Radar Vegetation Index Code for Dual Polarimetric Sentinel-1 Data in EO Browser

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Vegetation indices are extremely helpful in understanding the agricultural crop conditions and their mapping. In optical remote sensing, Normalized Difference Vegetation Index (NDVI) is one such index which conveys such crop health condition within a scene. However, the limitation of optical remote sensing is the inability to penetrate cloud cover due to which ground data acquisition becomes limited within a crop growth season. Hence, a temporal gap in the acquired data might affect crop monitoring as well as crop mapping. On the contrary, Synthetic Aperture Radar (SAR) can penetrate the cloud cover, which provides the advantage of acquiring ground data during cloudy climatic conditions. Hence, the use of SAR data might be an appealing alternative to monitor crop conditions, especially during the monsoon season. In this context, Kim and Van Zyl [1] introduced the Radar Vegetation Index (RVI) for full polarimetric (FP) SAR data. RVI for FP SAR data is given by, RVI(q) = (8*HV)/ (HH + VV + 2*HV), where, HH, VV and HV are backscattering coefficients. Later Charbonneau et al. [2] reduced this formulation for dual polarimetric (DP) SAR data. However, the equation of RVI for DP SAR data was formulated using HH and HV backscattering coefficients. The RVI for this DP SAR data was given as, RVI(h) = (4*HV)/(HH+HV).

In contrast, Sentinel-1 SAR data is consisting of VV and VH polarizations. Hence, the information of the HH backscattering coefficient is absent in this data set. Here, in EO browser coding VV and VH backscatter coefficients are used instead of HH and HV as given by [3]. Thus, the formulation of RVI for Sentinel-1 SAR data is, RVI(v) = (4*VH)/(VV+VH). This RVI(v) index is applied over the time series Sentinel-1 data from 24-Jun.-2019 to 27-Dec.-2019 in Vijayawada, India. In this time period, rice is majorly cultivated over the region, and the monsoon cloudy climatic condition mainly dominates this time.

Hence, ground data acquisition using optical sensors is challenging. However, SAR data exhibits no effect of such cloudy conditions, and they also reflect the crop conditions in the backscatter response according to the phenological growth stages. RVI's are the representative of randomness in scattering. Hence, during the rice growth period, the crop canopy density increases gradually, which, as a result, increases the randomness in SAR scattering. Therefore, a high variation in the VH component is profound within the growth period. Due to this reason, RVI(v) showed interesting dynamics of rice growth within the time frame. During the initial phase, around 24-Jun., the crop fields were non-cultivated. Hence, the RVI(v) produced low values. After that, depending on the time of the sowing of rice, the RVI(v) has increased.

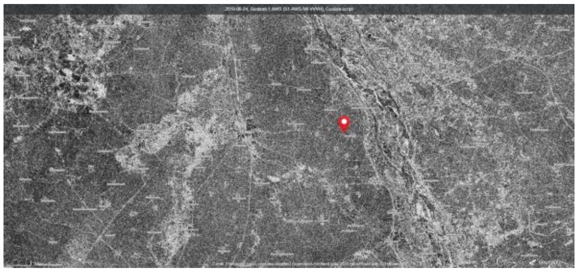
During 21-Nov. all rice fields were at the highest phenological stages due to which RVI(v) reached high values. Moreover, beyond 21-Nov. harvest of rice started, and the RVI(v) started decreasing. Around 27-Dec. most of the fields were harvested, which again produced low values of RVI(v). Hence, RVI(v) has the potential to monitor crop phenological stages, which might be used in the global scenario. The code is easy to compute and has faster computation using the EO browser.

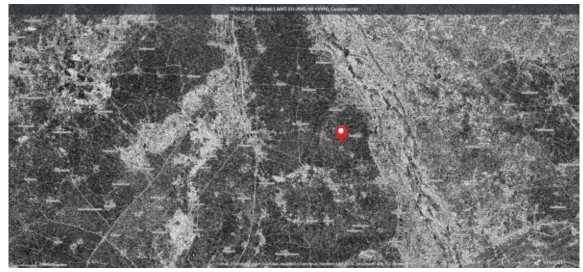
References

[1] Kim, Y.; van Zyl, J.J. A Time-Series Approach to Estimate Soil Moisture Using Polarimetric Radar Data. IEEE Trans. Geosci. Remote Sens. 2009, 47, 2519–2527.

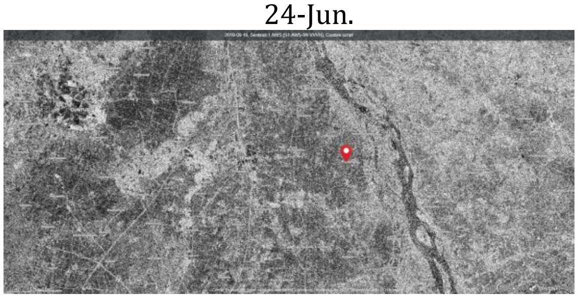
[2] Charbonneau, F.; Trudel, M.; Fernandes, R. Use of Dual Polarization and Multi-Incidence SAR for soil permeability mapping. In Proceedings of the 2005 Advanced Synthetic Aperture Radar (ASAR) Workshop, St-Hubert, QC, Canada, 15–17 November 2005.

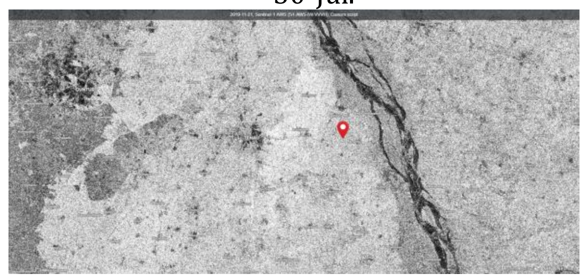
[3] Nasirzadehdizaji, Rouhollah, et al. "Sensitivity Analysis of Multi-Temporal Sentinel-1 SAR Parameters to Crop Height and Canopy Coverage." Applied Sciences 9.4 (2019): 655.



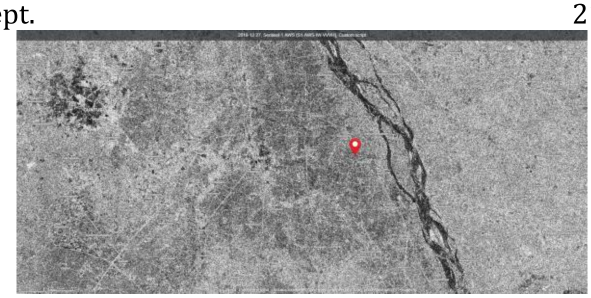


24-Jun. 30-Jul.





16-Sept. 21-Nov.



27-Dec.

Fig. Temporal variation of RVI(v) depending on the rice phenological stages over Vijayawada, India using Sentinel-1 SAR data.