Observational Evidence that agricultural Intensification and land use change may be reducing the Indian Summer Monsoon Rainfall

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Abstract: Using gridded daily rainfall observations, and monthly satellite land surface datasets, the connection between land use change and monsoonal rainfall climatology is analyzed. A combination of statistical analysis involving genetic algorithm (GA), Empirical Orthogonal Function (EOF), and causal discovery algorithms (CDA) are used. Study objectives are to (i) identify regional trends in the observed precipitation data over the Indian summer monsoon region, (ii) investigate the relation between land use change/ agriculture intensification and changes in rainfall, and (iii) explore whether land use change and agricultural intensification has caused change in the rainfall climatology.

The satellite based vegetation dataset shows significant agricultural intensification over northern India. For the period just before start of the summer monsoon season (April and May), the normalized differential vegetation index (NDVI) shows an increase only over Peninsular India. The EOF and GA based analysis identified the strongest climatic signal for monsoon rainfall with an increasing trend over the east-central regions of India and a decreasing trend in monsoon seasonal precipitation over north/north-west India. The areas of decreasing rainfall coincided with regions of agricultural intensive land use, and are analyzed further. The correlation and the causal data analysis suggest that premonsoon (March-April) vegetation affects July month precipitation over peninsular India. In particular, a negative relationship exists between them. The results are more robust over Peninsular and northern India indicating that an increase in NDVI has possibly weakened the early monsoon rainfall in this region. The results of this study suggest that land use change associated with agricultural intensification could be reducing the summer monsoon rainfall over certain regions of India.

Keywords: Land use land cover change, Indian monsoon, Agricultural Intensification, irrigation, Causal Analysis, Genetic algorithms, soil moisture, NDVI.