**Final Curriculum**

**Drought Management for Monitoring and Early Warning**

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| **Module number & name** | **Module 1: Drought Concept and risk management approaches** | **Module 2: Introduction to indices and indicators for drought monitoring** | **Module 3: Selecting relevant indices and indicators for your region** | **Module 4: Practical application of drought monitoring and forecasting tools**  |
| **Introduction text** | This module introduces drought and integrated drought management and forms the conceptual basis for the subsequent modules on drought monitoring. Drought is a complex hazard, and this module will explore its characteristics, causes and impacts. In addition, it will show how climate change is aggravating droughts and their impacts in many regions of the world. Integrated water resources management is central to reducing risk of drought and is a central consideration for this e-learning course.The module presents an overview of the three pillars of integrated drought risk management: (1) monitoring and early warning, (2) vulnerability and impact assessment, and (3) risk mitigation and response – to ensure participants understand the full extent of actions required for integrated drought management. The remainder of this course focuses in detail on Pillar 1. Several international processes are in place that promote action towards integrated drought management. These included the Sustainable Development Goals, the Paris Agreement, the Sendai Framework for Disaster Risk Reduction, and the UN Convention to Combat Desertification. It is within the framework of these global agreements that action on drought management must take place. Finally, some examples of historical droughts from the West Africa region are provided in the supporting materials.  | Water and its management are important in understanding and mitigating the risk of drought. This module explains how the hydrological cycle influences drought characteristics (severity, duration, timing, spatial extent), and how understanding the different ways of measuring hydrological parameters can support in monitoring drought, including precipitation, soil moisture, evaporation, groundwater, etc. Access to data or monitoring products are key in the drought monitoring and early warning process. This module explains what an early warning system comprises and reviews methods for hydro-meteorological datacollection, including ground-based measurements, remote sensing techniques and open-data sources. National meteorological and hydrological services have a key role to play in collecting this data, while WMO provides the standards to which this data must adhere. Finally, this module will provide an overview of drought indicators and indices, which are used to describe drought conditions and provide a basis for drought impact assessment.  | Drought indicators and indices are used to describe drought conditions and provide a basis for drought assessment. Following from the presentation of relevant data and the overview of drought indices and indicators presented in Module 2, this module focuses on a selection of indicators and indices that are particularly relevant for the West African region and listed in the Handbook of Drought Indicators and Indices (WMO and GWP, 2016). By highlighting their advantages and disadvantages, participants will be able to understand how they could be applied and interpreted in the context of drought assessment.  | This final module in the course provides some practical examples of drought monitoring and forecasting tools and products that can be used. Using the knowledge and information gathered in modules 2 and 3 as a basis, the focus of this practical application will be on agricultural drought, including monitoring, forecasting, impact assessment.You’re presented with examples of real applications of the Drought Early Warning System (DEWS), with guidance on how this could be applied in their context or used as inspiration.  |
| **Module goal** | The goal of this module is to introduce the key concepts relevant for this e-learning course, including the definitions and characteristics of drought, common impacts, the drought life cycle, integrated water resources management, climate risk and vulnerability. By providing cases of historical droughts from the West African region, participants will be well placed after completing this module to understand drought hazard and consider the challenges and opportunities from drought management in the region before being introduced to the various indicators and tools that can be used in the subsequent modules. | The goal of this module is to introduce the key concepts of drought monitoring and early warning systems, in particular the data and the indices and indicators that can be used for monitoring drought. The focus of this module will be on understanding how the hydrological cycle plays an important role in the way droughts develop. Methods for hydro-meteorological data collection in relation with the water cycle (precipitation, soil moisture, evaporation, groundwater) will be reviewed. In addition, an overview of drought indices (meteorological, hydrological, agricultural, composite, etc) will be given to introduce the next module that will focus on selected indices. | The goal of this module is to introduce selected drought indices and indicators with an overview of the datasets needed for calculation and their advantages/disadvantages. The aim is to illustrate how the use of different indicators/indices can be used for capturing different drought time scales. This module will help participants understand a selection of drought indicators/indices relevant in the region. | The goal of this module is to explain the importance of drought monitoring and forecasting tools and products to assess the impact of agricultural drought and provide a practical example of how these tools can be applied.  |
| **Learning objectives** | * Explain the drought phenomenon and how climate change affects it
* Differentiate between drought and other types of water shortages
* Summarize available approaches to manage drought risk with a focus on the role of monitoring and early warning
* Demonstrate how integrated drought management is related to international processes such as the UN Sustainable Development Goals
* Understand the regional drought risk through historical hazard and impact data
 | * Outline the elements of a drought early warning system
* Identify parameters and techniques for measuring components of the hydrologic cycle
* Understand the climatological context for drought monitoring
* Explain the role of drought impacts in drought monitoring
 | * Assess, select, and interpret regionally relevant indices
 | * Identify available data sets for drought monitoring (and forecasting)
* Analyse relevant indices – with a focus on agricultural impacts
* Create a drought intensity map from data and indicators
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| **Mandatory content**  | Training Manual: Drought Risk Reduction in Integrated Water Resources Management. Chapter 1: Introduction to integrated drought management. (Pages 1-17) <https://www.unepdhi.org/wp-content/uploads/sites/2/2020/09/Cap-Net_DRR_Manual.pdf> Global Assessment Report on Disaster Risk Reduction: Special Report on Drought 2021 – **Summary for policy makers** (EN) (pages 1- 22) (FR) (pages 1-24) [GAR Special Report on Drought 2021 | UNDRR](https://www.undrr.org/publication/gar-special-report-drought-2021) (select relevant section to avoid repetition of training manual)Three pillars factsheet <https://www.droughtmanagement.info/wp-content/uploads/2021/06/IDMP_3pillars_factsheet.pdf>  | Training Manual: Drought Risk Reduction in Integrated Water Resources Management. Chapter 2: Monitoring and Early Warning (Pillar 1) (pages 19-23) <https://www.unepdhi.org/wp-content/uploads/sites/2/2020/09/Cap-Net_DRR_Manual.pdf> WMO/GWP - Handbook of Drought Indicators and Indices <https://library.wmo.int/index.php?lvl=notice_display&id=19498#.YZ4aBtCZND8> (chapters 1 to 3) (EN and FR) | Training Manual: Drought Risk Reduction in Integrated Water Resources Management. Chapter 2: Monitoring and Early Warning (Pillar 1) (pages 23-30) <https://www.unepdhi.org/wp-content/uploads/sites/2/2020/09/Cap-Net_DRR_Manual.pdf>WMO/GWP - Handbook of Drought Indicators and Indices <https://library.wmo.int/index.php?lvl=notice_display&id=19498#.YZ4aBtCZND8> (chapters 4 to 6) (EN and FR) | Training Manual: Drought Risk Reduction in Integrated Water Resources Management. Chapter 2: Monitoring and Early Warning (Pillar 1) (pages 30-35) <https://www.unepdhi.org/wp-content/uploads/sites/2/2020/09/Cap-Net_DRR_Manual.pdf>Demo of the UNEP-DHI Portal developed: *Video demo to be developed.* UNCCD Drought monitoring provides free access to near real-time data for drought monitoring. <https://knowledge.unccd.int/drought-toolbox/page/monitoring-and-early-warning> Global Information and Early Warning System on Food and Agriculture (GIEWS) monitors the condition of major food crops across the globe to assess production prospects. *Use this tool to select your country and extract a drought intensity map.* <https://www.fao.org/giews/earthobservation/country/index.jsp?lang=en>*Explore an example of a regional drought early warning system. The DroughtWatch drought monitor is one of the outcomes of the DriDanube project (2017–2019), which aimed to increase the capacity of the Danube region (a large part of south-eastern Europe) to manage drought-related risks. The DroughtWatch user interface features different data products from a range of operational remote sensing satellites, data from meteorological stations and drought impact reports*[DroughtWatch | Drought Watch](https://droughtwatch.eu/)  |
| **Recommended Reading** | Chart of the Sendai Framework for Disaster Risk Reduction 2015-2030: <https://www.preventionweb.net/files/44983_sendaiframeworkchart.pdf> (EN) <https://www.unisdr.org/files/43291_frenchsendaiframeworkfordisasterris.pdf> (FR) Case Study West Africa: GAR: Special Report on Drought 2021 (EN)<https://www.undrr.org/publication/drought-west-africa> A review of droughts on the African continent: a geospatial and long-term perspective (EN) <https://hess.copernicus.org/articles/18/3635/2014/hess-18-3635-2014.pdf> UNDP - Mainstreaming drought risk management: A Primer. Case Study: Local DRM for Enhanced Resilience in Niger (page 63-66) EN:<https://www.undp.org/sites/g/files/zskgke326/files/publications/Mainstreaming%20DRM-English.pdf> FR: Etude de cas: GRS locale pour une résilience accrue au Niger (page 65-69) <https://www.undp.org/sites/g/files/zskgke326/files/publications/Mainstreaming%20DRM-French.pdf>  | Multi-hazard Early Warning Systems: A Checklist <https://library.wmo.int/doc_num.php?explnum_id=4463> Earth Observation Data for West Africa Climate Resilience (only EN)<https://eo4sd-climate.gmv.com/publications/brochure/earth-observation-data-west-africa-climate-resilience>Cap-Net Training Manual on EO for IWRM<https://cap-net.org/wp-content/uploads/2020/04/EO-manual-2017-LR.pdf> (EN only)Strategic framework for drought risk management and enhancing resilience in Africa: White Paper (page 18-33) (EN only) <https://knowledge.unccd.int/sites/default/files/2019-04/African_drought_white_paper.pdf> Drought indicators and indices handbook (IDMP) (EN)<https://www.droughtmanagement.info/literature/GWP_Handbook_of_Drought_Indicators_and_Indices_2016.pdf> (FR) <https://www.droughtmanagement.info/literature/WMO-GWP_Manuel-des-indicateurs_2016.pdf>  | Standardized Precipitation Index User Guide <https://library.wmo.int/index.php?lvl=notice_display&id=13682#.YZ4ZtdCZND8> (EN and FR)Drought indicators and indices handbook (IDMP) (EN and FR)<https://www.droughtmanagement.info/find/guidelines-tools/handbook-drought-indicators-and-indices/> <https://www.droughtmanagement.info/literature/WMO-GWP_Manuel-des-indicateurs_2016.pdf> UNCCD Good Practice Guidance on Drought Risk (Hazard, Exposure, Vulnerability). *The document contains a step-by-step procedure on how to calculate the SPI and create a map. Note that this exercise might require downloading of some data and running special tools (using R or Python language) for computation. The selected list of available SPI calculation tools can be found in Table 3* (page 33-43) EN <https://www.unccd.int/sites/default/files/documents/2021-09/UNCCD_GPG_Strategic-Objective-3_2021.pdf>  | N/A  |
| **Recommended websites** | *The main website gathering all types of reports and information on disaster risk reduction, including drought management.*[PreventionWeb.net: the knowledge platform for disaster risk reduction](https://www.preventionweb.net/)Resources from UNCCD Drought Toolbox about Vulnerability and Risk Assessment:<https://knowledge.unccd.int/drought-toolbox/solutions/risk-assessment/2414> IDMP website with resources on the pillars, library and glossary[Integrated Drought Management Programme](https://www.droughtmanagement.info/)  |  | Indicators and indices listed below are based on the IDMP Handbook on Drought Indicators and Indices:<https://www.droughtmanagement.info/indices/> TAMSAT (Tropical Applications of Meteorology using satellite data and ground-based observations) *provides access to daily rainfall estimates for all of Africa at 4km resolution*TAMSAT-ALERT provides reliable forecasts of land-surface conditions | Examples of Drought Monitoring and Early Warning from UNCCD Drought Toolbox: <https://knowledge.unccd.int/drought-toolbox/solutions/early-warning/2396> East Africa Drought Watch: East Africa Drought Watch is a near-real time system that uses Earth Observation and Weather Information to monitor drought conditions in the East Africa region<https://droughtwatch.icpac.net/> Examples of drought monitoring and early warning systems provided by the Integrated Drought Management Programme. Each link to a system comes with a reference to the drought indicators/indices used:<https://www.droughtmanagement.info/pillars/monitoring-early-warning/>  |
| **Recommended videos**  | Interview with Juergen Vogt, Special Advisor European Drought Observatory – GAR 2021 Report <https://www.youtube.com/watch?v=A17gthn96BY&list=PLBDwPnveHho-fi-xk-d6cvEeoZCHTYJYd&index=8> UNDRR GAR Special report on drought 2021<https://youtu.be/7tCU7ee1NNM>  | Drought and Agriculture by FAO: <https://youtu.be/J5WMyD9-CHs>  | This video from UN-SPIDER shows how to calculate the Standardized Vegetation Index (SVI) with a script in Google Earth Engine<https://youtu.be/ulr57I1Y5eE>  | Flood and Drought Tool video (EN): [ttps://www.youtube.com/watch?v=ZyvwZQaZyG4&t=1s](https://www.youtube.com/watch?v=ZyvwZQaZyG4&t=1s)Flood and Drought Tool video (FR):<https://www.youtube.com/watch?v=Ti8uSnU17IQ> UNCCD-led Drought toolbox<https://youtu.be/PPw74wp1gck> Webinar on Drought Early Warning & Preparedness (demo of UNEP-DHI portal starts at 00:20:00) (EN). *This webinar gives an insight into drought preparedness tools. It showcases the UNCCD Drought Toolbox, the Flood and Drought Portal, and the UNCCD Drought Initiative. Organized by UNEP-DHI, in collaboration with DHI and UNCCD (UN Convention to Combat Desertification).* <https://youtu.be/XH5FIfM49oU> What Does the U.S. Drought Monitor Map Show? – Timescales of Impacts<https://www.youtube.com/watch?v=CPIYuArBFbo&ab_channel=NationalDroughtMitigationCenter>  |
| **Take home messages** | 1. Drought is a complex a hazard due to its nature and wide-ranging impacts
2. Droughts are predicted to intensify and occur at higher frequencies due to human-induced climate change
3. Integrated Drought Management offers opportunities for managing the risk of drought by reducing exposure and vulnerability
4. There are many international agreements in place which guide action to reduce the risk of droughts
5. West Africa is particularly susceptible to drought risk
6. Monitoring and early warning plays an essential role in drought risk management
 | 1. Drought occurrence and severity vary in both space and time and requires looking at all the components of the hydrological cycle to be characterized.
2. There are a large variety of ground-based measurements that can be used to calculate the different components of the hydrological cycle.
3. In recent years, advancements have been made in the creation of open (modelled) datasets using satellite or combined satellite and ground measurement data.
 | 1. There are many drought indicators and indices. It is often challenging to choose the most suitable indicator or index, especially when they are linked to a drought plan as triggers for drought management actions.
2. Composite indicators have been developed to merge different indicators and indices to use the strengths of a variety of inputs
3. Calculation of indicators or indices can range from easy to complex
4. There is a list of most commonly applied indices
 | 1. The effective and timely delivery of information on drought characteristics is key in a drought early warning system (DEWS)
2. Sufficient historical data must be available to characterize drought severity
3. The technical information behind drought hazard identification must be simplified, through visualization, and translated into potential impact
4. In recent years, many products on drought monitoring have been developed and are now operational.
5. Current information (and not necessarily forecasted) is already of great importance to decision-makers.
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| **Discussion Forum topics** | Describe your personal or professional experience of drought. What are the main challenges and opportunities you foresee in implementing integrated drought management actions?  | Which drought information products are provided in your country by the National Meteorological and Hydrological Services. How are they used?How can you best work with those impacted by drought to ensure that they are getting the most relevant drought-related information? | Which drought indices or indicators are particularly important in your country?Which indices or indicators would you like to learn more about?  | Visit the UNCCD Drought monitoring portal and check the data available for your country. Share and compare the current drought hazard in your country with other course participants using data retrieved from the tools presented in this course.  |
| **Quiz** | 1. Definition: Which of these definitions of drought is incorrect?
* Drought is a prolonged absence or marked deficiency of precipitation
* Drought is a period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance
* **Drought is the outcome of increased solar radiation**
1. True of false: aridity, water scarcity, drought and desertification are the same thing?
* True
* **False**
1. Which is the most destructive disaster affecting agriculture in monetary terms (cost of impact)?
* Floods
* **Droughts**
* Tsunamis
* Wildfire
1. True of false, there are no indirect impacts of drought on society and especially vulnerable populations?
* True
* **False**
1. Drought impacts
* Water quantity
* Water quality
* **Both water quantity and water quality**
1. Select the correct answers which together form the three pillars of drought management?
* **monitoring and early warning**
* crisis management
* **vulnerability and impact assessment**
* humanitarian action
* **risk mitigation and response**
1. Select the correct answer: How is drought considered in the Agenda 2030 Sustainable development goals?
2. There are no goals relevant for drought management
3. Drought management has its own dedicated goal
4. **Several goals are relevant and complementary for drought management**
5. Which international agreement advocates for: “The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.”
* Paris Agreement
* **Sendai Framework**
* Accra Agreement
1. What does UNCCD stand for?
* **UN Convention to Combat Desertification**
* UN Convention to Control Drought
* UN Convention to Cancel Dryness
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1. Complete the statement: The GAR Special Report on Drought 2021 emphasizes that while drought poses a significant threat to achieving the goals the 2030 Agenda for Sustainable Development (2030 Agenda) and of the Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework), this threat can be substantially reduced by:
2. **applying prospective, proactive, and innovative approaches to drought risk management**
3. applying reactive processes after the drought has started
 | 1. True of false, drought can occur in any climate region around the globe, even deserts and rainforest?
* **True**
* False
1. Which of the essential characteristics of drought can be influence by the hydrological cycle?
* Severity
* Duration
* Timing
* Spatial extent
* **All of the above**
1. Which components of the hydrological cycle are important to characterize drought? Select the correct answer(s):
* **Precipitation**
* **Evapotranspiration**
* Tidal and ocean currents
* **Soil moisture**
* **Groundwater flow, run off and river discharge**
* All of the above
1. True of false, the use of satellites for remote sensing has become a vital technical tool in water management?
* **True**
* False
1. Which of these is not part of drought risk management?
* hazard, exposure, vulnerability, and impact assessment
* **archiving historical drought information**
* a drought early warning system (monitoring and forecasting)
* preparedness and mitigation
1. A DEWS typically aims to track, assess, and deliver relevant information concerning
* **Climatic, hydrological and water supply conditions and trends**
* Population growth and economic development trends
* Environmental degradation
1. True of false, the objective of a DEWS is to provide timely information in advance of, or during, the early onset of drought to prompt action (via threshold triggers) within a drought risk management plan as a means of reducing potential impacts?
* **True**
* False
1. True of false, one of the goals of the Sendai Framework is to substantially *reduce* the availability of, and access to, multi-hazard EWS and disaster risk information and assessment to people by 2030?
* True
* **False**
1. National meteorological and hydrological services have a key role to play in collecting data. Who sets the standards for this type of data?
* National ministries
* Regional organizations
* Stakeholder groups
* **WMO**
1. Drought indicators or indices are often used as a tool to identify and/or depict drought conditions. Which of these two statements is correct?
* **These vary depending on the region and the season**
* Global standards are in place to ensure everyone uses the same indicators and indices
 | 1. Which indices classification is not listed in the Handbook of Drought Indicators and Indices?
* Meteorology
* Soil moisture
* Hydrology
* **Socioeconomic**
* Remote sensing
* Composite or modelled
1. The “ease of use” classification for indicator/indices follows:
* A black and white approach
* **A traffic light approach**
* A rainbow approach
1. The Standard Precipitation Index (SPI) is calculated using the following input parameters:
* **Precipitation**
* Temperature
* Soil moisture
* Vegetation
* All of the above
1. SPI weaknesses are that:
* **It does not consider temperature**
* It is not recognized by WMO as a drought indicator
* It is not possible to create a map of the spatial variability over an area
* It is not very sensitive to meteorological drought
1. There is one set of indicators/indices that works well in all countries:
* True
* **False**
1. Select the indicators/indices that are based on meteorology input parameters:
* Soil Moisture Anomaly (SMA)
* **Effective Drought Index (EDI)**
* **Standardized Precipitation Index (SPI)**
* Vegetation Condition Index (VCI)
1. Vegetation Condition Index (VCI) can be used to characterize:
* Meteorological drought
* Hydrological drought
* **Agricultural drought**
1. Which one of these indices has been recommended by WMO as a starting point for meteorological drought monitoring?
* **Standardized Precipitation Index (SPI)**
* Palmer Drought Severity Index (PDSI)
* Combined Drought Indicator (CDI)
 | 1. A robust DEWS integrates data into a comprehensive assessment of:
* Current drought and water supply conditions
* Future drought and water supply conditions
* **Both current and future drought and water supply conditions**
1. Which of the following parameters is not included in a DEWS?
* Precipitation and other climatic parameters
* Hydrology such as streamflow
* Climate integrated with hydrological data
* **Agriculture and crop data**
1. It is necessary to have forecasted datasets in a drought early warning system (DEWS)
* True
* **False**
1. DEWS is used to:
* Prevent a drought hazard occurring
* **Alert decision-makers when to trigger actions from a drought management plan**
* Reduce the vulnerability of a drought event
1. The main objective of a DEWS is to be used as:
* A monitoring tool to have access to the latest climate conditions
* **A decision-support system to inform when to trigger appropriate mitigation and response actions**
* A learning tool to educate vulnerable populations about the risk of drought
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