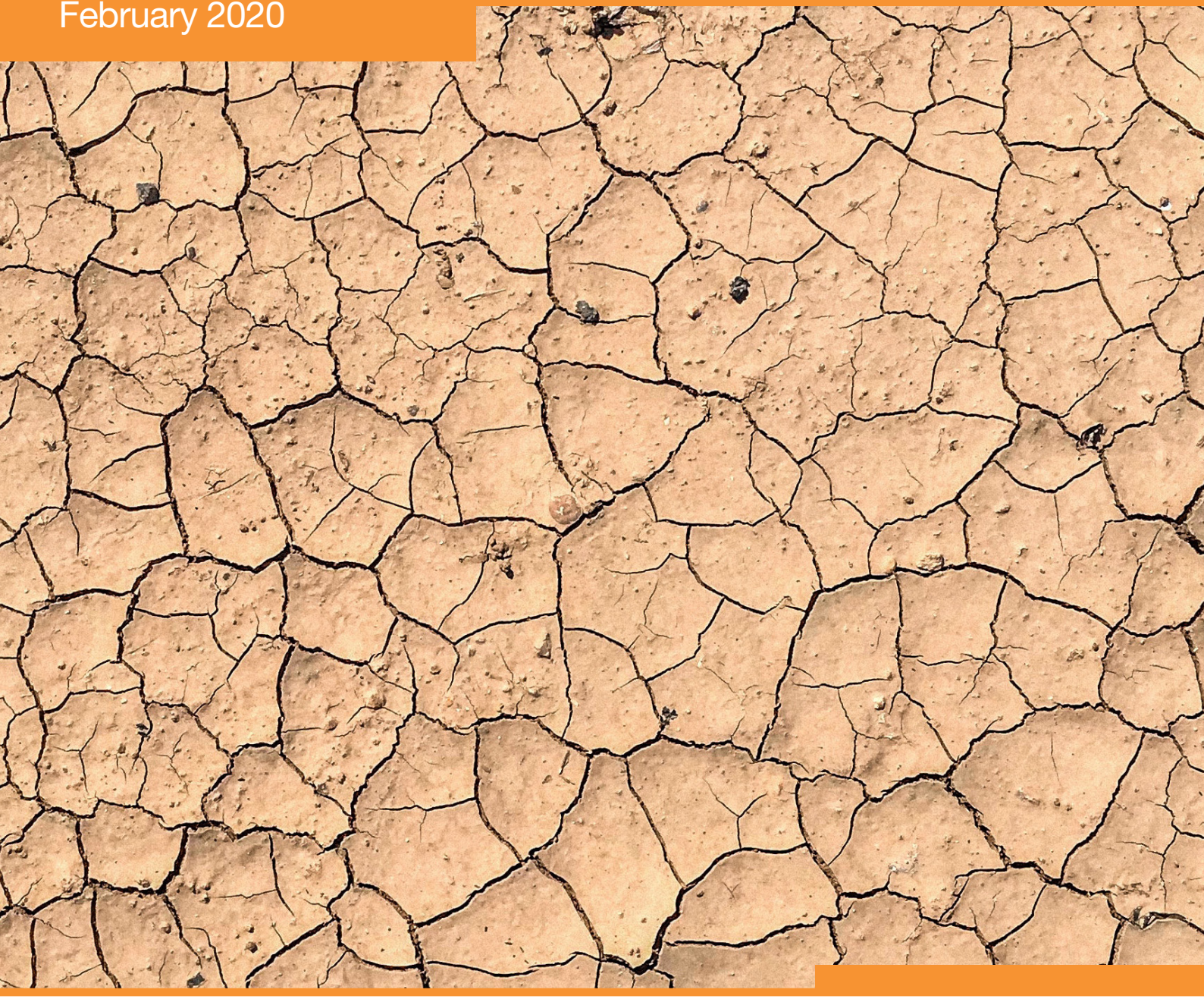
Advancing Drought Monitoring, Prediction, and Management Capabilities

Scientific Workshop Report

February 2020



INDIA-UK
Water Centre
भारत-यूके
जल केन्द्र

Advancing Drought Monitoring, Prediction, and Management Capabilities

Scientific Workshop Report

Published February 2020

India-UK Water Centre

www.iukwc.org

UK Coordination Office

UK Centre for Ecology & Hydrology

Benson Lane

Crowmarsh Gifford, Wallingford

OX10 8BB

UK

Indian Coordination Office

Indian Institute of Tropical Meteorology

Dr. Homi Bhabha Road

Pune-411008,

Maharashtra

India

CITATION

Atkinson, P. M. and Chakravarthi, V. (2020). Advancing Drought Monitoring, Prediction and Management Capabilities: Scientific Workshop Report Date 2018 . The India-UK Water Centre; UK Centre for Ecology & Hydrology, Wallingford and Indian Institute of Tropical Meteorology, Pune.

Version 2.0 22/08/19

Natural Environment Research Council

Ministry of Earth Sciences
Government of India

The India-UK Water Centre promotes cooperation and collaboration between the complementary priorities of NERC-MoES water security research.

भारत-ब्रिटेन जल कें द्र एमओईएस-एनईसीआरसी(यूके) जल सुरक्षा अनुसंधान के पूरक प्राथमिकताओ के बीच सहयोग और सहयोग को बढ़ावा देने के लिए करना है

Front cover image: Dry cracked mud, Pexels.

Contents

Executive Summary

This report represents an overview of the participation, activities and conclusions of a Scientific Workshop held at Lancaster University, UK from the 18th to 20th September 2019, and convened by Professor Peter M. Atkinson of Lancaster University and Dr Vishnubhotla C. Chakravarthi, University of Hyderabad, India. It outlines the Workshop itself, provides some explanation of the goals of the Workshop and shows how the Workshop was structured to ensure coverage of the key elements and support the greatest amount of discussion. The report also details the delegates, the main topics covered by the delegates and the key points raised. Finally, the report gives the key themes arising from the discussion and some recommendations for the future.

The report is intended for the workshop participants, members of the India-UK Water Centre Open Network, and other policy, business and community stakeholders.

Figure 1: Workshop Delegates being buffeted by the winds in Lancaster

1. Workshop Conveners

The Scientific Workshop was convened by the India-UK Water Centre (IUKWC) and led by the co-coordinators:

Prof Peter Atkinson

Lancaster Environment Centre

University of Lancaster

Lancaster University

Lancaster, LA1 4YQ

United Kingdom

Email: pma@lancaster.ac.uk

Dr Chakravarthi Vishnubhotla

University of Hyderabad

Prof. C.R.Rao Road

Gachibowli, Hyderabad

Telangana 500046

India

Email: vcvarthi@rediffmail.com

The Workshop was held at Lancaster University, UK, from 18th to 20th of September 2018.

2. Workshop Aims

Water is the primary medium through which we feel the effects of climate change. Water availability is becoming less predictable in many places and increased incidences of drought are exacerbating water scarcity and, thereby, negatively impacting agriculture and, in turn, its productivity. An integrated knowledge of water (both surface and subsurface), the biosphere and environmental flows is required to devise sustainable agricultural and economic systems that will allow us to decelerate climate change, protect us from extremes and adapt to unavoidable change at the same time.

With the above backdrop, the Centre for Earth, Ocean and Atmospheric Sciences, University of Hyderabad, India and the Lancaster Environment Centre, Lancaster University, UK under the aegis of the India-UK Water Centre, came together to review the status of drought monitoring, prediction, and management, to provide geo-scientific inputs to help reduce the extent and impact of droughts and build drought resilience. The specific aims of the Workshop were to:

- Assess the state-of-the-art of the science of drought monitoring, prediction and management globally and in India, with special focus on remote sensing-based approaches;
- Identify gaps between research knowledge and operational requirements for drought policy and management; and
- Lead to a road map for advancing operational capabilities for drought policy, monitoring, prediction and management in India.

The IUKWC is based around five key cross-sectoral themes and aims to deliver a portfolio of activities across these themes. This Workshop focused on the IUKWC theme on developing hydro-climate services to support water security.

3. Workshop Participants

The workshop brought together, on one platform, the key actors engaged independently in the three domains of drought monitoring, prediction and management to leverage cutting edge drought science for meeting society's needs for drought planning and management.

An open call was made to members of the water sciences sector in June 2018. The leads and IUKWC secretariat assessed the applications in line with the IUKWC application review procedures and all applicants were notified in July 2018. The call targeted hydrologists, meteorologists and climate scientists, climate modellers, statisticians, stakeholders and policy-makers.

A total of 30 delegates were selected (11 from India and 19 from the UK) including students, from 92 applications. A further four delegates were invited from India and the UK to complete the delegation. Due to unforeseen circumstances a few delegates had to cancel at the last minute. The list of delegates who attended the workshop is shown in Table 1.

Table 1. List of delegateS

	Name	Institution
	UK	
1	Paula Arce Vicente	University of Exeter
2	Mark Everard	University of the West of England
3	Alexandre Gagnon	University of the West of Scotland
4	David Leedal	JBA Risk Management
5	Simon Parry	UK Centre for Ecology and Hydrology (UKCEH)
6	Ina Pohle	James Hutton Institute
7	Hamish Prichard	British Antarctic Survey
8	Nevil Quinn	University of West of England
9	Indrani Roy	University of Exeter
10	Gloria Salmoral	Cranfield University
11	Andy Turner	University of Reading
12	Jadunundan Dash	University of Southampton, UK
13	Justin Sheffield	University of Southampton, UK
14	Nic Arnold	University of Lancaster (support team to Lead)
15	Ce Zhang	University of Lancaster (support team to Lead)
16	Peter M Atkinson	University of Lancaster (UK Lead)
17	Harry Dixon	IUKWC UK Coordinator (UKCEH)
18	Sunita Sarkar	IUKWC UK Secretariat (UKCEH)
19	Emma Bennett	IUKWC UK Secretariat (UKCEH)
	INDIA	
20	Suryachandra Rao Anguluri	Indian Institute of Tropical Meteorology (IITM)
21	Jeganathan Chockalingam	Birla Institute of Technology (BIT)
22	Pawan Kumar Joshi	Jawaharlal Nehru University, New Delhi, India
23	Kasiviswanathan Kasiapillai Sudalaimuthu	Indian Institute of Technology (IIT) Mandi
24	Pankaj Kumar	Indian Institute of Science Education and Research (IISER) Bhopal
25	Vimal Mishra	Indian Institute of Technology (IIT) Gandhinagar
26	Abhishek Anantarao Pathak	National Institute of Technology Karnataka (NITK)
27	Neelamraju Hanumantha Rao	University of Hyderabad
28	MD Saquib Saharwardi	Indian Institute of Science Education and Research (IISER) Bhopal
29	Venkadesh Samykannu	Tamil Nadu Agricultural University
30	Sahana Venkataswamy	Indian Institute of Technology (IIT) Bombay
31	Kondru Venkateswara Rao	ICAR-CRIDA, Hyderabad
32	Pulak Guhathakurta	India Meteorological Department (IMD)
33	Kripan Ghosh	India Meteorological Department (IMD)
34	Parth Sarathi Rao	University of Hyderabad (India Co-Lead)
35	Vishnubhotla Chakravarthi	University of Hyderabad (India Lead)
36	A. K. Sahai	IUKWC India Coordinator (IITM)
37	Priya Joshi	IUKWC India Secretariat (IITM)

4. Workshop Structure

The workshop was held over three days, with each day divided into sessions, including a cultural visit to the Lancaster Castle allowing the delegates to get a chance to see the city. A total of 15 talks and 15 posters were presented, with ample time for discussions after each session, as well as networking between sessions and at dinner.

Prior to the start of the Workshop, the Workshop co-coordinators created a schematic diagram that aimed to provide some structure to guide the Workshop delegates in navigating through the topics considered within the three days (Figure 2). This diagram was presented by Professor Atkinson at the start of the Workshop and revisited again at the end, providing a framework to support discussion.

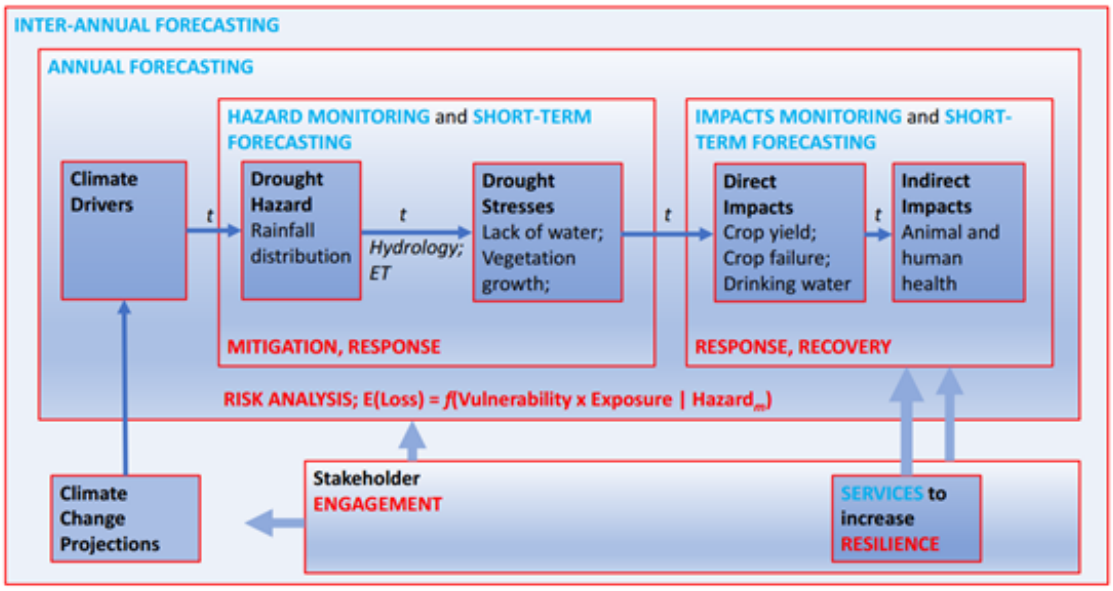


Figure 2. Schematic diagram capturing the structure and relationships between elements covered by the Workshop. The text in black details measurable system variables or states, the text in light blue characterises the operations (e.g., forecasting) relating to these states and the text in red characterises the same in a risk analysis framework. t is time, ET is evapotranspiration. (source: Prof. P.M. Atkinson)

The first day began with a welcome to the delegates and a brief introduction to the IUKWC and its objectives by Professor Harry Dixon of UKCEH and the UK Co-ordinator of the IUKWC. This was followed by a presentation by the two leads, Professor Peter Atkinson and Dr Vishnubhotla Chakravarthi, on the Workshop objectives, structure and process, and the expected outcomes, respectively, using Figure 2 as a guide. The introduction session was concluded by an inaugural talk given by Dr Atul K. Sahai of IITM, and Indian co-ordinator for IUKWC, on the efforts of the Monsoon Mission programme in predicting the long break-spells during monsoons that lead to drought conditions over India.

The remainder of the three days was split into eight themed sessions, each with a specific objective. In the first four sessions delegates presented their research (Figure 3), whereas in the last four sessions delegates had the opportunity to bring together their knowledge and research into considering next steps (Figure 4a). The visit to Lancaster city was held on the second day (Figure 5).

The first four sessions were as follows:

1. **Drought monitoring with special focus on multi-sensor data-based indicators, and indices at operational scales.** The objective of this session was to assess drought monitoring indicators and indices at global, national, regional and local (fine spatial and temporal resolution) scales for agricultural applications based on remote sensing, site-based sensing and machine learning.
2. **Drought forecasting at operational scales (with special focus on prediction analytics).** Assessments of state-of-the-art fine resolution drought forecasting from downscaled climate models and data analytics (machine learning/deep learning approaches) were presented.
3. **Information on drought services, improving drought assessment, monitoring and risk assessment for operational decisions for managing agricultural and water systems.** This session included talks focused on the use of remote sensing and other EO products to develop monitoring, forecasting and risk management of droughts (and floods) and responses in agricultural productivity.
4. **Drought impacts on food, water, agriculture and social systems.** The objective of this session was to take a holistic systems approach to consider cropping, hydrological, agricultural and social factors to determine the maximum utility of climate predictions and projections.

The first two sessions of the Workshop were deliberately designed to cover hazard monitoring and short-term forecasting (the left of the two inner red boxes in Figure 2). The third Workshop session covered drought services and monitoring to improve operational decision-making (the small box on SERVICES at the bottom in Figure 2), while the fourth session covered drought impacts and the whole system, with a focus on stakeholder communities (the right of the two inner red boxes and the whole system in Figure 2).

Each session ended with at least 10 minutes for discussion and further questions. Two sessions were dedicated to posters, which were placed in the same room. This had the added benefit that over time delegates continued to discuss the posters over tea and lunch breaks, further enhancing their interactions.

On the last day, Professor Atkinson presented Figure 2 again with the PESTEL framework, as a primer to help bring out the challenges that are facing drought monitoring, prediction and management in the context of highly heterogenous political, social, environmental, technological, legal and economic settings in the Indian sub-continent (Figure 4b). Delegates were then asked to split into groups and to discuss two topics:

- Future directions of fine resolution integrated drought prediction, monitoring, risk assessment and management, where delegates considered requirements, challenges and gaps around the development of hydroclimatic data and services platforms for drought assessment and management at operational scales. These were considered by reviewing geophysical variables, available databases, spatial and time scales, satellite sources, models, indicators/indices, and analytics tools. Delegates were tasked with coming up with the key actions and priorities.
- Strategies to engage stakeholders and agri-service providers for packaging knowledge for drought resilience, where delegates were asked to consider amongst other things: institutional frameworks for engagement, knowledge needs for actions/decisions, knowledge packaging attributes in advisories, capacity building of stakeholders, and to determine the key actions and priorities.

The groups used the discussions and information from presentations from the preceding days to inform their discussions. They each made a presentation on the outcomes of their discussions on

both topics to the wider group, which fed into a concluding statement by Professor Jeganathan Chockalingam of BIT in India.

A presentation was also made by Mandy Dillon, a member of the Research Development Team at Lancaster University, on current funding that could be exploited to further develop research in this area.

The agenda for the workshop can be found in Annex A and the list of poster presentations with abstracts can be found in Annex B. All presentations, from those who consented to sharing with other members of the Open Network of Water Scientists, can be found on https://iukwc.org/workshop-presentations. You need to be logged into the Open Network to access this page.

A B

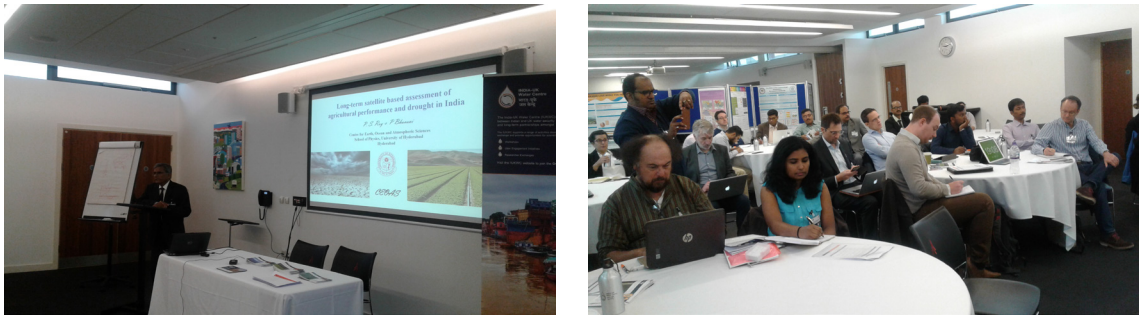


Figure 3: (a) Presenter, Dr PS Roy and (b) delegates listening to presentations

A B

Figure 4: (a) Delegates undertaking group discussions, and (b) Professor Atkinson presenting the PESTEL framework

Figure 5: Part of the delegation at the entrance to Lancaster Castle

5. Workshop Conclusions and Outputs

The Workshop was designed to ensure sufficient time and opportunities for both sharing by, and discussion between, the delegates. This resulted in several key gaps and challenges being outlined and opportunities for future collaborative research being suggested.

5.1. Key themes arising

Several key points were made during the presentations of the Workshop:

Monitoring and forecasting the drought hazard

- Due to likely climate change scenarios, monsoon sub-seasonal spells are likely to undergo changes both in terms of frequency and intensity.
- Such climate changes may lead to extreme situations and the commensurate impacts may be harder to predict on water resources, agricultural productivity, infrastructure and, in turn, the lives of millions of people on the Indian subcontinent.
- Based on real-time drought monitoring using hydrological models and other drought indicators, drought frequency has been shown to have increased over many parts of India.

Drought services and risk

- The IMD Agro-meteorological Advisory Services (AAS) in India is a world-class service. The IMD demonstrated that they have reached 24% of farmers, which has contributed an incremental reduction in risk by 25%. The IMD is making efforts to strengthen weather observations by extending the AAS network to district levels and supporting block level advisory.

Drought impacts and the whole system

- Delegates stressed the need to consider satellite sensor-derived indices of all the cropping seasons and yield forecasts to link to the cumulative effects of drought.
- The case was made for a novel approach for vulnerability mapping in present and future climate scenarios.
- The need for a unified system for combining the inputs of agro-meteorological services, remote sensing of impacts and especially of local stakeholder communities was presented.

Perhaps the most interesting outcomes from the Workshop arose in the second half during the four sessions focused on group discussion and bringing key issues to the fore. Here, the conceptualization in Figure 2 was helpful in framing some of the issues that emerged as important. These are as listed below:

- Fine spatial resolution, reliable information on weather and other factors like real-time crop productivity and stress were identified as major gap areas.
- A challenge was identified as how to better link the large, monolithic national systems for forecasting the drought hazard (e.g. end of drought due to monsoon) and the requirements of farmers and local people. Some of the time-consuming social science work undertaken by delegates with local communities shows how difficult this task really is.

- The idea of building a unified system that would refine national information to be locally relevant was discussed as a major opportunity.
- A strong case was made for the rapid adoption by the community of tools like Google Earth Engine.
- Excessive withdrawal and declining recharge of groundwater were identified as major areas of concern for future water availability in the context of a changing monsoon.
- There is a need to bring together academics focused on remote sensing of impacts and social-environmental systems and national institutions focused on meteorological services. Consideration should be given to how connectivity and synergy can be increased.
- Crop selection to increase resilience of the farming community was also recommended as a way forward.

5.2. Conclusions from the Workshop

The Workshop provided a valuable forum to bring together scientists, practitioners and stakeholders from a wide range of disciplines to discuss and debate critical issues relating to drought globally, and more specifically in India. The Workshop was highly structured to cover hazard monitoring, short-term forecasting, services and the whole system in the first half, and broad discussion of key challenges and opportunities in the second half. The Workshop was useful in introducing and establishing the network. Consideration should now be given to how to achieve follow on and continuity. An accompanying Water Brief, summarizing the key thematic points and recommendations arising from the Activity can be found at www.iukwc.org.

5.3. Participant feedback

At the conclusion of the Activity a feedback form was circulated to participants who were asked to provide comment on:

- The Workshop content;
- The meeting venue and organisation; and
- Networking opportunities.

The delegates were also requested to provide any further comments and an overall score out of 10 for the Workshop. This was a voluntary exercise and we received thirteen responses (39% of the delegation).

The overarching positive feedback received from delegates centred on the opportunities and openness of the discussions. The opportunity to network was also highly appreciated. However, the majority of the respondents felt that the participants were too science and academia focused, and that there would have been great benefit derived from having practitioners and policy makers included. This is something that should be taken into consideration for the next workshops.

Feedback on the venue and meeting space were also generally positive, with IUKWC's Secretariat considered as well organised and pleasant to work with. However, the distance between the accommodation and the meeting venue caused some concern, as did the lack of variety in the food. These aspects could be considered for future workshops.

All 13 respondents said that they made new contacts as a result of the workshop, with the majority selecting future research collaborations as a highly probable outcome of the new connections. Information sharing and knowledge exchange were considered equally important secondary benefits.

Some constructive comments included:

- Holding a workshop on comparative water governance between the two countries and developing a project that would provide science-based, data-oriented tools for drought monitoring.
- Developing better connections between events by, for example, having a presentation on the outcomes of previous Workshops in the series.
- Developing a mechanism to enlarge the network.

The respondents rated the Workshop 8.6 out of 10, overall.

'The team of IUKWC worked very hard for providing all the information and facilities - thank you to all organizers.'

6. Annexes

Annex A: Agenda

Day 1 – Tuesday 18th September 2018

Time	Agenda Item
09:30 – 10:00	Registration
10:00 – 11:00	• Welcome and Introduction to the IUKWC (10 min) *Harry Dixon (IUKWC Coordinator, UKCEH)* • Introduction of delegates (10 min) *Harry Dixon* • Workshop objectives, structure, and process (10 min) *Peter M. Atkinson, Lancaster University, UK* • Brief Remarks on the expected outcome of the workshop (10 min) *V. Chakravarthi, University of Hyderabad, India* • Inaugural talk: Monsoon mission efforts in predicting long break spells during monsoon leading to drought conditions over India (20 min) *Atul Sahai (IUKWC Coordinator, IITM)*
11:00 – 11:30	Tea
11:30– 13:00	**Session 1: Drought monitoring with special focus on multi-sensor data-based indicators, and indices at operational scales** **Objective:** Assessment drought monitoring indicators and indices at global, national, regional and local (high spatial and temporal resolution) scales for agricultural applications based on remote sensing, site-based sensing and machine learning. **Chair:** Nevil Quinn, Centre for Floods, Communities and Resilience, University of Western England (UWE) Format: 3* 20 min talks + 5 min questions (25 min total per presentation) • From drought research to decision-making: Experiences from the UK and beyond *Simon Parry, UKCEH, UK* • Monitoring drought condition and providing outlook by drought indices like, SPI, SPEI and AAI from weekly to monthly scales. *P. Guhathakurtha, IMD, India* • Using multi-source EO data for monitoring crop health and productivity from farm to national scale. *Jadunundan Dash, University of Southampton, UK* Discussion (10 min)
13:00 – 14:30	Lunch

14:30 –15:30	**Session 2.1: Drought forecasting at operational scales (with special focus on prediction analytics)** **Objective:** Assessment of state of art of fine resolution drought forecasting from downscaled climate models and data analytics (machine learning/deep learning approaches **Chair:** Suryachandra Rao, IITM, India Format: 2* 20' talks + 5' questions (25' total per presentation) • Analysing Indian Summer Monsoon and related teleconnections using observations and CMIP5 models. *Indrani Roy, University of Exeter, UK* • The role of multi-model assessment in near real time drought monitoring in South Asia. *Vimal Mishra, IIT, Gandhinagar, India*
15:30 - 16:00	Tea
16:00 – 17:00	**Session 2.2: Drought forecasting at operational scales (with special focus on prediction analytics)** **Objective:** Assessment of state of art of fine resolution drought forecasting from downscaled climate models and data analytics (machine learning/deep learning approaches **Chair:** Pulak Guhathakurta, IMD, India Format: 2* 20' talks + 5' questions (25' total per presentation) • Monsoon mission efforts in generating high resolution drought prediction. *Suryachandra Rao, IITM, India* • Spectral analyses of low flow time series in the UK and links with atmospheric circulation indices. *Alexandre Gagnon, University of the West of Scotland, UK* Discussion (10 min)
17:00 – 17:30	Wrap-up of Day 1: Peter M. Atkinson and V. Chakravarthi
17:30 – 18:45	Poster Session 1
19:00 – 21:00	Dinner at Foodworks Restaurant, Lancaster House Hotel (On Campus)

Day 2 – Wednesday 19th September 2018

Time	Agenda Item
08:30– 08:40	Welcome to Day 2: V. Chakravarthi and Peter M. Atkinson
08:40 - 10:30	**Session 3: Information on drought services, improving drought assessment, monitoring, and risk assessment for operational decisions for managing agricultural and water systems** **Objective:** Drought services, and drought assessment, monitoring and risk assessment at operational scales in agricultural and water systems **Chair:** Simon Parry, UKCEH, UK Format: 4* 20' talks + 5' questions (25' total per presentation) • Monitoring and forecasting floods and droughts in data scarce regions. *Justin Sheffield, University of Southampton, UK* • Long-Term satellite based assessment of agriculture performance and drought in India. *P.S. Roy, University of Hyderabad, India* • A global database of rainfall-runoff models for flood and drought-risk management. *David Leedal, JBA Risk Management, UK* • Leveraging recent trends in high resolution geospatial data and analytics in agricultural drought monitoring. *Dr N.H. Rao, University of Hyderabad, India* Discussions (10 min)
10:30 – 11:00	Tea - Logistics for Afternoon Trip to Lancaster Castle
11:00 – 12:35	**Session 4: Drought impacts on food, water, agriculture and social systems** **Objective:** To understand hydrologic and agricultural systems in the context of climate predictions and projections **Chair:** Pawan Joshi, Jawaharlal Nehru University, India Format: 4* 20' talks + 5' questions (25' total per presentation) • Risk of economic impacts to irrigated agriculture due to drought management. *Gloria Salmoral, Cranfield University, UK* • Agrometeorological Advisory Services for monitoring, preparedness and management of agriculture drought. *K Ghosh, IMD, India* • Water scarcity trends, interlinked vulnerabilities and potential solutions in a complex dry land Indian catchment: the Banas system, Rajasthan *Mark Everard, University of West of England, UK* Discussions (20 min)
12:35 – 12:50	Wrap-up of Day 2: V. Chakravarthi and Peter M. Atkinson
12:50 – 14:00	Lunch
14:20 – 18:00	Visit to Lancaster Castle *All delegates to be at the bus by 14:20 sharp
18:30 – 21:00	Dinner at The Borough, Lancaster City Centre

Day 3 – Thursday 20th September 2018

Time	Agenda Item
08:30 – 08:40	Welcome to Day 3: Peter M. Atkinson and V. Chakravarthi
08:40 – 10:10	**Session 5: Breakout Topic A: Future directions of fine resolution integrated drought prediction, monitoring, risk assessment and management** Development of hydroclimate data and services platform for drought assessment and management at operational scales - geophysical variables, databases, spatial and time scales, satellites sources; models, indicators/ indices, analytics tools; actions and priorities
10:10 – 11:30	Poster session 2 with Refreshments
11:30 – 13:00	**Session 6: Breakout Topic B: Strategies to engage stakeholders and agri-service providers for packaging knowledge for drought resilience** Institutional frameworks for engagement: identifying knowledge needs for actions/decisions; Knowledge packaging attributes in advisories; Capacity building of stakeholders; actions and priorities
13:00 – 14:00	Lunch
14:00 – 15:30	**Session 7: Feedback from Breakout Groups** **Chair:** Peter M. Atkinson
15:30 – 16:00	Tea
16:00 – 16:30	**Session 8: Conclusions and Next Steps** **Chairs:** Peter M. Atkinson and V. Chakravarthi • Short presentation giving conclusions from the workshop and next steps *C. Jeganathan, BIT, India*
16:30 – 17:00	Close of meeting Feedback and Posters removed

Annex B: List of Posters

Dr Venkadesh Samykannu

Tamil Nadu Agriculture University, Tamil Nadu, India

Validation of MODIS & CHIRPS Products for Drought Monitoring

The importance of gridded products has drastically increased for ecological assessment nowadays. The analysis over the gridded data for the quality on it is a mandatory study for any kind of assessment studies. Satellite rainfall data commonly compare the rainfall estimated by satellites with rain gauge data. As such, we assessed the accuracy of satellite products - (a) Climate Hazard Group (CHG) –a satellite-only Climate Hazards Group Infra-Red Precipitation (CHIRPS)

Product, at a monthly time scale from 2015 to 2017 in Tamil Nadu using ground-based measurements. The MODIS NDVI drought indices deriving from remote sensing data have been used to monitor meteorological or agricultural drought, there are many indices that can suitably reflect the comprehensive information of drought from meteorological to agricultural aspects. This method is favourable to monitor the comprehensive drought.

Prof C Jeganathan

BITS, Mesra, India

Drought Modelling and Challenges.

Drought is a complex phenomenon, and many approaches have been explored and utilized over past many decades. Though computer and satellite technology have contributed immensely in understanding this drought process, still there are gaps and challenges. In this presentation I discuss those developments and challenges.

Dr K S Kasiviswanathan

IIT, Mandy, Himachal Pradesh, India

Intensity-Duration-Frequency analysis of meteorological drought: a case study on Cauvery River basin, India

In this study, we performed SPI based drought analysis for assessing the intensity, duration and frequency over Cauvery river basin using Indian Meteorological Department (IMD) high resolution gridded data over a period of 80 years. An increase in drought magnitude was found in the downstream of river basins during the period 1971–2010 relative to the base period 1931–1970.

Mr Abhishek Pathak

NIT, Surathkal, India

Bivariate drought analysis in Krishna River basin using copula

The study aims to assess the combined effect of meteorological and agricultural drought (derived with the aid of remote sensing techniques) in a typical river basin of India. Popularly used meteorological drought indices (SPI, RDI and SPEI) were compared with the remote sensing based Vegetation Condition Index (VCI). Different families of Archimedean copulas were employed to study the joint response of meteorological drought index and remote sensing based Vegetation Condition Index. The proposed methodology would be useful in better understanding of regional droughts and also helps to establish an effective water resources management policies for preparedness and mitigation of drought impacts effectively.

Md Saquib Saharwadi

IISER, Bhopal, India

An outlook to Indian monsoon drought teleconnections from seasonal to decadal scale.

India is an agriculture-based country with 1.3 billion populations. According to recent IPCC (AR5) report, drought frequency and intensity may increase in future over India. Therefore understanding different teleconnections is very important for this increase in future. These teleconnections lead to the intra-seasonal and inter-annual variability at the different scale.

Dr Venkateshwar Kondru

CRIDA, Hyderabad

Drought Monitoring and Drought Management- Status Report on India.

The presentation covers the present status of drought monitoring in India by state and central governments and the developmental programs launched for mainstreaming drought resilience. The recent guidelines on drought monitoring and the efforts of ICAR and state agriculture universities in overcoming drought in rainy season would be covered.

Dr. P.K. Joshi

Jawaharlal Nehru University (JNU), Delhi, India

Applicability of downscaled land surface temperature for agricultural drought and soil moisture mapping.

This study outlines downscaling of LST for generating Vegetation Health Index (VHI) and Temperature Vegetation Dryness Index (TVDI) at finer resolution. We used LST at actual 1000 m and at downscaled 500 m and 250 m resolutions with NDVI, VHI and TVDI to map agricultural drought and soil moisture levels over north western India.

V Sahana

IIT, Mumbai, India

Drought Atlas for India using a multivariate approach.

Drought is a natural hazard caused due to the lack of precipitation and significantly affects the society. Characterization of drought properties is essential to take steps for the drought mitigation measures. India being an agricultural-dominated country, water availability plays a major role in its prosperity and productivity. An effective way to quantify the drought properties is through drought index, which represents the deficit of either a single or multiple drought variable. This index is further used for drought modelling to find the characteristics of drought such as severity, duration, return period. Drought is caused due to influence and interaction of multiple variables with each other. Therefore, a multivariate approach for drought characterization is emphasized in the present study and the Multivariate Standardized Drought Index (MSDI) is used to monitor the drought in 30 meteorological subdivisions of India. The drought initiation and termination times are well captured in MSDI. The joint distribution of severity and duration are fitted using a suitable copula. The severity-duration-frequency (SDF) curves are derived for each of the meteorological subdivision in India and the drought atlas is constructed for different return periods of severity. Further, the drought atlas maps are used to assess the rarity associated with historical drought events observed in India. Through this study, the rarest drought event of each of the meteorological subdivisions are identified and the probability of occurrence of the associated drought severity conditioned on drought duration for that rare drought event is quantified. The drought atlas maps prepared aid in the drought hazard assessment for framing drought mitigation strategies, long term planning and water resources management and insurance service providers.

Ina Pohle

James Hutton Institute

Assessment of long-term changes in hydrology and river temperature to inform mitigation measures to enhance resilience of river systems

Dr Andy Turner

University of Reading

Interaction of Convective Precipitation with Monsoon Precipitation: Atmosphere, Surface and Sea (the INCOMPASS field campaign of 2016).

This work gives an overview of the key results emerging from the ground and airborne field campaign during the Indian monsoon of 2016. This includes the role played by patterns of wet and dry soils in the development of convective rain storms.

Dr David Leedal

JBA Risk Management

The JBA India Crop Model

The JBA India Crop Model is a probabilistic insurance loss model developed for the purposes of yield based loss assessment within the guidelines of the Pradhan Mantri Fasal Bima Yojana scheme (Prime Minister's Crop Insurance Scheme 'PMFBY'). The model has been developed utilising state-of-the-art physical crop modelling techniques. This poster describes the key methods employed by this model.

Dr Nevil Quinn

University of the West of England (UWE)

Centre for Floods Communities and Resilience: Synergistic Application of Sentinel-1 & Sentinel-2 for Assessment of Soil Moisture in Droughty Environments.

The ability to monitor soil moisture at high resolution remains a challenge. In recent years Sentinel-1 and Sentinel-2 have shown great potential in this area. Using the south-west USA as a case study we explore the synergistic application of these satellites to assess soil moisture under drought conditions.

Miss Paula Arce Vicente

University of Exeter

Assessment of drought effects in water resources availability.

Although surface water resources are usually managed, groundwater is not well understood yet. It is critical to further research the interactions between surface and groundwater and to assess the impact of droughts on both. This will contribute to the development of an integrated approach to water resources management that can secure global water and food for the increasing world population.

Dr Hamish Pritchard

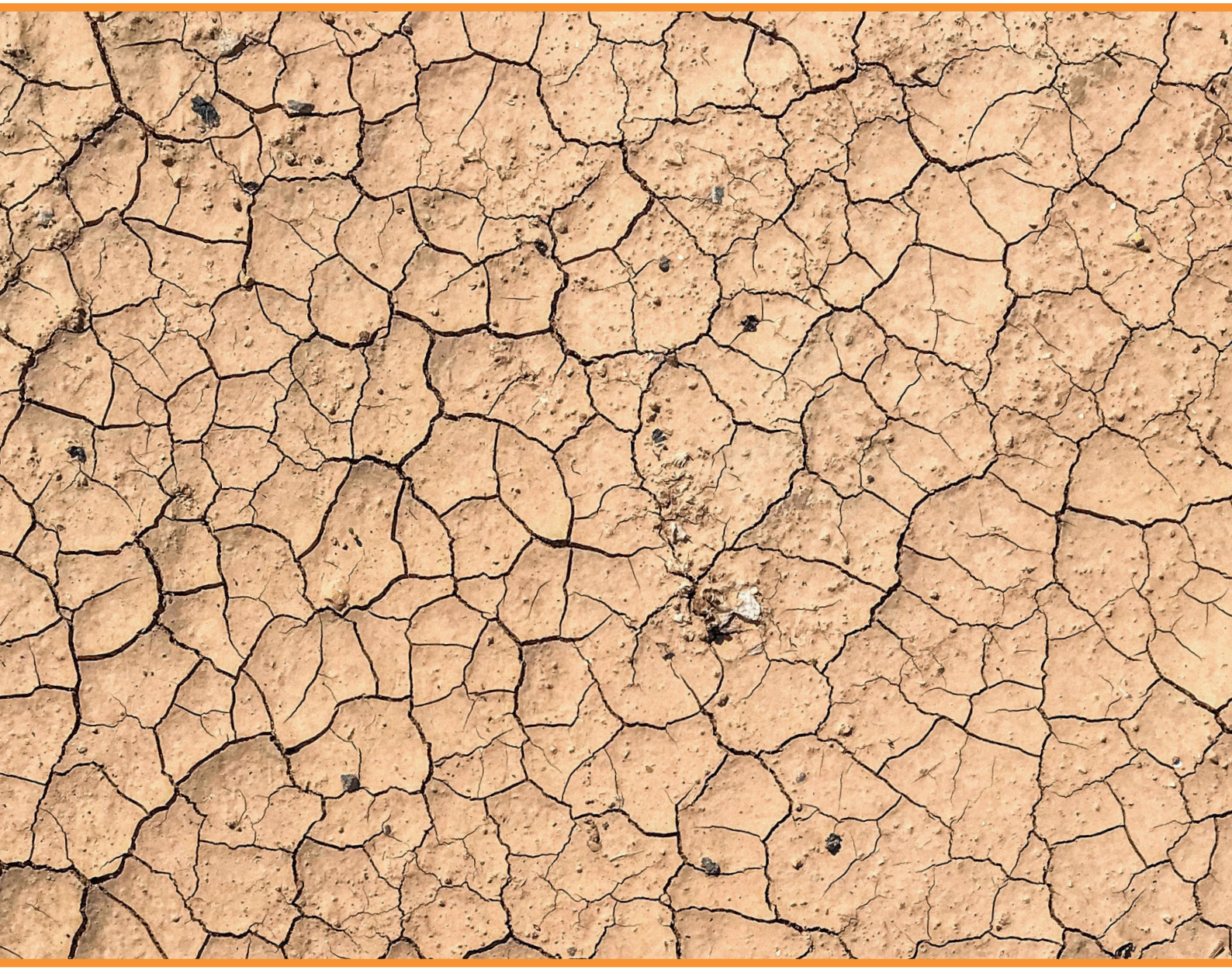
British Antarctic Survey

Asia's glaciers are a regionally important buffer against drought: a revised assessment

Back cover image: Dry cracked mud, Pexels.

INDIA-UK
Water Centre
भारत-यूके
जल केन्द्र

www.iukwc.org



Natural
Environment
Research Council

सत्यमेव जयते
Ministry of Earth Sciences
Government of India

UK Centre for
Ecology & Hydrology