IUKWC (India UK Water Centre)

Development of hydroclimatic services for the Himalayas

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Workshop on climate change over the High Mountains of Asia

IITM Pune, 9. October 2018

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Water Centre
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A Natural Environment Research Council and Ministry of Earth Sciences funded **virtual joint centre**.

Hosted by the Indian Institute of Tropical Meteorology and the Centre for Ecology & Hydrology

NERC
SCIENCE OF THE ENVIRONMENT

सत्यमेव जयते

CEH Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

INDIAN INSTITUTE OF TROPICAL METEOROLOGY PUNE

www.iukwc.org

The Centre aims to support the development of the sustained and meaningful interdisciplinary UK-India partnerships needed to deliver collaborative water resources research

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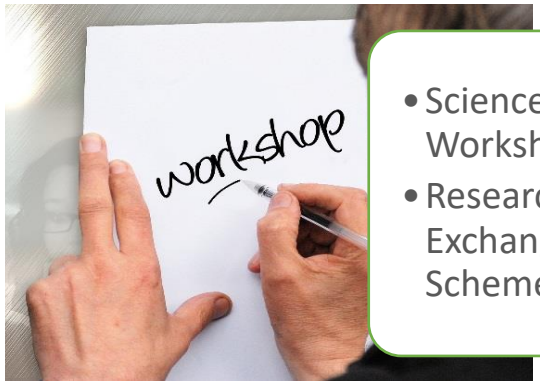
Functions of the Centre

Engaging the Community

- Open Network of India-UK Water Scientists
- Website / social media

Facilitating Partnerships



- Science Workshops
- Researcher Exchange Schemes

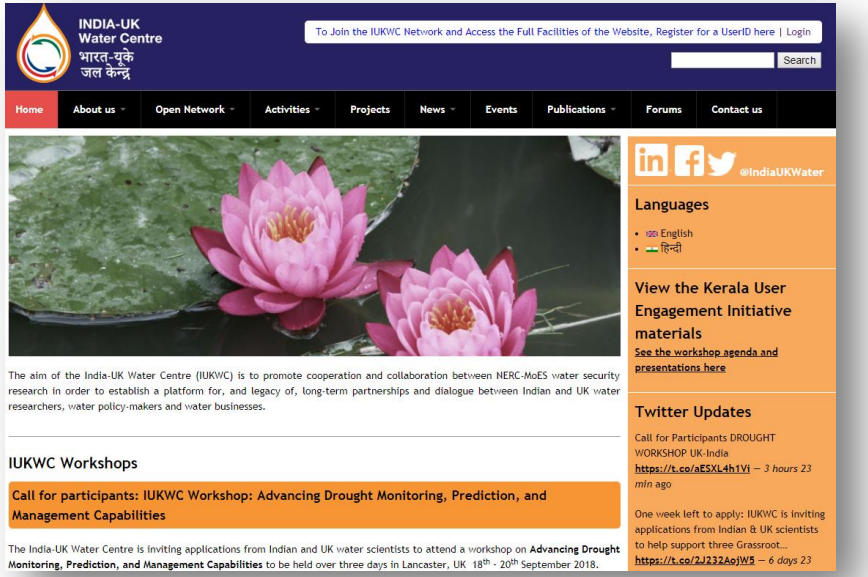
Enhancing Knowledge Exchange

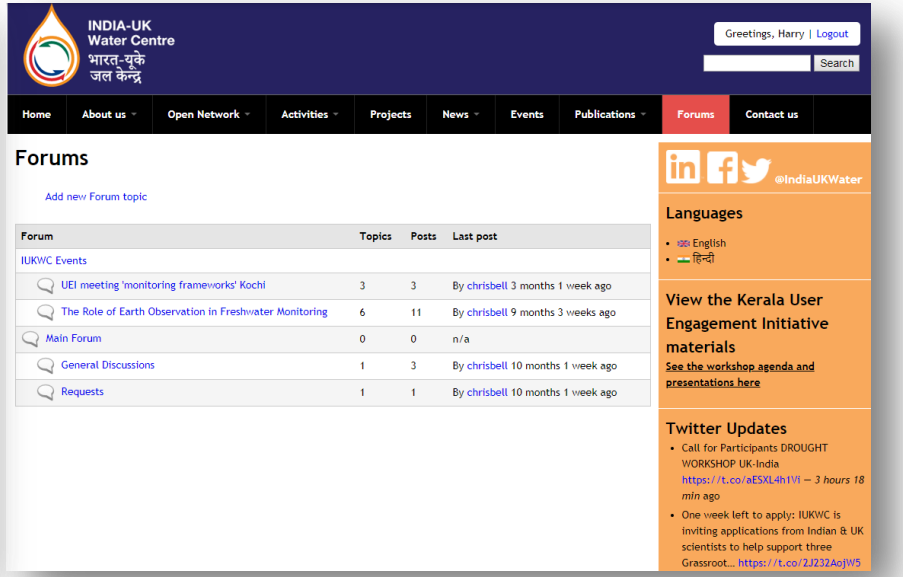
- User Engagement Initiatives
- Grassroots Exposure Sessions

Supporting Future Collaboration

- Pump Priming Projects

IUKWC Online Tools





- Presentation – published on the website for logged in members access
- Open Network – useful for contact details
- Discussion Forum – keep group discussion going after an event
- Twitter - @IndiaUKWater

Some of the Recent and Forthcoming IUKWC Activities

Precipitation forecasts and climate predictions for basin-scale hydrological modelling in the Himalayas (workshop Dehradun, May 2018)

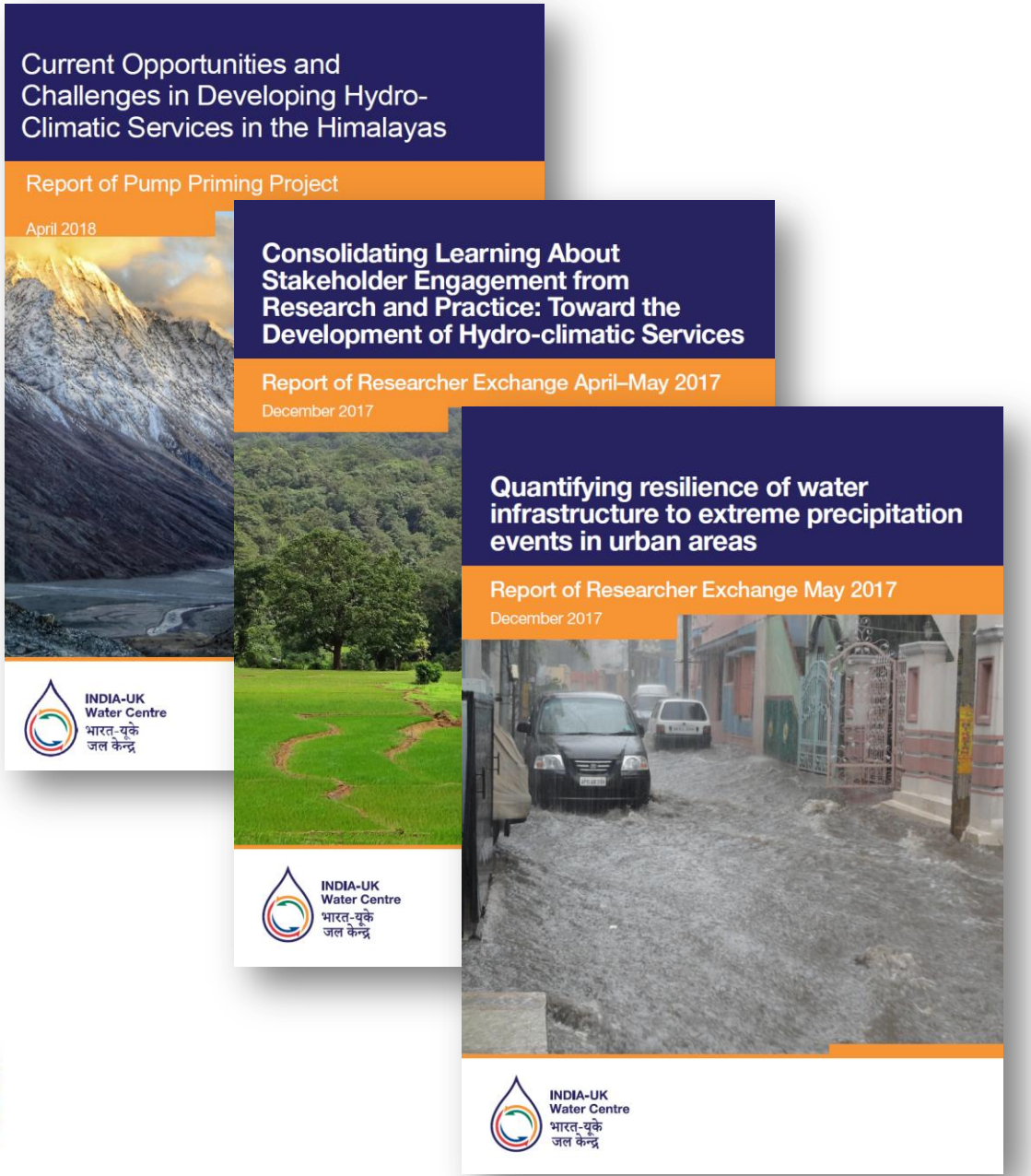
Identified ways of optimising new hydro-climatic services for stakeholders (workshop Pune, November 2016)

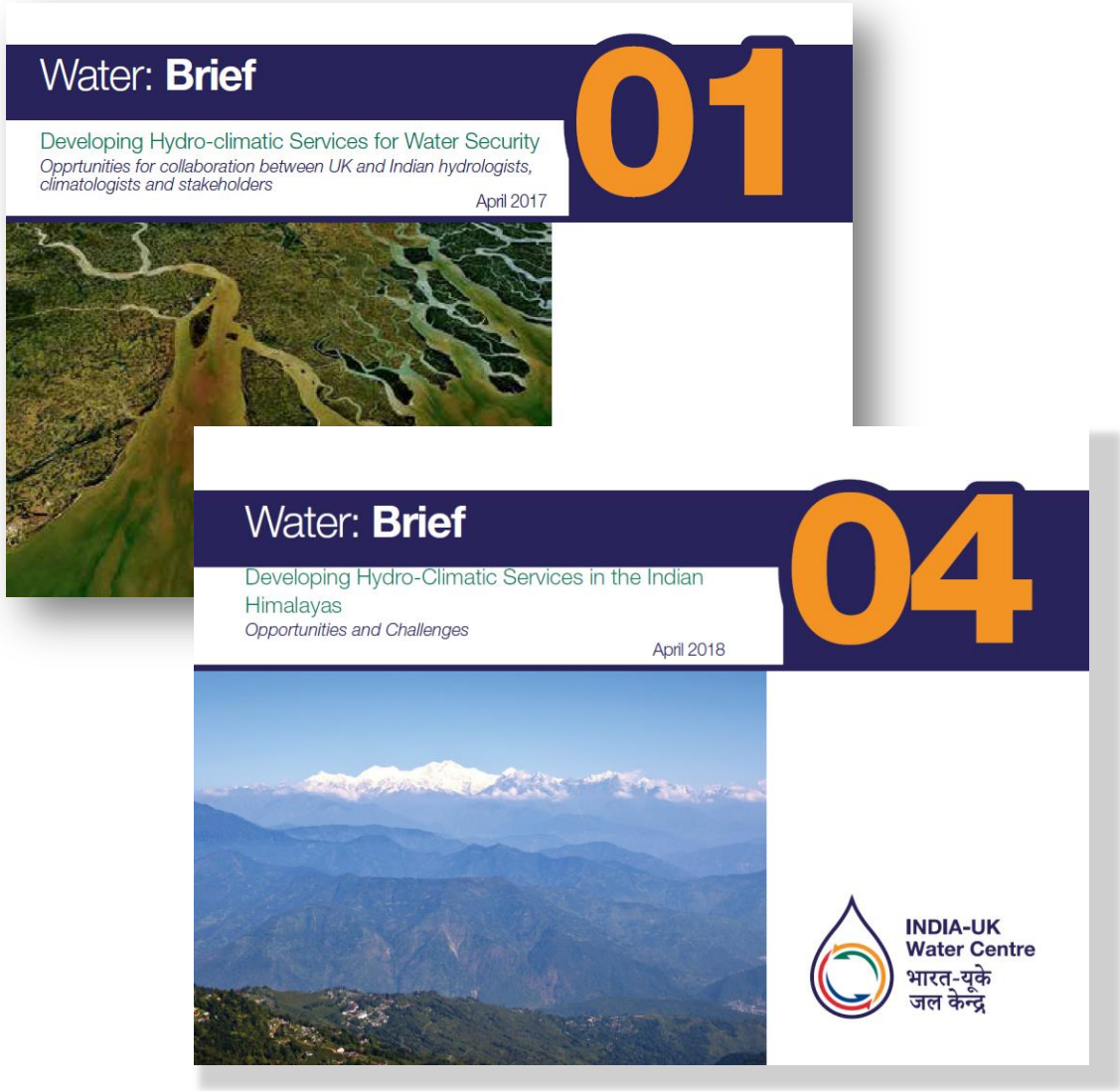
Antibiotics in the River Foss catchment and comparison of antibiotic exposure in the UK and India

Improving freshwater monitoring frameworks and data for research and management

Managing and monitoring agricultural water demand

IUKWC Publications





http://iukwc.org/publications

www.iukwc.org

Current Opportunities and Challenges in Developing Hydro-Climatic Services in the Himalayas

Report of Pump Priming Project

April 2018

INDIA-UK Water Centre
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UNIVERSITY OF BIRMINGHAM

M. Widmann , R. Blake , K.P. Sooraj, A. Orr, J. Sanjay , A. Karumuri, A.K Mitra , E.N. Rajagopal, A.F. Van Loon , D.M. Hannah, N. Barrand, R. Singh, V. Mishra, F. Sugden and D.S. Arya

Context

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- over 1 billion people depend on Himalayan water supply
- variability on daily and interannual timescales
- droughts and floods
- climate change

Demand

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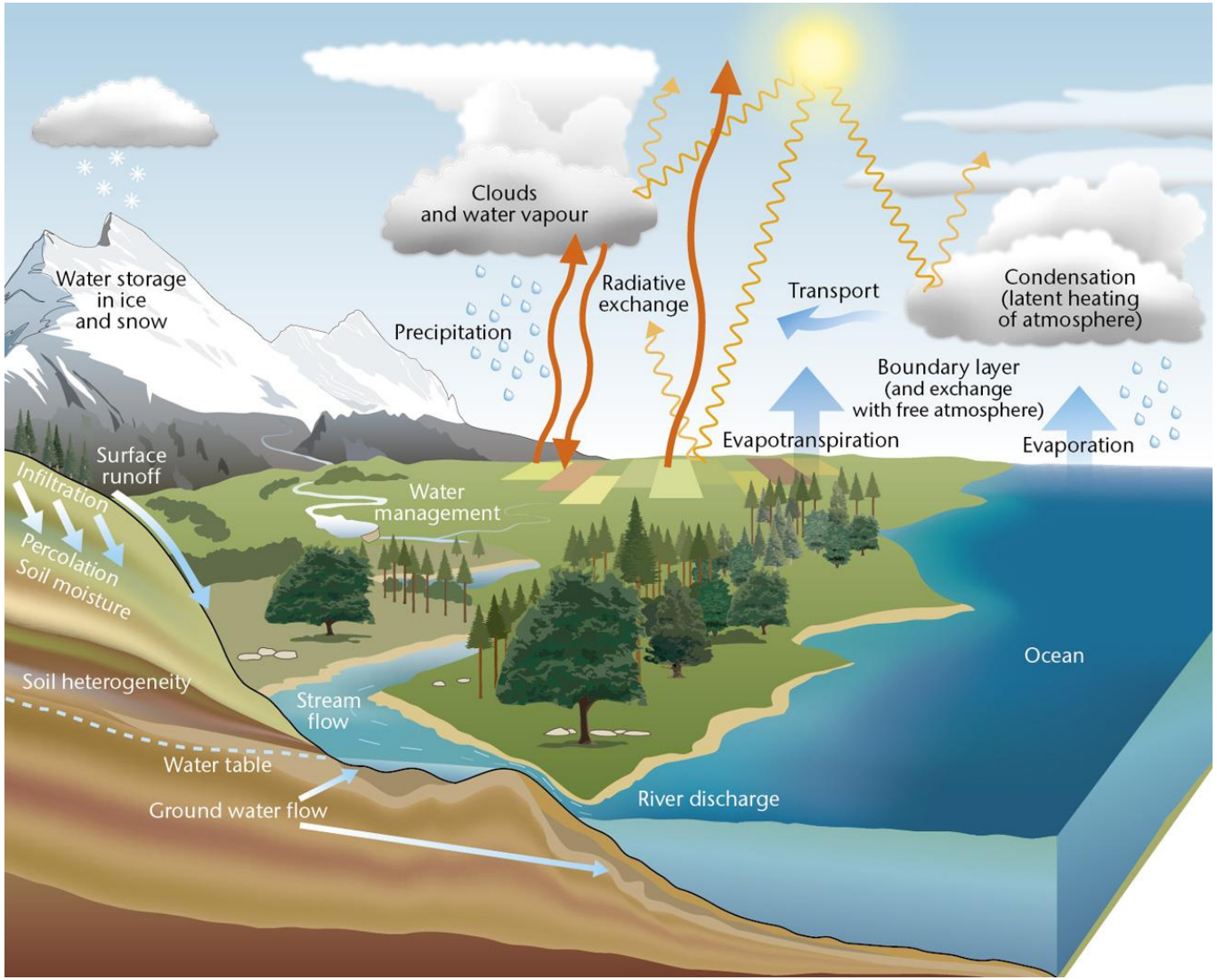
- short-term and seasonal predictions
- climate change projections
- variables:
  - precipitation, temperature, radiation, wind speed
  - river flow and ground water levels
  - snow depth, snow water equivalent
  - glacier extent and volume

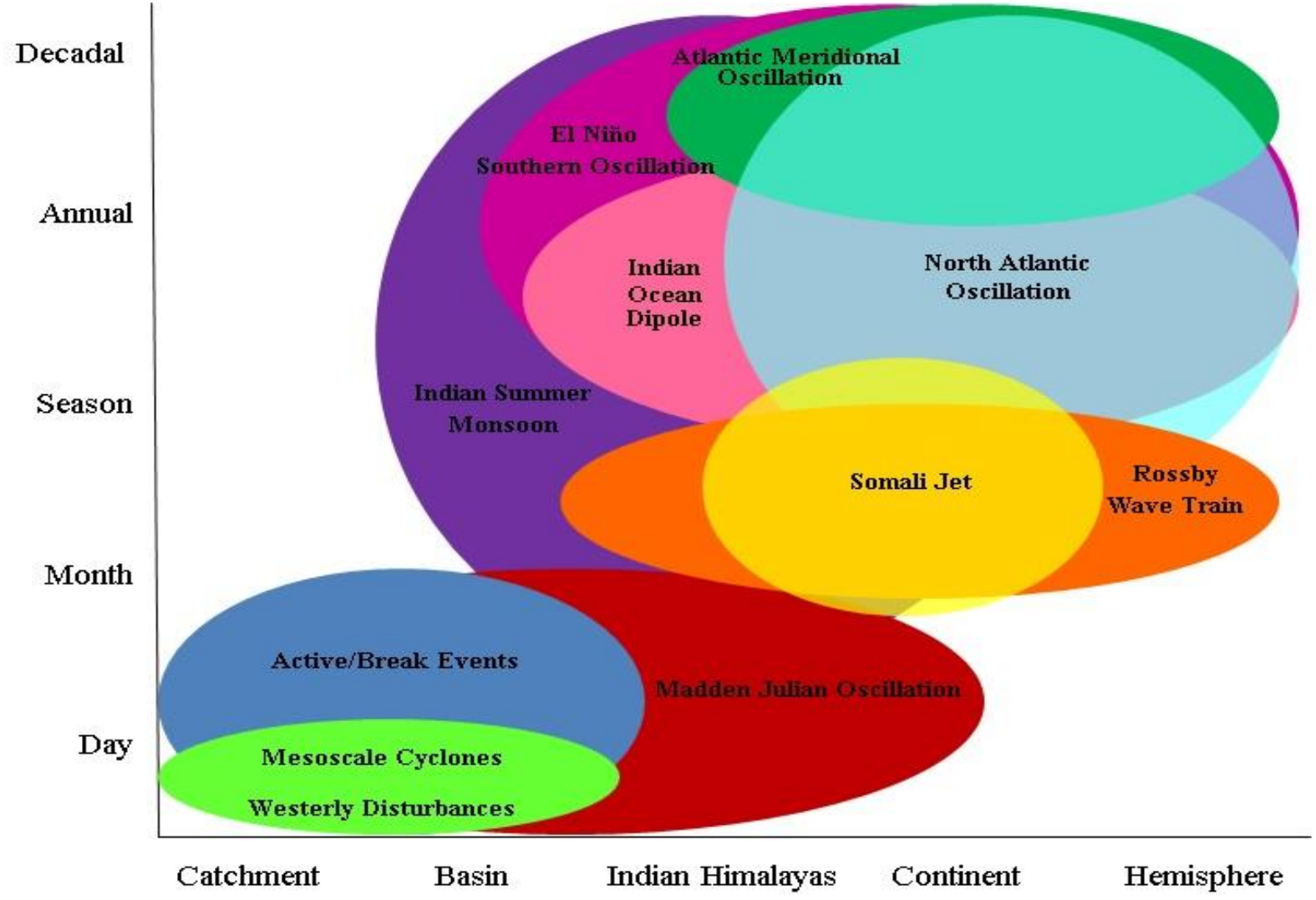
Hydro-climatic processes



(courtesy UK Met Office)

- Atmosphere and ocean
- Run Off
- Ground Water
- Snow Melt
- Glacial Melt
- Water Use

Meteorological processes



- Relevance on different timescales?
- Interactions?

(Widmann et al. 2018, IUKWC report)

Challenges: scientific understanding

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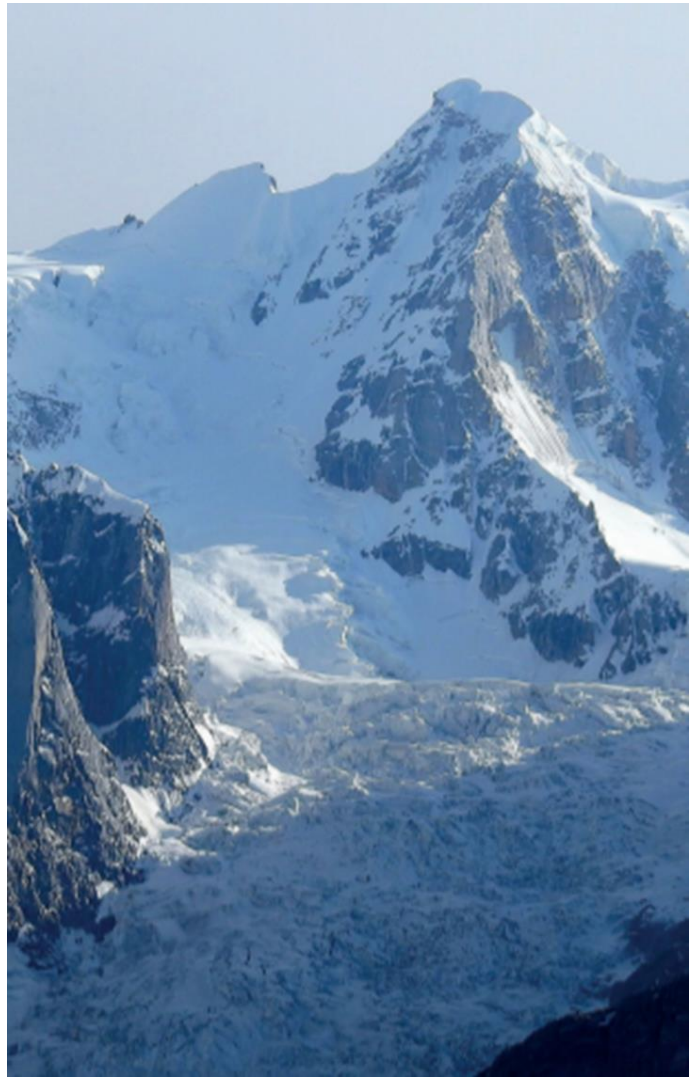
- Effect of climate change on large-scale drivers of regional climate? (e.g land-sea temperature contrast, summer monsoon, hemispheric-scale wintertime atmospheric circulation)
- Effect of land-use changes on climate?
- Role of small-scale processes in modifying the weather and the climate change signal?
- Glacier mass and processes?
- Hydrological catchment processes, especially related to storage and transfer (both natural and man-made)?
- Effects of changes in water use and management?

Challenges: observations

Lack of in-situ and remote sensing high-resolution observations (meteorological, hydrological, glaciological) in mountain areas for

- process understanding
- improvement of meteorological and glacio-hydrological models (e.g. parameterisations)
- model validation
- initialisation of simulations



Challenges: observations

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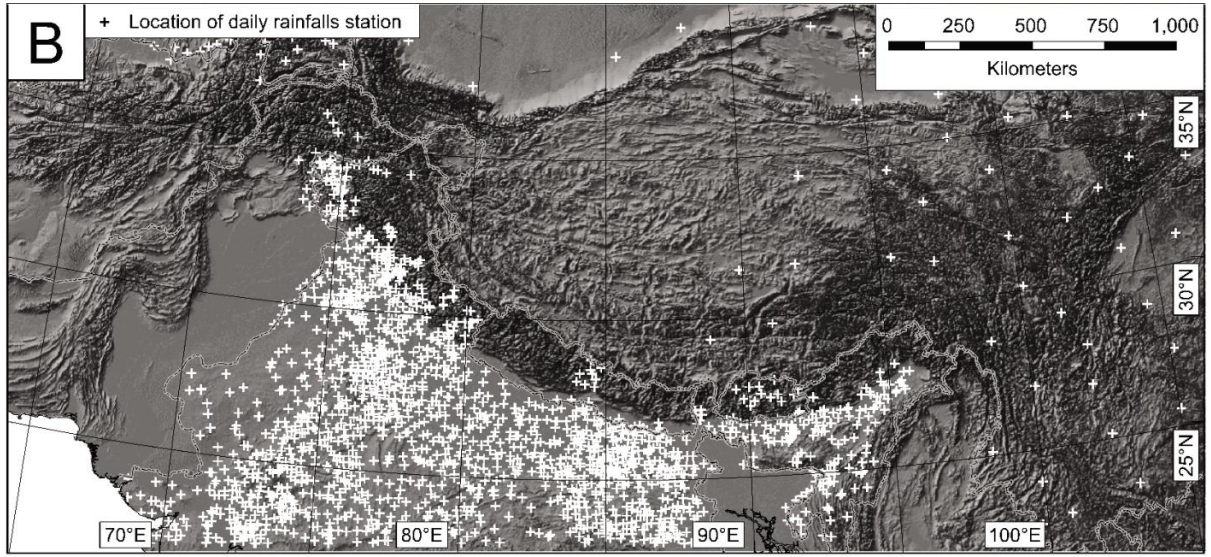
Locations of daily rainfall stations



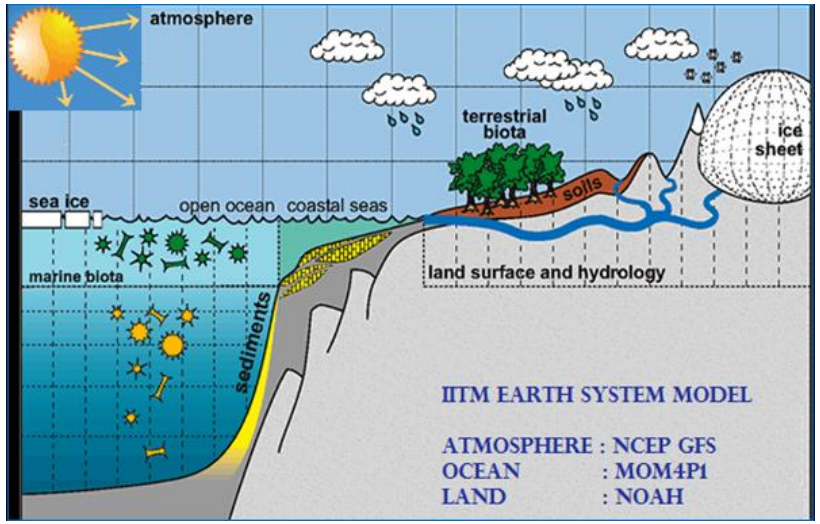
Bookhagen & Burbank (2010

Gridded products

- APHRODITE (25 km grid spacing, daily) **interpolated station records, no new information**
- TRMM (25 to 5 km grid spacing, 3-hourly) **problems over mountains**
- ERA-Interim reanalysis (0.7°, 6-hourly) **simulated, can have large biases**

Challenges: modelling and prediction

India and the UK have substantial modelling capabilities. There is a chance to move towards integrated meteorological/climatological-glacio-hydrological modelling on all timescales.



Challenges include:

- Incomplete validation of weather forecasting and climate models
- Biases in simulated meteorological variables make coupling with glacio-hydrological models difficult
- Confusion about suitable downscaling and bias correction models
- Increasing computing resources is essential to meet the need for better process representation and uncertainty quantification.

Ways forward: observations

- Making existing meteorological and hydrological observations available through a common platform
- Setting up high-resolution meteorological and hydrological networks in test catchments
- Exploring the usefulness of crowd-sourced data
- Further development of the use of remote sensing data and calibration methods.

Workhop: Integrating precipitation forecasts and climate predictions with basin-scale hydrological modelling in the Himalayas (Wildlife Institute of India. Dehradun, May 2018)

Ways forward: modelling and prediction

- **Developing and evaluating integrated meteorological-hydrological models for the test catchments**

- Requires interdisciplinary meetings, but overcoming the substantial technical and scientific challenges will only be possible in interdisciplinary projects on developing integrated modelling

- Increasing computing resources for better process representation and uncertainty quantification.

- Analysing large-scale biases in global climate models that affect the regional climate over the Himalayas

- Evaluating global and regional meteorological models following a systematic validation framework

- Evaluating and giving guidance on suitable downscaling and bias correction methods
(similar to EU-COST action VALUE)

IUKWC workshop Dehradun, 2018

Challenges and ways forward: communication

- Identify user groups and sectors, their specific information needs, and the role of hydro-climatic information in decision making.
- Facilitate close collaboration between information providers and users.
- Provide information on different aggregation levels and communicate uncertainties.
- Identify lines of communication. Government agencies dealing with water resources, floods or droughts, should be in direct two-way communication with the providers of hydro-climatic information. Ways of informing the general public should take into account illiteracy in parts of the population.
- Include advice on actions in short-term to seasonal forecasting, for instance by using warning levels with recommendations.
- Provide information on changes in hydrological extremes as part of climate change projections.

Challenges and ways forward: education

- Engaging with schools and pupils from an early age is important to create awareness in the general public on hydro-climatic extremes and climate change, and to increase resilience.

- Engaging students and early-career researchers in interdisciplinary meetings and projects focused on hydroclimatic issues is needed to prepare the next generation of scientists to deal with the challenges in this field.

Thank you !

Promoting cooperation and collaboration between Indian and UK water researchers, water policy-makers and water businesses

More information available via:

Follow us at @IndiaUKWater on Twitter / @IUKWC on Facebook

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Moving forward at the workshop

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- Refine and consolidate understanding of current situation and challenges
- Foster interdisciplinary dialogue
- Formulate short-term actions to move forward
- Formulate medium-term research directions and needs for collaboration
- Address communication and outreach issues

Moving forward at the workshop

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Moving forward at the workshop

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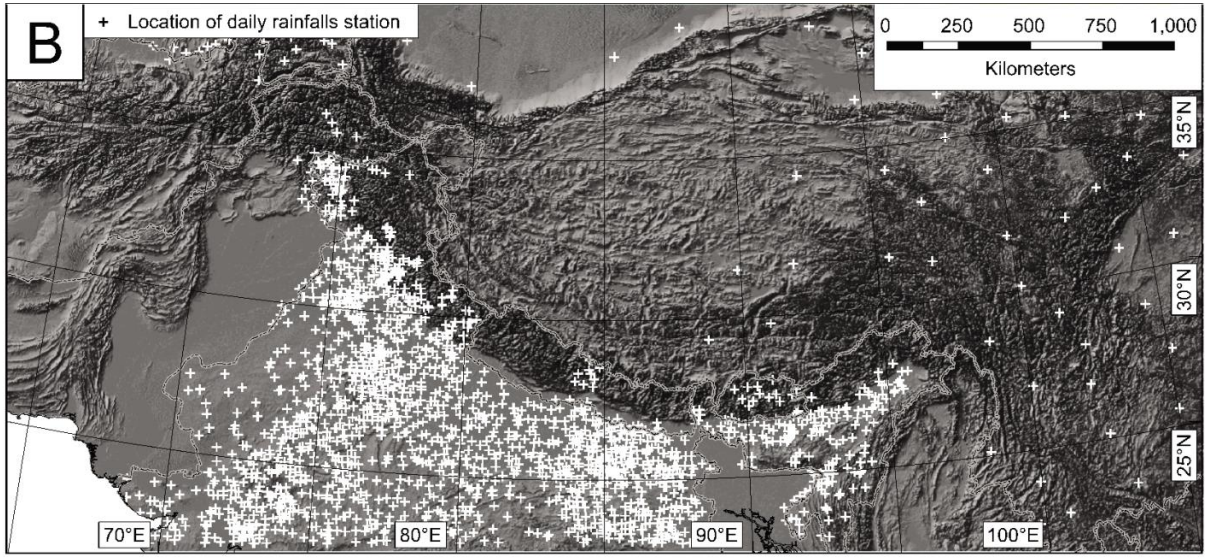
Precipitation data and hydrological models

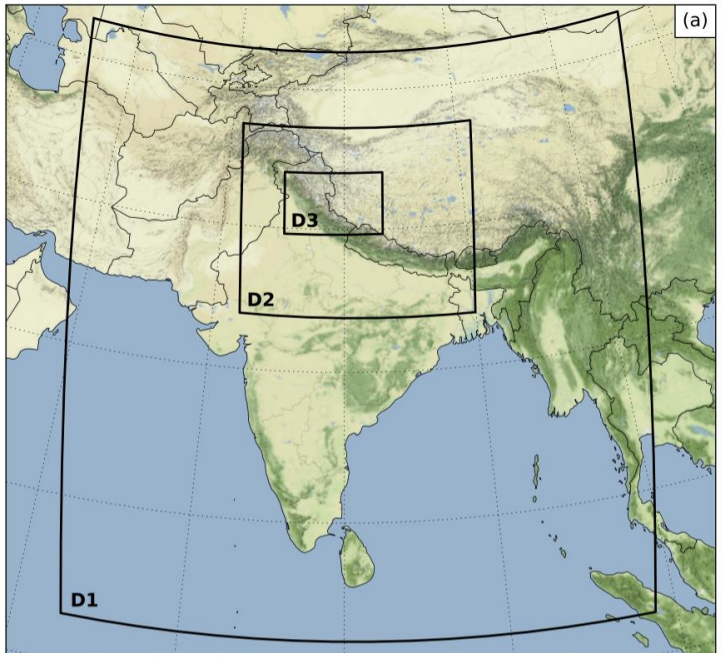
- Hydrological models are highly sensitive to errors in precipitation data
- Timing, intensity, and spatial distribution all important
- Phase (rainfall or snowfall) also important
- Typically require daily data
- Establishing this information from in situ measurements in the Himalayas is highly challenging



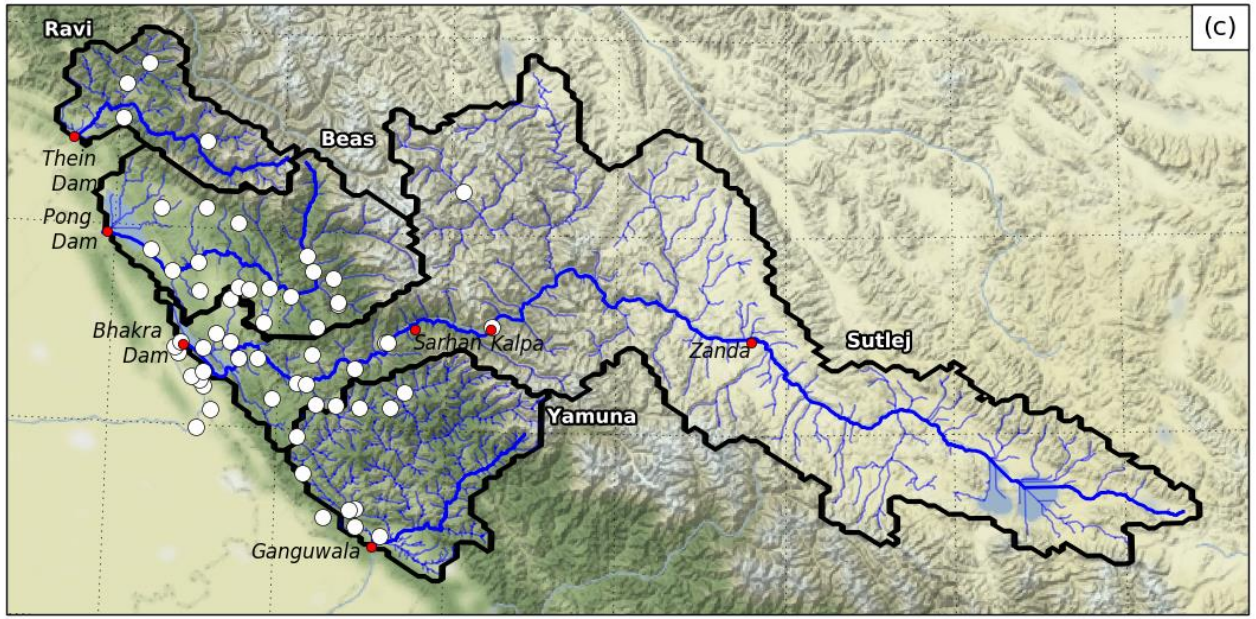
Bookhagen & Burbank (2010)

- Establishing this information from gridded datasets is also highly challenging
  - APHRODITE (25 km grid spacing, daily)
  - TRMM (25 to 5 km grid spacing, 3-hourly)
  - ERA-Interim reanalysis (0.7°, 6-hourly)

WRF model setup



WRF Model Setup	
Number of domains	3
Horizontal grid spacing	45 km, 15 km, 5 km
Period	1980-2015
Number of vertical levels	30
Model top	50 hPa
Forcing data	ERA-Interim reanalysis
Topographic dataset	SRTM
Land Cover dataset	USGS & Randolph Glacier Inventory



<u>Quality control checks:</u>

1. Length of record < 6 years
2. Double mass curve analysis
3. Snow only stations
4. Metadata – poor quality and/or homogeneity

63 sites not included

Challenges and opportunities: modelling and prediction

- India and the UK have excellent scientific communities in meteorology, climate research, hydrology and glaciology, and substantial modelling capabilities.
- Chance to move towards integrated meteorological/climatological-glacio-hydrological modelling on all timescales to increase the usefulness of the models
- Requires interdisciplinary meetings, but overcoming the substantial technical and scientific challenges will only be possible in interdisciplinary projects on developing integrated modelling
- Increasing computing resources is essential to meet the need for better process representation and uncertainty quantification.
- Predicting meteorological and hydrological extremes should be a key element