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Research article

SPECIFYING OPTIMAL VEGETATION INDICES FOR PLANT PRODUCTION EVALUATION OF TAFTAN RANGELANDS USING SPECTRAL REFLECTION OF SATELLITE IMAGERY

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ABSTRACT: In present study, satellite imagery was used to provide plant production map of rangelands in Taftan. For this purpose, plants indices obtained through digital data of TM Landsat images were used. In order to assess the correlation between canopy percentage and satellite data, data of 40 sites with good distribution in the region was collected and estimated using available data and plant indices by applying linear regression of plant productionpercentage. The correlation between indices and field data was calculated and extracted for each index of plant productionmodel. Given the results of present work, such plant indices as PVI, PVI1, MSAVI2 and TASAVI1 had the highest with the Plant Plant production roductionso that PVI was selected to provide Plant Productionmap. Using the regarding model, plant production map was in 8 classes. The findings indicated that the region has production of 200-250$_{kg/ha}$. This assessment was repeated for 4 major plant types. The results showed that specifications of each type determine vegetation indices capability to evaluate canopy and amount and quality of Chlorophyll as well as environmental factors such as rainfall and altitude have the highest impact on indices efficiency.

Keywords: Satellite data; plant index; Plant production; Taftan

INTRODUCTION

The rangelands are taken into account as the life bed and one of the most important ecosystems. Since changing and dynamic are inherent features of ecosystem, grasslands are not an exceptional and always are varying. Rangeland scientists often highlight having updated and reliable information about rangelands for scientific and correct planning[2]. Climate elements changes can be effective on plants phonological, height, growth and production statuses[17]. Therefore, annual vegetation changes about annual rainfall changes and other climate factors are expected, and given the changing such factors in short- and long-term periods, canopy and thereby rangelands production will have permanent changes which should be scanned and evaluated annually. Estimation of these cases needs high cost and time which was historically achieved only through field works. Emerging remote sensing science, plenty of researchers have tried to utilize this technology for environmental, rangeland and forestry sciences. Yamani and Mazidi[25], in their investigation on vegetation using NDVI, RVI, NRVI, PVI and SAVI indices in Siahkooh desert, concluded that NDVI index delivers better results for that region. Freitas *et al*[8] showed that NDVI index has a high correlation with vegetation in forests. Rahdari *et al*[21], by a comparison on plant indices to provide canopy percentage in Moote of Isfahan, found that SAVI index with a correlation coefficient of 0.78 had the highest correlation with canopy and it was selected to provide vegetation percentage map. In this study, NDVI, TSAVI1 and RVI indices had high correlation coefficients. Najafi[18], by an assessment on vegetation changes in Ahwaz plain, found that PVI2 with a correlation coefficient of 0.89 has the highest relationship with the region coverage. Also, Chitade and Katyur[5] and Martha *et al*[15] in the studies regarding Indian rangelands and Sundarakumar[24] in the study of Vijayawada region, showed efficiency of satellite data on vegetation estimation. Yanli *et al*[26], using satellite date and plant indices in rangelands of Shaanyi province of China, studied on vegetation and showed efficiency of such data particularly its feasibility to investigate time changes in regional vegetation. Zarrine *et al*[27], using satellite imagery and indices, determined plant productionand wild life capacity of Tangsayyad region.

One of the common questions in remote sensing studies area is the best way of vegetation study according to width and diversity of vegetation. Oniel[19] showed that reflection of different coverage results in different correlations in different plant types. Also, Colombo *et al*[7] found that, in case of separated rangelands coverage types, the correlation between indices and coverage is 33 percent more that simultaneous study in a wide region. Hadian *et al*[9], using 14 plant spectral indices in different plant types, showed that the correlation between canopy and plant indices in each type has a high accuracy up to 81 percent. Due to extensive pastures of Taftan and lack of updated information, present work tried to take advantage of satellite date to study vegetation of mentioned pastures and provide the conditions for studies in types level and use the results for similar works.

MATERIALS AND METHODS

A representation on studied region

The studied region is placed in Khash city of Sistan and Balouchestan Province at southeast of Iran. This zone is located in center of the province and at the end of Iran-Tourani continent and near Khalij-Omani continent. The pastures of the region are expanded from the plains with a height of 1382 meters to tall mountains with a height of 4042 meters at Taftan peak. The mean annual rainfall and temperature of Khash is 160 ml and 19.7 $^{\circ C}$, respectively. The Exo Terra Monsoon Rainfall System also affects the regions. Besides, altitudinal gradient has provided different rainfall conditions there so that the statistics of 23 rain gauge stations, with exiting the plain and entering slopes of Taftan, show the rainfall will be increased and reached to 180 ml and 260 ml in heights of 2000 m and 4000 m, respectively[22]. These conditions have caused richer vegetation compared to other sections of the zone (Fig 1).

Figure.1 Taftan rangelands cover

Plant types

In order to specify plant type in studied regions, Floristic-Physiognomic method was used and the types were separated based on partial dominance of species. The specie with the highest canopy percentage along with the second specie which had at least 50 percent of the first specie coverage was specified as plant type[16]. Totally, 18 plant types were specified so that, according to width and dominance of 4 plant types of the region, the study was conducted in these types individually.

Ground sampling

Plant production was measured by random-systematic method separated by plant species. First, sampling points were determined randomly, regarding coordinates were logged by GPS and then canopy was specified during 3 transects.

Satellite data

In present study, TM satellite data was used concurrent with sampling date. In order to reduce error to less than 0.5 pixels, geometric correction was performed using 1:50000 topography maps and Digital Elevation Model (DEM) of the region. Using 7 bands of satellite imagery, false color images with the best OIF composition were provided and used. Desired plant indices were produced by Idrisi software and used beside the bands.

Spectral ratio determination

By NDVI index and using the information derived through the sites about percentage of bare soil, the pixels related to bare soil were given on yielded image. By entrance of such data into Excel software and defining spectral value of Infrared bands as the dependent variable (y) and spectral value of Infrared bands as the independent variable, the relation between them was studied as Y=a*x+b, where:

TM_4=y (spectral value of bare soil in Infrared band) and TM_3=x (spectral value of bare soil in the red band); soil line equation was used to provide the indices affected by this relation. Totally, 35 plant indices were used here which were presented by different researchers. The used indices are shown in Table 1.

Table-1. Plant indices were used

BI	IPVI	MSI	PVI	SAVI	TVI
DVI	LAI	NDVI	PVI_1	$SAVI_1$	VI_1
EVI	LWCI(IR)	$NDVI_{ab}$	PVI_2	SBI	VI_5
GEMI	$MIRV_1$	NRR	RVI(NIR)	TNDVI	VI_6
$GNDVI_1$	$MSAVI_1$	Pd_{311}	SARVI	$TSAVI_1$	VI_{14}
GVI	$MSAVI_2$	Pd_{312}	$SARVI_1$	$TSAVI_2$	

After ground sampling and applying necessary corrections on images, using Idrisi software and transfer of sample points' ground position on bands and indices, corresponding numeral value in each band and index for mentioned points were extracted.

Plant production modeling:

In order to assess regression equation and select suitable measurement indices for plant production specification of types, by considering plant production as dependent variable (y) and plant indices as independent variable, the required analysis was conducted. In this stage, the plant indices and the bands with the highest correlation were used. The correlation between bands and different indices with plant production amount was computed by SPSS version 19 and Pearson test; after determining the correlations, feasibility of regression equations presentation for the relations between bands and indices with plant production was conducted to model coverage. Then, using AcrGis software, cover classes were specified and corresponding map was extracted.

Results verification

In order to verify classification, 20 random points were determined in each type and classified images were compared in error matrix by referring to the field and determining Plant Production in such points and thereby introducing them into the software. In this verification, Kappa coefficient was used which is considered as a more proper method by considering incorrect pixels.

$$\text{Kappa} = \frac{p_o - p_c}{1 - p_c} \times 100$$

Where:

p_0 is observed accuracy and p_c is expected agreement.

RESULTS

3-1 Canopy measurement results in studied sites

By a field assessment and the measurements done, the canopy value was determined in each of studied sites (Table 2).

Table-2. Plant production value in studied sites

Sites	Plant types	Plant production	sites	Plant types	Plant production
1	Amygdalus scoparia / Artemisia lehmania	32	21	Hamada.salicornica	14.8
2	Artemisia lehmania- gallonia.sp	16.5	22	Zygophillum euryptrum – Artemisia santolina	17.9
3	Amygdalus scoparia	40.1	23	Artemisia sieberi	21.04
4	Pistacia atlantica/ Artemisia lehmania	38.12	24	Artemisia sieberi	15.01
5	Artemisia lehmania	47.03	25	Artemisia lehmania	35.4
6	Artemisia lehmania	48.01	26	Artemisia lehmania	82.7
7	Zygophillum euryptrum	16	27	Artemisia lehmania	20.7
8	Zygophillum euryptrum	19.2	28	Amygdalus scoparia/ Artemisia lehmania	35.85
9	Zygophillum euryptrum – Artemisia santolina	16.65	29	Amygdalus scoparia/ Artemisia lehmania	37.4
10	Artemisia sieberi	16.02	30	Artemisia lehmania	61.79
11	Artemisia lehmania	38.4	31	Zygophillum euryptrum	14.21
12	Amygdalus scoparia / Artemisia lehmania	40.75	32	Salsola tomentosa	16.91
13	Artemisia lehmania	52.02	33	Hamada.salicornica	13.05
14	Pistasia atlantica - Amygdalus scoparia	33.05	34	Artemisia sieberi	12.53
15	Amygdalus lysiudes	18.36	35	Artemisia sieberi- Cosinia stocksi	10.17
16	Amygdalus lysiudes	20.24	36	Artemisia santolina	14.55
17	Artemisia lehmania	25.5	37	Zygophillum euryptrum – Hamada salicornica	17.3
18	Artemisia sieberi	13.68	38	Haloxilon persicum	18.5
19	Amygdalus scoparia / Artemisia sieberi	20.24	39	Haloxilon persicum - Zygophillum euryptrum	17.97
20	Artemisia sieberi	9.5	40	Zygophillum euryptrum	13.6

The results derived from the correlation between bands and plant indices with Plant production (Tables 3 and 4).

Table-3. Correlation assessment results between bands individually with plant production percentage

Row	Bands	Scope	Different types			
			Artemisia lehmania	Amygdalus lysiudes - Artemisia lehmania	Artemisia sieberi	Zygophillum euryptrum
1	TM_1	0.5*	0. 64$^{n.s}$	0. 67$^{n.s}$	0.18$^{n.s}$	0.46$^{n.s}$
2	TM_2	0.66*	0.44$^{n.s}$	0.33$^{n.s}$	0.37$^{n.s}$	0.68$^{n.s}$
3	TM_3	0.66*	0.45$^{n.s}$	0.77$^{n.s}$	0.461$^{n.s}$	0.664$^{n.s}$
4	TM_4	0.68*	0.56*	0.56*	0.557$^{n.s}$	0.632$^{n.s}$
5	TM_5	0.43$^{n.s}$	0.342$^{n.s}$	0.407$^{n.s}$	0.185$^{n.s}$	0.172$^{n.s}$
6	TM_7	0.57*	0.46$^{n.s}$	0.46$^{n.s}$	0.146$^{n.s}$	0.144$^{n.s}$

**: Significant at1% level; *: Significant at 5% level n.s: insignificance

Table-4. Indices correlation with plant production in studied zone

Row	Band	Scope	Plant types			
			Artemisia lehmania	*Amygdaluslysiudes-Artemisia lehmania*	*Artemisia sieberi*	*Zygophillum euryptrum*
1	BI	0.56**	0.19$^{n.s}$	0.56$^{n.s}$	0.16$^{n.s}$	0.80*
2	DVI	0.69**	0.89**	0.79$^{n.s}$	0.06$^{n.s}$	0.54$^{n.s}$
3	EVI	0.71**	0.89**	0.73$^{n.s}$	0.56$^{n.s}$	0.66$^{n.s}$
4	GEMI	0.44**	0.84**	0.84*	0.185$^{n.s}$	0.60$^{n.s}$
5	GNDVI1	0.42**	0.77$^{n.s}$	0.80$^{n.s}$	0.156$^{n.s}$	0.77$^{n.s}$
6	GVI	0.22$^{n.s}$	0.64$^{n.s}$	0.80$^{n.s}$	0.36$^{n.s}$	0.70$^{n.s}$
7	IPVI	0.72**	0.89**	0.81*	0.12$^{n.s}$	0.53$^{n.s}$
8	LAI	0.66**	0.87$^{n.s}$	0.79$^{n.s}$	0.11$^{n.s}$	0.53$^{n.s}$
9	LWCI	0.34**	0.14$^{n.s}$	0.11$^{n.s}$	0.25$^{n.s}$	0.26$^{n.s}$
10	MIRVI1	0.19$^{n.s}$	0.28$^{n.s}$	0.83$^{n.s}$	0.50$^{n.s}$	0.31$^{n.s}$
11	MSAVI1	0.71**	0.87**	0.78*	0.10$^{n.s}$	0.53$^{n.s}$
12	MSAVI2	0.76**	0.86**	0.80*	0.09$^{n.s}$	0.53$^{n.s}$
13	MSI	0.32*	0.12$^{n.s}$	0.14$^{n.s}$	0.26$^{n.s}$	0.29$^{n.s}$
14	NDVI	0.72**	0.75$^{n.s}$	0.77$^{n.s}$	0.10$^{n.s}$	0.53$^{n.s}$
15	NDVIab	0.72**	0.70$^{n.s}$	0.72$^{n.s}$	0.10$^{n.s}$	0.54$^{n.s}$
16	NRR	0.73**	0.85**	0.89$^{n.s}$	0.10$^{n.s}$	0.53$^{n.s}$
17	Pd311	0.07$^{n.s}$	0.23$^{n.s}$	0.67$^{n.s}$	0.12$^{n.s}$	0.89$^{n.s}$
18	Pd312	0.6**	0.196$^{n.s}$	0.77$^{n.s}$	0.18$^{n.s}$	0.84$^{n.s}$
19	PVI	0.81**	0.85$^{n.}$s	0.88*	0.15$^{n.s}$	0.09$^{n.s}$
20	PVI1	0.79**	0.85$^{n.s}$	0.87$^{n.s}$	0.10$^{n.s}$	0.08$^{n.s}$
21	PVI2	0.67**	0.56$^{n.s}$	0.31$^{n.s}$	0.35$^{n.s}$	0.36$^{n.s}$
22	RVI	0.73**	0.85**	0.80*	0.10$^{n.s}$	0.53$^{n.s}$
23	SARVI	0.66**	0.34$^{n.s}$	0.86$^{n.s}$	0.23$^{n.s}$	0.71$^{n.s}$
24	SARVI1	0.71**	0.57$^{n.s}$	0.70$^{n.s}$	0.15$^{n.s}$	0.09$^{n.s}$
25	SAVI	0.38**	0.88$^{n.s}$	0.88$^{n.s}$	0.82$^{n.s}$	0.54$^{n.s}$
26	SAVI1	0.72**	0.88$^{n.s}$	0.89$^{n.s}$	0.14$^{n.s}$	0.53$^{n.s}$
27	SBI	0.23$^{n.s}$	0.21$^{n.s}$	0.16$^{n.s}$	0.01$^{n.s}$	0.82$^{n.s}$
28	TNDVI	0.71**	0.79$^{n.s}$	0.88*	0.10$^{n.s}$	0.53$^{n.s}$
29	TSAVI1	0.75**	0.87**	0.89*	0.12$^{n.s}$	0.58$^{n.s}$
30	TSAVI2	0.74**	0.87**	0.86*	0.10$^{n.s}$	0.52$^{n.s}$
31	TVI	0.7**	0.84$^{n.s}$	0.80$^{n.s}$	0.09$^{n.s}$	0.53$^{n.s}$

**: Significant at1% level; *: Significant at 5% level n.s: insignificance

Table-5. Indices correlation with plant production in studied zone

Row	Band	Scope	plant types			
			Artemisia lehmania	*Amygdaluslysiudes-Artemisia lehmania*	*Artemisia sieberi*	*Zygophillum euryptrum*
32	VI1	0.36*	0.39 n.s	0.8 n.s	0.24 n.s	0.58 n.s
33	VI5	0.17 n.s	0.30 n.s	0.81 n.s	0.50 n.s	0.34 n.s
34	VI6	0.2 n.s	0.28 n.s	0.82 n.s	0.51 n.s	0.31 n.s
35	VI14	0.19 n.s	0.15 n.s	0.59 n.s	0.11 n.s	0.46 n.s

**: Significant at1% level; *: Significant at 5% level n.s: insignificance

Simple linear regression analysis results between indices and plant production and verification of the models derived from regression (Tables 5-9)

Table-6. Verification results of the models derived through linear regression of indices in plant production estimation

Row	Plant index	Regression model	Estimation error	Row	Plant index	Regression model	Estimation error
1	TNDVI	1.3224*TNDVI+.0778	1.6	8	TVI	712.6*TVI-488.15	1.607
2	RVI	216.51*RVI-200.01	1.8	9	MSAVI2	264.81*MSAVI2+15.513	1.22
3	IPVI	963.93*EPVI-466.02	1.607	10	EVI	-697.09*EVI+16.609	1.22
4	NDVI	481.97*NDVI+15.945	1.606	11	TSAVI1	-34.64*TSAVI1+261.47	1.32
5	$NDVI_{ab}$	3.795*NDVIab-469.82	1.607	12	TSAVI2	-34.218*TSAVI2+259.97	1.3
6	$MSAVI_1$	330.88*MSAVI1+15.951	1.607	13	PVI2	4.06*PVI2+36.689	1.29
7	$SAVI_1$	330.53*MSAVI1+15.271	1.607	14	LAI	99.766*LAI+206/8	1.22

Table-7. verification results of the models derived from linear regression in estimation of plant production for *Artemisia lehmania* type

Row	Plant index	Regression model	Estimation error	Row	Plant index	Regression model	Estimation error
1	EVI	-207.49*EVI+28.975	2.9	3	NRR	60.941*NRR+29.171	2.3
2	IPVI	227.86*EPVI-110.15	2.02	4	RVI	60.941*RVI+31.77	1.9

Table-8. verification results of the models derived from linear regression in estimation of plant production for *Amygdalus lysiudes / Artemisia lehmani* type

Row	Plant index	Regression model	Estimation error	Row	Plant index	Regression model	Estimation error
1	$TSAVI_1$	-10.569*TSAVI1+93.3	1.9	6	RVI	60.97*RVI-31.77	2.3
2	IPVI	227.86*IPVI-99.15	2	7	$TSAVI_2$	-10.41*TSAVI2+102.71	1.95

Table-9. verification results of the models derived from linear regression in estimation of plant production for *Amygdalus Zygophillum euryptrum* type

Row	Plant index	Regression model	Estimation error
1	BI	-12.33*BI+66.9	2.2

Multivariate regression analysis results

Initially, utilizing all bands, multivariate regression analysis was performed in stepwise mode. The results showed that, in terms of plant production, bands 1, 3 and 4 are able to exist in premier model (Table 10).

Table-10. Multivariate regression analysis results for plant production estimation

Band or plant index	Regression model	R	Estimation error
TM_1,TM_3,TM_4	$Y= 168.483-1.579TM_1 +2.177TM_4 - 1.892TM_3$	0.8**	3.8
$TNDVI_1$,PVI	Y= -3.180-1.138 TNDVI1+2.696 PVI	0.88**	2.48

**: Significant at1% level; *: Significant at 5% level n.s: insignificance

The investigation on concurrent existence of indices in multiple model and estimation of rangelands using the indices with the highest correlation showed that canopy is merely can be calculated by single-index models and hybrid model showed no higher correlation. Bork[4] also reported that the most proper method to estimate coverage of grasses, broadleaf weeds and shrubs is simple regression other than multiple regression.

Providing plant production map

Plant production map of studied zone was provided using the model derived from PVI in *ArcGis* environment and production classification was done (Fig 2).

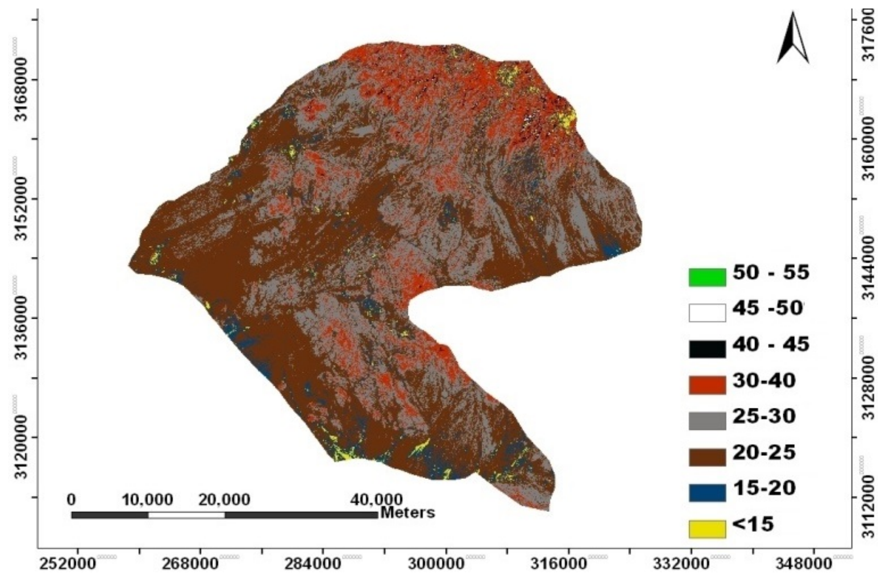

Figure. 2 plant production map of using the PVI model(gr/m^2)

Verification of produced maps

The verification was conducted by error matrix preparation and determination of Kappa coefficient and general accuracy of produced maps (Table 11).

Table-11. Verification results of produced map

Kappa coefficient	0.81
General accuracy	0.84

DISCUSSION AND CONCLUSION

The results show efficiency of satellite data in canopy estimation particularly TM bands. Several researchers have shown such efficiency. Khavaninzadeh and Khajedin[14], in a study on Yazd grassland, found that TM_3 and TM_4 show the highest efficiency. Freitas[8], Amiri and Yegane[3] and Zarrine *et al*[27] also have revealed efficiency of satellite data to determine vegetation. Relatively low correlations and their significance level show more necessity of use of plant indices. The indices investigation indicates that most of the indices with high correlation with plant production are the indices formed by composition and consolation of close infrared and red bands.

In arid areas, light reflection is partly done by bare soil. Therefore, lack of attention to this section of reflection affects strongly coverage study. In contrast, use of the indices which have considered this section can increase the study efficiency. Hybrid and soil line indices are of such category. These indices have shown a high correlation with plant production. Totally, the highest correlation is related to IPVI, LAI, MSAVI1, MSAVI2, TSAVI1, NDVI, NDVIab, SAVI1, TNDVI and TVI with a correlation higher than 0.85. Sing [23], with similar results show that NDVI, SAVI and MSAVI2 have the least errors to investigate some species in the desert and they are reliable in vegetation studies of these regions.

Rahdari et al [21], with a study on a same region with present study, showed that SAVI, NDVI, $TSAVI_1$ and RVI have a correlation coefficient of 0.76 with canopy amount.

Low precipitation and high evaporation as well as loss of greens and consequently reduced photosynthesis give rise to incidence of spectral changes inside different plant species and different positions and affect strongly reflective properties[14],[12]. In present study, lack of indices correlation in *Artemisia sieberi* plant type against several correlations in *Artemisia lehmania* and/or *Amygdalus lysiudes /Artemisia lehmania* show that pigment kind is effective on reflectance amount and thereby indices efficiency because *Artemisia sieberi* has silver-white oriented green leaves and its green pigment is relatively poor. However, *Artemisia lehmania* with a relatively more strong green color makes a quite distinct reflectance with surrounding soil. *Amygdalus lysiudes*, with the ability to form branch, stem erect and quite clear green leaves has helped significantly to this process. Oneil[19], found that different plant types show different correlations with the indices due to specification of constituent species specifications. Prigent[20] also indicated different spectral reflection of plants in terms of difference in chlorophyll kind and plant structure. Artemisia produces two leaf kinds in vegetative growth stages: winter leafs which fall at the end of rain season and tiny summer leaves which were formed in order to minimize evaporation level. Emerging and activity of these leaves follow season conditions[13]. Consequently, fall of winter leaves and emergence of tiny summer leaves are expected to happen proportionate with change of environmental temperature and air humidity. With altitude change, temperature loss and increased relative humidity derived, winter leaves will definitely have more strength. Therefore, grassland of *Artemisia lehmania* concurrently with a class higher than *Artemisia sieberi* has different conditions and leaf surface will be quite different in these two types. Therefore, spectral reflection, particularly in infrared range, is quite affected and different reflective properties will be appeared. This can partly convince such a difference.

In the regions with rainfall of less than 500mm, the rainfall has the highest correlation with phytomass compared to other environmental factors[10]. At rainfall season with increased temperature, a major part of ground temperature is evaporated such that Forb and Grass species can quickly attract and develop the growth. However, brushwood species have less efficiency in this regard and thereby the least canopy, plant production development and green leaf production occurs for them[11]. In vegetative regions located in relatively lower heights and plains, rainfall occurs naturally as much as annual average amount and lack of effective gradient (e.g. height) has caused the rainfalls affected by such gradients and same gradients with mountains conditions would not occur in the region and the plant growth would only dependent upon normal rainfalls. Also, Akbarzade and Mirhaji[1], in a study on steppe grasslands of Roudeshour, showed that canopy of brushwood species has a high correlation with the rainfall amount.

The leave surface index is one of the main determinants of plant indices correlation and ground coverage amount such that a direct correlation can be established between indices and lead surface index[6]. One of the most important reactions of arid areas plants dealing with early environmental drought is reduction of water losses through waste water mechanisms inhibition. For this purpose, the plants naturally reduce transpiration to 25-50 percent by reduction of leaf surface and quantity[13].

Multiple droughts in this region and inherent specification of such plants have resulted in reduced production of green and Chlorophyll-containing leaves relative to biomass volume and canopy surface and plant production. With decreased leaf surface in this vegetative form, reflection is affected and distinction with surrounding environment is reduced as well. As a result, number of derived suitable indices in this form would be relatively low. *Artamisia santolina-Zygophillum euryptrum* plant type which has been created with presence of shrub vegetative form along with bush one, follows this principle. Consequently, quantity of indices which show correlation with plant production was stringly reduced in this type as well.

Totally, it can be addressed that environmental and plant specifications such as altitude, rainfall amount, accompanied plant species, plant physiologic properties, etc give rise to arise the attributes in rangelands which directly affect efficiency of satellite date in vegetation and plant production studies by effect on reflection amount.

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