United Nations
Convention to Combat
Desertification

Food and Agriculture
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Global Water
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WORLD
METEOROLOGICAL
ORGANIZATION

DROUGHT IMPACT AND VULNERABILITY ASSESSMENT

A RAPID REVIEW OF PRACTICES AND POLICY RECOMMENDATIONS

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A RAPID REVIEW OF PRACTICES AND POLICY RECOMMENDATIONS

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ABSTRACT

National policies should take a proactive approach to direct and coordinate drought vulnerability assessments with vulnerable groups. This rapid review explores the application of available approaches and methods for assessing drought impacts and vulnerability. It is based on a series of interviews with expert practitioners from different drought-affected regions of the world. This was complemented by a brief review of the relevant published literature and a summary appraisal of the strengths and weaknesses of the range of assessment approaches available.

At the present time, most of the available assessments still fall short in their consideration of the longer-term impacts and vulnerability associated with drought. However, they can be improved by practical application and continuous review including the most vulnerable groups. International action can support national efforts to apply the best available approaches, build capacities and exchange lessons. This is necessary to reduce the wider destabilising effects of un-managed drought risks and persistent vulnerability on the regional and global economies and security. Vulnerability baselines, achievable targets and monitoring systems can facilitate global assessment and reductions in drought risk.

EXECUTIVE SUMMARY

This rapid review explores the strengths and weaknesses of available approaches and methods for assessing drought impact and vulnerability at the sub-national, national, regional and global levels. Such assessments should be integrated across sectors, scales and timeframes, and should include the most vulnerable groups. They should reveal adaptation capabilities, priority actions to enhance them and the economic implications of these actions.

The review is an explorative activity drawing on experiences from different parts of the world. It was carried out in consultation with the World Meteorological Organisation (WMO), the United Nations Convention to Combat Desertification (UNCCD), the Global Water Partnership (GWP) and the Food and Agriculture Organization of the United Nations (FAO). The application of current methods for drought impact and vulnerability assessments was explored through a series of interviews with expert practitioners from different drought-affected regions of the world. This was complemented by a brief review of relevant published literature.

At the present time, most of the available assessments still fall short in their consideration of the longer-term impacts and vulnerability associated with drought. However, the available methods and approaches can be improved by practical application and continuous review. Drought impact assessments are time-sensitive and must identify disaster responses and resources rapidly. In contrast, there is an opportunity for governments to more systematically design and apply iterative vulnerability assessments with the most vulnerable groups.

National policies can direct and coordinate assessments, including sub-national and regional processes. Well-directed inclusive assessments should put in place vulnerability baselines, achievable targets and monitoring systems for drought risk and early warning. This will facilitate assessment of drought impacts and reductions in vulnerability and risk. Applying vulnerability assessments proactively and inclusively can enable more marginalised and vulnerable groups to take part. This should also help to reduce the impacts on the most vulnerable groups when droughts strike.

The review identified three approaches that can be combined for grounded "bottom-up" vulnerability assessments that:

1. Focus on people and their livelihoods, including the most vulnerable and marginalised groups and individuals;
2. Capture changes in the production of ecosystem-services including from agriculture and across other sectors; and
3. Account for effects on the water balance at basin and sub-basin levels that further exacerbate vulnerability to drought.

National assessments can use the findings generated through these approaches to identify both long- and short-term effects on their national budgets and economies. To make use of these methods, regional and international development partners need to invest in building assessment capacity at the national level. This is necessary to reduce the wider destabilising effects that un-managed drought risks and persistent vulnerability cause for the regional and global economies and security.

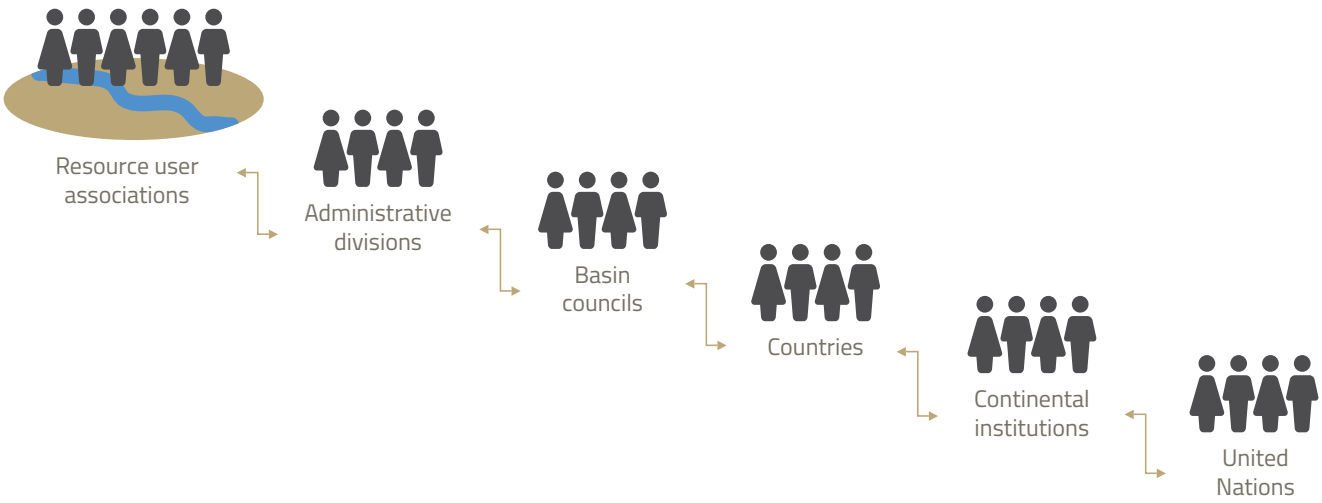
EXTENDED SUMMARY

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. The World Meteorological Organisation (WMO), the United Nations Convention to Combat Desertification (UNCCD), Global Water Partnership (GWP) and the Food and Agriculture Organization of the United Nations (FAO) have initiated a review of methodological approaches and tools for assessing drought impact and vulnerability.

Vulnerability is the tendency of society to be impacted by a disaster. Drought impacts occur directly and indirectly over long and short periods. There is often an overlap and interplay between approaches to the assessment of drought impacts and vulnerability. On the one hand, impact assessment is recommended to include consideration of the impacts of droughts on future vulnerability. On the other, drought vulnerability assessments tend to be informed by the experiences of past drought impacts – particularly when it comes to economic assessments. Such assessments should be integrated across sectors, scales and timeframes, and should include particular consideration of the most vulnerable groups. They should reveal adaptation capabilities, priority actions to enhance them and the economic case for these actions.

This review explores the strengths and weaknesses of available approaches and methods for assessing drought impacts and vulnerability at the national, local and global levels (see Figure I and summary Table). The review takes into account the experiences of selected experts in affected countries and was guided by staff members at the UNCCD Secretariat, GWP and WMO. The application of current methods for assessing drought impact and vulnerability was explored through a series of interviews with expert practitioners from different drought-affected regions of the world. This was complemented by a review of the relevant published literature via targeted keyword searches of peer reviewed international scientific publications. Grey literature published by the Integrated Drought Management Programme (IDMP), Global Facility for Disaster Risk Reduction (GFDRR) and others was also consulted.

Figure I: A grounded approach to drought vulnerability assessment



Source: Based on figurative illustration by author.

Due to the wide range of global experiences of drought impacts and vulnerability, and the diversity of potential impacts and observation methods, this review was not exhaustive. Time limitations and a desk-based approach further constrained the scope of the review. Many of the approaches and issues raised require further consideration. It is worth noting that a large volume of publications deal with or touch upon assessment approaches, methods and issues under many different related terms and subject headings. Nonetheless, the study has generated an overview of a substantial range of methodological approaches and tools for the assessment of drought impacts and vulnerability. It offers a short introductory guide to a broad range of approaches and some examples of their application.

For drought impact assessment, the methodological approaches reviewed included studies conducted by national agencies and a globally coordinated guidance system developed via the GFDRR. Recent inter-agency assessments applying this guidance have included cross-sectoral impacts and long-term as well as short-term impacts of drought on economies and societies. The available guidance also considers the impacts of other hazards that may be exacerbated by drought and require a multi-hazard assessment approach. However, the peer reviewed publications on drought impact assessment that were identified during the review were more limited in scope. The majority of publications accessed via keyword searches for "drought impact assessment" were devoted primarily to consideration of drought impacts in the agricultural sector. Very few peer reviewed publications assessing drought impacts on other critical sectors were found.

Vulnerability assessments can enable national actions to reduce drought risks. When integrated with drought early warning systems, they can support rapid actions. They can also inform longer-term investments in improved water resource management and other aspects of development planning. They do not always set out to evaluate the economic cost of susceptibility to future droughts, but they often include a range of applicable quantitative indicators, gauging the relative severity of the drought risks. In a few exceptional cases, recent studies that have appeared in the literature on resilience have sought to assess the economics of vulnerability. They calculate the resilience dividends that decision-makers could secure by taking early action, rather than waiting for impacts to become apparent. Such studies have used a range of methods including participatory scenario development methods, as well as agro-ecological models to simulate avoidable loss and damages and a household economy approach to assess their economic significance.

Approaches applied for vulnerability assessment at the local and regional levels can inform national and global assessments (Figure I). This contrasts to post-disaster crisis responses which may allow less time for consultation. Local assessments of vulnerability to drought should contribute to national, regional and global assessments. Where local and regional actors are expected to invest in drought management, pre-emptive vulnerability assessments that they make will also feed directly into their decision-making to reduce drought risks.

Three broad approaches for grounded pre-emptive characterisation and analysis of vulnerability to drought from the local level were identified and reviewed (Figure II and Table I). These can:

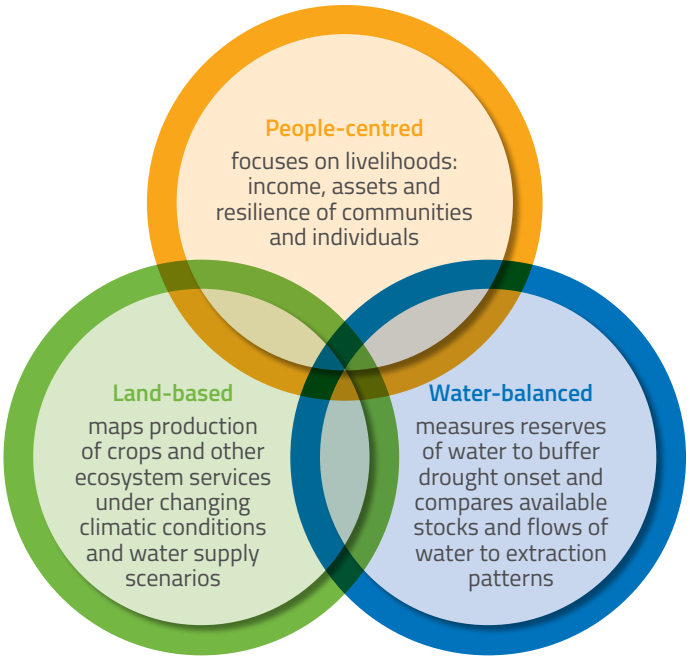
1. Focus on people and their livelihoods
2. Capture changes in the production of ecosystem-services including from agriculture; and
3. Account for effects on the water balance at basin and sub-basin levels under increasing water stress

The three approaches to vulnerability assessment identified in this review overlap and can involve the use of similar tools and datasets (qualitative and/or quantitative). Many of these tools have been developed for purposes that go beyond the assessment of vulnerability to drought. They are often not standardised or globally applicable but may be modified and customised for application in different contexts. Intentional combination and layering of the three overlapping frameworks can be recommended as a positive strategy, since the relative strengths and weaknesses of one can balance out the blind spots of another. In particular, addition of a water balance accounting approach to supplement analyses built on the livelihoods and agro-ecological approaches can reveal deepening vulnerability to hydrological and socio-economic droughts. This is an important addition to available understanding of the impacts and vulnerabilities associated with agro-ecological and meteorological droughts which are more routinely assessed.

Vulnerability assessments that are too narrowly focused on seasonal agricultural and meteorological drought effects tend to overlook factors that can deepen vulnerability over the longer term and ignore available opportunities to address them. It is important to increase attention to the further-reaching hydrological and socio-economic aspects of drought because increasing water demands in the new sectors of growing economies are deepening the water deficit. In many of the world's drier areas this transition to more frequent and prolonged hydrological drought is already occurring due to falling water tables, reduced surface water flows and the resulting loss of resources that previously buffered the onset of droughts. While the wealthy can pay to supplement dwindling water supplies, socio-economic drought often creates further disadvantages for people who are already poor and marginalized.

The review of country experiences and published literature affirms that most assessments still fall short in their consideration of the longer-term impacts and vulnerabilities associated with hydrologic and socio-economic drought. These indirect impacts and vulnerabilities are frequently human-made and caused by conflict, urban development, and land and water management patterns. The indirect impacts deserve greater attention, so that they could be either prevented or managed as part of a pro-active and preventive drought risk management approach for policy and practice.

Figure II: Assessing three dimensions of vulnerability from the ground up



Source: Figurative illustration by author.

A summary of the major strengths and weaknesses of various methodological approaches, tools and datasets for assessing drought impact and vulnerability reveals their collective and complementing strengths (Tables I, II and III). Pre-emptive vulnerability assessments that are carried out ahead of time at the local level (Table II) can be more inclusive and better informed than assessments that are carried out at the national or international levels (Table III), which often do not take place until after the disaster has happened (Table I). To improve understanding at the strategic level and ensure that sufficient local scale assessments are carried out, there is a need to connect across scales.

The use of rapid participatory methods that engage vulnerable groups and include women is generally advisable before launching ambitious quantitative studies. It is important to note that assessments that rely primarily on remote sensing and secondary statistics may prove biased or incomplete. They should be reviewed before designing new field surveys and monitoring systems, which can be expensive to maintain and manage over long periods, unless they are already well embedded in existing local institutions and processes.

Impact and vulnerability assessment practices are periodically reviewed at the global level by IPCC Working Group 4 on Impacts, Adaptation and Vulnerability. Regional early warning systems and processes can feed into and trigger assessments of drought risk, vulnerability and resilience at different scales. A globally coordinated process for assessment of vulnerability to all climate-related disasters, including drought, has been established for the UN Sustainable Development Goal (SDG) 1, target 1.5.[1] The SDGs also include targets to balance water stress (6.4) and achieve land degradation neutrality (15.3). A global map of drought vulnerability has been derived from global generic datasets proposed as proxy indicators for vulnerability to drought (see Table III).

Table I: Strengths and weaknesses of methodological approaches to assessment of drought impacts

Methodological approaches	Short characterisation of approach	Examples of relevant methods, tools & datasets	Links or references to examples	Strengths	Weaknesses
Post Disaster Needs Assessment (PDNA)	Inter-agency collaborative assessment done in-country to define scope and priorities for coherent disaster response	See 2 volumes of guidance materials (GFDRR 2013) Relies mainly on national statistics	(GFDRR 2012b; GFDRR 2017b; GFDRR 2018a; GFDRR 2018f)	Economic case is presented Methods are comprehensive: cross sectoral, long-term view The methods are intended to be multiscale and include fieldwork	Time constraints may compromise application of the methods The connection to the local level and affected communities is acknowledged to be weak, especially where timeframes are constrained Heavily reliant on pre-existing data accessible in country
Global Rapid post-disaster Damage Estimation (GRADE)	Proposed new method for desk-based precursor to above	Relies mainly on remote sensing & WorldPop Relatively new/ untested	(Gunasekera et al. 2018)	Compatible with PDNA Rapid, inexpensive	Connection to the ground non-existent – approach is rapid & desk-based. Unlikely to consider the needs of most vulnerable Heavily reliant on pre-existing data accessible outside country
Emergency Events Database (EMDAT)	Compilation of cases (see also review of other available databases in Appendix)	Relies on contributors' methods	https ://www.emdat.be/	Economic case is presented for proactive mgt approach Includes private sector, insurance companies, etc covers a long period (see Appendix for more comparison)	Incomplete, assessment methods depend on agencies contributing Relies on secondary data, lacks in-depth details – e.g. does not identify geographical locations and extents

[1] By 2030 build the resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.

Table II: Strengths and Weaknesses of Methodological Approaches to Assessment of Drought Vulnerability on the Ground

Methodological approaches	Short characterisation of approach	Examples of relevant methods, tools & datasets	Links or references to examples	Strengths	Weaknesses
Community-based resilience and livelihoods assessment approach	Focuses on people, their assets and ability to recover from drought	Participatory Rapid Appraisal (PRA) and secondary datasets: household surveys, census, project-driven databases, etc	(IPCC 2014a) (Dazé et al. 2009; PROVIA 2013) www.ihsn.org **Case study in this report: Ethiopia (PSNP)**	Ensures people-centred analysis, broader than income only Includes presentation of economic case at household level Can accommodate long-term time horizon Considers capacities of different kinds Familiar to practitioners Connects to agro-ecosystems	Data-intensive and time consuming Focuses on household scale – may not be multi-scale May not capture effects on the national and regional economy Can favour recommendations to diversify the livelihood portfolio Often misses identification of strategic water management solutions
Ecosystem-based agro-ecological approach	Focuses on ecosystems, their productivity and responses to climate extremes	PRA: seasonal calendars Remote sensing of landcover/use systems and climate Crop-water response and bio-economic models (including livestock) Value chain analysis Ecosystem service valuation	www.seea.un.org see also: FAO LADA (ELD 2015; ELD and UNEP 2015; INWEH 2011) (Cowie et al. 2018; Swiderska et al. 2018) Examples in this report: DriDanube project and assessments in Senegal groundnut basin.	Ensures coverage of resource-dependent production systems Can connect to climate models and to economic models Can be mapped and monitored at low cost using satellite derived data Many agricultural adaptation options likely to be identified Familiar to agricultural extension systems and capacities in place	Inclusion of poor and marginal groups not always systematic More oriented to agriculture than other sectors May not capture vulnerabilities in urban areas Not necessarily long term Focuses on field scale – may not be multi-scale May have relatively short time horizons Does not consider water needs in other sectors of the economy
Water balance accounting and basin management approach	Focuses on water availability, and relation to demands from different sectors of the economy	Climate information and models, PRA: resource mapping Water resource accounting (SDG 6.4) and demand estimates Global and catchment hydrologic models, remote sensing and Geographic Information Systems (GIS)	(UNWater 2017) (He et al. 2017) (https://seea.un.org/content/seea-water) (Pedro-Monzonís et al. 2016; SEEA 2017) Case study in this report: India Other examples in this report: Colombia, Mexico and Brazil	Considers water availability and demand across the economy including in urban areas Makes effective use of climate models and scenarios Connects to drought monitoring and early warning systems Can enable identification of capacity needs Can enable identification of risk management actions	Institutional challenges to coordinate data collection, management and analysis Data on water extractions often incomplete in drought-affected areas May require information on groundwater management Municipal and industrial water extractions growing faster and less well understood than agricultural water use Transboundary issues, political and security sensitivities in some countries

Table III: Strengths and Weaknesses of Methodological Approaches to Assessment of Drought Vulnerability at the National and International Levels

Methodological approaches	Short characterisation of approach	Examples of relevant methods, tools & datasets	Links or references to examples	Strengths	Weaknesses
National approaches					
Macro-economic assessment approach	Focuses on implications for national economic development planning	National wealth accounts and GDP National economic growth models	(GFDRR 2012b; IBRD 2005; Venton 2018) Example in this report: Kenya	Can explore long-term economic effects of drought on the economy and justify improved national decision-making	Often overlooks informal economies where most vulnerable populations earn their livings Economic assessments are controversial and often contested/rejected
Institutional analysis	Focuses on stakeholder dynamics, communication and power relations	Mapping institutions Venn diagrams, network analysis	(King-Okumu et al. 2017a) **Case study in this report: Mexico**	Situates assessment in governance context Provides roadmap for design of assessment process	Subjective, political, dynamic To identify and include all relevant stakeholders can be challenging/ endless
Inclusive approach	Focuses on design of the consultation process	Targeting focus groups, e.g., gender analysis (SDG 5) Disaggregated datasets	(IBRD 2010) (Askin et al. 2012)	Ensures inclusion of women and marginal groups Can identify capabilities of these groups as well as vulnerabilities	May be time-consuming and logistically challenging Inclusion of random token representatives not always effective In pre-existing conflict situations can be sensitive
Global approaches					
Tracking of SDGs	Datasets tracked at the national level	SDG Targets 1.5, 6.4, 15.3	https://sustainabledevelopment.un.org/?menu=1300	All countries have committed and international community intends to support	Focus on national-level datasets does not effectively target the most drought-prone regions within countries
Global vulnerability map	Component of global drought risk map (alongside hazard and exposure maps)	Global generic indicators and GIS	(Carrão et al. 2016)	Visual, comparative, exposure map is effective and powerful http://edo.jrc.ec.europa.eu/scado/php/index.php?id=3000	Disconnected Timebound Vulnerability map does not stand alone without exposure map Data flaws

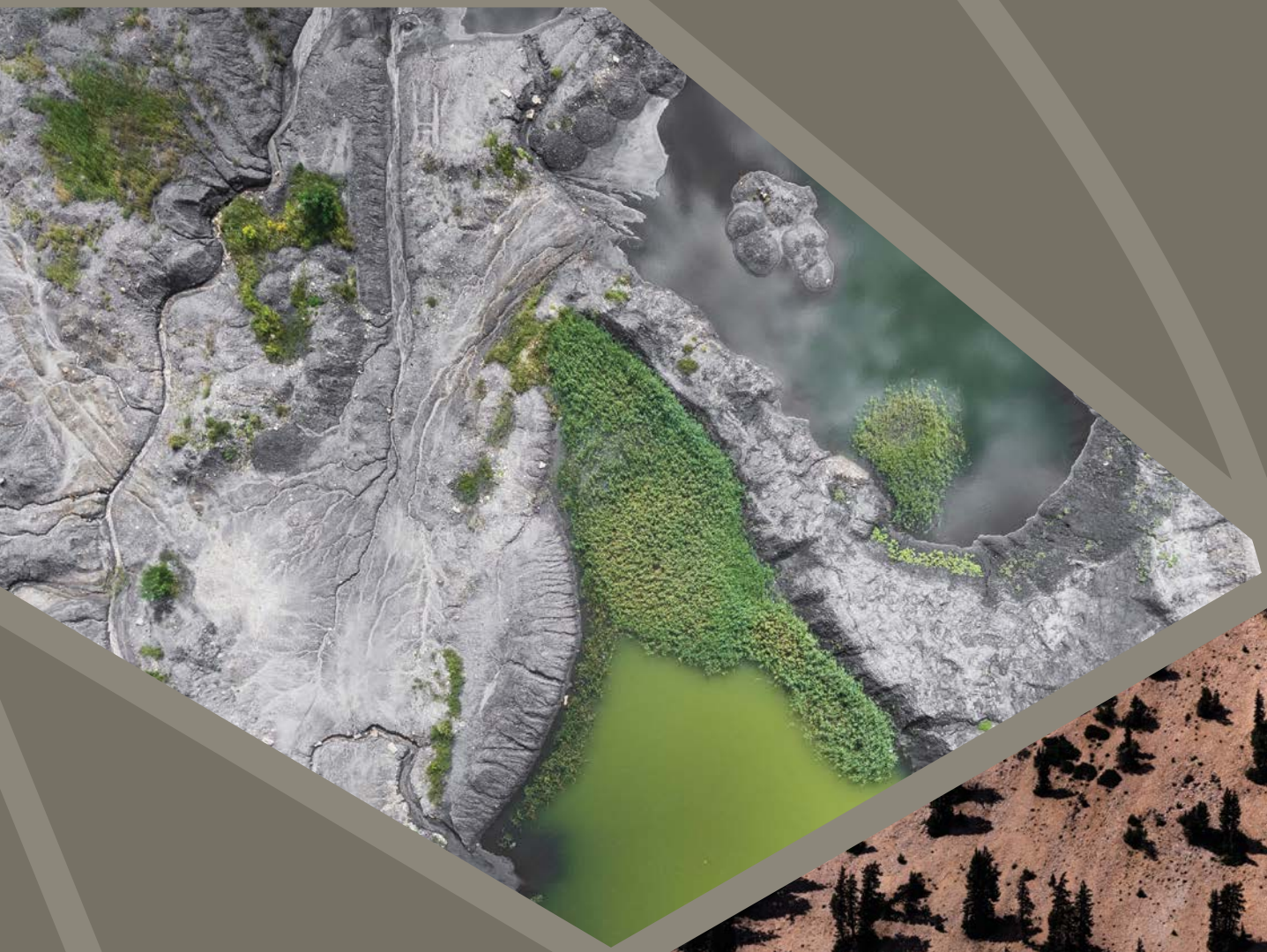
Although methods for assessing resilience to disasters, water stress and land degradation neutrality are evolving gradually through the SDG process, there is significant scope for acceleration of this progress, and examination of how the three dimensions (in Figure II and Table II) intersect. Closer attention to the effects of drought on intra-annual variations in water extraction at the basin and sub-basin levels in drought-affected regions is needed. This process should consider the spatial and temporal distribution of impacts and vulnerabilities during periods of heightened water stress and drought emergencies, as well as evaluate them over longer time periods.

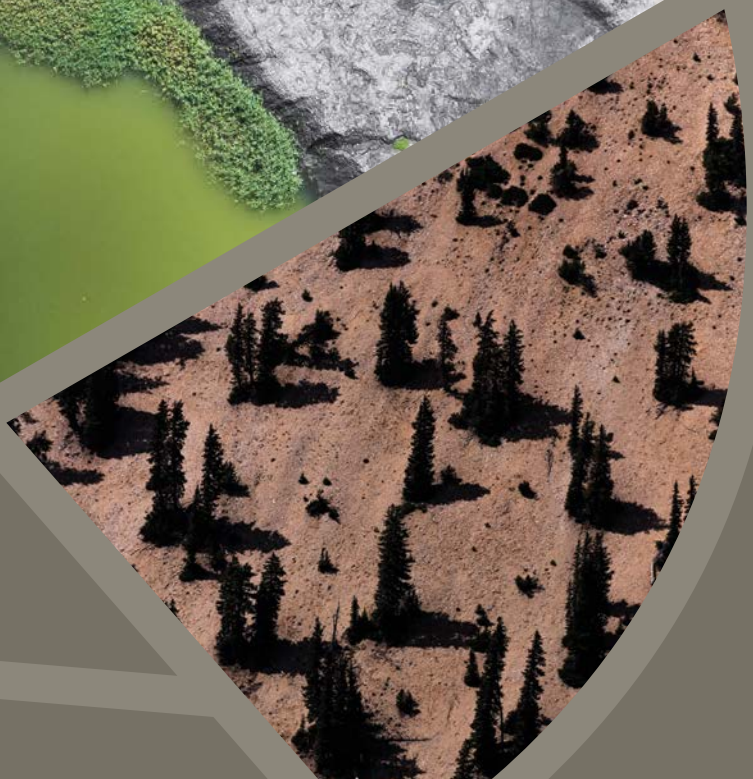
Policy recommendations focus on the opportunity for more pre-emptive vulnerability assessments to guide risk reduction strategies as well as on better evaluation of drought impacts. Well-targeted assessments should include drought vulnerability baselines, achievable targets and relevant measures. National assessments can use the findings that are generated through these approaches to identify both long- and short-term effects of drought on their national expenditures and economies. National policies should direct and coordinate these assessments together with sub-national and regional vulnerability assessments to be applied proactively and inclusively. This will enable the marginalized and vulnerable groups to participate in the assessments and improve the quality of findings concerning the effects of drought on these populations.

Examples of good practices in assessing drought vulnerability, as identified though this review, should be shared and applied more widely. There is potential for the compilation and further review of targeted manuals and information based on practical experiences in different parts of the world.

International processes such as the IPCC are playing a critical role in building capacities for the assessment of loss and damage associated with meteorological and adverse seasonal weather conditions that affect agricultural production. However, pro-active resilience and vulnerability assessments focusing on the human-made hydrologic and socio-economic aspects of drought (as well as impacts on agriculture) require further international attention. This could be provided through more grounded international scientific processes, as convened by the national Parties to the UNCCD and its Drought Initiative. International partners should ensure that drought vulnerability assessments focus more immediately on hydrologic and socio-economic vulnerability to droughts affecting all sectors of the economy.

Global, regional and national financial institutions can boost security and economic development by ensuring that resilience and vulnerability assessment processes are systematically and explicitly built into regional and national drought monitoring systems and sustainable development planning. These assessments should involve all stakeholders and take place on a regular basis. They should review effective hydrological status reports and trends; update vulnerability assessments using social and economic data, forward-planning scenarios as well as define appropriate actions. For example, the World Bank has supported effective regional capacity building programmes to improve drought vulnerability assessment in Brazil and Mexico. Similar technical cooperation is needed in many parts of Africa and Asia. This should enable better informed actions at all levels to stop further exacerbation of global threats and hazards by preventable hydrologic and socio-economic droughts occurring in marginal dry areas of developing countries.





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LISTS

List of Acronyms

BWS	Baseline Water Stress
CONAGUA	National Water Commission of Mexico
CoP	Conference of the Parties
DfID	Department for International Development, UK
DRAMP	Drought Resilience Adaptation and Management Policy
DRR	Disaster Risk Reduction
ECLAC	UN Economic Commission for Latin America and the Caribbean
EDC	European Drought Centre
EMDAT	Emergency Events Database
ERPA	External Relations, Policy and Advocacy Division of UNCCD Secretariat
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FEWSNET	Famine Early Warning Systems Network
GFDRR	Global Facility for Disaster Risk Reduction
GIS	Geographic Information Systems
GRADE	Global RApid post-disaster Damage Estimation
GWAVA	Global Water Availability Assessment method
GWP	Global Water Partnership
HEA	Household Economy Analysis
IDMP	Integrated Drought Management Programme
IMTA	Instituto Mexicano de Tecnología del Agua
IPCC	Intergovernmental Panel on Climate Change
IRIN	Integrated Regional Information Networks - provider of humanitarian news services
LDCs	Least Developed Countries
LSMS	Living Standards Measurement Surveys
LULUCF	Land Use, Land Use Change and Forestry
NDMA	Drought Management Authority, Kenya
NDMC	National Drought Management Center, US
NDMP	National Drought Management Policies Initiative
NDRMC	National Disaster Risk Management Commission, Ethiopia
NDVI	Normalized Difference Vegetation Index
NGO	Non-Governmental Organization
NWP	Nairobi Work Programme of the UNFCCC
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PDNA	Post Disaster Needs Assessment

PMPMS	Drought Prevention and Mitigation Measures Programs, Mexico
PRA	Participatory Rapid Appraisal
SBSTA	Subsidiary Body for Scientific and Technological Advice
SDG	Sustainable Development Goals
SEEA	UN System for Environmental Economic Accounting
SPI	Science-Policy Interface of the UNCCD
SWAT	Soil and Water Assessment Tool
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNGRD	Unidad Nacional para la Gestión del Riesgo de Desastres (National Unit for Disaster Risk Management, Colombia)
UNISDR	United Nations Office for Disaster Risk Reduction
UK	United Kingdom of Great Britain
WASH	Water, Sanitation and Hygiene sector
WMO	World Meteorological Organization
WDRP	Woreda Disaster Risk Profile, Ethiopia
WRI	World Resources Institute

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1. INTRODUCTION

Mitigation of drought hazards will require complex global actions to regulate the climate system. In contrast, mitigation of drought impacts by reducing ***vulnerability*** can be achieved through social organization at the national and sub-national levels. Yet, in many countries, costly humanitarian emergencies continue due to deficiencies in decision-making and the lack of well-conceived assessment processes to guide effective decisions.

At the present time, an array of different tools and methods are used globally, nationally and locally to assess drought impacts and vulnerability. No coherent universal system of measurable indicators to address vulnerability and resilience to drought in the affected countries has been agreed. At the UNCCD COP13, Parties agreed that the work of UNCCD would be monitored through qualitative information and requested the UNCCD Committee on Science and Technology to assist in the establishment and improvement of the monitoring framework.

This review explores the strengths and weaknesses of available methodological approaches for assessing drought impacts and vulnerability at the national, local and global levels. Such assessments should be coordinated across sectors, scales and timeframes, and should particularly address the most vulnerable groups. They should reveal adaptation capability, identify priority actions for its improvement and present the economic case for decision-makers to agree on necessary measures.

The findings of the review are intended to contribute to knowledge sharing on policies for drought preparedness among the UNCCD Parties and support the UNCCD Drought Initiative. They may also be of relevance to wider ongoing processes that address global risks, including drought and other interacting hazards (IBRD 2018). They take into consideration the SDGs – in particular, SDG 6 target 6.4 on water stress and SDG 1 target 1.5 to build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.

1.1 The challenges in assessing drought impacts and vulnerability

Both nationally and globally, a society's decision whether or not to act to avert emergencies caused by drought is driven by the perception of vulnerability to the anticipated impacts – or the potential consequences of inaction (WMO/GWP 2017). Vulnerability is best defined as the tendency of a society to be impacted by the hazard (Carrão et al. 2016; IPCC 2014a) (see selected relevant definitions of terms from IPCC in Appendix 1).

There are a growing number of national assessments of the economic impacts of droughts in developing countries (CRED/UNISDR 2018; Jeggle and Boggero 2018). Global recognition of the connection between vulnerability to drought and other types of fragility is also relatively well-established (IBRD 2018). However, the impacts of drought still remain largely underestimated, particularly droughts that have occurred in the poorer parts of the world (CRED/UNISDR 2018). The wider global impacts that result from continuous economic devastation, insecurity and persistent development deficits associated with drought are also poorly understood and documented (IBRD 2018).

Pre-emptive drought vulnerability assessments still have not received the same level of attention in national policies as the post-disaster impact assessments. National drought policies and preparedness plans based on multiscale impact and vulnerability assessments are needed to effectively guide the shift from the reactive to a proactive and preventive risk management approach (Sivakumar et al. 2014). Vulnerability and impact assessment is one of the three pillars that have been identified for national drought management planning (Tadesse 2016; Tsegai et al. 2015; Wilhite 2011a).[2] According to the Compendium of drought management practices at the national level issued by the High-level Meeting on National Drought Policy,[3] promoting standard approaches to vulnerability and impact assessments is the first key element of a national drought management policy (NDMP).

1.2 The WMO/FAO/GWP/UNCCD collaboration: technical support and capacity building

The World Meteorological Organization (WMO), the United Nations Convention to Combat Desertification (UNCCD) and the Food and Agriculture Organization of the United Nations (FAO) have been collaborating in the framework of a UN-Water Initiative on ''Capacity Development to support National Drought Management Policies'' (NDMP). This requires a detailed review of the relevant tools and methodologies for assessing drought impacts and vulnerability with implications for policy. The activity responds to Decision 29/COP.13: The UNCCD policy advocacy on drought[4] is based on the framework in ICCD/COP(13)/19[5] (see: http://www.droughtmanagement.info/).

The Integrated Drought Management Programme (IDMP) provides a framework and technical support to countries, enabling the ministries and national stakeholders to develop and implement national drought plans and policies (Pischke and Stefanski 2016). UNCCD's Drought Resilience Adaptation and Management Policy (DRAMP) framework (ICCD/COP(13)/19), provides some additional recommendations on assessing drought vulnerability and risk in the short term.

According to the DRAMP framework (ICCD/COP(13)/19), assessing drought vulnerability and risk entails:

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2 See: http://www.droughtmanagement.info/pillars/vulnerability-impact-assessment/

3 In ICCD/CRIC(11)/17 https://www.unccd.int/sites/default/files/sessions/documents/ICCD_CRIC11_17/17eng.pdf

4 https://www.unccd.int/sites/default/files/sessions/documents/2017-08/ICCD_COP%2813%29_19-1711042E.pdf

5 https://www.unccd.int/sites/default/files/sessions/documents/2017-11/cop21add1_eng.pdf

1. Identifying drought impacts on vulnerable economic sectors including cropping and livestock, biodiversity and ecosystems, energy, tourism and health
2. Assessing the physical, social, economic and environmental pressures on communities before, during and shortly after drought in order to identify who and what is at risk and why
3. Assessing conditions or situations that increase the resistance or susceptibility to drought and the coping capacity of communities affected by drought; and
4. Assessing the extent of potential damage or loss in the event of drought

This is similar to the EC recommended disaster risk assessment framework which begins with a more explicit focus on exposure as the entry-point to the analysis of vulnerability (EC 2010 p27):

1. Identification of elements and people potentially at risk (exposure)
2. Identification of vulnerability factors/impacts (physical, economic, environmental, social/ political)
3. Assessment of likely impacts
4. Analysis of self-protection capabilities reducing exposure or vulnerability

According to ICCD/CRIC(11)/17:

> 'National drought (and water scarcity) management policies should promote strategies that emphasize the development and implementation of pre-impact programmes and preparedness plans as well as policies that are directed towards drought risk reduction. These policies reduce risk by building and consolidating the resilience of livelihoods, establishing more timely and appropriate responses that protect livelihoods and human life, tackling the root causes of vulnerability and managing the associated drought risks rather than focusing on each individual crisis.
>
> 30. NDMPs are not stand-alone. They will be mainstreamed into and complement existing national and international initiatives such as the UNCCD NAPs, RAPs and SRAPs, disaster risk and reduction management policies, national climate change adaptation policies and plans, as well as integrated soil and water conservation management practices, policies and plans.'

1.3 The UNCCD Drought Initiative: policy approaches and knowledge exchange

The UNCCD has recently launched the new Drought Initiative that will work to enhance the resilience of communities and ecosystems to drought through the development and implementation of national action plans and associated technical and policy tools. The aim is to promote a paradigm shift in approach to the way drought is managed – from a reactive and crisis-based approach towards one that is more proactive and risk-based. The convention supports countries in developing comprehensive national plans of action ready to be set in motion to deal with drought well before it strikes.

The UNCCD (2016) has observed that the adoption of national drought policies focused on risk reduction and complemented by drought mitigation plans at various levels of government will have significant ripple effects across key sectors. It would support the implementation of Sustainable Development Goal 6 through the promotion of integrated water resources management. Vulnerability to future drought episodes can be significantly reduced and the coping capacity of communities, indeed entire nations, can be improved.

The Parties to the UNCCD considered the elaboration of the Drought Initiative during COP 13 (see: ICCD/COP(13)/CRP.2). The UNCCD SPI proposes to provide guidance to support the adoption and implementation of land-based interventions for drought management and mitigation. A UNCCD conceptual framework on drought preparedness, developed by the SPI, could guide multi-stage and multi-scale intertwined processes for adopting and implementing land-based interventions for drought management and mitigation. The framework would consider stages, tools and requirements for implementing land-based interventions and monitoring their effectiveness. Co-benefits of increased resilience and reduced vulnerability of ecosystems and populations are likely to be achieved as a result. The work to be done by the SPI will lay the scientific basis for the approaches to drought preparedness by the UNCCD.

2. CONCEPTUAL DEFINITIONS AND REQUIRED SCOPE OF APPROACHES, TOOLS AND METHODS

The definitions of droughts, their impacts and associated vulnerabilities are continually evolving. In each case, there are subtle differences of understanding among the public and practitioners in different fields that affect the ways in which these terms are understood and used. Clearly, the nature and magnitude of drought impacts depend on the definition and understanding of the initial drought hazards. Furthermore, there is some notable interdependence between the understanding of impacts (which may require identification of the effect the drought has on vulnerability) and understanding of vulnerability itself (which often is limited to the anticipation of likely impacts). The following sections briefly review relevant definitions and their significance for the selection of appropriate assessment approaches, methods and tools.

As presented in these definitions, assessments of drought impacts and vulnerability should not be limited to the agricultural sector, but should be integrated across sectors, scales and timeframes. They should also include particular consideration of the most vulnerable groups to ensure that findings are relevant to all members of the society who are likely to be affected by droughts. Such assessments are likely to reveal adaptation capabilities and priority actions to enhance them. Finally, it is important to underline that assessments are not meant to promote pre-conceived solutions. However, they can and should lead to the objective identification of effective solutions as part of a pro-active drought risk management approach.

2.1 Defining and assessing drought

Four types of drought are conventionally recognized and widely referred to (Tadesse 2016; Wilhite 2000; Wilhite and Glantz 1985):

1. **Meteorological drought** – a deficiency of precipitation, as compared to average conditions, over an extended period of time
2. **Agricultural drought** – a reduction in soil moisture availability below the optimal level required by a crop at each different growth stage, resulting in impaired growth and reduced yields
3. **Hydrological drought** – when precipitation deficiencies begin to reduce the availability of surface and subsurface water resources, when there is substantial deficit in surface runoff below normal conditions, or when there is a depletion of ground water recharge; and
4. **Socio-economic drought**[6] – when human activities are affected by reduced precipitation and related water availability. Socioeconomic drought associates human activities with elements of meteorological, agricultural and hydrological drought

[6] Some drought management experts prefer to exclude consideration of socio-economic drought from this typology because they do not recognize the role of humans in creating drought hazards. They see socio-economics as relevant for explaining the impacts of droughts, and vulnerability to them, but not the nature and causes of the drought hazards themselves.

Maintaining the regulation of the global climate system may help reduce the frequency and severity of meteorological droughts, but extreme events cannot be eradicated altogether. On the other hand, societies can manage their land and water resources to prevent meteorological droughts becoming agricultural, hydrological or socio-economic droughts. In light of this, it is important that impact and vulnerability assessments give consideration to agricultural, hydrological and socio-economic droughts, rather than focusing too narrowly on meteorological droughts.

The observation of hydrological and socio-economic droughts requires information on water resource conditions, trends and use patterns by society, not only meteorological information. However, in many dry and drought-prone areas of the world, this information is still not yet systematically recorded or used by authorities to prepare for droughts, assess their impacts or reduce vulnerability to them. Unfortunately, mismanagement of land and water resources due to lack of strategic information and maladaptation by societies can accelerate and exacerbate hydrological and socio-economic drought effects, particularly on the most vulnerable. Thus, socio-economic effects become both the impact and the cause of drought. The result is a vicious circle of drought, degradation and desertification.

In the international drought Disaster Risk Reduction (DRR) community of practice, drought hazards are increasingly distinguished and separated from drought exposure and vulnerability by the common framework:

Risk = Hazard * Vulnerability * Exposure

These are in turn distinguished from impacts, even if sometimes there may be overlaps.

2.2 Defining and assessing drought impacts

The UNISDR (2017) defines disaster impacts as follows:

> **Disaster impact** is the total effect, including negative effects – such as economic losses – and positive effects – for example, economic gains – of a hazardous event or disaster. The term includes economic, human and environmental impacts, such as death, injuries, disease and other negative effects on human physical, mental and social well-being.

The IPCC (2014a)[7] provides the following definition of impacts associated with climate change, including but not limited to drought:

> **Impacts (Consequences, Outcomes)**
> Effects on natural and human systems. In this report, the term "impacts" is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to the effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructure due to the interaction of climate changes or hazardous climate events within a specific time period and the vulnerability of an affected society or system. "Impacts" can also mean consequences and outcomes.

The impacts of climate change on geophysical systems – including floods, droughts and sea level rise – a subset of impacts called physical impacts.

The IPCC report (p6)[8] expressed high confidence that impacts from drought and other climate extremes included alteration of ecosystems, disruption of food production and water supply, damage to infrastructure and settlements, morbidity and mortality, and consequences for mental health and human well-being. This definition underlines the need for impact assessment methods that are cross-sectoral and can include consideration of socio-economic effects occurring across different sectors of the economy and over a range of timeframes.

Recent guidance available at the international level (EU/WB/UN 2014) focuses on two main aspects of the impacts of disasters such as droughts that require assessment:

1) **Economic impact at macro and micro levels:** the estimation of the disaster's likely effects on economic performance and the temporary macro-economic imbalances that may arise from it, as well as its varied impacts on personal and household income and employment in all sectors.
2) **Human development impact:** the impacts of the disaster on quality of human life in the medium and long term.

[7] Note: an IDMP Glossary is also available at: http://www.droughtmanagement.info/find/glossary/

[8] https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf

This guide gives particular consideration to the economic cost of drought impacts to enable international cooperation and financing of post-disaster responses. On the one hand, drought impact assessments should include consideration of economic impacts. However, it is also important to recognize and acknowledge that economic assessments – no matter how thorough they are – are not able to capture and account in economic terms for all the relevant social impacts of a failure to manage drought.

Finally, it is worth considering that impacts of drought can be both positive and negative. Success in surviving and managing drought can bring positive impacts for society by strengthening social connections. It is important to acknowledge this because failure to do so can cause societies to write off drought prone regions as unworthy of investment.

2.3 Defining and assessing vulnerability to drought

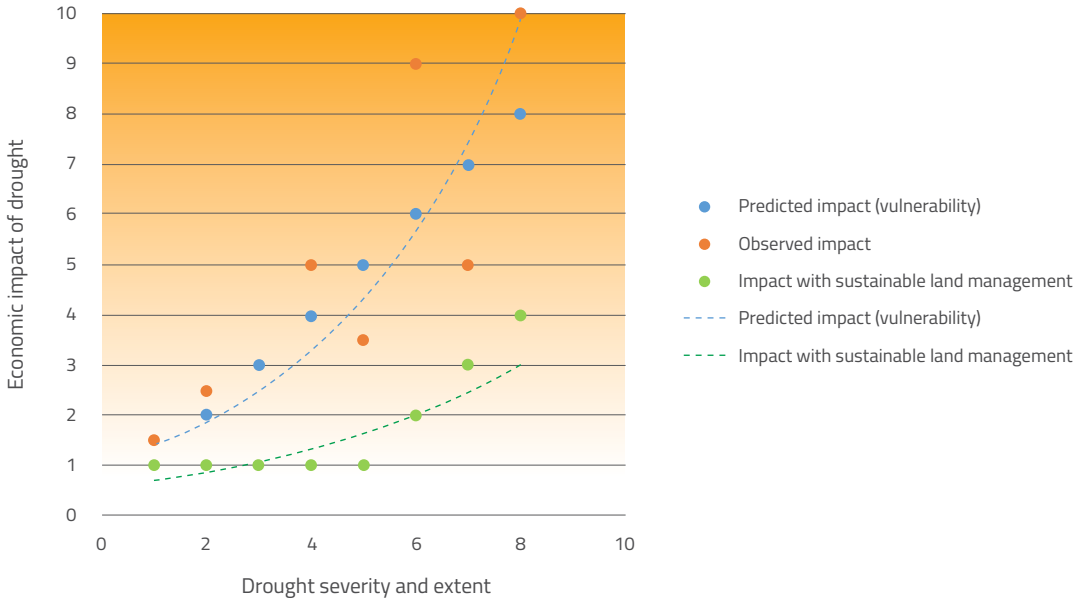
Whereas impact assessments focus on effects that have already occurred or are set in motion, vulnerability assessments focus on assessing impacts that might have not happened yet, and could be prevented or mitigated. Vulnerability includes a variety of concepts such as the sensitivity or susceptibility to hazards and the lack of capacity to cope and adapt (IPCC 2014):

> **Vulnerability**
> The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

The recent literature on vulnerability to drought is vast, and is interconnected with an even broader literature addressing vulnerability to other climate and non-climate related hazards (after Adger 2006). The direct relationship between vulnerability and adaptive capacity also connects drought vulnerability to several other fast-growing bodies of literature that include a range of overlapping conceptual definitions surrounding the idea of capacity, including the capacities and resilience of human and natural systems. The most simplified definitions of resilience and adaptive capacity include factors that enable communities or systems to withstand hazards such as drought without irreversible changes in state and functions – for example, loss of assets.

Increasingly, the concept of vulnerability is nested within broader drought risk assessment frameworks for drought preparedness, as in the case of the DRAMP framework (ICCD/COP(13)/19). This defines vulnerability as an element related to but distinct from the nature of the drought hazard, and the system or population that is exposed to it. If these relationships are explicit and well-established, the vulnerability and risk factors can be quantified, hazard-vulnerability curves can be mapped (as in ECA 2009 and Figure 1) and quantitative predictions of the cost of droughts can be made. Achievements toward the reduction or modification of the vulnerability factors could then be measured and a clear economic case presented for such interventions. A recent application of an approach of this kind refers to cost curves that are used to predict a relationship between drought indices and effects on GDP in China (Su et al. 2018).

Figure 1: Stylized figurative representation of assessment of drought vulnerability and impact



Source: Figurative illustration by author.

3. REVIEW METHODS

This review was developed through consultation including selected practitioners supporting the UNCCD Drought Initiative, UNCCD Secretariat External Relations, Policy and Advocacy (ERPA) team and colleagues at the WMO and the GWP. It draws on literature on drought impacts and vulnerability that has been published via the international drought management initiative[9] and the Global Facility for Disaster Risk Reduction (GFDRR).[10]

In addition to the general review of the available literature, two targeted keyword searches of peer-reviewed international scientific publications were made using the keywords: ''Drought Impact Assessment'' and ''Drought Vulnerability Assessment'' via the online bibliographic search engine SCOPUS. The published studies in the international peer-reviewed and grey literature revealed a series of methodological approaches for assessing drought impacts and vulnerabilities and several reviews of their strengths and weaknesses.

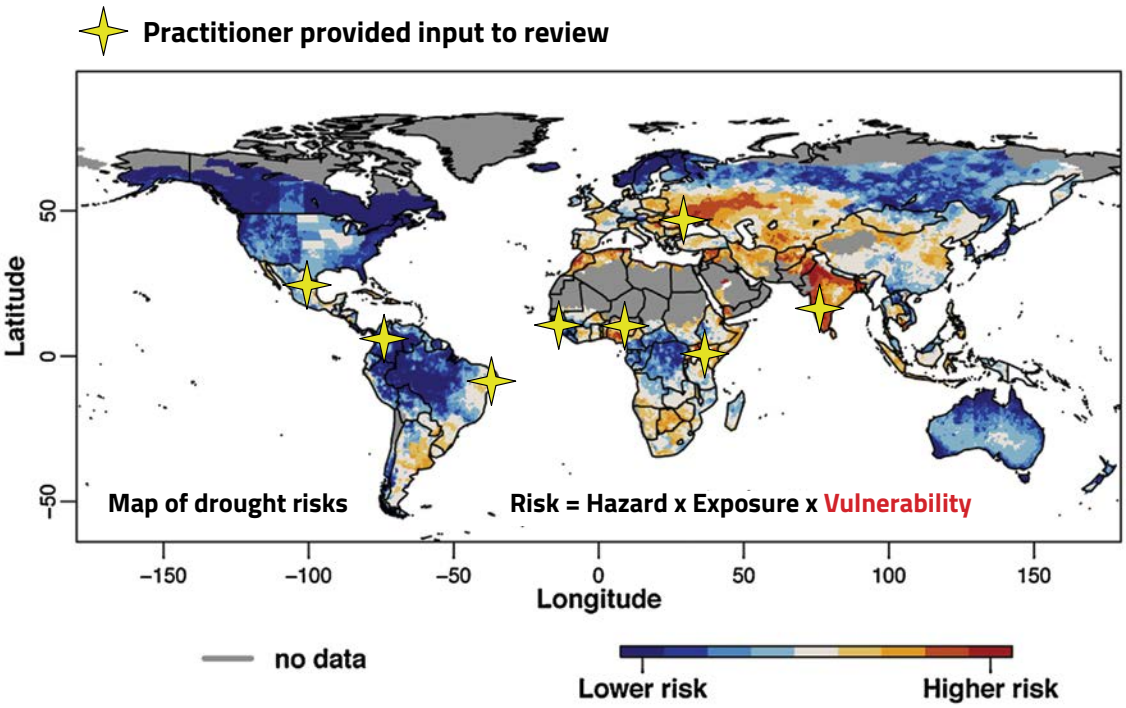
A small focus group of key informants including national focal points and experts in affected countries were selected and contacted individually by the UNCCD Secretariat to request their inputs to the study (see acknowledgement and Figure 2). The key informants were distributed across different regions considered to be at risk from drought. A series of basic questions were formulated and shared with them in advance by email to facilitate their inputs:

1. Has any drought impact assessment previously been conducted in your country? (please give details and provide links to or copies of reports, where possible)
2. Has any drought vulnerability assessment previously been conducted in your country? (please give details and provide links to or copies of reports, where possible)
3. What are the priorities to improve assessment of drought impacts and vulnerability in your country?
4. Are the existing processes for assessing drought impacts and vulnerability sensitive to the differentiated needs of different areas and vulnerable groups within the population, including gender-sensitive approaches, as well as specific vulnerabilities and needs of elderly, youth, disabled and minority groups?
5. What regional-level processes are in place to assess drought impact and vulnerability in your region and are they sufficient?

[9] see: http://www.droughtmanagement.info

[10] see: https://www.gfdrr.org/en/publications

Figure 2: Inputs to the review from selected expert practitioners



Source: Global drought risk map, Carrão el al, 2016.

Follow-up conversations were then held via Skype and phone. Although time available for the consultation of key informants was limited, this part of the study proved to be the most productive and could usefully be extended to include a larger number of focal points and experts in Least Developed Countries (LDCs) and possibly from developed countries as well.

4. DROUGHT IMPACT ASSESSMENT

4.1 Scope of drought impacts and methodological approaches for assessment

A global database has been established for the assessment of drought impacts.[11] The database contains reports on the impacts of droughts that occur around the world. The information is sourced from national governments as well as United Nations agencies (OCHA, IRIN, WFP, FAO), other international organizations (World Bank, IFRC), reinsurance companies (SwissRe, MünichRe, AON Benfield) and press agencies. The database therefore relies on methods used by these agencies and organizations.

Due to the combination of direct impacts, indirect associations and multiplier effects involved, recording and monitoring such hazards in global databases is a complex process (Wirtz et al. 2012). Furthermore, the keepers of the dataset acknowledge that gaps in data on losses for many disasters, as well as variations in data availability across regions and disaster types, make analysis challenging and may result in significant underestimations of damage for some regions of the world (CRED/UNISDR 2018). UNISDR also maintains its own database of disaster information DesInventar (although it is not focused exclusively on drought).

Relevant databases have been established at the level of the European Drought Centre (EDC) Drought Impact Database and the US National Drought Management Center (NDMC) Drought Impact Reporter. Within the European Union (EU), there have been some efforts to coordinate methodologies that are used to collect and record data on disaster losses (EC 2010; Groeve 2014). But these methods are still limited, and available databases vary in their level of completeness and detail. In addition, IT systems differ in purpose, complexity and openness. A rapid overview of different types of impacts that are included in these databases is included in Appendix 1.

The quantification of loss and damage due to climate change is increasingly coordinated at the international level due to the Warsaw International Mechanism for Loss and Damage (See UNFCCC decision 2/CP.19 and Article 8 of the Paris Agreement).[12, 13] The mechanism was created by the UNFCCC in 2013 to "address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change."

[11] See https://www.emdat.be/

[12] https://unfccc.int/topics/adaptation-and-resilience/workstreams/approaches-to-address-loss-and-damage-associated-with-climate-change-impacts-in-developing-countries#eq-3

[13] https://theconversation.com/how-should-we-compensate-poor-countries-for-loss-and-damage-from-climate-change-55612

(Mechler et al. 2018). It promotes the implementation of approaches to address loss and damage associated with climate change impacts in a comprehensive, integrated and coherent manner:

- Enhancing knowledge and understanding of comprehensive risk management approaches to address loss and damage
- Strengthening dialogue, coordination, coherence and synergies among relevant stakeholders
- Enhancing action and support, including finance, technology and capacity-building

Also, under the UNFCCC, the Nairobi Work Programme (NWP) on impacts, vulnerability and adaptation to climate change[14] is a mechanism designed to facilitate and catalyse the development, dissemination and use of knowledge that can inform and support adaptation policies and practices. This includes impacts and vulnerability as one of two designated work areas, and methods and tools for assessment as a sub-working area. Drought, water scarcity and land degradation are identified as a cross-cutting theme. The NWP operates under the overall guidance of the Chair of the Subsidiary Body for Scientific and Technological Advice (SBSTA), with assistance from the secretariat, and contributions from Parties and other relevant stakeholders. Its adaptation knowledge portal[15] contains 129 tools for climate change impact and vulnerability assessment as of December 2018.

The EU, UN Agencies and the World Bank have developed guidelines for conducting Post-Disaster Needs Assessments (PDNA) for droughts and other disasters (p20-21 EU/WB/UN 2014). These define the effects and impacts of disasters and offer guidance on how they should be assessed for the purposes of preparing disaster recovery frameworks intended to align international and local support as parts of a single, government-led post disaster recovery process. According to the PDNA guidelines, ***impact*** analysis is based on an assessment that should consider three main elements:

- The disaster effects
- The sector development plans
- Lessons from past experiences and the emerging concerns that derive from the events

The PDNA Guide (EU/WB/UN 2014) is conceived as a shared approach and common platform for analysis and action to assess the impacts of disasters after they have hit and to start the recovery planning process. It embraces various assessments and planning techniques applied by UN agencies, and the method for assessing damages, losses and needs as developed by the UN Economic Commission for Latin America and the Caribbean (ECLAC) and applied by the World Bank. Volume A of the Guide outlines how to facilitate planning and organization of the PDNA and lists the process and steps for conducting it. Volume B of the guide provides technical guidance for sector specific assessments including:

- Social Sectors: Housing and Settlements; Education; Health; Culture; and Nutrition
- Productive Sectors: Agriculture, livestock, fisheries and forestry; Industry, commerce and trade; Tourism
- Infrastructure Sectors: Water, sanitation and hygiene (WASH); Community infrastructure; Energy and electricity; Transport and telecommunications
- Cross-cutting Sectors/Themes: Employment and livelihoods; DRR; Governance; Environment; Gender; HIV/AIDS and Age

The guidance aims to be comprehensive and seeks a full assessment of the impacts of the disaster. As a result, it is ambitious and complex. According to the guidance, the specific time period in which impacts may occur can be long. The analysis of the ***impact*** of the disaster provides the ***medium and long-term*** projection of the effects of the disaster on the various sectors of the economy and the national development plans.

However, because the PDNA is usually conducted after an emergency is declared so that the impact analysis can form the basis of the recovery strategy, there is a practical need for the assessment to be completed relatively quickly, so that the international community could provide necessary assistance. While the formal guidance recommends that 6-12 weeks should be allowed for conducting PDNAs, a recent review (Jeggle and Boggero 2018) found that in many cases, this period is shortened to 3-4 weeks for the assessment to be completed and the response to be financed. In light of this, there may be some distance between the aspirations set out in the guide and the scope of the assessments that are feasible within the available timeframes.

[14] https://unfccc.int/nwp

[15] https://www4.unfccc.int/sites/NWPStaging/Pages/Tools.aspx

As a precursory part of the impact assessment, the ***effects*** of disasters are determined through the assessment of four main elements:

1. **Damage to infrastructure and physical assets:** the quantification of public and private sector infrastructure and assets destroyed in the disaster
2. **Disruption of access to goods and services:** assessment of the disaster effects on service delivery, including the availability and quality of services, and on the population's access to goods and services that are required to support lives and livelihoods
3. **Governance and decision-making processes:** assessment of the disaster effects on social and decision-making processes including people's ability to exercise their citizenship and priority development policy objectives
4. **Increased risks and vulnerabilities:** assessment of which risks increase as a result of the disaster and how; and which additional threats or deteriorating conditions raise vulnerability of people

These effects are expressed both in quantitative and qualitative terms by geographical divisions and sociological characteristics of the population such as gender, age, ethnicity and disability. Following the description of effects, the economic/monetary value of the effects are estimated for ***damage*** to infrastructure and assets as well as economic ***loss*** due to changes in financial flows as linked to changes in the outputs of the productive sector, on the operating costs for delivery of goods and services, on governance processes and for management of risks.

The economic value of the effects of the disaster is calculated for the four key effects:

- Value of total and partial destruction of infrastructure and physical assets in all sectors, productive and social
- Value of changes on service delivery, production of goods and services and access to goods and services
- Value of changes to governance and decision-making processes
- Value of changes to risks, vulnerabilities, and environmental impact

For all PDNAs (including those for non-drought hazards, such as floods and earthquakes), the guidance recommends that the assessment team evaluates the occurrence of climate extremes such as droughts that can affect access to water and sanitation (GFDRR 2017a p26):

'It is necessary to quantify these events, which can often be performed in the baseline survey, in order to allow for comparison to previous events. Of equal interest is to evaluate how the populations have responded and adapted to these events, which usually requires field surveys and studies. These behaviours are climate change adaptation and are linked closely to the perceptions and resources of the population, defining their capacity and resilience to respond to extreme climatic events. This degree of resiliency also needs to be measured and included in the needs assessment and eventually into the recovery strategy.'

It is notable that the medium-long-term timeframe foreseen for the PDNA impact assessments, according to the guidance (EU/WB/UN 2014) is more ambitious than the focus on timeframes before, during and shortly after drought, as so far foreseen in the DRAMP. The range of impacts considered is also considerably more diverse than a checklist of historical, current and potential drought impacts provided in available National Drought Management Policy Guidelines (WMO/GWP 2014 p36-39).

The GRADE approach (developed by the World Bank GSURR D-RAS KSB and supported by GFDRR) (Gunasekera et al. 2018) offers a more rapid desk-based precursor to the PDNA, which can provide an initial estimation of the physical post-disaster damage incurred by key sectors within two weeks of the disaster. This approach is better suited to other types of hazards, but may also contribute to a preliminary assessment of drought impacts. The approach aims to create an independent, credible sectoral quantification of the spatial extent and severity of a disaster's physical impact, addressing specific damage information needs in the first few weeks after a major disaster, and complementing the more comprehensive PDNA process. It relies on the WorldPop dataset (see www.worldpop.org).[16]

4.2 Application of methodological approaches for drought impact assessment

Practitioners interviewed during this review reflected on the lessons from drought impact assessments that had previously been conducted in their countries. Impacts across sectors have been observed through these assessments. However, impacts on the agricultural sector are the most readily assigned an economic value.

[16] For additional information, contact: A.J.Tatem@soton.ac.uk; linard.catherine@gmail.com; jeremiah.j.nieves@outlook.com

From the keyword search of peer-reviewed publications on "drought impact assessment," 28 studies were located. No fully cross-sectoral drought impact assessments have been found among these, and the majority focus on the agricultural sector. Variation of the keyword selection could be applied to continue the search for peer-reviewed examples of holistic assessments of drought impacts. The remainder of this section refers mainly to grey literature on drought impact assessment compiled by international and national institutions, particularly through the GFDRR.[17]

The global generic approach and methodology for post-disaster needs assessment of the impacts of droughts and other disasters developed by the international community has been applied through a range of assessments in different parts of the world (Jeggle and Boggero 2018). However, many available assessments of drought impacts predate the PDNA guidance (see e.g. DMCSEE 2011; Parry et al. 1988). A previous review of drought impact studies from around the world (UNISDR 2009) identified many examples of drought impact assessments conducted in the United States, and also some from other countries including Vietnam and Portugal. Among them was a toolbox[18] of rapid assessment methods for humanitarian responses which has evolved with successive disasters. This has been reapplied for assessment of drought impacts in Lesotho (MDAT 2016).

The PDNA studies focusing on drought impacts that were identified on the GFDRR website included primarily studies from sub-Saharan Africa, including Kenya (GFDRR 2012b), Uganda (GFDRR 2012a), Djibouti (GFDRR 2011), Somalia (GFDRR 2018c; 2018d; 2018e) and Malawi (GFDRR 2017b). However, also included among PDNA assessments were studies of drought from the Marshall Islands (GFDRR 2017c), Vietnam (GFDRR 2017d) and India (GFDRR 2008). In some cases, PDNAs consider multiple hazards including drought combined with others, as in the cases of Vietnam and a recent multi-hazard risk assessment study from Afghanistan (GFDRR 2018a).

4.3 Applied drought impact assessments: strengths and weaknesses

Acknowledged scope remains for the international PDNA methodology to be adjusted to country contexts and to increase participation by affected communities (Jeggle and Boggero 2018). Nevertheless, the existing tools and methods are already relatively well-developed. Problems may have more to do with their application under time-constrained emergency conditions. Inclusive public consultation processes can be time-consuming to orchestrate and difficult to undertake in a crisis. The guidance for PDNAs includes ambitious requirements for baseline studies to be conducted using national records on population, infrastructure and natural resources. Unfortunately, in many developing countries detailed databases containing this information are not available. Even where information may have been collected previously, it can become less accessible to external facilitators after a disaster.

On the one hand, the PDNA guidance requires assessors to identify what has been destroyed during the drought – infrastructure, assets and services. But it also makes apparent the possibility that previous services and infrastructure may have been inadequate and creates an opportunity for improvement. The guidance for the baseline studies also requires the assessment team to weigh very complex and controversial questions that concern the governance and decision-making processes that existed before the crisis. It is important to have a full understanding of these issues before evaluating the effects of disaster. Although this guidance is logical, it may also be challenging for the assessment team to fully use it within a very limited timeframe. Team members' ability to do this will inevitably depend on their background, experiences and preconceptions. The GRADE approach is lighter and faster than the PDNA but involves even less engagement with stakeholders and their knowledge.

Beyond these practical strengths and weaknesses of the impact assessment approaches and ambitions, there are many methodological questions inherent in the valuation of effects on ecosystems and economies. The PDNA guidance offers helpful norms for the valuation of effects on infrastructure, services and even institutions and their decision-making processes. However, it is important to recognize that events such as drought distort markets and economies. This can render the task of valuation extremely problematic. A range of other ethical and methodological considerations may also affect the valuation tasks required. Nonetheless definitive statements of economic value obtained from PDNA process are its major strength which enables decisions and allocation of funds in response to the identified impacts of drought.

[17] see: https://www.gfdrr.org/en/publications

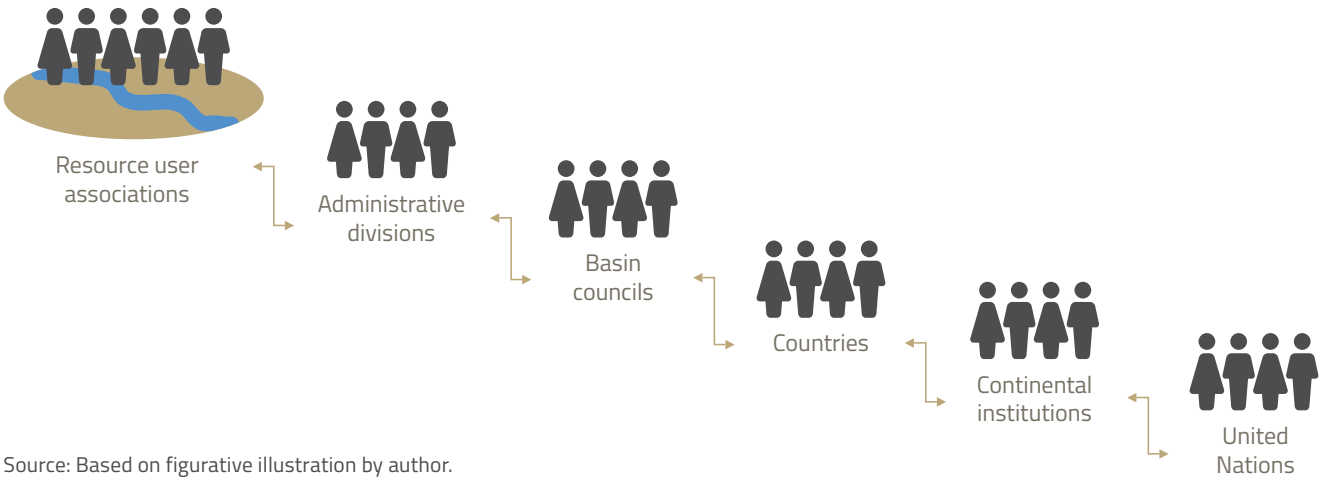
[18] Available at: https://www.humanitarianresponse.info/en/operations/cambodia/document/hrf-rapid-assessments-toolkit

5. DROUGHT VULNERABILITY ASSESSMENT

The identification of likely drought impacts – described in the previous section – is an important part of a vulnerability assessment. Vulnerability analysis can then work backward from these impacts to uncover, explain and assess human, social, economic, political, physical and environmental factors that can exacerbate or mitigate the risks (UNISDR 2009, p.37). In drought-prone countries, the identification of likely drought impacts is often retrospective, drawing on experience of past droughts. However, vulnerability assessments are seen as a way to inform actions that can reduce future drought risks.

While post-disaster drought impact assessments tend to be top-down processes, assessments of vulnerability can take a more bottom-up approach (Satapathy et al. 2014). Community-driven vulnerability assessments carried out at the level of resource users (Figure 3) can take the time to identify who is the most vulnerable to drought, and to ensure that these groups are included in the assessment process. In this way, national and global level understanding of drought impacts and vulnerability on the ground can be facilitated. A notable example has been provided by Mexico, where basin councils have been mobilized to conduct drought vulnerability assessments as a key part of the national programme for drought preparedness (Box 1).

Figure 3: A grounded approach to drought vulnerability assessment

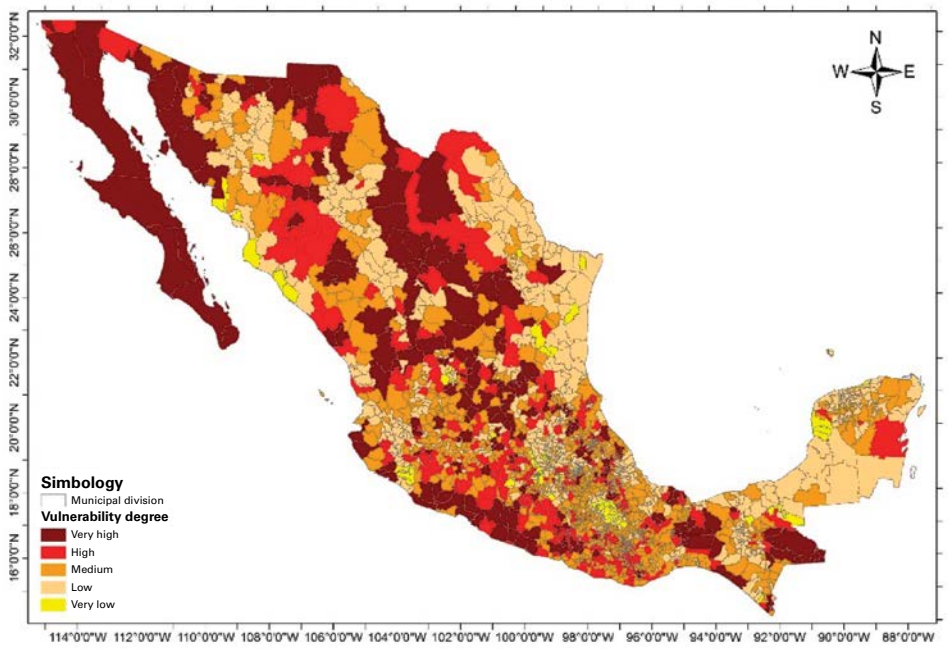


Source: Based on figurative illustration by author.

Box 1: Assessing vulnerability to drought at the basin-level in Mexico

In 2013- Drought Prevention and Mitigation Measures Programs (PMPMS), were created in 26 Watershed Councils across the country (as well as 13 cities). To achieve this, selected universities were engaged by the Instituto Mexicano de Tecnología del Agua (IMTA) to support each watershed council. Teams of investigators were given standardized guidance prepared by IMTA concerning the scope of the assessments to be carried out. However, due to limited and uneven availability of datasets, they could not apply consistent procedures or methods. A comparison of the methods used, including various indicators and weighting systems (Meza-González and Ibáñez-Hernández 2016) provided a basis for further refinements (Ortega-Gaucin et al. 2018a; 2018b). This has eventually resulted in the development of a standardized drought vulnerability index for vulnerability mapping to the level of the municipalities (Figure 4).

Figure 4: Mapping vulnerability to drought in Mexican municipalities



Source: Ortega-Gaucin et al. 2018a.

IBRD (2017); and WMO/GWP (2014) describe how CONAGUA staff and researchers from 12 national institutions were trained to standardize the activities and contents of these programs, which were implemented in the second and third years of PRONACOSE (2014–2015). After evaluation of the implemented programs in 2016–2017, the programs are to be improved, updated, and implemented again starting in the sixth year (2018). It is expected that a gradual implementation will continue beyond the sixth year through the ownership of the programs by the basin councils.

The example of Mexico demonstrates that methodological debates, data limitations and uncertainties can be overcome by applying a pragmatic approach. Using the best available assessment tools enables participation by stakeholders in a practical review process. This progressive use and review encourages improvements to available tools and methods over time. The engagement of the watershed councils in the review process is essential because these councils include the representatives of all water users. They face inevitable challenges when trying to bring their members together to agree on actions that will reduce vulnerability to drought instead of increasing competition for scarce resources. As a result, the councils require periodic training and re-training to be able to respond collectively as proposed in PMPMS recommendations. The success of PRONACOSE and PMPMS relies on the watershed councils' ability to own the vulnerability assessment, collectively assimilate problems, and build the necessary consensus among stakeholders for implementing solutions. This inclusive consensus-based approach is a social process that needs time. But it is the best way forward because during drought, nobody should have to act alone.

Source: Based on personnal communication by Mario Lopez, Rene Lobato Sanchez and published material by Ortega-Gaucin et al. 2018a.

Institutional analysis is an important preparatory step in the design of the vulnerability assessment. It requires mapping of relevant institutions and stakeholders and consideration of their mutual relationships and roles. A very rapid and simplified approach using a hand-drawn Venn Diagram to identify institutions and their relations is illustrated by Macchi (2011). More sophisticated approaches, methods and tools for stakeholder influence-mapping and analysis are also available (e.g. as described in Mayers 2005 or; Schiffer and Hauck 2010; Stein et al. 2014).

If the vulnerability assessment includes actors from only one sector (e.g. agriculture), this will constrain the scope of its findings and recommendations. However, bringing together a more diverse range of stakeholders can be challenging and requires stronger national leadership and support. Strategic attention from the responsible national authorities and direction to these aspects in the design of the vulnerability assessment is important. The UNCCD Drought Initiative has recently supported inclusive discussion of vulnerability to drought in Nigeria during national inception and validation workshops for a drought early warning system (FMEN 2017). For a cross-sectoral assessment of vulnerability to drought in the context of climate change adaptation, see: https://climateanalytics.org/projects/pas-pna-science-based-national-adaptation-planning-in-sub-saharan-africa/senegal/

Multi-scale assessments can connect disaster impacts on vulnerable people and regions to effects on the wider economy, public expenditures and global processes. It is important to clarify why and how less vulnerable people should also support policies to reduce drought impacts and vulnerability. Vulnerability assessment approaches commonly applicable on the ground in affected areas can be broadly classified into three types:

1. People-centred assessments of vulnerability in terms of poverty livelihood assets and resilience
2. Land-based mapping and models of ecosystem-service production
3. Hydro-meteorological assessments including water balance accounting

These frameworks build in reference to stakeholder groups and ecological systems that will require smaller units of analysis at the subnational/local scale. It is also likely that some of them may cross national boundaries and connect in different ways to global scale processes and vulnerability assessments. The progressive layering of these frameworks in the vulnerability assessment can help to ensure that long-term effects via the national and regional economies are included, as well as short-term effects on individuals, households and their assets.

The three broad approaches to grounded "bottom-up" vulnerability assessment identified in this review overlap and can involve the use of similar tools and datasets (qualitative and/or quantitative) (Figure 5). Intentional combination and layering of these overlapping frameworks can be recommended as a positive strategy, since the relative strengths and weaknesses of one can balance out the blind spots of another. In particular, addition of the water balance accounting approach to supplement analyses built on the livelihoods and agro-ecological approaches can reveal vulnerability to hydrological and socio-economic droughts. This is an important addition to the overall understanding of the impacts and vulnerabilities associated with agro-ecological and meteorological droughts, which are more routinely assessed.

5.1 People-centred livelihoods resilience framework

Scope:

The UNISDR (2009) has recommended the use of livelihoods frameworks in drought vulnerability assessment to capture the macro and micro factors, and long-term trends affecting vulnerability. A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both presently and in the future without undermining the natural resource base.[19] Resilience is (IPCC 2014a):

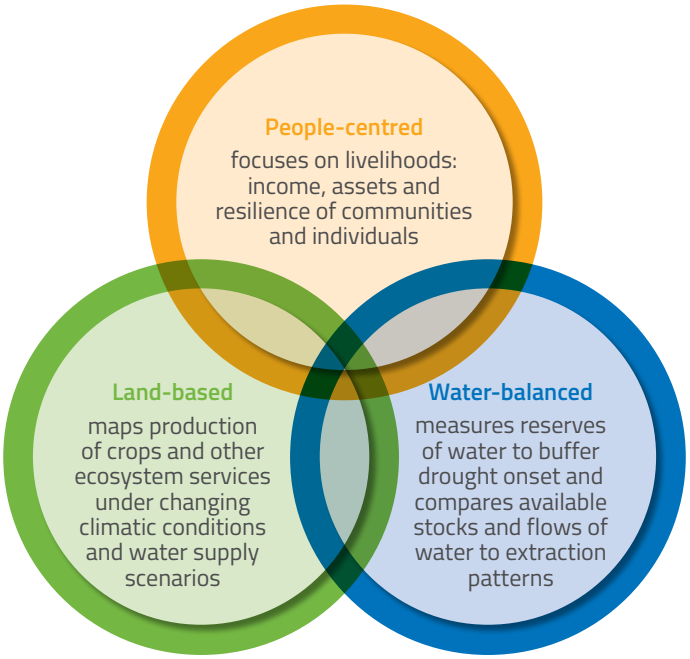
> 'The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.'

Resilience to drought is an essential consideration in livelihood assessments in drought-affected communities. The UK Department for International Development (DfID) (2014) defines resilience as:

> "a composite attribute possessed by each individual, that represents their ability to anticipate, avoid, plan for, cope with, recover from and adapt to (climate related) shocks and stresses. Improved resilience means that an individual is better able to maintain or improve their well-being despite being exposed to shocks and stresses."

[19] http://efls.ca/webresources/DFID_Sustainable_livelihoods_guidance_sheet.pdf

Figure 5: Assessing three dimensions of vulnerability from the ground up



Source: Figurative illustration by author.

As an essential part of the global SDG to end poverty in all its forms everywhere, countries have committed themselves to track and review progress toward the following target (1.5):

> By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

The essence of the livelihoods approach is that it puts people at the centre of the analysis and is cross-sectoral, taking into account economic, political and cultural factors. Understanding the asset base is also crucial, including physical assets such as land and livestock, human capital and social capital (Khayyati and Aazami 2016; Zarafshani et al. 2016). Generally speaking, the stronger and more diverse the household's asset base, the more drought-resilient it is likely to be, and the greater its ability to switch between different livelihood strategies during droughts (Antwi-Agyei et al. 2013).

A key principle in the design of vulnerability assessments concerns the inclusive definition of stakeholders and the particular targeting of vulnerable groups. Understanding differentiated vulnerability within communities is important, as some stakeholders can be more vulnerable than others or vulnerable in different ways (IPCC 2014b p6; Munroe et al. 2015; Sphere 2018; Swiderska et al. 2018). The vulnerability of impoverished communities to disasters is often increased by marginalization due to physical ability, caste, age, race, ethnicity and gender. Gender is particularly widely recognized as a core factor in the determination of vulnerability to drought and other disasters (Box 2). It has been recognized globally that low-income women and those who are marginalized due to marital status, physical ability, age, social stigma or caste are especially disadvantaged during disasters such as droughts.

Using the livelihoods framework, it is possible to explore questions such as: "What are the assets that individuals and communities will use to sustain them over during a prolonged period of drought?" For example, if drought reduces availability of water or food supplies and raises their prices, some households could be forced to sell productive assets such as tools and animals to purchase basic necessities, while others who have no assets to sell may go hungry unless resilience-building actions are taken.

Where a community and livelihood type(s) can be identified, familiar tools for participatory rapid appraisal can be used with community representatives (Box 3).

Box 2: Gender as a determinant of vulnerability to drought

Disaster affects men and women differently and the risks for both genders are not equal –therefore gender shapes the capacities and resources of individuals to minimize harm, adapt to hazards and respond to disasters. It is important to recognize that women are often well positioned to assess vulnerability and manage risk because of their roles as both users and managers of environmental resources, economic providers as well as caregivers and community workers. For these reasons it is necessary to ensure that vulnerability assessments at all levels identify and use gender-differentiated information to ensure that both vulnerabilities and capacities of women and men are fully considered.

There is now a dedicated SDG target on gender equality (SDG 5). Numerous guides to addressing gender issues in vulnerability and adaptation assessments are already available:

- The Gender, Climate Change and Community Based Adaptation Guidebook (UNDP 2010) provides examples of mainstreaming of gender issues in adaptation projects around the world
- CARE has produced a guide (CARE 2010) to integrating gender and women's empowerment in adaptation projects, starting with assessment of differentiated vulnerabilities
- The Global Gender and Climate Alliance (Askin et al. 2012)
- Mainstreaming gender in health adaptation to climate change programmes (WHO 2012)

Source: Partially based on UNISDR 2009.

Once the livelihood types have been characterized and broad answers to the questions raised above have been identified using qualitative assessment tools, quantitative tools may be used to test these findings, establish baselines and track achievement of changes in vulnerability and impacts under changing drought conditions and management strategies.

Often, quantitative indicators can be sourced from readily available local statistics. They tend to draw on conceptual models and methods that have already been established through national economic development programmes and international assistance from humanitarian agencies and development partners. For example, in Ethiopia, the Household Economy Analysis (HEA) (Holzmann et al. 2008; Lawrence et al. 2008)[20] is well-established, therefore this has been adopted into vulnerability assessments (Box 4). In other countries, Living Standards Measurement Surveys (LSMS) or other available socio-economic surveys may similarly form the basis for quantitative indicators to be used in vulnerability assessment.

Various reviews and guides to the use of quantitative econometric methods are available for assessment of vulnerability in general (e.g. Hoddinott and Quisumbing 2003; Moret 2014; Naudé et al. 2009). These reduce the broad qualitative focus of the livelihoods assessment to measure and track selected key aspects and variables of livelihood vulnerability. For example, vulnerability can be assessed using econometric models to quantify expected poverty, expected utility or as uninsured exposure to risk, all of which can be measured (Hoddinott and Quisumbing, 2003; Naudé, Santos-Paulino, and McGillivray, 2009) based on data acquired from questionnaires at the individual, household and community levels, such as the World Bank's LSMS, if available (Jha and Dang 2009).

Where gaps still remain in information needed to understand vulnerability following use of available secondary statistics, or to provide baselines for measurement of future improvements, it is sometimes possible to mobilize additional survey activities. Recommended methods for the design of these surveys reflect established good practices in household survey design more broadly.[21]

Moret (2014) observed that each quantitative measurement relies on a predetermined definition and understanding of vulnerability, which may or may not line up with perceptions of vulnerability at the community level. Furthermore, a one-size-fits-all definition of vulnerability may not capture specific aspects of vulnerability of marginal groups within the community and households – such as women, youth, the elderly and disabled. In light of this, consideration of qualitative assessments or assumptions is an important aspect of the design and analysis of quantitative assessments.

[20] See: https://www.heacod.org/en-gb/Pages/Home.aspx

[21] These are not described in this review, but relevant information is available from http://www.ihsn.org/

Box 3: Participatory diagnostic tools for vulnerability assessment

A range of rapid qualitative assessment methods is available to assess vulnerability to climate change (Dazé et al. 2009; PROVIA 2013; Swiderska et al. 2018). These draw on well-established participatory appraisal techniques which have been widely used by rural development and extension workers for community-based adaptation project planning since the 1970s.[22] More recently, this body of work has expanded to include assessments of urban vulnerability (Taylor and Lassa 2015) and resilience assessments. These tools are useful for establishing shared understanding of issues within groups and communicating this understanding to external stakeholders, donors and decision-makers (See Hovland 2005, p.12-13).

These tools can also be applied by local government officers and community representatives as well as non-governmental organization (NGO) staff (see e.g.Jarso et al. 2017). Various international NGOs have produced field guides for applying these methods in different parts of the world (Chiwaka and Yates 2005; IFRC 2006; IFRC 2007; ChristianAid 2009; Dazé et al. 2009; Macchi 2011; PracticalAction n.d.; Swiderska et al. 2018). The approach provides a framework for dialogue within communities, as well as between communities and other stakeholders, enhancing scientific data with local knowledge and building adaptive capacity. For case study applications in East Africa see: (IFRC 2003a; IFRC 2003b; Jarso et al. 2017; NEF 2012a; NEF 2012b; Oliver et al. 2011).

The participatory tools and methods documented in the guides above and others include:

Historical Timeline to identify when droughts have occurred in the past and what happened

Rivers of Life: Participants are invited to use the symbol of a river to reflect on key stages in their experience, identify positive influences (tributaries) and challenges (rough waters).

Mapping of resources and hazards: to locate and characterize resources used and impacted during droughts, how they are accessed and by whom

Seasonal Calendar to identify practices in drought and non-drought years

Tree diagrams: Tree drawings or causal loop diagrams are used to explore cause-and- effect relationships, explain problems and impacts, break down factors and their relationships, and facilitate understanding of interconnected issues

H Diagram: a diagram shaped like a wide H can be used in numerous settings to rate items along a scale (for example, level of individual or community concerns about drought – from "not worried at all", to "extremely concerned"), providing an easy-to-understand visual representation of participants' responses.

Vulnerability Matrix to score the severity of different effects on different groups. See example in (Swiderska et al. 2018)

Force field analysis: to understand the factors that drive movement toward a particular goal (motivating forces) or blocking such movement (constraining forces or barriers). See Hovland (2005 14-15).

Participatory scenario development is a process that involves participation of stakeholders to explore the future in a creative and policy-relevant way. It can be used to identify the effects of alternative responses to emerging challenges and determine how different groups of stakeholders view the likely impacts of hazards such as droughts (see: CARE 2012; CARE 2017). IBRD (2010) includes detailed instruction for convening workshops to discuss adaptation options. The first session of the workshop focuses on vulnerability assessment, including a Plenary Explanation, then Table-group Activity using impact chains to identify climate change most relevant to the area, list the social groups most vulnerable to climate change, and identify why these groups are most vulnerable.

[22] To access a 25-year archive of Participatory Learning and Action (PLA) notes, go to: pubs.iied.org/search. php?s=PLA and for an in-depth review of Participatory Action Research, see Burns et al. (2012) and the journal issue it introduces.

Application:
In some countries such as Mexico, drought vulnerability assessments have focused on national objectives to reduce poverty, rather than on livelihood resilience more broadly. For that reason, they have not explicitly singled out and targeted particular vulnerable individuals or groups such as women (personal communication: Mario Lopez). However, particular vulnerability of women and girls under climate extremes such as drought is receiving increasing attention through a range of international humanitarian programmes in various parts of Africa, including Chad, Burkina Faso and Ethiopia (Le Masson et al. 2019; McOmber et al. 2019). Violence against women and girls is increasingly documented in the context of international humanitarian responses. As a result, factors affecting the livelihoods and resilience of women and girls, not just communities as a whole, are now receiving particular attention (Le Masson et al. 2019).

International support has enabled dedicated surveys of vulnerable households in Ethiopian woredas with a specific focus on disaster risk profiling (Box 4). These have been used to inform the design of social protection and assistance programming in the drought-affected areas. The keyword search of peer-reviewed literature produced additional examples of cases where rapid qualitative methods have been used to understand the nature of drought vulnerability preceding the compilation of quantitative indicators of vulnerability.

Strengths:
The strength of the livelihoods framework is that it is people-centred and takes into consideration the idea that communities are not just producers of crops or livestock, but may have accumulated a range of assets including cash, land, and social capital that can help them to survive a drought. The broadness of the framework creates entry points to consider many of the issues, targeting them in more depth via the other assessment approaches – for example, agro-ecological aspects, water resource management and economic development, as outlined in the following sections).

The approach can be applied at different scales – for communities, households or particular individuals within households who may be more vulnerable – for example, widows, and disabled. It can be helpful for decision-makers to understand what makes different groups vulnerable and how, so that decisions about assistance are better informed. The assessment process can also encourage the participants to think through and enhance the strategies.

Summary of strengths:

- Ensures people-centred analysis, broader than income only
- Can accommodate long-term time horizon
- Considers capacities of different kinds
- Familiar to practitioners. Connects to agro-ecosystems
- Includes presentation of economic case for decision-making to manage drought risk at household level

Weaknesses:
A recurrent problem with the use of this framework to guide vulnerability assessments is related to the tendency to over-simplify livelihoods assessments – especially when it is applied at national and regional scales - and to assume that livelihood strategies are more homogeneous than they actually are. This has frequently resulted in drought vulnerability assessments that assumed that large areas of Africa consist only of pastoralists and/or crop farmers. Major business sectors, such as food industries and hospitality, petty commerce, construction and transportation as well as communications are systematically overlooked in static preconceptions about livelihoods in many drought-prone areas.

Often, assessments using the livelihoods approach are selective and do not exhaustively pursue assessment of all aspects that the framework could accommodate. For example, although the livelihoods framework includes space for assessment of "natural capital," vulnerability assessments that pursue this approach often do not prioritize thorough investigation of water resources availability during drought and its management during non-drought periods. Furthermore, the livelihoods framework does relatively little to facilitate consideration of the social and power relations between members of different groups and political processes that shape many coping strategies and opportunities, despite frequent acknowledgements of their importance. Definitions of these essential aspects remain dependent on the understanding of facilitators and analysts or participants involved in the assessment process.

Summary of weaknesses/challenges:

1. Time consuming and requires complicated contextual data to show changes
2. Focuses on household scale – may not be applicable at multiple-scales
3. May not capture effects on the national and regional economy
4. Can favour culturally challenging recommendations to diversify the livelihood portfolio
5. Often misses identification of strategic water management solutions
6. Very challenging to apply objectively – even where quantitative survey methods are used

Box 4: Surveying, profiling and evaluating vulnerability to drought in Ethiopia

The vulnerable areas are mapped by using Woreda Disaster Risk Profile (WDRP), which is managed by the Disaster Risk Reduction Directorate of the National Disaster Risk Management Commission (NDRMC). Various tools were prepared for WDRP data collection and for implementing other Disaster Risk Management and Disaster Risk Reduction activities. These include the WDRP training manual, mitigation/adaptation plan guidelines, contingency plan guidelines, Disaster Risk Reduction Mainstreaming guidelines, and different standardized questionnaires and checklists. Capacity building activities were carried out on WDRP and DRR planning and mainstreaming guidelines and tools. In addition, the household economic approach was applied in different parts of the country.

The Woreda risk profiling was carried out with the participation of stakeholders from government and non-government organizations. These include the federal, regional, zonal and woreda experts and organizations such as the World Bank, UNICEF, UNDP, WFP, Spanish Aid, CordAid and others. In addition to their technical input, development partners have also provided financial support for the exercise. Validation of the Woreda risk profile and disaster risk reduction plans were carried out immediately after the data collection. Moreover, endorsement by the decision makers was very important at regional, zonal and woreda levels to ensure mainstreaming of disaster risk mitigation and adaptation strategies into sectoral development plans at woreda level. Tools developed for various analyses were updated based on the lessons learned from testing in the field and participation of stakeholders from the regions, zones, woredas and other partners.

Through a dedicated survey, woreda-specific hazards, vulnerabilities and capacities were identified for each community. For each woreda profile, sector-specific information was also collected. This included information on crop production, livestock production, human health, water and sanitation, environment and others factors related to community coping mechanisms and suggestions. A guide to the woreda profiling (MOARD No date) describes the use of qualitative and quantitative techniques as follows: first, secondary databases were identified and collated. Then further information not readily available was collected through **primary surveys** in each of the woredas. Three kinds of study tools have been used as part of the primary surveys. Two of these tools are qualitative while the third one is quantitative:

A. Qualitative tools
- Focus group discussion
- Key Informant Interview

B. Quantitative Tool:
- Household sample survey

Beshah (2017) reports that as of April 2017, WDRP data was collected for 412 woredas. Out of these, profiles have been developed for 345 woredas and were released on an official National Disaster Risk Management Commission website.[23] Through this exercise, the majority of disaster-prone woredas of Ethiopia have been covered.

The vulnerability mapping and assessments of household assets are used to inform a major social protection planning and drought relief effort in Ethiopia. Established in 2005, the Productive Safety Net Programme (PSNP)[24] aims to enable the rural poor that face chronic food insecurity to resist shocks, create assets and become food self-sufficient. It provides multi-annual predictable transfers, in the form of food, cash or a combination of both, to help chronically food-insecure people survive food-deficit periods and avoid depleting productive assets to meet their basic food requirements. The programme includes support for the generation of quantitative data required for evaluation purposes (see discussion in Maxwell et al. 2013; Ulrichs et al. 2019). For example, a study conducted by Knippenberg (2016) on the PSNP suggests that the programme *'reduces vulnerability [to a drought] by 60% and doubles the level of resilience, significantly improving the post-treatment recovery trajectory… When a household experiencing drought receives the mean level of PSNP payments (498 birr, approximately $23), their welfare drops less following a shock and recovers more rapidly.'*

Source: Beshah 2017; MOARD No date; Ulrichs et al. 2019.

[23] The following address is provided by Beshah : www.profile.dppc.gov.et – note: this is not available as of December, 2018.

[24] See https://www.wfp.org/sites/default/files/PSNP%20Factsheet.pdf

Way forward:
Recent studies that appeared in the literature on resilience in East Africa have sought to assess the value of household assets at risk due to droughts and the cost of increasing household income to prevent these losses. In some cases, such studies have been limited to data from secondary databases created through social protection programmes and drought early warning (FAO 2018; Venton 2018). In others, support has been provided for NGOs to implement participatory scenario development approaches to identify patterns of drought impacts (e.g. NEF 2012a; 2012b). Integration of these community-level exercises focused on livelihoods into national drought vulnerability and risk assessments is gaining recognition as a promising approach to drought preparedness planning.

Uninsured exposure to risk at the micro-level (identifiable from the livelihoods assessments) is an important part of macro-economic vulnerability, particularly in the short term, and especially when national governments anticipate the need to provide drought relief which may require external assistance. National governments should assess the costs of unaddressed vulnerability and different forms of intervention.

There is scope to address some of the identified weaknesses in this approach by integration with land-based mapping of ecosystem services and basin water accounting, as described in the following sections. The SDG process offers a global framework through which countries are already committed to monitoring all three dimensions of vulnerability as separate indicators. This creates an opportunity to explore the interdependence between these indicators at different scales.

5.2 Land-based mapping of ecosystem services

Scope:
Drought vulnerability and impact assessments refer to effects on the production of ecosystem services. A well-established approach to quantifying ecosystem services is to map land uses and vegetation types. Different types of ecosystem services and climatic effects can be connected to each mapped land area. The approach builds on a long-standing body of work on agro-climatic production systems and drought impacts (after Parry et al. 1988). Many of the participatory tools described in the previous section are also frequently used by agricultural extension workers to identify and map these systems (2012; 2015; CARE 2017). The available maps can be used to predict and model the potential for changes in agricultural productivity that result from climatic effects such as drought.

This assessment approach unites drought vulnerability assessments seamlessly into an extensive body of internationally coordinated scientific work that continues to evolve in global inventories of land use, land use change and forestry (LULUCF) under the UNFCCC[25] and SDG Indicator 15.3.1 on land cover and tracking of land degradation neutrality (LDN) under the UNCCD (Cowie et al. 2018).[26] It is also directly relevant to the intended indicator for measurement of the UNCCD Strategic Objective 3, as agreed at the UNCCD COP13, with emphasis on vulnerability of ecosystems. The establishment and improvement of a monitoring framework for this indicator is now under discussion by the UNCCD Committee on Science and Technology.

Considerable scientific attention has been devoted to connecting agro-ecological maps to models of vegetation and crop responses to water stress (e.g. AquaCrop or others). These models can predict specific effects on food production and water availability under different drought and non-drought conditions and resource management strategies (after Carter and Konijn 1988). This makes assigning economic value to effects on crop production relatively straightforward in cases where market prices are well-known and systematically recorded by the local statistical services.

Methods for assessing ecosystem productivity for a broader range of land cover and land use types, including urban ecosystems, rangelands and wildlife habitats as well as cropping systems have received increased attention in recent decades. Nonetheless, these remain in the early stages of development compared to the staple crops. The UN System for Environmental Economic Accounting (SEEA) provides a global framework for ecosystem accounting.[27]

Application:
The agro-ecological approach to the assessment of vulnerability to drought can be mapped across the extent of a country using available information on climate and land characteristics (after Carter and Konijn 1988) and can help to structure the identification of agricultural livelihood types for further analysis (see previous section). For example, the Famine Early Warning Systems Network (FEWSNET) uses agro-ecological zones as the basis for overlaying and analysing remotely sensed environmental hazard products to measure the vulnerability and coping capacity of local communities.

[25] See resources at: https://unfccc.int/topics#:d6466783-27a7-4ddf-b357-58474e555a5e

[26] See https://knowledge.unccd.int/topics/sustainable-development-goals-sdgs/national-use-indicator-1531

[27] See https://seea.un.org/

Drought monitoring systems increasingly incorporate observation and mapping of climatic effects and changes into other remotely sensed variables such as Normalized Difference Vegetation Index (NDVI). These can be used to identify and predict trends in drought onset and effects on agricultural production. These land observation-based approaches are popular among practitioners in drought affected countries and regions all over the world. The approaches to vulnerability assessment are increasingly incorporated into drought early warning systems used to trigger emergency-phase classifications and responses, including the distribution of relief and assistance to farmers. These can include distribution of food, cash payments or other concessions to vulnerable households through national drought-relief programmes. Nowadays, financial institutions and insurers in various countries also frequently use vegetation condition Indices.

A drought monitoring product maintained by the Czech Globe institute can serve as an example of a drought-monitoring system that makes use of remote sensing data and model simulation of soil moisture.[28] An essential part of the system is the network of voluntary monitors that report drought impacts on the ground. A system based on remote sensing only has also been recently expanded across the broader Central European region as part of the DriDanube project.[29]

The literature on agro-ecological approaches to assessing drought vulnerability continues to address the methodological issues related to the integration of remote sensing, geographic information systems (GIS) and field-based survey techniques into the monitoring of drought vulnerability and impacts. These tools can speed up the assessment, reduce costs, ensure that the results are objectively verifiable and consistent, and enable a wider group of students and citizen scientists to contribute to the knowledge base. However, use of remote techniques without sufficient testing and validation in the field can lead to unusable results.

Numerous examples of agro-climatic or agro-ecological approaches have been identified through the keyword search on "drought vulnerability assessment" among the peer reviewed scientific publications (e.g. Boultif and Benmessaoud 2017). Recent applications identified through the keyword search on "drought vulnerability assessment" included Kamali et al. (2018). While methods and tools for assessment of the productivity and vulnerability of cropping systems are numerous and relatively sophisticated, methods and tools for assessment of the productivity or vulnerability of forest and rangeland systems have received relatively less attention in the published literature. Wildlife reserves, urban areas and other growing land-uses have received even less attention.

The larger the number of stages, products and values included in the model of the land-based production system, the more complexity and uncertainty is introduced to the vulnerability assessment. For example, modelling vulnerability to drought of a cropping system is simpler than modelling vulnerability to drought of a livestock production system that includes forage production as one of its components, alongside other aspects that consider possible climatic and other effects on livestock health and nutrition. This can be illustrated in a case from the region of Kaffrine in Senegal (King-Okumu et al. 2017b). To capture the additional dimensions of these agro-ecosystems requires employing a range of different methods, tools and databases. Additional complexity and methodological choices are necessary when farmers' decisions related to production, harvesting, post-harvest activities and marketing are likely to vary. The models should also be sensitive to external influences that affect prices, security and other social dimensions of a production system.

Addressing land-based production systems as part of a larger economy that includes urban areas and other associated systems will introduce many more layers of complexity.[30] A range of methodological issues surrounds the conversion of effects on physical production systems into economic effects on households, regions and national economies. In some cases, these also interact with global economic processes. Additional methodological questions concern forecasting of prices. In some cases, it is possible to connect ecological models to additional contributions to the economy via value chains created by processing, transportation and demand for agricultural inputs. It is also challenging but possible to model environmental impacts associated with agro-chemical use, groundwater depletion, land tenure, access to capital and other effects of ecosystem management.

Strengths:

The major strength of land-based approaches to assessing drought effects on the production of ecosystem services lies in the precedents and tools that make these approaches feasible, popular and widely used. They can be applied rapidly in areas with relatively low local institutional capacity and limited background information, eliminating the need for delineation of catchment boundaries, monitoring of water bodies, etc.

[28] See http://www.intersucho.cz/en/

[29] http://www.interreg-danube.eu/dridanube

[30] For a collection of urban assessments of vulnerability to drought and other climatic changes , see Habitat (2012).

Summary of strengths

- Ensures coverage of resource-dependent production systems
- Can connect to climate and economic models
- Can be mapped and monitored at low cost using satellite derived data
- Many agricultural adaptation options likely to be identified
- Familiar to agricultural extension systems and capacities in place

Consistent use of these approaches provides opportunities for progressive improvement in some aspects.

Weaknesses:
Assessments that focus on land-based models of ecosystem-service productivity tend to be limited to one-dimensional agricultural production, assuming a lack of alternative livelihoods and obscuring the diversity of non-agricultural incomes, assets and opportunities that might be available, particularly in urban and urbanizing areas.

Although agro-ecological assessments are usually designed to take climatic conditions into account, they do not necessarily consider the availability or depletion of water from sources other than rainfall – e.g. underground and surface reservoirs, and the demands for water that may result from domestic, urban or other uses (see next section). Modelling crop responses to water stress using available modelling crop water response tools introduces additional assumptions about farmers' land and water management decision-making which may be inaccurate and require verification.

Summary of weaknesses/challenges:

- More oriented to agriculture than other sectors
- Tendency to simplify production systems, focusing on a few high-value products
- Inclusion of poorest and most marginal or landless groups and specific resources that they depend on is not always systematic
- May not capture vulnerabilities in urban and urbanizing areas (hydrological and socio-economic drought)
- Focuses on field scale, may not be multi-scale
- Not always long term (focus is on annual land productivity rather than effects on land value and growth of economies)
- Often have relatively short time horizons – for example, one year
- Do not consider water needs in other sectors of the economy: can lead to recommendations to increase irrigation without considering competing water demands

Way forward:
The UNCCD LDN framework is integrated with the SEEA[31] and SDG agendas.[32] This is an evolving global discussion with its own momentum and involvement process from countries. While the LDN process does not usually consider drought effects, there is a need to connect land-based assessments to more recent findings on the economics of risk and resilience (Bahadur et al. 2015; Bond et al. 2017a; 2017b; Venton 2018).

Available methodological guidance for assessing the economics of adaptation to climate extremes and disasters (briefly summarized in Swiderska et al. 2018) includes exploring the sensitivity of ecosystems to drought-related losses in the Sahel (King-Okumu and Diop 2017) and the Horn of Africa (King-Okumu 2015). Insights from a broader global body of available methodological guidance on the economics of land degradation are also available (ELD 2015; ELD and UNEP 2015; King 2011).

5.3 Water balance accounting at basin level

Scope:
Water resource accounting is an area of ecosystem accounting that focuses on available volumes of water in different parts of the ecosystem[33] (Pedro-Monzonís et al. 2016; SEEA 2012; SEEA 2017). Water balance accounting compares the volume of available water to the volumes extracted (UNWater 2017). Water stress occurs when the level of water extraction is high in relation to resource availability, as happens during hydrological drought. Sometimes, hydrological drought may be a temporary phenomenon. But water extractions that reduce flows in surface water bodies and cause the water table to be lowered can also alter the availability of water in the soil profile as well as surface water bodies and subsurface reserves unless the systems are replenished. Water stress can be exacerbated by rising water demands, causing a situation where insufficient water resources cannot meet water demands for agricultural and other uses (He et al. 2017).

Since availability of water in one part of a basin affects flows and availability in other areas, assessments should focus on the hydrological units (basins or catchments) rather than on administrative

[31] https://seea.un.org/events/expert-meeting-seea-indicators-sdgs-and-post-2020-agenda
[32] https://seea.un.org/sites/seea.un.org/files/presentation_1_barron_orr_ldn_indicators_session3_seea_wcmc_12feb2019_pdf.pdf
[33] https://seea.un.org/content/seea-water

units (Box 1). Basin-level water resources can be calculated on an annual basis, based on the volumes of precipitation and extractions. However, these calculations should also take into consideration the opening balance of water volumes stored in surface water bodies and underground. When extractions exceed replenishment during droughts, the deficit can be addressed by drawing on the stored reserves. If these are not replenished, a long-term alteration of the hydrological balance and functions of the system including ecosystem service production might follow. This degradation of the productive land and water resources is a form of desertification that can be exacerbated by drought.

Increased demand and higher prices for water services during droughts can disadvantage less wealthy water users and leave them more vulnerable. The distribution of impacts and vulnerabilities during periods of heightened water stress and drought emergencies also demands increased attention.

Available internationally agreed methods to calculate water stress (SDG 6.4) (UNWater 2017) focus on water accounts at the national level. However, countries are also encouraged to consider assessments at the basin level. In addition, the standardized approach focuses on annual timeframes, which may not fully capture long-term trends in declining water storage that increase vulnerability to drought. In addition, intra-annual variations require attention in water accounts because often there may be peaks in water stress at particular times of the year. While these may not show up in annual statistics, they can cause water shortages and alter water use patterns. Annual water accounts may also ignore extreme downpours that can cause floods and do not contribute to water supply at other times of the year unless the excess runoff is captured and stored.

The Water Evaluation and Planning System (WEAP), developed by the Stockholm Environment Institute,[34] serves as a tool commonly used to calculate competing demands for water and effects on the water balance at the basin scale. A review of other models that could be used for hydrological drought forecasting at the continental scale in Africa (Trambauer et al. 2013) concluded that viable global hydrological models include: PCR-GLOBWB (Beek and Bierkens 2009), Global Water Availability Assessment method (GWAVA) (Meigh et al. 1999), Hydrology Tiled ECMWF Scheme for Surface Exchanges over Land (HTESSEL) (Balsamo et al. 2009); LISFLOOD (De Roo et al. 2000; JRC 2011)[35] and Soil and Water Assessment tool (SWAT) (Faramarzi et al. 2013). These models can be connected to hydrological observation systems on the ground with sufficient institutional support and coordination.

To date, global efforts to integrate water balance models with hydrological observation systems have focused on the national programs for observation of surface and groundwater levels (GFDRR 2018b). However, in some countries, these services are not well integrated with the efforts of local institutions and water user groups in drought affected regions. For example, in Kenya, the government has struggled to establish Water User Associations to work with in the more drought prone regions. Meanwhile, customary resource user associations that have been active on the ground have struggled to achieve recognition and support from the government (King-Okumu et al. 2017a). Participatory approaches that encourage cultivation of best practices used by stakeholders are widely recommended (Wilhite 2011b) (Box 1). Various initiatives in different parts of the world explore the use of more bottom-up participatory approaches to resource monitoring and drought vulnerability assessment (e.g. Singh and Chudasama 2017 in India). But these are also rarely incorporated into national systems for drought vulnerability and early warning.

Application:

Water stress indices are used to monitor drought in most countries. Often, they focus on short-term effects on precipitation volumes and do not consider longer-term impacts on the volumes of water stored in the system. Widely used common indices (besides the aridity index) include the Standard Precipitation Index and a range of others listed in an IDMP handbook (Svoboda and Fuchs 2016). For further theoretical discussion of basin level vulnerability indices, see Vargas and Paneque (2017). Critically low water levels in key water sources provide a well-established drought indicator that is used to trigger drought management actions in India (Box 5) and the UK such as restrictions on water extraction for lower priority uses. Water levels are also included in drought monitoring systems in the US, Mexico and Brazil (De Nys et al. 2017).

In the Americas, water balance accounting is applied in different parts of the US – water demands have been taken into consideration in the development of drought indices for Texas (Rajsekhar et al. 2015). Mexico has encouraged its water basin councils to adopt some of the practices used in the US to develop drought vulnerability assessments (Box 1). Regional cooperation has enabled Brazil to learn from the US

[34] https://www.weap21.org/

[35] http://www.bristol.ac.uk/geography/research/hydrology/models/lisflood/

and Mexico how to establish a hydro-meteorological drought monitoring system (personal communication: A. Magalhaes, see: monitordesecas.ana.gov.br). In Colombia, drought vulnerability assessment includes consideration of the supply versus demand ration of surface water resources and a territory's capacity to maintain its supply in dry times as determined by the Water Vulnerability Index.[36]

In contrast to the situation in India and the Americas, relatively little information is routinely collected by governments about the water balance to monitor drought effects and vulnerability in the river basins and catchments of Sub-Saharan Africa. Drought early warning systems established with international cooperation tend to remain oriented toward emergency food distribution rather than enabling sustainable management of water resources. They mostly rely on combination of remote sensing and food-security indicators, rather than water availability measures. The Kenyan drought early warning system includes monthly survey data on water sources and distances to water trekked by pastoralists and their livestock, but it does not include any physical monitoring or modelling of hydrological processes affecting water availability.

Generally, studies of water-stressed basins are carried out on an ad-hoc basis and have not been integrated into vulnerability assessment processes and early warning systems at national, regional and global levels. For example, PCR-GLOBWB has been used to explore global drought risks and generate inter-regional comparisons (Wanders and Wada 2015; Wanders et al. 2015). It has also been applied at the continental level to investigate the relationship between climate-change drivers and potential groundwater recharge (PGR) patterns across Africa for a long-term record (1960–2010) (Nasta et al. 2016) and in the Yangtze River Basin in China (Lee et al. 2017; Zhou et al. 2017). The GWAVA model has been demonstrated as a relevant tool for drought vulnerability assessment in the West African Sahel (Meigh et al. 2005) and Asia (Chak et al. 2006). The same model has been applied in East and Southern Africa (Meigh et al. 1999). But neither of these has yet been systematically adopted by any of the national drought management systems.

The SWAT has been applied by scientists to simulate drought risks in many regions, including the Horn of Africa (Gies et al. 2014), and parts of India (Jain et al. 2015). The WEAP system has been widely used to model drought effects on water stressed basins, from the Colorado river and California (Yatesa et al. 2013; Yates et al. 2015; Forni et al. 2016) to parts of the Sahel (Mounir et al. 2013; Toure et al. 2017), Ghana (Dovie and Kasei 2018), Morocco (Johannsen et al. 2016), Algeria (Hamlat et al. 2013), Turkey (Yilmaz and Harmancioglu 2010), Greece (Demertzi et al. 2014), Thailand (Ngo et al. 2018) and Costa Rica (Hund et al. 2018).

In transboundary basins, understanding of the resource volumes available and extracted can be the subject of joint investigation as the basis for internationally negotiated agreements and management cooperation. Transboundary basin management conflicts also arise within countries. Cases of inter-state conflict over river basin management and flow allocations are heard by the Indian Supreme Court (Box 5).

A large number of peer-reviewed studies identified via keyword search ''drought vulnerability assessment' focus on assessing vulnerability in river basin units (e.g. Rossi et al. 2009; Wu et al. 2013; Ganapuram et al. 2015; Mishra and Nagarajan 2015; Ruiz-Agudelo et al. 2015; Stonevičius and Stankūnavičius 2015; Nagarajan and Sreedhar 2015; Pei et al. 2016; Thomas et al. 2016; Núñez et al. 2017; Kar et al. 2018). These employ various indicators to observe and classify meteorological drought conditions that affect basins in different parts of the world. A notable proportion of these studies originate from India. However, relatively few of the published drought vulnerability assessment studies from any region shed light on how drought affects water demand in populations and predicted increases in water demand in the basins during drought and non-drought periods. Exceptions include Núñez et al. (2017), which includes consideration of water extractions in Elqui River Basin, North-Central Chile.

Strengths:

Water resource accounting and monitoring of water stress have potential for addressing the growing problem of hydrological drought, providing a basis for analysis of how decisions by one group of land users upstream may influence the vulnerability of those downstream – either by altering vegetative cover that regulates surface and sub-surface flows or by extracting water from the system. This can then enable identification of scope for management improvements.

Summary of strengths:

- Considers water availability and demand across the economy including urban areas
- Can be connected to climate models and scenarios
- Connects to drought monitoring and early warning systems
- Can enable identification of risk management actions
- Can enable identification of capacity needs

[36] National Study on Water. IDEAM, 2014.

Box 5: Increasing case for scientific assessment and management of hydrological drought in India

Drought declaration and response management in India have always been a complex operation that requires coordination between various levels of government. In 2016, the Supreme Court of India heard accusations of inconsistent application of subjective criterion in the drought declarations by different States. The Court directed the Union government to revise its 2009 Drought Management Manual and to include an objective scientific approach. In 2016, a new manual placed complete responsibility on the State governments to monitor, assess and declare drought and prescribed a scientific to be used. The States may seek financial assistance from the Federal Government for drought-affected regions only in cases that fulfil conditions outlined in the manual.[37]

The manual provides stringent definitions for four indicators to determine drought onset and severity based on: rainfall, vegetation and soil moisture conditions, storage water level in reservoirs, streamflow and ground water levels, the extent of the area sown and crop conditions (GoI 2016). Based on these precisely defined criteria, droughts can be identified in a systematic way, and relief can then be planned and distributed more fairly. The manual describes how state governments should monitor available information sources on key variables relevant to drought:

- Meteorological Data – Rainfall and other parameters like Temperature, Wind speed and Relative Humidity (subject to availability), weather forecast - Short, medium, extended range
- Soil Moisture (subject to availability), Sown Area / Crop Health / Stress and Satellite-based Vegetation Index
- Stream Flow – Discharge, Groundwater Levels and Reservoir and Lake Storage / Level
- Impacts – Distress sale and migration of cattle, human migration, fodder availability, drinking water, animal health, employment opportunities in agriculture sector

Even with the drought manual, many controversies and concerns continue to arise over the assessment and declaration of drought.[38] Disputes between states also arise over historically agreed water allocations from the flows of shared rivers. The Stream Flow Drought Index (SFDI) is used to assess and declare droughts according to the drought manual (GoI 2016p41). Downstream states have accused those upstream of short-changing their allocated flow volumes. Water quality is also heavily affected by reduced flow volumes – since with less water to dilute effluents in the rivers, the concentration of pollutants increases. The Indian Supreme Court has been called upon to make rulings about the minimum flows of water from one state to another during the droughts. But no court can order water not to flow out of a porous riverbed if the water-table is depleted. This depends on the local environmental conditions, which will vary temporally and spatially.

Changing hydrological conditions have reduced water levels in the rivers and surrounding subsurface areas. Where water tables have fallen, flows of groundwater that once fed into riverbeds are no longer contributing to the river flow volumes. Instead water now seeps out of the riverbeds into soil that has been left dry due to the groundwater deficit. Groundwater conditions and recharge patterns are a critical factor for drought vulnerability. Whereas earlier in the century droughts were buffered by groundwater reserves. These reserves have been depleted in many areas as part of the coping strategies during previous droughts. Where the stores of water could not be replenished, vulnerability to drought has increased. The best ways to conserve water vary from one area to another and change with the seasons. When temporary water deficits incurred during droughts are not balanced when the rainy seasons come, droughts become more frequent and severe, and people become even more vulnerable.

There is increasing realization that a single standard and drought mitigation plan does not fit all parts of the country in the same way due to variations in land conditions and management opportunities. For example, in the drier areas, people are more skilled at saving water. When they receive additional water supplies through inter-basin transfers, they apply them to high-value economic uses. There is therefore a need for tailored planning of drought mitigation on the regional level, taking into account particular environmental, social and hydrological conditions, constraints and opportunities in each region. In a previous study (Pandey et al. 2010), areas with greater water utilization were considered to be more vulnerable to drought than those with low water utilization. However, the drought manual does not consider water demand projections.

Source: Based on personal communication from: Rajendra Prasad Pandey, 23 February 2019.

[37] https://www.weap21.org/

[38] http://www.bristol.ac.uk/geography/research/hydrology/models/lisflood/

Weaknesses:
Summary of weaknesses/challenges:

- Institutional challenges to coordinate data collection, management and analysis – data on water extractions is often incomplete in drought-affected areas
- May require additional information on groundwater management
- Municipal and industrial water extractions are growing faster and less understood than agricultural water use
- Transboundary issues, political and security sensitivities in some countries

Way forward:
The collection and management of data on water demand and extractions presents a major institutional coordination and governance challenge. Addressing this challenge is essential for effective planning of economic development as well as for drought management in the dry areas. Citizen science, remote sensing and smart technologies offer new ways to overcome parts of the challenge.

Globally coordinated methods for observing water stress at the basin level are emerging via the Sustainable Development Goal 6.4. Lately, the WMO has proposed to create a global hydrological monitoring system.[39]

Relevant datasets are compiled from the national level in the AQUASTAT database by the UN Food and Agriculture Organization. Although imperfect, global data on baseline water stress (BWS) (Gassert et al. 2014a; 2014b) and percentage of renewable water retained by hydrological catchment is already available from the Aqueduct database of the World Resources Institute.[40]

[39] See: http://www.wmo.int/pages/prog/hwrp/chy/hydrosos/index.php

[40] See: http://www.wri.org/our-work/project/aqueduct

6. DISCUSSION OF COMPARATIVE STRENGTHS, WEAKNESSES AND ISSUES ARISING FROM THE REVIEW

This review of methodological approaches is not exhaustive due to the diversity of global experiences, the range of vulnerabilities and potential impacts of drought, associated observation methods and the large volume of publications dealing with assessment under a wide range of different subject-headings and areas. Time limitations and the desk-based approach constrained the scope of the review. Many approaches and issues raised merit further consideration. Nonetheless, an overview of the wide range of methodological approaches and tools for the assessment of drought impacts and vulnerability has been generated. This discussion highlights some of the main strengths and weaknesses of the assessment approaches that are available.

Taking action after drought has already occurred is costly, and it is impossible to compensate for all forms of damage caused by the disaster. Nevertheless, where support for the assessment and leadership are strong, methodological approaches and tools for assessing drought impacts can include integration across sectors, consideration of long and medium timeframes, and generation of economic assessments that can support decision-making. However, top-down process and pressures to implement rapid assessments may constrain methodological options to engage all stakeholders and fully consider all impacts of the drought. Accessing data and institutions in the affected areas can be problematic at times of crisis, conflict and emergency.

Identified methodological approaches for drought impact assessment included a globally coordinated approach developed via the GFDRR, as well as a series of case studies from the US and other countries compiled by UNISDR (2009) and Parry et al. (1988). Relevant material has also been collected in various reports of the IPCC and other UNFCCC processes and the EMdat database. Recent assessments included cross-sectoral impacts and long-term as well as short-term impacts of drought. However, peer-reviewed publications on drought impact assessment were much more limited in scope, focusing primarily on the agricultural sector.

The comparative advantage of assessing vulnerability to droughts before they happen is that it can enable preventive actions that reduce drought risks, avert the worst impacts and reduce costs. Vulnerability assessments often take a more bottom-up approach and facilitate engagement at the community, national and regional levels, including of vulnerable groups. Because vulnerability is complex, assessments tend not to focus exclusively on generating economic arguments, and do not necessarily seek quantitative results. However, in many cases, methodological approaches can progressively combine qualitative and quantitative data collection. It is rare for such approaches to be guided at the national level, and therefore comprehensive cross-sectoral vulnerability assessments are few.

For drought vulnerability assessment, the SDG process, particularly targets 1.5, 6.4 and 15.3, may provide a basis for a globally coordinated approach. Beyond these targets, three broad overlapping and complementary frameworks for characterization and analysis of vulnerability to drought were identified in this review. They include the livelihoods framework, agro-ecological mapping and modelling approaches, and basin-level water balance accounting. These methodological approaches are not standardized and may draw on a range of tools and methods (qualitative and/or quantitative) for application in different contexts. These are often modified and customised for application in specific locations, according to stakeholder needs.

Intentional combination and layering of the three overlapping frameworks can be recommended as a positive strategy, since the relative strengths and weaknesses of one approach balances out the blind spots and weaknesses of another. In particular, addition of the basin water accounting approach to supplement analyses built on the livelihoods and agro-ecological frameworks can be important to capture deepening long-term vulnerability to hydrological droughts as they are becoming more frequent (IPCC 2018).

The approaches applied for vulnerability assessment at the local and regional levels can inform national and global assessments. Where local and regional actors are expected to invest in drought management, the assessments may also feed directly into decision-making. Where vulnerability assessments are integrated into drought early warning systems, necessary actions may be predetermined – for example, the declaration of a drought status and the delivery of specific forms of assistance. Vulnerability assessments can also inform longer-term investments in improved water resource management and other aspects of development planning to mitigate and avoid the escalation of crises. To justify major investments in drought-proofed development planning, vulnerability assessments may have to include an outline of the economic case and projections.

Vulnerability assessments do not always set out to attach an economic value to projected susceptibility to droughts, but they often include the use of quantitative indicators of various kinds. These gauge the relative severity of the drought risks. In a few exceptional cases, recent studies that appeared in the literature on resilience have sought to assess the economics of vulnerability. They calculate the resilience dividends that decision-makers could secure by taking early action, rather than waiting for impacts to occur.

Methods that have been particularly effective for this purpose include participatory scenario development approaches (e.g. NEF 2012a; 2012b) and the household economy approach (Venton 2018), as well as agro-ecological models to simulate avoidable loss and damage. These should be studied further and should be better integrated with the basin water accounting approach.

There is often overlap and interplay between approaches to the assessment of drought impacts and vulnerability. On one hand, drought impact assessment should include consideration of the impacts of droughts on future vulnerability (GFDRR 2013). On the other, drought vulnerability assessments tend to be informed by the experiences of past droughts – particularly when it comes to economic assessments which often refer to specific costs associated with the impacts of past droughts (EC 2010). However, economic activities and settlement patterns are changing rapidly in many developing countries, creating a need to anticipate new types of impacts that will be different to past experiences.

A summary of the major strengths and weaknesses of the main approaches identified is presented in Table 3. This comparison reveals the collective strengths and complementarities of available methodological approaches, tools and methods. Nonetheless, findings from the review of country experiences and published literature suggest that most of the available assessments still fall short in their consideration of the longer-term impacts and vulnerabilities associated with hydrologic and socio-economic drought. These impacts and vulnerabilities are man-made via urban development, as well as land and water management patterns. They are therefore worthy of greater attention so that they could be either prevented or managed as part of a pro-active and preventive drought-risk management approach for policy and practice.

Identifying overlaps and comparative advantages between approaches to assessing drought impacts and vulnerability highlights scope for international knowledge exchange, documentation of case studies and creation of guidance materials.[41] For example, in Colombia, methods for assessment of hydrological aspects of drought are more advanced than in some other regions. On the other hand, in parts of Africa, there has been significant investment in studies to assess the economics of vulnerability and resilience to socio-economic drought and the potential of sustainable land management for building drought resilience (King-Okumu et al. 2017b; NEF 2012b;

[41] Examples of accessible materials available in the international literature on climate change do not focus only on drought but include Balangue (2013); Satapathy et al. (2014) and others.

Venton 2018). The exchange of this knowledge and practical experience should emphasize and facilitate particular consideration of the most vulnerable groups and their adaptation capabilities, priority actions to enhance them and the economic case for including these actions into national assessment processes.

The reasons why assessments do not succeed in applying all available methods may be related to shortage of time and resources as well as a lack of methodological guidance. Although many sources have been cited in this review, it is difficult to identify a single generic universal guidance that is applicable to all contexts. Such guidance would need to be comprehensive, yet sufficiently accessible to meet the needs of policymakers who are often under pressure to deliver assessments rapidly under challenging social and political circumstances. Even with unlimited time and resources, it would be hard to imagine a fully exhaustive assessment of all drought vulnerability factors and impacts. Decision-makers inevitably have to balance aspirations for exhaustive coverage with efficiency.

The best advice is to adopt a consistent approach to vulnerability assessment and learn by doing (personal communication: Mario Lopez). The more assessments are conducted ahead of time, the easier it will be to assess the impacts when a drought occurs, and the more manageable the impacts are. A similar observation has been made by Jeggle and Boggero (2018) who found that national statistical systems and capacities prepared well in advance inevitably facilitate the assessment task.

Table 1: Strengths and weaknesses of methodological approaches to assessment of drought impacts

Methodological approaches	Short characterisation of approach	Examples of relevant methods, tools & datasets	Links or references to examples	Strengths	Weaknesses
Post Disaster Needs Assessment (PDNA)	Inter-agency collaborative assessment done in-country to define scope and priorities for coherent disaster response	See 2 volumes of guidance materials (GFDRR 2013) Relies mainly on national statistics	(GFDRR 2012b; GFDRR 2017b; GFDRR 2018a; GFDRR 2018f)	Economic case is presented Methods are comprehensive: cross sectoral, long-term view The methods are intended to be multiscale and include fieldwork	Time constraints may compromise application of the methods The connection to the local level and affected communities is acknowledged to be weak, especially where timeframes are constrained Heavily reliant on pre-existing data accessible in country
Global Rapid post-disaster Damage Estimation (GRADE)	Proposed new method for desk-based precursor to above	Relies mainly on remote sensing & WorldPop Relatively new/ untested	(Gunasekera et al. 2018)	Compatible with PDNA Rapid, inexpensive	Connection to the ground non-existent – approach is rapid & desk-based. Unlikely to consider the needs of most vulnerable Heavily reliant on pre-existing data accessible outside country
Emergency Events Database (EMDAT)	Compilation of cases (see also review of other available databases in Appendix)	Relies on contributors' methods	https ://www.emdat.be/	Economic case is presented for proactive mgt approach Includes private sector, insurance companies, etc covers a long period (see Appendix for more comparison)	Incomplete, assessment methods depend on agencies contributing Relies on secondary data, lacks in-depth details – e.g. does not identify geographical locations and extents

Table 2: Strengths and Weaknesses of Methodological Approaches to Assessment of Drought Vulnerability on the Ground

Methodological approaches	Short characterisation of approach	Examples of relevant methods, tools & datasets	Links or references to examples	Strengths	Weaknesses
Community-based resilience and livelihoods assessment approach	Focuses on people, their assets and ability to recover from drought	Participatory Rapid Appraisal (PRA) and secondary datasets: household surveys, census, project-driven databases, etc	(IPCC 2014a) (Dazé et al. 2009; PROVIA 2013) www.ihsn.org **Case study in this report: Ethiopia (PSNP)**	Ensures people-centred analysis, broader than income only Includes presentation of economic case at household level Can accommodate long-term time horizon Considers capacities of different kinds Familiar to practitioners Connects to agro-ecosystems	Data-intensive and time consuming Focuses on household scale – may not be multi-scale May not capture effects on the national and regional economy Can favour recommendations to diversify the livelihood portfolio Often misses identification of strategic water management solutions
Ecosystem-based agro-ecological approach	Focuses on ecosystems, their productivity and responses to climate extremes	PRA: seasonal calendars Remote sensing of landcover/use systems and climate Crop-water response and bio-economic models (including livestock) Value chain analysis Ecosystem service valuation	www.seea.un.org see also: FAO LADA (ELD 2015; ELD and UNEP 2015; INWEH 2011) (Cowie et al. 2018; Swiderska et al. 2018) Examples in this report: DriDanube project and assessments in Senegal groundnut basin.	Ensures coverage of resource-dependent production systems Can connect to climate models and to economic models Can be mapped and monitored at low cost using satellite derived data Many agricultural adaptation options likely to be identified Familiar to agricultural extension systems and capacities in place	Inclusion of poor and marginal groups not always systematic More oriented to agriculture than other sectors May not capture vulnerabilities in urban areas Not necessarily long term Focuses on field scale – may not be multi-scale May have relatively short time horizons Does not consider water needs in other sectors of the economy
Water balance accounting and basin management approach	Focuses on water availability, and relation to demands from different sectors of the economy	Climate information and models, PRA: resource mapping Water resource accounting (SDG 6.4) and demand estimates Global and catchment hydrologic models, remote sensing and Geographic Information Systems (GIS)	(UNWater 2017) (He et al. 2017) (https://seea.un.org/content/seea-water) (Pedro-Monzonís et al. 2016; SEEA 2017) Case study in this report: India Other examples in this report: Colombia, Mexico and Brazil	Considers water availability and demand across the economy including in urban areas Makes effective use of climate models and scenarios Connects to drought monitoring and early warning systems Can enable identification of capacity needs Can enable identification of risk management actions	Institutional challenges to coordinate data collection, management and analysis Data on water extractions often incomplete in drought-affected areas May require information on groundwater management Municipal and industrial water extractions growing faster and less well understood than agricultural water use Transboundary issues, political and security sensitivities in some countries

Table 3: Strengths and Weaknesses of Methodological Approaches to Assessment of Drought Vulnerability at the National and International Levels

Methodological approaches	Short characterisation of approach	Examples of relevant methods, tools & datasets	Links or references to examples	Strengths	Weaknesses
National approaches					
Macro-economic assessment approach	Focuses on implications for national economic development planning	National wealth accounts and GDP National economic growth models	(GFDRR 2012b; IBRD 2005; Venton 2018) Example in this report: Kenya	Can explore long-term economic effects of drought on the economy and justify improved national decision-making	Often overlooks informal economies where most vulnerable populations earn their livings Economic assessments are controversial and often contested/rejected
Institutional analysis	Focuses on stakeholder dynamics, communication and power relations	Mapping institutions Venn diagrams, network analysis	(King-Okumu et al. 2017a) **Case study in this report: Mexico**	Situates assessment in governance context Provides roadmap for design of assessment process	Subjective, political, dynamic To identify and include all relevant stakeholders can be challenging/ endless
Inclusive approach	Focuses on design of the consultation process	Targeting focus groups, e.g., gender analysis (SDG 5) Disaggregated datasets	(IBRD 2010) (Askin et al. 2012)	Ensures inclusion of women and marginal groups Can identify capabilities of these groups as well as vulnerabilities	May be time-consuming and logistically challenging Inclusion of random token representatives not always effective In pre-existing conflict situations can be sensitive
Global approaches					
Tracking of SDGs	Datasets tracked at the national level	SDG Targets 1.5, 6.4, 15.3	https://sustainabledevelopment.un.org/?menu=1300	All countries have committed and international community intends to support	Focus on national-level datasets does not effectively target the most drought-prone regions within countries
Global vulnerability map	Component of global drought risk map (alongside hazard and exposure maps)	Global generic indicators and GIS	(Carrão et al. 2016)	Visual, comparative, exposure map is effective and powerful http://edo.jrc.ec.europa.eu/scado/php/index.php?id=3000	Disconnected Timebound Vulnerability map does not stand alone without exposure map Data flaws

7. SUGGESTED RECOMMENDATIONS FOR POLICY

Emerging recommendations for national drought management policy

There is an opportunity for the UNCCD and its Parties in drought-affected countries to take stock of which approaches, tools and methods they are using to assess vulnerability and resilience. They can exchange knowledge and experiences from different countries on how well these tools and methods are working, the extent to which they connect across scales and how well they capture the vulnerability and resilience of disadvantaged groups. The UNCCD offers a forum for these discussions, and for evaluation of ongoing needs for further development either of the tools and methods or of in-country capacities and systems through which they can be applied. The connection across scales from local to global agendas and the international spotlight should also offer opportunities to enable national representatives to overcome internal barriers and connect across the sectors of the national economies and administrations.

Emerging recommendations for national policymakers include the following:

- Take a pro-active approach to assess vulnerability before drought crisis escalates
- Foster inclusive, cross-sectoral and multi-scale approaches to vulnerability assessment
- Integrate assessments of impacts on livelihoods, ecosystem service production and water balance accounting
- Assess both predictable and emerging economic implications of ongoing vulnerability to drought
- Review past assessments to identify and fill gaps
- Learn by trial and review which methods are best-suited to encourage participation in vulnerability assessments by different groups – including women, men, youth, elderly, disabled and minorities
- Document assessment successes and failures – including cases where anticipated drought impacts do not occur and vice-versa (some of these may indicate effective management)
- Share best practices and lessons learned with decision makers at different levels
- Learn from others' mistakes and successes by taking part in coordinated international knowledge exchange
- Where best practices or lessons learned are relevant to experiences for more than one country, seek out and validate generalizable lessons and document them to provide training materials for future decision makers
- Promote the improvement of global databases on drought impact and vulnerability (including information on wider impacts beyond the national economies of the countries where the initial impacts are first observed)

This review has identified gaps in vulnerability assessments applied in various parts of sub-Saharan Africa concerning vulnerability to hydrological and socio-economic droughts. It has also noted emerging strengths in this area in country experiences from Colombia and Mexico, amongst others. This suggests that there is an opportunity to achieve benefits through internationally coordinated knowledge exchange in this area. We have also observed opportunities to make greater use of participatory scenario planning approaches and methods, such as those explored in parts of East Africa. These can be used in combination with past drought impact assessments to improve assessments of present and future vulnerability to drought such as those developed by the GFDRR, particularly for East and Southern Africa. There is also a need to foresee new risks and impacts as developing economies grow and the world is increasingly interconnected.

It would be beneficial to continue the review of the practical application of national approaches to impact and vulnerability assessment, and to include contributions from more of the least developed countries. These are likely to include cases where drought impacts and vulnerability are combined with a range of other vulnerabilities to complex hazards, as in Yemen, Somalia and Afghanistan. Contributions from developed countries could also be useful if they include discussion of weaknesses, as well as strengths in their assessment approaches. This could be achieved using the GFDRR guidance to generate a checklist of drought impacts to be considered across sectors.[42] The continued review of published literature could also be useful. However, it would be advisable to expand the scope of the search terms to include more literature on resilience assessment and the resilience dividend along with continued focus specifically on drought impacts and vulnerability. While maintaining a focus on the vulnerability, impacts and drought-resilience-building potential of land and ecosystems, it would be desirable to take into consideration and coordinate with the ongoing IPCC and GPDRR processes. It is important to underline the notable strengths and complementary but differentiated focus of these processes.

So far there are few peer reviewed publications of national achievements in drought impact, vulnerability and resilience assessment that are genuinely cross-sectoral, employ all three of the frameworks and succeed to address hydrological and socio-economic droughts. Rather, most focus primarily on short-term, seasonal and meteorological phenomena. Very few publications focusing on the hydrology and socioeconomics of droughts, land degradation, desertification and sustainable land management strategies in the worst affected countries have been identified. To address this situation, the UNCCD Drought Initiative could consider providing dedicated support to practitioners in affected countries to undertake peer review and publish the results of such assessments. Experts who have contributed to this review could form the basis of a strong advisory committee for this project.

Emerging recommendation for regional coordination

Processes and systems for early warning and longer-term decision-support that exist at national and regional levels in some cases already take into consideration certain vulnerability and resilience factors – either implicitly or explicitly. For example, the Kenyan drought early warning system routinely includes monitoring of malnutrition among children under the age of five. However, these factors and their relation to drought are complex, dynamic and are subject to change (Venton 2018). Following the establishment or enhancement of impact vulnerability and resilience assessments at the national level, there may be an opportunity for countries to review and re-calibrate the factors and assumptions concerning vulnerability and resilience included in the national and regional drought early warning systems, databases and development plans.

Most early warning systems focus on either meteorological or agricultural drought, but few effectively capture hydrological vulnerability and impacts of drought or provide a well-balanced assessment of socio-economic vulnerability and impacts across all sectors of the economy and society. At present, early warning systems in the Horn of Africa do not include quantitative indicators of water stress that the countries have committed to track as part of the SDG monitoring, such as SDG 6.4 and SDG 6.5. These indicators are also not included among planned indicators that contribute to the monitoring of the UNCCD Strategic Objective 3 on ecosystems vulnerability and community resilience to drought.

In other regions, international knowledge exchange has improved national capacities for hydrological monitoring – for example, in the case of Brazil where experts received training from counterparts in Mexico to produce a hydrological monitor with the support from the World Bank (De Nys et al. 2017). Drought bulletins of this kind provide information on exposure to drought and evolving drought risks. There is still

[42] A previous checklist provided to the IDMP (WMO/GWP 2014) by the University of Nebraska was oriented primarily to impacts in the agricultural sector. There is therefore an opportunity to update this using the available guidance on the identification of drought impacts (GFDRR 2013) and further practical experiences gained by practitioners since the IDMP began its work.

scope for further consideration of vulnerability assessment approaches that should be triggered following the identification of drought hazards and exposure. A focused review of practices in different regions, could initiate a knowledge exchange process supported either by the UNCCD Drought Initiative or the relevant international financing institutions including the regional development banks and/or the World Bank.

Emerging recommendation for global assessment

Currently, even the best available global assessment system[43] under-reports the impacts of droughts in the developing world and does not effectively consider distributional, ethical and social dimensions of these costs across the global economy. Nor does it register costs for developed countries incurred due to continued drought emergencies in developing countries. These do not only include the costs of humanitarian relief, but also the negative effects on developed country economies and societies that are due to extreme global inequalities and insecurity. There is a need for global assessments to connect more effectively to impact and vulnerability assessments at local and national levels in the drought-affected countries, and to evaluate expenditures for international cooperation. This will make a global assessment process less biased and incomplete. Such an assessment would also need to capture and account for successful drought preparedness wins where meteorological drought hazards did not result in economic disasters, decline and degradation, as well as losses and damages where they do.

There is a clear need for improved international knowledge exchange and capacity building in developing countries to enhance drought impact and vulnerability assessment. International processes such as the IPCC and WIM play a critical role in building capacity for the assessment of loss and damage associated with meteorological droughts and short-term effects on agricultural production seasons. Impact and vulnerability assessments that focus on the further -reaching man-made hydrologic and socio-economic aspects of drought could benefit from international scientific processes initiated by the Parties to the UNCCD and its Drought Initiative, with international partners supporting these sovereign scientific processes. This should lead to better-informed actions that limit further exacerbation of global threats and hazards of preventable hydrologic and socio-economic droughts that occur in marginal dry areas of developing countries.

There is a need to establish a global assessment process that could assess the global economics of drought vulnerability and impacts, registering progress achieved in reducing or avoiding them. The international, national and local governance systems could then use this process to track their progress in de-escalating manageable drought risks. If the global institutions and financing systems can achieve and demonstrate progress in managing manageable drought risks, they might also overcome other global disaster risks. Evidence of this would be useful to track progress against drought, to improve the performance of the international governance and financing systems, and to convince sceptics that it is necessary to behave responsibly and support such systems for the common good.

[43] https://www.emdat.be/

8. CONCLUSIONS

There is a wide range of available methodological approaches and tools for assessing drought impacts and vulnerabilities. There are also varied experiences in the application of them that could be shared by affected countries. In light of this, there is a notable scope for international knowledge exchange, documentation of case studies and creation of guidance materials. These should encourage national assessment processes to include particular consideration of the most vulnerable groups, integrate assessment across scales including the hydrological basin and sub-basin scales, consider the deep long-term effects of drought vulnerability and impacts and include economic assessments, wherever possible.

Drought impact and vulnerability assessments are likely to reveal adaptation capabilities, priority actions to enhance them and the economic case for these actions. However, to do so effectively, they should be objective, and should not focus only on the short-term effects of meteorological drought affecting single seasons of agricultural production, nor set out to build a rapid case for predetermined sectoral projects and programmes. Better informed assessments at all levels should help prevent further escalation of global threats due to drought impacts occurring in marginal dry areas of developing countries.

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Appendix: Comparison of international drought databases

Table 4: Comparison of international drought databases (prepared by Somoye Mukaila Olagake, Intern, UNCCD Secretariat)

	EMDAT https://www.emdat.be/emdat_db/	**NDMC** https://droughtreporter.unl.edu/map/	**EDC** http://www.geo.uio.no/edc/droughtdb/edr/DroughtEvents.php	**UNISDR** https://www.desinventar.net/index_www.html
Types of impacts included	Death People affected Losses incurred Damage	General Awareness Agriculture Business and Industry Energy Fire Plants and Wildlife Relief, Response and Restrictions Society and Public Health Tourism and Recreation Water Supply and Quality	Forestry Agriculture and livestock farming Fresh water aquaculture and fisheries. Energy and Industry Waterborne transportation Freshwater ecosystems: habitats, plants and wildlife Terrestrial ecosystems: habitats, plants and wildlife Public water supply Tourism and recreation Water quality Soil system Wildfires Air quality Human health and public safety Conflicts	Death Houses destroyed / damaged Spatial distribution People directly /Indirectly affected. Losses $USD Damages in crops (Ha)
Advantages of database design and management	Provides a global assessment of drought disaster. User friendly data base Has a wide range of temporal drought data collection.	Registration not needed. Detailed searchable information about drought impacts on various sectors of the country. Lists sources.	Contains information about drought impacts No registration needed (open source) Gives information on Impact category and impact description.	Disaster issues are treated on country basis
Disadvantages of database design and management	Sources of data not well detailed. Requires registration to access data.	Not so user friendly compared to EMDAT database Data is only about USA and doesn't cover global drought crises.	Not up to date as selectable date ends at 2014 Not detailed compared to that of the USA database Provides no information about data source. Not comprehensive.	Ensures inclusion of women and marginal groups Can identify capabilities of these groups as well as vulnerabilities

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Convention to Combat
Desertification

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Organization of the
United Nations

Global Water
Partnership

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