

ASSESSMENT OF SEASONAL VEGETATION DYNAMICS OVER PARTS OF THAR DESERT USING GEOSPATIAL TECHNIQUES

SURAJ KUMAR SINGH, GOWHAR MERAJ, NIYAMOTULLA MONDAL, A. K. BERA, MANISH KUMAR VERMA, JAGPAL SINGH TOMAR AND SHRUTI KANGA*

Centre for Sustainable Development, Suresh GyanVihar University, Jaipur, Rajasthan

Date of Receipt : 30.4.2021

Date of Acceptance : 02.7.2021

Sattelite-based remote sensing techniques are known to be effective and inexpensive methods to estimate agricultural productivity. The health of the vegetation cover is a function of its biochemical and physiological characteristics and thus is a vital indicator of seasonal crop productivity and monitoring crop growth (Gonsamo and Pellikka, 2012). Multispectral remote sensing has been frequently used for assessing vegetation dynamics using specific vegetation indices (Frampton *et al.*, 2013). Vegetation indices (VIs) are widely used to analyse the vegetation changes on seasonal time scales, interannual, and decadal (Qi *et al.*, 1994). In the study, vegetation growth has been represented in terms of four vegetation indices, Normalized Difference Vegetation Index (NDVI), Red-Edge NDVI (NDVI_{re}), Wide Dynamic Range Vegetation Index (WDRVI), Red-Edge Wide Dynamic Range Vegetation Index (WDRVI_{re}).

NDVI

The normalized difference vegetation index (NDVI) is the most common vegetation index to determine the vegetation cover area and varies between -1 to 1. The *Kharif* season is characterized from July to October. Major crops

grown during this season includes millets, bajra, and mung bean. In 2016, NDVI values showed an area of 23,596 km² (41%) under moderate category, followed by 22239 km² (39%) and 11,473.5 km² (20%) under poor and good categories, respectively. In 2019, NDVI values showed a maximum 24,629 km² (43%) area under the moderate category, followed by 21,769 km² (38%) and 10846 km² (19%) under the poor and good categories. NDVI variation map of *Kharif* season indicated that during the year 2016-2019, moderate and poor vegetation classes are high compared to good vegetation [Fig. 1. (a)]. The *Rabi* season is considered from November to March. Major crops grown during this season include wheat, mustard, and rai. In 2016, NDVI values show a maximum area of 25,360 km² (44%) under a moderate category, followed by 21,480 km² (37%) and 10,470 km² (18%) under the poor and good categories, respectively. In 2019, NDVI values represented a maximum area of 28,178 km² (49%) under the poor category, followed by 17,945 km² (31%) and 11,185 km² (20%) under the moderate and good categories, respectively. *Rabi* season from 2016 to 2019 revealed that the poor and moderate vegetation classes are high compared

*Corresponding Author E-mail i.d: shruti.kanga@mygyanvihar.com

to good vegetation, and the moderate vegetation cover area is slowly increasing.

The *Zaid* season is from April to June; this season is also known as the summer season. Principal crops are grown during this season for fodder purposes. In the year 2016, NDVI values showed the maximum area of 30,304 km² (53%) under the moderate category, followed by 24,433 km² (43%) and 2,573 km² (4%) under poor and good categories, respectively (Fig. 1. (b)). In the year 2019, NDVI values indicated a maximum area of 29,653 km² (52%) under moderate category, followed by 23,554 km² (41%) and 3,991 km² (7%) under the poor and good category, respectively [Fig. 1. (c)]. NDVI variation map of *Zaid* season from 2016 to 2019 indicated that the moderate and poor vegetation cover area is high compared to a good vegetation cover area.

Red-Edge NDVI

The Red-Edge Normalized difference vegetation index (NDVI_{re}) is a handy vegetation index to determine the stress vegetation cover area. Usually, the value range of 0.3 to 0.6 is considered stress vegetation but varies from season to season and species to species. In the year 2016, red-edge NDVI represents a maximum area of 33,062 km² (58%) under a moderate category, followed by 16,984 km² (30%) and 7,154 km² (13%) of poor and good categories, respectively. In the year 2019, red-edge NDVI showed a maximum area of 28,086 km² (49%) under moderate category, followed by 15,686 km² (27%) and 13,535 km² (24%) in poor and good categories, respectively. Red-edge NDVI values during the *Kharif* season from

2016 to 2019 depicted that the moderate vegetation cover area is high compared to other vegetation areas, and an increase of good vegetation can be delineated in recent years [Fig. 2. (a)].

In the year 2016, red-edge NDVI showed a maximum area of 29,924 km² (52%) under a moderate category, followed by 20,498 km² (36%) and 6778 (12%) covered by poor and good categories, respectively. In 2019, red-edge NDVI showed a maximum 33,081.8 km² (58%) area under a moderate category, followed by 19,918.6 km² (35%) and 4,310 km² (8%) under poor and good category, respectively [Fig. 2. (b)]. *Rabi* season red-edge NDVI variation during 2016-2019 indicated that the moderate vegetation was high compared to poor and good vegetations. The Red-Edge Normalized Difference Vegetation Index helps determine the stress vegetation cover area. This red-edge NDVI index indicates poor to moderate vegetation.

The *Zaid* season in the year 2016 represented a maximum area of 2,22,274 km² (39%) under good category, followed by 20,000 km² (35%) and 14,926 km² (26%) under poor and moderate categories, respectively. In the year 2019, red-edge NDVI showed a maximum area of 25,365 km² (44%) under a moderate category, followed by 2,412 km² (39%) and 9,422.2 km² (16%) under poor and good categories, respectively [Fig. 2. (c)]. In the *Zaid* season, red-edge NDVI values suggested that vegetation conditions vary from year to year and season to season. The index thus computed indicated high cover under poor and moderate condition vegetation compared to other vegetation cover areas. During the last two years, good condition vegetation cover declined.

WDRVI

WDRVI is beneficial when Near Infrared (NIR)'s higher sensitivity is less compared to NDVI. These indices are also proportional to the

estimation of the Leaf Area Index (LAI) over broad area. Using this index, the vegetation conditions were classified as poor, moderate, and good.

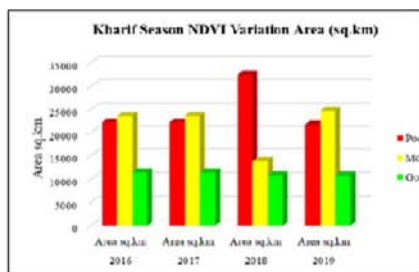


Fig. 1. (a) Area Statistics – Kharif season

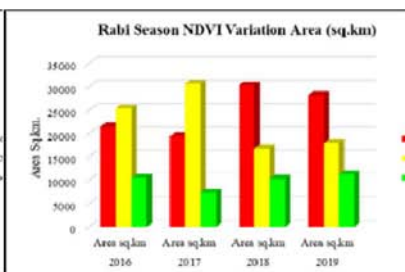


Fig. 1. (b) Area Statistics – Rabi season

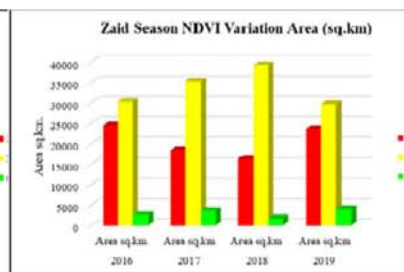


Fig. 1. (c) Area Statistics – Zaid season

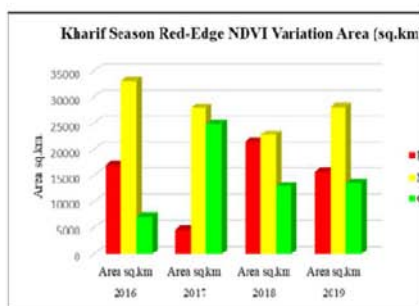


Fig. 2. (a) Area Statistics – Kharif season

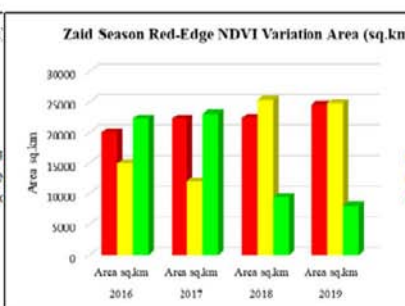


Fig. 2. (b) Area Statistics – Zaid season

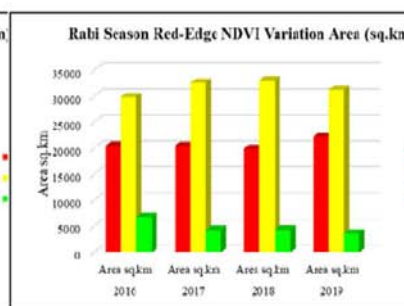


Fig. 2. (c) Area Statistics – Rabi season

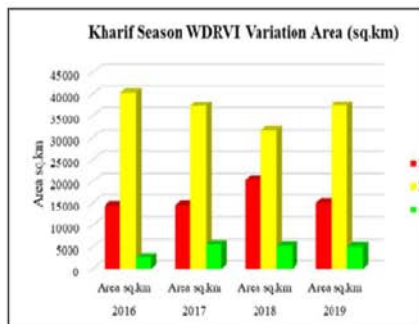


Fig. 3. (a) Area Statistics – Kharif season

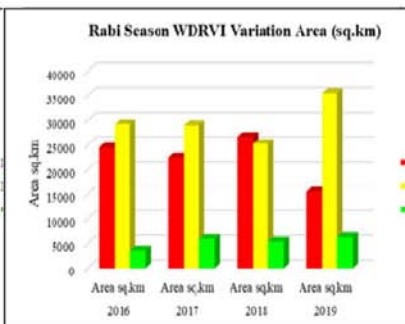


Fig. 3. (b) Area Statistics – Rabi season

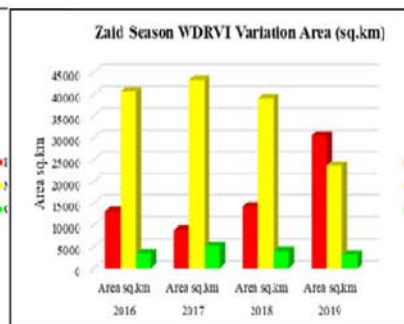


Fig. 3. (c) Area Statistics – Zaid season

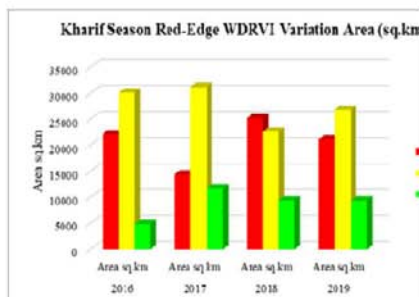


Fig. 4. (a) Area Statistics – Kharif season

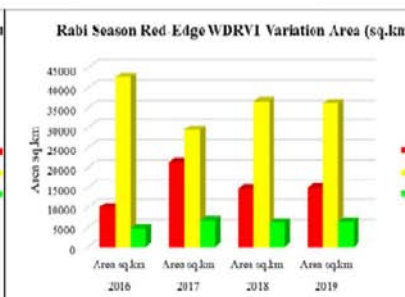


Fig. 4. (b) Area Statistics – Rabi season

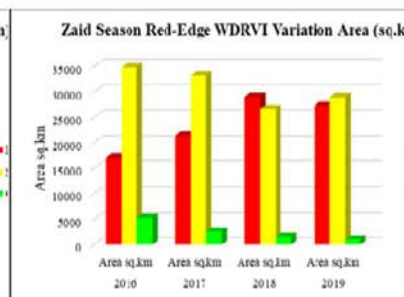


Fig. 4. (c) Area Statistics – Zaid season

The *Kharif* season is represented by a maximum 40,189 km² (70%) area under a moderate category, followed by 14,396 km² (25%) and 2,614 km² (5%) covered under poor and good classifications, respectively. In 2019, WDRVI showed a maximum extent of 37,301 km² (65%) under moderate category, followed by 15,030 km² (26%) and 4,976 km² (9%) under poor and good categories, respectively (Fig. 3. (a)). *Kharif* season indicated that the moderate condition vegetation is high every year in comparison to other vegetation categories.

The *Rabi* season of the year 2016 showed a maximum area of 29,097 km² (51%) under moderate category, followed by 24492 km² (43%) and 3611 km² (6%) under poor and good categories, respectively. In 2019, WDRVI showed a maximum of 35555 km² (62%) under moderate category, followed by 15,501 km² (27%) and 6,253 km² (11%) under poor and good categories, respectively [Fig. 3. (b)].

In the *Zaid* season, WDRVI values of 2016 showed a maximum area of 40,599 km² (71%) under moderate category, followed by 8,833 km²

(15%) and 3,426 km² (6%) under poor and good categories, respectively. In the year 2019, WDRVI depicted a maximum area of 30,471 km² (53%), under a poor category, followed by 23566 km² (41%) and 3,163 km² (6%), under moderate and good categories, respectively [Fig. 3. (c)]. An overall analysis of WDRVI value during the *Zaid* season showed the high area under moderate and poor vegetation categories compared to the good vegetation, which is low.

Red-Edge WDRVI

The Red-edge WDRVI index measures the stress vegetation on a large area, and it was shown in three vegetation categories: poor, moderate, and good. In the *Kharif* season of 2016, the maximum area was 30,142 km² (53%) under moderate category, followed by 22141 km² (39%) and 4917 km²(9%) under poor and good categories, respectively. In the year 2019, red-edge WDRVI showed a maximum area of 26,817.4 km² (47%) under moderate category, followed by 21167 km²(37%) and 9,323 km² (16%) under poor and good categories, respectively [Fig. 4. (a)]. The Red-Edge WDRVI variation in

Table 1. Comparative analysis of the area of vegetation cover types using four different vegetation indices

S No.	Index	<i>Kharif</i> (average area in km ² 2016–2019)			<i>Rabi</i> (average area in km ² 2016–2019)			<i>Zaid</i> (average area in km ² 2016–2019)		
		Vegetation Cover Type			Vegetation Cover Type			Vegetation Cover Type		
		Poor	Moderate	Good	Poor	Moderate	Good	Poor	Moderate	Good
1	NDVI	24670.58	21448.58	11162.70	24851.43	22649.48	9808.85	20684.53	33607.80	2963.18
2	NDVI _{re}	14677.45	27962.53	14615.00	20777.75	31734.20	4743.78	22309.48	19269.55	15676.45
3	WDRVI	16077.70	36597.75	4579.60	22283.98	29697.83	5301.08	16683.85	36617.05	3927.28
4	Red-Edge WDRVI	20737.30	27683.63	8834.13	15230.15	36170.18	5882.25	94737.10	123678.70	10607.00

this *Kharif* season indicated that the moderate and poor vegetation categories is high compared to the good vegetation, which is low.

Rabi season of 2016 indicated a maximum area of 42,645 km² (75%) was covered under a moderate category, followed by 9932 km² (17%) and 4623 km² (8%) under poor and good categories, respectively. In 2019, spatial variation of red-edge WDRVI showed a maximum area of 36,066 km² (63%) under a moderate category, followed by 14,962 km² (26%) and 6,280 km² (11%) covered under poor and good categories, respectively (Fig. 4. (b)). The Red-Edge WDRVI variation of *Rabi* season depicted that the moderate vegetation category is high compared to the good vegetation, which is low.

The *Zaid* season of 2016 characterizes a maximum area of 34855 km² (61%) under moderate category, followed by 17,061 km² (30%) and 5,284 km² (9%) covered under poor and good categories, respectively. In 2019, the spatial variation of red-edge WDRVI showed a maximum area of 28,938 km² (50%) which was covered under moderate category, followed by 27,299 km² (48%) and 1,072 km² (2%) covered under poor and good categories, respectively

(Fig. 4. (c)). The comparative analysis of the area of vegetation cover types using four different vegetation indices is shown in Table 1. These inferences were essential for understanding the role of the natural factors in governing crop productivity across different seasons. This helps in the efficient management of productivity-related issues during intensive agricultural practices.

REFERENCES

- Frampton, W.J., Dash, J., Watmough, G and Milton, E.J. 2013. Evaluating the capabilities of Sentinel-2 for quantitative estimation of biophysical variables in vegetation. *ISPRS Journal of Photogrammetry and Remote Sensing*. 82: 83–92.
- Gonsamo, A. and Pellikka, P. 2012. The sensitivity based estimation of leaf area index from spectral vegetation indices. *ISPRS Journal of Photogrammetry and Remote Sensing*. 70: 15–25.
- Qi, J., Huete, A. R., Cabot, F and Chehbouni, A. 1994. Bi-directional properties and utilizations of high resolution spectra from a semi-arid watershed. *Water Resources Research*. 30: 1271–1279.