HELP Guiding Principles for Drought Risk Management under a Changing Climate

Catalysing actions for enhancing climate resilience

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Catalysing actions for climate-resilient drought

HELP Guiding Principles for Drought Risk Management under a Changing Climate
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About HELP
The High-level Experts and Leaders Panel on Water and Disasters was convened at the request of the UN Secretary General's Advisory Board on Water and Sanitation in 2007. The ambition of HELP is to assist the international community, governments and stakeholders in mobilizing political will and resources. HELP will promote actions to raise awareness, ensure coordination and collaboration, establish common goals and targets, monitor progress, and take effective measures aimed at addressing the issues of water and disasters. Contact HELP secretariat for more information on the HELP activities (helpsecretariat@wateranddisaster.org).

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Why this report?

Within Disaster Risk Reduction (DRR) and water-related climate risks, much attention is paid to floods and storm surges. However, droughts are among the most far-reaching yet most impactful natural hazards to both nature and humanity.

In recent years, countries around the world have been hit hard by drought events that affect food supplies, agricultural incomes, employment, drinking water supplies, ecosystem health, transportation systems, and energy production. As the risk of drought is increasing due to ongoing climate change the HELP community started the flagship initiative to draft a report as guidance for supporting, defining and refining DRR for drought risk management. In this report proactive approaches, having greater emphasis on building resilience, are advocated.

This present 'Flagship Report on Drought Risk Management under a Changing Climate' aims at raising awareness and mainstream best practices for climate-resilient integrated drought management worldwide. The report addresses the following issues:

- how climate change is modifying drought and impacting ecosystems, societies and economic sectors;
- how climate change is affecting drought preparedness and response measures by imposing the need to adapt to increasing uncertainty;
- guiding principles for preparing drought risk management plans considering the current and future climate change impacts and promoting sustainable and equitable sharing of water resources.

The report provides an overall picture of how policy makers can enable climate-resilient drought management and directs the reader to some useful capacity building tools and programmes. It does so through various illustrative case studies of climate-resilient drought management and reference to the current state-of-the-art in drought risk management knowledge and understanding,

Due to climate change, drought may no longer be a temporary aberration but increasingly become part of everyday experience. It can be argued that this is already experienced in several regions, for example Brazil, but even when not yet experienced as such, climate change requires preparation for the uncertain future.

Returning to implementing 'traditional' measures that are mainly focused on emergency response during or after a drought event, is no longer an option in many cases, and is not sustainable in the long-term. In addition, improving water use efficiency alone is insufficient and may require stricter regulation or water allocation agreements to prevent an increase of water use (Jevons' paradox), the impact of which on individual stakeholders and cross-sectoral impacts should not be underestimated.

This report argues that what is needed to deal with droughts under climate change is a fundamental shift in how countries prepare for, manage and respond to drought. The report also highlights what is needed to get there, both at the highest policy level and at the level of implementation (project level). At the policy level, guiding principles for policy responses, governance, finance and social inclusiveness are presented, working in parallel and in agreement with DRR, Sustainable Development Goals (SDG's), etc. At the project level, some practical examples for inspiration and guidance are presented.

1

Climate change and droughts

Periods of drought with varying frequency, intensity and duration are a natural part of the water cycle in many regions of the world, and as such can be essential to regulating and maintaining ecosystem function and biodiversity. Over the past few thousand years, society have successfully adapted to living with periodic droughts in many regions.

However, according to the recent IPCC assessment (IPCC, 2021), worldwide freshwater resources are under increasing pressures of rapidly intensifying climate change effects (together with effects of land use change, soil degradation, and water mismanagement), putting the availability and quality of water resources and socio-economic developments at risk.

Impacts of droughts

According to different estimates at global level, at least 1.5 billion people have been directly affected by drought this century, and the economic cost over roughly that time has been estimated at $124 billion. The true cost is likely to be many times higher because such estimates do not include much of the impact in developing countries (UNDRR, 2021). Drought is also having a destabilizing effect on human livelihoods, triggering widespread emigration in some regions. In a recent survey by the UN's International Organization for Migration (IOM), drought was cited by 21% of the respondents as a very important reason to leave, and by an additional 18% as part of the reason to leave (IOM and UNCCD, 2019).

Drought impacts are often indirect and cascading. They are highly dependent upon social, economic, regional, and climatological contexts. Because of the difficulty in directly correlating drought impacts to a specific event, and because droughts may not even be identified until the impacts are already locked in, attribution is challenging. This, in turn, has consequences in terms of creating adequate preparatory and response policies as well as in securing appropriate drought finance (UNDRR, 2021).

Multiple drought-related climatic impact-drivers are projected to change in many regions of the world

In the 5th IPCC assessment report (IPCC, 2014), increases in the severity and frequency of drought in some regions such as Northern Africa (Sahel) and the Mediterranean were considered "likely". Due to difficulties in distinguishing long-term climate change from decadal-scale drought variability, drawing out larger trends in future drought occurrences was said to be "challenging to predict".

The 6th IPCC Assessment Report (IPCC, 2021), accompanied by an Interactive Atlas, takes an additional step. The Interactive Atlas identifies the following regions in which the three drought-related Climatic Impact Drivers[1] are all expected to increase, albeit at various pace and with various degrees of confidence: North, West Southern and East Southern Africa, Southern Australia, the Mediterranean,

Western/Central Europe and Western North America. In addition, there are nine regions, in Australia and the Americas, where two of the three drought-related drivers are expected to increase. Also noteworthy is that there are several arctic regions (not traditionally associated with drought events) where 'fire weather' will increase.

Drought and water stress

Drought is the manifestation of the shortage of water due to short- or long-term precipitation deficits. It is a predominantly natural phenomenon. Water scarcity defines a more persistent water stress condition (months, seasons, years) occurring when the water demand for human needs regularly exceeds the sustainable supply capacity of the natural system in river basins. Water scarcity is the consequence of anthropogenic impacts on the availability of water resources, e.g. water use by economic sectors and water abstraction for drinking water. Water stress is a term combining quantitative scarcity, water quality and water accessibility and generally is exacerbated during periods of drought. It occurs when there is insufficient water available to meet the demands of the environment and our society and economy, in terms of quantity or quality (The Global Compact, 2014; EEA, 2021). Table 1 provides the key characteristics of some terms that are often used in the context of droughts.

		Temporal extension		
		Short-term (days, weeks)	Mid-term (months, seasons, years)	Long-term (decades)
Causes	Natural	Dry Spell	Drought	Aridity
	Man-made	Temporary water overabstraction	Water scarcity	Desertification

Table 1. Overview schema of drought-related terms (source: Schmidt et al., 2012).

Drought categories and drought types

Droughts start with a period of lower-than-average precipitation, which then, depending on its duration, intensity and timing, may propagate through the hydrological cycle and lead to such effects as low soil moisture content, decreasing groundwater levels, saltwater intrusion, deteriorating water quality and reduced river discharges. Following these propagation phases, drought is often categorized in four ways (NDMC, 2019): meteorological drought, agricultural or soil moisture drought, hydrological drought and socio-economic drought (Figure 1). An additional fifth category known as ecological drought has emerged in recent years, emphasizing the impact of droughts on ecosystems and the associated effects on human communities that rely upon them. Ecological drought occurs when water availability drops below the threshold required to sustain natural ecosystems and its services to society (ecosystem services). A risk of extreme ecological droughts is that they can push ecosystems beyond a tipping point where they can no longer recover, such as the loss of species, shifts from perennial to intermittent flows, or desertification, which among others will result in reduced capacity to deliver ecosystem services.

Distinctions in the duration, impact, and physical expression of different drought types are essential for defining coherent responses. Recognition of the relevance of drought types such as "flash droughts" (spanning weeks or months) (Asmerom et al., 2013), "midsummer droughts" as experienced in Central America and the Caribbean (UNESCO, 2021) and

1 Climatic impact-drivers (CIDs) are defined as physical climate system conditions (e.g., means, events, extremes) that affect an element of society or ecosystems. Depending on system tolerance, CIDs and their changes can be detrimental, beneficial, neutral, or a mixture of each across interacting system elements and regions. The CIDs can be explored in the WGI Interactive Atlas *https://interactive-atlas.ipcc.ch/*. In the context of drought, three CIDs are of particular interest: hydrological drought, agricultural and ecological drought, and fire weather. Fire weather is defined as weather conditions conducive to triggering and sustaining wildfires.

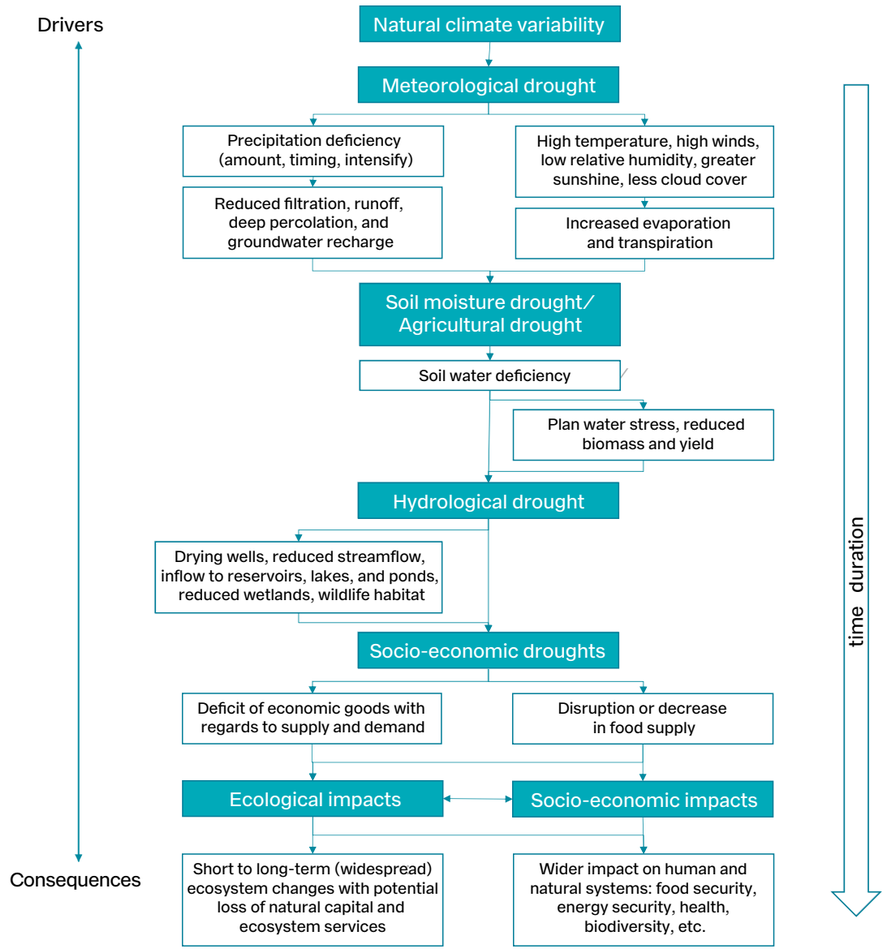


Figure 1. Categories of drought and their impacts. Adapted from: Van Loon et al. (2016).

"mega-droughts" (spanning years or even multiple decades) (Asmerom et al., 2013) are pushing countries to re-examine existing drought policies and planning measures for conditions they originally were never designed to address. Due to complex feedback loops between water, geology, land-cover, climate cycles, and socio-economic systems, broad generalizations about drought conditions and response measures are of limited utility. Greater attention must be paid to the local hydrologic and climatic context, keeping in mind that the extent of droughts can be so wide that also the regional dimension is relevant.

Given the potential for complex multi-sectoral drought impacts, comprehensive risk-based approaches are important for reducing the impacts of drought. The palette of available risk assessment methodologies and drought response options matters. While much attention has been paid to risks associated with rapid onset water-related disasters, such as floods and storms, more work is needed to raise awareness and mainstream best practices for climate-resilient integrated drought management worldwide (Mens et al., 2022).

2

Current status in drought risk management

A common element in recent literature on drought risk management is the exhortation to make the transition from reactive disaster management to proactive drought risk management, with the ultimate goal to increase climate resilience of ecosystems, society and economic sectors. Drought risk management should include forward-looking elements, taking account of climate change (among others) as an important factor that will affect and potentially aggravate future events.

Drought risk approach

A common element in recent literature on drought risk management is the exhortation to make the transition from reactive disaster management to proactive drought risk management, with the ultimate goal to increase climate resilience of ecosystems, society and economic sectors. Drought risk management should include forward-looking elements, taking account of climate change (among others) as an important factor that will affect and potentially aggravate future events.

Drought risk is commonly defined and assessed as: risk = hazard x exposure x vulnerability. Drought hazard represents the likelihood of a drought event of given subtype, onset, intensity and/or duration, exposure the value or area of an affected interest or economic sector, and vulnerability the degree to which the sector is likely to be impacted. These three components must be described in terms that are sector specific, location specific, and dynamic. Much research is currently devoted to the development of indicators to enable adequate risk assessments.

Figure 2 presents a schematic view of the interplay between categories of droughts, risk components, risks and sectors.

Different sectors may be affected by different drought categories, and thus may need different indicators to determine and characterize droughts. Rain-fed agriculture, for example, is dependent on precipitation, whilst irrigated agriculture depends on irrigation water taken from rivers or the groundwater and shipping on water levels in rivers.

Exposure to drought extends to all assets and sectors located in a drought-prone area. Exposure can be characterized with available spatial and statistical data on areas, intensity of use, numbers of factories etc. In data-scarce regions proxies are often derived from satellite data and data of population density.

Drought vulnerability typically is subdivided into four categories: social (level of well-being of individuals and communities), economic (economic status of individuals, communities and nations), infrastructural (infrastructures needed to support the production

of goods and sustainability of livelihoods) and environmental/ecosystem factors.

A thorough understanding of the diverse direct and indirect vulnerabilities and potential impacts to natural and human systems is needed to develop appropriate risk management strategies tailored to specific sectors and user needs (Vogt et al., 2018). Droughts contain characteristics that relate to systemic risks (UNDRR, 2021); they can have hidden impacts on human health and well-being such as heat stress, food insecurity, migration, social instability, and other factors.

Drought may affect a given sector differently in different countries, depending on their intrinsic exposure and vulnerability as well as existing mitigation measures and the countries' adaptive capacity (Naumann et al., 2015; Mens et al., 2022). In this context, drought risk mitigation measures, targeted at strengthening drought resilience of society and sectors, can significantly reduce the risk of a sector to a drought event. Such drought risk mitigation measures include, but are not limited to: improved cooling techniques, drought-resistant crops, or lighter river navigation vessels, but also institutional transformations, livelihood and economic diversification, insurance and other market tools, social safety nets, monitoring and data collection, and early warning and alert systems. In the same way, the existence of well-regulated and implemented integrated drought management plans helps to reduce the risk of a sector to a drought event to a great degree.

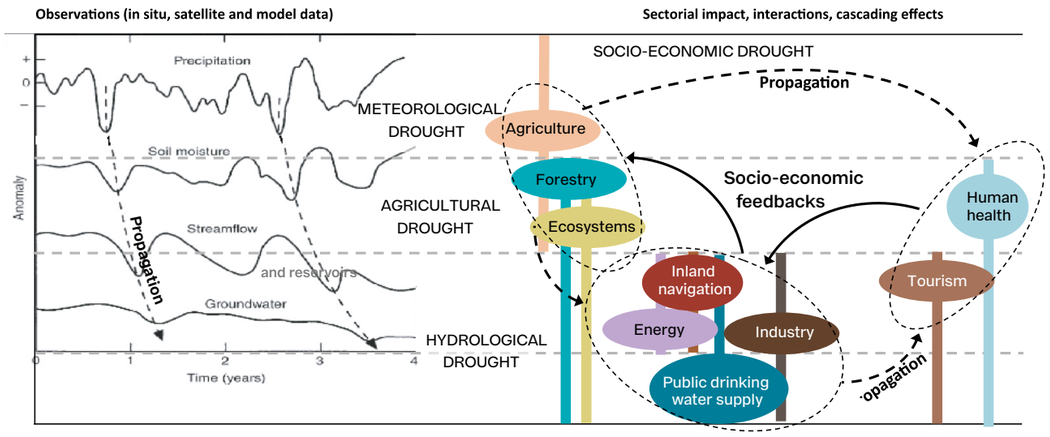


Figure 2. Schematic view of the interplay between drought categories and risks. The left panel shows the propagation of the physical occurrence of drought from meteorological drought, through agricultural drought to hydrological drought. The right panel shows the risk of drought of nine prominent water-dependent sectors. Vertical bars indicate the categories of physical drought that impact a particular sector. Sectors with close interactions are grouped in three clusters with interactions and feedbacks between clusters shown as well (own elaboration).

Drought risk management approaches

Over recent years, several international organizations have published reports drawing attention to drought and proposing new approaches to drought risk management. Prominent ones include, in order of publication date:

- WMO, GWP, 2014: National Drought Management Policy Guidelines: A Template for Action. Includes a 10-step process to develop national drought management policy and drought preparedness and mitigation plans. Some of the publications cited below build on them.

- UNESCO, on behalf of WWF, 2016: A strategic approach for drought risk management. This report presents amongst others definitions, causes and impacts, categorizations, a strategic drought risk management framework, a portfolio development approach and 8 golden rules for strategic drought risk management.

- UNCCD, 2017, together with WMO and GWP: White paper on drought in the LAC region. This paper presents a 10-step process in line with the 3 pillars of drought management (see below) and includes an atlas with case studies descriptions.

- United Nations, 2018: Words into Action - Implementation guide for addressing water-related disasters and transboundary cooperation. This report integrates disaster risk management with water management and climate adaptation and includes guidelines and pragmatic roadmaps to programming an effective implementation strategy. The report is the result of co-production process aiming at knowledge transfer.

- GCA, 2019: Background paper about water and climate action. This paper's focus is on convergence of water and climate action and it presents a framework of proposed activities towards climate resilient water management.

- World Bank, 2019: Principles and Implementation Guidance for drought hazard and risk assessment. Aimed at professionals who require practical guidance while assessing drought, this guidance includes key definitions, four guiding principles, a workflow framework, an online drought catalogue, and examples (case studies) of applications.

- UNESCO, 2020: Water and Climate Change. The United Nations World Water Development Report 2020. UN-Water's flagship report on water and sanitation issues. This edition illustrates the linkages between water and climate change. It describes the challenges and opportunities of climate change and provide potential responses, addressing the interrelations between water, people, environment and economics.

- UNESCO, 2021: Midsummer Drought Atlas for Central America and the Caribbean. The atlas was developed by integrating several regional methodologies into a software package and using a homogenous data source. The Midsummer Drought is of paramount importance for water and food security in the region. The atlas allows for identification of this event's characteristics, as well as specific areas with highest vulnerability, thus facilitating implementation of more effective and targeted policies.

- World Bank (Browder et al., 2021): An EPIC Response: Innovative Governance for Flood and Drought Risk Management. This report provides practical guidelines, amongst others a hydro-climatic policy matrix to guide tasks. It defines four stages in maturity level of drought risk management and planning (together with flood management). It introduces a drought cascade to guide the design order of measures.

- UNDRR, 2021: Special Report on Drought 2021 – Global Assessment Report on Disaster Risk Reduction. This report aims to make a step forward in building the awareness that with improving understanding of the globally networked aspects of drought and other complex risks, the changes required to reduce risk and improve the experience of drought become possible. The report contains a list of recommendations for the type of governance that is needed to make the transition from risk to resilience.

- UNCCD (Barker et al., 2021): Good practice guidance for national reporting on UNCCD Strategic Objective 3. This report provides practical advice on how on how to calculate three indicators used for reporting progress towards the UNCCD objective "to mitigate, adapt to, and manage the effects of drought in order to enhance resilience of vulnerable populations and ecosystems".

The one thing all these publications have in common is that they draw attention to the large impacts of drought and emphasize the need to take actions quickly. All have their specific merits in addressing different groups of stakeholders and pointing out the relevance of different aspects of the physical system, including the planning procedures, the transactional environment or the type of governance.

One approach that is used in several publications, that has been successfully applied in national and regional drought studies, is the “Three Pillars” strategy for drought management, formulated in 2015 by UN-Water’s Decade Programme on Capacity Development and its partners (Figure 3). The Three Pillars help structure an integrated approach that addresses multiple components of drought management, including disaster risk reduction, climate adaptation strategies, and national water policies. While the Three Pillars approach is similar to other types of disaster risk management, the types of monitoring systems, the scope of the assessment, and the responses will be specific to drought management (WMO and GWP, 2016). The second pillar - vulnerability and impact assessment - has been by design defined very broadly, in order to be adapted to the context in terms of time and funding available and sectoral and societal focus. It may include a rapid assessment immediately after a drought for humanitarian purposes, or a more elaborate ex ante assessment for drought planning and resilience building purposes. In the latter case, it should encompass the analysis necessary to build long term resilience to drought, which would include climate risk assessment and stress testing. Whether this is done in practice is a different question and the need to include a climate risk assessment must be articulated more explicitly for this pillar.

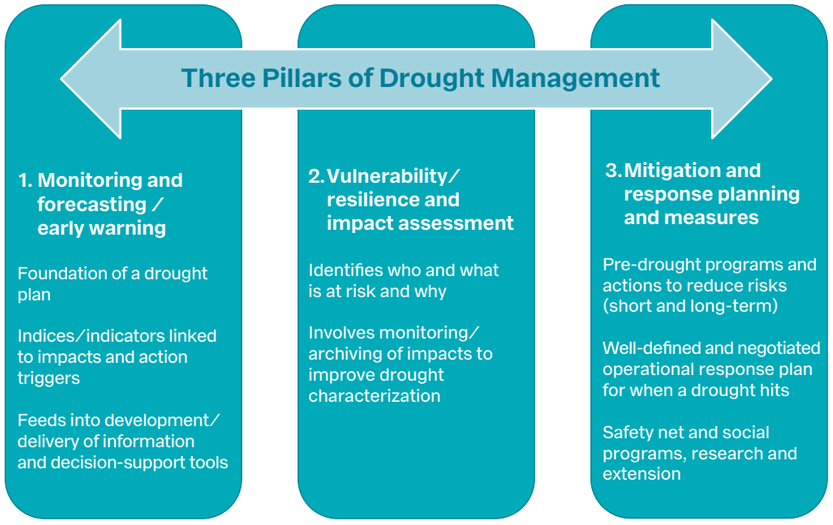


Figure 3. Three pillars of drought management. Adapted from WMO and GWP (2014).

Drought risk management, disaster risk reduction and resilience

Disaster Risk Reduction (DRR) is aimed at preventing new and reducing existing disaster risk (hazard, exposure or vulnerability), and managing residual risk, all of which contributes to strengthening resilience and therefore to the achievement of sustainable development (UNISDR, 2017).

Drought Risk Management (DRM) and DRR are connected, but there are differences. To name three prominent differences:

- DRR addresses all hazard types and not only climate-related ones, including for example earthquakes, explosions and environmental pollution disasters;

- DRR usually considers the probability of occurrence of extremes as static, while in DRM additionally taking account of the changes caused by future climate change is a key element;

- DRR has its origins mostly in civil protection and related ministries, while DRM often has its roots in scientific theory and ministries of environment.

Both fields can benefit from shared data gathering and presentation procedures. For climate change actions, it is becoming a high priority to implement a comprehensive, integrated risk approach by considering the full disaster management cycle: prevention/mitigation, preparedness, response and recovery (EEA, 2017). The UNDRR Policy Brief on Disaster Risk Reduction and Climate Change emphasizes the urgency to act and provides six policy recommendations (UNDRR, 2021b). As the key aim of the Sendai Framework is to prevent new and reduce existing disaster risk, it will benefit from prospective and proactive drought risk management to reduce and, where possible, avoid future risks and to increase resilience to the changing drought hazard. Therefore, the Global Assessment Report (GAR) Special Report on Drought (UNDRR, 2021a) reconfirms the need for convergence and integration of strategies within international mechanisms – including DRR, climate change adaptation (as per the Paris Agreement), the Convention on Biological Diversity, the Convention to Combat Desertification and the Sustainable Development Goals. Arguably, climate-informed drought risk management is a tool for connecting these three mechanisms as it addresses sustainable development, climate adaptation, and DRR.

Policy responses to drought risk

In previous sections of this chapter, the approaches and activities that should be incorporated in drought risk management have been considered. Drought policy defines the strategic goals and arranges the enabling factors for operational drought risk management.

As operational drought risk management can be divided into actions and measures to be taken during the pre ‘cold’ phase in preparation of a drought, and during the ‘hot’ phase when a drought event is happening, drought policy should provide guidelines for both phases and connect them. Two prominent tasks of drought policy are:

- To provide clear guidelines for decision-making during the ‘hot’ phase. These guidelines should be based on a pre-existing priority list of water-dependent sectors and users and include DRR practices. Plans should be in place for transparent and timely provision of information to, and expert consultation with, water users.

- To align long and short-term actions taken against drought impacts, in order to avoid lock-ins and disinvestments. Long-term measures may include spatial measures and emphasize enhancing water supply (e.g., increasing storage capacity, groundwater recharge, or reuse and recycling) coupled with improved demand management (e.g., reducing overall use, reviewing allocation rights, or educational campaigns) (IDMP, 2018). Each sector as a water user will have its own specific set of preventative measures to lessen the likelihood or impact of droughts. All such measures should be designed under commonly accepted principles of priority actions (e.g. ‘use water efficiently – save available water – supply additional water’) and take proper account of climate change and socio-economic developments. Short-term measures, taken when drought has already begun, should be selected in such a way that they do not undermine established long-term measures.

Water efficiency programs curtail water demand and are designed to create long-term (or permanent) water use reductions. This strategy can reduce the impact of subsequent droughts and the strategies may continue beyond the term of a drought. However, improved water efficiency should always be coupled with other short- and long-term demand management methods to ensure that the water conserved through efficiency techniques is not simply reallocated to other uses (unless that is the stated goal of the efficiency intervention).

3

Adapting to the future hydrological conditions

In this chapter we highlight a set of principles in the field of integrated drought risk management that need special attention, because they both are essential for adequate policy implementation and are not always addressed adequately in practice. We call these the HELP principles for climate resilient drought risk management.

The reader should be aware that this set of principles is not necessarily complete nor that it constitutes a complete framework for increased drought resilience planning and implementation: reference to the many resources listed in Chapter 2 is recommended for more details on the range of options. What we want to achieve from presenting these principles here is to give an initial strategic steer and impulse towards improving drought risk management.

We have identified twelve principles, grouped in three categories: two core principles, based on shared values; four principles of thinking modes that foster good planning and management; and six principles to avoid overlooking planning aspects (Table 2).

HELP core principles	Principle 1:	Respect environmental limits for land and water use
	Principle 2:	Increase the resilience of the whole of society, including its vulnerable communities, to droughts and water scarcity
HELP principles on modes of thinking	Principle 3:	Think in terms of integrated systems
	Principle 4:	Think and plan in cyclic terms
	Principle 5:	Plan from the bottom-up and co-design measures with affected communities
	Principle 6:	Embrace proactiveness and learn to deal with uncertainties
HELP principles on planning aspects	Principle 7:	Work in coordination with international agreements and conventions
	Principle 8:	Consider drought risk management as an issue without borders
	Principle 9:	Mitigate the impact of drought and water scarcity on ecosystems and biodiversity
	Principle 10:	Invest in nature-based and hybrid infrastructure
	Principle 11:	Tap into public-private finance and expand the role of drought-risk insurance
	Principle 12:	Strengthen monitoring and evaluation

Table 2. The twelve HELP principles for good, climate resilient and integrated drought risk management.

Sustainable management and use of fresh water resources and ecosystems play a key role in preserving biodiversity and facilitating social development and economic prosperity. Water, therefore, is the cornerstone of many (if not all) of the Sustainable Development Goals. Implementation of the drought risk management principles inevitably will contribute to the SDG's, in particular SDG 1 (No poverty), SDG 5 (Achieve gender equality and empower all women and girls), SDG 6 (Clean water and sanitation), SDG 13 (Climate action) and SDG 15 (Life on Land). Drought risk management approaches that considers the HELP principles will promote building resilience of the vulnerable, with special attention for the arid, poor, fragile and conflict areas, and reduce their exposure and vulnerability to extreme drought events due to changing climate. As drought risk management is preparing for adapting to climate change risks, it contributes to building community peace, trust and security.

CASE: ALTA DE LA PICASA CATCHMENT, ARGENTINA

The Alta de la Picasa catchment is located in a transition zone between the humid and arid pampas. The area is affected by increasing variability in the rainfall regime, causing floods and droughts. Coupled with unbalanced land use this has had a significant negative effect on agricultural production. In 2021 a project was started, supported by modelling studies. One of the outcomes is that awareness is growing that technical measures such as water storage and water transfer will not solve the problems. Instead, the key is to develop sustainable land-use management practices, including measures such as decreasing the current area of soya bean monoculture and increase areas of natural vegetation.

This approach requires cooperation of the stakeholders and their recognition that this is the most feasible solution to restore the balance in the environment. The stakeholder engagement process was started, supported by a collaborative modelling approach.

Two basic HELP principles based on shared norms and values

Principle 1
Respect environmental limits for land and water use
Society should take the natural carrying capacity of land and water resources as the base for its sustainable use of the resources and economic growth. Spatial planning and total water use should be adjusted to the hydrological cycle and sustainable water balances, in particular towards the total available renewable water resources (surface runoff, groundwater recharge and soil moisture) now and under future scenarios of climate change and socio-economic development. Water managers need to define the safe operating space in terms of water quantity and availability while securing adequate flows to support ecosystems and its services and good water quality. In search for meeting growing water supply, food, and energy needs, and controlling the high inter-annual variability in water availability, decision makers must decide on water management priorities and actions accordingly.

Principle 2
Increase the resilience of the whole of society, including its vulnerable communities, to droughts and water scarcity
Drought risk management (DRM) should consider the social dimension explicitly and aim to develop sustainable, inclusive solutions, identifying and addressing segments in society, including gender issues and indigenous communities' issues, according to their vulnerability to drought. DRM should embrace the basic principle of 'leaving no one behind' and ensure that the whole of society is able to take part in the benefits of proposed measures and transitions. Inclusiveness calls for improving the ability, opportunity, and dignity of all people – especially disadvantaged populations - to take part in decisions of water resources planning and management. An inclusive process of integrated water resources planning and management is the one where all people feel valued, their differences are acknowledged and fairly addressed, while their basic water rights are met so they can live in dignity. Inclusiveness also implies an awareness about unintended consequences of water security measures, which might cause or contribute to adverse human rights impacts on some groups. To that end, an inclusive process is recommended that purposely defines mechanisms for preventing (or mitigating) eventual adverse impacts through open dialogue and consultation between public authorities and potentially affected groups. Ideally, water managers, authorities, and communities should agree on mechanisms for preventing grievances and – should they occur – a transparent process for resolving disagreements.

POST-DISASTER HOUSING AND LIVELIHOOD RECOVERY

From a review of hazard literature on post-disaster recovery, it emerges that affected persons perceive housing and livelihood as critical for their recovery.

Most post-disaster recovery programs have focussed on housing provision. Part of the reason is that this produces visible outcomes with high political appeal. The justification often comes from the argument that housing is a basic human right and is also an industry that generates economic activities. However, housing reconstruction or provisioning in post-disaster recovery programs has mostly benefitted middle-income households who were homeowners prior to disasters. Renters and female headed households (who often do not have property rights) lose out in the process.

The livelihood recovery programs are a set of development-based interventions that involve improving the resilience of household livelihoods so that food and other basic needs can be met on a sustainable basis. The problem is that while practice on post-disaster recovery approaches recovery as a sectoral framework with housing and livelihoods as two sectors with minimal overlap, households plan cross-sectorally for their recovery.

Security of livelihood, income and social ties are important for households for their well-being and it is important that these are secured. Insurance policies for income and asset loss may help households in restoring their well-being sooner. Long-term plans for guaranteeing income security would require restitution of jobs and employment. The loss of life of an earning member takes a toll on emotional well-being of the household. Again, insurance policies for the loss of life due to disaster may speed up the recovery process. Immediately after disaster, mitigating the negative effect of loss of income would require approaches like direct cash transfers.

Social capital is an important contributor to housing well-being for vulnerable communities in resettlement colonies. This can be explained by high interdependence of working families for childcare, aged care, road safety, financial security, psychological counselling, and similar other support services which are otherwise not available or are unaffordable. Countries may benefit from creating a permanent disaster relief fund for the vulnerable communities and private insurance against disaster.

The role of fourth tier (comprising community-based organisations, self-help groups and association of persons) in post-disaster reconstruction is immense and needs to be formally incorporated in the process. The social capital that these associations have, can draw resources, human and capital, for post-disaster reconstruction. During COVID 19 pandemic, self-help groups have been able to deliver urban services, food and protective equipment to most vulnerable households in many slums in India.

Family gathering water in Dhule, Maharashtra, India

CASE: INTEGRATED DROUGHT MANAGEMENT PLANS FOR THE HORN OF AFRICA

The Integrated Drought Management Programme (IDMP) in the Horn of Africa promotes drought resilience of countries, communities and ecosystems in the region. The programme bundles a variety of small-scale, community-driven IDMP projects. A common element is to support stakeholders at all levels by providing policy and management guidance and by sharing scientific information, knowledge and best practices for Integrated Drought Management. One of the projects is about the Abreha we-Atsebeha watershed in northern Ethiopia. In the past, the land had become severely degraded as a result of soil erosion, deforestation, overgrazing and loss of biodiversity. This had reduced drought resilience to the degree that, in 1998, the government proposed that the community should be relocated to a more water-secure and fertile area. This gave the people the impetus to begin addressing their deep-rooted problems and 'heal their land'. Faced with relocation, which was considered as a betrayal of their country, culture and religion, they began the long journey towards adopting an integrated participatory watershed management approach. Measures included the construction of soil and stone bunds, trenches and percolation pits, small storage dams, water harvesting ponds and hand dug wells. Erosion gullies were converted into water harvesting sites, springs were developed as sources of drinking water, fruit trees and naturally occurring species were planted. Women received additional training in documentation and other aspects of building resilience to climate change. As a result of these interventions, the community has become food self-sufficient, transforming their land and turning degraded hillsides into productive farmland.

Further reading:
https://www.droughtmanagement.info/idmp_hoa/

Four principles on modes of thinking to prepare a targeted DRMP

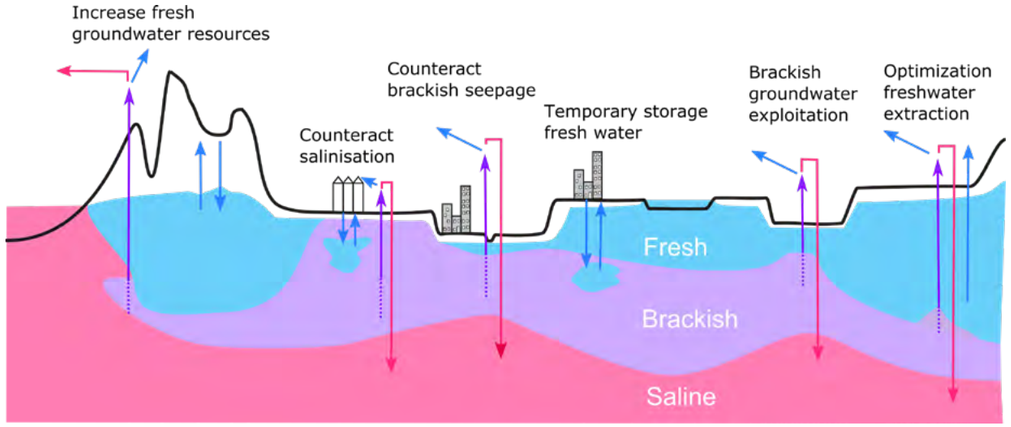
Principle 3
Think in terms of integrated systems
The issue of drought is intrinsically complex, as it involves various compartments of the soil-water-atmosphere physical system, spatial planning, many parts of the social system including its governance, legal and financial arrangements, the economic system including the water-dependent sectors, and the environment. Furthermore, as measures for drought risk management often involve short-term investments with benefits on the long term, the intrinsic uncertainties related to climate change and socio-economic development need to be confronted and accommodated. Addressing these issues separately is no longer a viable option, at least in most cases. Partly this is because issues and challenges related to drought risks usually propagate the entire socio-economic system. Interdependencies should be addressed, therefore, in an all-encompassing drought risk policy. A further cause is the fact that the use of water and more in general, the use of natural resources, ecosystem services and available space, has intensified to the degree that measures taken in one sector immediately have repercussions elsewhere. How such integrative thinking is shaped largely depends on the context. Again, the references cited in Chapter 2 provide some examples of how this may work out in practice. Development of systemic approaches and various types of nexus approaches have been started and, although many methodological problems may yet need to be resolved, these certainly help guide integrative thinking.

CASE: COASTAR RESEARCH AND IMPLEMENTATION PROJECT, THE NETHERLANDS / CHILI

The Alta de la Picasa catchment is located in a transition zone between the humid and arid pampas. The area is affected by increasing variability in the rainfall regime, causing floods and droughts. Coupled with unbalanced land use this has had a significant negative effect on agricultural production. In 2021 a project was started, supported by modelling studies. One of the outcomes is that awareness is growing that technical measures such as water storage and water transfer will not solve the problems.

Instead, the key is to develop sustainable land-use management practices, including measures such as decreasing the current area of soya bean monoculture and increase areas of natural vegetation.

This approach requires cooperation of the stake-holders and their recognition that this is the most feasible solution to restore the balance in the environment. The stakeholder engagement process was started, supported by a collaborative modelling approach.



Additional information on application in Chili: *https://www.deltares.nl/en/news/coastar-goes-chile/*

Principle 4
Think and plan in cyclic terms
Drought risk management plans should be developed in a cyclic and iterative process. Cycles may, for example, proceed from coarse to detailed approximations, from reaping easy gains to addressing the complex problems in their implementation, or from working in a basic governance setting to a more mature one. Such a staged approach fits well with the concept of the evolution stages of drought risk management, from nascent to effective, as recommended in World Bank's, "A Policy Framework for Hydro-Climatic Risk Management: Shared Responsibilities and Hidden Connections" (WB, 2021).

A cyclic process architecture enables momentum to be gained by working towards intermediate goals, when the end goals are clear but cannot yet be reached. This prevents the whole process slowing down when, for example, one or some of the steps are not yet fully developed. It promotes a 'learning by doing' attitude. Key in a cyclic approach is that lessons learned in one cycle are transferred to the next. The planning process should be made flexible enough to accommodate necessary adjustments. Part of the success of this approach is having technical professionals make recommendations to policy specialists and decision makers, and vice versa technical professionals receiving feedback and accommodate questions from decision makers.

Connected to a cyclic approach is the gradual development and improvement of a governance structure to secure the practical, manageable implementation of plans that span all levels of government, multiple geographical scales and time (MED Joint Process WFD/EUWI Water Scarcity Drafting Group, 2006). Such a structure help clarify who takes action, why, when and how, and how this action is funded.

CASE: THE DUTCH DELTA PROGRAMME FOR FRESH WATER

The Delta Programme for Fresh Water has the aim to render the Netherlands resilient against freshwater shortages. The programme follows a cyclic approach. Every six years a problem analysis is executed based on the progress of measure implementation, emerging trends in land and water use, improvements in the conceptual and modelling framework, new insights in climate change, and new projections of demographic and economic growth. With these analyses the strategy is adjusted and a new six year investment plan is developed. In 2020 the national strategy was updated, incorporating the lessons learned during the drought of 2018-2020. For the high part of the Netherlands the emphasis is on retaining and storing rainwater. In the low part of the Netherlands emphasis is on retaining and distributing the available water more efficiently based on real-time data on the availability of and demand for fresh water.

More information on the Delta Programme: https://english.deltaprogramma.nl/

CASE: CO-DESIGN OF CLIMATE SERVICES IN EDEM ANI, NIGERIA

Climate information is often not used to its full potential in adaptation planning and decision-making. More bottom-up and inclusive approaches to tailor information to users' specific institutional and decision contexts were explored in a project to improve agricultural decision-making in Edem Ani, Enugu State, Nigeria (Butterfield and Osono, 2020). Tailored information meets the ambition to bridge the gap between providers and users of climate information.

The case points to the importance of clearly identifying the potential beneficiaries of climate services, to highlight the differences between direct users and the broader potential beneficiaries. For example, in this case, the people who will make direct use of climate services are the farmers and local community. This group includes those who are most vulnerable to the climate challenge, and who are most affected by related decisions. By contrast, the users who make decisions regarding the provision of information and services are another group. These people are more likely to be extension officers, and representatives of NGOs, state and local government, the private sector, and academia.

As the case study demonstrated, indigenous coping strategies for climate adaptation are physically strenuous, with potential related negative health effects. Some coping strategies also require significant financial investment. As a result, one assumed objective of co-exploration and co-production processes would be to make adaptation options more viable by reducing costs, effort and negative health impacts.

The project created multiple opportunities for farmers, local, state and national government officials to share information. The process revealed a sophisticated understanding of climate information, its current usage, and its potential future benefits for the community and state. This sharing of knowledge in the project activities reflects an essential part of the co-production process. This is the starting point of developing co-produced climate services knowledge for decision-makers.

Project website: https://www.sei.org/publications/improving-the-co-production-of-climate-services-for-agriculture-a-case-study-from-nigeria/

Principle 5
Plan from the bottom-up and co-design measures with affected communities

By adopting a bottom-up approach and co-design planning principles, society can simultaneously reduce its sensitivity and increase its adaptive capacity to droughts. Depending on how local users experience drought, now or in the future, in their own context, water users and consumers are actively involved to adjust their behavior and operation. This involves the full range of water-related economic sectors: agriculture, industry, mining, energy production, domestic water use, tourism, shipping, plus the environment. In practice this implies following a bottom-up approach in designing drought management plan and identification of meaningful indicators that define projects that make the system more flexible and indicate cross-sectoral relations and trade-offs. Particular efforts should be made to address social inclusive representation in planning and water resources management interventions, by identifying and engaging the most vulnerable people.

Bottom-up processes are instrumental in (a) seeing a system as a whole, (b) defining problems in inter-locking, systemic ways, (c) engaging with diverse stakeholders to define a shared vision of what resilience can look like with change, and (d) creating collaborative, effective solutions.

UNESCO and AGWA (2021) published a policy brief 'Planning Water Resilience from the Bottom-Up to Meet Climate and Development Goals'. As a contribution to the bottom-up approaches, UNESCO and the International Center for Integrated Water Resources Management (ICIWaRM), published Climate Risk Informed Decision Analysis (CRIDA); see case study below.

CASE: FROM RECOVERY TO BOTTOM-UP RESILIENCE BUILDING IN THE ZIMBABWEAN HIGHLANDS

Zimbabwe is exposed to multiple weather-related hazards, suffering from frequent periodic cyclones, droughts, floods and landslides. The situation is becoming worse due to the impact of climate change, which is increasing the frequency and intensity of tropical storms and cyclones, as well as more intense and frequent droughts.

An example of such conditions were seen in 2019, when a long drought in the Zimbabwean highlands was followed by tropical Cyclone Idai, affecting 270 000 people and displacing 60 000, making it the most devastating natural disaster to occur in the country. The impact of a drought followed by the cyclone has therefore increased environmental risks, which will in turn affect local adaptation capacity to future climate shocks. All these factors indicate that similar events in future are therefore likely to cause even more destruction.

As part of the Zimbabwe Idai Recovery Project, funded through the World Bank and managed by UNOPS, UNESCO is supporting the affected communities to move from recovery towards resilience building through a multidisciplinary approach.

The project embraced the Climate Risk Informed Decision Analysis (CRIDA), a methodology that uses a bottom-up approach to climate change adaptation. Starting from a very detailed assessment of the climate risks for the local communities and their livelihoods, climate change scenarios are explored for the area and the impact on drought frequency and occurrence identified, leading to a better insight into expected water security challenges. By involving local community members from the start, adaptation actions are jointly identified and implemented.

An second key aspect of the project is to reduce the impact of future risks, by providing drought early warning information, as included under principle 12.

UNESCO has also supported the community to become a Biosphere Reserve, to allow the area to be managed sustainably in agreement with its current and future climate and to move away from damage recovery and move truly towards resilience building.

Further reading:
https://en.unesco.org/be-resilient_zim
Information on the CRIDA methodology:
https://en.unesco.org/crida

CASE: DEVELOPMENT OF DROUGHT RISK MANAGEMENT PLAN IN SLOVAKIA

Drought management practice in Slovakia used to be reactive and based on crisis-oriented drought policies. The 2018 'Value of H_2O in the country' plan includes a range of measures which is proactive and focuses on prevention and mitigation instead of reacting to drought once it has occurred. The measures involve modernisation of irrigation systems, changes in forest structure, rainwater harvesting, planting trees, development of green spaces, and in the urban environment, installing green and vertical roofs and promoting rainwater infiltration. The plan also covers water management, via reconstruction of smaller reservoirs of water and green infrastructure, including wetlands restoration. There is also a crisis plan to supply water during prolonged drought and programmes for public education and raising awareness of drought and water scarcity. Together, these measures should mean that even during long, dry spells, there will be some mitigation of drought effects.

Additional information: *https://reliefweb.int/report/slovakia/can-drought-be-prevented-slovakia-aims-try*

How to integrate drought into planning process for development of the RBMPs?

- Step 7 Develop an educational programme
- Step 6 Develop a research and science progamme
- Step 5 Publicize the DMP to the public for comments and active involvement
- Step 4 Produce/update the Drought Management Plan
- Step 3 Inventory of data needed for Drought Management Plan development
- Step 2 Define the objectives of a drought risk-based management policy
- Step 1 Develop a drought policy and establish a Drought Management Committee

Drought policy development and production of Drought management plan

Principle 6

Embrace proactiveness and learn to deal with uncertainties

In line with the recommendations of the Sendai Framework for Disaster Risk Reduction, drought risk management should transit from a reactive to a proactive mindset. Proactiveness requires scenario analyses of all environmental, economic and societal aspects that are impacted by drought, and preparation of different ways of coping with its consequences. This entails deepening the analysis to incorporate inherently uncertain future conditions. By developing outlooks and scenarios for climate and socio-economic changes a 'feel' (or common understanding) can be developed among planners and stakeholders alike for drought conditions that may develop.

The response to uncertainty should (a) focus on robust responses to high confidence impacts, and (b) plan for flexibility for low-confidence but potentially very detrimental impacts. Further options to be considered include low-regret ("limited-" or "no-regret") options, win-win options, options that favor reversibility, flexibility and safety margins, soft strategies and appropriate delay of actions or decisions[2]. Scenarios, sketching different plausible futures, are instrumental in raising awareness of prevailing trends and related uncertainties. Scenarios can further be used to benchmark proposed measures and can be incorporated in adaptive planning approaches and adaptive pathways. Applied to ongoing drought events, management tools and policies must be in place to assess different scenarios for the continuation of the drought, considering questions like 'What if it rains tomorrow?', 'What if is still dry a year from now?', 'What medium-term forecasts should trigger increased government intervention?'. Such an approach should reduce economic and ecological damage and social unrest caused by droughts and will help to reduce mis-investments in measures that need to be revised before the end of their technical lifetime.

2 https://climate-adapt.eea.europa.eu/knowledge/tools/uncertainty-guidance/topic3

CASE: CLIMATE RISK INFORMED DECISION ANALYSIS IN SOUTH-AFRICA

The water crisis in Cape Town, South Africa, was brought about by a regional shortage in the Western Cape. Reservoir levels had been reducing since 2015, and between mid-2017 and mid-2018 the water levels were between 15 and 30% of their total capacity (CSAG, n.d.). The crisis led to the development of a long-term strategy to protect resources, using a holistic approach. This example shows how a climate-induced shortage was dealt with by adopting a new management approach.

On the longer term (after 2040) a 'water gap' is predicted occur at a yearly basis, causing significant water scarcity risks for sectors having high water demand and the vulnerable user groups. This implies the water gap may become a structural problem resulting from both drier future climatic conditions and a predicted increase in the water demand (population increase and economic growth). Current measures mainly benefit urban areas, the industrial sector and agricultural sector. Nature and biodiversity however, may be adversely affected

The new strategy includes several elements. Among them:

- Sufficient, reliable water from diverse sources. Water supply now depends mainly on reservoirs, but diversification of water resources is an important element in the future water strategy of the basin. Cape Town will develop new and diverse supplies of water (which could include groundwater and reused and desalinated water) in a cost-effective and timely manner to increase resilience and substantially reduce the likelihood of severe water restrictions in the future. It is committed to increasing the available supply, in a way that is adaptable and robust to changes in circumstances.
- Shared benefits from regional water resources. Cape Town will work with key stakeholders and partners, including other urban and agriculture water users, and other spheres of government, to make the most of the opportunities to optimize the economic, social and ecological benefits of regional water resources, and to reduce the risks. This will be done through collaborative processes.

Source: City of Cape Town (2019) *www.capetown.gov.za/thinkwater*

Principle 7
Work in coordination with international agreements and conventions
Drought risk management planning should build on and enhance parallel planning initiatives at regional or global level. The Sendai Convention on Disaster Risk Reduction has already been mentioned in Section 2.3 and the SDG's at the beginning of this Chapter. Other prominent initiatives are UN-Habitat, the development of National Risk Assessments (OECD), UNFCCC/UNDP National Adaptation Plans, UNECE's Handbook on Water Allocation in an International Context, Europe's Adaptation Strategy and National Adaptation Strategies and Plans, the Convention on Biological Diversity and the Convention to Combat Desertification. Climate change seems not always adequately accounted for in all international agreements.

THE WATER CONVENTION

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) requires Parties to prevent, control and reduce transboundary impact, use transboundary waters in a reasonable and equitable way and ensure their sustainable management, which has growing importance during drought periods. Parties bordering the same transboundary waters have to cooperate by entering into specific agreements and establishing joint bodies. For specific basins or aquifers bilateral or multilateral agreements already exist. The water convention fosters their establishment and implementation, as well as further development.

https://unece.org/environment-policy/water

CASE: THE ROLE OF INTERNATIONAL CONVENTIONS IN THE MURRAY DARLING BASIN WATER MANAGEMENT

The Australian Water Act 2007 provides for managing waters of the Murray Darling Basin, including in droughts, in a manner that gives effect to relevant treaties to which Australia is a party, such as the Ramsar Convention on Wetlands, the Convention on Biological Diversity and the Desertification Convention, as set out in the Murray-Darling Basin Plan. Strategies for achieving this include the deployment of water rights held by the national government exclusively for the environment, ensuring the environment can receive a share of available water even in the driest periods regardless of jurisdictional boundaries and demands of water users. More information *here*.

These national level processes augment protection by Australian state governments of base flows and other water earmarked for the environment. The use of scarce water for the environment is subject to rigorous monitoring and evaluation. An example of how this works in practice at one Ramsar-listed wetland can be seen.

Further reading: *https://www.awe.gov.au/water/cewo/making-a-difference/bringing-benefits-banrock-station*.

Five HELP principles on planning aspects that should not be overlooked

Principle 8
Consider drought risk management as an issue without borders
Drought events often have an international dimension and, thus, internationally coordinated drought risk management is required to address issues such as over-abstractions, return flows, and the maintaining of environmental/ecological flows in transboundary river basins. International cooperation is usually mandated with formal agreements and international commissions. Cooperation may address several sectors or risks and address besides drought, water scarcity, floods, navigation and hydro morphology, inter alia. Ideally such agreements should address the potential impacts of climate change and socio-economic development and link these to policy planning, governance and implementation. In this context, it is apt to mention here the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention).

CASE: IRAQ, AN ASSESSMENT IN THE CONTEXT OF DISPLACEMENT RISKS

In partnership with the Government of Iraq, a preliminary assessment was made by international organizations to assess the links between drought and displacement of people. In this case, the reason for people to leave their homes was not a quantitative shortage of water, but the quality of water, which was insufficient for the intended purposes of irrigation and domestic use. Climate change is expected to further exacerbate the impacts of these developments. Upstream dams and increases in irrigation water use both within Iraq and in upstream riparian countries, all combine to reduce river flows and river water quality. Therefore, measures at transboundary, national and sub-national level must be developed and co-ordinated to reduce water losses and the impacts of droughts on water quality.

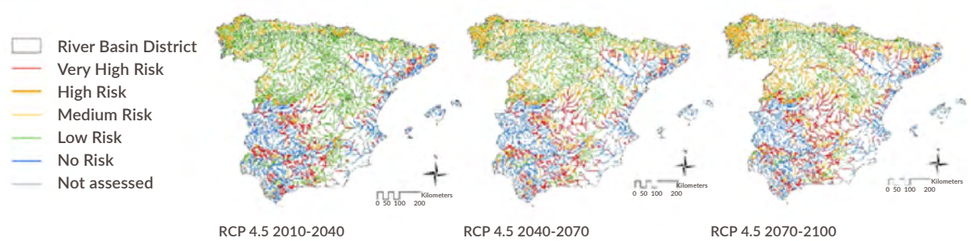
Further reading: *https://www.rudaw.net/english/middleeast/iraq/101220211#:~:text=At%20least%203%2C334%20families%20remain,Migration%20(IOM)'s%20Displacement*.

Principle 9
Mitigate the impact of drought and water scarcity on ecosystems and biodiversity
Droughts have direct and indirect impacts, not only on economic water-dependent functions but also on ecosystems and biodiversity. They may result in, for example, abrupt changes in ecosystem characteristics or bush fires that affect or threaten species. Such impacts are often overlooked. They are different from respecting ecological limits when allocating water; respecting ecological limits does not necessarily prevent them, especially during extreme events. Impacts of drought on ecosystems and biodiversity may propagate into the services that are delivered by ecosystems. Mapping the primary impacts and the ways in which they propagate is essential in raising awareness of damage to ecosystem services. At the same time, policy and management decisions need to allow these systems to adjust to shifting climate conditions.

CASE: SPAIN, REVISION OF THE DROUGHT MANAGEMENT PLANS

Spain has had Drought Management Plans in force since 2007, based on the determination of significant indicators and thresholds that trigger the adoption of predetermined operational measures. These plans are complementary to the cyclic River Basin Management Plans that should include strategic measures to balance available resources and water use, compatible with the achievement of environmental objectives in all water bodies. In recent years, specific studies have been undertaken to improve understanding of the impacts of drought and scarcity on economic activity and particularly on aquatic ecosystems by:

- monitoring the effect of ecological flow regimes on water bodies, the fluvial environment and the related aquatic and riparian ecosystems;
- analysing systematically the available datasets of parameters and indicators of ecological, physicochemical, and quantitative water status in relation to past drought episodes;
- approaching the expected evolution of water quality elements and associated aquatic and terrestrial ecosystems under different climate change scenarios.



Source: Pérez-Martín, Miguel y Estrela Segrelles, Clara, Universitat Politècnica de València 2020. «Determinación de los mapas de peligrosidad, exposición, vulnerabilidad y riesgo asociados al Cambio Climático en España». Draft, December 2020.

Principle 10
Invest in nature-based and hybrid infrastructure

Wetland restoration, floodplain restoration and groundwater recharge are promising nature-based solutions (NBS) to increase resilience against droughts. In addition, there is a wide range of small-scale on-farm measures that increase the infiltration of rainfall into the soil and/or the storage of groundwater. In cities, NBS can be cost-effective for achieving the SDGs and for climate adaptation (IPBES, 2019). As an example, the EU-funded Naturvation project assesses what NBS can achieve in cities, examines how innovation is taking place, and works with communities and stakeholders to develop the knowledge and tools required to realize the potential of NBS for meeting urban sustainability goals. Furthermore, establishment of Eco-hydrology demonstration sites and experimental basins should be enhanced as those are based on a holistic approach to aquatic ecosystems that integrates hydrology and biology to identify the most adequate solutions for the benefit of society and ecosystems.[3]

Current challenges in implementing NBS include the necessary upscaling of measures: challenges in governance, financing, in quantifying the benefits and in securing the acceptance of the benefits. Furthermore, there are knowledge gaps in understanding and securing social equity in the impacts of climate change.

3 http://ecohydrology-ihp.org/demosites/

CASE: THE PEDRAJAS-ALCAZARÉN MANAGED AQUIFER RECHARGE (MAR) SCHEME IN CENTRAL SPAIN

The Pedrajas-Alcazarén managed aquifer recharge (MAR) scheme, located in Valladolid, north central Spain, is an integrated and multi-functional water and ecosystem management intervention with benefits for nature and local communities. The scheme became operational in 2011. Discharge from a wastewater treatment plant (representing 94% of total infiltration) is combined with river and urban runoff and conveyed through a 2-km pipeline to an excavated earthen infiltration canal. From the canal the water recharges the underlying sandy and unconfined aquifer, which has a water table at about 14 m below soil surface. The system provides local end-users with additional water for irrigation of 400 ha of high-value crops as well as enhanced ecosystem services downstream by means of wetland support and water for productive uses.

Stakeholders benefitting from the MAR intervention are organized in an Irrigation Community, which maintains the system. The water table has risen by around 0.75 m from 2012 to 2016. Initial problems with high total organic carbon in the aquifer were solved by additional filtration measures and a recent WWTP improvement. Cultural and social barriers against wastewater reuse in the area are waning, as the local population lose the fear of reclaimed wastewater reuse. Another lesson learned is that the participation of stakeholders, specifically farmers and other actors in water management, has a direct and positive impact on public acceptance of the scheme.

The Pedrajas-Alcazarén MAR scheme: (a) connection point where the flows from the WWTP, rooftop runoff and Pirón River diversion converge; (b) valve where the pipeline feeds the infiltration canal; and (c) previous sandpit reused as infiltration pond (source: TRAGSA).

Principle 11
Tap into public-private finance and expand the role of drought risk insurance

During the implementation phase of drought risk plans, bottlenecks may develop due to a lack of financial resources. To avoid these, options for upscaling should be investigated at an early stage: public-private partnerships, blended finance (combining development financing with other financing sources) and the use of climate funds are options that should be explored and appropriate arrangements made. UNDRR (2021a) stresses the need for improved coherence in financial strategies for managing drought-related systemic risks at the global and national levels. Overviews of the main available options are provided in UNDRR (2021a) and Browder et al. (2021).

CASE: THE AFRICAN FINANCIAL ALLIANCE ON CLIMATE CHANGE (AFAC)

The AFAC aims to put the financial sector at the centre of climate action in Africa. The pan-African alliance brings together Africa's key financial institutions, including central banks, insurance companies, sovereign wealth and pension funds, stock exchanges, as well as commercial and development banks, to mobilise private capital flows towards continent-wide low-carbon and climate resilient development. Its goal is for Africa's financial actors to take a lead role in driving low-carbon and climate-resilient action in Africa.

AFAC will promote climate action through the following core objectives: knowledge sharing, climate risk-mitigating financial instruments, climate risk disclosure, and climate finance flows.

The alliance positions African financial actors as key stakeholders in the evolving global climate finance architecture, helping design solutions and mobilising private capital for climate action. Financial institutions could be supported to:

1. Measure and manage climate investments and risks
2. Disclose climate-related information to enable investors make informed choices
3. Develop risk-reward mechanisms to influence systemic behavioural changes

AFAC will complement and leverage other global and regional climate change initiatives being launched by the Group of Twenty (G20) countries and other stakeholders for their respective countries/ regions. This harmonisation of actions will ensure seamless alignment across governance structures and frameworks, policies, standards, procedures and instruments.

More information:
https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/african-financial-alliance-on-climate-change-afac

Principle 12
Strengthen monitoring and evaluation
Monitoring (both for operational forecasting and planning), evaluation, development and dissemination of information should be allotted sufficient financial and technical support. In particular:

- Data on water use in economic sectors, the sources used, the ratio of abstracted and returned water, the quality of returned water, is often not available at all or not available at the scale at which drought risk is analysed (e.g. only national data available).
- Knowledge on the drought impact and vulnerability of specific sectors and of specific segments of society to drought and water shortages is incomplete.
- Data on the future potential of water saving measures in economic sectors is lacking.
- There is a high potential for early warning systems based on local data in combination with global data/tools using satellite data, especially in data-scarce environments.

The UNESCO Intergovernmental Hydrological Programme (UNESCO-IHP) has been providing support to enhance human capacity, policy guidance and tools to the countries to address drought-related challenges of which (Verbist et al., 2016) present some examples. Through capacity building at regional institutions in Western, Eastern and Southern Africa, drought monitoring, and early warning tools have been transferred and validated for inclusion into national climate risk management plans. In Latin America and the Caribbean, a drought atlas[4] was produced to identify the frequency of meteorological droughts and the exposure of population to droughts. National drought observatories were developed in two pilot countries, providing locally relevant and actionable drought monitoring and early warning information, socio-economic vulnerabilities and appropriate drought indicators for decision-making to strengthen current drought policies for these countries.

4 http://www.climatedatalibrary.cl/CAZALAC/maproom/

CASE: CREWS – CLIMATE RISK AND EARLY WARNING SYSTEMS

CREWS is a partnership of several international organisations (World Bank, World Meteorological Organisation and UN Office for Disaster Risk Reduction) and countries which forms a mechanism that funds Least Developed Countries (LDC) and Small Island Developing States (SIDS) for risk informed early warning services.

The aim of the initiative is to close the capacity gap by enhancing service delivery of developing countries, to ensure the availability of essential information and services needed by governments, economic sectors and citizens. The partners' engagement in CREWS contributes to meeting these goals by leveraging the technical expertise of its members in providing enhanced warning services with a seamless approach for climate and weather events.

Country and regional projects are implemented by the countries with the support of Implementing Partners who provide technical assistance and capacity development.

CREWS follows an integrated approach, including aspects of improving risk knowledge, modernizing hydrometeorological infrastructures, improving dissemination and communication of actionable warnings, strengthening the capacity of national services, developing linkages with sectors and communities by tailoring services and products, strengthening the ability to prepare for and respond to warnings, and integrate into global services and agendas.

Further reading: *https://public.wmo.int/en/climate-risk-and-early-warning-systems-crews*

CASE: THE CITIZEN OBSERVATORY OF DROUGHT

The Citizen Observatory of Drought (*https://observasequia.es/*) is a citizen science portal to advance better knowledge of the drought risk in Spain, initially focused on the Andalusian River Basin Districts, by hosting a meeting place for different disciplines to foster dialogue between the science, politics, and society.

The Citizen Observatory has centralized and standardized the information generated by different administrations and develops an interactive geo-viewer which presents different layers of climatic and hydrological data, on planning and management of droughts, together with a comprehensive set of indicators of vulnerability to drought risk, including adaptation capacity to be fed by users: risk perception, climate change perception, institutional trust and social acceptance of different management measures. The possibilities of consultation, participation and deliberation are expanded with the holding of workshops, stimulation actions and interaction through Twitter and YouTube accounts, a conversational ChatBot, questionnaires through a web application, the design of Story Maps and the development of collaborative cartographies. The Observatory accounts for 30 research and partner organisations and has engaged with more than 1000 citizens so far, monitoring perception changes regarding water use by sectors, climate change impacts and effective measures amongst others.

4 Moving forward

As climate change is seemingly upon us, urgent action is needed to tackle current and future drought events and develop robust and practicable drought risk management plans. The general approaches that have been developed by an increasing number of organizations internationally, along with today's prevailing conceptual approaches, have only been briefly presented in this report.

The building blocks of drought risk management that, in our view, need an additional impulse, because they have the potential to improve drought risk management considerably, are provided as our *HELP Principles for Drought Risk Management*. We are confident that significant progress can be made if these principles can be put into practice and Drought Risk Management Plans are developed in all regions and countries where the issue of drought is relevant, establishing cross-boundary working relations where needed, fostering good water management, and capitalizing on potential water savings, storage in aquifers and reservoirs.

Nevertheless, we know that there will be regions where problems related drought will persist or even worsen, despite the implementation of the recommended interventions to reduce risk. Dependent on the actual situation and the future frequencies and intensities of drought events, the moment may arrive where current water and land use practices can no longer be maintained. The aforementioned AR6 Atlas (IPCC, 2021) provides indications where this can happen and thus, where preparatory actions for a further future are called for. It is expected that there will be areas where under the then prevailing conditions and at that point in time, more systemic changes will be needed. Addressing future drought-related resilience will require profound shifts in institutions, technologies, consumption patterns and personnel, as well as the ecological, economic and social processes they influence (UNDRR, 2021a). Before such systemic changes can be planned and implemented, a much better understanding is required of the key interdependencies underlying the current risks and resilience related to drought and water use by society, ecology and economy, during droughts and under normal circumstances. The earlier these are outlined (and this is one of the key messages of this paper), the higher the chances that they can be avoided, and that today's measures can be devised in such a way that no efforts are wasted.

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