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Dempster-Shafer Theory – a step towards development of rainfall prediction model through a time domain approach

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Predicting the Indian Summer Monsoon Rainfall (ISMR) with adequate lead time is and has been an important area of research over the globe. In the past, during the 1980s, a strong connection with ENSO (El Niño–Southern Oscillation) was established, which showed an increased affinity of droughts during El Niño and increased in rainfall during La Niña, i.e., opposite of El Niño. Northeast India is prone to water-induced disasters because it is situated in the eastern Himalayan periphery and has a fragile geo-environmental setting and economic underdevelopment. The region's robust hydrological and monsoon regimes, especially the Brahmaputra and the Barak (Meghna) river systems, are both a resource and a source of vulnerability [1]. According to the India Meteorological Department (IMD), northeast India comprises three meteorological sub-divisions: (i) Assam and Meghalaya (A&M); (ii) Arunachal Pradesh (ArP); and (iii) Nagaland, Mizoram, Manipur, and Tripura (NMMT) [2] and hence rainfall over northeast India does not correspond to any single station. The Rainfall over India in the four months of the summer monsoon, June-September, is very prominent for the country's economy; a rainfall deficiency can have a gross impact during this period on the Indian economy.

In the study described in the current paper, we created a methodology to determine the relative uncertainty related to the amount of rainfall corresponding to the summer monsoon (JJAS) and post monsoon (OND) over Northeast India throughout the period of 1871–2016. Applying Dempster-Shafer Theory we have obtained joint basic assignments by using two judgement criteria for the fuzzy sets that represents closeness of the observed values, two measures of central tendency for various window sizes generated from the original time series. For OND, the study found a higher rate of increase in uncertainty than for JJAS with changing the window size. The final conclusion of this study is that this method could provide some insight about the most advantageous ratio of training and test cases for predictive models using supervised learning. A belief measure is defined by a function $Bel: \mathcal{P}(X) \to [0,1]$, which satisfies the axioms of fuzzy measures and another additional axiom define as follows [3]:

$Bel(A_1 \cup A_2 \cup \ldots \cup A_n) \geq \sum_i Bel(A_i) - \sum_{i<j} Bel(A_i \cap A_j) + \ldots + (-1)^{n+1} Bel(A_1 \cap A_2 \cap \ldots \cap A_n)$, for every $n \in \mathbb{N}$ and every collection of subsets of X.

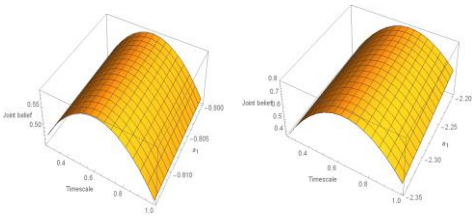

Fig 1&2: Schematic showing evolution of joint belief measure with time scale for JJAS and OND rainfall respectively

1. R. Mahanta, D. Sarma and A. Choudhury, "Heavy rainfall occurrences in northeast India", *International Journal of Climatology*, **33(6),** 30 May 2012, pp.1456-1469, doi: https://doi.org/10.1002/joc.3526

2. M. Mohapatra, H.R. Biswas, G.K. Sawaisarje, "Spatial variability of daily rainfall over northeast India during summer monsoon season," *Mausam*, **62(2)**, 1 Apr 2011, p. 215–228.

3. G.J. Klir and T.A. Folger, “Fuzzy sets, uncertainty, and information,” Pearson India Education Services Pvt. Ltd., Chennai,India , 2015.