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Impact of drought on spatio-temporal pattern of phenology in Rajasthan

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ABSTRACT

This study presented the impact of drought on spatio-temporal pattern of crop phenology and also showed interannual variation in phenological parameters in Rajasthan state of India. The GIMMS NOAA-AVHRR NDVI dataset from 1982 to 2005 was used to generate *kharif* season phenology analogues such as start of season, end of season, time of peak vegetative stage, length of season and maximum NDVI and also their temporal trend using TIMESAT software. Drought resulted in delayed in sowing and timing of peak vegetative growth, sometimes causing early maturity of crops and thus leading to overall shortening of crop season. The temporal trends in phenology parameters are showing an early shift in *kharif* season as well as a general reduction in its duration. Partly these trends could be the result of adaptation to increasing rainfall deficit with time.

Key words: Phenology, NDVI, remote sensing, drought, Rajasthan

Drought is one of the most common environmental stresses that affects growth and development of plants (Aslam *et al.,* 2006). The usual effects of drought on the development of a plant are a lowered production of biomass and changes in crop phenology of agroecosystem.

Vegetation phenology examines life cycle events such as bud burst, flowering, and leaf senescence (Schwartz, 2003). It is an independent measure on how ecosystems are responding to climate change and therefore experiencing renewed interest from the scientific research community. The effect of global warming and climate change on biological processes has been well documented (Badeck *et al*., 2004). In the present context of climate change and increasing land degradation and desertification (Le Houerou, 1996), being able to calculate the impact of a drought on crop phenology is crucial in determining the environmental consequences of a hypothetical change in climatic conditions.

Recent technological advances in studying the Earth from space have resulted in a new field of phenological research that is concerned with observing the phenology of whole ecosystems and stands of vegetation on a global scale using proxy approaches. Among various satellite-derived indices, the NDVI has evolved over a period of time as a primary tool for monitoring vegetation changes and interpretation of the impact of climatic/weather events on the biosphere. However, phenological parameters extracted by remote sensing are only an approximation of the true biological growth stages.

A number of approaches using a variety of satellite remote sensing products have been used to derive metrics related to land surface phenology (Sakamoto *et al.,* 2005; White and Nemani, 2006; Jonsson and Eklundh, 2002, 2004; Sehgal *et al.,* 2009; Chakraborty *et al.,* 2011; Patel *et al.,* 2011). However, Land Surface Parameters (LSP) databases have not yet been satisfactorily validated due to difficulty in obtaining sufficiently extensive ground observations throughout the growing season. Even without extensive validation, a number of applications areas have employed LSP data successfully, including studies on ecosystems analysis, disasters, land use, and climate change (Reed *et al.,* 2009).

Using NDVI time series from AVHRR, positive trends of Lenth of Growing Season (LGS) have been detected for North America and Eurasia (Zhou *et al*., 2001). Sehgal *et al.* (2009) derived the spatial pattern of temporal trends in phenology metrics and productivity of crops grown, at disaggregated level in Indo-Gangetic Plains of India using time series of AVHRR PAL NDVI dataset.

Present study employed the TIMESAT software (Jonsson and Eklundh, 2004) to estimate phenological parameters from the time series GIMMS AVHRR NDVI dataset. The objective of this article is to investigate changes in vegetation phenology during *kharif* season due to impact of drought at regional scale in the Rajasthan state of India. The phenological parameters were derived for *kharif* season for 24 years from 1982 to 2005.