Contrary to the large variety

Although vegetation cover is only one of many parameters that can be monitored and used for grassland management in Iran, vegetation cover is the most frequently used indicator in remote sensing to measure grassland production and level of pasture degradation (Li et al., 2010; Cui et al., 2012) because it strongly reflects the ecological value of grasslands, especially in the highland (Guo et al., 2006; Cui et al., 2012; Yan and Lu, 2015) such as Sabalan. In our study, the correlation analysis (Table 5) demonstrated that the total canopy cover had an intermediate significant correlation with indices, including TVI, CTVI, TTVI, RVI, PVI, PVI1, PVI2, PVI3, DVI, TSAVI1, and TSAVI2. As it has already been proven in similar studies (O'Neill 1996; Li et al. 2006; Paltsyn et al. 2017), the green vegetation cover can be quantified by a number of satellite image-driven indices. Given that in 12 studied sites, Grass life form is the most abundant vegetation life form in most of the sites (Table 1); therefore, all the slope-based, distance-based and orthogonal transformations VIs had a relatively strong correlation with Grass canopy cover data significantly.

Likewise, the forb canopy cover field data is not significantly related to any of the VIs, which is likely related to the dominance of the species of other life forms relation to FCC in almost all studied sites. Ghorbani et al. (2017b) in a study at Sabalan compared the performance of 24 VIs to estimate the above-ground at sub-life forms (grasses, forb, shrubs and total vegetation) using Landsat OLI and found that the highest R2 was established between RVI, TNDVI and GNDVI and Grass life form (dominant life form). However, Zarrineh et al. (2012), reported the strongest relationship between Grass life-form primary production (dominant life form) and DVI. In spite of the different VIs and estimated parameter, but it is clear that the dominant life form has the best estimation result using Vis.

Determining the best OLI spectral bands and image-derived VIs that would be able to predict (life forms) canopy cover and subsequently condition in Sabalan rangelands was one of the main purposes of this study. For this purpose, we developed empirical regression models combining in-situ measurements obtained through the analysis of reflectance values from Landsat OLI individual channels and vegetation indices (Table 6). Except in the case of TCC, Near Infrared band has appeared in the 3 regression models established between measured SHCC, GCC, AND FCC and OLI bands. Regarding that, the healthy green plants have a specific reflection in the visible and near-infrared (NIR) domain of the spectrum, so this finding can be interpreted because that in the NIR, the canopy structure of the all 3 life forms strongly reflect the energy. Also, the results of our study indicated that pixel values of Landsat OLI spectral bands and vegetation indices were convincingly related to on-the-ground field estimates of the percentage of shrub, total canopy cover (combined green plant), and grass, with linear regressions (R2= 0. 77, 0. 81, and 0. 84, respectively).

The results reported by Boyd (1986) suggest that the Landsat MSS data and calculated VIs are highly correlated to brush canopy cover. Liu et al. (2005) accurately quantified grassland cover density from Landsat TM spectral pixel values with an accuracy level of 89% using a linear regression model. Baugh and Groeneveld (2006) evaluated quantitatively the performance of fourteen vegetation indices (VIs) using a Landsat TM dataset in sparsely vegetated arid regions and found that NDVI and NDVI offset performed best of all the tested VIs, both with R2= 0. 77. All the above-mentioned studies leading to good prediction result, are limited to examining the relationship between total canopy cover with Landsat spectral bands and VI's, meanwhile the ability of aforementioned independent variables to estimate the different life forms has not been investigated. Jafari et al. (2007) evaluated and compared different groups of vegetation indices derived from Landsat TM images for estimating Vegetation cover components (Perennial species, Ephemeral and grass species, Total vegetation) using simple linear regression. They reported that stress related vegetation indices using TM bands consistently showed significant relationships (R2= 0. 1–0. 3) with all combinations of field cover components. Smith et al. (2015) reported the capability of Landsat imagery to differentiate the various grassland components in the mixed grassland prairie. In our study FCC field data was not significantly related to any of the VIs and also FCC showed the weakest forecasting relationship only with AVI and band 4 via a third-order polynomial regression (Table 6) demonstrating better fit to the data than first and second-order regressions. These results in the case of FCC are in agreement with the results of Guo et al. (2007) and Paltsyn et al. (2017) who reported for second-order polynomial regressions describe relationships between VIs and percentage of vegetation cover better than first-order models; however they elucidate that second-order polynomial regressions should be used with caution for areas with dense vegetation cover (percentage of vegetation cover > 80%), because at such thresholds the predicted relationships seemed to saturate.

Furthermore, areas with very low vegetation cover (< 5%), can generate negative projections when the 2nd polynomial order models are applied, but it does not be problematic in middle and low coverage (Guo, 2007). Thus, the developed statistical models are appropriate for use in our studied sites (with 29−78% vegetation cover) except Sabalan (with 85%±2. 97canopy cover). Given that this study was carried out only at the northern part of Sabalan with Grass dominated vegetation cover, other studies need to be done in other parts with probable different dominant vegetation life forms. Through verifying the predictive power of the selected indices in estimating the green cover, the employed VIs can be used in assessing and monitoring of Sabalan rangelands on a regional scale. Because of not having an obvious difference between the performances of the 3 types of VIs for CC estimation and between the indices belonging to a certain group, therefore, our study challenges the issue of the specificity of each VIs group to specific life forms. The distance-based VIs require more specialized knowledge and expertise to calculate the soil line, which results in difficulties in the use of the indices. In this regard, the Slope-based VIs is recommended due to the extensive application and its convenient calculations. Considering the spatial resolution of the used images (30 m) and the high density of field sampling, the field CC data inevitably were combined and in each site the average values of 30 plots (900 m2 area) canopy cover (360 plots in the study area) were used for the modeling process; that will cause loss of information measured in field surveys. Therefore, less filed data in similar cases may lead to satisfactory results. Contrary to the large variety of vegetation indices used in the study, it is obvious that the application and interpretation of these procedures in different environments need more research efforts. Our study confirmed the efficiency of vegetation indices as a suitable auxiliary tool to field sampling methods for the assessment of canopy cover across broad and impassable mountainous rangelands such as Sablan.