Regional Workshop On

Drought Monitoring and Management Using Earth Observation and Weather Forecast Data

Webinar Report

Organized on: 07th July 2021

Jointly By

SAARC

SAARC Disaster Management Centre (IU)
Gandhinagar, Gujarat, India

&

UNITED NATIONS
Office for Outer Space Affairs

IWMI
International Water Management Institute

UN-SPIDER and IWMI

Contents

Droughtscape in South Asia: Unpacking, Interventions and Way Forward

Unpacking Drought: Definition and more

Given the complex nature of droughts, their definition varies across climatic regions and has traditionally varied across affected sectors and scientific disciplines. It is therefore difficult to compare drought characteristics across time and space.

The Intergovernmental Panel on Climate Change (IPCC) defines drought as “a period of abnormally dry weather long enough to cause a serious hydrological imbalance” (IPCC, 2012). It results from a shortfall of precipitation over a certain period, from the inadequate timing or the ineffectiveness of the precipitation, and/or from a negative water balance due to an increased atmospheric water demand following high temperatures or strong winds.

A generic definition of drought was proposed as “an exceptional lack of water compared with normal conditions” (Van Loon et al., 2016). Note the stress here is on “exceptional”, which distinguishes drought (a time-limited event) from water scarcity, a long-term structural imbalance between water availability and demand (i.e., an unsustainable overuse of water resources) and from aridity, a seasonally or fully dry climate.

Droughts typically last from months to a few years, and may be exacerbated by antecedent dry conditions in soil moisture as well as by low reservoir and aquifer levels.

As special cases, extreme and long-lasting “megadroughts” can persist for decades, while so-called “flash droughts” are short periods (usually less than 3 months) of high temperatures and/or strong winds, resulting in increased evapotranspiration and a fast depletion of soil moisture that can lead to major impacts, especially in the agricultural sector.

Not all droughts result in disasters. A drought becomes hazardous when water demands are no longer met and becomes a risk when there is a diminishing capacity to cope with the lack of water. This risk can result in dangerous consequences for people’s livelihoods, the economy, ecosystems’ health, and even the lives of humans and animals.

Understanding what the future holds

On the global scale, recent climate change, characterized by global warming and climate extremes that are more frequent and more severe (IPCC, 2014a), has caused only a limited increase in the frequency of and area affected by meteorological drought events. In recent decades, several drought hotspots (areas particularly often or severely affected) have been identified as:

- The Mediterranean region (Hoerling et al., 2012)
- Southern Australia (Van Dijk et al., 2013)
- Sub-Saharan Africa (Greve et al., 2014)
- Southern South America (Penalba et al., 2014)

- Some areas in China (Xu et al., 2015)
- South-western United States of America (Diffenbaugh et al., 2015)
- North-eastern Brazil (Marengo et al., 2017)

Carrão et al. (2018) mapped climate change effects on global patterns of drought hazard for the mid-century (2021–2050) and late century (2071– 2099) under three climate change trajectories, referred to as representative concentration pathways (RCPs). Projections indicate droughts that are more frequent and more severe (even more severe than the worst droughts in the period 1981–2010) over wide parts of the world, in particular Mexico, the United States of America, southern Australia, and most of Africa, central Asia, southern Europe, most of central and South America.

Table 1 presents past trends (Spinoni et al., 2019; JRC GDO, 2018) and future projections (Spinoni et al., 2020, forthcoming) of meteorological drought hazard.

Table 1: Projections of Drought Hazard with respect to Global Warming Levels (GWL) specific to the Asian region

Macroregion	Hazard (2000–2019)	Projected hazard (GWL 3°C and 4°C)
Central Asia	Severe	Very severe
Eastern Asia	Very severe	Severe
North-eastern Asia	Low	Very low
North-western Asia	Low	Low
Southern Asia	Severe	Moderate
South-eastern Asia	Low	Low
Western Asia	Very severe	Severe
Tibetan Plateau	Low	Severe

Drought in the South Asian Context

A comprehensive review by Naveendra kumar et al. on extreme events in South Asia concluded that droughts have become more 'notable' in South Asia during the recent decades. The most common droughts observed in South Asian countries are due to the variability of amount (i.e., less or absence), onset, and the distribution pattern of rainfall during the primary monsoon season. Apart from the rainfall characteristics, high heat stress, which would cause high evaporation, is also a reason for drought in countries like Bangladesh and Sri Lanka. The processes involved in soil erosion can aggravate the drought conditions like in Bangladesh. The poor soil texture (i.e., low water-holding capacity, high permeability, and infiltration), which percolates more available water at surfaces into deep layers, causes drought in Afghanistan. Even, the persistence of strong wind over inadequate vegetative cover has caused drought, such as the annual drought from April to August in Afghanistan. The Asian Development Bank (ADB) elaborates that localized drought have 3 to 5 years of recurrence interval, and on the other hand, spatially extended droughts occur in every decadal interval.

In the South Asia region, drought impacts predominantly on crop production. Apart from the Maldives, the remaining South Asian countries are agriculture-based countries. Table 2 describes the examples of the drought impacts on agriculture in the South Asian countries except for the Maldives.

Table 2: Effects and Impacts of Drought in South Asia

Country	Drought Impact on Crop Production
Afghanistan	Twelve million farmers in Afghanistan were affected by the drought during 1990–2009. In the suburbs of Ghor, Badghis, and Hirat, the cultivation area has declined by nearly 70% due to prolonged droughts. Drought lowered the crop diversity The yields of peas, cotton, wheat, and barley were reduced significantly by 88%, 17%, and 50–70%, respectively. 80% of forests and pastures were destroyed in the Nimroz, Helmand, and Farah provinces of Afghanistan due to drought.
Bangladesh	Annually, 2.32 million ha and 1.2 million ha of rice fields are destroyed due to drought in Kharif and Rabi seasons, respectively. The severe drought in Bogra in 1866 and 1951 hit hard on rice production, and rice prices increased massively. Drought during 1994–1996 caused heavy damage to rice, jute, and bamboo clumps.
Bhutan	The combined effect from the change in the onset of rainfall, drought, and windstorms causes crop damage of 1–19%.
India	The lowest crop production recorded for the last 50 years was observed in 2002 during the Kharif (March to June) season, and crop loss caused a 1% reduction in the GDP of India. Consecutive drought during 2000–2012 caused a severe loss in crop production.
Nepal	Drought during 2008/09 winter season affected 70% of the agricultural areas, and the production of winter crops decreased by 17% at the national level. Drought during 2009/10 affected rice fields, with production decreasing by up to 11% at the national level.
Pakistan	Production of main crops decreased by 10%, and simultaneously, minor crops had a similar dropdown
Sri Lanka	Intermittent drought from 1974 to 2008 decreased crop production by 56%. The loss of seed paddy for the upcoming season was caused during the droughts in 2012/13 and 2016/17. Failure of two consecutive cultivating seasons during the drought in 2016/17 and an enormous increase in rice prices.

Use of Science & Technology in Drought Monitoring & Assessment

The assessment and monitoring of drought using drought indices are more appropriate than the direct use of hydro-meteorological indicators. More specifically, indicators are hydro-meteorological variables used to define drought situation such as rainfall and temperature. On the other hand, drought indices are obtained by numerically using hydro-meteorological inputs and the drought indicators. The indices intend to estimate the drought state (i.e., severity, spatio-temporal attributes of drought events) for a certain period. The World Meteorological Organization and Global Water Partnership summarized and provided 50 indices used practically and theoretically in many drought studies. The frequently used drought indices in South Asia can be categorized based on the variables used and grouped into:

(a) hydro-meteorology,
(b) soil water,
(c) remote sensing, and
(d) composite or modelled

Table 3 below summarizes the droughtscape in South Asia.

Table 3: Droughtscape in South Asia

Country	Description				
	The Most Severe Drought Events during Recent 30 Years (1990–2020)	Vulnerable Sectors to the Drought	Drought Assessment Method	Drought Monitoring Methods	Drought Prediction Methods
Afghanistan	1998–2006, 2007, 2008, 2018	Agriculture, Water resource, Social and economic; Mass migration	SPI, NDVI , PDSI, PNPI, DI, CZI	SPI, DI, PDSI, PHDI, Z-index , SPEI	SADMPS
Bangladesh	1994, 2000	Agriculture, Water resources	SPI, SPEI, SGWI , NDVI	SADMS	sc-PDSI, VCI , SADMPS
India	2000, 2002, 2009, 2012	Agriculture, Social and economic Water resources	SPI SPEI, VTCI, SWI VCI, TCI, VHI , NDVI, PDN, EDI , RDI, DSI	SPI, SPEI , SADMS , SADMPS	SPI, RDI , GEFS, RMSNN, DMSNN, ARIMA, SADMPS
Nepal	1992, 2008–2009, 2012–2013, 2015	Agriculture, Water resources	SPI, VCI , SPEI, RDI , sc-PDSI, SFI, PHDI	SADMS	SADMPS
Pakistan	1998–2004	Agriculture, Water resources, Social and economic	SPI, DI, NDVI	SADMS	SADMPS
Sri Lanka	2001, 2004, 2012, 2014, 2016–2017	Agriculture and livestock production , Social and economic, Water resources , Hydropower & Flora & Fauna	SPI, PDSI, Novel index	SADMS	SPI, SADMPS

Way Forward

Decision-making that takes account of multiple values, uncertainty and sequencing of implementation is maturing. An adaptive approach to risk management and governance that bridges structural and systemic changes and enables capacity, prototyping, learning and action at multiple scales is needed. Adaptive governance aims to deal with uncertainties and surprises inherent in transforming complex social, technological and ecological systems. It relies on iterative learning, planning, policymaking implementation and evaluation over time (U.S. Global Change Research Program, 2018; EEA, 2019).

Governance has many connotations. In its broadest and most common form, it denotes the structures and processes for collective decision making (Nye and Donahue, 2000). It is also described as a different way of governing in which the State is not the only actor (Stoker, 1998).

Risk governance has been defined as "the totality of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed and communicated, and management decisions are taken" (IRGC, 2018). It is usually associated with how to enable societies to benefit from change – so-called "upside risk" or opportunity – while minimizing downside risk or losses (UNDRR, 2019). In contrast, systemic risk is usually seen as downside risk. The realization of systemic risk leads to a breakdown, or at least a major dysfunction, of global systems (e.g. the food system). Assessing, communicating and managing – in short, governing – systemic risk is compounded by the potential for losses to cascade across interconnected socioeconomic systems, to cross political borders, to irreversibly breach system boundaries and to impose intolerable burdens on entire countries. Thus, there is an urgent need to enable capabilities for developing and sustaining multi-scalar drought-related resilience and governance by building enabling conditions for the shift to drought-related systemic risk governance.

Program Note

Drought Monitoring and Management Using Earth Observation and Weather Forecast Data

Context

The climate variability during the summer monsoon magnifies the frequency and intensity of drought and floods across South Asia which is already facing the heat of the COVID 19 pandemic. Droughts are categorized as slow-onset disasters which are difficult to identify and gradually destroy the areas and affect millions of communities. As per WMO, drought is defined as a prolonged dry period in the natural climate cycle that can occur anywhere in the world. Among weather-related natural hazards, drought is probably the most complex and severe due to its intrinsic nature and wide-ranging and cascading impacts.

In South Asia, drought occurs frequently in arid and semi-arid regions and has affected 1.46 billion people with an economic loss of over 7 billion USD in the last 56 years. Early 2000 onwards, severe droughts affected vast areas of South Asia, including western India, and southern and central Pakistan. The South Asian regions are among the perennially drought-prone regions of the world. India, Pakistan and Sri Lanka have reported droughts at least once in every 3 years in the past five decades, while Bangladesh and Nepal also suffer from frequent droughts.

Inappropriate land use, increasing pressure on natural resources, water scarcity, and climate change scenarios aggravate drought events. Drought events result in loss of livelihood, poverty and food insecurity as agriculture is the major sector impacted. It affects agricultural production, public water supply, energy production, transportation, tourism, human health, biodiversity, natural ecosystems, etc. The related impacts develop slowly, are often indirect and can linger for long times after the end of the drought. While the impacts result in severe economic losses, environmental damage and human suffering, they are generally less visible than the impacts of other natural hazards (e.g. floods and storms) that cause immediate and structural damages, which are clearly linked to the hazard and quantifiable in economic terms.

While it is impossible to control the occurrence of droughts, the resulting impacts may be mitigated through appropriate surveillance, early warning and management strategies in a drought management plan, wherein, Earth observation based information system plays crucial role.

Objective

The objective of the webinar is to discuss advances in earth observation and weather forecast data, approaches and tools to help achieving drought resilience in the Member States. The event will highlight various global to regional platform and related tools for monitoring and early warning to guide policy makers in promoting timely drought management measures.

Participants

This webinar aims to engage Senior Officers from Ministries/Dept. of Agriculture, Water Resources, Meteorology, Climate Change; agencies dealing with application of Remote Sensing & Geospatial technologies; National Disaster Management Organizations (NDMOs) from all the SAARC Member States.

Organizers

- SAARC Disaster Management Centre (IU); and
- United Nations Office for Outer Space Affairs (UNOOSA), through its United Nations Platform for Space based Information for Disaster Management and Emergency Response (UN-SPIDER)
- International Water Management Institute (IWMI), Sri Lanka

Agenda

S.No.	Time	Topic	Duration	Speaker	Moderator
1.	13:30 – 14:05	**Inauguration of the webinar**	**35 min**	**SDMC (IU)**	
		Welcome & Introduction of the Director SDMC(IU)	02 mins	**Ms. Prashansa, RO-PM, SDMC(IU)**	
		Inaugural Address & Introduction of the Speakers	05 mins	**Director, SDMC (IU)**	
		Opening Remarks	08 min	**Director General, IWMI**	
		Introductory Remarks by Member States	20 min *(2 min each + 4 min moderation)*	Representative from each of the SAARC Member States	**Director, SDMC(IU)**
2.	14:05 – 14:20	**Opening Session**: Outcome of the GAR Special Report on Drought 2021	**10 min**	**Dr. Daniel Tsegai, UNCCD**	**Dr. Shirish Ravan, UNSPIDER/UNOOSA**
		Discussion	05 min		
3.	14:20 – 15:05	**Technical session**	**45 min**		**Dr. Shirish Ravan, UNSPIDER/UNOOSA**
i.		UN-SPIDER learning resources and advisory services for drought management and response	12 min	**Dr. Shirish Ravan, UN-SPIDER/UNOOSA**	
		Questions	*03 min*		
ii.		Earth observation data for drought monitoring and early warning in South Asia	12 min	**Dr. Giriraj Amarnath, IWMI**	
		Questions	*03 min*		
iii.		Drought management efforts relevant to dryland region	12 min	**Dr. K.V. Rao, CRIDA**	
		Questions	*03 min*		

4.	**15:05 – 15:50**	**Experience of using Earth observation for drought management from Member States**	**40 min** *(5 min each)*	Representatives from each of the SAARC Member States	**Director, SDMC(IU)**
		Discussion	*05 min*		
5.	**15:50 – 16:00**	**Closing**	**10 min**	**SDMC (IU)**	**Director** **RO-PM**

Regional Workshop on

Drought Monitoring and Management Using Earth Observation and Weather Forecast Data

Introductory Session

On behalf of the SAARC Disaster Management Centre, Ms. Prashansa Dixit welcomed all the delegates from the SAARC Member States, esteemed resource persons and partners for the webinar.

The keynote address was given by Mr. P.K. Taneja, Director, SDMC (IU). He highlighted the importance of this webinar and welcomed all the dignitaries from the Member States and introduced the resource persons.

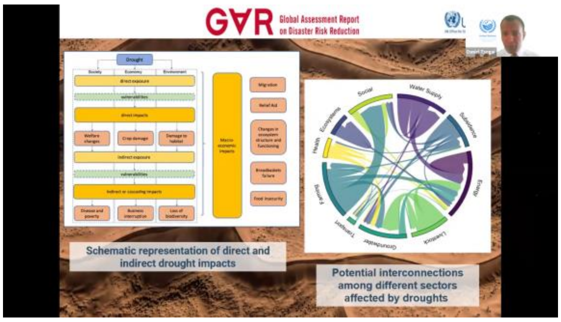
Opening remarks were given by Dr. Mark Smith - Director General, IWMI

Dr. Mark Smith acknowledged the long-standing partnership of SDMC(IU) with IWMI. He mentioned that this webinar is an opportunity to assist nations in advancing the drought management system. The region is making progress in use of tools of earth observation and weather forecast data for early and effective response. He also mentioned about Regional Drought Monitoring & Management that IWMI is promoting since 2005 in South Asia, using approaches involving earth observation and modelling tools. IWMI and partners are also developing integrated drought management tools in South Asia.

Representatives from each Member States gave their introductory remarks.

Opening Session: Outcome of the GAR Special Report on Drought 2021

Dr. Daniel Tsegai, UNCCD

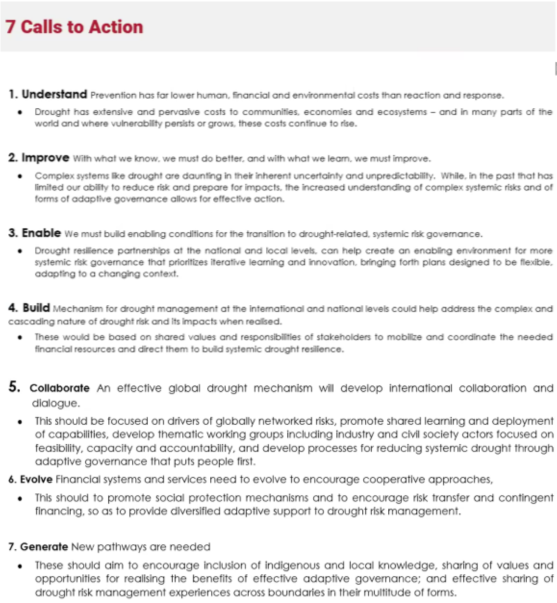


Dr. Daniel from United Nation Convention to Combat Desertification and also one of the lead authors of the GAR Special Report on Drought 2021, delivered an opening session on the outcome of the report. He talked about the three main elements of the report- Modernizing current understanding of drought, the lived experience of droughts, and drought risk to resilience- considering drought as systemic risk. The GAR report recognizes the direct and indirect impacts of drought on society, economy and environment; and potential interconnections among different sectors affected by drought like transport, farming, health, groundwater, energy, livestock, etc. The report also highlights that until drought strikes a nation or is not declared as an issue, then it is just managed by one Ministry like water, agriculture, etc. But when drought thrives, it becomes a national issue. It should be considered as national issue before it thrives. There should be national dialogue and all segment of economy should be part of the drought planning.

Dr. Daniel showed drought simulation for four projected warming levels of global temperatures. Drought frequency and severity will likely increase with increase in global temperature. Due to the widespread and cascading impacts - often not explicitly attributed to drought - damage and cost are usually seriously underestimated.

He explained the systemic drought risks- the multi-scale nature of drivers and of institutions affecting food system. Drought is also a core issue in the SDGs, by minimizing impacts of droughts, countries can progress on achieving many of the SDGs.

The GAR report says that 'Drought demands innovation', it cannot be business as usual. It requires prospective and proactive measures, improved drought risk assessment and management by enhancing and sustaining the capabilities of communities and individuals. The report has given seven calls to action:



7 Calls to Action

1. **Understand** Prevention has far lower human, financial and environmental costs than reaction and response.
   - Drought has extensive and pervasive costs to communities, economies and ecosystems – and in many parts of the world and where vulnerability persists or grows, these costs continue to rise.
2. **Improve** With what we know, we must do better, and with what we learn, we must improve.
   - Complex systems like drought are daunting in their inherent uncertainty and unpredictability. While, in the past that has limited our ability to reduce risk and prepare for impacts, the increased understanding of complex systemic risks and of forms of adaptive governance allows for effective action.
3. **Enable** We must build enabling conditions for the transition to drought-related, systemic risk governance.
   - Drought resilience partnerships at the national and local levels, can help create an enabling environment for more systemic risk governance that prioritizes iterative learning and innovation, bringing forth plans designed to be flexible, adapting to a changing context.
4. **Build** Mechanism for drought management at the international and national levels could help address the complex and cascading nature of drought risk and its impacts when realised.
   - These would be based on shared values and responsibilities of stakeholders to mobilize and coordinate the needed financial resources and direct them to build systemic drought resilience.
5. **Collaborate** An effective global drought mechanism will develop international collaboration and dialogue.
   - This should be focused on drivers of globally networked risks, promote shared learning and deployment of capabilities, develop thematic working groups including industry and civil society actors focused on feasibility, capacity and accountability, and develop processes for reducing systemic drought through adaptive governance that puts people first.
6. **Evolve** Financial systems and services need to evolve to encourage cooperative approaches,
   - This should to promote social protection mechanisms and to encourage risk transfer and contingent financing, so as to provide diversified adaptive support to drought risk management.
7. **Generate** New pathways are needed
   - These should aim to encourage inclusion of indigenous and local knowledge, sharing of values and opportunities for realising the benefits of effective adaptive governance; and effective sharing of drought risk management experiences across boundaries in their multitude of forms.

Technical Session 1: UN-SPIDER learning resources and advisory services for drought management and response

Dr. Shirish Ravan, UN-SPIDER

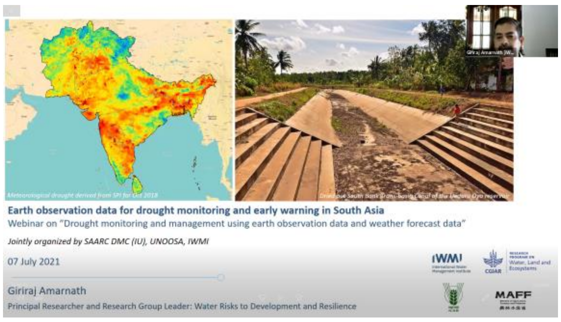
Dr. Ravan presented on the learning resources of UN-SPIDER available for the participants. He highlighted that earth observation information is important for drought stock taking, risk & vulnerability assessment, simulations, etc. Space technology is about earth observation, satellite meteorology, global navigation satellite systems (GNSS) and satellite communication.

He gave glimpse of changing river course of River Padma in Bangladesh (NASA image) for period of 2000-2008. The river changing pattern, studied through historical data, holds big impact on irrigation system, water supply, disaster risk or drought management strategy.

Dr. Ravan further explained the role of UN-SPIDER as capacity builder and its knowledge portal. He discussed the recommended practices on drought monitoring using various index, available on the portal.

Technical Session 2: Earth observation data for drought monitoring and early warning in South Asia

Dr. Giriraj Amarnath, IWMI



Dr. Giriraj mentioned few key points like:

- Past drought management efforts have been reactive.
- Drought impacts are increasing and becoming complex across sectors; they setback development efforts.
- Impact assessments are lacking or there is no consistent methodology.
- Climate change will continue to alter frequency, severity and duration of drought for many regions.
- Policy makers need to be convinced that drought preparedness and risk management are worthy of upfront investments.

He gave an overview of drought statistics in South Asia- EMDAT reported 46 major drought events (1950-2020) impacting 1.4 billion people with economic loss of over 6.9 billion USD. Also there has been lack of robust damage reporting and comprehensive sector wise impact from droughts.

Dr. Giriraj discussed on IWMI's Drought Resilience Initiatives, one of them being The South Asia Drought Monitoring System (SADMS) and how it can be leveraged for action and decision making. The drought surveillance system provides information on agriculture stress using satellite indices, drought severity maps, digital and dynamic contingency plans, and impact on crops.

He highlighted the importance of short term and sub-seasonal forecast to understand location specific climate risk rather than long-range forecast. He further explained the importance of drought early warning system. EWS promotes early/anticipatory action and early finance. With this he gave example of Afghanistan Drought Early Warning Decision Support Tool (AF-DEWS)- it is a powerful tool that can access open-source satellite data and produce science-based knowledge products to assist decision making.

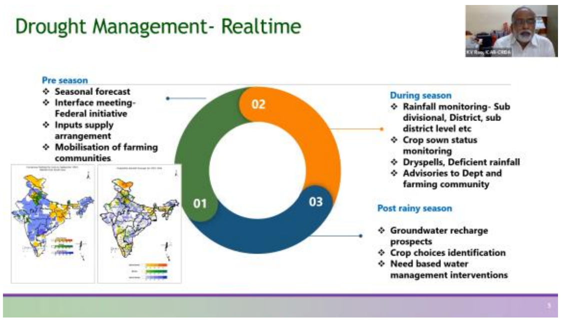
The takeaway message from his session were:

- Strengthen regional drought monitoring and management (e.g. SADMS) as an important step towards proactively enhance drought resilience.

- Efforts to develop robust decision support information products and rapid dissemination among users and importantly able to predict and detect droughts early.
- Integrated drought management requires a collaborative approach within and between levels of government and with the private sector.

Technical Session 3: Drought management efforts relevant to dryland region

Dr. K V Rao, CRIDA



Dr. K V Rao, took the session on Drought management efforts relevant to dryland region in the specific context of India.

He first gave an overview of rainfed areas and cultivation area, diverse crop cafeteria, characterization by large number of small and marginal farmers, inadequate infrastructure etc. Further he gave details on how rainfed areas are encountering frequent droughts with time scale.

He talked about drought management initiative considering real time management and long term measures; focus is to work with long term measures for drought proofing.

He explained drought with three major points:

- Within the season how do we manage
- End of the season what kind of support that can be given
- For a long-term purpose of drought region what are the decision that can be taken up.

While talking about real time drought management of base country, he explained that, it is being looked up in three ways: Pre monsoon Season, During Season, & Post rainy Season.

For long term measures, for monitoring more in drought prone regions, he presented ideas of ongoing programs of India. Major departments involved and initiatives taken were discussed.

At end of the session, he suggested there are efforts for taking long term measures but what is needed is real time management for farmers as well as the government departments to make use of available tools like space application based indices for drought prone regions. For intervening at the ground level.

Experience of using Earth observation for drought management from Member States

Afghanistan

Afghanistan shared the use of indices-based approach to assess drought. This has been helpful to understand the severity of drought in the various provinces of Afghanistan. This has also been useful to assess the effect and impact of drought and thereby plan for relief, mitigation, adaptation and preparedness. The use of AF-DEWS has also been very useful.

Bangladesh

Bangladesh recognises Drought as a disaster and hence, the standing orders on Disaster emphasises on multi-departmental approach towards its management. The representative emphasised on the need of trans-boundary cooperation on action, but more on research, which is perhaps, the need of the hour. The representative highlighted the geo-climatic variability amongst Member States which would play a major role in contextualising drought management in different countries. Also, longer term forecast models should be worked upon to ensure robust early warnings and impact-based forecasting. A suggestion was made to issue bulletins / advisories in this regard too which would enhance the capacity of the Member States.

Bhutan

The representative reported about the state of affair in Bhutan, reflecting on the agro-climatic zones and hazards like forest fires.

India

The representative from NDMA, reflected on the drought proneness of India and highlighted the evolution of drought management policies in India, starting from Famine Codes of 1883 to Drought Manual of 2016. India uses a combination of indices across different sectors (hydrological, crop based, soil based etc.) through multiple institutions at different levels to manage drought issues in India. He highlighted the two-trigger mechanism of drought declaration in India. A whole range of initiative of drought mitigation was also presented and emphasis was put on drought response and relief measures too.
Another representative made a brief presentation on the state of affair of drought in different states of India and the different agencies involved. A reference was made on the Crop Watch Group, NADAMS, BHUVAN.

Maldives

The Member State representative couldn't present.

Nepal

No Participant.

Pakistan

Pakistan presented the bouquet of indices that are used - meteorological, satellite (RS based), hydrological. Emphasis was laid on the use of composite drought index which is an ensemble of different effective indices. A glimpse of drought hazard map was presented along with precipitation-based analyses.

Sri Lanka

The representative gave a brief about the droughts in Sri Lanka and the effects and impacts of those events. Information was given about the monthly bulletins. References were about WFP-PRISM, collaboration with university too. Researches have shown the declining trend of rainfall along with the expressive variability, future climate scenarios and its possible effect on future drought occurrences. An integrated way forward was also proposed highlighting the importance of index-based insurance. A request was made to prepare a disaster forecasting mechanism for SAARC countries.

Concluding Remarks

Concluding remarks were given by Director, SDMC(IU) and proposals given by Member States (Bangladesh and Sri Lanka) were well noted. Program ended with a vote of thanks by Ms. Prashansa Dixit.

Glimpse of the webinar

Webinar on

Drought Monitoring and Management Using Earth Observation and Weather Forecast Data

07th July, 2021

Details of the Speakers

#	Name	Designation	Contact Details
1	**Dr. Daniel Tsegai**	Programme Officer, United Nations Convention to Combat Desertification (UNCCD) Secretariat, Germany	dtsegai@unccd.int
2	**Dr. Shirish Ravan**	Programme Officer (Head, UN-SPIDER Beijing Office)	shirish.ravan@un.org , +43-69914595293
3	**Dr. Giriraj Amarnath**	Principal Researcher – Disaster Risk Management and Climate Resilience, International Water Management Institute (IWMI), Sri Lanka	A.Giriraj@cgiar.org , +94-767770046
4	**Dr. K V Rao**	Convenor- Agriculture Contingency Cell, ICAR-CRIDA, India	mkv33@yahoo.co.in , +91-9441067855
5	**Dr. Mark Smith**	Director General, International Water Management Institute (IWMI), Sri Lanka	mark.smith@cgiar.org , +94-76 8599512

List of Participants

#	Country Name	Flag	Participants Name	Designation	Department	Contact Details	
						Mobile Number	Email Address
1	Afghanistan		Mr. Eng Mohammad Sediq Hassani		Afghanistan National Disaster Management Authority	93 700285257	msg.hassani@gmail.com
2	Afghanistan		Mr. Sayed Abdul Baret Rahmani	Sr.Advisor	Afghanistan National Disaster Management Authority	93 796695685	sayed.brahmani@gmail.com
3	Afghanistan		Mr. Asmatullah Mohammadi	Head of Monitoring Unit	Afghanistan National Disaster Management Authority	93 789448098	asmat6000@gmail.com
4	Afghanistan		Mr. Shafiullah Stanikzai	Director of Monitoring & Evelevation	Afghanistan National Disaster Management Authority	93 745078795	snayel20@gmail.com
5	Afghanistan		Mr. Sayed Hares Hofiam	Head of Emergency Events	Afghanistan National Disaster Management Authority		hares.hosianishm@yahoo.com
6	Afghanistan		Mr. Izafullah Kamily	Flood and Drought Expert	Afghanistan National Disaster Management Authority	93 777925096	izafullah.kamily@gmail.com
7	Afghanistan		Mr. Eng Sayed Sarwuddin Saifi	Technical Advisor to Minister	Afghanistan National Disaster Management Authority	93 777224522	eng.saifi786@gmail.com
8	Afghanistan		Mr. Mohammad Omar Mohammadi	Director	Afghanistan National Disaster Management Authority	93 708293231	omar.mohammadi@gmail.com

#	Country Name	Flag	Participants Name	Designation	Department	Contact Details	
						Mobile Number	Email Address
9	Afghanistan		Mr. Eng Hirwais Sediqi	Member Risk Mitigation Directorate	Afghanistan National Disaster Management Authority	93 744127509	eng.mirwaissediqi@gmail.com
10	Afghanistan		Mr. Eng. Abdullah Akef	Director of Risk Mitigation	Afghanistan National Disaster Management Authority	93 777080508	abdullah.akef@gmail.com
11	Bangladesh		Mr. Mirza Shawkat Ali	Director (Climate Change & International Convention)	Department of Environment	880 1720222363	dircc@dow.gov.bd
12	Bangladesh		Dr. Md. Abul Kasem	Superintending Engineer	Head Quarter, BMDA, Rajshahi	880 1718058987	dmkasem@bmda.gov.bd
13	Bangladesh		Dr. Md. Abdul Mannan	Meteorologist	Storm Warning Centre, Bangladesh Meteorological Department	880 1627739445	mannan_u2003@yahoo.co.in
14	Bangladesh		Mr. Md. Tariful Newaz Kabir	Meteorologist	Climate Division, BMD	880 1938595320	kabir5797@gmail.com
15	Bangladesh		Mr. Md. Amirul Hossain	Addl Chief Engineer	Bangladesh Water Development Board	880 1318235268	ce.tsd@bwdb.gov.bd
16	Bangladesh		Mr. Md. Arifuzzaman Bhuyan	Executive Engineer	Flood Forecasting and Warning Centre, BWDB	880 1715040144	arif8_bwdb@yahoo.com
17	Bangladesh		Ms. Zebun Nessa Jabedur	Deputy Director	Department of Agriculture Extension	880 1716909247	z.nessa@yahoo.com
18	Bangladesh		Mr. Syed Ashraf ul Islam	Communication Media Specialist	Department of Disaster Management	880 1700716729	cms@ddm.gov.bd

#	Country Name	Flag	Participants Name	Designation	Department	Contact Details	
						Mobile Number	Email Address
19	Bangladesh		Mr. Mohammad Hafizur Rahman	Assistant Director (GIS)	Department of Disaster Management	880 1515670067	hafiz.ddm@gmail.com
20	Bangladesh		Ms. Jebunnahar Mayna	Assistant Director (ERCC)	Department of Disaster Management	880 1515255701	nahar.jebun0403@gmail.com
21	Bhutan		Mr. Tandin Wangchuk	Deputy Executive Engineer	National Centre for Hydrology and Meteorology		tandinw@nchm.gov.bt
22	Bhutan		Ms. Monju Subba	Engineer	NCHM		msubba@nchm.gov.bt
23	Bhutan		Mr. Saroj Acharya	Meteorology Officer	NCHM		sacharya@nchm.gov.bt
24	India		Mr. Anup Kumar Srivastava	Sr. Consultant (Drought)	NDMA, New Delhi		
25	India		Dr. Sweta Baidya	Research Associate	NIDM, New Delhi	91 9158210843	drswetabaidya@gmail.com
26	India		Ms. Pritha Acharya	Sr. Research Fellow	NIDM, New Delhi	91 9891186036	prithacharya@gmail.com
27	India		Mr. Kopal Verma	Jr. Consultant	NIDM, New Delhi	91 9013098656	kopal38@gmail.com
28	India		Ms. S Mamtha	Acting Director	MNCFC, India	91 1125843224	mamatha.ncfc@nic.in
29	India		Dr. C S Murthy	Group Director	Agriculture Sciences & Applications Group, NRSC		murthy_cs@nrsc.gov.in

#	Country Name	Flag	Participants Name	Designation	Department	Contact Details	
						Mobile Number	Email Address
30	India		Dr. K H V Durga Rao	Group Head	Disaster Management Support Group, NRSC		khvdurgarao@yahoo.com
31	India		Mr. Deshraj Meena	Specialist Officer - II	Disaster Management & Relief Department	9783861145	relief-rj@nic.in
32	India		Mr. Jaynarayan Yadav	Agricultural Research Officer	Disaster Management & Relief Department	9785777738	jdagr_atc@rediffmail.com
33	India		Mr. B S Rathod	Joint Director (Agriculture)	Disaster Management & Relief Department	9414888187	jdagr_atc@rediffmail.com
34	India		Mr. Virender Sharma	Joint Director (Agriculture)	Disaster Management & Relief Department	9414340138	jdagr.crop.agri@rajasthan.gov.in
35	India		Mr. Shivendra Vashney	Programmer	Disaster Management & Relief Department	9001632707	relief-rj@nic.in
36	India		Mr. Vijay Singh	Project Director	BISAG-N, Gandhinagar	9909945009	bisagsp12@gujarat.gov.in
37	India		Mr. Khalid Mahmood	Project Director	BISAG-N, Gandhinagar	9909945010	bisagsp10@gujarat.gov.in
38	Maldives		Mr. Mohamed Aslam	Meteorologist	Maldives Meteorological Service	960 3037222	mohamed.aslam@met.gov.mv
39	Maldives		Mr. Ahmed Shabin	Meteorologist	Maldives Meteorological Service	960 9926161	ahmed.shabin@met.gov.mv ahm3dshabin@gmail.com

#	Country Name	Flag	Participants Name	Designation	Department	Contact Details	
						Mobile Number	**Email Address**
40	Maldives		Mr. Anwar Ali	Deputy Director General	Ministry of National Planning, Housing & Infrastructure	960 7776505	anwar.ali@planning.gov.mv
41	Maldives		Ms Hawwa Ageela	Project Coordinator	Ministry of National Planning, Housing & Infrastructure	960 7765636	hawwa.ageela@planning.gov.mv
42	Maldives		Mr. Abdul Latheef Moosa	Agriculture Officer	Ministry of Fisheries Marine Resources and Agriculture	960 7905771	Abdul.latheef@fishagri.gov.mv
43	Pakistan		Ms. Ghazala Qaiser	Deputy Director	NDMC, Pakistan Meteorological Department	92 3334465861	ghazalaqaiser@gmail.com
44	Pakistan		Ms. Asma Jawad Hashmi	Deputy Director	National Agromet Centre, PMC, Pakistan	92 3455468129	asma_aiya@hotmail.com
45	Pakistan		Dr Javed Iqbal	Professor	Institute of Geographical Information System	92 3315486668	Javed@igis.nust.edu.pk
46	Pakistan		Dr. Shakil Ahmad	Assistant Professor	NUST Institute of Civil Engineering	92 3042790172	engrshakilahmad@hotmail.com
47	Pakistan		Mr. Razal Iqbal	Director Implementation	National Disaster Management Authority	92 3015565737	dirimp@ndma.gov.pk
48	Sri Lanka		Mr. M K Thisara Madushanka	Agriculture Instructor	Ministry of Agriculture	94 712345960	thisara.mktm@gmail.com
49	Sri Lanka		Mrs. Sepati de Silva	Assistant Director (Land)	Ministry of Environment	94 701288223	sepalisilva@yahoo.com
50	Sri Lanka		Mrs. Dulani Wickramaarachchi	Development Officer	Ministry of Environment	94 775419092	dulani.w88@gmail.com
51	Sri Lanka		Ms Anusha Warnasooriya	Director (Climate change & research)	Department of Meteorology	94 774368390	rashanthie@yahoo.com

52	Sri Lanka		Major General Sudantha Ranasinghe	Director General	Disaster Management Centre	94 773957896	dg@dmc.gov.lk
53	Sri Lanka		Ms. Anoja Senivirathna	Director (Mitigation, Reseach & Development)	Disaster Management Centre	94 772320525	anoja@dmc.gov.lk
54	Sri Lanka		Ms D Kasundari Dissanayake	Director	Ministry of Agriculture	94 713485187	kasundari.dissa@gmail.com
55	Sri Lanka		Mr. T N M Peiris	Meteorologist	Department of Meteorology	94 112694846	nandalalpeiris@gmail.com
56	Sri Lanka		Mr. H M R C Herath	Meteorologist	Department of Meteorology	94 112694846	met.herath@gmail.com
57	Sri Lanka		Mr. K M S N Kumarasinghe	Hydrogeologist	Water Resource Board	94 718199198	sasikakum@gmail.com
58	Sri Lanka		Mr. R R G R Rajapaksee	Assistant General Manager	Water Resource Board	94 718199198	ruwanrajapaksee@gmail.com