Spatiotemporal Clustering of Hydrological Droughts in Peninsular India

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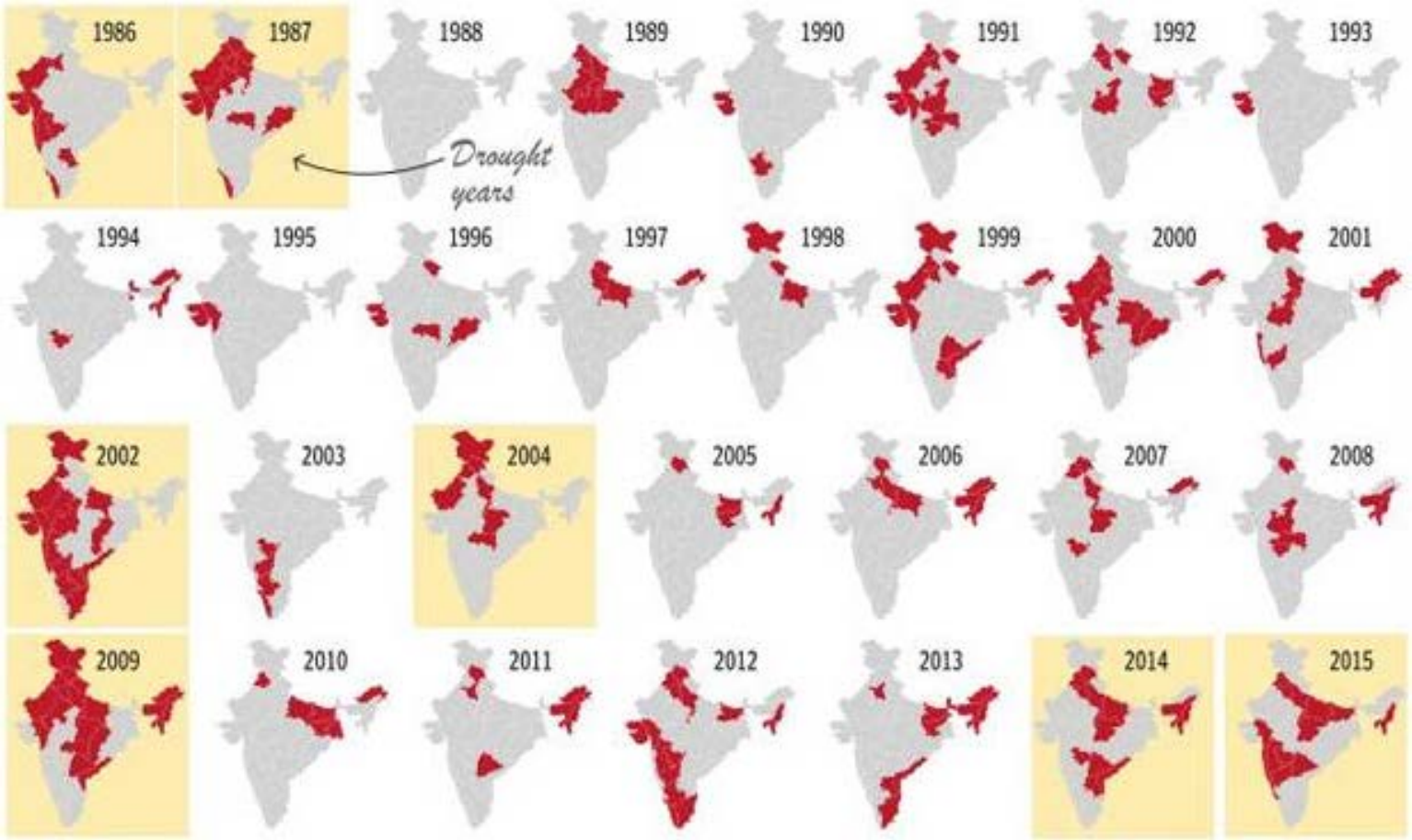
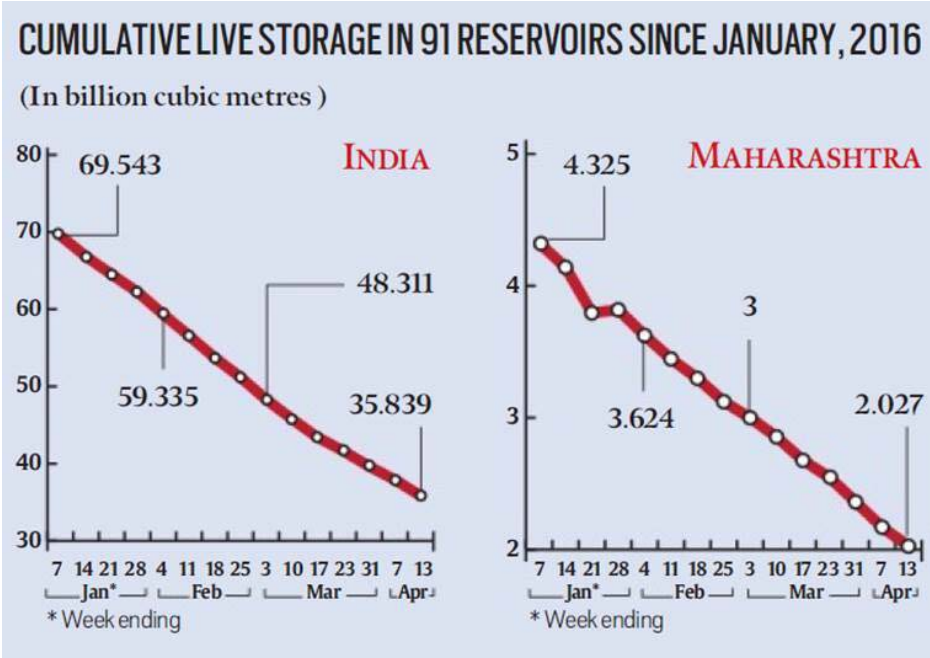
Climate Risks: Droughts in India

Geographic Spread of Droughts in past 30 years



Source: Times of India, April 2016

Drop in water levels in 91 reservoir of the country

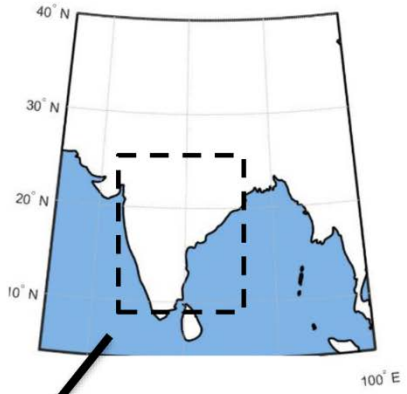


Source: The Indian Express; Central Water Commission, April 2016

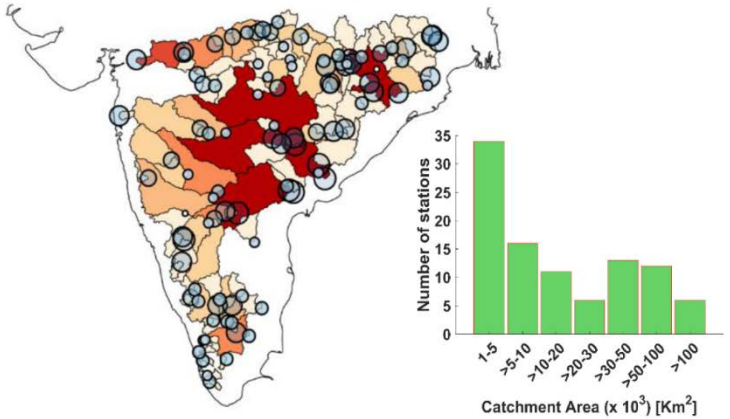
Research Gaps

- Lack of confidence in drought propagation at tropical rain-fed catchments – little to no study on comprehensive understanding on drought stages – onset, propagation & recovery.
- Most analyses are limited to seasonal to sub-annual scale – higher temporal resolution aid in predictive modelling & forecasting efforts.
- Very few studies investigated "drought-rich" & "drought-poor" locations as well as periods for *rain-fed basins in India* – region is water-stressed & tends to reach a near *day-zero condition* (Parvatham & Priyadarshini, 2019).

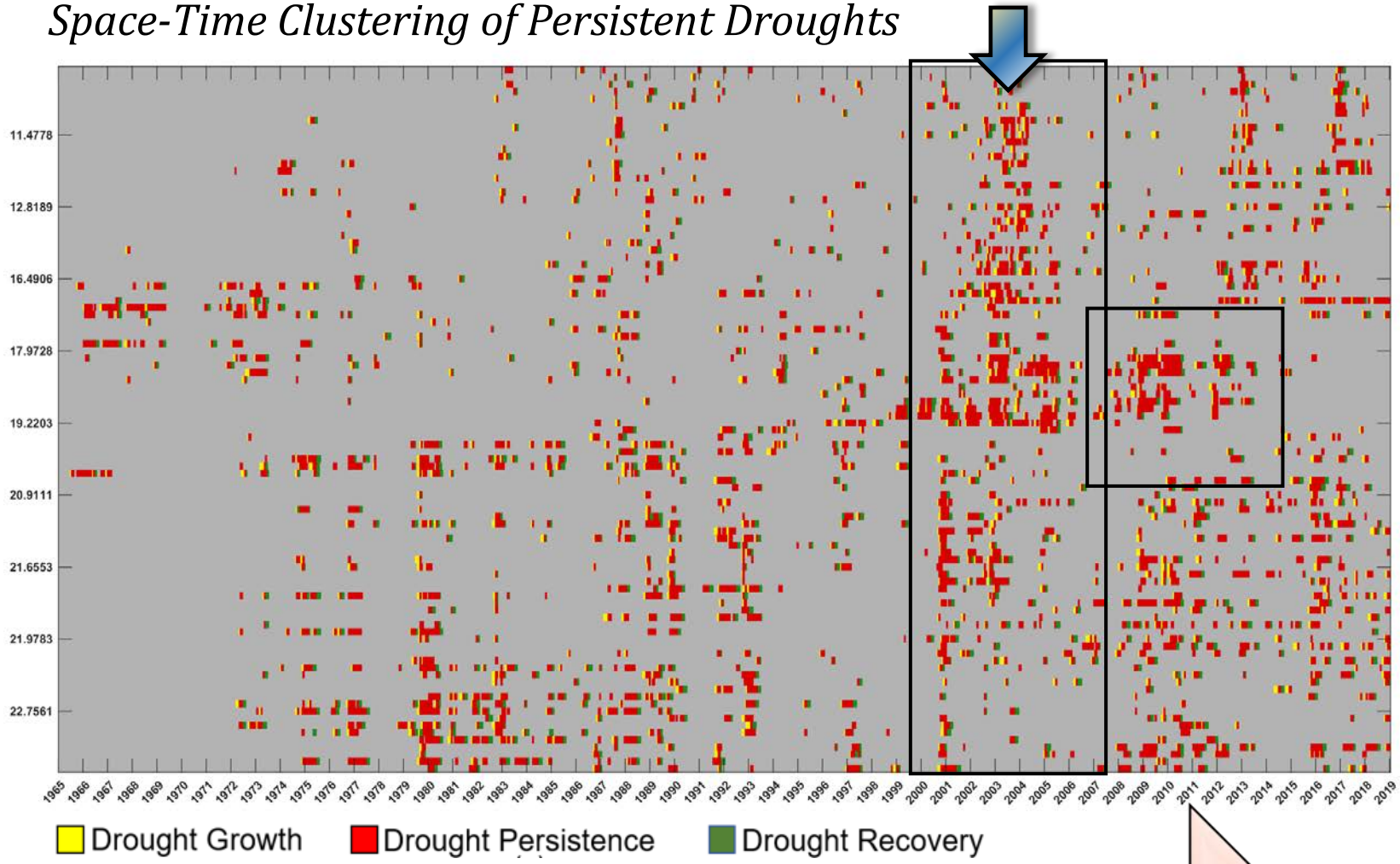
Delineation of Hydrological Droughts in Peninsular Catchments

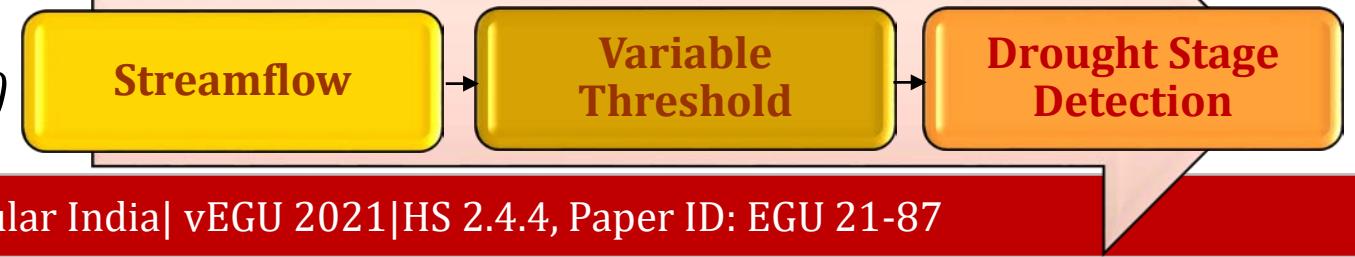


Peninsular India



Space-Time Clustering of Persistent Droughts

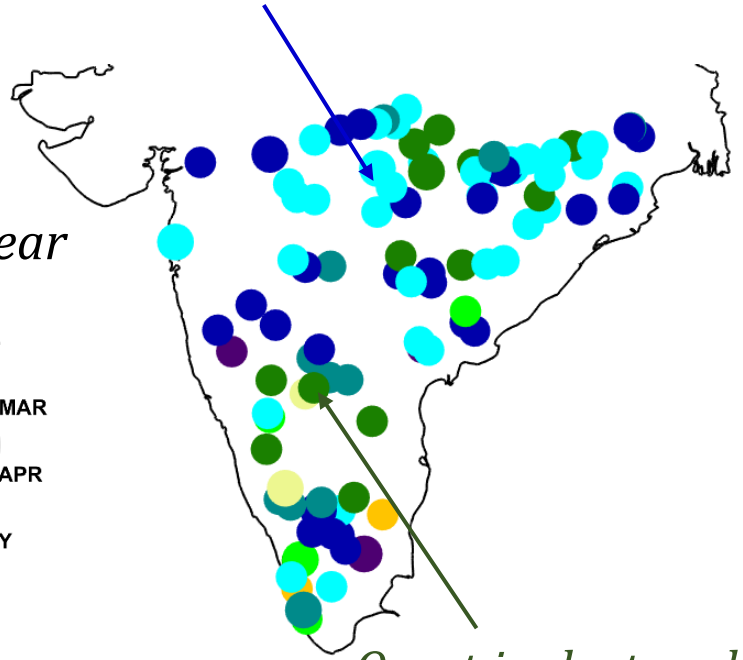




Ahmadi & Moradkhani (2019)

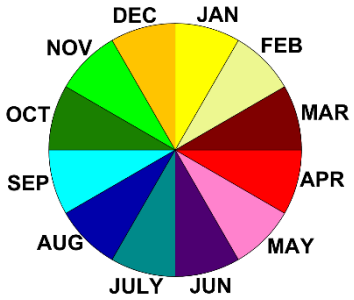
Pattern in Drought Onset

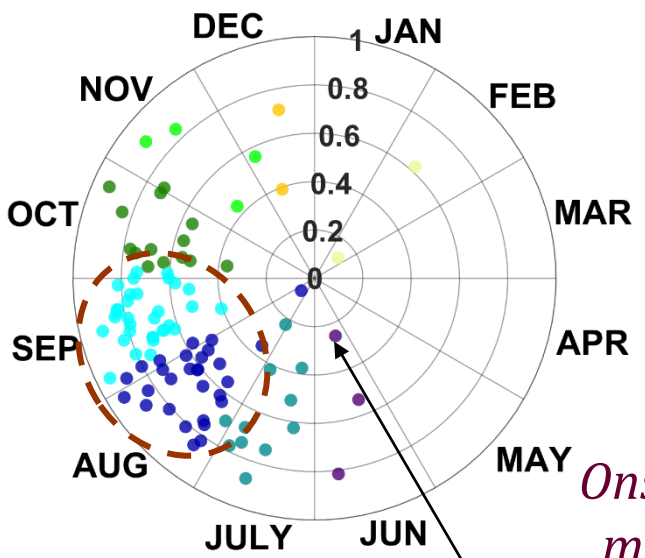
Onset is clustered around Aug-Sept.



Onset is clustered around Oct.

Season of the year





Regularity Scale

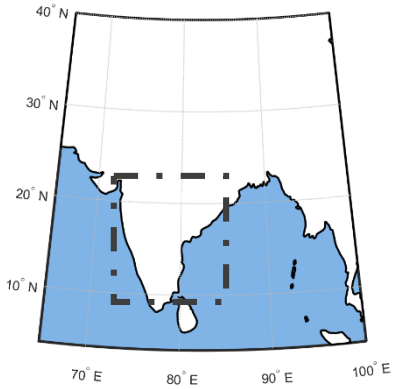
0.9 *High*

0 *Low*

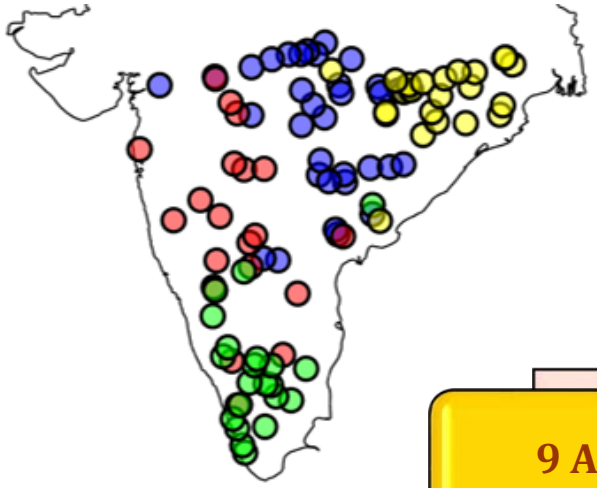
Onset during the beginning of monsoon tends to irregular.

- Onset of hydrological drought is associated with failure or delayed arrival of monsoon (June – September) rainfall
- > 60% sites show mean onset of droughts by the end of two monsoon seasons – August & September.

Detection of Homogeneous Drought Regimes



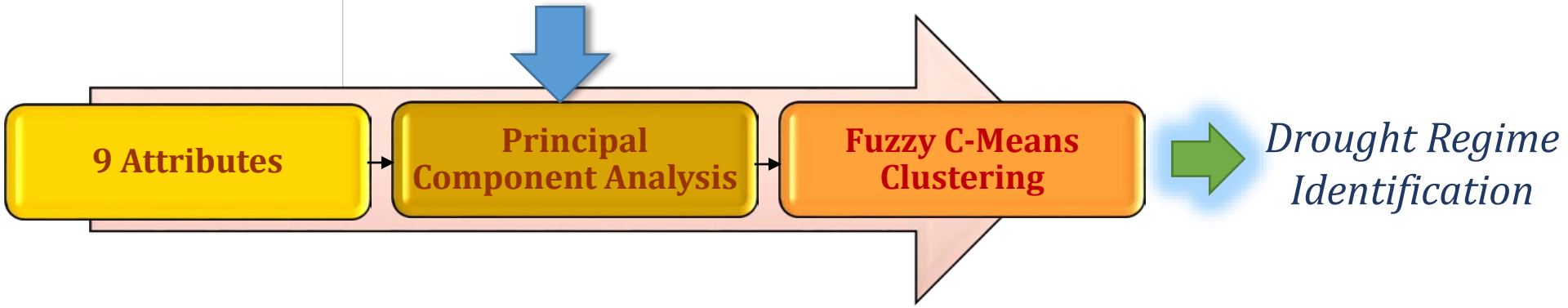
Regime (Spatial Extent)
- 1 (35%)
- 2 (20%)
- 3 (21%)
- 4 (24%)



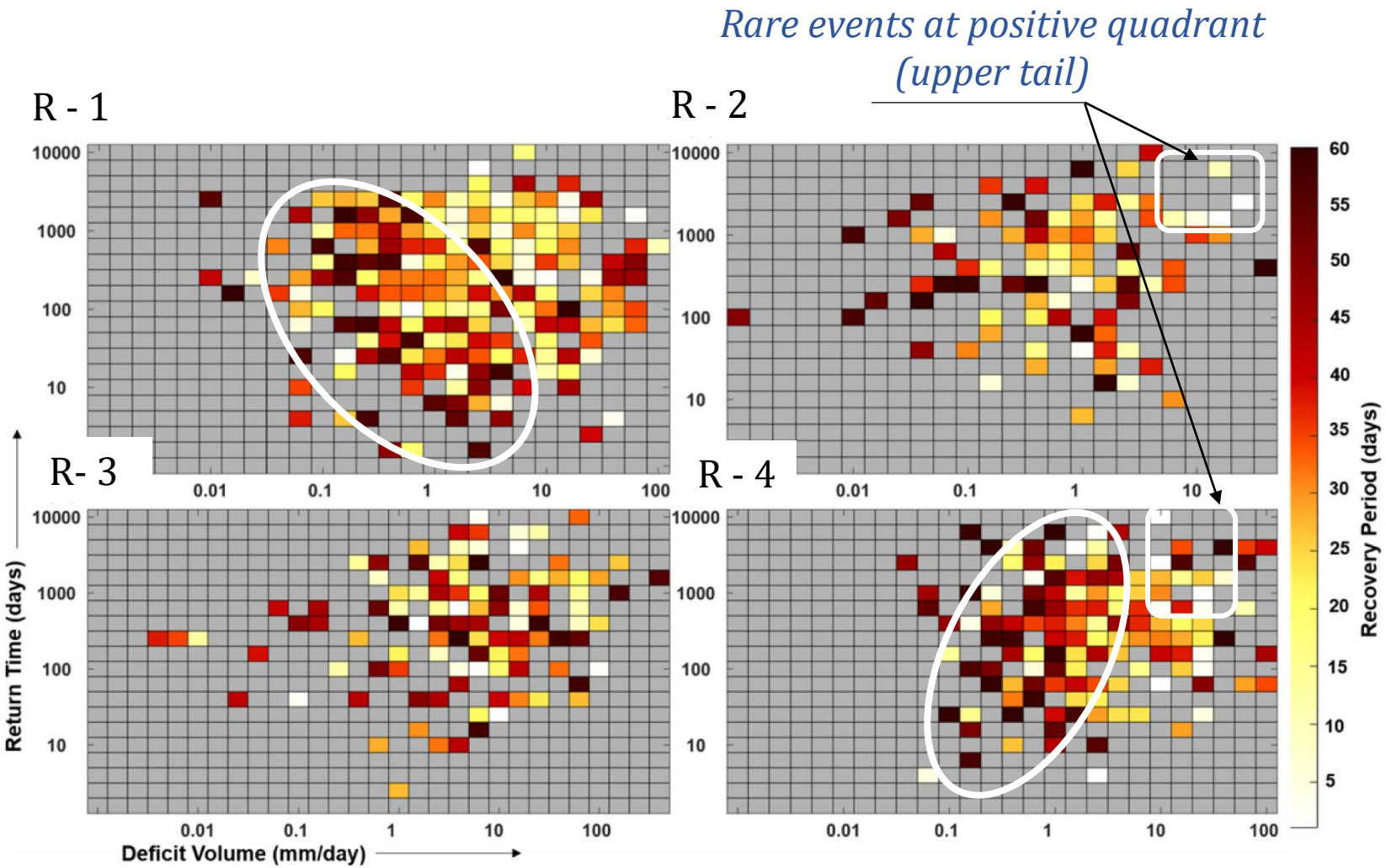
Criteria to Select Drought Cluster

- Geospatial locations of gauges
- Mean & Extreme drought attributes
- Catchment-specific attributes – baseflow index, area
- Drought seasonality attributes

Dimension Reduction



Identification of Drought Vulnerable Regions



- ***Regime 1***: *Frequent and severe droughts coincided with a large recovery period – a partial recovery compounded by a severe episode.*
- ***Regime 4***: *Reverse mirror image of R1 – rare events have low recovery length.*

Regime 2 is potentially more resilient to drought – less severe droughts have long recovery length – a few outlying events have smaller recovery length.

R – *i, where i* = 1 – 4 drought regimes

Summary: Key Insights

- *Variable threshold approach* is successfully implemented in tropical rain-fed catchments – temporal evolutions of several drought phases – *Onset, growth, persistent & recovery* are identified.

- Catchments show a marked *seasonality in discharge patterns* as well as in *onset & termination*

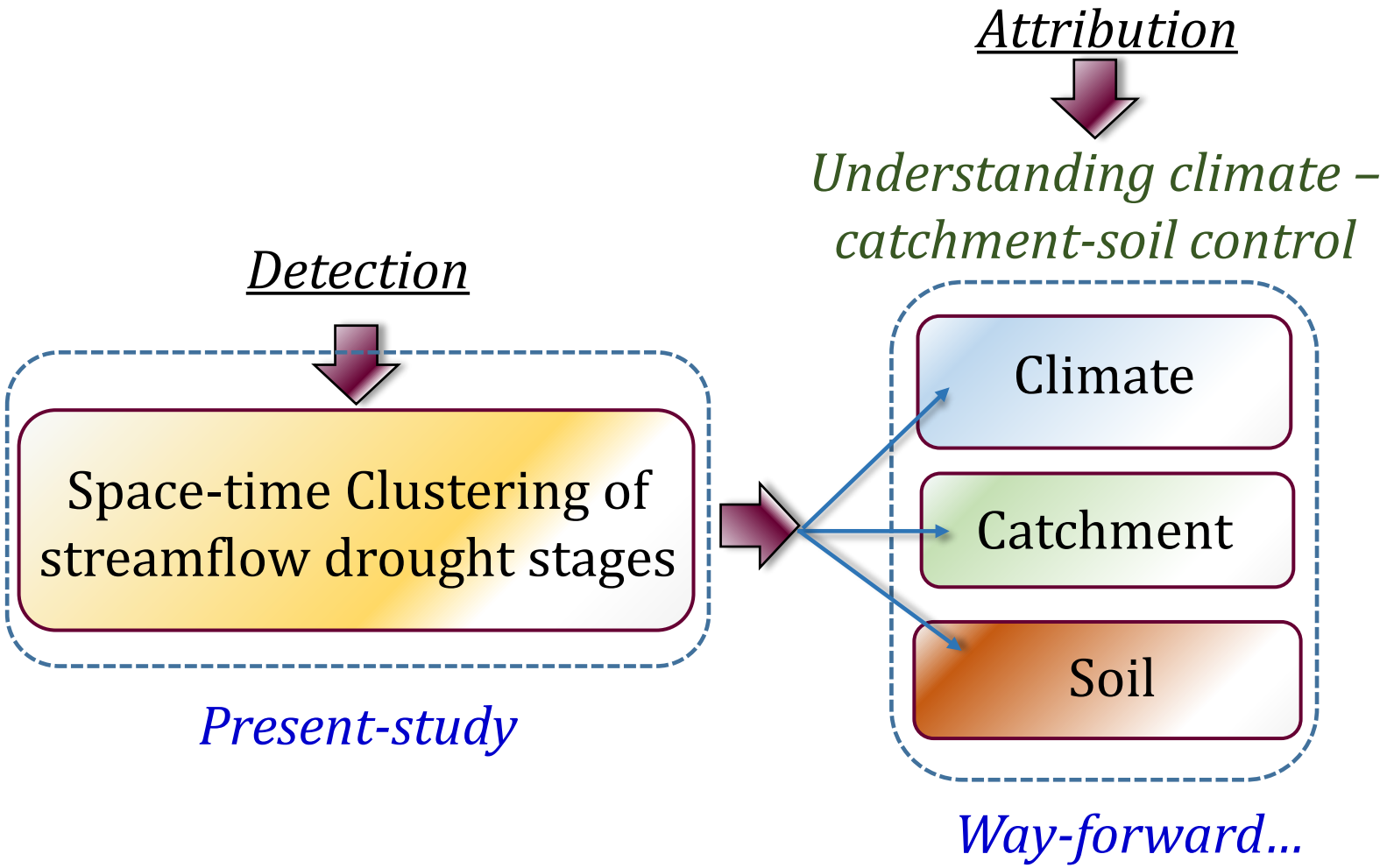
  - *Failure/delayed arrival* of monsoon leads to the occurrence of hydrological droughts – Onset is clustered during the *end of monsoon*.

- *A spatial Clustering of drought vulnerable areas* are identified through Fuzzy approach

- Regime-1 in Central peninsular India show severe and frequent droughts compounded by large recovery periods

  - Partial recovery compounded by severe & frequent drought may put *regional Carbon-budget at a risk,* endangering ecosystem productivity & resilience.

In a Nutshell…



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- Parvatam, S. & Priyadarshini, S. On Day Zero, India prepares for a water emergency. *Nature India* https://www.natureasia.com/en/nindia/article/10.1038/nindia.2019.84 (2019).

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Thanks!

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- Bhupinderjeet Singh, singhbhupinderjeet096@iitkgp.ac.in
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Acknowledgement DST SERB

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