Pak. J. Bot., 53(6): 2143-2155, 2021. DOI: http://dx.doi.org/10.30848/PJB2021-6(38)

ASSESSMENT OF POTENTIAL FUNCTIONAL USE OF FLORISTIC COMPOSITIONS IN LANDSCAPE RESTORATION OF HABITATS IN ARID REGIONS

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Abstract

Plant diversity has been rapidly disappearing in arid and semiarid regions as a result of climate change and human activities. Nevertheless, the use of plants for various purposes is still widespread. One of the most urgent applications of plant diversity is the use of native plants in the restoration of landscape habitats on account of their extreme importance in supporting wildlife in natural and urban landscapes and their contributions to the process of transformation to sustainability. In fact, the arid and semiarid regions require greater focus insofar as the use of their native species is concerned; plant diversity needs to be adopted in planting projects to improve the vegetal list so that it becomes more compatible with the harsh conditions there. The present work, therefore, aims to assess the plant diversity of the main habitats by studying and analysing floristic compositions, life form, and chorological characteristics in order to select the materials of new plants, which are to be used in different landscapes under arid and semiarid conditions. This study covers 63 samples in all habitats in Wadi Al-Ahsibah in Al-Baha province in the southwest part of Saudi Arabia. Plant species were classified and arranged in accordance with their plant families, life form, chorology, and habitats, and, finally, with the aim to assess the functional use of landscape restoration. The results recorded a total of 202 plant species belonging to 142 genera and 62 families. This list provided 111 species as the materials for new plants for landscape architecture in accordance with visual appeal, functions, and potential environmental benefits like landscape restoration, hydrological applications, soil conservation, afforestation, and support of wildlife. Finally, the arid and semiarid regions have great potential for biodiversity and floristic composition, which could form a wide resource for several kinds of environmental and urban projects.

Key words: Native plant, Planting design, Plant diversity, Sustainability, Plant materials, Landscape architecture, Potential environmental benefits.

Introduction

Plant diversity has been of great interest to mankind since ancient times for several reasons, which include supplies of food, fibres, medicines, as well as plant materials for use in landscape restoration projects. The rapid change in the rhythm of urbanization in the past few decades in Saudi Arabia has caused great decreases in vegetation composition and big changes in the natural landscape structure (Alzandi, 2015). In turn, biodiversity losses disturb the ecosystem function, compromise the delivery of ecosystem services, and likely reduce the resilience of these systems to disturbances (Landis, 2017). Human activities impact plant diversity, wildlife, and natural habitats by modifying or transformation natural areas into agricultural plots, or urban and suburban developments (Landis, 2017, Hassan & Hassan, 2019). On other hand, there is sufficient evidence to indicate that biodiversity is essential to provide a wide range of ecosystem services supporting the quality of human life (Rastandeh, *et al*., 2017). Floristic composition studies focus on plant structure in natural ecosystems, thereby providing an important insight into plant biodiversity (Abdel Khalik *et al*., 2013; Salem, *et al*., 2016; Thomas *et al*., 2017; Shalabi & Masrahi, 2019). However, utilization of these studies in the applied fields is still limited despite the importance of opening up more efficient scope for the use of biological diversity like medicinal, aromatic, industrial, and woody plants as well as their use in planting projects, which cover urban, rural, and natural landscapes. They also maintain and support ecosystems by reusing biodiversity in landscaping and wildlife sustenance. The details provided by studying the floristic composition from the lifeform and chorological aspects are an important input in the good selection of these species in the fields of planting projects.

Many limitations can be seen in the arid and semiarid regions-namely the low and inconsistent precipitation, high temperatures and evaporation, poor soil, and special types of vegetation (Ghazal, 2015). In fact, these fragile regions are considered to be the home to many endemic and rare species that are well adapted to these harsh conditions (Thomas *et al*., 2017), and hence, they require more attention to prevent the loss of plant diversity. On the other hand, the arid climate is dominant all over Saudi Arabia except in the heights of the southwest province, which is classified as semiarid (Al-Nafie, 2008).

The selection of plant materials for landscape restoration is a-if not the-major issue in several types of sustainable projects. Plant materials in Landscape Architecture (LA) have many functions: structural (architectural or functional), environmental (ecological), and visual (aesthetic) (Robinson, 2004). Moreover, planting trees and urban forests have many benefits: social, aesthetic, healthful, architectural, climatic, engineering, economic, and ecological benefits, and their uses range from intangible psychological and aesthetic benefits to the amelioration of urban climates and reductions in air pollution (Konijnendijk *et al*., 2005).

Nowadays, the plant materials already in use in planting projects in arid and semiarid regions, especially when selected for environmental purposes, are required to be improved because most of these species have been introduced. That is to say, they require more maintenance to survive. Hence, it is necessary to select new plant materials that can tolerate these harsh arid and semiarid conditions, and that can be very effective in the future by requiring minimal maintenance, low water consumption, and limited need for other services.

Native plants-which are selected from the local flora-can have superior adaptation to local climatic stresses, and, hence, play a high potential role in making planting projects more sustainable. This gives the planting designers more options to use these species as plant materials in planting projects. However, these are still not available in many areas (Morash *et al*., 2019). Native plants have several advantages; they are well adapted to local soils and climate conditions, and are often more resistant to insects and diseases. They also provide new colours, shapes, and forms, and give the design a local identity (Adams *et al*., 1978). Moreover, they generally require less maintenance compared to non-natives; hence, the use of native plants helps preserve the natural ecosystems and enhances the impacts of wildlife and ecosystem restoration (Koester, 2008).

Several studies have noted an increase in the use of native plants by LA worldwide, as in Hawaii in the United States of America (Brzuszek *et al*., 2007), in Italy (Baltzoi *et al*., 2015), and in Turkey (Gokturk *et al*., 2006; Surat & Eminağaoğlu, 2018). Many authors from the Middle East, such as from the United Arab Emirates (UAE), have emphasized the use of native plants because of their potential to develop unique landscapes (Alam *et al*., 2017), or have suggested several species from native plants to be used in LA projects (Adams *et al*., 1978; Ricks, 1992), especially when sustainability is sought in planting projects.

From the viewpoint of floristic composition, the vegetation cover of Saudi Arabia is low in floristic diversity; the total number of plant species recorded in Saudi Arabia is 2,172. These belong to 840 genera and 149 families; most of them are recorded from the Asir Mountains in the southwestern part of the country (Al-Nafie, 2008). On the other hand, the Arabian Peninsula comprises mainly of two phytogeographical regions (Al-Nafie, 2008). The first one is the Saharo-Arabian region (Zohary, 1973) or the Saharo-Sindian region, and the second one is the Sudano-Zambezian region, the Sudanian region, or the Sudano-Zambezo-Sindian region. The Sudano-Zambezian region presents two sub-regions (I): Eritreo-Arabian (EA), which stretches from West Africa over a narrow strip along the Red Sea coast south of Makkah (Tihamah plain), below 1,800m on the Asir Mountains, and (II): Afromontane (Af), an archipelago-like regional centre of endemism, which covers the Asir Mountains, since the areas are higher than 1,800m above sea level (asl) (Al-Nafie, 2008).

The distribution of lifeforms is closely related to physiognomy, topography, and landform (Abdel Khalik *et al*., 2013). The distinguishing feature of the plant life in Saudi Arabia is the xerophytic vegetation (Zahran, 1982), and it is typical of the desert flora, where the majority of species are therophytes and chamaephytes (Abdel Khalik *et al*., 2013). Areas at high altitude are characterized by the dominance of phanerophytes, followed by hemicryptophytic and geophytic species (Al-Yemeni & Sher, 2010).

This study attempts to test two main hypotheses. First, there is a variation in respect of the floristic composition, lifeform, and chorological characteristics, among the habitat types of Wadi Al-Ahsibah. Second, from the perspective of landscape restoration, plants of the native species are one of the best ways to achieving sustainability in landscape architecture projects. Hence, the plant list of Wadi al-Ahsibah can be applied as a source for different functional and environmental uses in LA projects.

Study area: Wadi Al-Ahsibah is a major important watershed in the Al-Baha region in the southwest part of Saudi Arabia. It is located at 19.30°–20.02°N and 40.95°–41.71°E (Fig. 1), covering around 1,300km^2.

The Al-Ahsibah watershed is dominated topographically by different features. It starts from the top of the Asir Mountains, more than 2,350m (asl), near Al-Baha city; it then declines westwards on the Red Sea escarpment, and then continues around Al-Moukhwat city in Tihamah plateau, which ranges between 1,100m (asl) and the sea level. It is marked by several small mounts and ridges that can reach some 2,000m in height, like Jabal Shada Al-Aala and Al-Asfal, which have several endangered trees (Thomas *et al*., 2017). It finally reaches the Red Sea near Muzalife city. The populated areas and the agricultural activities increase in the plain landscape in the downstream of the valleys in the Tihamah plains.

The study area belongs to the greater Afro–Arabian fault (Rift Valley). It is predominated by plutonic rocks and quaternary alluvial deposits, with aeolian sand occupying the wadis and coastal plains (Prinz, 1983). The soil in the coastal plains is covered by a thin veneer of poorly sorted, fine to coarse-grained sand and gravel, but it is aeolian sand or sandy loam to loam in Tihamah, while the sandy loam soil on the escarpments is eroded and spread on rocky slopes in holes. It is protected by rocks. Furthermore, the sandy loam soil in the mountains is developed and the organic layer can always be recognized (Ghazal, 2015).

Data from five climate stations (Al-Baha, Baljurashi, Mandeqe, Muzilife, and Mokhwat) were taken to assess the temperature and rainfall in the study area. The mean annual rainfall in the Tihamah province ranges from 66 to 180mm, but on the high mountains it reaches 541mm, falling mainly during winter, with limited rainfall in summer. The maximum temperature is very high during the summer in Tihamah—it reaches 40.4°C-but on the high mountains, it is only 34°C. In winter, the minimum temperatures are 19.7°C and 8.1°C respectively (Table 1).

The arid climate dominates in most of the study area in the coastal and Tihamah plains while the high mountains are classified as semiarid.

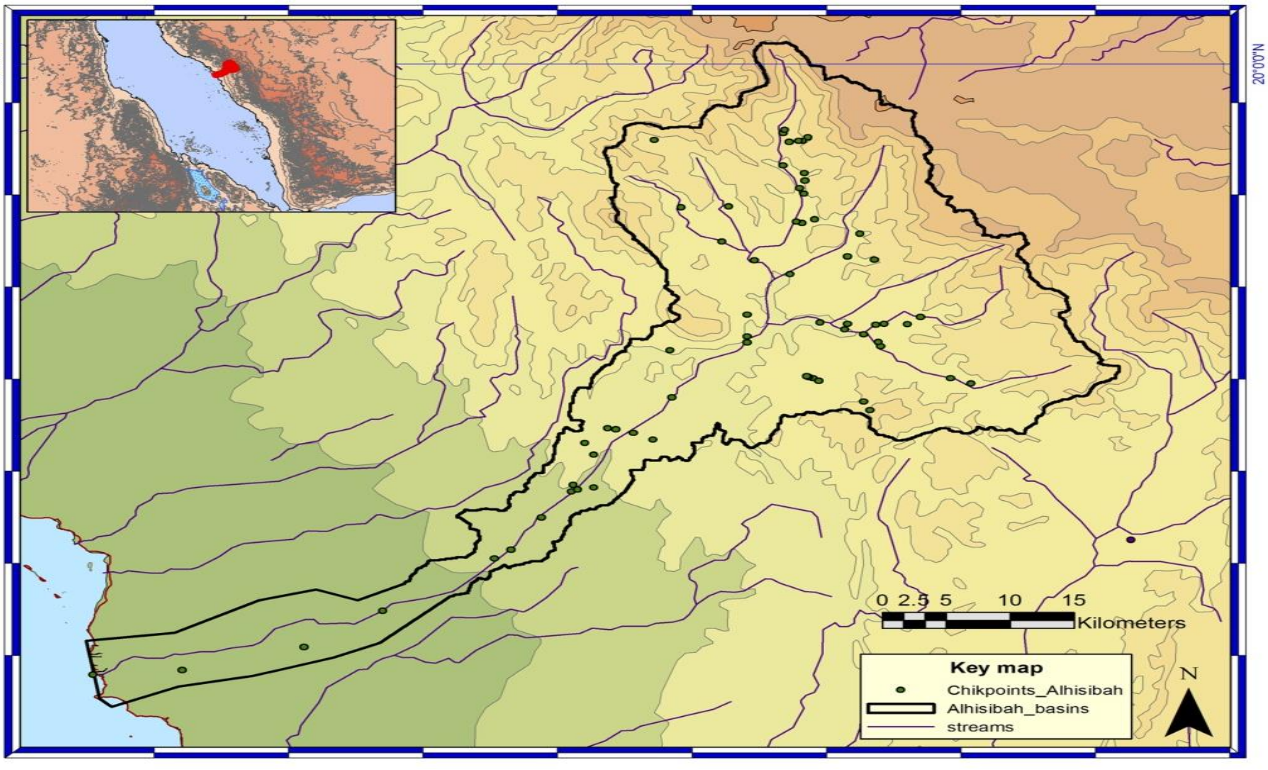

Fig. 1. Location of the study area, showing plots, watershed boundary, tributaries, and topography.

Table 1. The mean, minimum, and maximum temperatures and rainfall data recorded in Wadi Al-Ahsibah, using climate data from five stations for more than a 25-year period.

	Temperature (C°)						Rainfall (mm)	
	Winter		Summer		Mean/year		Minimum	Maximum
	Min. C°	Max. C°	Min. C°	Max. C°	Min. C°	Min. C°	Max. C°	
Tihamah plains	19.7	33.3	26.5	40.4	25	35.7	66	180
Asir mountain heights	8.1	24.1	11.5	34	12.5	23.5	218	541

Source: The General Authority for Meteorology and Environmental Protection (PME), Saudi Arabia (Period: 20 to 30 years)

Materials and Methods

The research method consists of three stages. In the first one, field visits to Wadi Al-Ahsibah were carried out. A total of 63 sample plots (plots: quadrates of 20×20m each) were studied along the Wadi Al-Ahsibah, which covered most of the habitats in the study area (Fig. 1). It included a description of the site's characteristics, elevation, slope, aspect, and vegetation coverage. In the second stage, samples of the collection plant species were identified, classified, and arranged in a list within the floristic composition in accordance with their lifeform, chorology, and habitat. Lifeform data for all vascular plant species were recorded in the field in accordance with the position of regenerative buds and parts during the unfavourable season (Raunkiaer, 1934). The data were compared with other studies in the region, and the field record was then adopted in case there was any dissimilarity. A chorological analysis of the floristic categories of species was conducted using the floras of Saudi Arabia (Collentette, 1999; Chaudhary, 1999–2001). The chorological units were selected from Zohary (1973) and Al-Nafie (2008) as follows: Cosmopolitan (Cosm), Tropical (Tr), Saharo–Arabian (SA), Sudano–Zambezian (SZ), Irano–Turanian (IT), and Mediterranean (Me). Habitat types and their environments were recognized by relying on topographic, geological, hydrological, and soil maps as well as climate characteristics and vegetation components. Moreover, for each habitat, the environmental characteristics and variables, including the total number of species (N) and the average value Shannon (H) and Simpson (S) indices (Legendre & Legendre, 1998), were also identified, using CANOCO software for Windows Version 4.56.

In the third stage, the plant species functional to the use for different types of landscape restoration projects were assessed from the recorded list of native plants in the study area and classified in accordance with their LA values and plant types and characters, and the potential environmental benefits of the plants in landscape restoration projects (Table 2).

The collected plant specimens were identified in accordance with the Saudi Arabian floras (Collentette, 1999; Chaudhary, 1999–2001), and were corrected by (https://www.gbif.org/). The specimens were deposited in the Department of Landscape Architecture, Faculty of Architecture and Planning (previously the Faculty of Environmental Design), King Abdulaziz University.

Table 2. The categories of LA values and plant types and characters, and the potential environmental benefits of the plants in landscape restoration projects.

The LA values	
Form or structure suitable for planting projects (S), colours and shapes of leaves (L), flowers or fruits (F), aromatic foliage and scent (A)	
Types and characters	
Palm (p), tree [large (tl), medium (tm), and small (ts)], shrubs [large (sl), medium (sm), and small (ss)], ground cover (gc), and climber (cl)	
Landscape restoration projects	**Potential environmental benefits**
Visual and other sensory (V)	Public and private LA, residential landscapes, structural landscaping, shadow tree roadside
Functional and structural characteristics (F)	Roof, rock, and drywall gardens
Afforestation (A)	Shelterbelts, green belts, highway road, windbreakers
Landscape reclamation (R)	Restoration of degraded vegetation landscape
Soil conservation (S)	Soil erosion (wind and water), stabilizing mobile sand dunes
Wildlife support (W)	Plant diversity conservation, creation of wildlife habitats
Hydrological applications (H)	Flood stormwater management, water conservation
Urban environment (U)	Urban climates, atmospheric purification, air quality, acoustic control, pollution control, traffic control, energy control, and carbon sequestration

Results and Discussion

The plant diversity is a very important source for vegetal materials in planting projects, especially in the arid and semiarid regions. The details of the floristic composition may increase the efficiency of the application of native plants in planting design, thereby giving the designer more options to select plant materials. In fact, the planting designer eagerly uses native plants in urban and environmental project designs. The emphasis has now shifted to the use of native plants for solving engineering problems as well as for beautification. When plants are used consciously or unconsciously to perform these functions, they are exploited for engineering uses. For that, it is necessary to give native species greater care for use in the new list of plant materials in the arid and semiarid regions so as to approach sustainability in planting projects.

Habitats types on Wadi Al-Ahsibah: The field survey of the study area covered 63 samples. Six habitat types were distinguished, depending on climatic factors, geology, topography, soil, and hydrology. These habitats were: (1) Coastal plains (C), which comprised the area of the seashore inundated with tides. (2) Aeolian sand dunes (D): These sand dunes were formed in the downward portions of the valley, especially in the plains. (3) Undulating plateau (P) formed by the hills and plains, which are compatible with the Tihamah Plain. (4) Rocky hills (R) included the escarpment and plateau that lost most of the soil or are still protected among rocky cracks and holes. (5) Watercourses and valleys (W) consisted of streams flowing along in the downstream. (6) High mountains (M) were those parts of the mountains at a greater height, and were covered by the remnants of *Juniperus* forests at all levels of degradation (Table 3). In general, these habitats are consistent with the habitat models that have been recorded in the Al-Baha region (Ghazal, 2015; Al-Aklabi, *et al*., 2016).

Floristic composition of the Wadi Al-Ahsibah: By surveying all the habitats in the study area, 202 species were recorded and listed in (Table 4). The floristic composition was recognized for each species.

Table 4: List of species and floristic composition for all species recorded in this study, arranged by families and botanical names, with details of their chorotypes, life forms, habitats, planting projects, LA values, and types used (the codes used in this table were described in the methodology of this study). Chorotypes: Cosmopolitan (Cosm), Tropical (Tr), Saharo–Arabian (SA), Sudano–Zambezian (SZ), Irano–Turanian (IT), and Mediterranean (Me); Lifeforms: Therophytes (Th), Chamaephytes (Ch), Phanerophytes (Ph), Hemichyptophytes (H), Geophytes (Ge), Lianas (Li), and Epiphytes (Ep). Habitats: Aeolian sand dunes (D), coastal plains (C), undulating plateaus (P), rocky hills (R), watercourses and wadis (W), high mountains (M); LA values: Form or structure suitable for LA (S), colours and shapes of leaves (L), flowers or fruits (F), aromatic foliage and scent (A); Types and characters: Palm (p), tree [large (tl), medium (tm), and small (ts)], shrubs [large (sl), medium (sm), and small (ss)], ground cover (gc) and climber (cl); Environmental potential benefits**:** Visual and other sensory (V), Functional and structural characteristics (F), Afforestation (A), Landscape reclamation (R), Soil conservation (S), Wildlife support (W), Hydrological applications (H), and Urban environment (U).

The 202 species recorded in Table (4) belong to 142 genera and 62 families. These respectively present about 9%, 18%, and 42% of the total number of species, genera, and families of the flora in Saudi Arabia. The major plant families that contributed to the formation of vegetation of the study area are Compositae and Leguminosae (10.8%; 22 species each), followed by Poaceae (5.9%; 12 species), Solanaceae and Lamiaceae (4.4%; 9 species and 3.9%; 8 species respectively) while four families (Apocynaceae, Capparaceae, Euphorbiaceae, and Malvaceae) were presented by 3.4%; 7 species. Moreover, 12 families were represented by 3–1.9%, 3–6 species (48 species in total), and a further 13 families each containing just two species and 28 families represented by a single species (Table 5). These numbers conform to the general description of the flora of Saudi Arabia (Collentette, 1999; Al-Naif, 2008).

Table 3. Vegetation types, dominant species, vegetation coverage, and climate conditions for habitats were recognized in the study area.

Habitat type	Altitude (m asl)	Vegetation	Dominant species	Climate	Vegetation coverage
Arid region: From seashore to 1,100m					
Coastal plains (C)	>10m	Mangrove vegetation	*Avicennia marina*	Deluge by high tide	Number of patches
Sand dunes (D)	10–200m	Grassland vegetation (xerophytes annual and permanent species shared with leaf shrubs)	*Diptergium glaucum*, *Panicum turgidum*, *Salvadora persica*, *Cadaba rutandifolia*, and *Leptadenia pyrotechnica*	Rainfall less than 100mm, temperature ≥32°C	Very low >10%
Undulating plateau (P)	200–1,100m	Arid Acacia woodland vegetation	several species of *Acacia* sp. mainly: *A. ehranbergiana*, *A. etbaica*, and *A. totilis*	rainfall 100–170 mm, temperature 29–32°C	Medium 40–50%
Watercourses (W)	200–1,100m	In the downstream	*Zizyphus spina-christi*, and *Calotropis procera*		Medium 30–50%
Semiarid region: from 1,100m–summit					
Rocky hills (R)	1100–1800m	Semiarid Acacia and evergreen woodland vegetation	*Acacia asak*, *Olea europaea*, and *Ficus* sp.	Rainfall 220–270mm, temperature 22–29°C	High 50–70%
Watercourses (W)	1100–2000m	In the upstream	*Ficus* sp., *Rhus* sp., and *Pistacia* sp.		Medium 40–60%
High mountains (M)	2000m–summit	Juniper forest vegetation	*Juniperus procera*	Rainfall 280–400mm, temperature ≤22°C	High >60%

The chorological records in the flora of Wadi Al-Ahsibah showed that the mono-regional (one region) is dominant in the study area by large numbers of SZ elements (79; 39.1%), followed by SA elements (37; 18.3%), but other regions like Tr, Me, Cosm, and IT were recorded in lower numbers (11; 5.4%, 11; 5.4%, 7; 3.5%, and 3; 1.5% respectively). Furthermore, the highest bi-regional (two regions) elements are recorded by SA–SZ (19; 9.4%), while the remaining species (32; 15.8%) belonged to other types. The pluri-regional (many regions) had just 3; 1.5% (Fig. 2).

The chorological spectrum in the study area was reflected in the two major regions SZ and SA. The first one is dominated by the semiarid climate region, which exists in the heights, as shown in the juniper forests, and most of the escarpments of Asir Mountains. The latter shows strongly in the arid region in Tihamah, the western escarpments, and the coastal plain, where the semi-forest of *Acacia* vegetation is presented, and extends from the sea level to around 600m (asl) on sand dunes and rocky hills. It is characterized by an arid desert region, with very poor species diversity.

In general, the numbers and percentages for lifeforms of the species in the study area were as follows: (60; 29.7%) chamaephytes, (56; 27.7%) therophytes, (49; 24.3%) phanerophytes, (24; 11.9%) hemichyptophytes; followed by geophytes (10; 5%), and, finally, lianas and epiphytes (2; 1%, and 1; 0.5% respectively) (Fig. 3). On the other hand, the lifeforms that appeared in the semiarid region were as follows: therophytes (43; 21.3%), chamaephytes (40; 19.8%), phanerophytes (33; 16.3%), and hemichyptophytes (19; 9.4%), while, in the arid region, the figures were: chamaephytes (20; 9.9%), phanerophytes (16; 7.9%), therophytes (13; 6.4%), and hemichyptophytes (5; 2.5%) (Fig. 3).

Six different habitats were recorded in the study area; the result of counting the number of species in each habitat showed that the high mountains element has the highest number (45; 22.3%), followed by the rocky hills element (33; 16.3%). The other habitats have less than 5%. The rocky hills habitat was recorded in all regions of the study area as this type of habitat presents deteriorated vegetation caused by human activities. On the other hand, the species seen in two habitats were concentrated in two types viz. rocky hills, watercourses and rocky hills, and high mountains (28; 13.9 and 21; 10.4% respectively), three habitats viz. rocky hills, watercourses, and high mountains (13; 6.4%), and four and five habitats types viz. rocky hills, Sand dunes, Coastal plains, watercourses, and Undulating plateau (3; 1.5%). This highlights the point that there is a high level of human interference (Table 6). Floristic composition and diversity clearly varied among the different habitats studied.

The diversity indices for each habitat type showed that the high mountains and rocky hills were the highest values for Shannon and Simpson indices (H = 2.89 and 2.71, S = 16.60, 15.33 respectively) followed by the watercourses and undulating plateau, and the lowest values were for the aeolian sand dunes and then the coastal plains (Table 7).

Table 4. List of species and floristic composition for all species recorded in this study, arranged by families and botanical names, with details of their chorotypes, life forms, habitats, planting projects, LA values, and types used (the codes used in this table were described in the methodology of this study).

Family	Plant name	Chorotypes	Life form	Habitat	planting projects	LA value	Type used
Acanthaceae	*Anisotes trisulcus* (Forssk.)Nees	SZ	Ph	P,R,W	V,F	F	sm
	Barleria bispinosa (Forssk.)Vahl	SZ	Ph	P,R,W	-	-	-
	Blepharis ciliaris (L.)B.L.Burtt	SA,IT	Ch	P,R,W	-	-	-
Adiantaceae	*Cheilanthes pteridioides* C. Chr.	Me	H	R,M	-	-	-
	Cheilanthes vellea (Aiton) Domin	Me	H	M	-	-	-
Aizoaceae	*Aizoon canariense* L.	SA,IT	Th	R	-	-	-
	Trianthema portulacastrum L.	SZ	Th	W			
Aloaceae	*Aloe shadensis* Lavranos & Collen.	SA	Ch	R	V,F	L,F	gc
Amaranthaceae	*Aerva javanica* (Burm.f.)Juss. ex Schult.	SA,SZ	Ch	D,P,R,W	V,S,F	F	gc
	Atriplex leucoclada Boiss.	SA,Tr	Ch	M	V,F,S,F	L	sm
	Chenopodium murale L.	IT,Me	CH	M	-	-	-
	Chenopodium album L.	Cosm	Th	R,M	-	-	-
	Salsola imbricata Forssk.	SA,SZ	Ch	W	V,S,F	L	ss
	Salsola kali L.	SA,Me	Th	R,W,M	-	-	-
Amaryllidaceae	*Crinum album* (Forssk.) Herb.	SZ	Ge	R	V,F	L,F	gc
Anacardiaceae	*Pistacia falcata* Becc. ex Martelli	Sz	Ph	R,W	V,F,W	S,F,A	tl
	Rhus retinorrhaea Steud. ex A. Rich.	SZ	Ph	R,W,M	V,F,S,W	S,L,A	sm
Apocynaceae	*Adenium obesum* (Forssk.) Roem. & Schult.	SA	Ph	R,W	V,F	S,F,L	sm
	Calotropis procera (Aiton) Dryand.	Tr	Ph	D,C,P,R,W	V,F,S,W,U,H	F,L	sl
	Carissa edulis (Forssk.) Vahl	SZ	Ph	R,W	V	S,F	ss
	Gomphocarpus fruticosus (L.) W.T. Aiton	SZ	Ch	R,W	-	-	-
	Leptadenia pyrotechnica (Forssk.) Decne.	SA,SZ	Ph	D,P,W	V,F,S,W	S,F	sm
	Periploca somaliensis Browicz	SZ	Li	M	V,F	S,F	cl
	Rhazya stricta Decne.	SA	Ch	W	V,L	S,L	gc
Arecaceae	*Hyphaene thebaica* (L.)Mart.	SA,SZ	Ph	D,W,C	V,W	S,L	p
	Phoenix caespitosa Chiov.	SZ	Ph	R	V,W	S,L	p
Asclepiadaceae	*Caralluma russelliana* (Courbai ex Brongn.) Cufod.	SZ	Ch	P,R,W	V,F	S	gc
Asclepiadaceae	*Cryptolluma edulis* (Edgew.) Plowes	SA	Ch	W			
Asparagaceae	*Asparagus setaceus* (Kunth) Jessop	SZ	Ge	M	V,F	L	gc
Asphodelaceae	*Asphodelus tenuifolius* Cav.	SA,Me	Ge	M	V,F	F	gc
Aspleniaceae	*Ceterach officinarum* DC.	IT,Me	Ge	M			
Barbeyaceae	*Barbeya oleoides* Schweinf.	SZ	Ph	R	V, F	S,L	ts
Boraginaceae	*Buglossoides arvensis* (L.) I.M. Johnst.	Cosm	Th	M	-	-	-
	Heliotropium aegyptiacum Lehm.	SZ	Th	D,R	-	-	-
	Heliotropium arbainense Fresen.	SA,SZ	Ch	D,R,W	-	-	-
	Heliotropium pterocarpum (DC. & A. DC.) Hochst. and Steud. ex Bunge	SA,SZ	Th	P	-	-	-
	Trichodesma trichodesmoides Gürke	SZ	Ch	R	-	-	-
Brassicaceae	*Diplotaxis harra* (Forssk.) Boiss.	IT,ME	H	M	-	-	-
	Erucastrum arabicum Fisch. & C.A. Mey.	SZ	Th	M	-	-	-
	Sisymbrium loeselii L.	IT,ME	Th	M	-	-	-
Burseraceae	*Commiphora myrrha* (Nees) Engl.	SZ	Ph	R	V	S	ts
Cannabaceae	*Celtis africana* Burm.f.	SZ	Ph	R,W	V,W	S	tl
Capparaceae	*Cadaba farinosa* Forssk.	SZ	Ch	P,W	V,F,S,W,U	F	sm
	Cadaba rotundifolia Forssk.	SZ	Ch	D	V,F	S	sl
	Capparis decidua (Forssk.)Edgew.	SZ	Ph	D,C,P,W	V,F,S,W,H	S,F	sl
	Capparis spinosa L.	Me,IT	Ph	R,W	V,S,W	F	ss
	Dipterygium glaucum Decne.	SZ	Ch	D,C,P,W	V,S	F	gc
	Maerua crassifolia Forssk.	SA,SZ	Ph	P,R,W	V,F,S,W	S,F	tm
	Maerua oblongifolia (Forssk.) A. Rich.	SZ	Ch	D,W	V,F	L	cl
Caryophyllaceae	*Dianthus strictus* ssp. Sublaevis (Boiss.) Reeve	Me	Th	M	-	-	-
	Minuartia picta (Sm.) Bornm.	IT,Me	Th	D	-	-	-
Celastraceae	*Maytenus arbutifolius* (Hochst. ex A. Rich.) R. Wilczek	SZ	Ph	R,W,M	V,S	S,F	sm
Combretaceae	*Combretum molle* R. Br. ex G. Don	SZ	Ph	R	-	-	-
Commelinaceae	*Commelina benghalensis* L.	SZ	Th	R,W	V	F	gc
Compositae	*Achillea biebersteinii* Afan.	IT	H	R,M	V,S,F	F,A	gc
	Bidens biternata (Lour.) Merr. and Sherff	Tr	Th	R,W,M	-	-	-
	Calendula arvensis (Vaill.) L.	Cosm	Th	M	V	F	gc
	Conyza incana (Vahl) Willd.	SZ	Ch	R,M	-	-	-
	Conyza stricta Willd.	SA	Th	M	-	-	-
	Crepis foetida L.	IT,Me	Th	M	-	-	-
	Crepis sancta (L.)Bornm.	IT,Me	Th	M	-	-	-
	Echinops spinosissimus Turra	IT,Me	Ch	R,M	-	-	-
	Echinops hystrichoides Kit Tan	SA	H	P	-	-	-
	Felicia abyssinica Sch.Bip. ex A. Rich.	SZ	Th	M	V,F	F	gc
	Felicia dentata (A. Rich.) Dandy	SZ	Th	R,M	V,F	F	gc
	Hedypnois rhagadioloides (L.) F.W. Schmidt	Me,SZ	Th	M			

Table 4. (Cont'd.).

Family	Plant name	Chorotypes	Life form	Habitat	planting projects	LA value	Type used
	Launaea procumbens (Roxb.) Ramayya and Rajagopal	Tr	Th	-	-	-	-
	Osteospermum vaillantii (Decne.)Norl.	SA	Ch	R,W,M			
	Pluchea dioscoridis (L.) DC.	SZ	Ch	M	V,S	F,A	ss
	Psiadia punctulata (DC.) Vatke	SA,SZ	Ch	R,W,M	V,S	L,F,A	ss
	Pulicaria crispa Sch.Bip.	SA,SZ	Ch	R,W	V	-	gc
	Pulicaria petiolaris Jaub. & Spach	SZ	Ch	P	V	-	gc
	Pulicaria schimperi DC.	SZ	H	P	V	-	gc
	Senecio asirensis Boulos and J.R.I. Wood	SZ	Ch	M	-	-	-
	Sonchus asper (L.) Hill	SA	Th	R	-	-	-
	Tanacetum santolinoides (DC.) Feinbrun and Fertig	SA,IT	Ch	M	-	-	-
Convolvulaceae	*Convolvulus oxyphyllus* Boiss.	IT	Ch	W	-	-	-
Crassulaceae	*Umbilicus horizontalis* (Guss.) DC.	Me,SA	Ge	M	-	-	-
Cucurbitaceae	*Citrullus colocynthis* (L.) Schrad.	IT,Me,SA	Th	D,P,R,W	-	-	-
	Coccinia grandis (L.) Voigt	Tr	H	P,R,W	V	L	ss
	Cucumis pustulatus Naudin ex Hook. f.	SA	H	R	-	-	-
	Zehneria scabra Sond.	SZ	Li	R	-	-	-
Cupressaceae	*Juniperus procera* Hochst. ex Endl.	SZ	Ph	R,M	V,F,S	S,L,A	tl
Cyperaceae	*Cyperus conglomeratus* Rottb.	SA	Ge	D,W,C	V	L	gc
Ephedraceae	*Ephedra foliate* Boiss. ex C.A. Mey.	SA,SZ	Ch	R,W,M	V,F	S	cl
Euphorbiaceae	*Acalypha ciliata* Forssk.	SZ	Th	R	V	L	gc
	Euphorbia inaequilatera Sond.	SZ	Th	R,W	-	-	-
	Euphorbia inarticulata Schweinf.	SZ	Ch	M	V	F	gc
	Euphorbia schimperiana Scheele	SZ	Th	M	-	-	-
	Jatropha glauca Vahl	SZ	Ch	R,W	V,F	F,L	ss
	Jatropha pelargoniifolia Courbai	SZ	Ch	D,W,C	V,F	F,L	ss
	Ricinus communis L.	Cosm	Ph	R,W	V,F	S,L,F	sm
Geraniaceae	*Erodium cicutarium* (L.) L'Hér.	Me,SA	Th	M	-	-	-
	Erodium neuradifolium Delile ex Godr.	Me,SA	Th	M	-	-	-
	Geranium lucidum L.	Me	Th	R	-	-	-
	Geranium molle L.	Me	Th	M	V	F	gc
	Geranium trilophum Boiss.	SZ	Th	R,M	-	-	-
Lamiaceae	*Lavandula atriplicifolia* Benth.	SA	Ch	R	V,F	F,A	ss
	Lavandula dentata L.	Me,SZ	Ch	R,M	V,F	F,A	ss
	Lavandula pubescens Decne.	SZ	Ch	P,R,W,M	V,S	F,A	ss
	Micromeria imbricata (Forssk.) C. Chr.	SZ	Ch	R,M	-	-	-
	Otostegia fruticosa subsp. *Schimperi* (Benth.) Sebald	SA	Ch	R,W,M	V,S,F	S,F,A	sm
	Plectranthus barbatus Andrews	SZ	Ch	R	-	-	-
	Teucrium polium L.	SA,IT	Ch	M	V,F	A	gc
Leguminosae	*Acacia asak* (Forssk.) Willd.	SA	Ph	R,W	V,F,R,W	S,F	tl
	Acacia ehrenbergiana Hayne	SA	Ph	D,P,R,W	V,F,R,S,W,U	S,F	sl
	Acacia etbaica Schweinf.	SZ	Ph	P,R,W	V,F,R,S,W,U	S,F	tm
	Acacia hamulosa Benth.	SZ	Ph	P,R	V,F,R,S,W	S,F	sl
	Acacia oerfota (Forssk.) Schweinf.	SZ	Ph	P	V,F,R,S,W	S,F	sl
	Acacia origena Asfaw	SZ	Ph	R,M	V,F,R,S,W,U	S,F	tl
	Acacia tortilis (Forssk.) Hayne	SZ	Ph	D,C,P,R,W	V,F,R,S,W,U	S,F	tm
	Anagyris foetida L.	Me	Ph	M	V,F,R,S,U	LF	sm
	Cassia italica (Mill.)Lam. ex F.W. Andrews	SA,SZ	Ch	W	V,R	F	ss
	Crotalaria microphylla M. Vahl	SZ	Th	D	-	-	-
	Indigofera schimperi Jaub. & Spach	SZ	Ch	R	-	-	-
	Indigofera arabica Jaub. & Spach	SA	Ch	P	-	-	-
	Indigofera spinosa Forssk.	SA,SZ	Ch	D,C,P,R,W	V,R	F	ss
	Lotononis platycarpa (Viv.) Pic. Serm.	SA+SZ	Th	M	-	-	-
	Medicago polymorpha L.	Me	TH	M	-	-	-
	Medicago orbicularis (L.) Bartal.	SZ	Th	M	-	-	-
	Microcharis tritoides (Baker)Schrire	SZ	Ch	R	-	-	-
	Ononis reclinata L.	Me,SA	Th	M	-	-	-
	Rhynchosia malacophylla (Spreng.) Bojer	SZ	H	R	-	-	-
	Senna alexandrina Mill.	SZ	Ch	P,W	V,R,F	F	ss
	Tephrosia nubica (Boiss.) Baker	SA,SZ	Ch	W	-	-	-
	Vicia sativa L.	Me	Th	M	-	-	-
Loranthaceae	*Phragmanthera austroarabica* A.G. Mill. & J. Nyberg	SA	Ep	M	-	-	-
Malvaceae	*Abutilon bidentatum* Hochst. ex A. Rich.	Tr	Ch	P,W	V	L,F	Ss
	Abutilon fruticosum Guill. & Perr.	SA	Ch	R	V	L,F	Ss
	Abutilon pannosum (G. Forst.) Schltdl.	Tr	Ch	P,R,W	V,F	L,F	Ss
	Grewia tembensis Fresen.	SZ	Ph	R	V,S,F	F	sm
	Grewia tenax (Forssk.) Fiori	SZ	Ph	R,W	V,S,F	F	sm
	Hibiscus vitifolius L.	SZ	Ph	R	V,F	F	ss
	Malva parviflora var. *microcarpa*	IT,Me	Th	M	V	F	gc

Table 4. (Cont'd.).

Family	Plant name	Chorotypes	Life form	Habitat	planting projects	LA value	Type used
Moraceae	*Ficus glumosa* Delile	SZ	Ph	R,W	V,F,W	S,L	sm
	Ficus palmate Forssk.	SZ	Ph	R,W	V,F,W	S,L	sm
	Ficus salicifolia Miq.	SA,SZ	Ph	R,W	V,F,S,W	S,L	tl
	Ficus sycomorus L.	SZ	Ph	P	V,F,S,W,U	S,L,F	tl
Nyctaginaceae	*Commicarpus plumbagineus* (Cav.) Standl.	SA	TH	R,W	-	-	-
Oleaceae	*Jasminum grandiflorum* L.	SZ	Ch	R,W	V,F	F,A	cl
	Olea europaea subsp. *cuspidate* (Wall. & G. Don) Cif.	SA	Ph	R,W,M	V,F,W	S,L,F	tl
Orobanchaceae	*Parentucellia latifolia* (L.) subsp. *flaviflora* (Boiss.)	IT	Th	R,W	-	-	-
Papaveraceae	*Argemone mexicana* L.	Tr	Th	R,W			
Peraceae	*Clutia myricoides* Jaub. & Spach	SA	Ph	R,M	V,F,F	L	sm
Phyllanthaceae	*Phyllanthus rotundifolius* Klein ex Willd.	SA	Th	R	-	-	-
Plantaginaceae	*Plantago cylindrical* Forssk.	Me,SA	Th	R,M	-	-	-
	Anarrhinum forsskaolii (J.F. Gmel.) Cufod.	Me,IT	Th	R,M	-	-	-
	Kickxia pseudoscoparia V.W. Sm. & D.A. Sutton	SA	Ch	R,W	V	F	gc
	Lindenbergia indica Vatke	SA	H	R	-	-	-
Poaceae	*Avena sativa* L.	Me	Th	M	-	-	-
	Cenchrus ciliaris L.	Tr	H	P,R,W	V	S	gc
	Cynodon dactylon (L.) Pers.	Cosm	Ge	M	V,F		gc
	Eragrostis papposa (Desf. ex Roem. & Schult.) Steud.	SZ	H	W	-	-	-
	Hyparrhenia hirta (L.) Stapf	IT,Me,SA	Ge	R,W,M	V,F	L	gc
	Panicum atrosanguineum Hochst. ex A. Rich.	SZ	Th	M	-	-	-
	Panicum turgidum Forssk.	SA,SZ	Ge	D,C,P,W	V,S,F	L	gc
	Pennisetum orientale Rich.	SA	H	R,W	V,S	L,F	gc
	Pennisetum setaceum (Forssk.) Chiov.	SA	H	R,W	V,S,F	L,F	gc
	Stipa capensis Thunb.	Me	Th	P,W	-	-	-
	Stipagrostis plumosa Munro ex T. Anderson	IT,SA	H	W	-	-	-
	Themeda triandra Forssk.	Cosm	Ge	R,M	V	L	gc
Polygalaceae	*Polygala abyssinica* R. Br. ex Fresen.	SZ	Ch	R,M	V,H	F	gc
	Polygala erioptera DC.	SA	Ch	D,W	V	F	gc
Polygonaceae	*Rumex nervosus* Vahl	SZ	Ch	M	V	L,F	ss
	Rumex vesicarius L.	SA	Th	R,W,M	V,S,F	L,F	gc
Primulaceae	*Anagallis arvensis* var. *caerulea* (L.) Gouan	Tr	Th	M	-	-	-
Pteridaceae	*Actiniopteris semiflabellata* Pic. Serm.	SA	H	R	-	-	-
Resedaceae	*Caylusea hexagyna* (Forssk.) M.L. Green	SA	H	R,M	-	-	-
	Ochradenus baccatus Delile	SA,SZ	Ph	P,R,W	V	S	sm
	Reseda lutea L.	IT,ME	Ch	R,M	-	-	-
Rhamnaceae	*Rhamnus lycioides* L.	Me	Ch	W,M	-	-	-
	Rhamnus dispermus Ehrenb. ex Boiss.	SA	Ph	M	V	S	ss
	Sageretia thea (Osbeck) M.C. Johnst.	SA,IT	Ph	R,M	V,F,F	S	ss
	Ziziphus spina-christi (L.) Willd	SA,SZ	Ph	D,P,R,W	V,F,S,W,U,H	S,L,F	tl
Rubiaceae	*Galium aparinoides* Forssk.	SZ	Th	M	V,W,F	S	cl
Rutaceae	*Ruta chalepensis* L.	Me,SA	Ch	R,M	V,S,F	L,A	ss
	Teclea nobilis Delile	SZ	Ph	R	V	L	sm
Salvadoraceae	*Dobera glabra* (Forssk.) Juss. ex Poir.	SZ	Ph	R	V,F,W,U	S	tl
	Salvadora persica L.	SZ	Ph	D,W	V,F,S,W,H	S,L,A	sl
Sapindaceae	*Dodonaea viscosa* Jacq.	SZ	Ph	R,W,M	V,F,S,U	S,L	sm
Solanaceae	*Datura stramonium* L.	Cosm	Th	P	V	F,L	gc
	Lycium shawii Roem. & Schult.	SA	Ph	R,W	V,F,S,W,F	S,F	sm
	Solanum schimperianum Hochst.	SZ	Ch	R	-	-	-
	Solanum anguivi Lam.	SA	H	R	-	-	-
	Solanum grossedentatum A. Rich.	SZ	Ch	R,W	-	-	-
	Solanum incanum L.	SA	Ch	P,R,W,M	V,S,F	L,F	gc
	Solanum nigrum L.	IT,Me,SA	H	M	-	-	-
	Solanum villosum Mill.	SA	Th	R,M	-	-	-
	Withania somnifera (L.) Dunal	IT,Me	Ch	R,W,M	V,S,W,F	L,F	ss
Tamaricaceae	*Tamarix nilotica* (Ehrenb.) Bunge	SA	Ph	D,P,W	V,F,S,U,H	S,F	sm
Tiliaceae	*Triumfetta flavescens* Hochst. ex A. Rich.	SZ	Ch	R	-	-	-
Urticaceae	*Forsskaolea tenacissima* L.	SA,IT	H	R,W	-	-	-
Urticaceae	*Parietaria alsinifolia* Delile	SA	Th	M	-	-	-
verbenaceae	*Avicennia marina* (Forssk.) Vierh.	Tr	Ph	C	V,F,W,H	S,L	sl
	Lantana camara L.	Tr	Ph	R	V,S,F	F,A	ss
Vitaceae	*Cissus quadrangularis* L.	SZ	Ch	D,R,W	V,W,F	L	cl
	Cissus rotundifolia Vahl	SZ	Ch	R	V,W,F	L	cl
	Cyphostemma digitatum (Forssk.) Desc.	SZ	Ch	R	-	-	-
Zygophyllaceae	*Fagonia bruguieri* DC.	IT,SA	Ch	W	-	-	-
	Fagonia indica Burm.f.	SA	H	R,W	V	F	gc
	Tribulus arabicus Hosni	En	H	P,R,W	-	-	-
	Tribulus terrestris L.	SA,SZ	Th	D	-	-	-

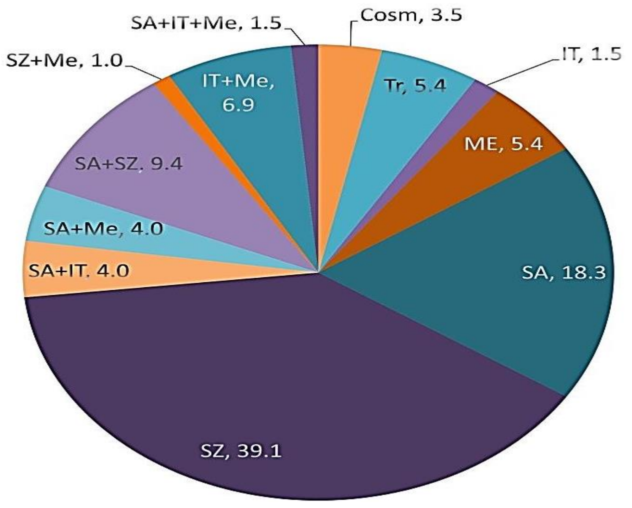

Fig. 2. The percentages of the chorological characteristic in the floristic composition of Wadi Al-Ahsibah. Cosmopolitan (Cosm), Tropical (Tr), Saharo–Arabian (SA), Sudano–Zambezian (SZ), Irano–Turanian (IT), and Mediterranean (Me).

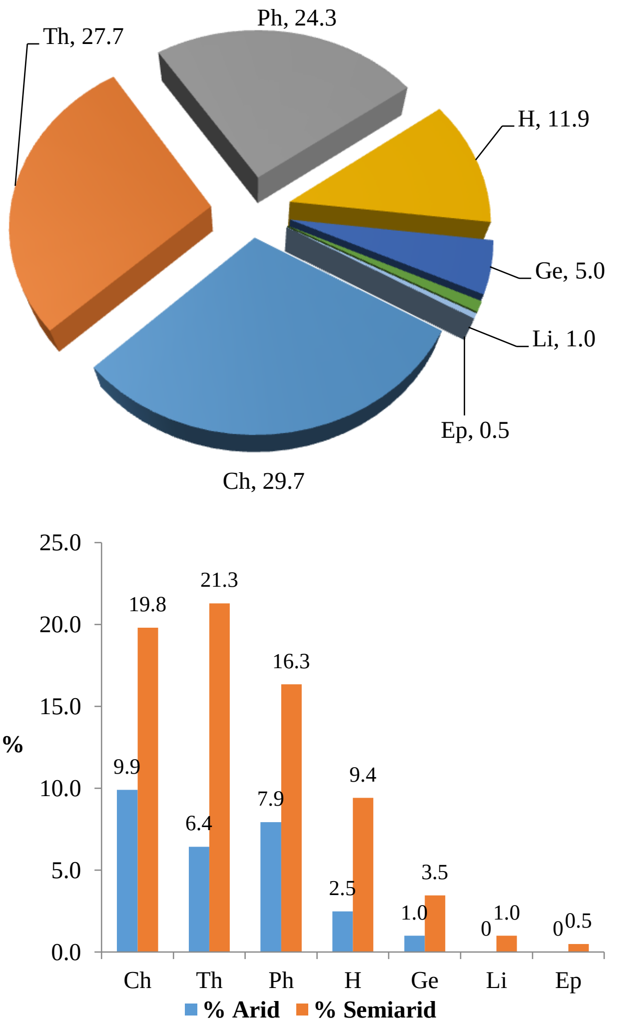

Fig. 3. (Left): The percentage of lifeform categories of the species recorded in the floristic composition of Wadi Al-Ahsibah. (Right): The percentage of the lifeforms of the species recorded as belonging to their climate regions. Therophytes (Th), chamaephytes (Ch), phanerophytes (Ph), hemichyptophytes (H), geophytes (Ge), lianas (Li), and epiphytes (Ep).

The diversity indices of the habitats in the study area were high in the areas of the juniper forests and of the semiarid climate. In general, these are characterized by evergreen forests with several strata that contain ground cover, shrubs, and many woody species, while the diversity indices were low in Tihamah, where the sand dunes and coastal steppe vegetation dominated.

The tendency of the floristic composition in this study is similar to those reported by several authors who studied watersheds in the southwestern region of Saudi Arabia-for example, Al-Hasher Mountain (Shalabi & Masrahi, 2019), Wadi Khulais (Alsherif *et al*., 2013), Wadi Al-Noman (Abdel Khalik *et al*., 2013), and Taif (Al-Sodany *et al*., 2014). A similar result was also reported for the northern part of the Eastern Desert of Egypt (Abd El-Ghani, 1998). This may be caused by the similarity of regions and habitats like topographic, soil, and climate factors.

Selected species for landscape restoration: From the 202 species listed in the study area, 111 species were selected for use as native plants for landscape restoration in arid and semiarid conditions (Table 4). For these, the LA values, plant types and characters, and environmental benefit functions were distinguished.

The selected species covered the most types of plant material used in the projects. The shrub types were the ones most available in the list (50 species) (most of them small and medium shrubs: 24 and 20 species respectively), followed by ground cover (32 species). The tree types were presented by 17 species (most of them were large trees), and the climbers were presented by six species, and, finally, just two species of palms were recorded. On the other hand, the results showed that 68 species were used for flowers and/or fruits, followed by 47 species for leaves with good colour and shape, and then 43 species had special forms or structures suitable for use in planting projects, and 15 species had aromatic foliage and scent. The environmental functions of the plant list of Wadi Al-Ahsibah flora were also suggested. The functional and structural characteristics, soil conservation, afforestation, and wildlife support were also supported by 43, 42, 33, and 32 plant species respectively, while the urban environment, reclamation of landscape, and hydrological applications were supported by 12, 11, and 7 plant species respectively (Table 8).

Applications of native species in different kinds of landscape restoration: Plant diversity has several benefits when used for restoration habitats. These include reductions in the spread of invasive species, which cause great damage to the natural vegetation, assistance to the plant communities in restoration of their capabilities in their geographical area and development of natural ecosystems, achievement of local a local landscape personality, which is reflected by native plants that are closely related to the local environment, and reduction in the maintenance services provided in the planting of plants. This is one of the potential benefits of native plants.

An understanding of the diversity of lifeforms and the details of chorological and geobotanical regions will support the selection of plant materials in planting projects with more species from all types of LA value characters and environmental functions. This gives the designer more flexibility and a good opportunity to choose species in the right way and shifts the planting projects for greater sustainability. For example, *Salvadora persica* is a large shrub with multi-stems that can be used in the SZ region as a perfect species for sand dunes and sandy plains in valleys. It is perfect for use as afforestation, soil conservation, wildlife support, and hydrological applications. *Hyphaene thebaica* is one of the important palm species in Arecaceae that is spread in SA and SZ regions; its form is very special with dichotomous branches and large leaves, which is used in afforestation, wildlife support, and hydrological applications in coastal plains, streams, and sand dunes. *Plectranthus barbatus* is a unique ground cover with a good form, leaves, flowers, and scent; it is suitable for use for visual values and soil conservation. The acacia group species contain many trees and shrubs (large trees like *Acacia origena* and *Acacia asak*, medium trees like *Acacia etbaica* and *Acacia tortilis*, and shrubs like *Acacia oerfota*, *Acacia ehrenbergiana,* and *Acacia hamulosa*), with different shapes, forms, and colours for visual and other sensory purposes. These are, however, very good species for environmental uses like afforestation for several ecological purposes (Fig. 4).

Fig. 4. Some photos of the species proposed for use in landscape restoration projects: 1-*Ziziphus spina-christi*. 2-*Calotropis procera*. 3-*Cadaba farinose*. 4-*Leptadenia pyrotechnica*. 5-*Caralluma russelliana*. 6-*Salvadora persica*. 7-*Juniperus procera*. 8-*Acacia tortilis* .9-*Plectranthus barbatus*. 10-*Felicia abyssinica*. 11-*Rumex nervosus*. 12-*Capparis decidua*. 13-*Dodonaea viscosa*. 14-*Adenium obesum*. 15-*Acacia hamulosa*. 16-*Anisotes trisulcus*.

Table 5. The total numbers and percentages of species and genus were presented in each family in the floristic composition of Wad Al-Ahsibah.

Family	Genus		Species		Family	Genus		Species	
	No.	%	No.	%		No.	%	No.	%
Compositae	16	10.4	22	10.8	Cucurbitaceae	4	2.6	4	2.0
Leguminosae	13	8.4	22	10.8	Moraceae	1	0.6	4	2.0
Poaceae	10	7.1	12	5.9	Rhamnaceae	3	1.9	4	2.0
Solanaceae	4	2.6	9	4.4	Zygophyllaceae	2	1.3	4	2.0
Lamiaceae	5	3.2	8	3.9	Plantaginaceae	4	2.6	4	2.0
Capparaceae	4	2.6	7	3.4	Brassicaceae	3	1.9	3	1.5
Apocynaceae	7	4.5	7	3.4	Resedaceae	3	1.9	3	1.5
Euphorbiaceae	4	2.6	7	3.4	Acanthaceae	3	1.9	3	1.5
Malvaceae	4	2.6	7	3.4	Vitaceae	2	1.3	3	1.5
Amaranthaceae	4	2.6	6	3.0					
Boraginaceae	3	1.9	5	2.5	13 Families with two species			2	1.0
Geraniaceae	2	1.3	5	2.5	28 Families with one species			1	0.6

Table 6. The total numbers and the percentage of species in habitats in the floristic composition of Wadi Al-Ahsibah.

Habitat types	One habitat		Types	2 habitats		Types	3 habitats		Type	4 and 5	
	No.	%		No.	%		No.	%		No.	%
High mountains (M)	45	22.3	R,W	28	13.9	R,W,M	13	6.4	D,C,P,W	3	1.5
Rocky hills (R)	33	16.3	R,M	21	10.4	D,R,W	2	1	D,P,R,W	4	2
Watercourses (W)	9	4.5	D,R	1	0.5	D,P,W	2	1	P,R,W,M	2	1
Coastal plains (C)	1	0.5	D,W	3	1.5	D,W,C	3	1.5			
Sand dunes (D)	4	2	P,R	1	0.5	P,R,W	11	5.4	D,C,P,R,W	3	1.5
Undulating plateau (P)	8	4	P,W	4	2						
			W,M	1	0.5						

Table 7. The average values of diversity indices for samples [total number of species (N), Simpson index (S), and Shannon index (H)] are presented for the different habitats in the study area. (The highest values are shaded).

Habitat types	Number of species in habitat (N)	Simpson index (S)	Shannon's diversity (H)
Sand dunes (D)	8	7.23	1.99
Coastal plains (C)	5	4.17	1.05
Undulating plateau (P)	11	9.63	2.25
Rocky hills (R)	**18**	**15.33**	**2.71**
Watercourses (W)	12	9.83	2.27
High mountains (M)	**22**	**16.60**	**2.89**

Table 8. Landscape restoration projects, LA values, and plant types for all plant species were listed in the study area.

Landscape restoration projects	No. of species	LA value	No. of species	Plant's type		No. of species
Visual and other sensory (Vi)	107	Form or structure (s)	43		High (tl) > 9m	11
Afforestation (Af)	33	Flowers or fruits (F)	68	Trees	Medium (tm) 6–9m	4
Wildlife support (Wl)	32	Colour and shape of leaves (L)	47		Small (ts) 6–3m	2
Reclamation of landscape (Rl)	11				High (sl) > 3m	6
Soil conservation (Ss)	42	Aromatic foliage and scent (A)	15	Shrubs	Medium (sm) 3–1m	20
Urban environment (Ue)	12				Small (sl) <1m	24
Functional and structural Characteristics (Fs)	43			Palms		2
Hydrological applications (Hy)	7			Ground cover		32
				Climbers		6

The species selected in this study were proposed for special use in planting projects. As functional and structural characteristics, the list suggested 43 species to be used for roof, rock, and drywall gardens, 35 species for ground cover species: *Achillea biebersteinii*, *Aerva javanica*, *Caralluma russelliana*, *Crinum album*, *Felicia dentata*, *Hyparrhenia hirta*, *Pennisetum setaceum*, and *Rumex vesicarius*, and eight bulbous geophytes, such as *Crinum album*. For urban environments, 12 species were suggested; four of them were large trees, two medium trees, two large shrubs, and four medium shrubs. For other purposes, the study suggests 42 species for soil conservation suitable for all types of habitats and are referred for most geobotanic regions, 32 species for wildlife support, 33 species for afforestation, 11 species for reclamation of landscape, and seven species for hydrological applications (Table 8).

The degradation of the landscape in arid and semiarid regions as a result of the increasing interferences of human activities could be irreversible because the erosion of the soil has destroyed the natural ecosystems and plant diversity has vanished. Hence, the first action to preserve the remnants of the patches of natural vegetation is to effectively use new native species selected from natural flora for landscape reclamation in planting projects. The landscape reclamation with a sustainability approach obliges the planting designer in the arid and semiarid regions to use special plant materials that can resist the harsh conditions and require minimal maintenance. These types of plant materials, which might be available from the natural flora of the arid and semiarid regions, can provide the planting projects with diversity in all plant forms, shapes, and colours, and more types of leaves and flowers.

Conclusion

This study describes and analyses the floristic composition of Wadi Al-Ahsibah, which is one of the major wadis in the Al-Baha region on the western escarpment of the Asir Mountains. The results show that the main diversity is presented in the upstream of the wadi, where the juniper forest is located, while the downstream has a low diversity under arid conditions. Human activities and climate change have caused high disturbances in the natural landscape of the study area. On the other hand, the floristic composition of the study area used to be the source for the novice list of plant materials in planting projects in arid and semiarid conditions; these give the designer more options to select species from native plant species with a good understanding of floristic details for suitable functional uses and for applying the new concept of sustainability. Some of these native plant species recorded in this study can be widely utilized in planting projects for social, aesthetic, healthful, architectural, climatic, engineering, economic, and ecological purposes in the urban and rural areas under arid and semiarid regions. Finally, it is necessary to carry out experiments under field conditions to determine the adaptation and regeneration abilities, as also propagation methods, of the new native plant list.

Acknowledgment

This project was funded by Deanship of Scientific Research (DSR), King Abdulaziz University, Jeddah, under grant No. (D-8-137-1441). The author, therefore, gratefully acknowledges the DSR technical and financial support. I would like to thank Abdulrahman Al-Zahrani, Madani Abu El-Faddel and Ahmad Al-Shareef from the Saudi Geological Survey organization SGS for their help. I am also grateful to Dr. Nabegh Ghazal Asswad for revising the text language.

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(Received for publication 2 March 2020)