

## Plant Habitat Study of QaraDagh- Darbandikhan Area

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### Abstract

A study was conducted on the plant habitat structure and the endemic species of QaraDagh-Darbandikhan area. The distribution of vegetation composition in both locations was identified. All vegetation zones and their keystone species are described in this manuscript. Historical data was integrated within the current records based on software applications. A habitat map was created, based on the topographical distribution of the study site. A total of 380 plant species belonging to 65 families were recorded. Within this total number, 44 taxa were identified as endemic species distributed with their occurrence in both QaraDagh and Darbandikhan areas. The current habitat is also important for different threatened fauna, especially the Persian Leopard (*Panthera pardus saxicolor*) and Wild Goat (*Capra aegagrus*) which according to IUCN Red List are Endangered and Vulnerable, respectively. Threats on the habitat assessed were overgrazing, random fires, road constructions/expansion, sign of urbanization expansion and pollution from the associated garbage and waste. In other locations, there are issues of agricultural expansion, reforestation of slopes by non-native trees and conversion of the natural habitat to vineyards and orchards, using different species of forest communities as firewood. The result of this study confirms the urgent need for plant habitat conservation in the study area for the sustainability of the living communities.

### Introduction

A habitat is a place or environmental area that is inhabited by a particular species of animal, plant and other organisms, in which the organism can survive and reproduce. Organisms' success, survival, and reproduction can be proceeded in a habitat provided with numerous of specific resources, including food, shelter, and water resources [1]. Different wild animals are using the physical and biological resources within a habitat as a source for foraging, cover, nesting, escape, denning, and other life activities [2].

Due to uncertain environmental and demographic disturbance, many available small habitat populations are more susceptible to extinction [3]. These changes in long-term will certainly restrict the species

flexibility to variable environmental condition [4]. Although efforts are enacted to conserve rare and threatened species, focus should also be directed toward common species and their conservation as well, as the commonness and the abundance of gene flow rescue between these species do not sufficiently guarantee their long-term protection [5, 6]. Reducing the genetic diversity and species richness in these species will negatively impact the composition of plant community and ecosystem functions [7].

Limitation in appropriate habitat data scale at large scales hinders the ability to conserve species at risk of extinction. Information about the optimal conditions for habitat survival and regeneration of species is vital to plan the conservation strategies. Risk of desiccation is among the major barriers to rehabilitate plant species in ecosystems [8], as the water scarcity being the barrier for nearly half of plant species of dry habitats [9], especially for topographic lowlands rather than uplands [10]. It is expected that changing in the current environmental condition has negatively influenced the biodiversity [11], as the plant species face the hazard of extinction out of their adaptive environment range [12, 13].

Topographical regions of Iraq are divided into three regions of Arabian Shield, Foothills of the Zagros Ranges, and Mesopotamian Plain [14]. The second region represents 18% of Iraq to cover the majority of Iraqi Kurdistan areas, while the landforms areas and the amount of rainfall have been categorized according to the different land parcels (Table 1).

Table-1. Types of terrain, landforms, and rainfall (mm) in Iraq

<i>Types of terrain/Landform</i>	<i>Area (Km<sup>2</sup>)</i>	<i>Percent</i>	<i>Rainfall</i>
<i>Plains</i>	<i>132 500</i>	<i>30</i>	<i>50-200</i>
<i>Undulating/Terrain Land</i>	<i>42 000</i>	<i>10</i>	<i>250-450</i>
<i>Mountains</i>	<i>92 000</i>	<i>21</i>	<i>400-1 000</i>
<i>Deserts</i>	<i>168 552</i>	<i>39</i>	<i>50-200</i>
<i>Total</i>	<i>435 052</i>	<i>100</i>	

**Source:** General Directorate of Horticulture [15]

### ***Biomes and Ecoregions of Iraq***

Iraq covers an area of 434,320 km<sup>2</sup> and is part of the Palearctic Realm, which is known to be the largest of the eight terrestrial eco-regions on the Earth. The eco-regions of Iraq have been classified under World Wide Fund for Nature (WWF) system into five major terrestrial biomes [16]. These biomes are further divided into over 800 geographically distinct ecoregions, sharing a vast majority of their species, ecological dynamics and environmental conditions.

Zagros Mountain Forest steppe is one of the most divergent eco-regions for plant habitat being part of the Taurus-Zagros Mountain range with the unique geographical formation that extends across three different parts of Kurdistan south, east, and north. This eco-region is occupying nearly 30,000 km<sup>2</sup> covering about 7% of the entire Kurdistan Region of Iraq (Figure 1). Within this eco-region, QaraDagh-Darbandikhan area as a part of the extensive Zagros Mountain Steppe eco-region [17], is identified as a one of the key site for biodiversity in Iraq [16].

Despite the presence of a reasonable portion of Zagros Mountain range in Kurdistan Region, fewer efforts have been attempted to conserve the biodiversity and habitat there. In some locations, the natural vegetation has been reduced to a remnant of their former extent, due to the environmental effects and the human disturbance activities that changed vegetation composition and increased the threat of their extinction.

The project “Rehabilitating the transboundary habitat of the Persian Leopard through the creation of a peace park- a multi-stage approach to conservation” was initiated in 2016, in collaboration between Nature Iraq (NI), the Kurdistan Botanical Foundation (KBF) and the Persian Wildlife Heritage Foundation (PWHF), a counterpart Iranian organization. The first stage of this conservation endeavor was to map the status, range and habitat of the Persian Leopard and its prey species. Nature Iraq and KBF focused initially on establishing the areas that are important for Leopards from historical data, determine their overall conservation status within those areas, and identify existing threats within the study area.

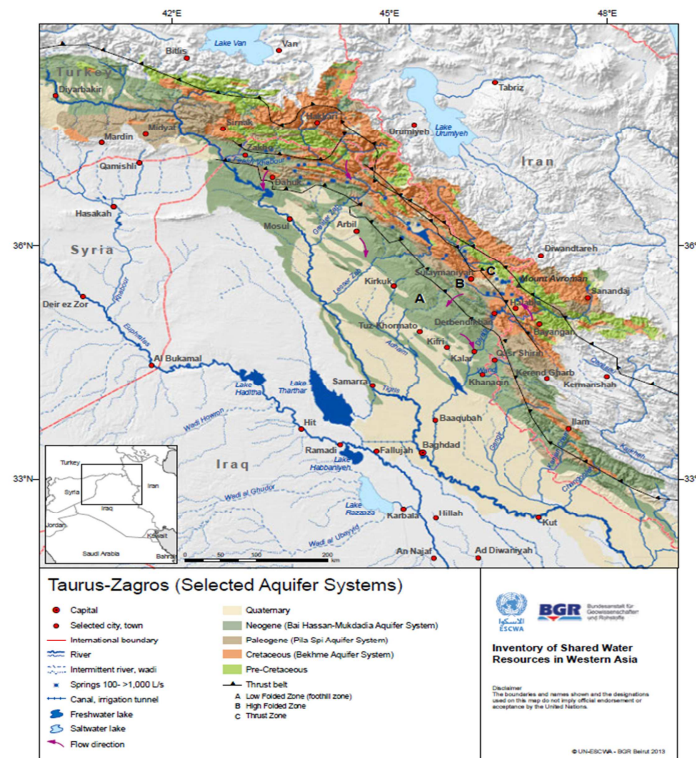


Figure-1: Map of the Taurus-Zagros Mountain range, extends across three countries of Iran, Iraq and Turkey [18]

Based on the above justification, we have proposed this investigation, as part of the whole project, to study the plant habitat in QraDagh-Darbandikhan area of the Zagros-Mountain Region based on the historical data and field surveys for the study area, to be used as a basis for the future conservation plan of the area's ecosystem. Background information about habitat classification, including plant zones in the delineated area, keystone species, threatened plant species were the main background information collected in for this study. The main threats to habitat and conservation status are also investigated for the study area, through mapping important habitats based on vegetation zones.

## Materials and Methods

### Study site:

The study area is located in the Kurdistan Region of Iraq (KRG) within Sulaimani Governorates. The area is situated in QaraDagh and Darbandikhan south west and south of Sulaimani city, respectively.

### ***Vegetation Zones of The Study Area:***

All Seven volumes of Flora of Iraq; Volume 1, 2, 3, 4 (part A), 4 (part B), 8 and 9 [14, 19-23] were studied to determine the recorded plant species in the study area. The position of the available species according to their families and their names were updated based on the International Plant Names Index (IPNI, 2017) <http://www.ipni.org/ipni/plantnamesearchpage.do>. Field surveys were conducted for the representative locations within the study area for 2016-2017, to be checked with the historical data of vegetation coverage and plant species. The observation of common plant species and habitat status were recorded during the field surveys. GIS map was created with the Google Earth software package (Google, 2017) and analyzed by GE-Path V1.4.5. The delineation of the study site was determined to position between latitudes 35°27'–35°04'N and longitudes 45°09'–45°39'E. A total of 25 waypoints were recorded based on GPS and data recording on the description of the slope, exposure, the percentage of vegetated area and dominant tree, shrub, herb and grass species, according to the point-centered quarter method for density estimation by Cottam G and Curtis JT [24].

### **Results and Discussion**

The study site was estimated to occupy approximately 1178 km<sup>2</sup> for all mountain-forest, Moist-steppe and thorn cushion zones in Darbandikhan and QaraDagh. The elevation is ranged from as low as 334m near Solawa to the highest point of 1816m in Qopi QaraDagh Mountains (Figure 2). Different elevations will determine the growth of different forests and grasslands there, through behaving different climatic conditions.

To explore the current status of vegetation habitat and the availability of the plant species in the study area, data from field surveys of representative locations of the study area was integrated with the historical data in Flora of Iraq (all seven volumes). This action is attempted for checking the status of plant species, because some of the historical data has been gathered at different times in the past and the habitat ranges might be changed with time, due to climate change and human activities [25].

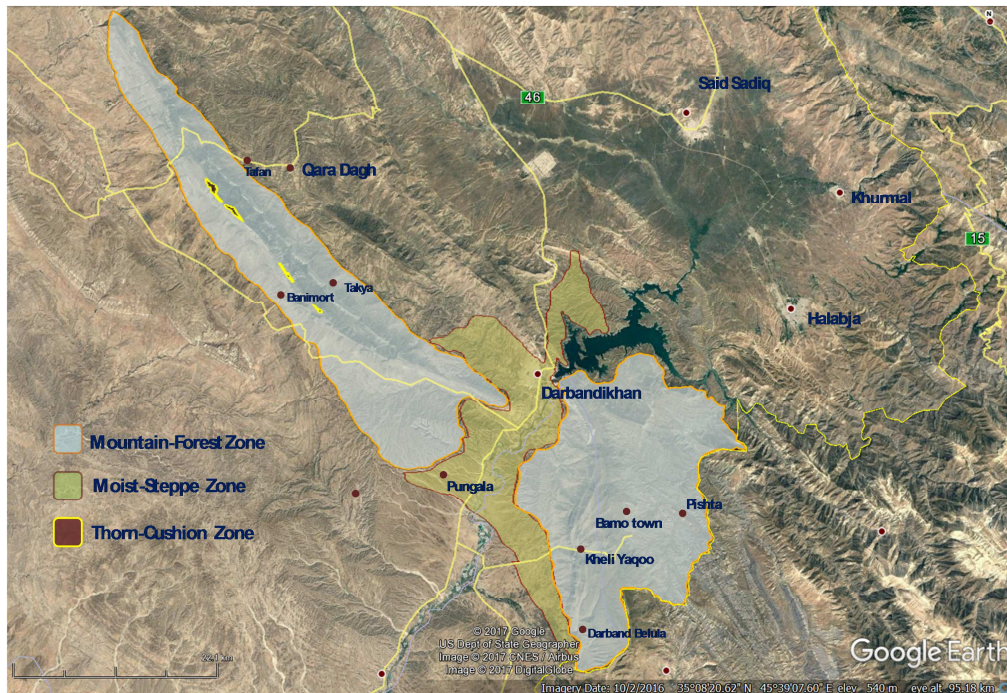


Figure-2: GIS map showing the topographic and habitat delineation of Moist-Steppe Zone, Mountain-Forest Zone and Thorn-Cushion Zone of the study area, Sep. 2017

The study area contains about 65 families, 216 genera and 380 plant species (Figure 3). The highest number of species belongs to *Fabaceae* family with 56 species, followed by *Asteraceae* and *Poaceae* with the abundance of 36 species each. The presence of such high number of species indicates the high richness and diversity of plant species in the study area.

Although it is not always easy to distinguish between the neighboring zones, we were able to distinguish topography and vegetation zone distribution in the study area according to Guest E and Al-Rawi A [14] and Ahmad S [26] as follows:

#### ***A-Moist Steppe Zone***

It is estimated to cover about 259km<sup>2</sup> including upper plains near Darbandikhan Lake toward the foothills surrounding the lake extending beside Sulaimani-Darbandikhan main road toward Hasana Gawra and Chinara villages in the north with the elevation of 620m and it is also extended toward the south of Darbandikhan near Solawa with the lowest elevation of 334m.

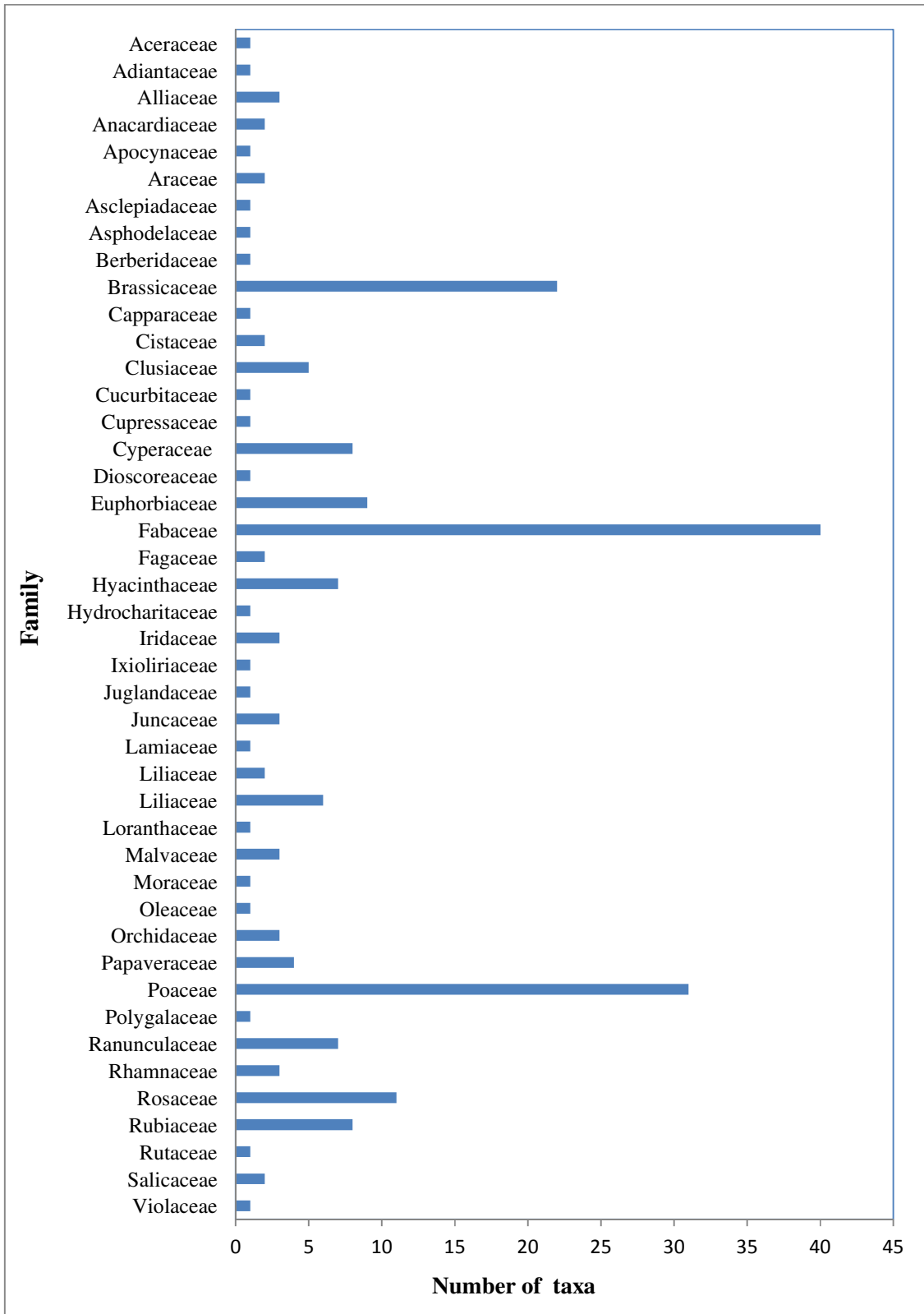


Figure-3: Number of species of different families in the study area

This zone occupies 22% of the study area (Figure 4), and it is dominated by *Pistacia eurycarpa*, *Prunus arabica* and *Gundelia tournefortii*. They are in association with some perennial grasses and herbs including *Poa bulbosa*, *Hordeum bulbosum*, *Vitex pseudo-negundo*, *Pteropyrum olivieri*, and *Anemone coronaria* (at spring time).

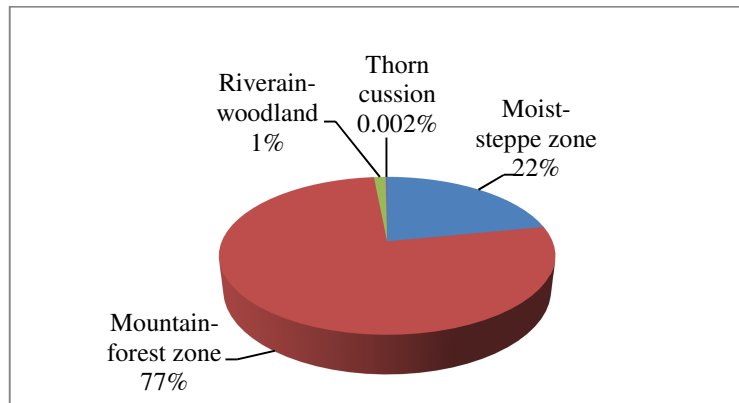


Figure-4: Vegetation zones ratios for the study area

The Moist steppe was classified based on the following habitat or vegetation as follows:

**1. Steppe non-irrigation:** Commonly found near Darbandikhan Lake north of Biekie village and in the south of Darbandikhan city extended from Qaslan toward Kamtaran and Baxahanara. The zone has clay and sandy soils with a steep slope (27°-45°), dominated by *Triticum* sp. and *Hordeum* sp. There are foothills crossed by deep valleys, dominated by *Paliurus spina-christi*, *Nerium oleander*, *Phragmites australis* and *Vitex pseudo-negundo* associated with different wild grass species like *Hordeum* sp., *Aegilops* sp., and *Avena* sp. (Figure 5). There are also some conservation issues in the zone such as the frequent threat of random fires, the abundance of overgrazing, road and agriculture expansion



Figure-5: Moist steppe non-irrigated field, near Bierke village of Derbandikhan showing the population of *Paliurus spina-christi* (KBF, Sep. 2016)

**2. Steppe irrigation field:** Can be found at the eastern side of Darbandikhan city, between, Kanisard and Bawakhoshek villages. From the south of Darbandikhan, close to Banikhelan village also some irrigated field can be seen. It has a clay soil with a steep slope (27-45°). There are some spots of agricultural land cultivated with *Hordeum* sp., *Triticum* sp. and some vegetables, such as; *Solanum lycopersicum*, *Cucumis*

*sativus*, *Abelmoschus esculentus*, *Solanum melongena*, *Piper* spp., *Cucurbita* spp., *Phaseolus* spp. and *Allium cepa*. The lands are covered with *Prosopis farcta* which grows after harvesting the crops (Figure 6). Conservation issues of the area are agricultural expansion and building construction.



Figure-6: Steppe irrigation field in Bierkie village near Derbandikhan, dominated by *Prosopis farcta* after harvesting the main crops (KBF, Sep. 2016)

**3. The foothill sub-zone:** The zone starts from the bases of mountain zones and stretched toward the steppes, such as in Pungala and Kheli Yaqoo. The area has a rocky soil with a slope (15-45°). It consists of the Foothills between the Iraq-Iran border, close to Pishta village (Figure 7). It is dominated by *Quercus aegilops*, *Quercus infectoria*, *Prunus arabica* and *Pteropyrum olivieri*.

The moist steppe zone within the study area has been affected by overgrazing and human disturbance such as construction and road expansion and reforestation of slopes by non-native trees, conversion of the natural habitat to vineyards and orchards.



Figure-7: Foothill sub-zone with serpentine soil near Pishta village, dominated by *Quercus aegilops* (KBF, Oct. 2016)

### ***B-Mountain-Forest Zone***

The zone area is expected to cover around 907km<sup>2</sup>, covering the majority of the study area (77%). The zone has a wide range of elevation starting from the lowest point (550m) in Mortka village of Darbandikhan location, raised to the highest point of 1816 in Qopi QaraDagh. Out of this area, QaraDagh has covered about 468km<sup>2</sup> that extends nearly 59km from the north-west toward the south-east of QaraDagh. While in Darbandikhan the zone occupied nearly 439km<sup>2</sup>. The lower limits of this zone are

near the southern part of Bamo mountain, to above Banaspan village in Sartak, with an elevation of up to 1615m. The characteristic vegetation of the forest zone is oak trees. The conservation issues for this zone are reforestation of slopes by non-native trees, conversion of the natural habitat to vineyards and fruit orchards, and the increase of recreation throughout the year, random fires, destruction of forest communities due to unorganized firewood cutting, road constructions-expansion, overgrazing, and pollution from the associated garbage and wastes.

Forests can be classified based on the following habitats or vegetation:

**1- Low Oak Forest:** The dominant species in this habitat are *Quercus aegilops*, *Quercus infectoria* *Pistacia eurycarpa* and *Pistacia khinjuk* (Figure 8).



Figure-8: Low oak forest dominated by *Quercus aegilops* and *Q. infectoria* near Hasana gawra on Pashare Mountain, Derbandikhan (KBF, Oct. 2016)

**2- Medium Oak Forest:** The dominant species include *Quercus aegilops*, *Quercus infectoria*, and *Acer monspessulanum*, associated with *Populus euphratica*, *Crataegus azarolus* and *Nerium oleander*. Typical grassland is abundant on Zawali Mountain that is dominated by different species of *Hordeum sp.*, *Aegilops sp.* and *Avena sp.* Some populations of *Myrtus communis* were also observed in the site (Figure 9). This habitat seems to be suitable for the Leopard and its prey species, due to recent observations of the Leopard and its prey in this area.



Figure-9: Medium oak forest in Zawali Mountain, Derbandikhan, associated with a population of *Myrtus communis* (KBF, Sep. 2016)

**3- High Oak Forest:** The dominant species is *Quercus infectoria* and *Q. libani* associated with *Quercus aegilops*, *Pistacia eurycarpa*, *Acer monspessulanum* and *Crataegus azarolus*. There is a good population of grass among the woodland dominated by *Hordeum* sp., *Aegilops* sp. and *Brumus* sp. (Figure 10). A vast area of the high oak forest from Khoshik Mountain was disturbed either by fire and/or overgrazing especially from the eastern part of the mountain (Figure 11). A very rare species of *Eryngium pyramidale* is present, which grows beside the road and the population consists of a few mature individuals, and recently a *Cousinia calocephala* Jaub. & Spach was found as a new species to Iraq in QaraDagh [27]. The zone is under the threats of fire, landmines, overgrazing and residential and commercial development, in addition to the disturbance of oak forest habitat to be replaced with vineyards and orchards. The continued effect of these threats could endanger the biodiversity and the landscape of the region.

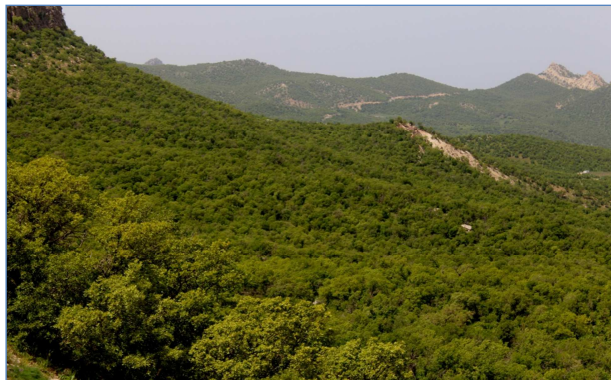


Figure-10: High oak forest in Qopi Qara-Dagh Mountain, Qara-Dagh (KBF, May 2016)



Figure-11: High forest zone in Khoshik Mountain, Derbandikhan, habitat disturbed due to fire is abundant in the location (KBF, Sep. 2016)

### ***C- Riverain Woodland***

The area is about 16km<sup>2</sup>, consisting of 45 main riverains (2.2-8.8km). In Darbandikhan location it occupies about 10.72 km<sup>2</sup>, counting for 16 riverain woodlands. There are 29 main riverain woodlands in QaraDagh occupying around 5.53 km<sup>2</sup>. Two types of riverain woodlands can be found in the study area:

**1. Plain Riverain forest:** There are 11 plain riverains in the study area including Sirwan River extended across most of Darbandikhan location started from the dam of Darbandikhan toward Darband Belula. These riverains are dominated by *Salix acmophylla*, *Populus euphratica*, *Populus alba* and different species of *Tamarix*. These species are in association with some perennial herbs or shrubs such as *Rubus sanctus*, *Xanthium spp.* and *Cyperus spp.*

**2. Mountain Riverain forest:** This kind of riverain forest consisting of 34 in both QaraDagh and Darbandikhan. The arborescent native species commonly found alongside the mountains in the forest zone are *Salix acmophylla*, *Salix aegyptiaca*, *Platanus orientalis*, *Fraxinus syriaca* and *Populus euphratica*. Among shrubs *Vitis vinifera*, *Rebus nactus*, *Rosa canina*, *Nerium oleander*, *Vitex agnus-castus* and *Paliurus spina-christi* are abundant there.

#### D- Thorn-Cushion or Subalpine Zone

It is the highest phytogeographical zone in the study area, consisting of four small spots, located in Qopi QaraDagh Mountain. The zone is expected to be around 2km<sup>2</sup> starting from an elevation of 1700m. This zone has unique vegetation types and dominated by different perennial grasses and herbs species like *Lolium persica*, *Acantholimon sp.* and *Acanthophyllum sp.* in association with *Prunus argentea*, *Asyneuma persica*, and *Dianthus orientalis*. These species were found to tolerate high light condition and winds there.

In addition to identifying the plant species for different geographical and vegetation zones within the study area, the endemic plant species restricted to the study area were also detected according to their appearance in different vegetation zones for both QaraDagh and Darbandikhan Locations (Table 2). Number of endemic species can be found in Appendix 1.

Table-2: Endemic species in QaraDagh-Darbandikhan area with their habitats

No.	Taxa	Zone				Occurrence	Locations
		Steppe and foothills	Forests	Thorn-cushion	Riverain		
1	<i>Acantholimon blackelockii</i>		*	*	Very rare	QaraDagh	
2	<i>Alcea arbelensis</i>	*	*		Occasional	QaraDagh & Darbandikhan	
3	<i>Allium qaradaghense</i>		*		Occasional	QaraDagh	
4	<i>Alyssum penjwinense</i>	*	*		Rare	Darbandikhan	
5	<i>Astragalus gudrunensis</i>		*	*	Rare	Darbandikhan	
6	<i>Astragalus octopus</i>		*	*	Occasional	Darbandikhan	
7	<i>Bunium cornigerum</i>		*	*	Rare	QaraDagh	
8	<i>Campanula perpusilla</i>		*		Very rare	Darbandikhan	
9	<i>Centaurea koeieana</i>	*	*		Rare	Darbandikhan	
10	<i>Cousinia inflata</i>		*	*	Frequent	QaraDagh & Darbandikhan	
11	<i>Cousinia kopi-karadaghensis</i>		*		Occasional	QaraDagh & Darbandikhan	
12	<i>Echinops inermis</i>		*		Frequent	QaraDagh	
13	<i>Echinops syriacus</i> Boiss.		*		Very rare	Darbandikhan	
14	<i>Erysimum filifolium</i>		*		Rare	QaraDagh	
15	<i>Ferula haussknechtii</i>		*	*	Occasional	QaraDagh	
16	<i>Ferula orientalis</i> L.		*	*	Very rare	QaraDagh	
17	<i>Ferulago bracteata</i>		*	*	Frequent	QaraDagh	
18	<i>Ferulago bracteata</i>		*	*	Occasional	QaraDagh	

19	<i>Ferulago stellata</i>	*		Rare	QaraDagh
20	<i>Fritillaria crassifolia</i> subsp. <i>kurdica</i>	*		Rare	QaraDagh
21	<i>Galium hainesii</i>	*	*	Rare	QaraDagh & Darbandikhan
22	<i>Malabaila secacul</i> subsp. <i>aucheri</i>	*		Rare	QaraDagh
23	<i>Minuartia sublineata</i>	*		Very rare	Darbandikhan
24	<i>Onosma albo-roseum</i> var. <i>macrocalycinum</i>	*		Very rare	QaraDagh & Darbandikhan
25	<i>Onosma cardiostegium</i>	*		Rare	QaraDagh & Darbandikhan
26	<i>Onosma haussknechtii</i>	*		Rare	QaraDagh
27	<i>Ornithogalum iraqense</i>	*		Very rare	Darbandikhan
28	<i>Ornithogalum kurdicum</i>	*		Rare	QaraDagh
29	<i>Phlomis kurdica</i>	*	*	Occasional	QaraDagh & Darbandikhan
30	<i>Picris longirostris</i>	*		Rare	QaraDagh & Darbandikhan
31	<i>Picris strigosa</i> subsp. <i>macrotricha</i>	*		Very rare	QaraDagh
32	<i>Prangos corymbosa</i>	*		Very rare	QaraDagh
33	<i>Scaligeria assyriaca</i>	*	*	Rare	QaraDagh
34	<i>Scilla kurdistanica</i>	*		Very rare	QaraDagh
35	<i>Serratula grandifolia</i>	*		Occasional	QaraDagh
36	<i>Silene araratica</i>	*		Occasional	QaraDagh & Darbandikhan
37	<i>Stachys kotschyii</i>	*		Rare	QaraDagh
38	<i>Stachys kurdica</i>	*	*	Occasional	Darbandikhan
39	<i>Teucrium melissoides</i>		*	Occasional	QaraDagh
40	<i>Tragopogon bupthalmoides</i> var. <i>latifolius</i>	*		Rare	QaraDagh
41	<i>Tragopogon vaginatus</i>	*		Rare	QaraDagh
42	<i>Turgenia lisaoides</i>	*		Occasional	QaraDagh
43	<i>Umbilicus tropaeolifolius</i>	*		Rare	Darbandikhan
44	<i>Verbascum alceoides</i>	*		Very rare	QaraDagh

These species are very crucial in applying the optimum conservation plans for the region, as different endemic species have different ecological conditions that tolerate range of environmental conditions [28]. Presence of this number of endemic species in the area is indicating reasonable plant biodiversity in these areas, indicating their adaptation to variable environmental conditions [29].

The current study is found to be essential to indicate the biological diversity of plant species (forest and herbaceous layer) to facilitate the study of plant ecosystem and their stability in the region [30]. It also facilitates the understanding of the integrated contribution of different animal species (especially the IUCN Red List species) in the entire habitat that offers proper conservation and managing of natural resource in the study area [31]. The Persian leopard *Panthera pardus saxicolor*, is one of the examples of an endangered carnivorous species according to IUCN Red List [32] which was recorded for the first time in 2011 in QaraDagh area [33]. Nature Iraq camera traps through the Persian Leopard conservation project, have also recorded the Leopard in Darbandikhan area in 2016 and videos of it have been obtained. The study area also supports threatened mammal species, such as the Wild Goat *Capra aegagrus* (VU), Mouflon *Ovis orientalis* (VU), Striped Hyena *Hyaena hyaena* (NT). Hence, the presence of plant habitat in the study area is a genetic reservoir for many plant species, and the protection of such spots is inevitably required.

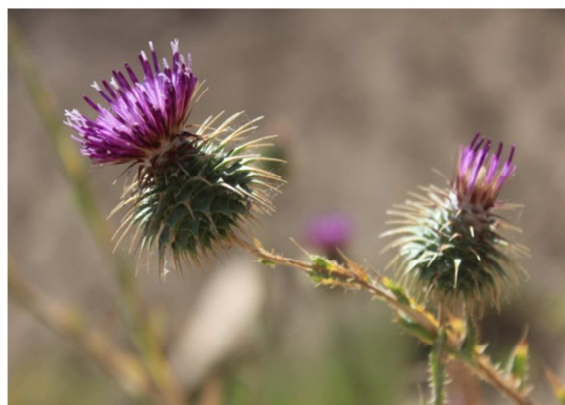
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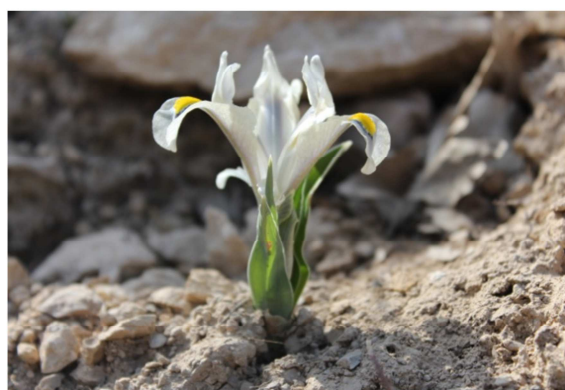
Appendix-1: Endemic and new species in QaraDagh-Darbandikhan area



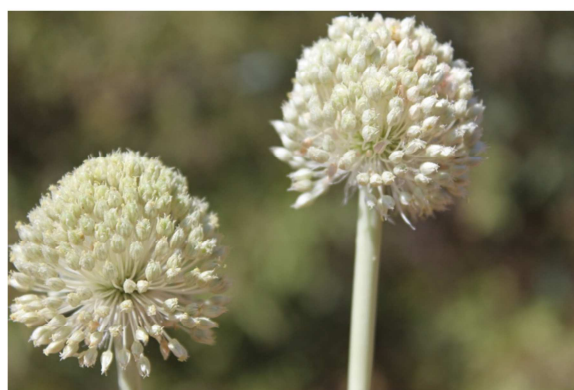
***Cousinia kopi-karadaghensis* Rech.f.**



***Rhamnus kurdica* Boiss.**



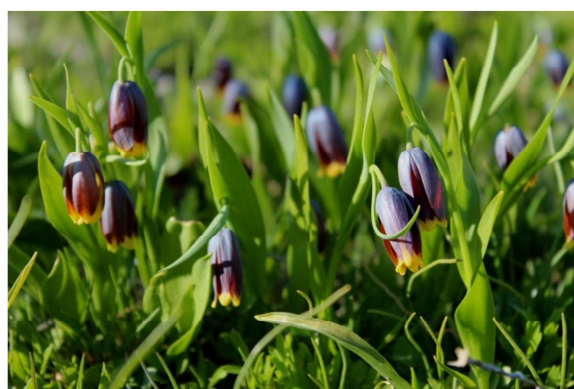
***Iris postii* Mouterde**



***Allium qaradaghense* Feinbrun**



***Serratula grandifolia* P.H.Davis**



***Fritillaria crassifolia* Boiss. subsp. *kurdica*  
(Boiss. Noë) Rix**

Appendix-1 (continued..)



***Phlomis kurdica* Rech.f.**



***Ferula haussknechtii* H. Wolff ex Rech.f.**



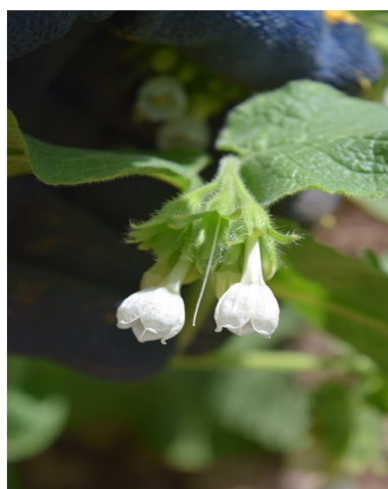
***Stachys kotschyi* Boiss. & Hohen.**



***Alcea arbelensis* Boiss. & Hausskn.**



***Cousinia calocephala* Jaub. & Spach**  
New to Iraq



***Symphytum kurdicum* Boiss. & Hausskn.**