering the various stakeholders, and using a risk layering approach.</li> </ul>                                                                                                                                                                                                                                                                                    |

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                    | <ul style="list-style-type: none"> <li>▪ Integrate drought finance strategies in the development of drought management plans early on.</li> <li>▪ Align budgeting and investments across all sectors with the goal of proactive drought management</li> <li>▪ Incentivize investments in drought resilience by households and firms</li> </ul>                                                                                                                                               |
| Development organizations          | <ul style="list-style-type: none"> <li>▪ Increase funding for proactive drought management</li> <li>▪ Ensure drought management is included as a complementary objective whenever relevant</li> <li>▪ Critically evaluate and support the development and adaptation of financial instruments for drought management that are in line with equity and drought mitigation (including climate) goals</li> </ul>                                                                                |
| Research institutions              | <ul style="list-style-type: none"> <li>▪ Improve the empirical knowledge base on the business case for and the co-benefits of proactive drought management</li> <li>▪ Analyze the extent of public and private investments in proactive drought management and investigate factors supporting such investments</li> <li>▪ Critically analyze drought finance instruments</li> <li>▪ Critically accompany the development of drought finance strategies and evaluate their effects</li> </ul> |
| Finance and insurance institutions | <ul style="list-style-type: none"> <li>▪ Align all investments and activities with climate and drought risk management goals</li> <li>▪ Further develop cost-effective and transparent finance and insurance instruments for drought risk management</li> </ul>                                                                                                                                                                                                                              |
| Individuals and firms              | <ul style="list-style-type: none"> <li>▪ Understand exposure to drought risk</li> <li>▪ Pro-actively invest in drought resilience</li> <li>▪ Maintain savings and seek insurance</li> </ul>                                                                                                                                                                                                                                                                                                  |

*fig.32: Stakeholder-specific recommendations for supporting finance strategies for proactive drought management*





## CHAPTER 6

### *Outlook and next steps*

6.1



## 6.2 Gaps: Known and unknown unknowns

“A bleak look into the future tells us we've seen nothing yet, with a mix of shifting climates, poor water management practices, and growing population densities promising a 'pandemic' of catastrophic droughts awaits.” (Science Alert, 2021, s.p.)

The risks associated with drought are complex, systemic, and increasing. Some elements of these are well understood, precisely modeled, and quantifiable on various scales. Others, however, remain on the level of working hypotheses or uncertain prognostics with little empirical base. Yet, there is a third category of fully unknown relations and fields, totally unknown until experienced and discovered in retrospect, if at all.

The total amount of wildlife lost and species extinct is one of such dimensions (comp. GAR, 2021, 83); future trends in regional precipitation averages and variability is another (Simpson et al. 2016). Practical knowledge gaps, according to a UNCCD survey, mark that 62.5% of all respondents see the need for more science-based knowledge for the policy interface. Knowledge gaps range across all fields of drought risk management, be it in the field of vulnerability assessments and monitoring or empirical data on low and high-tech solutions to minimize risk. “After a long debate on unknown, low-probability, and high-impact events, it has been suggested that extreme scenarios could be more common than was previously supposed, and that this requires us to develop a new understanding of their drivers. There are persistent gaps in the research, and they need to be addressed.” (Pescaroli & Alexander, 2018, 2246)

Drought impacts are strongly modulated by the socioeconomic characteristics of affected areas, such as their vulnerability and resilience to drought, as well as their level of drought preparedness. Therefore, and based on the prior structure of this report, the following table tries to outline five broader categories and their associated epistemologies, ranging from known frontiers of knowledge to identifiable knowledge gaps, to unknown fields and undefinable unknown unknowns. The five categories stretch from the natural and social sciences to drought policies, communications, and financial mechanisms associated with drought.

|                          | Knowledge frontiers                                                                 | Knowledge gaps                                                                                          | Unknown fields                                                | Unknown unknowns |
|--------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|------------------|
| Earth and Social Science |                                                                                     |                                                                                                         |                                                               |                  |
| Planetary boundaries     | How can we move back into a safe operational space?                                 | How do we shift societal intent to remain within a safe operational space?                              | Which planetary boundaries do we not see?                     |                  |
| Climate crisis           | How will global warming affect regional precipitation and evapotranspiration rates? | How will global warming affect extra-tropical circulation and hence regional precipitation variability? | Which accelerating and multiplying factors are we unaware of? |                  |

|                                    | Knowledge frontiers                                                                                                                  | Knowledge gaps                                                                                                                                                                        | Unknown fields                                                                                         | Unknown unknowns |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------------------|
| Hydrology / Hydrological cycle     | What kinds of land use changes have which effects on ground water recharge rates? What factors influence these effects in what ways? | How and within what time spans do different kinds of land restoration affect ground water recharge rates?                                                                             | How do the carbon and water cycle interact on various scales?                                          |                  |
| Pedosphere / Soil science          | To what extent does soil organic matter loss increase ecological, agricultural, and socioeconomic drought risk?                      | How can we actively and effectively support soil-building processes in various ecotones?                                                                                              | Which soil formation, storage and feedback mechanisms do we not yet understand?                        |                  |
| Biodiversity                       | What is the impact of drought on biodiversity?                                                                                       | How do drought resilience and biodiversity correlate in various biomes?                                                                                                               | The existence of many species is unknown to us.                                                        |                  |
| Restoration                        | How many hectares of (agro-) ecological systems can we restore quickly and effectively?                                              | How to effectively overcome societal barriers that hinder large-scale ecosystem restoration?                                                                                          | What are the unintended negative side-effects of any ecological intervention under current parameters? |                  |
| Conservation                       | What nature conservation strategies support drought mitigation most effectively?                                                     | What is a region's drought risk carrying capacity?                                                                                                                                    | Which conservation thresholds have we crossed already?                                                 |                  |
| Biomimetics                        | Where are the limits of biomimicry?                                                                                                  | How can we best imitate natural processes?                                                                                                                                            | What dimension of natural cycles do we not see and recognize?                                          |                  |
| Societal drought risk determinants | What are the effects of natural resource access and control patterns on drought risk?                                                | Which political factors (including, e.g., corruption and accountability) determine drought risk in which ways, and what are their roles, relative to other drought risk determinants? | What market forces affect drought risk in what way?                                                    |                  |
| Drought Policies                   |                                                                                                                                      |                                                                                                                                                                                       |                                                                                                        |                  |
| Global                             | What kind of reforms are needed within the UNCCD system?                                                                             | How can we assess the effectiveness of the framework?                                                                                                                                 | What kind of binding agreements should be aimed for?                                                   |                  |
| Regional                           | Does UNCCD regional clustering need to be reformed?                                                                                  | What alternative structures of regional UNCCD clusters would be feasible and advantageous?                                                                                            | What role is there for regional alliances in the future?                                               |                  |



|                                        | Knowledge frontiers                                                                                                                              | Knowledge gaps                                                                                                                                                            | Unknown fields                                                                      | Unknown unknowns |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------|
| National                               | What factors contribute to the success of DRM?                                                                                                   | How can we evaluate the effectiveness of NDPs?                                                                                                                            | How far can legal accountability be taken?                                          |                  |
| Sub-national                           | How do we best initiate <i>communities of learning and practice</i> for effective DRM?                                                           | How do we best initiate <i>communities of learning and practice</i> for effective DRM?                                                                                    | How do we best take sub-national actions into account?                              |                  |
|                                        |                                                                                                                                                  |                                                                                                                                                                           |                                                                                     |                  |
| Communication / Information Science    |                                                                                                                                                  |                                                                                                                                                                           |                                                                                     |                  |
| Narratives                             | What are science-based narratives about drought?                                                                                                 | How do we best present and represent a diversity of perspectives?                                                                                                         | Which perspectives do we overlook?                                                  |                  |
| Media                                  | What role does media play in mitigating drought risks?                                                                                           | How does media encourage and amplify drought risk behavior?                                                                                                               | What would an ideal media environment look like to reduce risk exposure?            |                  |
| Social transition (transition science) | How do we initiate rapid social transformation?                                                                                                  | How can theories of change of be further improved and made applicable?                                                                                                    | What hinders the pathway to impact and how do we counteract this?                   |                  |
| Holistic drought management            | Which effective interventions are rolled out by which (state) actor?                                                                             | Which existing interventions are effective and under which conditions?                                                                                                    | Which novel interventions are yet to be discovered?                                 |                  |
|                                        |                                                                                                                                                  |                                                                                                                                                                           |                                                                                     |                  |
| Finance                                |                                                                                                                                                  |                                                                                                                                                                           |                                                                                     |                  |
| Business case of proactive DRM         | What are the benefits of action and the costs of inaction?                                                                                       | How do we identify perverse incentives and remove these?                                                                                                                  | Which negative impacts of our current economic models do we overlook?               |                  |
| Incentives and investment decisions    | What factors support public and private investments in proactive DRM?                                                                            | Which existing tax and financial incentives most effectively encourage investment in proactive DRM in which contexts?                                                     | Which more effective tax and financial incentives will be designed and implemented? |                  |
| Drought finance instruments            | What are the potentials, advantages, disadvantages, and risks of different drought finance instruments in different national and local contexts? | Which savings and/or insurance models are best suited in which contexts and for which groups of stakeholders? What are the best ways to foster their widespread adoption? | Which instruments have negative impacts on other SDGs?                              |                  |
| Restoration finance                    | Are there scalable business-driven restoration cases that have proven profitable for ecological functions,                                       | How do we divert business-as-usual finance streams into an emerging restoration economy?                                                                                  | Which aspects of restoration are distorted or lost through the introduction of      |                  |

|       | Knowledge frontiers                                                  | Knowledge gaps                                            | Unknown fields                          | Unknown unknowns |
|-------|----------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------|------------------|
|       | social equality, and financial returns?                              |                                                           | financial instruments?                  |                  |
| Value | Monetization of nature or the naturalization of the monetary system? | What are the risks of monetizing drought risk management? | What will a new value system look like? |                  |

*fig. 33: Overview on drought-related epistemologies frontiers (own)*

Some of the numerous knowledge gaps can and need to be addressed. Others remain but might be exposed through future drought events and critical inquiry into how and why those events unfold in a particular way, and how management was attempted or not. Such critical inquiry into past and present drought events and their (non-)management is crucial for better controlling these in the future. Yet, it is often the case – as it is more comfortable – to return to ‘business as usual’ after a drought. The critical post-drought inquiry that is always urgently needed should include questions such as:

- Why did the drought unfold in this way?
- Which drought impacts could have been avoided in what way?
- Why were no drought preparedness measures, or the wrong measures, taken?
- Why were there no alerts, or why did alerts not lead to actions?
- What are the lessons learned for future drought risk management?

Yet, much more importantly, and in the spirit of this Blue Paper and the current knowledge frontier of drought management – which puts first priority on avoidance, preparedness, and proactive interventions – are a set of other questions. These pre-drought inquiries must include, for example:

- Was priority given to ecosystem restoration for drought resilience?
- Has a holistic National Drought Plan been drafted, activated, and put under constant revision?
- Were financial mechanisms established to enable investment in all aspects of holistic drought cycle management?
- Has a comprehensive vulnerability assessment been conducted for all societal sectors?
- Is an effective stakeholder-specific early warning system in place?

At the current stage, there is no gap analysis for drought preparedness stages of the UNCCD member states. The fact that a legal document has been drafted – one that tackles all sectors, designates responsibilities, defines accountability, and includes penalties – is a prerequisite for successful management, but it is also not a guarantee. Ways forward for the UNCCD drought initiative might include methods of obligatory reporting and transparency standards, especially and in foresight of any global compensatory and insurance schemes.

## 6.2 The way forward: Proactive and integrative

Droughts raise fundamental questions about the capacities of our societies to measure, evaluate and adequately prepare for an immanent risk. Perhaps more than any other hazard, the causal relationships of drought are hard to decipher and the duration almost unpredictable, with accumulating and cascading impacts.

It is important to create and develop a shared vision of a world, a socio-ecological system, where the goal to minimize risk is clearly articulated. Even though we know that it is neither physically possible nor economically feasible to eliminate drought risk entirely, we have created a world where no other hazard claims more human lives, creates more economic loss, and is the immanent result of a set of wrong “development” paradigms. Transformational change is needed, rapidly and across all systems.

Leaving the dystopian realities of the initial watershed drawing behind (page 34), and by moving to a desirable and anticipated future, one that is more drought resilient, fair, and integrative, the IWG draw a holistic watershed picture of such a future vision. The figure below shows 25 different intervention measures that will enhance any given socio-ecological system. The model describes a world that is land degradation neutral, has a stable atmospheric composition, and has achieved a great level of drought resilience. The experience we have as a species is limited, but using the best knowledge available, we have identified a couple of countermeasures and mechanisms will help mitigate and manage risks associated with drought.

It will not be possible to eliminate all drought risk, neither is it desirable or economically feasible. But it must be possible to reach a stage where the risks are manageable and where human activities don't further amplify natural incidences.

By taking a look from the peaks of mountains to the shores of the oceans, this report takes us on a final journey through a watershed with greatly enhanced drought resilience. It is of the utmost importance to reduce the amount of exposed soils without protective vegetative cover to an absolute minimum, acceptable only where annual crops are rotating on relatively flat surfaces. Mountain slopes, which are most susceptible to erosion, need to be taken under restoration and covered with endemic species suitable for the to-be-expected climatic changes in the centuries ahead. (Forest) landscape restoration starts here where most precipitation falls, where it needs to infiltrate and be retained, without creating run-off or erosion. Further down the slopes, where climatic conditions allow agriculture, a transitional phase includes agroforestry combined with terracing, enabling long-term sustainable utilization in a mixed zone. Water reservoirs on higher elevations play a crucial role to enable year-round water provision and need to be monitored and managed according to a clearly defined management plan and thresholds in times of drought.

With agroforestry systems marking a higher stage of resilience to drought than monoculture, it is important to accompany investments in agrarian intensification and irrigation technologies with higher protective plant growth. Soil organic matter content needs to be optimized for specific plant growth and soil moisture retention.



The more we mimic productive natural ecosystems in our food systems as well as in our build-up environments, the better we can withstand the shocks of a drought, enabling rainwater retention in-situ, filtering through soil substrate and recharging the aquifers below. This can be assisted through urban gardens, greening of roofs or the overall densification of urban areas. It goes without saying that the less space we occupy with the developed human world, the more natural hydrological cycles are maintained. Urban intensification, active family planning, and a curbing rapid population growth are a prerequisite for societal development in respect to planetary boundaries. One crucial factor in this is a dietary shift toward more plant-based nutrition that doesn't rely on industrial animal farming and is much less resource intensive, in regard to both land or water.

Not visible as physical infrastructure or interventions are the non-material dimensions of drought risk management, which are equally important, as much of this report has illustrated. This relates to the political, financial, communication, and educational dimensions that articulate themselves differently in a society that is more alert and aware about drought risks.

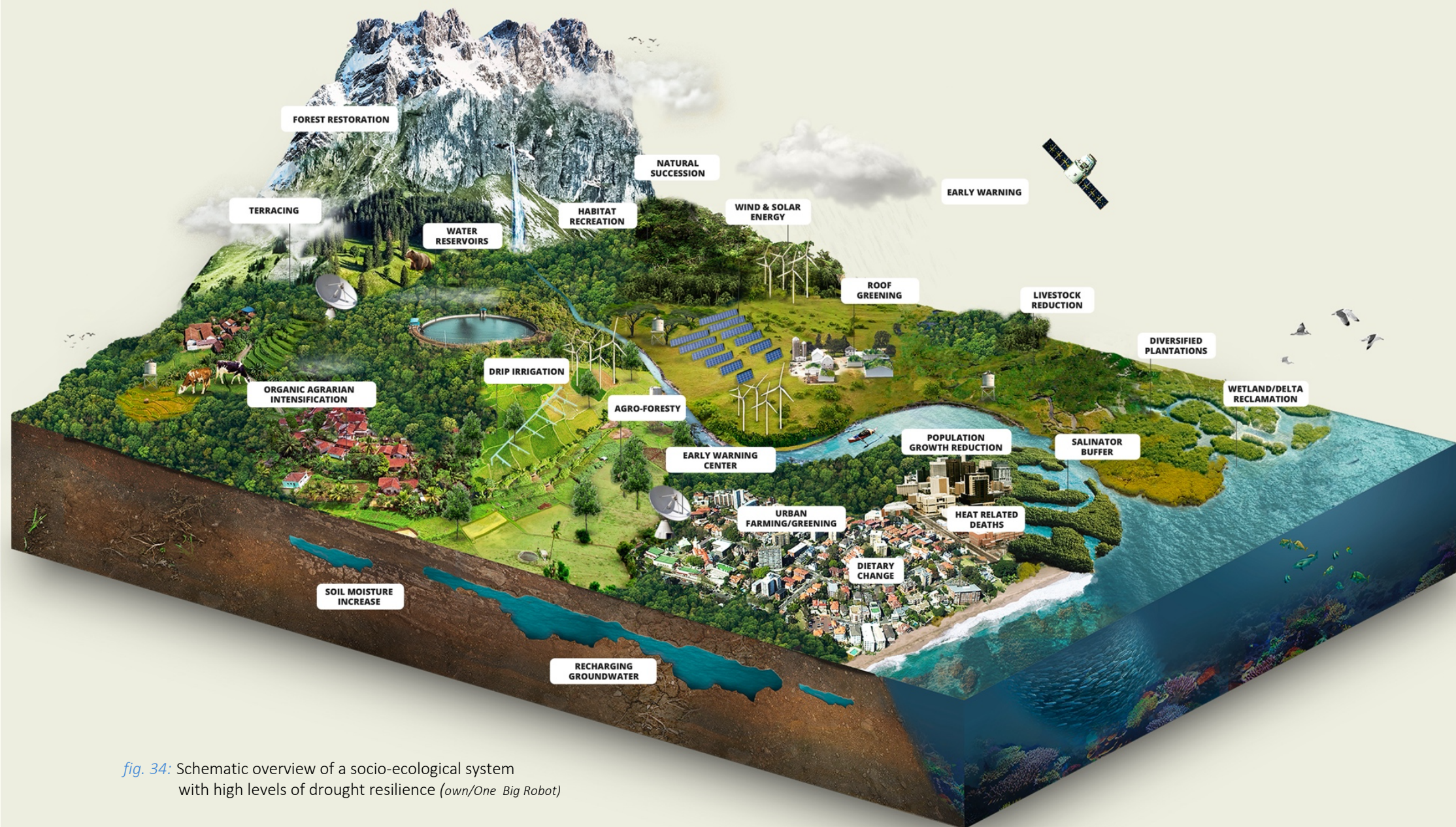


fig. 34: Schematic overview of a socio-ecological system with high levels of drought resilience (own/One Big Robot)





fig. 35: Restoration projects around the world and list of multiple benefits (own)





## Country

## Returns

Drought Resilience

Climate Regulation

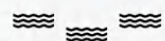
Biodiversity Increase

Cultural Value

Employment

Monetary Return

Australia



Canada



China



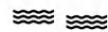
Germany



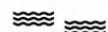
Ghana



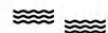
India



Kenya



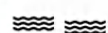
Peru



South Africa



United States









### 6.3 Call for action: Urgency and emergency

Drought and heat waves increasingly hit regions formerly unknown for such impacts. In 2021, places in western Canada hit temperatures higher than have ever occurred in Las Vegas (NOAA, 2021, s.p.). One of, if not *the* worst heat wave struck the entire Northwest Pacific, igniting forest fires on an unprecedented scale. Wildfires in Siberia have broken a record too, for annual fire-related emissions of carbon dioxide (Pultarova, 2021, s.p.). Energy prices in Brazil rose by 7% in 2021 due to drought, with the government asking its populace to cut back on consumption by at least 20% (Aljazeera, 2021, s.p.). Madagascar was on the brink of climate-change induced famine, with portions of the country deprived of rain for four years, making it the worst drought in almost half a century (Harding, 2021, s.p.).

We are facing an unprecedented emergency on a planetary scale. Preparing for drought means in many places to prepare for survival. Given the massive social and economic impacts of drought, the global awareness and level of support is shockingly insufficient. A systematic science-policy interface is in its infancy, reflected by the fact that an intergovernmental working group on drought was only established in 2019 with a limited two-year mandate. On a global level, there are no binding protocols on either proactive or reactive measures to be taken by nations to curtail the spells of drought.

With impacts reaching all levels of governance – and life on this planet, for that matter – and with water resource conflicts and forced migration on the rise, the prognosed trajectory for a warming planet with an additional billion humans every 12 years is one that we cannot want to follow.

The time is now to reverse these trends and make proactive drought risk reduction the maximum and new imperative and paradigm for the years to come.





## *CHAPTER 7*

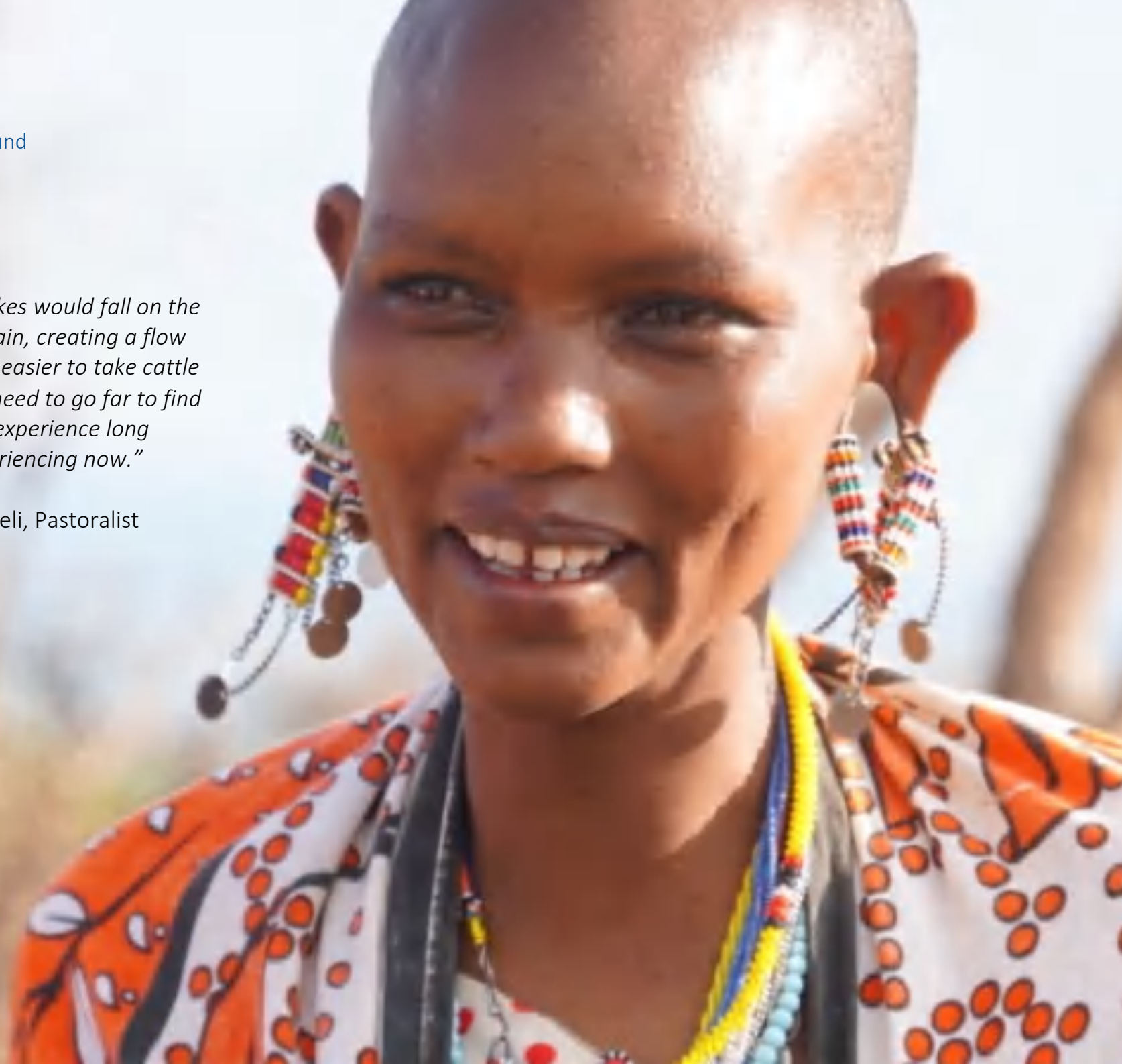
### *Epilogue*

## 7.1 Voices from on the ground

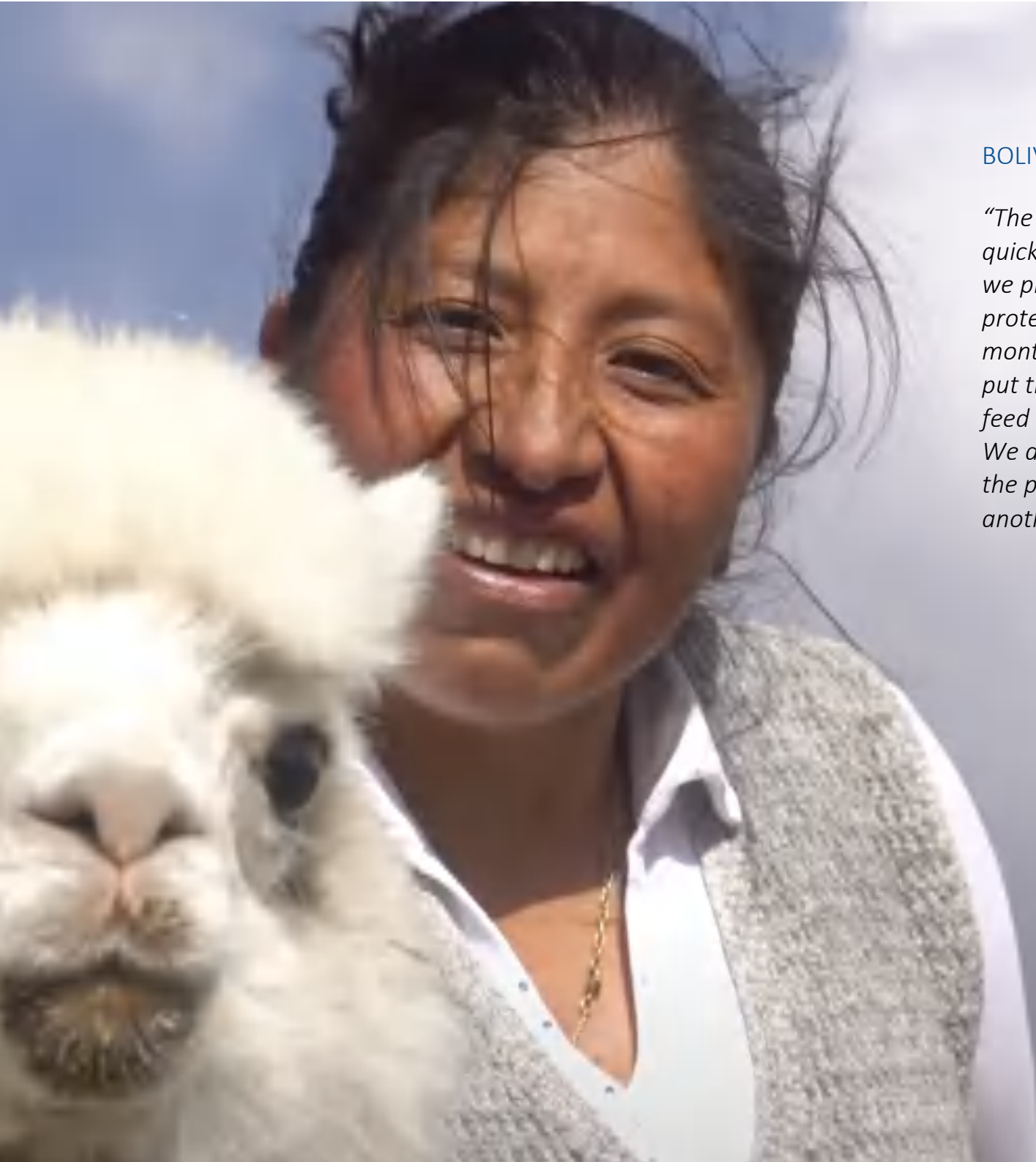
### KENYA

*“Back in the day, snowflakes would fall on the flat summit of the mountain, creating a flow of water. So, it was much easier to take cattle to graze here. We didn’t need to go far to find water. We never used to experience long droughts like we are experiencing now.”*

Elizabeth Sangale, Amboseli, Pastoralist







## BOLIVIA

*"The snow doesn't last long. Snow falls, and quickly it melts with the heat. During summertime, we protect the grass with a wired enclosure. We protect the grass so it can grow. For two or three months, the grass grows for the winter. After, we put the alpacas into the enclosure so they can feed there in winter.*

*We also move [the alpacas] to another place, so the pasture can rest, and then we move them to another one and so on."*

Sra. Naciana Carlos Gutierrez  
Leader of the Guardaña River Basin  
Management Organization



## JORDAN

*“Old people who are dead since 30 or 40 years would say that this is not their country if they would revive/return. In the past this country was very fertile and there were trees everywhere.*

*Through the animals I can make a living for me and my children. I have no salary, nothing except for the sheep. When a child is hungry, I go and sell a sheep to buy bread. There is a problem if I have only little fodder.”*

*Abu Hussain, Head of the Bani Hashem Hima Society*





## SENEGAL

*"Twelve countries are involved, from Dakar to Djibouti. It is around 7000 km long. Currently, we increase our reforestation efforts to fight against the advancing desert, and desertification. There is many benefits. It slows migration and there is a stabilization of the population. But without environmental education, there will be no fundamental progress. People need to be sensitized. All work depends on the level of consciousness of people."*

*Samuel Ndiaye, Forest Officer*

## TANZANIA

*“My current life is completely different from the life of my grandparents. The bushes and forests were still intact and healthy, and the wildlife were living peacefully, there was no disturbance. Later on, life changed, a bit, the fields and forests were being cleared. The forest was destroyed and the wildlife moved away.*

*Keeping large herds of cattle is not feasible anymore as the grass might be depleted and the river dries up. It is more important to maintain the water resource and protect its catchment.”*

*Neema Rutta, Agro-Pastoralist*





## 7.2 Voices from the IWG

Dr. Gunilla Björklund: *“We need to analyze which organizations are already partnering with the UNCCD, what their specific expertise in terms of drought is, identify gaps and close these.”*

Dr. Gaius Eudoxie: *“It would be good to give the group the opportunity to reflect on the whole topic and explore the interconnectivity.”*

Dr. Caroline King-Okumu: *“We didn’t put an option yet for improving the monitoring systems, possibly because this is so essential that we even can’t call it an option. Because it’s necessary.”*

Dr. Roger Pulwarty: *“The projections give us a sense where risks might be developing, but honestly, they underestimate a lot where drought is occurring, simply because, the projections are more conservative. Now that being said, they do identify areas of increasing drought where it is unclear what the models are saying relative to the models of precipitation. The IPCC report is meant for negotiation, not for use on the ground. What we are after in this is how do we map down the different scales. Yes, it is global, but it is also horizontal.”*



Prof. Dr. German Kust: *“We have the obligation to be much more concrete. What is the exact action required here?”*

Dr. Robert Stefanski: *“We need to be much more direct and precise with our language, especially since this document is to be translated into six different languages.”*

Dr. Mark Svoboda: *“The UNCCD did a major push to get national drought plans in the last couple of years. However, those did not involve any detail, any vulnerability and risk assessment. The next step is to take it to more country-context specific, and that requires a more extensive vulnerability and risk assessment. That’s really the thing that makes things go around.”*

Dr. Michael Brüntrup: *“We had a wish from several people to underscore that these recommendations or the work of the IWG takes place in a holistic understanding, in a holistic global system of drought management. There are things which are currently not under the UNCCD, but in which the UNCCD should play a role. We propose options and recommendations for the UNCCD, but within a holistic context. So, we have to deal with recommendations that go beyond.”*

Gutierrez-Espeleta: *“We are not dealing with an environmental issue here. It is one of sustainable development. This requires a new framework. We are not an implementing entity – we have a political mandate.”*

Dr. Daniel Tsegai: *“There are strong links between drought and land. We need to see the potential to enhance this drought-land-nexus in order to deal with poverty eradication, biodiversity loss, water and food security, focusing on the interconnections.”*



**United Nations**  
Convention to Combat  
Desertification

United for land

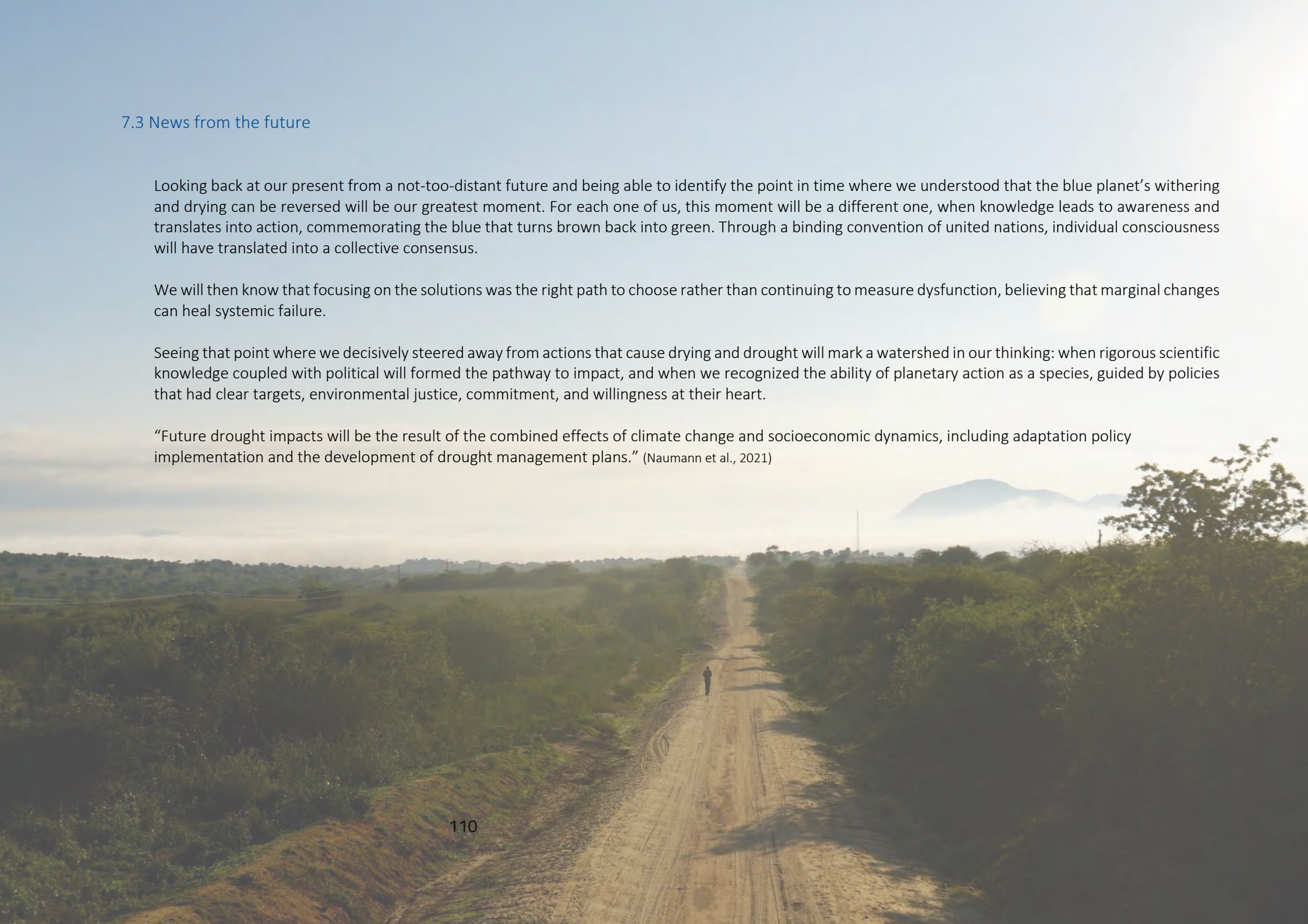
### 7.3 News from the future

Looking back at our present from a not-too-distant future and being able to identify the point in time where we understood that the blue planet's withering and drying can be reversed will be our greatest moment. For each one of us, this moment will be a different one, when knowledge leads to awareness and translates into action, commemorating the blue that turns brown back into green. Through a binding convention of united nations, individual consciousness will have translated into a collective consensus.

We will then know that focusing on the solutions was the right path to choose rather than continuing to measure dysfunction, believing that marginal changes can heal systemic failure.

Seeing that point where we decisively steered away from actions that cause drying and drought will mark a watershed in our thinking: when rigorous scientific knowledge coupled with political will formed the pathway to impact, and when we recognized the ability of planetary action as a species, guided by policies that had clear targets, environmental justice, commitment, and willingness at their heart.

“Future drought impacts will be the result of the combined effects of climate change and socioeconomic dynamics, including adaptation policy implementation and the development of drought management plans.” (Naumann et al., 2021)





## *ANNEX*

## List of IWG Members

Abdu Gasem **AlSharif**

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Directorate of Environmental Conventions and Climate Change Ministry of Environment, Water and  
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Senior Researcher, German Development Institute, **Germany**

Dr. María **de Estrada**

OMEGA- Agricultural Emergency and Disasters Monitoring Office Ministry of Agriculture, Livestock and  
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Agro pastoralist Expert / Responsible of the Water management and Desertification Control Division  
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Agroclimate Specialist

National Agroclimate Information Service Agriculture and Agri-Food Canada, **Canada**

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Department of Economics  
University of Calgary, **Canada**

Sara-Jade **Govia**

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Water Resources Management/Irrigation Team Leader Adaptation Fund Unit Coordinator  
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Global Team Lead – Soil, Water, and Agronomy (SWA) International Center for Agricultural Research in  
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Department of Agriculture, **Australia**

Jose Fidel **Pérez**  
Assistant Secretary, Drought Response Branch, Rural Policy and Farm Performance Division,  
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Luca **Perez**  
European Commission Office  
**Belgium**

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Economist of the National Directorate on Planification and Environmental Land Use Planning  
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Chief: Agricultural Meteorology Division in the Climate and Water Department  
World Meteorological Organization, **Switzerland**

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Associate Professor, Vice-Dean for Scientific Research University of Banja Luka, Faculty of Forestry,  
**Bosnia and Herzegovina**



Dr. Mark **Svoboda**  
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Nathalie **van Haren**  
Senior Policy Advisor, Both ENDS, **The Netherlands**

Hou **Wei**  
Senior Engineer  
National Climate Center (NCC), **China**  
Mr. Abduvokhid **Zakhadullaev**  
State Forestry Department, **Uzbekistan**

Alternates:

Thizwilondi **Rambau**  
UNCCD National Focal Point  
Deputy Director: Department of Environmental Affairs / UNCCD and wetland implementation  
**Republic of South Africa**

Shri Amitabh **Gautam**  
Joint Secretary, Drought Management Division, Department of Agriculture Cooperation and Farmer Welfare Ministry of Agriculture and Farmers, Welfare  
**India**

Abdolhoseni **Mohsen**  
Forests, Ranges and Watershed Management Organization (FRWO)  
**Iran**

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## Glossary (sourced from IPCC, UNCCD, CBD)

**Drought** A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term, therefore any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture drought, also termed agricultural drought), and during the runoff and percolation season primarily affects water supplies (hydrological drought). Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation. A period with an abnormal precipitation deficit is defined as a meteorological drought.

### **Megadrought**

A very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more.

**Extreme weather event** An event that is rare at a particular place and time of year. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season).

**Agroforestry** Collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components. Agroforestry can also be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (FAO, 2015a).

**Anthropogenic emissions** Emissions of greenhouse gases (GHGs), precursors of GHGs and aerosols caused by human activities. These activities include the burning of fossil fuels, deforestation, land use and land-use changes (LUC), livestock production, fertilisation, waste management, and industrial processes. See also Anthropogenic, and Anthropogenic removals.

**Anthropogenic** Resulting from or produced by human activities. See also Anthropogenic emissions, and Anthropogenic removals.

**Aridity** The state of a long-term climatic feature characterised by low average precipitation or available water in a region. Aridity generally arises from widespread persistent atmospheric subsidence or anticyclonic conditions, and from more localised subsidence in the lee side of mountains (adapted from Gbeckor-Kove, 1989; Türkeş, 1999).

**Biodiversity** Biodiversity or biological diversity means the variability among living organisms from all sources including, among other things, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (UN, 1992). See also Ecosystem, and Ecosystem service.

**Biomass** Organic material excluding the material that is fossilised or embedded in geological formations. Biomass may refer to the mass of organic matter in a specific area (ISO, 2014). See also Bioenergy, and Biofuel.

### **Traditional biomass**

The combustion of wood, charcoal, agricultural residues and/or animal dung for cooking or heating in open fires or in inefficient stoves as is common in low-income countries.

**Biome** 'Global-scale zones, generally defined by the type of plant life that they support in response to average rainfall and temperature patterns. For example, tundra, coral reefs or savannas' (IPBES, 2019).

**Climate** Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

**Climate change** A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/ or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes. See also Climate variability, Global warming, Ocean acidification, and Detection and attribution.

**Coping capacity** The ability of people, institutions, organisations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term. (UNISDR, 2009; IPCC, 2012a).

**Evaporation** The physical process by which a liquid (e.g., water) becomes a gas (e.g., water vapour).

**Evapotranspiration** The combined processes through which water is transferred to the atmosphere from open water and ice surfaces, bare soil, and vegetation that make up the Earth's surface.

#### **Potential Evapotranspiration**

The potential rate of water loss without any limits imposed by the water supply.

**Global mean surface temperature (GMST)** Estimated global average of near-surface air temperatures over land and sea-ice, and sea surface temperatures over ice-free ocean regions, with changes normally expressed as departures from a value over a specified reference period. When estimating changes in GMST, near- surface air temperature over both land and oceans are also used. See also Global mean surface air temperature (GSAT), Land surface air temperature, and Sea surface temperature (SST).

**Hazard** The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. See also Disaster, Exposure, Risk, and Vulnerability.

**Hydrological cycle** The cycle in which water evaporates from the oceans and the land surface, is carried over the Earth in atmospheric circulation as water vapour, condenses to form clouds, precipitates as rain or snow, which on land can be intercepted by trees and vegetation, potentially accumulating as snow or ice, provides runoff on the land surface, infiltrates into soils, recharges groundwater, discharges into streams, and ultimately, flows out into the oceans as rivers, polar glaciers and ice sheets, from which it will eventually evaporate again. The various systems involved in the hydrological cycle are usually referred to as hydrological systems.

**Land cover change** Change from one land cover class to another, due to change in land use or change in natural conditions (Pongratz et al., 2018).

**Land degradation** A negative trend in land condition, caused by direct or indirect human-induced processes including anthropogenic climate change, expressed as long-term reduction or loss of at least one of the following: biological productivity, ecological integrity or value to humans. [Note: This definition applies to forest and non-forest land. Changes in land condition resulting solely from natural processes (such as volcanic eruptions) are not considered to be land degradation. Reduction of biological productivity or ecological integrity or value to humans can constitute degradation, but any one of these changes need not necessarily be considered degradation.

**Land rehabilitation** Direct or indirect actions undertaken with the aim of reinstating a level of ecosystem functionality, where the goal is provision of goods and services rather than ecological restoration (McDonald, et al., 2016).

**Land restoration** The process of assisting the recovery of land from a degraded state (McDonald et al., 2016; IPBES, 2018).

**Mitigation (of climate change)** A human intervention to reduce emissions or enhance the sinks of greenhouse gases.

**Net-zero emissions** Net-zero emissions are achieved when emissions of greenhouse gases (GHGs) to the atmosphere are balanced by anthropogenic removals. Where multiple greenhouse gases are involved, the quantification of net-zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon). See also Net-zero CO<sub>2</sub> emissions, Negative emissions, and Net negative emissions.

**Nutrition transition** A predictable change in dietary patterns associated with a country's economic development whereby 'problems of under- and overnutrition often coexist, reflecting the trends in which an increasing proportion of people consume the types of diets associated with a number of chronic diseases' (Popkin, 1994).

**Pool, carbon and nitrogen** A reservoir in the earth system where elements, such as carbon and nitrogen, reside in various chemical forms for a period of time.

**Reforestation** Conversion to forest of land that has previously contained forests but that has been converted to some other use. [Note: For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation in the context of reporting and accounting Article 3.3 and 3.4 activities under the Kyoto Protocol, see 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.] See also Afforestation, Deforestation, and Reducing Emissions from Deforestation and Forest Degradation (REDD+).

**Risk** The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems.

**Respiration** The process whereby living organisms convert organic matter to carbon dioxide (CO<sub>2</sub>), releasing energy and consuming molecular oxygen.

**Risk assessment** The qualitative and/or quantitative scientific estimation of risks. See also Risk management, and Risk perception.

**Risk management** Plans, actions, strategies or policies to reduce the likelihood and/or magnitude of adverse potential consequences, based on assessed or perceived risks.

**Risk perception** The subjective judgment that people make about the characteristics and severity of a risk. See also Risk assessment, and Risk management.

**Runoff** The flow of water over the surface or through the subsurface, which typically originates from the part of liquid precipitation and/or snow/ice melt that does not evaporate or refreeze, and is not transpired.



**Social-ecological system** An integrated system that includes human societies and ecosystems, in which humans are part of nature. The functions of such a system arise from the interactions and interdependence of the social and ecological subsystems. The system's structure is characterised by reciprocal feedbacks, emphasising that humans must be seen as a part of, not apart from, nature (Arctic Council, 2016; Berkes and Folke, 1998).

**Socio-technical transitions** Where technological change is associated with social systems and the two are inextricably linked.

**Soil conservation** The maintenance of soil fertility through controlling erosion, preserving soil organic matter, ensuring favourable soil physical properties, and retaining nutrients (Young, 1989).

**Soil erosion** The displacement of the soil by the action of water or wind. Soil erosion is a major process of land degradation.

**Soil organic matter** The organic component of soil, comprising plant and animal residue at various stages of decomposition, and soil organisms.

**Soil moisture** Water stored in the soil in liquid or frozen form. Root-zone soil moisture is of most relevance for plant activity.

**Sustainable Development Goals (SDGs)** The 17 global goals for development for all countries established by the United Nations through a participatory process and elaborated in the 2030 Agenda for Sustainable Development,

**Transformation** A change in the fundamental attributes of natural and human systems.

**Transformative change** A system wide change that alters the fundamental attributes of the system.

**Uncertainty** A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, incomplete understanding of critical processes, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts) (see IPCC, 2004; Mastrandrea et al., 2010; Moss and Schneider, 2000).



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