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The Contribution of Land Uses in Determining the Vegetation Structure and Species Composition in High Altitude Areas of Al Baha Southwest Saudi Arabia

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Abstract The present study has been carried out in Al Baha region, southwest of Saudi Arabia. Five land use types were selected, namely abandoned terraces, communal areas, protected areas (enclosure areas), national parks and settlement areas. The quadrat of 25m * 25 m was laid over the different land uses to study the vegetation structure, plant composition, plant diversity and seedlings regenerating status. The results showed a total of 365 plant species belong to 72 families. The similarity in plant species composition among the land uses types was high in the abandoned terraces and protected areas with 92 %. The class distribution size of regenerated plant species was normal in abandoned terraces and protected areas but this normal trend was disturbed irregularly in communal areas, national parks and settlement areas due to a high level of human interference. However, a higher average of disturbance among the land uses was found to be significant with p- a value of 0.04 and 0.001 respectively. This amount of disturbance severely affecting the seedlings recruitment especially in the communal and settlement areas, indicating that there is an urgent need for planning the sustainable management for the appropriate measure to overcome the problem. IVI index revealed that there are somehow similarities in species composition between both communal areas and settlement areas. The outcomes of this study concluded that understanding the conflicts between human activities and land uses has to be taken into consideration for developing and sustainable management plans in futures. Therefore, the reduction of disturbances and creating participation management plans with local and indigenous people is essential to enhance the sustainability of the forests.

Keywords: *Abandoned terraces, Al-baha, disturbance, land use, protected areas, species richness and diversity*

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1. Introduction

The kingdom of Saudi Arabia has initiated significant changes in land use and vegetation cover since the government took a plan 30 years ago of exhaustive domestic development as a result of massive oil incomes [1]. In addition to the high complication to anthropogenic interference and climatic changes, the deterioration and degradation of the plant ecosystem are critical. This may be attributed to the extension of urbanization especially in the southwest of Saudi Arabia which is considered the most sensitive habitat for human disturbances due to the area geographical characteristic. The expected results to be occurred in such habitat are soil erosion, habitat loss and dieback of the conifer forest. These factors are leading to shrinkages in the plant populations and maybe extend or threat some sensitive species to the changes in the ecological aspect. Therefore, alteration in biological populations is expected to occur to immediate rates as human activities and global climate changes are increasing [2]. The government has initiated many of the protected areas (PAs) and National Parks (NPS) to enhance the restoration of the vegetation cover and increase biodiversity. Saudi Wildlife Authority (SWA) manages 15 protected areas around the kingdom, with an area of 86,582.4 km^2 (4.5%) of the total land [3]. Further plan has been set to extend the protected areas to reach the total of 22 areas, covering approximately 10.42 % of the country (208,356 km^2) and provides local communities with socio-economic benefits such as regulated and sustainable use of grazing, hunting, fishing, and other related recreational and tourism opportunities [4,5]. However, the concept of land use management in Saudi Arabia is relatively not well-established [4]. These could be attributed to the fact that people so far are not yet ready to lose their benefits of using the lands for grazing, woodcutting, and urbanization. Therefore, a lack of awareness may also be the obstacle and barrier for decision-makers to plan and set the package for land uses management, development, and restoration. Although, FAO [6] mentioned the rapid deterioration of forest cover from 2,728000 hectares to 977000 hectares from 1996 to 2008 respectively. Generally, such an approach to management plan often results in conflicts between local communities. This conflict may occur and increase forests' violation due to firewood smugglings and fire. Aref et al. [7] stated that forests of Southwestern Saudi Arabia are degraded and loss of environmental equilibrium as a result of changes has occurred to natural streams by road construction, conversion of natural forests to parks, random expanding in constructional, agricultural activities and fires. FAO [6] also confirmed the fact that the forests of Saudi Arabia are threatened by severe environment and human interaction factors including agricultural and urban expansion as well as firewood collection. The interaction of human activities and environmental factors is accelerated by a lack of qualified forestry personnel in comparison to the optimum required to implement the activities necessary to sustainably manage the resources. Darfaoui and Al Assiri [8] reported that both pasturelands and woodlands encounter critical challenges in Saudi Arabia, as a result of harsh environmental conditions (drought, unfertile soil) and anthropogenic pressures, (overutilization of firewood, over browsing and grazing, expansion of unmanaged civilization and serious recreation). However, the biological ecosystems are considered as being at risk with climatic changes in KSA including highlands forests and woodlands.

The government of Saudi Arabia has started several officials and/or legislative procedures and established many projects, to reduce the deterioration of forest lands, enhance the conservation plan, expand and develop existing forests. For instance, it signed a Memorandum of understanding with the Food and Agriculture Organization of the United Nations for partnership and cooperation in forest rehabilitation and conservation.

To enhance the government and other organizing efforts in developing and sustainable management of rangeland and forestry in Saudi Arabia, this study was conducted, to demonstrate the impact of land uses and sustainable management on vegetation cover and species richness, and to elevate the awareness among the local community to maintain and sustainable uses of lands.

2. Materials and Methods

2.1. Study Site

Al Baha region is located in the southwest of the KSA, between the latitude of 19/20 and longitude of 41/42. The region is characterized by high mountains within the continental dry climate but alleviated by Al-Sarawat Mountains above the sea level and their exposure to humid winds blowing from the narrow strap of Tihama in western Saudi Arabia which forms a moderate climate in summer and cool in winter. It contains diverse physiographic features such as mountain peaks, highland plateaus, moderate to steep slope mountains and valleys, with an altitude ranges from 200 to 2485 m above the sea level.

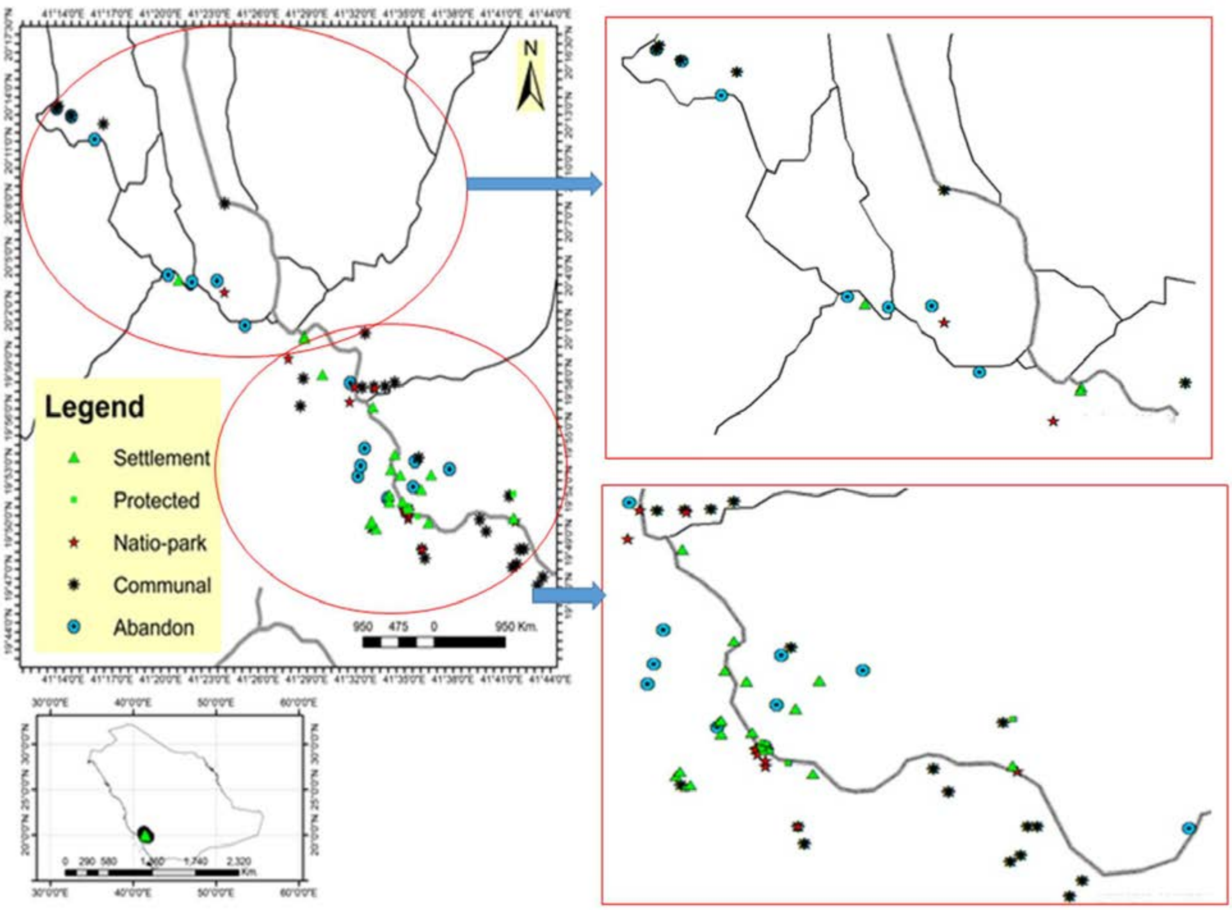

Figure 1. The study area and the sampling plots in each land uses type

The region is well known by having high plant diversity dominated by Juniperus procera, Acacia ehrenbergiana, A. asak, A. origena, Olea europaea, and Dodonaea viscose communities covering different ecological zones. Agricultural terraces spread over the high mountainous areas and produce field crops such as lentils millet wheat, sorghum, sesame, barley and vegetable crops like peppers, potatoes, a local pumpkin, tomatoes, carrots and others [9].

The study area is confined to the high mountains and plateau of the Al-Baha region stretching along the mountain chain from Baljurashi province in the south to Al Mandaq province, in the north between altitudes of 1900 m. a.s.l to 2385 m. a.s.l. The land use types in the region were classified to 5 land use types, they are found scattered on different ecological zones, few of them are overlapping or close to each other, the selected study sites were laid on these different land use types as shown in Figure 1 namely abandoned terraces, communal areas, protected areas (enclosure areas), national parks and settlement areas (Figure 1).

2.2. Sampling Procedures

To demonstrate the impact of land uses on plant richness and diversity, five different overlapping land uses namely abandoned terraces, national parks, fenced areas (protected areas), communal areas and settlement areas were selected to be surveyed and evaluated. A single scale sampling method was used for sampling procedures described by Synnott [10]; larpkern et al. [11]; Devi Prasad and Al-Sagheer [12]. In each land use, sixteen quadrats of 25*25m were constructed from a randomly chosen point in the area. To enumerate plant species richness and diversity in the quadrats system, all plant species were counted and morphologically identified to the species level using our experiences, a Handbook of Yemen Flora by Wood [13]. Wildflowers of Saudi Arabia by Collenette [14]: Flora of the Arabian Peninsula and Socotra by Miller et al. [15]. Within each quadrat, four smaller plots of 1 m2 were laid out in the four corners of quadrat to evaluate the regeneration state to reach a total of sixty-four plots in each land uses. All tree species < 30 cm GBH (girth at breast height) were considered regenerated seedlings and enumerated separately into regeneration classes based on their height and girth, i.e., Class IV (Young trees) >100 cm height and >10 cm GBH, Class III (Poles) >100 cm height and<10 cm GBH, class II (saplings) between 40-100 cm height and class I (seedlings) <40 cm height [12,16,17]. To make comparative assessments of plant diversity and species richness in different land use, a human disturbance was taken into consideration as a mean driver of altering the vegetation structure and composition [16,18,19,20]. Disturbances were taken into consideration based on the assumption that each land uses received different amounts of disturbances according to the land management plan and closer or distance to human activities. Therefore, a sign of disturbances like the formation of a footpath, presence of cut stumps or broken stems, domestic animal dungs (DAN) and animal grazing was measured. These factors were recorded in all quadrats and scores were given based on the author's observation on the amount of disturbance. Four levels of disturbance were set to each parameter namely high, medium, low and absent, with values of 1 to 4 for each parameter. The value of 1 was considered as the absence of disturbance whereas the value of 4 was considered as a severe disturbance [21].

2.3. Statistical Analyses

Species richness was analyzed using the following methods:

Direct count of species

Species richness was computed by using the direct count of species number in equal size samples. [11].

Shannon's diversity index, [22]

$$H' = \sum_{i=1}^{S} Pi\ Ln\ (pi) \quad (1)$$

Where pi is the proportion of individuals of species in I the species.

Jaccard Similarity index [23]

$$Gj = 1 - \left(\frac{a}{a+c+c}\right) \quad (2)$$

Where c is the number of species present only in quadrat 2, b is the number of species present in the quadrat 1 and a is the total number of species present in both quadrats or samples being compared.

Rarity index

Relative species richness and species abundance are described as core elements of biodiversity [24]. Relative abundance refers to how rare or common species is relative to other species in a certain area or community [25]. Therefore, the rarity index was assessed from the calculation of the relative frequency of each plant species [26].

Important value index for plant species (IVI)

Species importance value (IVI) was adapted for the assessment of the distribution of species abundance which is calculated by the following formula [27,28].

$$Relative\ frequency\ (RF) = \frac{frequency\ of\ species\ i}{sum\ frequencies\ of\ all\ species} \times 100 \quad (3)$$

$$Relative\ density\ (RD) = \frac{number\ of\ individuals\ of\ species\ i}{total\ number\ of\ individuals} \times 100 \quad (4)$$

$$Relative\ coverage\ (RC) = \frac{total\ cover\ for\ species\ i}{total\ cover\ of\ all\ species} \times 100 \quad (5)$$

$$IVI = RD + RF + RC. \quad (6)$$

2.4. Soil Analysis

Published date of soil physical and chemical characteristics of Ragadan forest R3SI was copied from Forest inventory project in the southwestern region of Saudi Arabia, Volume III, and Inventory of natural forests in the second zone [29].

Pearson correlation coefficients were computed between species diversity and disturbance parameters and soil characters based on Mukaka [30].

3. Results and Discussion

3.1. Species Composition and Richness

The outcome of comparative studies on species structure and composition among different land uses came on a par with the fact that species structure and diversity status are deeply impacted by land uses. And it also came on a par with the Authors' expectations and many researchers' work. Mutalemwa [31] studied the influence of different land uses types on birds and tree species diversity around lake Victoria Basin and the results showed that fishing zone had high bird diversity while the highest diversity in tree species was recorded in forest reserve land use. This could mainly be attributed to the poor land management resulted in degraded large amounts of land, reducing the ability to produce enough food, and consist a major threat to rural livelihoods in many developing countries [32]. Similarly, in the present study, many changes had been occurred due to the different land uses as shown in Table 1. The total plant species and families found in the study areas were counted to be 365 species and 72 families. This is considered high compared to a similar study conducted by Howladar et al [33] in the same geographical areas. The highest number of species richness was recorded in abandoned terraces followed by protected areas, settlement areas, communal areas and national parks with the numbers 201, 168, 128, 110 and 72 respectively. Although, plant density per hectare showed the same trend of species richness with high value in the abandoned terraces (450 plants/ha) and protected areas (499 plants/ha) compared with communal areas, national parks and settlement areas with value of 297.3 plant/ha, 248 plant/ha and 256 plant/ha respectively, also they reported that a total of 224 species representing 56 families of vascular plants are found in Al Baha catchment areas. The floristic composition of the different geomorphologic landscape units showed differences in species richness. Abandoned terraces seem to be a good habitat for plant species and showed the highest species richness and diversity (Shannon and Weaver diversity index) with 202 and 2.19 respectively. National parks showed less richness and diversity 72 and 1.701 respectively.

This variation in species richness and diversity can be related to the characters and the history of disturbance received of each land use for decades. High level of diversity and rich land in abandoned terraces and protected areas are mainly due to protection status, less value of cumulative disturbance index and may also be related to the fertile soil conditions, especially the moisture content and nutrient availability. Arevalo et al. [34] found that diversity and species richness were significantly found higher in the terraced plots when compared with the control plots. This also indicates differences in environmental and edaphic conditions. For a long time, the terrace soils have been prepared for the purpose of increasing yields and, once neglected, the level of the disturbance is not as high as with other disturbances (although the remaining soils generally offer characteristics for natural regeneration). These suitable conditions increase productivity and in some cases could be associated with higher diversity [35,36,37]. The outcome of this study revealed that disturbance was the main driver for alteration the species composition and diversity structures as shown in Table 2. However, species richness and diversity were found to be more in the abandoned terraces, protected areas when compared with the national parks, settlement areas indicating differences in cumulative average of disturbance parameters. The high average of disturbance was recorded in settlement areas, national parks and, communal areas with an average of 2.69, 2.40 and 2.13 respectively whereas the lowest were observed in abandoned terraces and protected areas with a cumulative value of 1.87 and 1.42 respectively. The average value of disturbance parameters such as lopping, cut stumps, road construction, fire, weeds, grazing, and footpath showed significant differences among parameters in different land uses P-value =0.04 and was highly significant among the land uses P-value 0.001.

Table 1. Plants Richness and Diversity indices among different land uses

Land uses type	Taxa_S	Individuals plants/ha	Shannon H'	Evenness e^H/S	Density Plants/ha	Freq%	Families/Land use
Abandoned terraces	202	**450**	**2.19**	0.61	**450**	6.18	56
Communal areas	110	347	1.03	0.58	297.3	5.47	49
National Parks	72	217	1.70	**0.62**	248	0.39	34
Protected areas	168	**499**	**2.05**	0.60	**499**	6.11	47
Settlement areas	128	405	1.09	0.60	**256**	0.49	52
Total	365	2058					72

Table 2. Means and Standard division of Disturbance Parameters in Different Land Use

Disturbance / Land use types	Lopping	Cut stumps	Road cons	Grazing	Fire	Weeds	Foot path	DAD	cover	cumulative average	P-value
Abandoned _terraces	1.4± 0.5	1.4 ± 0.9	0.8 ± 0.4	2.0 ± 1.0	0.8± 0.4	3.2 ± 0.4	2.2 ± 0.4	2.2 ± 0.4	2.8± 0.8	1.87	0.04*
Communal areas	1.8±0.45	1.8 ± 1.1	1.0 ± 0.7	2.0 ± 1.0	2.0± 0.7	2.6 ± 0.5	2.2 ± 0.4	3.0 ± 0.7	2.8± 0.4	**2.13**	
National Park	1.4±0.55	1.4±0.5	3.8 ± 0.8	2.2± 0.8	3.0± 0.7	1.2 ± 0.4	4.0 ± 0.7	2.4 ± 0.5	2.2± 0.8	**2.40**	
Protected area	1.4±0.55	0.6 ± 0.5	0.2 ±0.4	1.0 ± 0.0	0.4±0.5	4.4 ± 0.5	0.6 ± 0.5	0.6 ± 0.5	3.6± 0.5	1.42	
Settlement area	2.8±0.84	3.2 ± 0.4	3.4 ± 0.5	2.8 ± 0.4	1.6 ±0.5	3.2±0.4	3.4 ± 0.5	3.2 ± 0.8	0.6± 0.5	**2.69**	
Total average										10.51	
P-value	0.001**										

*Significant association @ 0.05, p- value ≤ 0.05, Mean and Standard Division (SD), Cumulative average disturbance (CAD), domestic animals dung (DAD).

Table 3. Similarity matrix among tree species in different habitats (Jaccard Similarity Index)

	Abandoned terraces	Communal areas	National Parks	Protected areas	Settlement areas
Abandoned terraces	1				
Communal areas	0.69	1			
National Parks	0.68	0.79	1		
Protected areas	0.92	0.70	0.71	1	
Settlement areas	0.64	**0.95**	**0.80**	0.70	1

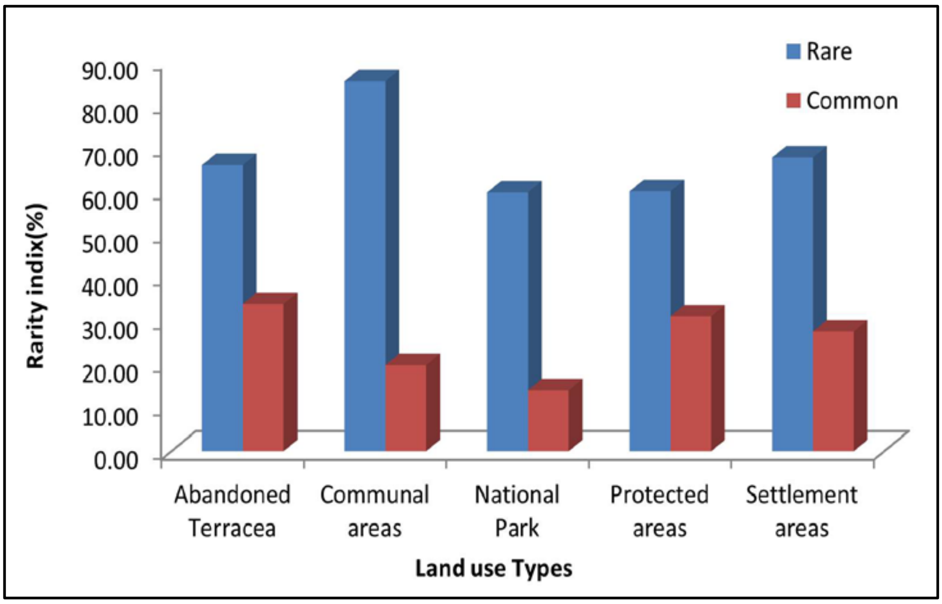

Figure 2. Distribution of rare and common plant species in each land uses

As a consequence of disturbance, similarities (Jaccard index) in species composition and structures among different land uses have been found to be interesting (Table 3). They have been found to be high between abandoned terraces and protected areas (92%). The similarity between communal areas and settlement areas was found to be very high (95%) indicating that species composition did not differ and could be considered similar. This may be related to the amount of disturbance occurring in both land uses as shown in Table 2. Similarly, the higher vegetation abundance in the terraces may be related to better soil conditions, particularly the higher water and nutrient availability [34]. The communal areas, settlement areas, and national parks are open access areas and are exposed to an increasing amount of disturbance, resulting in an alteration of the species composition and forest structure [38].

Although, disturbance changed the plant frequency in sampling plots, resulting in altering the species composition and structure. However, rare species were to be high in the communal areas, settlement areas and parks with a value of 85, 70, and 65%. Similarly, the common species were less in the same land uses with 15, 30, and 35% respectively as shown in Figure 2. The biological diversity of the open access areas (communal areas, settlement areas, and parks) are rapidly depleted due to the direct and indirect consequences of human activities. Rare species are generally thought to be more extinction prone than generalist or common species [39], as a consequence of human activities, which is reportedly making forest ecosystems more prone to damage by altering the frequency, intensity, and timing of fire events [6]

3.2. Important Value Index (IVI)

The arrangement of species in different land uses was thought to be affected by disturbance parameters as shown in Table 4. However, the alteration species arrangement was expected to change in different land uses. For instance, the dominant plant species in abandoned terraces were Cynodon dactylon, Cenchrus ciliaris, Urtica urens, Acacia origena and Onopordum heteracanthum and ranked from one to five, with an IVI value of 137.51, 125.38, 113.10, 102.30 and 94.30 respectively. On the other hand, the set of species, namely Erodium neuradifolium, Typha elephantine, Ipomoea sinensis subsp. *blepharosepala*, Centaurea pseudosinaica and Hyparrhenia hirta were ranked the top five dominated species with an IVI value 100.02, 94.17, 77.78, 75.00 and 75.00 in the communal areas, respectively whereas Typha elephantine, Centaurea pseudosinaica and Hyparrhenia hirta ranked seven, five and two in the settlement areas with an IVI value of 84.6, 95.00 and 115, respectively.

Interestingly, some similarities in species ranking were found with top five dominant plant species in abandoned terraces, national parks and protected areas. Hence, Cynodon dactylon and Cenchrus ciliaris were ranked first and third with an IVI value of 114.53 and 95.67 in the national parks, and third and second with an IVI value of 106.25 and 106.26 in the protected areas. Therefore, the partial similarities in the dominance of plant species among abandoned terraces, protected areas, and national parks from on the one hand and communal areas and settlement areas on the other were believed to be attributed to disturbance parameters, management plan, and ecological adaptation and site factors. Thus, the interactions among the environmental, edaphic and geographic factors finally resulted in controlling formation of vegetation types for each land use. Moro et al. [40] investigated phylogenetic patterns along environmental gradients related to edaphic environment and climate in the Caatinga, in Brazil. The results showed that dissimilarities in plant clustering were likely to reflect a variety of environmental factors at different sites or times. Pelissier [41] stated that the varied distribution and dominance of species across the sites could be attributed to the topography of the region and micro environmental condition. Moreover, species rank and their values in different land uses seemed to be affected by disturbances as shown in Table 2.

3.3. Regeneration

Seedlings recruitment and regenerated plant species were deeply impacted by anthropogenic disturbances especially in communal areas, settlement areas, and parks. However, the open-access areas for human disturbances altered the natural process of plant regeneration and showed irregularly shaped curved classes as shown in Figure 3. The frequency of the seedlings in classes I, II, III, and IV have unregulated distribution in contrast with areas that have less disturbance. The reason could be related to open access areas and exposition to cattle grazing, trampling and other human activities; in addition to the fact that the life cycle of plant species is impacted and plants did not bear fruits (seeds) naturally. These findings are expected due to the high average of disturbance in such land uses as shown in Table 2. Vazquez-Yanes and Orozco-Segovia [42] reported that seed establishment may also be affected by the intensity of disturbance while less intense disturbances such as canopy opening may induce many seeds to recruit. In both abandoned terraces and protected areas, size class follows a reverse J-shaped curve (Figure 1), which indicates the normal trend of regeneration. The frequency of the seedling in the first regeneration class (I) was the highest compared with the second (II), third (III) and the fourth (IV) regeneration classes. The stable trend has been obtained due to fewer disturbances and the remaining soils in the terraces and protected areas that offer favorable habitats for natural regeneration. These results came on a par with the findings of Boring et al. [43]; Lange and Graham [44]; Khan et al. [45]. They reported that the regeneration of tree species is greatly influenced by the interaction of biotic factors and environmental factors. Such favored interactions and also relatively lower disturbance levels as evidenced by the cumulative disturbance index could be attributed to health regeneration.

Table 4. Top ten dominated plant species and Ranks in different land use (Important value index, IVI), relative density, relative frequency and relative coverage

Species	Abandoned Terraces		Communal areas		National Parks		Protected areas		Settlement area	
	IVI	Rank	IVI	Rank	IVI	Rank	IVI	Rank	IVI	Rank
Cynodon dactylon	**137.51**	1	–	–	**114.53**	1	106.25	3		–
Cenchrus ciliaris	125.38	2	–	–	95.67	3	106.26	2		–
Urtica urens	113.10	3	–	–	–	–	–	–	–	–
Acacia origena	102.30	4	–	–	–	–	–	–	–	–
Onopordum heteracanthum	94.30	5	–	–	–	–	–	–	–	–
Asphodelus fistulosus	87.66	6	–	–	–	–	–	–	–	–
Achillea biebersteinii	86.82	7	–	–	85.71	4	**115.76**	1	109.68	3
Erodium neuradifolium	85.82	8	100.02	1	–	–	–	–	–	–
Aizoon canariense	85.66	9	–	–						–
Juniperus procera	85.06	10								–
Typha elephantina	–	–	94.17	2	71.43	6	87.57	5	84.6	7
Ipomoea sinensis ssp. blepharoscpala	–	–	77.78	3	–	–	–	–	–	–
Centaurea pseudosinaica	–	–	75.00	4	–	–	–	–	95.00	5
Hyparrhenia hirta	–	–	75.00	5	78.57	5	68.75	10	115	2
Latippes sengalensis	–	–	72.22	6	–	–	–	–	–	–
Ochradenus baccatus	–	–	65.70	7	–	–	–	–	–	–
Plantago lanceolata	–	–	65.56	8	–	–	–	–	–	–
Stipagrostis ciliata	–	–	61.11	9	–	–	–	–	–	–
Acacia origena	–	–	60.84	10	–	–	–	–	–	–
Kickxia elatine	–	–	–	–	100.00	2			80.00	8
Helichrysum forskahlii	–	–	–	–	64.29	7	68.76	9	–	–
Medicago laciniata	–	–	–	–	64.29	8	69.95	8	–	–
Themeda triandra	–	–	–	–	61.06	9	–	–	–	–
Echinops erinaceus	–	–	–	–	58.16	10	–	–	–	–
Celtis africana	–	–	–	–	–	–	101.42	4	–	–
Erodium cicutarium	–	–	–	–	–	–	75.83	6	65.03	9
Asphodelus tenuifolius	–	–	–	–	–	–	75.01	7	–	–
Cynoglossum bottae	–	–	–	–	–	–	–	–	**115.13**	1
Achyranthes aspera	–	–	–	–	–	–	–	–	100.04	4
Campanula edulis	–	–	–	–	–	–	–	–	85.00	6
Opuntia ficus-indica	–	–	–	–	–	–	–	–	65.00	10

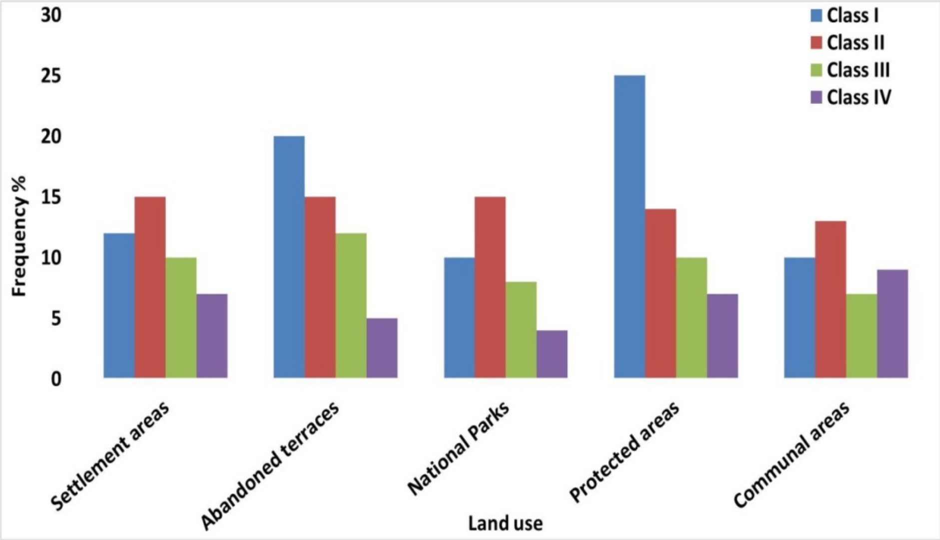

Figure 3. Distribution of regenerates among size classes

Disturbances and soil characteristics played a significant role in species diversity and dominance. Therefore, the alteration in species composition and vegetation structure in land-use types was the consequence of interaction among edaphic, geographic, environmental and anthropogenic factors. However, the Pearson correlation coefficient matrix showed a relatively significant correlation between some parameters with species richness and diversity as shown in Table 5. For instance, cut stumps, road construction, grazing, fire, and footpath had a significant negative correlation with the plant richness with value r=.-0.815, r=-0.716, r=-0.391, r= -0.924 and r=-0.665 respectively. Similarly, road construction was negatively correlated with the Number of Shannon's diversity index, density, and frequency with a value of r= -0.730, r= -0.421, r=-0.852 and r=-0.987 respectively. Grazing also negatively correlated with species richness, a number of individuals, Shannon's diversity index, density, and frequency with a value of r=-0.391, r=-0.467,r=-0.605 and r=-0.810 and -0.722. Road construction, especially in the sensitive habitats, have mostly negative effects on the distribution and dominancy of native plants than positive effects [46,47]. Soil traits are a key driver for plant biological processes and an important limiting factor for plant richness and diversity. This effect was even more pronounced in the positively correlated between clay and species richness, a number of individuals, Shannon's diversity index, density and frequency with a value of r=0.859, r=0.628, r=0.465, r=0.684 and r=0.818, respectively. This finding came according to the finding of Dolarslan et al. [48].

Table 5. Pearson Correlation Coefficient Matrix among Land Use

Disturbance and Soil Parameters	Plant richness and diversity				
	Species richness	Individuals	Shannon H'	Density Plant/ha	Freq%
Lopping	ns	ns	-0.743	-0.541	-0.525
Cut stumps	-0.815	-0.825	-0.746	-0.696	-0.612
Road cons	-0.716	-0.730	-0.421	-0.852	-0.987
Grazing	-0.391	-0.467	-0.605	-0.810	-0.722
Fire	-0.924	-0.987	-0.501	-0.887	-0.712
Weeds	0.774	0.976	ns	0.765	0.605
Footpath	-0.665	-0.806	-0.419	-0.878	-0.869
DAD	-0.448	-0.506	-0.762	-0.827	-0.512
cover	ns	ns	0.604	0.741	0.816
Gravel%	ns	ns	0.728	0.659	ns
Sand	-0.718	-0.570	ns	ns	ns
Sillt	0.390	0.347	ns	ns	ns
Clay	0.859	0.628	0.465	0.684	0.818
o.M/gkg-1	ns	ns	-0.498	-0.401	-0.533
Caco3/gkg-1	-0.420	ns	ns	ns	ns
Sp	ns	ns	-0.654	-0.588	-0.558
ph	0.338	ns	ns	ns	ns
Ec/dsm-1	ns	ns	-0.548	-0.454	-0.603
Ca	ns	ns	-0.549	-0.454	-0.593
Mg	ns	ns	ns	-0.609	-0.725
Na	0.508	0.665	ns	0.417	ns
K	ns	ns	-0.423	-0.388	-0.621
Hco3	ns	ns	-0.465	-0.353	-0.487
Cl	-0.343	ns 4	-0.372	-0.410	-0.742
So4	ns	ns	-0.566	-0.480	-0.608

* Significant association @ 0.05 P level, r = ± 0.337.

4. Conclusion

Species richness, Shannon Diversity Index, evenness and density were higher in the abandoned terraces and protected areas than national parks, communal areas, and settlement areas. These variations were driven by the cumulative disturbance index which is found to be significant among the different disturbance indexes and land uses types. However, the size class distribution of regenerated seedlings in abandoned terraces and protected areas showed a reverse J-shaped curve revealing the normal status of regeneration. This finding has been obtained due to fewer disturbances whereas the normal trend has been disturbed in the communal areas, settlement areas, and national parks, indicating the presence of disturbances in the land use types. Rarity index showed that the land uses with high disturbance have more rare plant species, indicating the impact of disturbance on alteration of species composition and forest structure. An important value index showed clearly the impact of disturbance in altering species dominance and distribution among land uses. Thus, the success of future management and conservation strategy depends on how it can reduce the amount of disturbance and enhance seedlings recruitment in settlements areas and communal areas. However, serious steps have to be taken either by researchers or decision-makers to enhance conservation plan strategies and elevating awareness among indigenous people.

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References

[1] Alqurashi, A.F., Kumar, L., "Land Use and Land Cover Change Detection in the Saudi Arabian Desert Cities of Makkah and Al-Taif Using Satellite Data." *Advanced Remote Sensing*, 3(3), 106-119, 2014.

[2] Kidane, Y., Stahlmann, R., Beierkuhnlein, C., "Vegetation dynamics, and land use and land cover change in the Bale Mountains, Ethiopia" *Environmental Monitoring Assess*, 184(12), 7473-7489, 2012.

[3] Al-Tokhais, A., Thapa, B., "Stakeholder Perspectives Towards National Parks and Protected Areas in Saudi Arabia." *Sustainability*, 11(2323), 2-15, 2019.

[4] Barichievy, C., Rob, D., Sheldon R, D., Wacher, T.L., lewellyn, O., Al-Mutairy, M., Alaqaili, A., "Conservation in Saudi Arabia; moving from strategy to practice" *Saudi Journal of Biological Science*, 25 (2), 290-292, 2018.

[5] Saudi Wildlife Authority, "*The National Strategy for Conservation of Biodiversity in the Kingdom of Saudi Arabia*." 2010.

[6] FAO, *Global forest resources assessment*, Country report Saudi Arabia FRA2010/185. 2010.

[7] Aref, I.M., El-Juhany, L.I., "The Natural and planted forests in Saudi Arabia; their past and present" *Arabic Gulf Journal of Science Research*, 18 (1), 64-72. 2000 (In Arabic).

[8] Darfaoui, El.M., Al Assiri, A. *A report prepared for FAO-RNE on Rresponse to Climate Change in the Kingdom of Saudi Arabia*, MOA, KSA, 2010, 17.

[9] Al-Aklabi, A., Al-Khulaidi, A.W., Hussain A., Al-Sagheer N.A. "Main vegetation types and Plant Species Diversity along an Altitudinal Gradient of Al Baha region, Saudi Arabia." *Saudi Journal of Biological Science*, 23 (6), 687-697, 2016.

[10] Synnott, T.J. *A manual of permanent plot procedures for tropical rain forests tropical Forestry Papers*. Department of Forestry Commonwealth Forestry Institute, University of Oxford. UK. 1979, 67.

[11] Larpkern, P., Moe, S.R., Totlan, O., "The effects of environmental variables and human disturbanceon woody species richness and diversity in a bamboo–deciduousforest in northeastern Thailand". *Ecological Research*, 24(1), 147-156, 2009.

[12] Devi Prasad, A.G., Al-Sagheer, N.A. "Floristic diversity of regenerated tree species in Dipterocarp forests in Western Ghats of Karnataka" *India Journal of Environmental Biology*, 33(4), 791-7, 2012.

[13] Wood, J.R., *Handbook of Yemen Flora*. Kegan Paul, 1991, 600.

[14] Collenette, S. *Wild Flowers of Saudi Arabia. National Commission for Wildlife Conservation and Development (NCWCD)*, Riyadh. 1999, 799.

[15] Miller, A.G., Cope, T.G., Nyberg, J.A. *Flora of the Arabian Peninsula and Socotra*, Edinburgh University Press, 1996, 586.

[16] Sathish, B. N., Viswanath,S., Kushalappa, C.G., Jagadish, M. R., Ganeshaiah, K. N., "Comparative assessment of floristic structure, diversity and regeneration status of tropical rain forests of Western Ghats of Karnataka, India." *Journal of Applied and Natural Science*, 5 (1), 157-164, 2013.

[17] Al-Sagheer, N.A. Devi Prasad, A.G., "Ecology and Diversity of Dipterocarpus Forests in Western Ghast of Karnataka, India." *Asian Journal of Microbiology, Biotechnology and Environmental Sciences*, 13 (3), 445-452, 2011.

[18] FSI., *Report on Inventory of forest resources of Kodagu*. South zone, 1995.

[19] Kushalappa, C.G., Kushalappa, K.A. Ecological changes in high altitude forests of Kodagu, in *south India proceedings of the Inter – Divisional Seoul conference*, Seoul, Korea, 1998, 91-97.

[20] Jeevan, K. *Distribution and reproductive biology of Vateria indica L. in central WesternGhats of Karnataka*. M. Sc thesis submitted to the University of Agricultural Sciences, 2007.

[21] Al-Sagheer, N.A., Devi Prasad, A.G., Prakash, N.A., "Impact of Anthropogenic Pressures on Forest Structure and Species Composition of Moist Deciduous Forest in Thithimathi Range of Western Ghats, India" *International Journal of Agronomy and Agricultural Research*, 4 (2), 131-149, 2009.

[22] Shannon, C.E., Weaver, W., *The Mathematical Theory of Communication*. University of Illinois Press, Urbana. 1949.

[23] Jaccard, P., "Nouvelles recherches sur la distribution florale" *Bulletin de la Société vaudoise des sciences naturelles*, (163), 223-270, 1908.

[24] Hubbell, S.P., *The Unified Neutral Theory of Biodiversity and Biogeography*. Princeton University Press, Princeton, NJ, 2001.

[25] McGill, B.J., Etienne, R.S., Gray, J.S., Alonso, D., Anderson, M.J., Benecha, H.K., Dornelas, M., Enquist, B.J., Green, J.L., He, F., Hurlbert, A.H., Magurran, A.E., Marquet, P.A., Maurer, B., Ostling, A., Soykan, C.U., Ugland, K.I., White, E.P., "Species abundance distributions: moving beyond single prediction theories to integration within an ecological framework" *Ecology Letters*, 10, 995-1015, 2007.

[26] Al-Khulaidi, A.W., Al-Sagheer, N.A., AL-turki, T., Filimban, F., "Inventory of Most Rare and Endangered plant species in Al Baha Region, Saudi Arabia" *International Journal of Biology, Pharmacy and Allied Sciences*, 7(4), 443-460, 2018.

[27] Curtis J.T., McIntosh, R.P., "The Interrelations of Certain Analytic and Synthetic Phytosociological Characters. *Ecology*, 31(3), 434-455, 1950.

[28] Manohar, M. "A Study on the Floristic Compositions of Hudguru Reserve Forest, Kodagu District, Karnataka, India" *International Journal of Current Research and Academic Reviews*, 3(9), 34-40, 2015.

[29] Ministry of Agriculture, Natural resources, *Forest inventory project in the southwestern region of Saudi Arabia, Volume III, Inventory of natural forests in the second zone*, King Abdulaziz City for Science and Technology, National King Fahd library, Riyadh, 2007, 260.

[30] Mukaka, M.M., "Statistics Corner: A guide to appropriate use of Correlation coefficient in medical research" *Malawi Medical Journal*, 24 (3), 69-71, 2012.

[31] Mutalemwa, R. *Influence of different land use type on bird and tree species diversity around lake Victoria basin in Bukoba municipality, Tanzania*. M.sc submitted to Sokoine University of agriculture. Morogoro, Tanzania, 2015, 59.

[32] Maitima, M. J., Olson, J. M., Mugatha, S. M., Mugisha, S. and Mutie.T. I., "Land Use Changes, Impacts and Options for Sustaining Productivity and Livelihoods in the Basin of Lake Victoria" *Journal of Sustainable Development in Africa*, 12, 189-190, 2010.

[33] Howladar, S., Al-Sodany, Y., Abdelkhalik, K., "Species richness of the catchment area of Al-Baha region, Saudi Arabia" *Bothalia African Biodiversity and Conservation*, 45(5), 64-91, 2015.

[34] Arevalo, J.R., Tejedor, M., Jiménez, C., Reyes-Betancort, J.A., Díaz, F.J., "Plant species composition and richness in abandoned agricultural terraces vs. natural soils on Lanzarote (Canary Islands)" *Journal of Arid Environments*, 124 (1), 165-171, 2016.

[35] van Ruijven, J., Berendse, F., "Diversity-productivity relationships: initial effects, long-term patterns, and underlying mechanisms" *Proceeding National Academic of Science, USA*, 102, 695-700, 2005.

[36] Loreau, M., Naeem, S., Inchausti, P., *Biodiversity and Ecosystem Functioning: Synthesis and Perspectives*, Oxford University Press, Oxford, 308, 2002.

[37] Tilman, D., Lehman, C.L., Thomson, K.T., "Plant diversity and ecosystem productivity: theoretical considerations. *Proceeding National Academic of Science, USA*, 94, 1857-1861, 1997.

[38] Hindrum, L., Mark, J., Hovenden, M.J., Mark, G., Neyland, M.G., Baker, S.C., "The effects of mechanical disturbance and burn intensity on the floristic composition of two-year old aggregated retention coupes in Tasmanian wet eucalypt forests" *Forest Ecology and Management* 279, 55-65, 2012.

[39] Mobaied, S., Machon, N. and Porcher, E., "Ecological specialization and rarity indices estimated for a large number of plant species in France" *Data in Brief*, 3, 165-168, 2012.

[40] Moro, M.F., Silva, I.A., Araújo, F.S.d., Nic Lughadha, E., Meagher, T.R., Martins, F.R., "The Role of Edaphic Environment and Climate in Structuring Phylogenetic Pattern in Seasonally Dry Tropical Plant Communities" *PLoS ONE*, 10 (3), 1-18, 2015.

[41] Pelissier, R., *Heterogente spatiale et dynamique d'une forest dense humide dans les Ghats Occidentaux de I'inde*. Publications du Department d' Ecologie, Institute Francias de Pondichery. 37, 1997.

[42] Vazquez-Yanes, C., Orozco-Segovia, A., "Patterns of seed longevity and seed germination in the tropical rainforest" *Annual Review of Ecological Systems*, 24, 69-87, 1993.

[43] Boring, L.R., Monk, C.D., Swank, W.T., "Early regeneration of a clear cut southern Appal achain forest" *Ecology*, 62 (5), 1244-1253, 1981.

[44] Lange, T.R., Graham, R.C., "Rabbits and the failure of regeneration in the Australian arid zones Acacia" *Australian Journal of Ecology*, 8(4), 377-381, 1983.

[45] Khan, M.L., Rai, J.P.N., Tripathi, R.S., "Regeneration and survival of tree seedlings and sprouts in tropical deciduous and subtropical forests of Meghalaya, India" *Forest Ecology and Management*, 14 (4), 293-304, 1986.

[46] Forman, R.T.T., Alexander, L.E., "Roads and their major ecological effects" *Annual Review of Ecological Systems*, 29, 207-231, 1998.

[47] Gelbard, J.L., Belnap, J., "Roads as conduits for exotic plant invasions in a Semiarid landscape" *Conservation Biology*, 17 (2), 420-432. 2003.

[48] Dolarslan, M., Ebru, Gul., E., Erşahin, S., "Relationship between Soil Properties and Plant Diversity in Semiarid Grassland" *Turkish Journal of Agriculture - Food Science and Technology*, 5 (7), 800-806, 2017.