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***Short communication***

# Remote sensing based vegetation indices and crop coefficient relationship for estimation of crop evapotranspiration in Ozat-II canal command

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The estimation of evapotranspiration is important for the water resource management, water requirement, water use efficiency and resulting crop productivity in canal command. The estimation of irrigation demand is really important for efficient management of water in the canal command area. The real time and spatial information on the area under irrigation and crops in the large command area for effective water management. Remote sensing provide a powerful tool for the identification of crops, crop status, area under crops, crop evapotranspiration, irrigation scheduling, etc.

The crop evapotranspiration represents the crop water demand and governed by weather and crop conditions. The Food and Agriculture Organization (FAO) Penman–Monteith empirical calculation is an accepted method for calculating crop water requirements and has been tried and tested worldwide (Monteith, 1965; Allen *et al.,* 1998;Gontia and Tiwari, 2010; Er-Raki *et al.,* 2010; Papadavid *et al.,* 2011). Remotely sensed spectral reflectance may provide an indirect estimate of crop coefficient or basal crop coefficients. Thecrop coefficient ($K_c$) can be estimated from spectral vegetation indices since both of them are related to leaf area index and fractional ground cover. Farg *et al.* (2012) estimated crop coefficient ($K_c$) and crop evapotranspiration ($ET_c$) using satellite data integrated with the meteorological data and vegetation indices (NDVI, soil adjusted vegetation index (SAVI). Kamble *et al.* (2013) estimated crop coefficient ($K_c$)-based crop evapotranspiration for irrigation water management using satellite-derived vegetation index. Bandyopadhyay *et al.* (2005), Gurusamy, *et al.* (2010), Papadavid *et al.* (2011) estimated the summer groundnut crop coefficient for the estimation of crop water requirement and irrigation planning.The study was undertaken to investigate the applicability of time-series Landsat-8, NDVI, SAVI data to establish the relationship between the crop coefficients at different growth stages of summer groundnut and remote sensing based vegetation indices for theestimation of crop evapotranspirationin Ozat-II canal command area.

The study area comprises the canal command area of Ozat-II dam across river Ozat near Badalpur, Junagadh district, Gujarat, India. The location of the command area lies between latitude 21$^0$12’46"N to 21$^0$33’04"N and longitude 70$^0$25’07"E to 70$^0$53’24"E.The total catchment of the dam is 475.24 sq. km. The projected culturable command area is 4918 h. The canal system comprises of 20.60 km long main canal.Four agricultural farms in the canal command area with summer groundnut crops were selected for the study. The location *i.e.* latitude and longitude of different farms were ;

Farm-1 : Lat : 21°22’40.562"N; Long : 70°31’13.168"E
Farm-2 : Lat : 21°22’4.805"N; Long : 70°29’43.433"E
Farm-3 : Lat : 21°22’42.594"N; Long : 70°31’59.405"E
Farm-4 : Lat : 21°22’28.387"N; Long : 70°28’54.934"E

The satellite images of Landsat 8 Operational Land Imager (OLI) of date of pass 25 March, 10 April, 26 April, 12 May and 28 May, 2014 representing different growth stages of summer groundnut were downloaded from www.earthexplorer.usgs.gov/. Geomatica V10.0 and GRASS GIS7.1 were used for image correction, image processing, composition of different bands, mosaicking of different scene, clipping of area of interest and preparation of vegetation indices. The primary and secondary data were collected and verified with the ground truth verification.The tabulated values of FAO-56 crop coefficients ($K_c$) were corrected for local climatic conditions using local climatic and soil parameters using standard formula (Allen *et al.,* 1998).

***Vegetation indices (VIs)***

The vegetation indices like NDVI (Rouse *et al.,* 1974), SAVI (Huete, 1988) etc have been generated using Landsat-8 data to predict crop coefficients at field and regional scales.

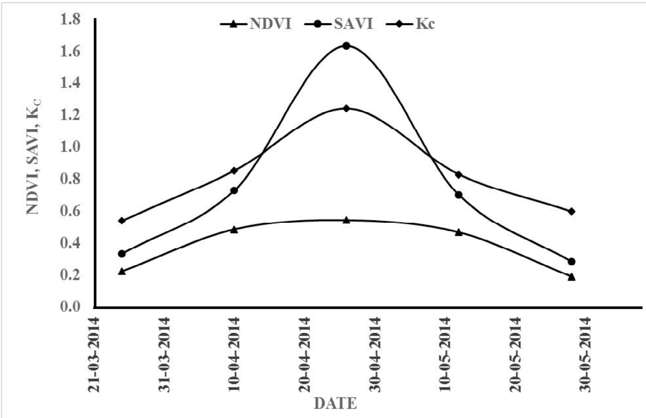


**Fig.1:** The trend of NDVI, SAVI and $K_c$ on different dates

$$\text{NDVI} = \frac{\text{NIR(Band5)} - \text{R(Band4)}}{\text{NIR(Band5)} + \text{R(Band4)}} \quad (1)$$

SAVI is calculated with a soil brightness correction factor (L) defined as 0.5 to accommodate most land cover types.

$$\text{SAVI} = \frac{[\text{NIR(Band5)} - \text{R(Band4)}] * [1 + \text{L}]}{[\text{NIR(Band5)} + \text{R(Band4)} + \text{L}]} \quad (2)$$

Where, NIR and R are the spectral reflectance of the vegetated land surface in the near infrared (NIR) (Band 5) and red (R) (Band 4) Landsat bands, respectively.L is a canopy background adjustment factor. An L value of 0.5 in reflectance space was found to minimize soil brightness variations and eliminate the need for additional calibration for different soils.

The crop coefficients of summer groundnut were corrected for local climatic condition from FAO-56 which were found to be 0.540, 0.852, 1.240, 0.829 and 0.598 on March25, April 10, April 26, May 12 and May 28, 2014 respectively.The vegetation indices maps of NDVIand SAVI were prepared using radiometric corrected five Landsat-8 images. The values of NDVI and SAVI for all image dates were collected for all four farms. It is noticed that the NDVI range is limited to low values for the first date (25 March 2014), since the crops have just begun to grow. The NDVI and SAVI value increased from developing stage to mid-season and then decreases to late season growth stage. The maximum value of NDVI and SAVI were found during mid-season of summer groundnut. The average maximum values of NDVIand SAVIfor the middle season growth stage were higher than both of developing and late-season growth stages. The trend of average NDVI, SAVI and $K_c$ with different crop growth stages as per different dates are shown in Fig 1.

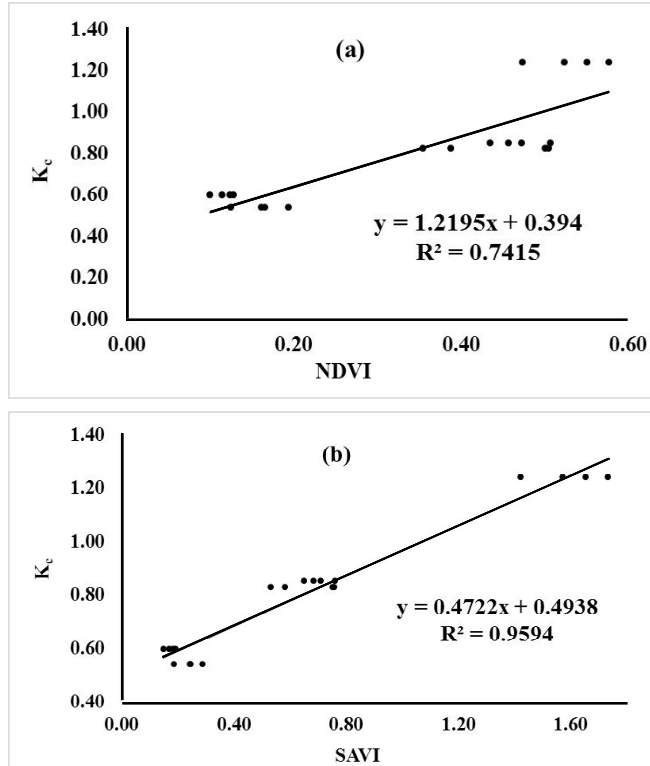


**Fig. 2:** Relationship between (a) NDVI and $K_c$ and (b) SAVI and $K_c$

***Relationship of crop coefficient ($K_c$) with NDVI and SAVI***

The relationships between NDVI and SAVI with $K_c$ (correlated for local conditions) were established as shown in Fig. 2 (a) and (b). It may help in developing simple and operational methods to monitor crop water requirements using a time series of images. According to this relationships of crop coefficients with NDVI and SAVI, the crop coefficient can be estimated for the estimation of evapotranspirationfor different growth period for irrigation scheduling.Several relationships between crop coefficient and vegetation indices are reported in the literature for different vegetation. This includes the linear relationship between $K_c$ and NDVI and between $K_c$ and SAVI. Taking into account similarities between the crop coefficient curve and vegetation index, Bausch and Neale (1987) established the potential for modeling crop coefficient as a function of vegetation index. Ray and Dadhwal, (2001); and Rafn *et al.,* (2008) used remotely-sensed vegetation indices, NDVI and SAVI to predict crop coefficients at field and regional scales.

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