Project Terminal Report

Ecogeographical and botanical surveys in the Idleb Rural Development Project Area – Jebel Zawia and Jebel Wastani

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June 2008

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Acknowledgements

In addition to the authors of the main and individual reports, a number of people have contributed to the study. Dr. Piero D'Altan prepared the base map of the project area. Mr. Fawaz Tulaymat undertook all GIS operations that resulted in the production of the final maps. In addition, he trained the staff of the Idleb Rural Development Project (IRDP) in handling the maps in a GIS environment. Mr. Hashem Abed designed the Web-based botanical database, installed it at IRDP, and trained IRDP staff in its use. Mrs. Wafa Jumaa made all necessary administrative arrangements.

Many thanks are due to Mr. Abdel-Hamid Mellah, Director of IRDP, for the excellent atmosphere of collaboration with his program, and for facilitating many administrative matters within the Ministry. At the same time we wish to thank Dr. Ahmed Darkalt, his predecessor, for the confidence expressed in ICARDA at the time of bidding for the contract. The work done by Prof. Ghalia Martini as consultant vegetation expert was also much appreciated.

1. INTRODUCTION

This report provides an account of the activities, results and recommendations arising from the studies undertaken by ICARDA under the terms of a contract with the Syrian Ministry of Agriculture and Agrarian Reform (MAAR) to undertake botanical and ecogeographical surveys in Jebel Wastani and Jebel Zawia in Idleb Governorate.

The activities and outputs detailed in this terminal report are part of a large Syria Government poverty alleviation project, the "Idleb Rural Development Project", in which the International Fund for Agricultural Development (IFAD) and the Arab Fund for Economic and Social Development (AFESD) participate as major lenders, and the United Nations Development Programme (UNDP) as donor. The project is located in Idleb Governorate (Fig.1, yellow), in the extreme north-west corner of the country. The project area encompasses the entire Governorate but initially focuses on the two major upland areas, Jebel Wastani and Jebel Zawia, and the adjacent lowlands, separated by the Ghab and Rouge valleys, which are intensively farmed under irrigation (Fig. 1).

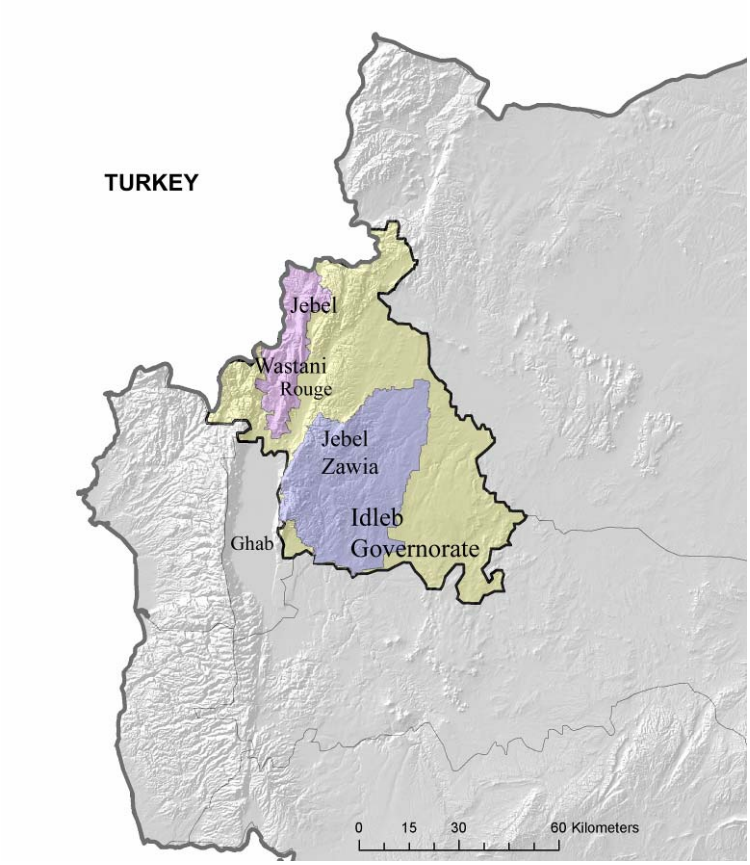


Figure 1. Location of the project area within Syria

A number of poverty studies (e.g. IFAD, 2001; Szonyi et al., 2005; Wattenbach, 2005; IFAD 2007) have identified this area as one of the main rural poverty hotspots in Syria (see further). According to Wattenbach (2005) the project area belongs to the 'Hilly (rainfed) farming system of NW Syria', which is characterized by dominance of small holdings (on average 3.06 ha per family), small plot sizes, narrow fields, steep slopes and shallow soils, as well as the majority of the land under tree crops, especially olives. Despite a favourable rainfall (see further), the lack of land with adequate soils for agricultural use, combined with a high population density, creates conditions of low per-capita income from agriculture and high

reliance on off-farm income, obtained through either seasonal farm labour in other farming systems or external labour markets (Wattenbach, 2005).

The main strategy of Government of Syria (GOS) to tackle poverty in the project area and to increase food production in the country, has been by removing the key constraint, lack of suitable land, through an extensive program of land development involving reclamation of rocky areas by rock removal. Experience gained in other parts of Syria has amply demonstrated that in terms of GOS objectives of increasing agricultural production from rainfed areas, and halting migration to the towns, de-rocking has been an unqualified success. It is difficult to conceive of an investment in agriculture that could have had such a dramatic effect – possibly on the par with providing irrigation to dry areas (IFAD, 2001).

While this intervention has directly brought many benefits to tens of thousands of small farmer households, and has undoubtedly helped to reduce the poverty of many, there is some evidence to suggest that insufficient attention is being paid to assessing and mitigating possible undesirable environmental impacts. One of these is a reduction in the diversity of the natural vegetation, including the land races of common food crops.

Land reclamation, resulting in the conversion of previously natural rangelands, however degraded, has the potential to impact on biodiversity, including the land races of common food crops. Moreover, heavy earth-moving equipment, as used in the de-rocking operations, could disturb archaeological, historical and cultural sites. For this reason, the loan agreement between the GOS and IFAD (International Fund for Agricultural Development, 2002) included an activity to conduct botanical and ecogeographical surveys. The specific objective of these surveys was to identify, characterize, map and develop management plans for areas with valuable plant biodiversity, within the overall context of the agricultural development plans of the Governorate based on the change in the farming systems of the area.

From several studies, submitted through a competitive bid, the MAAR selected ICARDA's proposal (Annex 5.1.) and granted a contract to undertake the studies (Annex 5.2).

The major tasks to be undertaken as part of the contract were:

- To carry out eco-geographical and botanical surveys
- To assess the economic importance of the botanical diversity in the project area
- To formulate proposals for its conservation within the new agricultural system

In terms of deliverables, the three key components, specifically mentioned in the agreement were the actual surveys and their results in the form of a database, a suite of map products that are at the basis for the conclusions and recommendations, and the actual management plans.

The administrative timeline for undertaking the studies and completing the report was as follows:

- Agreement signed: 21 May 2007
- Authorization by the Idleb Development Authority to start work: 7 August 2007
- Mid-term review: 1 November 2007
- Date completion works (survey + mapping): 7 January 2008
- Dissemination workshop: 25 March 2008
- Date submission report to State Planning Commission: 15 April 2008

This report consists of a Main Report and Annexes. The main report provides a synthesis of the different studies that were undertaken as part of the contract and refers the reader to a set of annexes that contain more details on various aspects of the study. The annexes contain the proposal, contract, reports of the individual studies, as well as the maps and a CD with all documents. The individual study reports in these annexes are presented by their own authors with their own references.

2. PROJECT AREA DESCRIPTION

2.1. Delineation

A simplified map of the project area, in relation to the major towns, roads, terrain features and surrounding areas is shown in Figure 2.

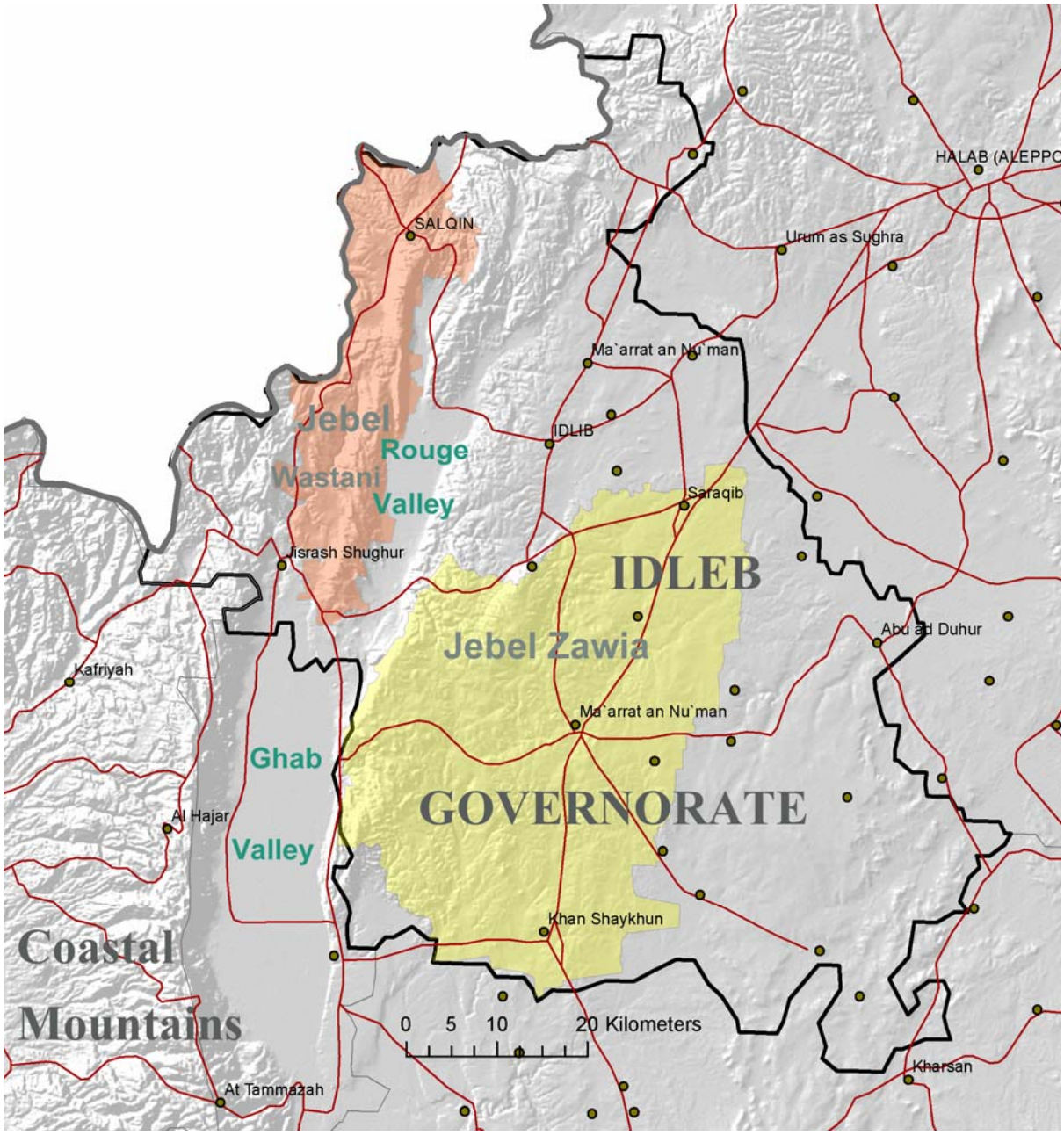


Figure 2. Delineation of the project area

The boundaries of Jebel Zawie and Jebel Wastani were obtained from cadastral maps. Jebel Zawia's northern boundary is around Saraqib, whereas it ends in the south around Khan Sheikhun. The western boundary is formed by the steep sloping east side of the Ghab and the Rouge valleys. Jebel Wastani's northern border extends beyond Salqin, close to Harim, which is already outside the project area. To a large extent it borders Turkey in the west, and

its eastern border is formed by the Rouge valley. Its southern end is at the town of Jishr Asshugur and the northern edge of the Ghab valley.

2.2. Climate

Generally speaking, the study area has a semi-arid Mediterranean climate characterized by hot, dry summers and mild and rainy winters. Nearly all of the rainfall occurs in the winter and spring rainy. Climate diagrams, based on averaged meteorological data[1], are provided for two major stations within or at the edge of the project area, Idleb (Fig. 3) and Jisr As Shuggur (Fig. 4). Idleb is typical for the climatic conditions in most of Jebel Zawia, whereas Jisr as Shuggur is more representative of the lower-lying areas in the western part of Jebel Wastani.

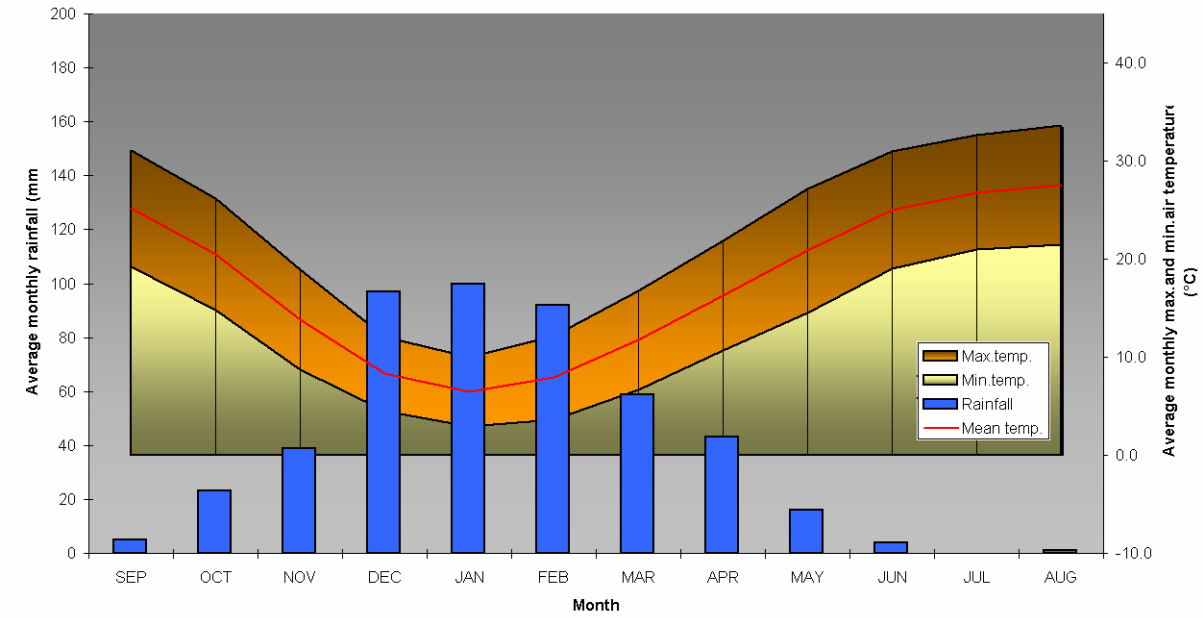


Figure 3. Climate diagram for Idleb (left axis for precipitation, right axis for temperature)

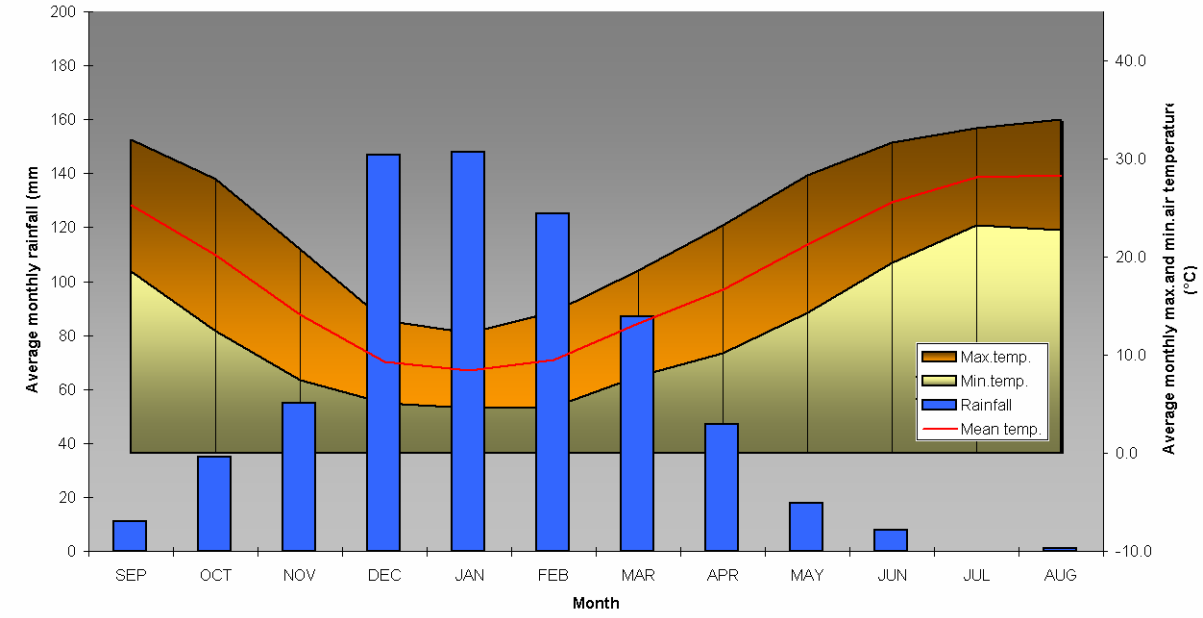


Figure 4. Climate diagram for Jisr As Shuggur

[1] Source: FAO, 2001.

The highest parts of Jebel Wastani and Zawia are about 2-3°C cooler than the values of these climate diagrams. Whereas the temperature pattern is almost identical between Idleb and Jisr As Shuggur, the latter location has clearly higher precipitation throughout the year (total annual mean = 682 mm, versus 479 mm for Idleb).

There is considerable variability in precipitation from year to year, as evidenced in Figure 5, which presents a 38-year time series between 1958 and 1996. More recent data were not available. The standard deviation is 120 mm, the coefficient of variation 24%.

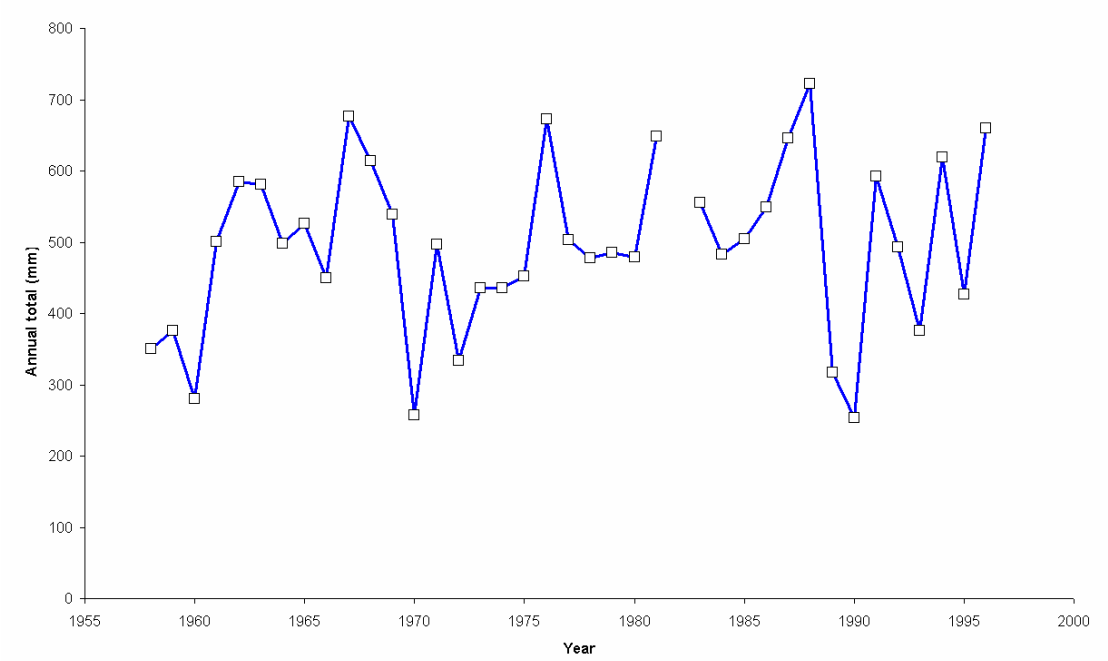


Figure 5. Annual precipitation in Idleb between 1958 and 1996

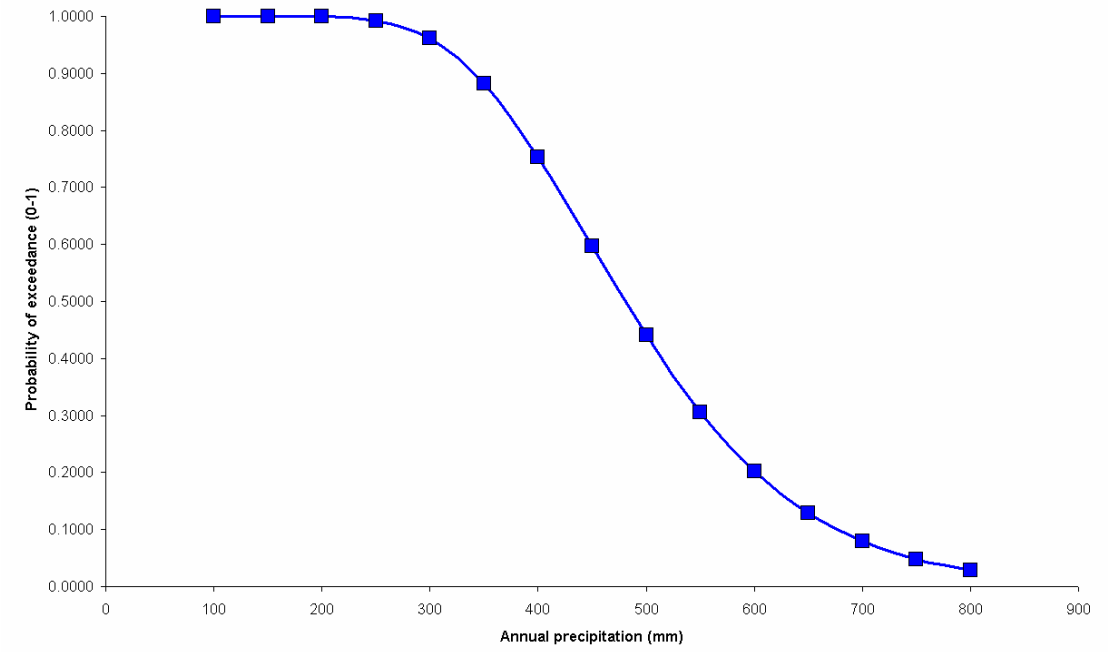


Figure 6. Probability of exceedance graph for Idleb (period 1958-1996)

Despite such variability, the minimum to be expected is sufficiently high to make the growth of most field crops possible, as indicated by Figure 6. Taking the time series 1958-1996 as representative for current climatic conditions and fitting the data onto a lognormal distribution, the probability to exceed 300 mm is 96%, and the probability to exceed 400 mm is 75%. Alternatively, in 4 years out of 5 a minimum annual precipitation of 385 mm can be expected, which is sufficient for climatically adapted cereals and food legumes, as well as olive and fruit trees of the region.

Except at high elevation (see section 3.2), there is no serious temperature constraint for agriculture in the project area. The number of days with frost is very low, hence the growing period is, under rainfed conditions, essentially limited only by the precipitation regime. The moisture-limited growing period is on average in Jisr As Shuggur about 200 days, starting in late October and ending in mid-April; in Idleb the growing period is slightly shorter, with a somewhat later start and earlier end.

In the UNESCO climate classification system Idleb has climate 'SA-C-W' (Semi-arid, Cool winter, Warm summer). In the Köppen system the climate class is 'Csa' ('warm temperate rainy climate with summer drought and hot summers').
The higher precipitation in Jisr As Shuggur results in a more humid climate class in the UNESCO climate classification ('SH-C-W', Sub-humid, Cool winter, Warm summer), but results in no change in the Köppen class.

2.3. Terrain

What distinguishes Jebel Wastani and Jebel Zawia mostly is that they are *upland* areas, with higher elevation than the surrounding areas. The range in elevation is quite high, especially

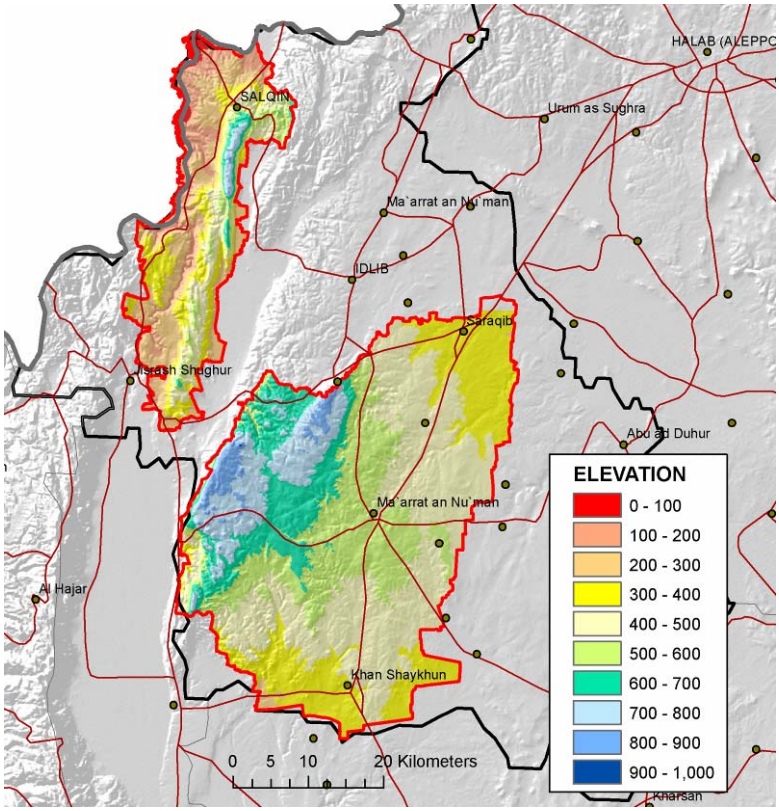


Figure 7. Elevation of the project area.

in Jebel Wastani, with a difference between the lowest (82 m) and highest point (841 m) of 759 m over a few km horizontal distance. Jebel Zawia rises less dramatically rising, although in absolute terms, its highest point (939 m) surpasses Jebel Wastani (Fig. 7).

As their names would suggest, it could be expected that Jebel Zawia and Jebel Wastani have uniformly hilly terrain. This is not always the case, especially in Jebel Zawia. Using a simple terrain classification based on the difference in elevation between 1-km pixels, it is possible to subdivide the project area into three distinct terrain units:

- *Plains*, having a maximum elevation difference between neighbouring pixels of 50 m;
- *Hilly terrain*, having a maximum elevation difference between neighbouring 1-km pixels of 50-300 m;
- *Mountainous terrain*, having a maximum elevation difference between neighbouring 1-km pixels exceeding 300 m.

As shown in Figure 8, less than 40% of Jebel Zawia can be termed 'hilly', whereas nearly 60% is plain-like, and less than 1% is mountainous. Jebel Wastani corresponds much more to the concept of a hilly landscape, with 84% being hilly, 7% mountainous, and 8% plains.

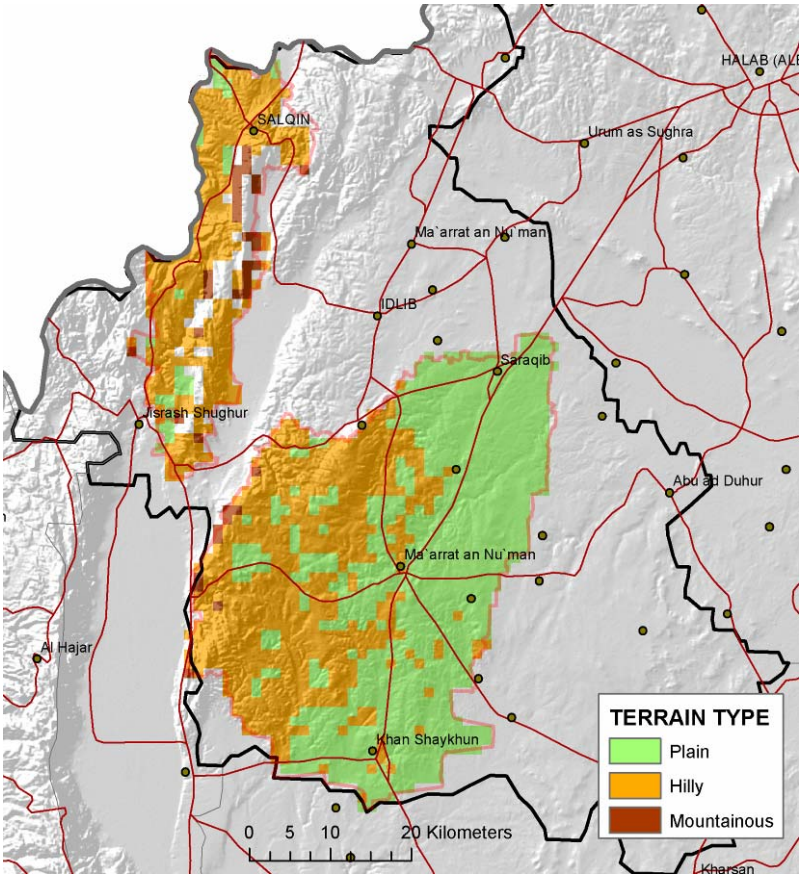


Figure 8. Plains, hilly and mountainous terrain in Jebel Wastani and Zawia

The same contrast between the rugged topography of Jebel Wastani and the more gentle landscapes of Jebel Zawia is expressed in the occurrence of steep slopes. Whereas in Jebel Zawia only 12% of the area has steep slopes (>12%), virtually all of them in the west part of the Jebel, in Jebel Wastani 47% of the land has steep slopes (Fig. 9)

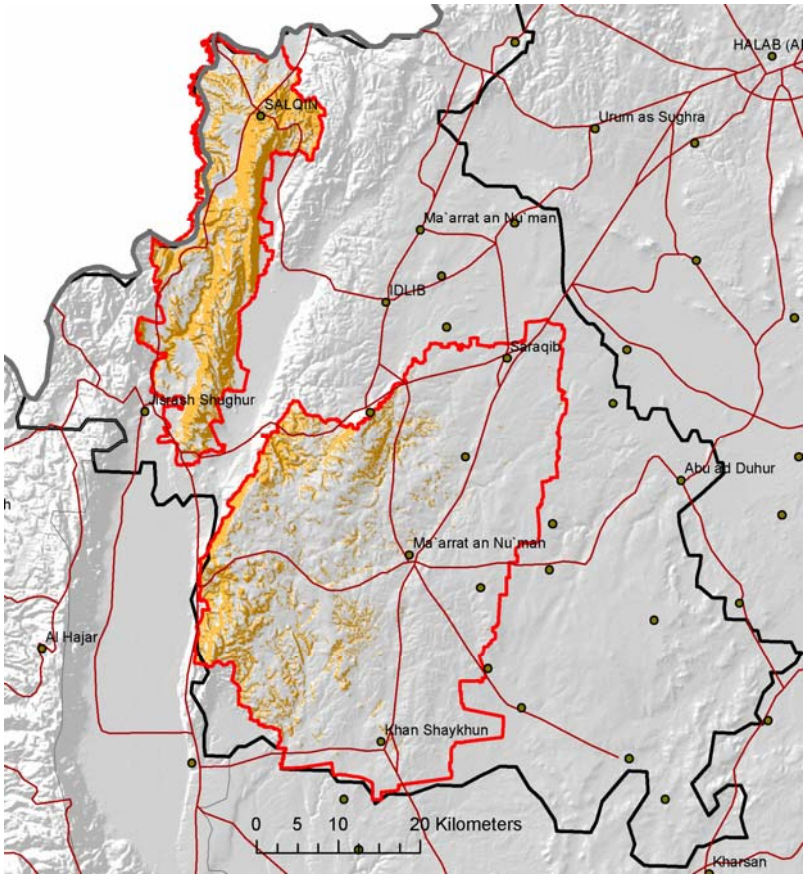


Figure 9. Areas with steep slopes (>12%)

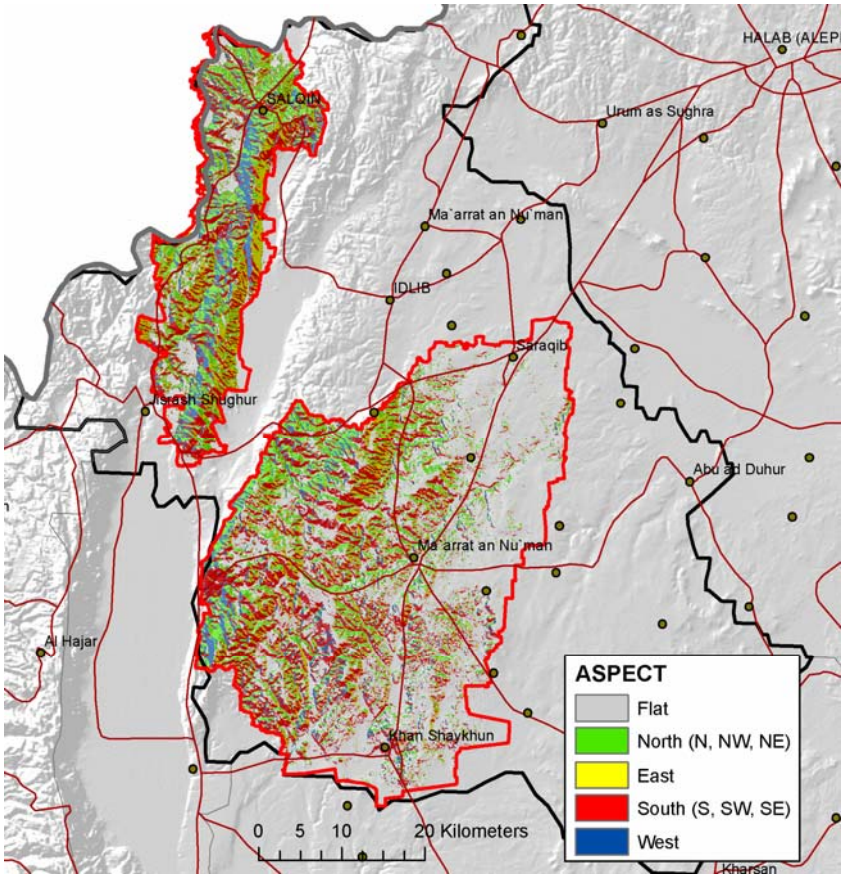


Figure 10. Main slope directions in the project area

Another factor of terrain differentiation is the slope direction or 'aspect', which in hilly terrain can determine exposure to or sheltering from prevailing winds, precipitation directions and radiation. West-facing slopes are expected to be wetter than east-facing, whereas south-facing slopes will be both warmer and drier than north-facing slopes. Figure 10 shows the aspect patterns in the project area. Where slopes do not exceed 5%, aspect is not considered.

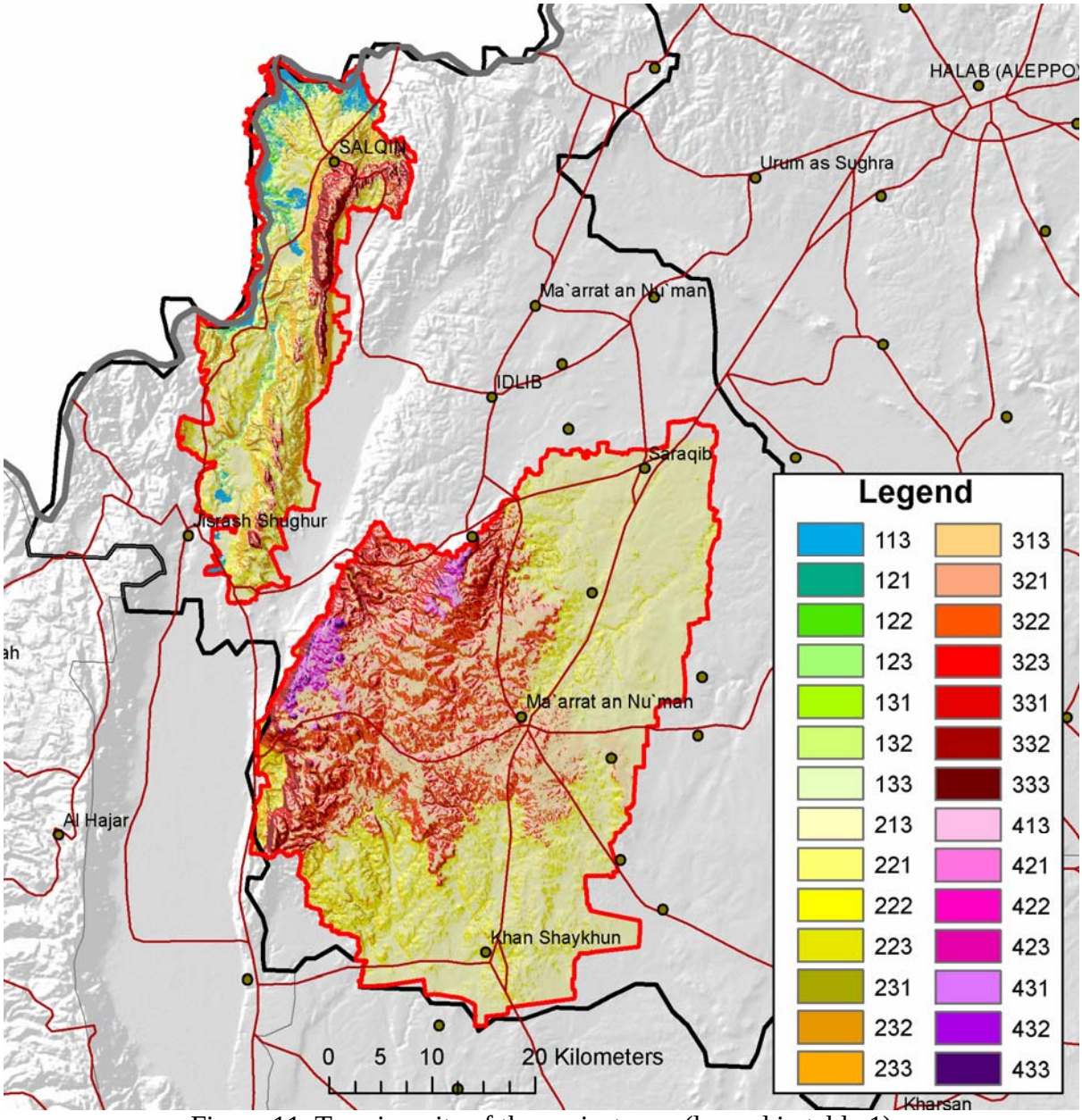


Figure 11. Terrain units of the project area (legend in table 1)

Combinations of elevation, slope and aspect thus constitute different environments that influence the comparative advantage of different land uses or species. Agriculture prefers flat or gently undulating land, whereas the presence of very steep, particularly north-facing slopes, where grazing is not possible and moisture conservation is better, promotes the conservation of natural vegetation and the preservation of wildlife habitats. A classification into *Terrain Units*, based on the combinations of these three factors, is a first mechanism to differentiate environments. However, it needs to be emphasized that whereas a classification

suggest crisp boundaries between these classes, in reality a very large number of possible transitions exists.
The distribution of the terrain units is shown in Figure 11. Table 1 indicates their features.

Table 1. Terrain units of the project area

Code	Was-tani?	Zawia?	Description
113	Yes		Elevation 0-200 m; slope 0-5%; undifferentiated aspect
121	Yes		Elevation 0-200 m; slope 5-15%; northern aspect
122	Yes		Elevation 0-200 m; slope 5-15%; southern aspect
123	Yes		Elevation 0-200 m; slope 5-15%; undifferentiated aspect
131	Yes		Elevation 0-200 m; slope >15%; northern aspect
132	Yes		Elevation 0-200 m; slope >15%; southern aspect
133	Yes		Elevation 0-200 m; slope >15%; undifferentiated aspect
213	Yes	Yes	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
221	Yes	Yes	Elevation 200-500 m; slope 5-15%; northern aspect
222	Yes	Yes	Elevation 200-500 m; slope 5-15%; southern aspect
223	Yes	Yes	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
231	Yes	Yes	Elevation 200-500 m; slope >15%; northern aspect
232	Yes	Yes	Elevation 200-500 m; slope >15%; southern aspect
233	Yes	Yes	Elevation 200-500 m; slope >15%; undifferentiated aspect
313	Yes	Yes	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
321	Yes	Yes	Elevation 500-800 m; slope 5-15%; northern aspect
322	Yes	Yes	Elevation 500-800 m; slope 5-15%; southern aspect
323	Yes	Yes	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
331	Yes	Yes	Elevation 500-800 m; slope >15%; northern aspect
332	Yes	Yes	Elevation 500-800 m; slope >15%; southern aspect
333	Yes	Yes	Elevation 500-800 m; slope >15%; undifferentiated aspect
413		Yes	Elevation > 800 m; slope 0-5%; undifferentiated aspect
421		Yes	Elevation > 800 m; slope 5-15%; northern aspect
422		Yes	Elevation > 800 m; slope 5-15%; southern aspect
423		Yes	Elevation > 800 m; slope 5-15%; undifferentiated aspect
431		Yes	Elevation > 800 m; slope >15%; northern aspect
432		Yes	Elevation > 800 m; slope >15%; southern aspect
433		Yes	Elevation > 800 m; slope >15%; undifferentiated aspect

2.4. Geology

The geological materials existing in the project area (Table 2) were obtained from the 1:200,000 geological map sheets Hama and Lattakia (Technoexport, 1963). Their extent is shown in Figure 12.
Basically these materials can be reclassified into 4 major lithological groups:

- A: soft materials, soils and sediments
- B: basalts
- C: soft and easily weatherable limestones and other calcareous sediments
- D: hard limestones

Lithological group E is a mixture of hard limestones and softer limestones and other calcareous sediments.

Table 2. Geological materials of the project area and their lithological groups

Map symbol	Description	Lithological group
Q4	Pleistocene, Upper Quaternary, recent deposits (pebbles, loams, grits,, gypsum, sands and salty clays	A
Q3-4-T	Pleistocene, Upper Quaternary, recent undifferentiated (loams, sandy loams, grits). Deluvium-proluvium (slope mantle, talus, alluvial fans)	A
Q3-T	Pleistocene, Upper Quaternary, clays, loams, limestones, sands. Deluvium-proluvium (slope mantle, talus, alluvial fans)	A
BN2	Pliocene basalts and alkaline basalts	B
BN3-1	Upper Miocene basalts	B
N2	Pliocene limestones and sandstones	C
mN2	Pliocene marine deposits: clays, marls, sandstones, conglomerates, tuff-breccias of basic rocks	C
cN2	Pliocene continental deposits: clays, marls, limestones, sandstones, conglomerates	C
N1-t	Neogene, Tortonian marls, limestones, clays, conglomerates	C
N1-h	Neogene, Helvetian limestones and conglomerates	C
N1-akv	Neogene, Aquitanian limestones, sandstones, clays, conglomerates, marls	C
Pg22-NL	Middle Eocene nummulitic limestones	D
Pg22	Middle Eocene clayey limestones, limestones and nummulithic limestones	E
Pg3	Oligocene limestones	C
Cr2 mb	Cretaceous, Maestrichtian, upper part. Clayey limestones	C
Cr2 cp	Cretaceous, Campanian, clayey limestones, flints	C
Cr2 cm-t	Cretaceous, Ceromanian and Turomanian undifferentiated, limestones and dolomites	C

Material A is located in valleys and almost entirely under agricultural use. Material B and C are also mostly taken into cultivation, because de-rocking has been relatively easy as the rocks are fairly soft or easy to detach, with a reasonable reservoir of agricultural soil in between.
The Paleogene nummulithic limestones (material D) are the hardest materials and bare surfaces with little or no soil (and agricultural use) are common on these materials, unless previous de-rocking has already taken place. On the other hand, here and there exist pockets of good agricultural soil between and even below the rocks. Hence, depending on slope and rock area coverage, the nummulithic limestones are the most relevant geological material to assess the feasibility of de-rocking, since these are the remaining free resource for creating new agricultural land.

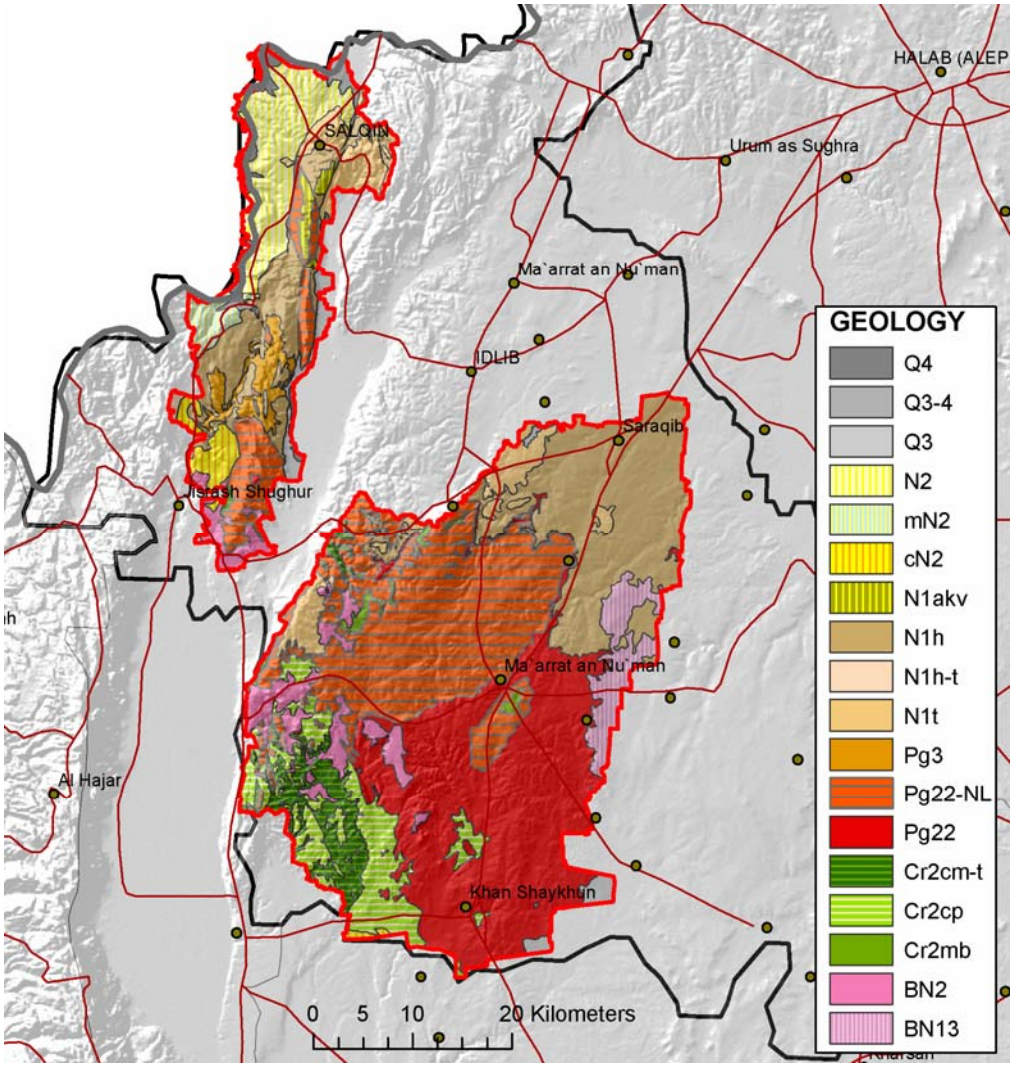


Figure 12. Geological materials in the project area (source: Technoexport, 1963)

2.5. Soils

Generally speaking, except where soil depth is severely limiting for crop or tree production, almost all soils of the project area have a good potential for agricultural use. They are calcareous, with a pH somewhat above 7, have a clayey or loamy texture, a good moisture storage capacity and have no significant fertility limitations or salinity problems. Looking closer, it is obvious that the soils of the project area show a close association with the lithological materials differentiated in the previous section.

2.5.1. Soils on Type A lithological materials

Soils of alluvial (deposited by rivers) and colluvial (transported downhill) origin are typical for the valley bottoms with type A lithology. They are clayey, very deep, usually darker than upland soils, and often affected by temporary flooding. Water is easily pumped up from wells or tubes near the river, hence this area is heavily cultivated with a variety of field and tree crops and vegetables.

Figure 13. Jebel Zawia: typical landscape of the basaltic areas, with omni-present agriculture and very few remaining natural areas

Figure 14. Soils developed on basalts in Jebel Zawia

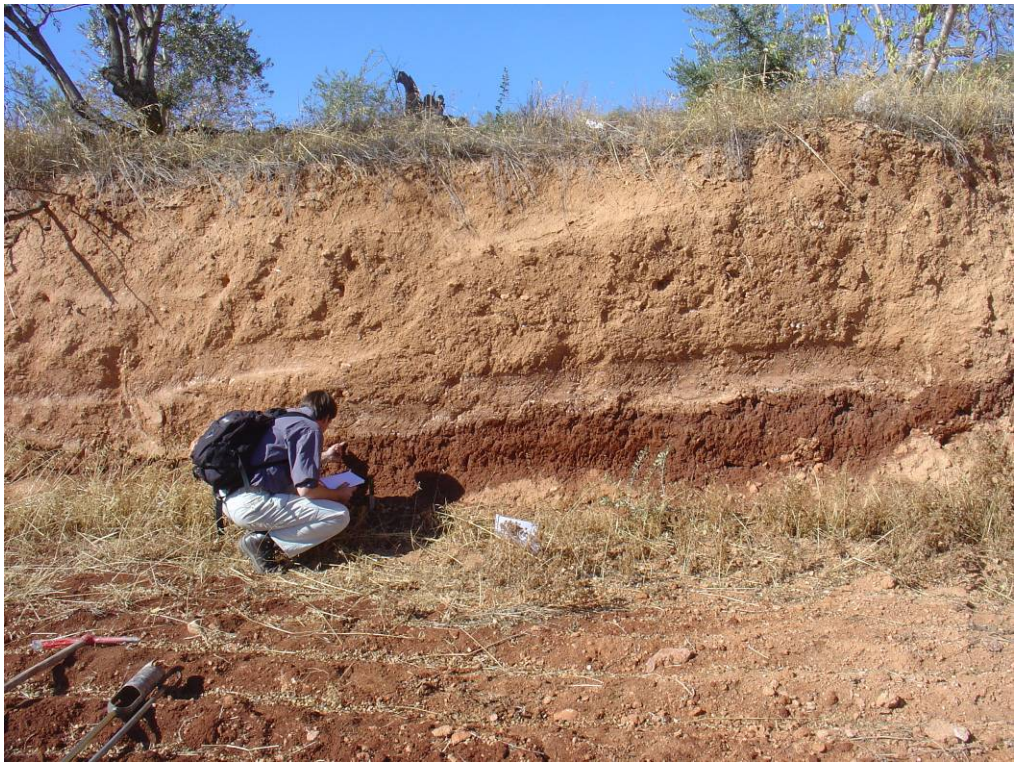


Figure 15. Deep soil profile, developed on hard limestones, near Kafr Talata, Jebel Zawia

Figure 16. Despite major differences in soil depth, the soils on hard limestones are very similar in their physical and morphological features.

Figure 17. Nummulithic limestone outcropping in gently undulating terrain in Jebel Zawia

Figure 18. Jebel Wastani: typical landscape on soils developed on lithological material C

Figure 19. Soft calcareous sediment underlying the soils of Figure 18.

Figure 20. Views on soils on lithological material C in Jebel Wastani. Orchards are a typical land use on these soils.

2.5.2 Soils on Type B lithological materials

These soils are typically well drained soils on basaltic uplands. They have darker colours (more brown than reddish) than soils in similar upland positions on limestones, and, although equally clayey, have a better permeability and workability. For this reason they are highly sought after agricultural soils and are nearly all used for crop production (Fig. 13). Owing to their otherwise favourable agricultural properties, previously shallow soils on basalt have been the first ones to be de-rocked, as rock removal was easier than on the nummulithic limestones.

2.5.3 Soils on Type C lithological materials

These soils are well drained, clayey and although mostly brown, colors vary from white to red, depending on the parent material in a specific location and position in the landscape. Their structure is not as well developed as in the soils on nummulithic limestones, but these soils are also used extensively for agricultural production. In Jebel Wastani they are preferred soils for olive orchards (Fig. 18), as they are not very thick, occur often on fairly steep slopes, and rock and stone removal was relatively easy in comparison to the hard limestones of Type D. In the northeastern corner of Jebel Zawia these soils are usually thicker and underlain by a shallow aquifer, and are used for a mixture of field and tree crops.

2.5.4 Soils on Type D lithological materials

These soils are common in both Jebel Wastani and Jebel Zawia and have all formed on nummulithic limestones. They are characterized by reddish or reddish brown colors, clayey texture, strong structure and extremely variable soil depth, depending on the position in the landscape and the erosion that took place in a particular location. In landscape positions where accumulation took place, mostly as a result of erosion uphill, the soil profile is deep (Fig. 15), whereas in others (Fig. 17), the nummulithic limestone emerges and the soil is confined to patches between the rocks. Despite their differences in depth, these soils are fairly homogenous in their physical properties. Once de-rocking has taken place, the soil depth can be increased either by homogenizing the soil from the surface layer, or eventually deeper layers, or by importing soil from an area with deeper soil.

2.6. Vegetation

Jebel Wastani and Jebel Zawia are home to a tremendous diversity in habitats and species. ‘Mosaic’ landscapes are common, in which different vegetation types are interleaved with one another in complex patterns, created by variations in soil, topography, exposure to wind and sun, and land use. The physiognomic vegetation types can range from forest (reforested and native), mixed with dense woodland, to shrubland and grassland.

All vegetation types in the project area belong the Eumediterranean bioclimatic zone, which is the Mediterranean bioclimatic zone dominated by *Quercus calliprinos, Quercus aegilops, Quercus infectoria, Pistacia palaestina, Rhamnus palaestinus, Phillyaris media.* Associated with these are many other species on the hard limestones that are indicators of vegetation degradation such as *Verbiscum, Salvia palaestina, Phillyaris media, Poterium spinosum, Cistus villosa, Calycotome, Oziris alba, Phlomis longifolia , Ononis spp. Phlomis longifolia Annula viscose, Scolmus spp, Echinops* and *Micromeria sp.*

The natural vegetation is mostly used as rangelands and within the rangelands the project area contains four main physiognomic vegetation types:

- Grassland
- Shrubland

- Open woodland
- Mixed forest and dense woodland

The first two types can occur in habitats with either low (<5%) or high (>5%) density of the vegetation cover.

About 17.4% of the project area is dominated by perennial and annual grasses (Poaceae), and herbaceous (non-woody) plants, also known as forbs. The grassland vegetation type is dominant in Jebel Zawia on basaltic rocks or basalts mixed with limestone, although even there these grasslands are remnants, since most of the footslopes and slopes on these rock types have been reclaimed to agricultural land use. The main grassland species of the project area are described in Annex 5.4.

Shrublands are dense thickets of evergreen sclerophyllous woody shrubs, such as *Sarcopoterium spinosum*, and geophytes such as *Asphodelus microcarpus,* and many other species. Usually the total vegetation coverage is very poor (<5%), as in most places shrubland is the result of degradation of former forest or woodland by cutting or overgrazing. The main shrubland species of the project area are described in Annex 5.4.

Most of the rangelands of the project area (76.2%) have more than 5% cover density. Within these the main physiognomic types of rangelands are maquis, open woodland, shrubs and grasslands. The open woodland is dominated by *Quercus calliprinos, Pistacia palaestina* and many other shrubs and trees. Open woodland is the result of degradation of former forest or dense woodland due to heavy use by humans. Whereas open woodland has the same vegetation composition as the forest or closed woodland, the cover and frequency of few key species has been changed dramatically, resulting even in the total disappearance of some important species. The main woodland species of the project area are described in Annex 5.4.

Mixed forest and dense woodlands, including maquis, reforested areas and natural forest, are estimated to cover 4.9% of the project area. The major species is *Quercus calliprinos,* in association with *Pistacia palaestina,* and many other scrub and trees. During the last few hundred years, most of the original woodland has been used heavily by humans for timber or firewood, or was replaced by agriculture. Grazing by goats and sheep and wood cuttingl prevented tree regeneration, and, without the shelter of trees, heavy autumn rainfall washed away much of the soil. The denuded bare rock, mostly porous limestones, resulted in rapid removal of moisture. Owing to all these factors the forest ecosystems have continuously declined in area and many forest tree species with a low spatial and biological selection, such as the *Quercus* species are permanently in a degraded stage. The main forest species of the project area are described in Annex 5.4.

Valleys are accumulation zones where the soils are deeper than any other terrain type. Where they are not used for growing tobacco, they support a rich plant biodiversity, with among the grasses mostly palatable species.

2.7. Land use/land cover

The project area is mostly cultivated. In both Jebel Wastani and Jebel Zawia tree crops cover about half the area. Irrigated and rainfed crops are strongly represented in the eastern part of Jebel Zawia where they cover about 26% of Jebel Zawia. The preference for tree crops, instead of field crops, is understandable as the amount of good agricultural land with deep soils is limited and much of the land, currently under agricultural use, has been reclaimed over the ages through either stone removal or de-rocking. Rangelands are important, especially in Jebel Wastani, where they cover about 26% of the area; in Jebel Zawia they are less prevalent (16%). Forests are mostly replanted and cover only a tiny fraction of the project area.
The land use/land cover map of the project area is one of the project's outputs and is presented in more detail in Chapter 3 and in Annex 5.5.

2.8. Farming system

The project area is characterized by a farming system in which perennial crops are the dominant component. The main crops of the system are olive, various fruit trees, although mostly cherry, and wheat. These crops, especially the fruit trees, are well adapted to the relatively good rainfall (see section 2.2) and cooler conditions that prevail in the hilly uplands, and to the generally shallow soils.
The combination of a relatively high population density (Fig. 21) and a narrow base of good agricultural land results in a small average holding size (about 3-3.5 ha) and a high dependency on off-farm and non-agricultural income sources. In a survey conducted by an IFAD appraisal mission (IFAD, 2002) it was found that the average farm size is around 3.3 ha, with nearly half of the farms less than 2 ha and only 25% more than 4 ha.

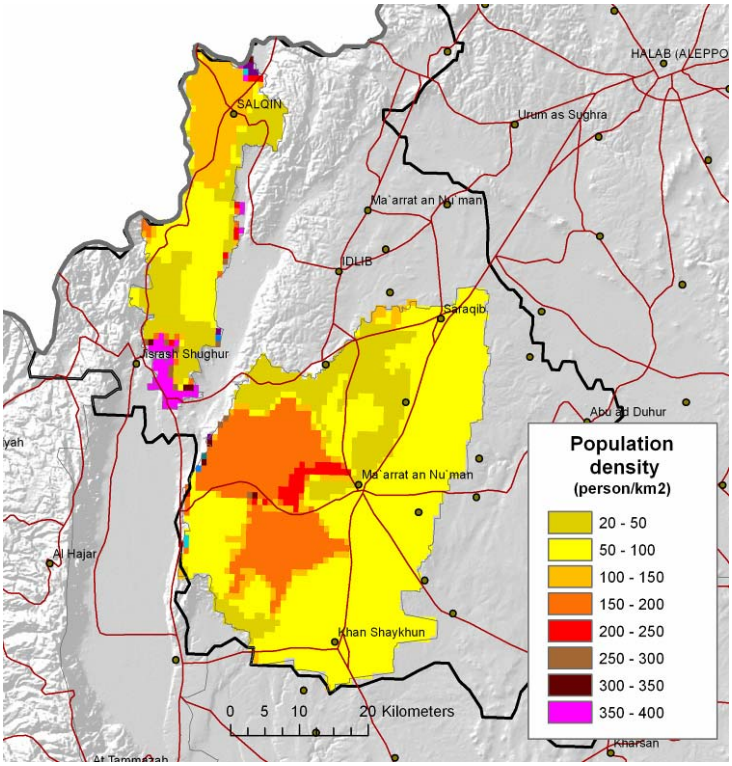


Figure 21. Population density in the project area (source: Szonyi et al., 2005)

Despite such system constraints, the share of non-agricultural families is low, which highlights the essentially rural character of the project area, even though some farmers are only part-time.
Typical for this system is that, compared to others, livestock is of less importance in the farming system due to the lack of grazing areas. These grazing areas are under increasing pressure, and associated degradation risk, due to the continuing land reclamation.

The farming system is essentially market-oriented. Although the only major city near to the project area is Idleb, good and improving road connections nowadays create market opportunities in all major cities of the country, including Aleppo, Lattakia and Damascus. The market-orientation of the farming system is reflected in its importance at the national level, as it supplies the national market with 31% of the Syrian olive production, 24% of cherries and 64% of the total Syrian Kaki production (Wattenbach, 2005) .

Compared to other farming systems, the conditions for agricultural production, such as small holding sizes and plots, shallow soils and steeper slopes are relatively unfavourable. Although largely adequate for the typical crops of the project area, high reliance on rainfed farming limits crop diversification. An additional constraint, particularly for the poorer population segments, is credit availability. Moreover, the sub-system is self-sufficient in agricultural labour and the seasonality of many agricultural operations generates a high labour surplus and temporary unemployment. For this reason the farming system contributes significant seasonal labour to other systems, including skilled agricultural labour for the pruning of perennials in the coastal farming system. As these operations increasingly fail to absorb the available labour, the local population also enters the external labour markets towards Lebanon and Gulf countries (Wattenbach, 2005).

Given the presence of some of the key contributors to poverty (small farm holdings shared by large rural households, low production potential of the land due to high rockiness and fragmented holdings, and limited alternative employment opportunities), it is not surprising that the project area is a hot spot of poverty in Syria. Wattenbach (2005) differentiates within this farming system three household types according to key assets (land size holding, the number of livestock, eventual other assets) and annual income. In his study the share of poor people in the rural population is estimated at 60%, the slightly better-off at 28% and the well-off at 12%. Within this system, poor farmers can expect to obtain an annual income of below SP 75,000, compared with SP 300-500,000 for the better-off farmers.

By creating new agricultural land from previously marginal areas, land reclamation through de-rocking has been one of the key strategies for removing the main constraint of the farming system, and, indirectly, for alleviating poverty. De-rocking is not a new process. In its Syria Country Evaluation Report IFAD (2001) lists a number of projects, in which de-rocking was the key mechanism for large-scale land reclamation. In 1977 the Fruit Trees Planting Project targeted areas in hilly and mountainous regions in Agricultural Stability Zone 1, and to a lesser degree in Agricultural Stability Zone 2. Some 360,000 ha of de-rocking and planting were planned, and by October 1999 some 268,000 ha had been achieved. Since 1980 the Green Belt Project around Aleppo has de-rocked 125,000 ha (in ASZs 2 and 3), of which 87,000 ha have already been planted. Since 1986 the Ali El Ali Project has de-rocked more than 62,000 ha, with a continuing annual target of 4,700 ha.

The de-rocking process developed and used in IFAD supported projects consists of three major operations; (i) initial clearing of the surface rocks using a front-mounted bulldozer

blade (Fig. 22); (ii) ripping to a depth of usually 90 cm to bring rocks to the surface, normally using a three-shanked ripper mounted on the rear of the bulldozer (Fig. 23); and (iii) raking rocks of over 30 cm diameter from the field, piling up the rocks at the field edges and levelling the field surface using a front-mounted toothed rake blade (Fig. 24). This methodology has proved satisfactory, and operations have been undertaken to a high standard. The results are that after de-rocking (Fig. 25), fields can be planted to various crops, depending on the rainfall, such as wheat and barley, pulse crops such as chickpeas, and fruit trees such as olives and apples.

Figure 22. Initial clearing of the surface rocks

Figure 23. Ripping the subsoil to bring rocks to the surface

Figure 24. Piling up the rocks at the field edges

Figure 25. After de-rocking, although still rough and stone-covered, fields can be planted to various crops

Figure 26. With time, manual stone removal and ploughing create an even seedbed

3. PROJECT IMPLEMENTATION

3.1. Surveys

3.1.1. Botanical survey

The objectives of the survey were:

- To map the botanical biodiversity within the project area, particularly in relation to the occurrence of indigenous wild species and land races;
- To assess the economic importance of the botanical biodiversity identified in the project area;
- To conserve the biodiversity by encouraging farming practices compatible with good management of the natural resources.

Methodology:

Eleven monitoring areas were selected in Jebel Zawia and Jebel Wastani in March 2007 based on the following criteria:

- Different land uses
- Different parent rocks
- Covering both a protected and degraded area
- Different plant communities
- Covering a wild herbaceous and forest area
- Covering the natural area and cultivated area

The botanical survey started mid-April and was completed in mid-June 2007. Within each area (Jebel Wastani and Jebel Zawia) it was undertaken at three levels of observation:

- At the level of the **monitoring area**: 7 monitoring areas were selected in Jebel Zawia and 4 monitoring areas in Jebel Wastani
- At the level of the **transect**: 3 transects were selected for each monitoring area for both herbaceous and trees plots. depending on the heterogeneity, the length of each transect was 50 to 250 m.
- At the level of the **plot:** 5 plots were selected in each transect of each monitoring area for both herbaceous and trees area. The distance between the plots was 15–30 m, the plot size in the herbaceous transect was 1 m^2, whereas the plot size in the trees transect was 100 m^2

The sampling approach is illustrated in Figure 27.

Measurements

- **Coordinates:** Latitude, longitude and altitude were recorded by GPS in the middle of each monitoring level, in the start and end points of each transect, and at each plot.
- **Photo:** Photos were taken in each monitoring area, each transect and each plot.
- **Terrain:** percent slope, slope direction (aspect) and length were taken in each transect, and slope direction in each plot.
- **Soil:** in each plot the following characters were taken:
    - Depth (cm)
    - Color (reddish, brownish, yellowish, grey or black)
    - Texture (Clayey, loamy, sandy or organic)

- Moisture (dry, moist or wet),
- Presence of aggregates
- Ploughed (yes or no).
- Free lime: by adding to the soil a few drops of hydrochloric acid to know if the soil is strongly calcareous, calcareous, slightly calcareous or non-calcareous.

- **Rocks:** in each plot the following characteristics were taken:
  - Abundance (%)
  - Type: basalt, light limestone, or dark limestone.
  - Weathered (fresh, weathered or rotten).
- **Stones:** in each plot the following characters were taken:
  - Abundance (%)
  - Type: basalt, light limestone, or dark limestone.
  - Size class: range from 0.2 cm to more than 60 cm).

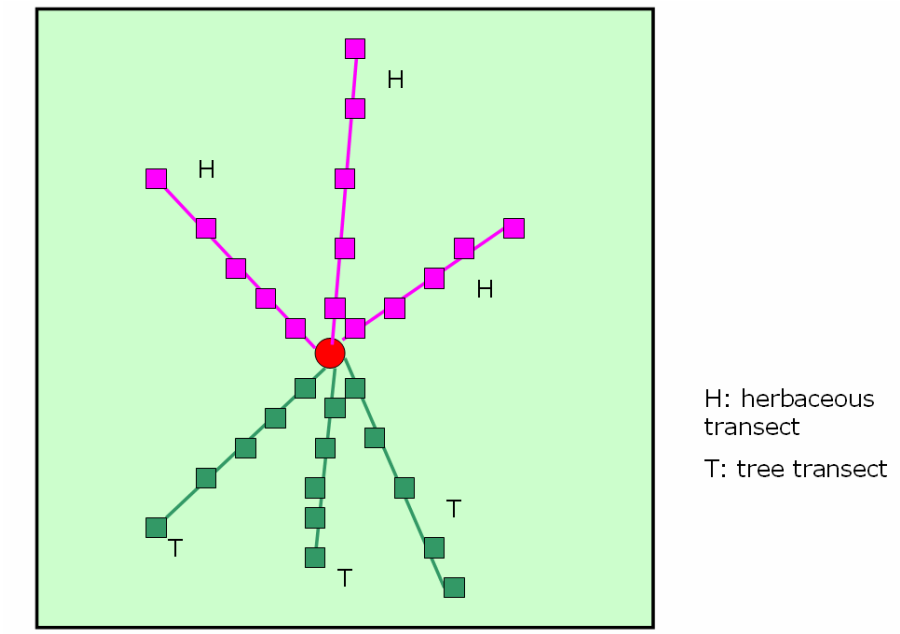


Figure 27. Transects and plots approach inside monitoring areas

Species survey:

Both in herbaceous plot and trees plot date of survey, surveyors, and plot size were recorded.

In **herbaceous plots** the following measurements were recorded:

- List of species: including botanical name, author, family, Arabic name, life form (Annual, perennial or biennial) and biotype (trees, shrub, herb or climber), the known species directly recorded in the field, plant species which could not be identified in the field were given a code, collected and labeled, these specimens were compared with herbarium material of ICARDA, and by using flora of Syria, Palestine.
- Plant cover (%) for each species
- Density: number of plants for each species/plot
- Growth stage: leave stage, flower or fruit formation
- Health: healthy or stress by caused by diseases, insects, parasites, cutting and burning or grazing
- Dominant and associated species: in each plot

In **trees plots,** in addition to the previous data for herbaceous plot, the following data for trees were recorded:

- Number of adult trees
- Height and diameter of each adult tree
- Number of seedlings and juveniles

Disturbance: the causes of disturbance at plot level (grazing, cultivation, plowing fallow, cut and carry, terracing, destoning, rock removal, construction or fire) were defined.

Degradation factors were recorded at the monitoring area level

- **General factors**: including overgrazing, urbanization, cropland encroachment, cutting, terracing, destoning, other land reclamation, quarries or fire, were evaluated on a scale from 0 (no or very low), 3 (low), 5 (medium), to 7 (high).
- **Botanical indicators**: the list of the indicator species of degradation was recorded, such as thistles, poisonous and unpalatable herbs and shrubs and poisonous bulbous.

Results

The plant species of the monitoring areas of Jebel Zawia and Jebel Wastani were catalogued, resulting in the identification of 339 species of higher flowering plants, belonging to 59 families and 209 genera.

The Leguminosae family is represented by the largest number: 78 species (23% of total number of species), followed by Compositae with 42 species (12.4% of total), Gramineae with 39 species (11.5%), Labiatae with 16 species (4.7%), Umbelliferae with 15 species (4.4%), Cruciferae with 13 species (3.8%), Caryophyllacea with 12 species (3.6%), and Rosaceae with 10 species (3%).

The climax plant association in most parts of Jebel Zawia and Jebel Wastani is the *Quercus calliprinos – Pistacia palaestina* association. The dominant herbaceous species are: *Trifolium stellatum, Hordeum murinum, Lagoecia cuminoides, Avena sterilis, Koeleria phleoides.* The dominant shrubs species are *Sarcopoterium spinosum, Asphodelus microcarpus.* The dominant trees species are *Quercus infectoria, Phillyrea latifolia, Crataegus azarolus.*

For a description of plant communities and associations is referred to Annex 5.3.

The analysis of the flora according to the life forms revealed that annual species are predominant with 212 species (62.7.1%), followed by perennials with 118 species (34.9.1%), and followed by biennials with 8 species (2.4%). According to biotype the flora in both Jebels consists of:

- Herbs: 282 species (212 annual species, 62 perennial species and 8 biennial species);
- Shrubs: 30 species (22 small shrubs species and 8 high shrubs species);
- Trees: 20 (16 tall trees species and 4 small trees);
- Climbers: total number of climber species: 6 (4 climber shrubs species, 1 climber herb species and 1 climber tree species).

For statistics on average vegetation cover, species cover, density and frequency% in both the herbaceous and tree plots of Jebel Wastani and Jebel Zawia, as well as tree height and diameter measurements is referred to Annex 5.3.

Table 3. Multi-functional use of major plants in the target areas

Species	Medicinal	Aromatic	Honey Production	Ornamental	Wood	Forage	Industrial Purposes	Foods
Styrax officinalis Snow drop bush	√	√	√	√	√	√	√	
Laurus nobilis Laurel	√	√	√	√			√	√
Crataegus azarolus Hawthorn	√		√		√	√	√	√
Pistacia palaestina Terebinth	√			√	√	√	√	√
Rhus coriaria Sumac	√		√	√		√	√	√
Quercus calliprinos Palestine Oak	√				√	√	√	√
Amygdalus orientalis Wild almond	√	√	√				√	√
Capparis spinosa Capers	√		√			√	√	√

Economic uses of plants in the project area

The target areas have a rich biodiversity and can be considered a source of natural products and free biological resource that provide income for the rural poor and on which they can depend for food, feed, fuel, medicine, clothing and shelter. Some plants have multiple uses (Table 18).

The following specific classes and subclasses for economic plant uses are according to GRIN (see references) and were modified from Cook 1995. For pictures of some important plants with economic uses is referred to Annex 5.3.

Animal food (fodder and forage)

Most the pastures of the target area are rich with high palatable legumes species (*Trifolium stellatum, Trifolium campestre, Trigonella filipes, Vicia palaestina* and *Medicago rigidul),* palatable grasses such as *Avena sterilis, Lolium rigidum, Koeleria phleoides, Hordeum bulbosum* and *Bromus danthoniae,* and palatable trees especially for goats, such as *Quercus calliprinos, Crataegus azarolus* and *Pistacia palaestina.*

Bee plants (honey)

There are plenty of species producing nectar that attracts honey bees, such as:

- herbs (*Trifolium* spp., *Euphorbia exigua* and *Sinapis arvensis*),
- shrubs (*Thymus syriacus, Capparis spinosa and Onopordum heteracanthum* and *Asphodelus microcarpus*), and
- trees (*Crataegus azarolus, Styrax officinalis, Pyrus syriaca* and *Prunus microcarpa)*

Environmental uses

1) Afforestation:

The best native trees species to be used for afforestation are *Crataegus azarolus, Amygdalus orientalis, Pyrus syriaca, Cerasus mahaleb* and *Lycium depressum.*

2) Environmental indicators:
Some species are good indicators of degradation, such as thistles (*Centaurea iberica, Echinops polyceras, Onopordum heteracanthum, Noaea mucronata*) and poisonous plants (*Ballota saxatilis, Dianthus multipunctatus, Peganum harmala, Asphodelus microcarpus*) (Fig. 31 in Annex 5.3.).
Some species are indicators of rocky areas, e.g. *Micromeria myrtifolia, Ajuga chia* and *Umbilicus intermedius* (Fig.32 in Annex 5.3).

3) Hedge:
The most common native trees species for use as hedges are *Crataegus azarolus, Amygdalus orientalis, Lycium depressum* and *Rhus coriaria.*

4) Erosion control:
In addition to trees, there are many shrubs species used for erosion control, such as *Sarcopoterium spinosum, Capparis spinosa, Lycium depressum, Rhamnus palaestinus, Rhus coriaria, Amygdalus orientalis and Noaea mucronata.*

5) Soil improvement:
Both herb and shrub legumes improve soil fertility by nitrogen fixation, such as *Trifolium spp, Medicago spp., Astragalus spp., Trigonella spp* and *Vicia spp.*

6) Graft stock:
Many native trees are used as a graft stock for some planted species such as:
- *Crataegus azarolus* is a graft stock for Pear
- *Olea europeae var. oleaster* is a graft stock for Olive
- *Prunus microcarpa* is a graft stock for Plum
- *Pistacia palaestina* is a graft stock for Pistachio
- *Ficus carica* is a graft stock for Fig
- *Amygdalus orientalis* is a graft stock for Almond
- *Pyrus syriaca* is a graft stock for Pear and Apple
- *Cerasus mahaleb* is a graft stock for Cherry

7) Shade / Shelter:
Common shade trees are *Pistacia palaestina, Quercus infectoria, Quercus calliprinos and Laurus nobilis.*

Use as food
1) Beverage base:
The resin of *Pistacia palaestina* is used as a tonic drink and the extract of the roots of *Glycyrrhiza glabra* is used as a drink**.**

2) Fruits:
The main species, used as a fruit are *Amygdalus orientalis, Crataegus azarolus, Ficus carica, Pistacia palaestina, Pyrus syriaca* and *Rhus coriaria*

3) Oil:
Oil is extracted from the seeds of herbaceous species *Brassica nigra* and *Sinapis arvensis*.

4) Leaves:
The main herb species with edible leaves are *Cichorium pumilum, Gundelia tournefortii.* The main shrub species is *Thymus syriacus* (Fig 34 in Annex 5.3).

5) Fungi:
Collection of mushrooms in the forest occurs in early spring

Use as food additive
1) Emulsifier:
The roots of *Gypsophila struthium* can be used to extract, after boiling with water, an emulsifier to add to Halaweh (special sweet) (Fig. 35 in Annex 5.3).

2) Flavoring:
Orchis mascula is a source of Sahlep, a white powder that is obtained by drying the tuber and grinding it into a powder that is mixed with milk (Fig 36 in Annex 5.3).

Use as fuel
1) Charcoal:
Charcoal is produced from different trees such as olives after pruning and *Quercus calliprinos* (Fig.37 in Annex 5.3)

2) Fuel wood:

The following species are used as fuel wood: *Quercus calliprinos, Pistacia palaestina* and *Rhamnus palaestinus*.

Industrial uses
1) Dye:
The bark of *Quercus calliprinos* and the leaves of *Rhus coriaria* are used in tanning (Fig. 38)

2) Carpentry:
The wood of *Pistacia palaestina, Laurus nobilis, Arbutus andrachne, Laurus nobilis* and *Olea europeae var. oleaster* are used in carpentry.

3) Soap:
The oil which is extracted from the fruits of *Laurus nobilis* is mixed with olive oil to make Al-Ghar soap. The emulsifier extracted from the roots of *Gypsophila struthium* is also in some soaps (Fig. 39 in Annex 5.3).

4) Pickles:
The flower buds of *Capparis spinosa* are collected by rural communities to make pickles for selling on the market (Fig.40 in Annex 5.3).

5) Cosmetics:
The oil of *Amygdalus orientalisusing* is used for skin care, *Matricaria chamomilla* for shampoo and creams.

6) Traditional handicraft:
The rural community uses the stems of wheat and oat to make straw plates (Fig. 41 in Annex 5.3.).

7) Aromatic plants:
The most common aromatic plants are *Pistacia palaestina, Amygdalus orientalis, Styrax officinalis* and *Laurus nobilis.*

8) Ornamental plants:
Figure 42 in Annex 5.3 shows examples of use of plants, such as *Lonicera orientalis, Alcea digitata, Iris aucheri, Cistus creticus* for ornamental uses.

9) Medicinal plants:
Table 4 lists plants occurring in the project area that have medicinal uses (Fig. 43 in Annex 5.3)

10) Non-vertebrate poisons (pesticide):
Inuline is extracted from the leaves of *Inula viscose* for use as insecticide.

11 Vertebrate poisons:
The seeds of *Styrax officinalis* are used as fish bait.

Table 4. The most common medicinal plants in Jebel Zawia and Jebel Wastani

Species	**Part used**	**Uses**
Quercus calliprinos	Bark	Anti-diarrhea, treatment of eczema
Pistacia palaestina	Fruits and seeds	Sedative, anti-asthma
Crataegus azarolus	Flowers and fruits	Strengthens the heart, hypertension
Amygdalus orientalis	Fruits	Oil for skin care
Styrax officinalis	Flowers	Cough, antispasmodic
Olea europeae var. oleaster	Leaves and fruits	Diuretic, laxative, against hypertension
Rhus coriaria	Leaves and fruits	Diuretic, anti-diarrhea, vitamin C
Thymus syriacus	Leaves	Headaches, asthma, cough
Capparis spinosa	Roots, flower's bud, fruits	Rheumatism, anti-diarrhea, diuretic
Ephedra peduncularis	Leaves	Cough, anti-asthma
Eryngium creticum	Flower's herb	Sleeplessness, rheumatism
Gundelia tournefortii	Fresh stem	Tonic for liver, enhances gall excretion
Inula viscosa	Flowered branches	Anti-parasites, anemia
Micromeria myrtifolia	Leaves and flowers	Asthma, throat inflammation
Cichorium pumilum	Roots and leaves	Activate the liver and kidney

3.1.2. Ecogeographical survey

The new land use/land cover map of Idleb Governorate, based on the interpretation of Landsat ETm+ satellite image of March 2003 (see Annex 5.5), allowed to put the results of the botanical survey (Annex 5.3) , which was conducted on a limited number of monitoring sites, in a spatial context. The land use/land cover map revealed a number of natural cover classes (forests, rangelands and bare rocks), which can be linked to vegetation types and life forms.

All of these cover classes in the project area are in fact mostly used as rangelands. The 'bare rocks' class represents rangelands with very low, and often much degraded, cover. The

forests, on the other hand, unless planted, represent the densest natural cover. Within these cover classes, four main physiognomic vegetation types can be distinguished, although not on a 1:1 relationship:

- Grassland
- Shrubland
- Open woodland
- Mixed forest and dense woodland

The first two types can occur in habitats with either low (<5%) or high (>5%) density of the vegetation cover.
These physiognomic types may contain different life forms. What differentiates the physiognomic types is not so much the presence or absence of one life form or another as the different proportions of life forms they contain (Table 5).

About 17.4% of the project area is dominated by perennial and annual grasses (Poaceae), and herbaceous (non-woody) plants, also known as forbs. The grassland vegetation type is dominant in Jebel Zawia on basaltic rocks or basalts mixed with limestone, although even there these grasslands are remnants, since most of the footslopes and slopes on these rock types have been reclaimed to agricultural land use. The main annual grassland species of the project area are *Hordium spontaneum, Aegilops ovata, Aegilops speitoides, Avena barbata, Hordeum glaucum.* The main perennial grasses are *Hordium bulbosum, Dactylis glomerata, Hyparrhenia hirta, Oryzopsis miliaceae, Poa bulbosa, Stipa bromoides, Stipa lagacscea.*

Table 5. Vegetation component cover (%)

Cover form (Physiognomy)	Type code	Life form			
		Tree	Shrub	Annual Grass	Perennial Grass
Grassland	G	-	< 2	>20	>20
Shrubland	S	<1	>15	>30	>15
Open woodland	W	<5	> 20	>15	>20
Dense woodland (Maquis)	Dw	>15	>5	.>10	>25
Reforested area	RF	>20	>5	>15	>10
Natural forest	NF	>25	>10	>15	>20

Shrublands are dense thickets of evergreen sclerophyllous woody shrubs, such as *Sarcopoterium spinosum*, and geophytes such as *Asphodelus microcarpus,* and many other species. Usually the total vegetation coverage is very poor (<5%), as in most places shrubland is the result of degradation of former forest or woodland by cutting or overgrazing. The main shrubland species of the project area are *Sanguisorba munon, Teucrium montberteti, Teucrium polium, Phlomis longifolia,Rosa Phoenicia,: Cynara syriaca, Dianthus multipunctatus, Ephedra campylopoda, Eryngium spp. Gundelia tinctoria Salvia palaestina,a Achillea micrantha, Achillea setaca, Onobrychis kotchyanana, Onopodon spp. Anthemis tinctoria, and Gundella tinctoria.*

The vast majority (76.2%) of the rangelands of the project area have more than 5% cover density. Within these the main physiognomic types of rangelands are maquis, open woodland, shrubs and grasslands. The open woodland is dominated by *Quercus calliprinos, Pistacia palaestina* and many other shrubs and trees. Open woodland is the result of degradation of former forest or dense woodland due to heavy use by humans. Whereas open woodland has the same vegetation composition as the forest or closed woodland, the cover and frequency of few key species has been changed dramatically, resulting even in the total disappearance of some important species. The main woodland species of the project area are *Ammagdalus orientalis, Cerasus mahlaba, Prunus microcarpus, Phyllyrea media, Pistacia paalestina, Crataegus azarolus, Olea europeae var. oleaster, Prunus microcarpa, Quercus aegilops, Q. calliprinos, Q. libani, Rhamnus palaestina, Rhus coriaria, Paliurus spina-christi, Styrax officinalis, Zizyphus spina-christi with many perinnials an dannuals . Achillea setaca, Onobrychis kotchyanana,Onopodon spp. Anthemis tinctoria, Gundella tinctoria, Hordium bulbosum, Dactylis glomerata, Hyparrhenia hirta, Oryzopsis miliaceae, Poa bulbosa, Stipa bromoides, and Stipa lagacscea.*

Mixed forest and dense woodlands, including maquis, reforested areas and natural forest, are estimated to cover 4.9% of the project area. The main natural forest species is *Quercus calliprinos,* in association with *Pistacia palaestina*, and many other scrub and trees. During the last few hundred years, most of the original woodland has been used heavily by humans for timber or firewood, or was replaced by agriculture. Grazing by goats and sheep and wood cutting prevented tree regeneration, and, without the shelter of trees, heavy autumn rainfall washed away much of the soil. The denuded bare rock, mostly porous limestones, resulted in rapid removal of moisture. Owing to all these factors the forest ecosystems have continuously declined in area and many forest tree species with a low spatial and biological selection, such as the *Quercus* species are permanently in a degraded stage.

The mixed forest and dense woodland include both native and planted species. In these mixed forests *Quercus calliprinos* is usually associated with *Pinus halepensis*, *Juniperus* and *Arbutus sp.* Such mixtures are often found within or around Byzantine ruins or near graveyards or holy, and therefore protected, places, The other kind of forest is replanted with exotic or introduced species. The reforested areas in Idleb Province are mostly composed of *Eucalyptus sp.* and *Cupressus sempervirens* .The tree species of the mixed forest and dense woodland vegetation types have deep roots that penetrate the rock and reach water tables during summer; the leaf-fall from the trees enriches the soil, and the shade of the trees, and the shelter they provide from wind, keep the soil moist.

Valleys are accumulation zones where the soils are deeper than any other terrain type. Where they are not used for growing tobacco or other crops, they support a rich plant biodiversity, with among the grasses mostly palatable species.

Degradation

Due to a huge increase in human and animal populations since about 100 years ago, resulting into uncontrolled wood cutting, burning (natural or intentional), herding of sheep and goats, conversion to agricultural land through land reclamation, and urbanization many native plants and animals have become extinct or endangered, especially the perennial species which were particularly vulnerable to the increase in grazing pressure. These pressures led to changes in the structure of the vegetation and in the floristic composition. The first degradation stage

was the transformation of the thick oak forests into various shrub formations. In fact, it is safe to say that, with the exception of a few 'witness' trees, the original forest no longer exists.

Further degradation led in places to the widespread occurrence of the dwarf shrub *Poterium spinosum* and the bulbous plant *Asphodelus microcarpus.* When the human and animal pressure becomes stronger even these degradation indicators are replaced by *Sarcopoterium spinosum*, a poisonous and unpalatable species. Bare rock is the extreme stage of forest degradation in this area.

The most common form of natural regeneration is the expansion *of Pinus halepensis, Cupressus sempervirens, Juniperus* and *Eucalyptus* species, which were introduced in the area to prevent erosion of mountain slopes.

It may be concluded that the current vegetation pattern in the project area is the result of changes in structure and composition that have been mostly influenced by human settlement.

A visual scoring of vegetation degradation, based on the presence of degradation indicator plants (Table 6), was undertaken at 40 sites in the project area. At the vast majority of these sites the vegetation showed either medium (50%) or high degradation (48%). Only in 1 site degradation was low (Figure 28).

Table 6. Indicator plants of vegetation degradation in Jebel Zawia and Jebel Wastani

Thistles	**Herb and shrubs**	**Bulbous**
Capparis spinosa	*Adonis aestivalis*	*Allium stamineum*
Carduncellus eriocephalus	*Ajuga orientalis*	*Arum conophalloides*
Carduus pycnocephalus	*Anagyris foetida*	*Asphodelus microcarpus*
Centaurea iberica	*Ballota saxatilis*	*Eminium spiculatum*
Centaurea pallescens	*Cistus creticus*	*Gagea chlorantha*
Crepis sanct	*Convolvulus dorycnium*	*Gladiolus aleppicus*
Echinops polyceras	*Dianthus multipunctatus*	
Eryngium creticum	*Micromera myrtifolia*	
Gundelia tournefortii	*Papaver rhoeas*	
Lycium depressum	*Peganum harmala*	
Noaea mucronata	*Phlomis orientalis*	
Notobasis syriaca	*Ranunculus asiaticus*	
Onopordum heteracanthum	*Roemeria hybrida*	
Picnomon acarna	*Senecio vernalis*	
Sarcopoterium spinosus	*Thymus syriacus*	
Prunus ursina	*Verbascum sinaiticum*	
Rhamnus palaestinus	*Verbascum transjordanicum*	
Scolymus maculatus		
Silybum marianum		
Sonchus tenerrimus		
Calycotome villosa		

Source: Amin Khatib, personal communication

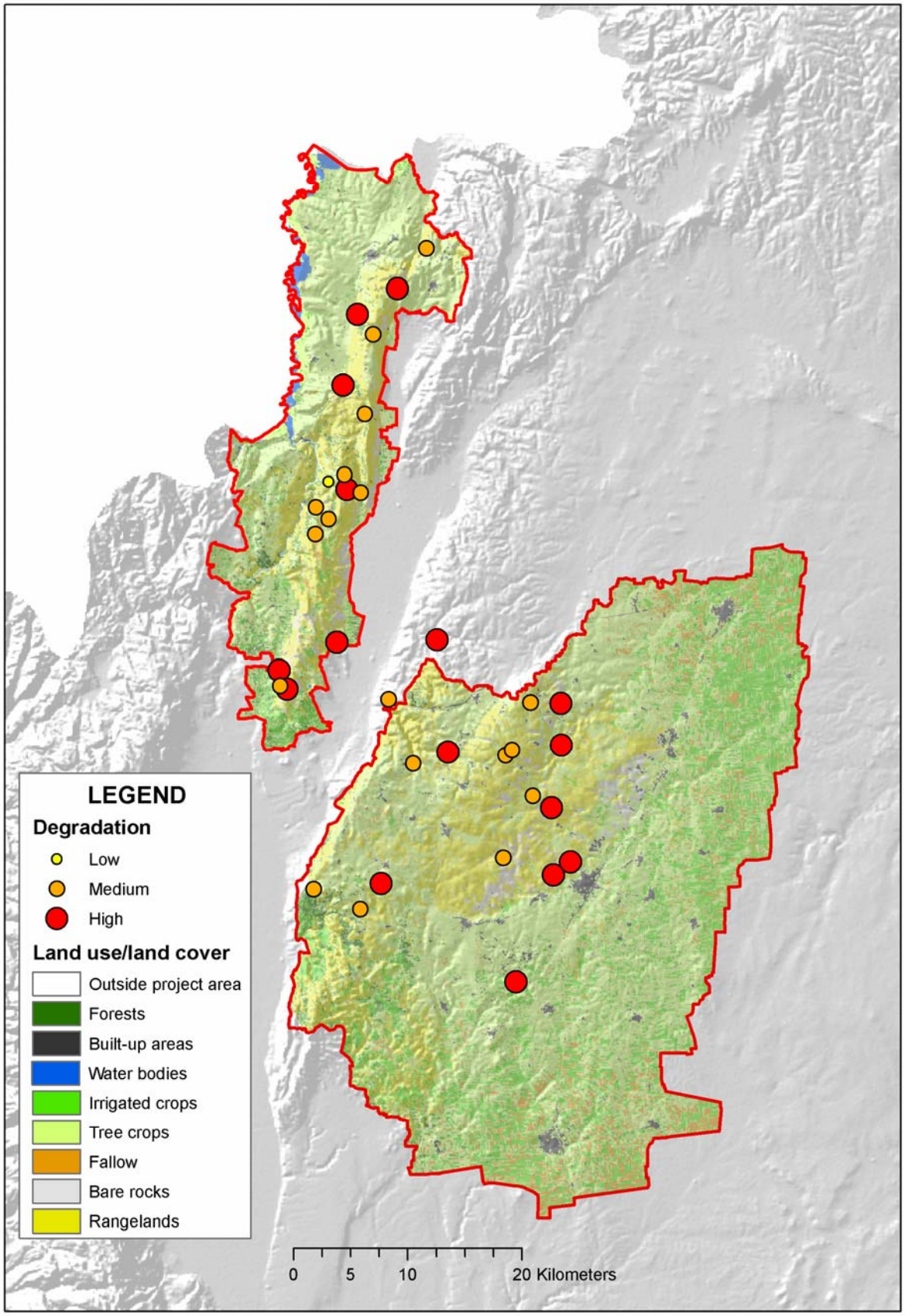


Figure 28. Observations of vegetation degradation

3.1.3. Agroecological characterization

A detailed characterization of the agricultural environment was undertaken in Jebel Zawia and Jebel Wastani as part of the contract. The results of this characterization are partly incorporated in the description of the project area (Chapter 2) and are also presented in the form of maps. In the next section details follow on the various maps produced.

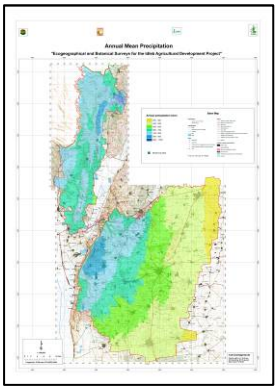
3.2. Maps

All maps in this report have been specially prepared for the implementation of the contract. The projection system is UTM Zone 37 and the datum WGS84. The level of detail is commensurate with reproduction at scale 1:50,000.
The maps are grouped together in Annex 5.7 in A3 format and are also reproduced in digital format on the CD. The print quality of the maps on the CD is adequate for reproduction in A0 format. In this section the maps are shown as thumbnails for easy recognition.

3.2.1. Base map

(Map 5.7.1.)
The base map is common to all thematic maps. It is reproduced separately because it contains very useful information for the implementation of some of the recommendations in the report and is very comprehensive. It shows topographic (contours, spot elevations) and hydrographic features (rivers and wadi beds, canals, dams and lakes), major and minor roads as well as tracks, and many features of human intervention (built-up areas, quarries, terraces, reforestation and orchard areas) and of cultural/historical significance (ruins, caverns, tells).
The base map has been prepared by combining in GIS digitized information from topographical maps, satellite imagery, and GPS measurements of sites and roads.

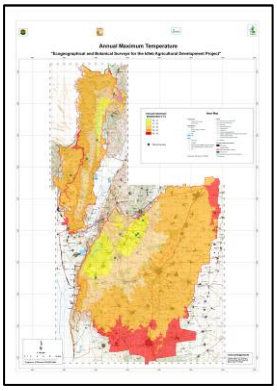
3.2.2. Climatic maps



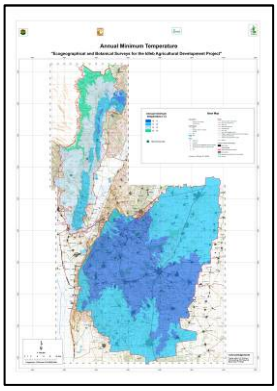
Annual mean precipitation
(Map 5.7.2.1.)
This map shows the distribution of annual average precipitation across Jebel Wastani and Zawia. The general pattern is clear, with higher precipitation in Jebel Wastani and the western part of Jebel Zawia (600-800 mm) than in the east of Jebel Zawia (350-600 mm).
This map, as well as the next two maps (annual maximum and annual minimum temperature|), has been prepared by spatial interpolation of point meteorological station data, provided by the Syrian National Meteorological Agency using the thin plate smoothing spline method of Hutchinson (1995) and ANUSPLIN software (Hutchinson, 2000).

Annual maximum and minimum temperature
These two maps show respectively the maximum **(5.7.2.2)** and minimum temperature **(5.7.2.3)** averaged for all months of the year. The patterns are in both cases determined by the elevation differences within the project area, hence the coolest areas are the high points of Jebel Wastani and the western edge of Jebel Zawia, with elevations around 700-900 m, and

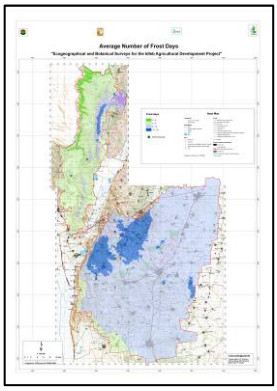
the warmest parts are the Ghab depression (outside the project area) and the eastern part of Jebel Zawia, with elevations of 200-300 m, and even less than 100 m in the Orontes valley west



(5.7.2.2)

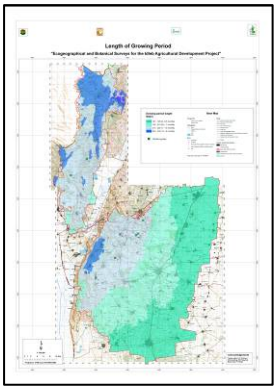


(5.7.2.3)



(5.7.2.4)

of Salqin. The map of average number of frost days **(5.7.2.4)** shows a similar pattern as the map of annual minimum temperature, with generally higher minima and less frost days in Jebel Wastani than in Jebel Zawia (4-8 frost days in Wastani, 8-12 in Zawia).

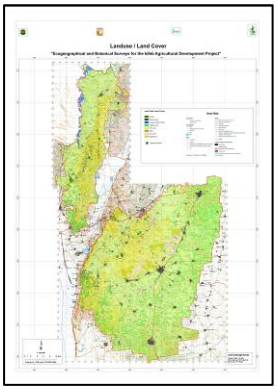


Length of growing period

(Map 5.7.2.5.)

The growing period is that part of the year in which neither temperature nor moisture present serious limitations to vegetation growth and crop production. As in both Jebel Wastani and Zawia temperature is a rather minor limitation, the growing period is principally determined by moisture, hence by precipitation. This explains patterns that are similar to those of precipitation, with the highest growing periods in Jebel Wastani (7-7.5 months), with even 7.5-8 months in the northern part of the Jebel, whereas in Jebel Zawia the growing period declines from 7-7.5 months in the western part to 6-6.5 months in the east.

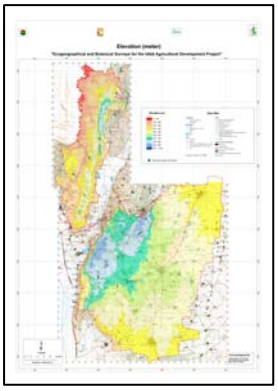
3.2.3. Land use/land cover



(Map 5.7.3)

The land use/land cover map is one of the main map outputs of this study and the basis for the spatialization of the botanical survey. The methodology is explained in Annex 5.5. The land use patterns are strongly related to the terrain and soil features, particularly slope, lithological material and soil depth. Where soils are deep, slopes are gentle and parent rocks are not hard limestones, cropland, either rainfed or irrigated, predominates. Rangelands are mainly located in areas unsuitable for cropping, such as those with steep slopes, shallow soils or hard limestone at or near the surface. Also forests are located in similar environments. The ‘bare rocks’ category mostly occurs on hard ‘nummulithic’ limestones. The class ’Temporary water bodies’ refers to a seasonal and unusual flooding event, as a result of heavy rains at the time the satellite image was taken (March 2003) and a dam burst in the Ghab Valley caused overflow of the Orontes river.

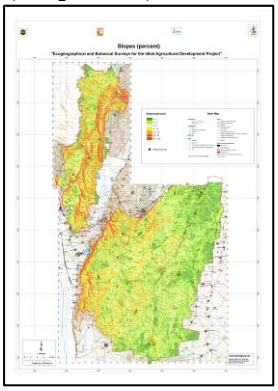
3.2.4. Elevation



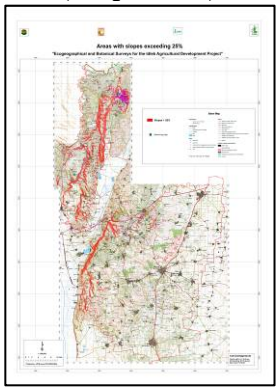
(Map 5.7.4)
The maximum range in elevation in the project area is more than 900 m, with a minimum of 13 m in the Orontes Valley of northern Wastani and 930 m at Nabi Ayyub, a basaltic hill in the western part of Jebel Zawia. The latter is generally at a higher elevation (minimum: 243 m; maximum: 939 m; mean: 508 m) then Jebel Wwastani (minimum: 82 m; maximum: 841 m; mean 318 m).
As explained earlier, elevation is a key factor in the local climate, through its influence not only on temperature, but also the precipitation pattern.

3.2.5. Slopes

(Map 5.7.5)



(Map 5.7.6.)



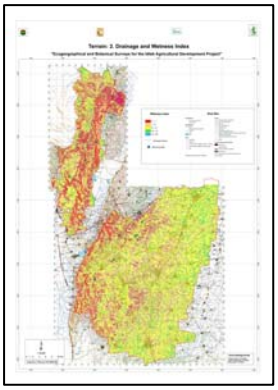
Map 5.7.5. shows the spatial distribution of 7 slope classes (0-2%, 2-5%, 5-8%, 8-15%, 15-30%, 3-60%, >60%). The map indicates that Jebel Wastani has more sloping land than Jebel Zawia, especially along the central ridge.

Areas with slopes exceeding 25% are shown in red in Map 5.7.6. There are two areas of concentration where these steep slopes prevail: again the central ridge of jebel Wastani and the western ridge that links the Ghab Valley to Jebel Zawia.

3.2.7. Aspect

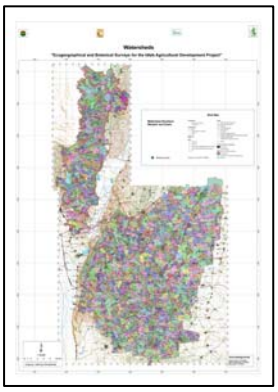
(Map 5.7.7.)
The aspect (or slope direction) has important implications for micro-climatic conditions. South-facing slopes are in general warmer and drier than north-facing ones, whereas west-facing slopes (the predominant direction of wind and rainfall) are wetter than east-facing slopes.
Map 5.7.7. shows only 5 classes (flat or undulating, north-facing, south-facing, east-facing and west-facing) in order to make the picture of slope directions look less random. The north-facing class includes the north, northwest and northeast, and the south-facing class the south, southwest and southeast. The aspect is only shown for areas where the slope exceeds 5%, below that it is not considered to have much influence.

3.2.8. Drainage and wetness index



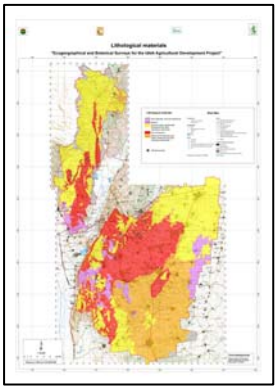
(Map 5.7.8.)
This map shows both the drainage network (streamlines) and the 'wetness index', or 'compound topographic index (CTI). The CTI is a quantification of the position of a site in the local landscape, in terms of either run-on or run-off characteristics. It is defined as:
CTI = ln (As / tanB) where *'As'* is the specific catchment area expressed as m^2 per unit width orthogonal to the flow direction and *'B'* is the slope angle. Specific catchment area was calculated with the Hydrology tools of ArcGIS, with *'As'* limited to a maximum value (100,000), which usually occurred in defined streamlines, to prevent the generation of very large values along major streams. A small value (0.01) was added to grid cells with zero slopes to avoid a denominator of zero.
The interpretation of CTI values can be useful in planning water harvesting activities. Low CTI values (in red) are indicative of terrain conditions that tend to lose soil or water, whereas high CTI values (green and blue) are those where water or soil tend to accumulate, usually in depressions and along streamlines.

3.2.9. Watersheds



(Map 5.7.9.)
This map shows many (thousands) small (a few km^2) watersheds in the project area, indicating that the catchment size is rather small and the potential for macro-catchment water harvesting limited.
The watersheds have been mapped using the Hydrology tools in ArcGIS.

3.2.10. Lithological materials

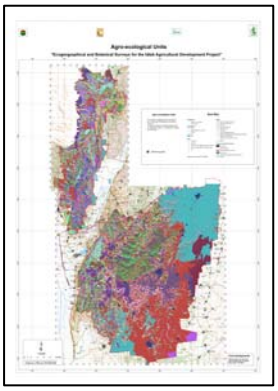


(Map 5.7.10)
This map, as explained in Chapter 2, is a re-classification of the geological map 1:200,000 of Technoexport map sheets Hama and Lattakia. Four materials were distinguished:

- A: soft materials, soils and sediments
- B: basalts
- C: soft and easily weatherable limestones and other calcareous sediments
- D: hard limestones

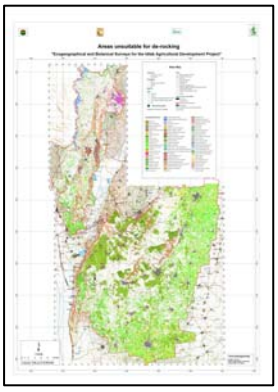
Lithological group E is a mixture of hard limestones and softer limestones and other calcareous sediments.

3.2.11. Agroecological units



(Map 5.7.11)
This map has been made by overlaying of the map of lithological materials, land use/land cover, and terrain units (Fig.11 and Table 1), which themselves are the result of overlaying elevation, slope and aspect (section 2.3). Even though the result of a number of generalization procedures in ArcGIS (boundary-clean and 'nibble'), the map remains highly complex map, containing 166 mapping units. Nevertheless only 17 agroecological units occupy 80% of Jebel Zawia (Annex 5.7). On the other hand, to cover 80% of Jebel Wastani, which is much smaller than Zawia, 34 agroecological units are needed, demonstrating that the biophysical environments are more complex there.

3.2.12. Areas unsuitable for de-rocking



(Map 5.7.12)
This map answers a key question for targeting the expansion of the new farming system: 'where can de-rocking take place considering technical and environmental constraints?'. It shows areas where de-rocking is unfeasible for a variety of reasons. These can be one or more of the following:

- Too many rocks: land cover is 'bare rocks'
- Too steep slopes: > 25%
- Presence of quarries
- Presence of historical ruins within a 100 m buffer zone
- Built-up areas and villages
- Already under crops (fallow, irrigated crops, orchards, terraces)
- Forest cover
- Potential to serve as conservation area

3.3. Development of management plans for conservation areas

What has clearly emerged from the studies undertaken in the project area (Annexes 5.3, 5.4. and 5.6) is that the biodiversity in the target areas has both a local and global significance and needs to be conserved *in situ* since alarming degradation and loss is taking place in the remaining natural habitats. A key principle is that in order to achieve an impact that is sustainable, a community-driven approach to the conservation of local agrobiodiversity needs to be followed that also provides benefits to the livelihoods of local communities. It is also evident that whatever conservation areas are proposed, they should be composed of the remaining less disturbed natural habitats.

Planning is a staged process and in the case of biodiversity conservation it is particularly important that the right sequence is followed, to avoid that the cart is put in front of the horse, e.g. that a management plan is drawn up before the conservation areas have been studied or even identified.

In the course of this contract the initial steps have been taken in a process that can easily take years before a conservation area is actually operational. In the next few sections these steps will be discussed as well as the possible follow-up.

Observation sites

The first step was the identification of areas with well preserved biodiversity. Forty observation sites were visited and a rapid assessment was undertaken of their biodiversity and degradation status. The locations of these observations sites is shown in Figure 2 of Annex 5.6 and their key terrain, habitat and agricultural features are summarized in Table 2 of the same annex.

All the sites are located outside the Ghab Valley and most are located in uplands, hills and plateaus (Fig. 29, left). The general habitats are mainly natural habitats fragmented by orchards of mainly olive and other fruit trees (Fig. 29, right). At Jebel Zawia most sites are natural grasslands or grasslands with shrubs. At Jebel Wastani woodlands and grasslands are predominant. With the exception of five sites which are exclusively located in natural habitats, all other sites are experiencing agricultural encroachment due to the establishment of fruit tree orchards (Fig. 30, left). These orchards have taken the most accessible and more flat lands. Most of the remaining natural habitats are either patches of forests and maquis or highly degraded rangelands with more than 70-80% of rocks (Fig. 30, right).

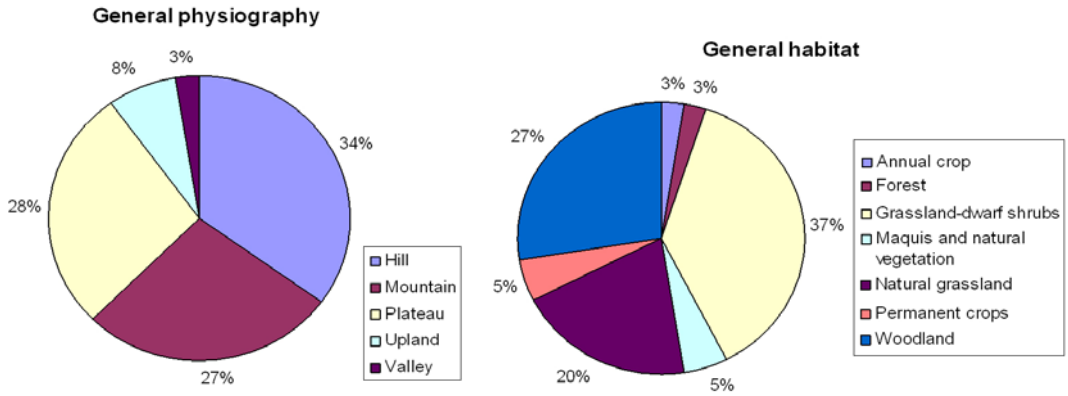


Figure 29. Physiography (left) and general habitats (right) of the observation sites

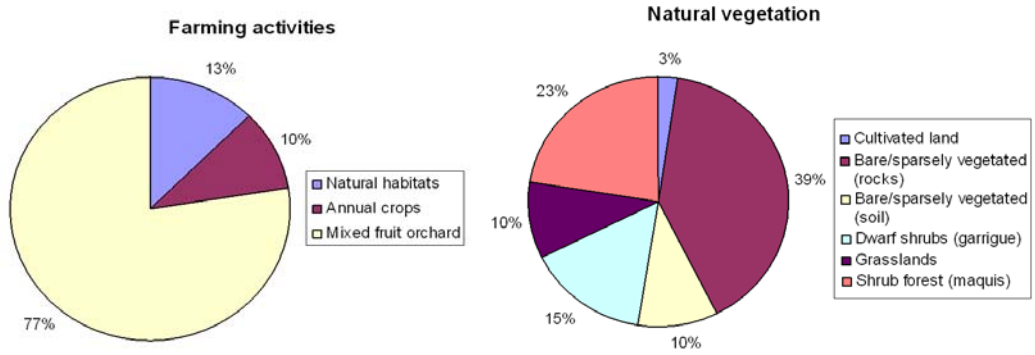


Figure 30. Farming activities (left) and natural vegetation types (right) of the observation sites

The threats to natural habitats and their biodiversity were assessed using the 0 to 9 scale. Overgrazing is the main factor of degradation affecting most of the sites in both areas, followed by land reclamation activities for urbanization and agricultural encroachment. Quarries are also severely affecting some of the sites (Table 7).

Table 7. Main threats to natural habitats and local agrobiodiversity

Site	Over-grazing	Urbani-zation	Agricul-tural Encroach-ment	Cutting	Terra-cing	Desto-ning	Quar-ries	Fire
Z01	5	1	5	5	1	1	0	0
Z02A	5	1	7	1	1	1	0	0
Z02B	1	0	0	1	1	1	5	0
Z03	1	0	3	1	1	1	3	1
Z04	1	5	7	1	5	5	5	1
Z05	5	1	3	1	1	3	3	0
Z06	0	5	1	5	1	5	0	0
Z07	9	0	5	5	1	5	0	0
Z08	5	1	1	1	1	3	1	0
Z09	5	5	3	5	3	5	1	1
Z10	9	5	1	1	1	5	3	1
Z11	1	9	9	1	1	5	5	0
Z12	9	9	5	5	5	9	9	1
Z13	9	9	5	5	5	3	9	1
Z14	5	7	5	1	5	1	3	1
Z15	9	0	0	5	0	1	3	0
Z16	3	0	0	9	1	1	1	0
Z17	7	1	1	7	3	3	5	
W01	5	5	3	9	5	3	5	0
W02	9	1	1	9	5	5	5	1
W03	5	3	5	5	3	3	3	0
W04	1	1	1	3	1	1	0	0
W05	9	7	9	5	5	5	9	1
W06	1	1	9	1	1	1	1	0
W07	9	5	9	9	9	9	3	1
W08	9	3	5	9	5	9	1	0
W09	9	5	3	7	5	3	3	0
W10	9	1	1	5	1	1	1	0
W11	9	9	5	3	3	3	1	0
W12	3	1	3	5	1	1	1	0
W13	1	5	1	5	1	1	1	0
W14	9	3	5	9	5	5	5	0
W15	9	1	5	9	1	1	1	0
W16	9	3	3	7	1	1	1	0
W17	9	5	5	9	3	3	7	0
W18	9	5	3	9	1	5	9	0
W19	9	5	5	7	3	5	5	0
W20	9	5	3	9	1	3	1	0
W21	9	3	5	7	5	5	7	0
W22	9	1	1	7	1	0	1	0

Most of the sites are affected by combined effects of many threats (Fig. 31). Especially the sites Z12, Z13, W05 and W07 are highly degraded. Only the sites Z02B, Z03, Z08 and W04 are least degraded, whereas the others have intermediate levels of degradation. While overgrazing has continued over millennia, the new threats to the natural habitats are due to land reclamation and quarries, which are spreading rapidly in the last 30-50 years.

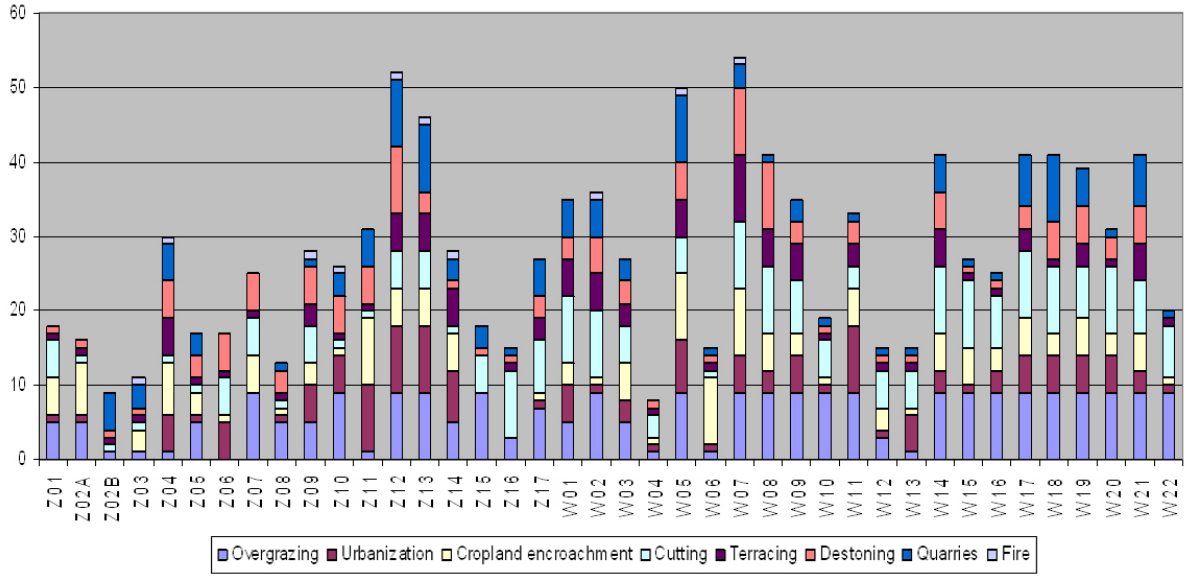


Figure 31. Main threats to natural habitats and local agrobiodiversity in the observation sites

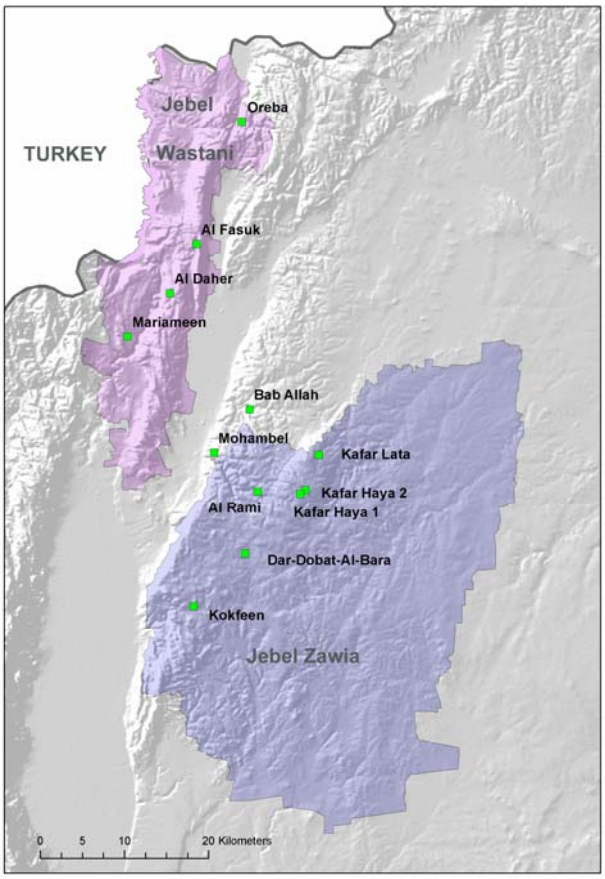


Figure 32**.** Monitoring sites in Jebel Zawia and Jebel Wastani

Monitoring sites

The second step was to select, on the basis of the criteria, already listed in section 3.1.1., and on the extent of the evaluated threats, eleven sites (Fig. 32) from the 40 sites visited. Botanical surveys were conducted in these sites to determine the species richness and densities. These sites were representative of the prevailing natural habitats and are rich in herbaceous, shrubs and wild tree species (Table 8).

Table 8. General habitats and species richness and composition of the selected monitoring sites in Jebel Wastani and Jebel Zawia

Site	Name	General habitats	Herbaceous	Shrubs	Trees	Total
Z1	Kafar Lata	Grassland-dwarf shrubs	100	10	6	116
Z2	Kafar Haya	Grassland-dwarf shrubs	82	15	8	105
Z3	Al Rami	Grassland-dwarf shrubs	85	7	6	98
Z4	Al Bara, Dar Dobat	Woodland	91	5	9	105
Z5	Mohambel	Natural grassland	92	3	0	95
Z6	Kokfeen	Natural grassland	52	1	0	53
Z7	Bab Allah	Grassland-dwarf shrubs	80	1	0	81
W1	Oreba	Woodland	111	13	9	133
W2	Al Fasuk	Woodland	106	10	7	123
W3	Mariameen	Woodland	89	14	5	108
W4	Al Daher	Woodland	81	6	4	91

Annex 5.6. contains for each monitoring site summary descriptions of the major threats, target species to be preserved and suggested technological, socio-economic, institutional and policy options that could be possible elements of conservation strategies.

Candidate conservation areas

The third step was, on the basis of the field experience gained at the 40 observation sites and the survey in the 11 monitoring sites, to select 'candidate' conservation areas. By 'candidate' is meant an area that has not formally been nominated as conservation area, but has sufficient characteristics to pre-qualify it for the long process of assessments, stakeholder consultations and eventually legislation and to attempt a 'dry run' at developing some guidelines for formulating management plans.

This initial study identifies a strong need to establish conservation areas in the remaining forest and woodland areas in Jebel Wastani, around monitoring sites W01 and W02, and in Jebel Zawia, around monitoring sites Z01 and Z04. At least 1,000 ha of natural forest area should be either protected or allow regulated use compatible with the biodiversity conservation goals. This type of protection will allow the conservation of viable populations of different species to allow enough genetic diversity for sustaining the populations and for the rehabilitation of degraded eco-systems.

Conservation areas are proposed at the monitoring sites Oreba and Al Fasouk in Jebel Wastani and the Kafar Lata and Dar-Dobat (Al-Bara) monitoring sites in Jebel Zawia.

The four proposed natural reserves are recommended to conserve the target species of forest and fruit trees species as well as the field crop wild relatives and landraces which are the most important to the development of the agricultural system in the area, based on de-

rocking. The reserves will also help to conserve the natural habitat in the sites through the prepared management plan which will allow the *conservation of all ecosystem components* including the targeted species. This approach will allow preserving the species richness and the related genetic diversity as well as the environmental benefits. This reserve will also serve, through rehabilitation and restoration efforts to conserve wild forest and fruit tree species endangered**.** The management plan will take into consideration the conservation of the species settled in the site, special attention will be devoted to the conservation of the following groups of species:

- **Forage legumes**: *Medicago* sp., *Vicia* sp., *Trifolium* sp., *and Lathyrus* sp.
- **Cereals**: *Triticum* sp., *Avena* sp., *Hordeum* sp., *Lolium sp.* and *Aegilops* sp.
- **Fruit trees**: *Quercus sp, Rhamnus sp., Styrax sp., Crataegus sp, Amygdalus sp., Prunus sp., Pyrus sp., Pistacia sp. and Olea sp.*

Oreba

In order to explain the principles of developing a management plan for an area in which the biodiversity needs to be protected, one area was studied in greater detail. A complete profile of this area, around monitoring site W1 (Oreba) was compiled, with descriptions of location, environmental conditions, status of plant biodiversity, tenure, land use and agricultural practices, factors of degradation, and an evaluation of the expected sustainability of the proposed management plan (Annex 5.6).

Next steps

From this identification of a biodiversity conservation need in the project area, the next steps will have to be made by the decision-makers in the relevant Ministries. Whether they agree or not with the current assessment, whether they feel there is a need for further studies, whether they have to consult with higher authorities or require some legislation to pass first, are possibilities that will obviously affect the final decision and are outside the scope of this study, since they are policy and implementation decisions. However, once the agreement in principle is given to establish a conservation area, the next step will be to develop a management plan. Whereas a management plan will have to be custom-made to the particular circumstances of a specific conservation area, there are some generic principles that may facilitate the development of the plan for the proposed or other areas in the project area.

There is a phased approach in developing a management plan. Figure 33 summarizes the main steps to be followed for the establishment of natural reserves.

If a site is selected for biodiversity conservation, it is because it contains abundant and hopefully genetically diverse populations of the target taxa. Therefore the goal will be to *maintain* the anthropogenic, biotic and abiotic dynamics of the site and the first logical step in formulating the management plan is to observe these dynamics. For this reason the area should be *surveyed* (site assessments) so that the species present in the ecosystem are known, the ecological interactions within the conservation area are understood, a clear conservation goal can be formulated and a means of implementation agreed.

The actual content or style of a management plan will vary depending on the location, target species, organization, staff involved etc. There is no standard format, but items generally included are: conservation objectives, site biotic and abiotic description, site history, public interest, factors influencing management, management prescription (what work needs to be carried out and precisely how and when to do it), ecological and genetic survey and

monitoring schedule, budget and manpower. As the specific focus of establishing a conservation area will be to preserve specific target species, the management plan will require details associated with the target taxa (e.g. taxonomy, phenology, habitat preference, breeding system, minimum population size, etc.) and description of the target populations at the site (e.g. mapping of populations and density within the site, auto-ecology within the area, syn-ecology with associated fauna and flora).

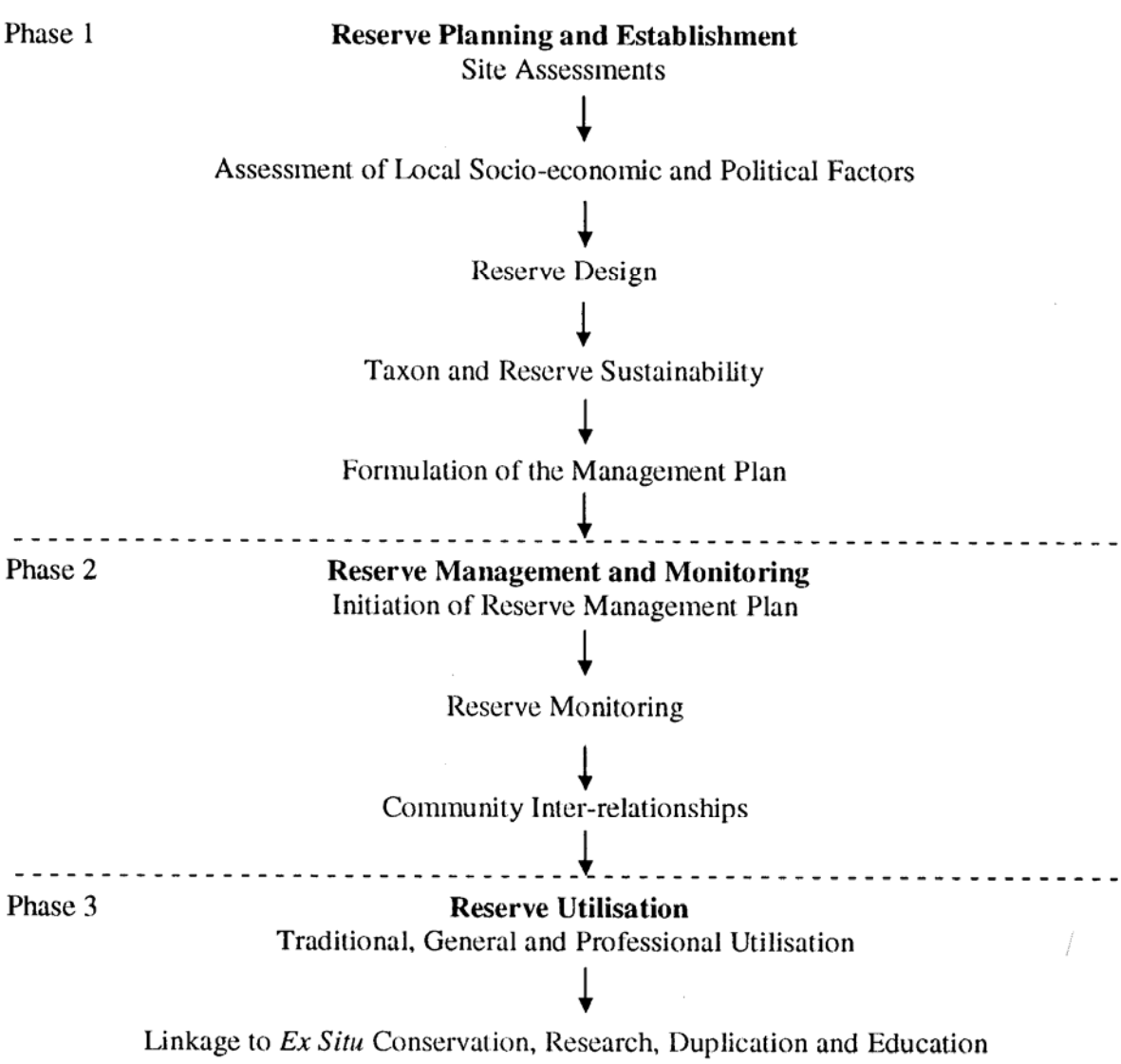


Figure 33. Phased approach to conservation area planning, establishment and management

Possible elements of a management plan can be summarized as follows:

1. *Preamble*: conservation objectives, reasons for siting of reserve, place of reserve in overall conservation strategy for target taxon, site ownership and management responsibility.
2. *Taxon description*: taxonomy (classification, delimitation, description, iconography, identification aids), wider distribution, habitat preferences, phenology, breeding system, genotypic and phenotypic variation, biotic interactions (e.g. pollinators, dispersal agents, herbivores, pests, pathogens, symbionts), local name(s) and uses,

other uses, present conservation activities (*ex situ* and *in situ*), threat of genetic erosion.

3. *Site evaluation*: evaluation of populations of the target taxon, reserve sustainability, factors influencing management (legal, constraints of tenure and access), externalities (e.g. climate change, political considerations), obligations to local people (e.g. allowing sustainable harvesting) and anthropomorphic influences.
4. *Site description*: location (latitude, longitude, altitude), map coverage, photographs (including aerial), physical description (geology, geomorphology, climate, hydrology, soils), human population (both within reserve and around it), land use and land tenure (and history of both), vegetation and flora, fauna, cultural significance, public interest (including educational and recreational potential), bibliography and register of scientific research.
5. *Status of target taxon in the reserve*: distribution, abundance, demography, and genetic structure and diversity of the target taxon within the site, autoecology within the reserve, interaction with associated fauna and flora, specific threats to population(s).
6. *Site objectives and policy*: site objectives, control of human intervention, allowable sustainable harvesting by local people and general genetic resource exploitation.
7. *Prescription*: details (timing, frequency, duration etc) of management interventions that will need to be carried out, schedule of ecological and genetic monitoring, population mapping, staffing requirements and budget, project register.

In order to work, i*n situ* conservation requires empowerment of local communities and continued accrued benefits from the conserved area. For this reason management plans need to provide mechanisms for empowering local communities and other key stakeholders to participate in the efforts of conservation of biodiversity of the region. Natural reserves (protected or fenced areas) are an example of management plan for exclusive conservation of biodiversity and ecosystem. Most often this type of conservation is not well received by local communities which depend on the use of local agrobiodiversity. To overcome this problem, the conservation area can be divided into a *core area*, a *buffer zone* and *transition area*. The core area can not be used except for research and monitoring activities, whereas the transition area can be use by local communities under a well defined and agreed management. To be effective, a conservation area requires a large area, either as a single lot if possible, or as several lots to be linked with corridors in case of fragmented natural habitats.

The management plans need to include clauses that define the technological, institutional and policy/legal options as well as value-added alternative sources of income that can provide the necessary incentives to local communities to promote the in situ/on-farm conservation of local agrobiodiversity. These options require inputs from international to farm activities. Hence, although the conservation area is definitely location-specific, its management may require actions at different scales of intervention, international, regional, national and local levels to ensure efficient conservation of the local agrobiodiversity.

The following examples illustrate possible actions that may be required or desirable at different scales of management.

At the international level

- Funding for conservation of local agrobiodiversity and the establishment of a conservation area could be provided through the Global Environmental Fund or other donors;
- The funding of rural development projects may be made conditional to the inclusion of biodiversity conservation studies, activities or outputs;
- Specialized agents may facilitate linkages to the outside world for enhancing the marketing opportunities of local products at international markets;

Actions at regional level

- Collaboration and consultation may be desirable with appropriate institutions in Turkey to ensure the conservation of viable populations within the border.
- Exchange visits for sharing of experiences and lessons learned from the implementation of management plans for conservation areas managed by local communities can be a great help in formulating such plans and avoiding obvious mistakes.
- Facilitating the exchange of germplasm for rehabilitation of degraded areas is an evident action that may yield concrete benefits in the short term.

At national, community and local levels

1. <u>Policy options</u>

- Afforestation with native species;
- Better land use planning based on land suitability;
- Regulation of the quarries and the land reclamation operations to allow for efficient conservation of areas rich in biodiversity. For the quarries, plans should be developed to rehabilitate the degraded areas either through replanting with native species or for agricultural purposes. A percent of the income from the quarries, as a kind of polluter tax, should be used to invest in the conservation of biodiversity rich areas.
- Provide initial incentives to empower local communities for the implementation of technological and alternative sources of income included in the management plans;

2. <u>Institutional options</u>

- Establishment of local NGOs and local cooperatives for coordinated actions to manage better natural resources;
- Establishment of institutions for collective actions for marketing of local products;
- Recognition of the role of women in conservation of local agrobiodiversity;

3. <u>Technological options</u>

- Reforestation of degraded forests using native species combined with water harvesting techniques,
- Range rehabilitation and management through esta lishment of range protected areas, deferred or rotational grazing, reseeding with native species using water harvesting techniques, development of alternative feeds such as feed blocks based on products fro local agrobiodiversity, introduction of feed legume forage in cereal rotation or as alley crops within the fruit tree orchards, …;
- Improvement of livestock management and health;
- For farming activities, plantation of fruit trees can be done without complete removal of rocks;

- Demonstration and transfer of low cost agronomic packages for the improvement of productivity of landraces of field crops and fruit trees;
- Introduction of organic farming.

4. Value-added technologies and alternative sources of income

- Training and establishment of food processing activities for cultivated and wild species (jam, compotes, dried fruits, diverse olive products, dairy products,…)
- Investigate alternative sources of income (sustainable collecting or cultivation of medicinal and aromatic plants, honey production, stone industry, eco-tourism,…)

3.4. Database

All botanical information was entered in a database accessible through a Web browser. The database was installed at the IRDP office and is open-ended, i.e. it can be updated. A screen view of one database form is shown in Figure 34.

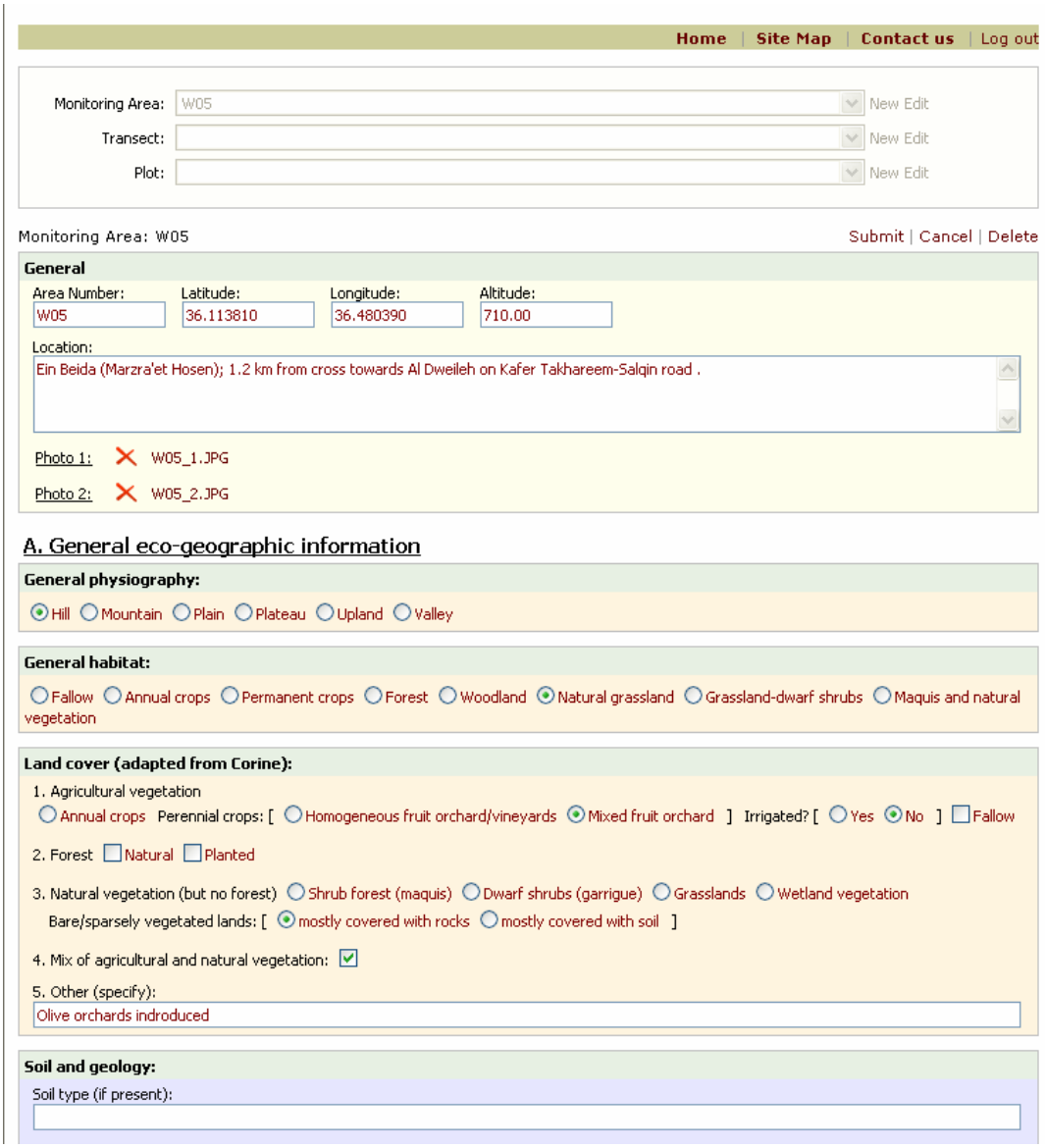


Figure 34. Screen view of the botanical database installed at IRDP.

3.5. Training

In January 2008, as part of the capacity building component of the project "Ecogeographical and botanical surveys in the Idleb Rural Development Project Area" the GIS Unit hosted for two weeks two staff members of the IRDP to learn how to use digital maps in a GIS environment. The same people were also trained in the use and updating of the botanical database.

3.6. Workshop

A 1-day workshop was held in ICARDA on 25 March to discuss the results from the various surveys and to exchange views on how best to conserve the biodiversity of the project area. An extract from the "Week at ICARDA" illustrates and summarizes the workshop.

Workshop on Biodiversity Conservation in the Idleb Development Project

A workshop on "Ecogeographical and botanical surveys for the Idleb Agricultural Development Project" was held at ICARDA, 25 March 2008. The workshop was jointly organized by ICARDA and the Syrian Ministry of Agriculture and Agrarian Reform to discuss the outcome of various surveys conducted by ICARDA.

Inaugurating the workshop, Dr Maarten van Ginkel, DDG-Research of ICARDA, welcomed the participants. He said that objective of the surveys was to locate, identify, map and develop management plans for areas with valuable plant biodiversity, within the overall context of the agricultural development plans of the region on the change in the farming systems of the area.

Dr van Ginkel said that the major tasks for the project were to carry out eco-geographical and botanical surveys, assess the economic importance of the botanical diversity in the project area and to formulate proposals for its conservation within the new agricultural system.

He said the application of GIS was widely increasing and was not merely limited to poverty mapping but was being used to identify soils types, crops varieties and even managing rangelands. "The sky is the limit in field of GIS," Dr van Ginkel said. "At ICARDA we have a very strong group of GIS, which can conduct detailed surveys."

Dr Maarten van Ginkel (center), DDG-Research inaugurating the workshop. On his right is Mr Abdel-Hamid Mellah, Project Director of Idleb Agricultural Development Project and Dr Eddy De Pauw, Head GIS Unit is on his left.

Mr Abdel-Hamid Mellah, Project Director of Idleb Agricultural Development Project, made a presentation and described in detail the various aspects of the project and its impact on improving the livelihoods of the communities living in the region.

Dr Eddy De Pauw, head of GIS Unit ICARDA, gave an overview of the eco-geographical and botanical surveys. He said that the Ministry of Agriculture and Agricultural Reforms awarded the contract to ICARDA to conduct surveys in Jebel Zawiye and Jebel Wastani regions in Idleb district.

The surveys, he said, have been completed identifying the vegetation cover, land uses and status of local biodiversity.

Dr De Pauw said 11 monitoring sites have been established for which a full botanical inventory has been developed. Base map at 1:50,000 scale resolution has been prepared and also a land use/land cover map based on Landsat imagery is ready. All botanical information has been entered into a database that is accessible through a Web browser. For management and action plans the survey has identified areas with high potential for bodiversity conservation, eco-tourism etc

Mr Amin Khatib made a presentation on botanical survey. Dr Weicheg Wu, Remote Sensing Specialist at ICARDA, made a presentation on land use and land cover mapping, Mr Nabil Batikha on natural vegetation types, Mr Ali Shehadeh on eco-geographical survey and management plans and Mr Hashem Abed on project database.

Figure 35. The Workshop on Biodiversity Conservation reported in the ICARDA Week

4. CONCLUSIONS AND RECOMMENDATIONS

The studies reported in this document fit within a strategy of the GOS to increase crop production and addressing poverty in Jebel Wastani and Jebel Zawia, within a context of sustainable development and conservation of the natural resource base and of biodiversity. The main mechanism for development in this area, land reclamation of marginal lands through de-rocking, obviously entails a risk to the natural biodiversity as well as to the many archaeological, historical and cultural sites in the area. For this reason, the loan agreement between the GOS and IFAD included an activity to conduct botanical and eco-geographical surveys.

A first component of the study was to carry out a detailed characterization of the agricultural environment in the project area. The results of this characterization are partly incorporated in the description of the project area (Chapter 2) and are also presented in the form of thematic maps (Annex 5.7). The Base Map (section 3.2.1.) contains relevant features of the entire project area as related to topography (contours, spot elevations), hydrography (rivers and wadi beds, canals, dams and lakes), major and minor roads as well as tracks, and many features of human intervention (built-up areas, quarries, terraces, reforestation and orchard areas) and of cultural/historical significance (ruins, caverns, tells).

The map of Agroecological Units (section 3.2.11) containing 166 mapping units, of which 17 agroecological units occupy 80% of Jebel Zawia and 34 occupy 80% of Jebel Wastani, demonstrates the diversity of the biophysical environments.

Another important output from the study is the map of areas unsuitable for de-rocking (section 3.2.12). It shows areas where de-rocking is unfeasible due to excessive rockiness, steep slopes, presence of quarries, historical ruins, built-up areas and villages, present cropland, forest cover and potential for biodiversity conservation.

The botanical survey, reported in detail in Annex 5.3 and summarized in section 3.1.1 of the Main Report, has been able to inventory the plant composition in the project area through detailed studies at 11 monitoring sites. The study identified 339 species of higher flowering plants and concluded that the project area has a rich biodiversity which, under careful management, can be a source of natural products providing income for the rural poor. Current and potential uses of this biodiversity were identified to include animal food (fodder and forage), honey production, afforestation, hedges, erosion control, soil improvement, graft stock, shade /shelter, beverage base, fruits, oil, leaves, fungi, food additive, charcoal, fuel wood, dye, carpentry, soap, pickles, cosmetics, traditional handicraft, aromatic plants, ornamental plants and medicinal plants.

The new land use/land cover map of Idleb Governorate, based on the interpretation of Landsat ETm+ satellite image of March 2003 (see Annex 5.5), allowed to put the results of the botanical survey, which was conducted on a limited number of monitoring sites, in a spatial context. The map revealed a number of natural cover classes (forests, rangelands and bare rocks), which can be linked to vegetation types and life forms. Within Jebel Wastani and Jebel Zawia all of these cover classes are in fact mostly used as rangelands. The ‘bare rocks’ class represents rangelands with very low, and often much degraded, cover.

In fact, degradation turned out, besides high biodiversity, to be as the second most important feature of the natural vegetation in the project area. A visual scoring of vegetation degradation, based on the presence of degradation indicator plants was undertaken at 40 sites in the project area. At the vast majority of these sites the vegetation showed either medium (50%) or high degradation (48%). Only in 1 site degradation was low.

The twin presence of biodiversity value, of both global and local significance, as well as the high degree of degradation and threats posed by competing land uses, points to the need for protection of the remaining natural habitats. This study identifies a strong need to establish conservation areas in the remaining forest and woodland areas in Jebel Wastani, around monitoring sites W01 (Oreba) and W02 (Al Fasuk), and in Jebel Zawia, around monitoring sites Z01 (Kafar Lata) and Z04 (Dar-Dobat, Al-Bara). At least 1,000 ha of natural forest area should be either protected or allowed regulated use compatible with the biodiversity conservation goals. This type of protection will make possible the conservation of viable populations of different species to allow enough genetic diversity for sustaining the populations and for the rehabilitation of degraded eco-systems.

This study provides the first step in a long process of planning, leading to establishing and managing protected areas, through the initial identification of areas with well preserved biodiversity. Clearly a management plan for biodiversity conservation can not be designed from a desk after a botanical/ecogeographical survey has been completed. It requires a phased approach, involving further assessment studies, proper delineation of the conservation areas, a consultative process with local communities weighing the potential benefits or losses resulting from conservation, and a legislative process.

Hence, as a follow-up to this study it is recommended that the following steps are taken:

- Detailed studies for (i) identifying the exact boundaries of the candidate conservation areas in both Jebel Wastani and Jebel Zawia and for (ii) providing baseline data on their state of biodiversity and degradation;
- A SWOT (strengths-weaknesses-opportunities-threats) analysis for each candidate conservation area;
- A review of the legal actions required leading to the establishment of a conservation area;
- A stakeholder consultative process, involving the local communities, the relevant Government agencies, and researchers to exchange views on the delineation, feasibility and need for protecting each of the candidate conservation areas, the kind of protection measures, and the nature of the development leading to benefits compatible with the conservation needs;
- Once candidate conservation areas have gone through this process of assessments, consultation and legal action and received an official status of protected areas, management plans will be required.
- Identification of potential donors to support these follow-up activities, including the development of the management plans.

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Ecogeographical and botanical surveys in the Idleb Agricultural Development Project Area

Annex 5.1. to Main Report

PROPOSAL

ICARDA PROPOSAL FOR IMPLEMENTING ECOGEOGRAPHICAL AND BOTANICAL SURVEYS FOR THE IDLEB AGRICULTURAL DEVELOPMENT PROJECT AREA

1. TECHNICAL PROPOSAL

INTRODUCTION

The Government of Syria, through the Ministry of Agriculture and Agrarian Reform (MAAR), requested IFAD to finance an agricultural development project for the Jebel Al Zawia and Jebel Al Wastani areas in Idleb Governorate. This project aims to alleviate poverty in these areas by reinvestment in local assets (e.g. through water harvesting, more efficient use of agricultural inputs, etc.) and in land reclamation.

As an essential input to the land reclamation and development component, the project needs to undertake, amongst others, eco-geographical and botanical surveys in order to ensure that areas with valuable plant biodiversity are located, identified, mapped and afforded in-situ protection against interference.

CONTENT OF THE PROPOSAL

Deliverables

ICARDA will conduct eco-geographical and botanical surveys covering the full project area of Jebel Al Zawia and Jebel Al Wastani (400,000 ha), in accordance with the specifications given below. These surveys will be used to map the botanical biodiversity within the project area, particularly in relation to the occurrence of indigenous wild species and land races. The information from the surveys will be provided in the form of both paper and digital map products. In addition, the economic importance of the botanical biodiversity identified in the project area will be assessed, and proposals for its conservation within the new agricultural system, after land reclamation, will be formulated.

Main activities

Eco-geographical and botanical surveys will be carried out in the project area in Idleb province. The objectives of these surveys will be to develop an in-situ conservation strategy, to give a clear image of the vegetation cover, land uses and status of local agrobiodiversity, and the factors of degradation using appropriate and standardized survey methodologies. All raw survey data will be documented and analyzed, and then incorporated and modeled in a geographical information system (GIS) to produce various kinds of agrobiodiversity maps.

The specifications, analysis and interpretation of these surveys, their integration in GIS, as well as the resulting management recommendations will be based on ICARDA's experience gained from the GEF/UNDP Regional Project on Conservation and Sustainable Use of Dryland Agrobiodiversity in West Asia.

ICARDA will provide management plans and action plans to be implemented for the promotion of in situ conservation of local agrobiodiversity. The plans will address in particular the following issues:

- Rangeland management options, natural habitats rehabilitation technologies including reforestation efforts;
- Technological packages, added-value technologies for landraces;
- Alternative sources of income;
- necessary actions for public awareness creation.

Specifications

Surveys
All observations will be georeferenced in a form ready for entry in a GIS.
The surveys will be carried out at three levels: the *plot area* level, the *monitoring area* level, and the *target area* (or project area) level.
At plot level species richness, density and frequencies will be assessed using quadrate sampling strategy, whereas the factors of degradation will be assessed using scaling method.

Monitoring sites will be established in areas indicated by the GIS as representative. In these areas the relationship between plot-level plant biodiversity with the surrounding environment will be studied, using appropriate terrain description procedures developed in the GEF/UNDP Regional Agrobiodiversity Project. Particular attention will be given to the description of soil properties, soil use and the extent of natural erosion.

Environmental characterization
The location of the sampling plots will be based on a spatial framework of *agroecological units*, developed through analysis in GIS of the main biophysical factors determining species distribution (climate, landform components, land use, soils and geology). This framework of agroecological units will allow a sampling strategy that will make optimal use of the available environmental diversity, and be the basis for outscaling and assessing the potential distribution of the various species.

For the purpose of determining the spatial extent of the management recommendations and action plans to conserve local biodiversity, a comprehensive characterization of the agroecology of the entire Jebel Zawia and Jebel Wastani target areas, will be undertaken in GIS. This analysis will be based on available spatial datasets related to climate, soils, landforms, land use and geology, in accordance with methods developed for the GEF/UNDP Regional Agrobiodiversity Project. This characterization will result in a map of *agroecological zones.*

Map products
A series of digital map layers will be prepared as a basis for the agroecological characterization of the survey area. These base layers will include the following:

- climate layers: related to precipitation, temperature, frost, growing periods
- land use/land cover
- geological parent materials
- landform related layers

Climate layers
Based on spatial interpolation of station climatic data using the ANUSPLIN thin-plate smoothing spline method and the SRTM digital elevation model as co-variable. These layers

will help to decide whether the Jebel Zawia and Jebel Wastani are climatically homogeneous or whether subzones exist with different climatic characteristics.

Land use/land cover layer
Based on visual interpretation (which is the most reliable) of Landsat ETM+ satellite imagery for the summer 2002 and spring 2003, a land use/land cover map will be prepared of the target area using the FAO Land Cover Classification System (LCCS). The map will be used as a basis for linking landscape-level with plot-level biodiversity.

Geology layer
Geological parent materials can be an important differentiating factor in the location of various indigenous wild species and land races. For this purpose the Geological Map of Syria at scale 1:200,000 will be digitized for the target area, and reclassified into a limited number of lithological groups relevant to different species.

Landform-related layers
Digitized maps for the project area will be purchased from the Ministry of Defense. From the digital maps a digital elevation model (DEM) will be prepared for the whole project area. From the DEM important parameters will be derived, of use for either the definition of terrain units (elevation, slopes, aspects, topographic indices and drainage network) or for the definition of hydrological units.

Soil layer
In this proposal, it is assumed that digital soils information at an approximate scale 1:50,000 will be provided by the GCSAR, who got a contract for conducting soil surveys in the area. On the basis of this and secondary information, ICARDA will conduct a rapid soil assessment for the area, using available soil survey information from low-resolution studies, satellite imagery and limited fieldwork. The information from the various sources will be used to establish spatially differentiated baseline data on physical and chemical characteristics of the soils, the state of land degradation and the land use patterns in relation to the natural resource base.

Agroecological units
A detailed layer based on the integration in GIS of selected layers related to climate, landforms, soils, land use and geology, using methods developed for the Regional Agrobiodiversity Project.

Agroecological zones
A summary layer developed by aggregation of the agroecological units map.

Biodiversity ratings layer
A map at landscape level showing the value for biodiversity conservation, based on landscape and land use criteria, using physiognomic classes.

Botanical distribution maps
Maps showing the likely distribution of the identified indigenous wild species and land races using the framework of agroecological units.

All GIS layers will be at a level of detail meaningful for printing at scale 1:50,000. The coordinate system used will be UTM-WGS1984. All layers will be provided in the form of

ESRI shape files or binary export files for optimal compatibility or any other format specified by the Ministry. In addition, all maps will be made available in printed format at scale 1:50,000.

Reports

A comprehensive report will be delivered containing the following sections:

- methodologies for botanical surveys and eco-geographical analysis in GIS
- distribution of indigenous wild species and land races in the target area
- identification of areas with particular value for in-situ biodiversity conservation
- recommendations for management plans for various agrobiodiversity conservation options and actions to promote the conservation of local agrobiodiversity within the new agricultural system
- paper copies of all maps
- references
- a CD with the full digital database

Implementation and coordination

Given the need to study *live* vegetation for plant identification purposes, the botanical surveys can only be undertaken in the period mid-March to end May 2006. In view of this limitation in time to actually conduct botanical surveys and the requirement expressed by the Ministry of Agriculture to complete the project within 5 months from initiation, the project can only start on 1 February 2006. It will then be completed by 30 June 2006.

ICARDA's Genetic Resources Unit (GRU) will be responsible for the technical coordination and supervision of the eco-geographical and botanical surveys, as well as delivering the content of the management plans for in-situ biodiversity conservation.

ICARDA's Geographic Information Systems Unit (GISU) will be responsible for the transfer of all survey data and their linking to environmental data in GIS, the production of intermediate environmental layers, the agroecological characterization of the target area, and the identification of the spatial domains for the identified indigenous wild species and land races.

Overall project coordination will be with the GISU. The botanical surveys will be undertaken by consultants, to be identified and appointed by the GRU. The GIS activities will be mostly undertaken by GISU staff, although the use of consultants for specific and limited tasks is also anticipated.

2. FINANCIAL PROPOSAL

BUDGET ITEM	SYL	US$
1) Botanical and ecogeographical surveys		
Operations		
Vehicle use	63,600	1,200
Digital camera *	21,200	400
Subtotal	***84,800***	***1,600***
Personnel		
Botanists, 2 @ 30 working days	318,000	6,000
Biodiversity specialists, 1 @ 30 days	159,000	3,000
GIS consultant, 1 @ 2 months	106,000	2,000
Data entry, 1 @ 10 days	53,000	1,000
Per diem, 80 days @ $10	42,400	800
Subtotal	***678,400***	***12,800***
2) GIS development		
Botanical transects in GIS	42,400	800
Climate-related maps (precipitation, temperature, frost, growing periods)	42,400	800
Map of land use/land cover	42,400	800
Map of geological parent materials	42,400	800
Baseline map soil information and land degradation	106,000	2,000
Map of agroecological units	106,000	2,000
Map of agroecological zones	106,000	2,000
Map of biodiversity ratings	106,000	2,000
Botanical distribution maps	106,000	2,000
Supplies	21,200	400
Purchase of digital topo-maps (Min. Defense)	385,000	7700
Subtotal	***1,105,800***	***21,300***
3) Reporting		
Report preparation	477,000	9,000
Publication	238,500	4,500
Subtotal	***715,500***	***13,500***
TOTAL	2,584,500	49,200
ICARDA overhead (15%)	387,675	7,380
GRAND TOTAL	**2,972,175**	**56,580**

Ecogeographical and botanical surveys in the Idleb Agricultural Development Project Area

Annex 5.2. to Main Report

CONTRACT

المركز الدولي للبحوث الزراعية
في المناطق الجافة (إيكاردا)

الجمهورية العربية السورية
وزارة الزراعة والإصلاح الزراعي
مكتب مشروع التنمية الريفية بإدلب

مذكـــــرة تفـــاهم

بين

وزارة الزراعة والإصلاح الزراعي

الجمهورية العربية السورية

و

المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا)

بشأن

تنفيذ المسوحات الجغرافية والبيئية والنباتية لمنطقة عمل مكتب مشروع التنمية الريفية بإدلب

مذكـــــرة تفـــاهم

بين

وزارة الزراعة والإصلاح الزراعي
الجمهورية العربية السورية

و

المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا)

بشأن

تنفيذ المسوحات الجغرافية والبيئية والنباتية لمنطقة عمل مكتب مشروع التنمية الريفية بإدلب

- استناداً إلى استدراج عروض أسعار بالمراسلة لتنفيذ المسح الجغرافي والبيئي والنباتي لمنطقة عمل مشروع التنمية الريفية بإدلب وعلى محضر فض العروض رقم /313/ تاريخ 2006/11/7 والمتضمن إرساء طلب العروض على المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا) فقد تم تنظيم مذكرة تفاهم بين وزارة الزراعة والإصلاح الزراعي ويشار إليها فيما بعد بـ (الوزارة) والمركز الدولي للبحوث الزراعية في المناطق الجافة ويشار إليه فيما بعد بـ (إيكاردا) للقيام بتنفيذ أعمال المسوحات الجغرافية والبيئية والنباتية في مناطق عمل مكتب مشروع التنمية الريفية بإدلب وقد تم الاتفاق على أعمال المسوحات الجغرافية والبيئية والنباتية بين الوزارة وإيكاردا وفقاً للشروط الواردة بالمواد التالية:

المادة الأولى

موضوع المذكرة: تلتزم إيكاردا بتنفيذ أعمال المسوحات الجغرافية والبيئية والنباتية لمناطق عمل مكتب مشروع التنمية الريفية بإدلب، وذلك بمقتضى العرض الفني والمالي الذي قدمته إيكاردا وبما يتوافق مع دفتر الشروط الفنية الموضوع من قبل مكتب مشروع التنمية الريفية بإدلب والمرفق مع المذكرة.

المادة الثانية

تعتبر الوثائق المقدمة من إيكاردا إلى الوزارة ضمن العرض الفني والمالي لتنفيذ أعمال المسوحات الجغرافية والبيئية والنباتية لمنطقة عمل مشروع التنمية الريفية بإدلب بمكوناتها ومرفقاتها المختلفة جزءاً لا يتجزأ من هذه المذكرة.

المادة الثالثة: التزامات إيكاردا

1. تقوم إيكاردا بصفتها الاستشارية بتنفيذ أعمال المسوحات الجغرافية والبيئية والنباتية بالقيام بالمهمة موضوع هذه المذكرة وفقاً لما هو مبين في مواضيع العمل الواردة ضمن دفتر الشروط بالفاعلية والكفاءة العلمية وفقاً للبرنامج الزمني المتفق عليه.
2. توفر إيكاردا الخبرة اللازمة لتنفيذ أعمال المسوحات الجغرافية والبيئية والنباتية (وفقاً لدفتر الشروط الفنية) من الخبراء ذوي الكفاءة والدراية العلمية. ويمكن لإيكاردا ولأسباب قاهرة ولحسن سير أعمال المسح وبالتنسيق مع الوزارة استبدال الخبير أو أحد الخبراء من الفريق (إذا كان فريقاً) على أن يكون البديل من ذوي الاختصاص المتعلق بأعمال المسح وموازي بالخبرة للخبير الذي سيتم استبداله.
3. تلتزم إيكاردا بتنفيذ أعمال المسح المكلف بها وفقاً لما ورد في دفتر الشروط الفنية وفي إطار المهام المرجعية ويمكن لإيكاردا في هذا الشأن وبالرجوع إلى إدارة المشروع والتنسيق معها أن تقوم بإدخال ما يكون ضرورياً وفي صالح الأعمال المطلوبة ومن التعديلات في العناصر الفنية أو في البرنامج الزمني وذلك وفق ما تقتضيه ظروف وطبيعة أعمال المسح أو ما قد يراه الخبراء الفنيون ذوي الاختصاص، بما يحقق بدرجة أفضل كفاءة للأداء والالتزام بالموعد المحدد وتحقيق الغايات التي يهدف إليها المسح.
4. تلتزم إيكاردا أن تبدأ بأعمال المسح فور إبلاغها أمر المباشرة بالتنفيذ وأن تقدم تقريرها عن أعمال المسح خلال شهر واحد من انتهاء الأعمال ومن خلال ورشة عمل تقيمها إيكاردا تدعو إليها المختصين في هذا مجال.
5. مدة تنفيذ المسوحات خمسة أشهر إعتباراً من تاريخ أمر المباشرة.
6. ستقوم إيكاردا بتشكيل فريق من المساحين لتنفيذ أعمال المسوحات الجغرافية والبيئية والنباتية وتتحمل إيكاردا النفقات الخاصة بفريق المسح وكذلك تتحمل إيكاردا نفقات إشراف المشروع على متابعة المسح.
7. في حال اقتضى الأمر تنفيذ عمل إضافي لخدمة المسح، يمكن عندئذ إضافته مع التكاليف المرتبطة به بعد اتفاق الطرفين بحيث لا يتجاوز المبالغ 25% من تكلفة المشروع.

المادة الرابعة: التزامات الوزارة

1. تلتزم الوزارة بدفع مبلغ لا يتجاوز 2972175 فقط مليونين وتسعمائة واثنان وسبعون ألفاً ومائة وخمس وسبعون ليرة سورية لا غير إلى إيكاردا لقاء القيمة الإجمالية لتكلفة أعمال المسوحات الجغرافية والبيئية والنباتية.
2. يتم تسديد المبالغ المستحقة بالليرة السورية لحساب (إيكاردا) رقم 3060/45708 لدى المصرف التجاري السوري (فرع 2) – حلب.
3. التسديد: يتم دفع 25% من المبلغ المستحق بعد توقيع مذكرة التفاهم مباشرة، و25% عند بداية المسح، و25% بعد انتهاء نصف مرحلة المسح، و25% عند تقديم التقرير النهائي، وذلك وفق كتب مطالبة من إيكاردا إلى المشروع.

المادة الخامسة: أحكام عامة

1. تقوم إيكاردا بإخطار الوزارة فور حدوث أي سبب قاهر خارج عن إرادة إيكاردا يعرقل أو يؤخر قيام إيكاردا بتنفيذ أعمال المسح، وإذا كانت أسباب التأخير راجعة إلى عوامل متعلقة بالوزارة يتم

معالجة المشكلة باتفاق الطرفين وتستمر إيكاردا في الأعمال الموكلة إليها على أن تلتزم الوزارة بدفع التزاماتها المالية المستحقة لإيكاردا وفق الفقرة (1) من المادة الرابعة من هذه المذكرة شريطة أن لا تكون إيكاردا مسؤولة عن هذا التأخير ولا يخل بالتزامات السداد وفقاً للمادة الرابعة.

أما إذا كانت الأسباب راجعة إلى ظروف متعلقة بإخلال إيكاردا بالتزاماتها الواردة في المادة الثالثة من هذه المذكرة، فيجوز في هذه الحالة للوزارة عند اقتناعها أن تمنح إيكاردا مهلة زمنية إضافية للوفاء بالتزاماتها والعمل على معالجة المشاكل الطارئة بالتنسيق بين الطرفين (الوزارة وإيكاردا). فإذا تعذر ذلك يحق للوزارة سحب أعمال المسح من ايكاردا وتنفيذها على حسابها بالطريقة التي تراها مناسبة، وتتحمل إيكاردا في هذه الحالة كافة النفقات وفروقات الأسعار الناجمة عن ذلك.

2. يتم تسوية أي نزاع بين طرفي المذكرة بالطرق الودية وفي حال عدم التمكن من تسويته بالطرق الودية يحال النزاع إلى القضاء الإداري في مجلس الدولة بدمشق لحل الخلاف وفقاً للأنظمة والقوانين النافذة في الجمهورية العربية السورية.
3. يجوز للوزارة فقط إلغاء هذه المذكرة بموجب كتاب موجه إلى إيكاردا ويسري العمل بموجبه فور تسليم إيكاردا هذا الكتاب، ولا يؤثر هذا الإلغاء بأي حال من الأحوال على استحقاق إيكاردا لتكلفة ما تم إنجازه من الأعمال حتى سريان الإلغاء.
4. يتم تسمية لجنة إشراف من مشروع التنمية الريفية بإدلب لمتابعة تطورات عملية تنفيذ المسح وما قد يطرأ من تعديلات خلال التنفيذ ويكون صلة الوصل بين إيكاردا والوزارة وتتحمل إيكاردا نفقات الإشراف كاملة.

المادة السادسة

المراجع القانونية في كل ما لم يرد فيه نص في هذه المذكرة يرجع فيها إلى نظام العقود الصادر بالقانون رقم /51/ لعام 2004 ودفتر الشروط العامة الصادر بالمرسوم رقم 450 لعام 2004 وفي حال عدم كفاية هذه النصوص يعتبر التشريع السوري هو المرجع المختص في تفسير نصوص هذه المذكرة.

المادة السابعة : العناوين

عنوان الوزارة:
وزارة الزراعة والإصلاح الزراعي
دمشق - الجمهورية العربية السورية

عنوان المركز:
المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا)
حلب - الجمهورية العربية السورية

المادة الثامنة

حررت هذه المذكرة على نسختين أصليتين باللغة العربية توزع نسخة لكل طرف

المادة التاسعة

1. كافة المراسلات المتعلقة بتطبيق هذه الاتفاقية توجه إلى:

وزارة الزراعة والإصلاح الزراعي- مديرية التعاون الدولي
هاتف: 011-44674480
فاكس: 011-44674481

مكتب مشروع التنمية الريفية بإدلب
هاتف: 023-235321
فاكس: 023-239119
البريد الإلكتروني: ahdarkalt@yahoo.com

المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا)
هاتف 1: 21-22134330
هاتف 2: 21-2213477 0
هاتف 3: 21-22251120
فاكس 1: 21-22134900
فاكس 2: 21-22251050

2. تصبح هذه المذكرة نافذة من تاريخ التوقيع عليها من قبل ممثلي الطرفين.

مدير الشؤون التجارية في
وزارة الزراعة والإصلاح الزراعي

السيد محمد الحريري

مدير مشروع التنمية الريفية بإدلب

د. أحمد دركلت

وزارة الزراعة والإصلاح الزراعي
الجمهورية العربية السورية

وزير الزراعة والإصلاح الزراعي

الدكتور عادل سفر

المركز الدولي للبحوث الزراعية
في المناطق الجافة (إيكاردا)

المدير العام

الدكتور محمود الصلح

Syrian Arab Republic
Ministry of Agriculture and Agrarian Reforms
Office of Rural Development Project in Idlib

International Centre for Agricultural Research in the Dry Areas (ICARDA)

Memorandum of Understanding

Between

Syrian Arab Republic
The Ministry of Agriculture and Agrarian Reforms
Department of International Collaboration

and

The International Centre for Agricultural Research in the Dry Areas (ICARDA)

Concerning

The execution of geographical, ecological and botanical surveys for the working region of the Office of Rural Development Project in Idlib

Memorandum of Understanding

Between
Syrian Arab Republic

The Ministry of Agriculture and Agrarian Reforms
Department of International Collaboration

And

The International Centre for Agricultural Research in the Dry Areas (ICARDA)

Concerning

The execution of geographical, ecological and botanical surveys for the working region of the Office of Rural Development Project in Idlib

– Reference is made to the solicitation of bidding offers by correspondence to execute the geographical, ecological and botanical surveys for the working region of the Office of Rural Development Project in Idlib and the minutes of tenders' opening session no 213 dated 7/11/2006 that includes the selection of the tender offered by the International Centre for Agricultural Research in the Dry Areas-ICARDA, a memorandum of understanding between the Ministry of Agriculture and Agrarian Reforms (hereafter called the Ministry) and the International Centre for Agricultural Research in the Dry Areas (hereafter called ICARDA) was organized to conduct geographical, ecological and botanical survey works in the working regions of the Office of Rural Development Project in Idlib. Agreement was reached between the Ministry and ICARDA on the geographical, ecological and botanical survey works according to the conditions outlined in the following articles

Article one

Subject of the memorandum: ICARDA shall conduct the geographical, ecological and botanical survey works for the working regions of the Office of Rural Development Project in Idlib according to the technical and financial tender ICARDA has provided and in accordance with the technical conditions book laid down by the Office of Rural Development Project in Idlib which is attached to the memorandum.

Article two

Documents provided by ICARDA to the Ministry within the technical and financial offer to execute the geographical, ecological and botanical survey works for the working region of the Office of Rural Development Project in Idlib, with its components and different appendices, are an integral part of this memorandum

Article three: ICARDA's obligations

1. ICARDA, in its consultancy status, shall execute the geographical, ecological and botanical survey works by carrying out the mission, subject of this memorandum, according to what is outlined in the working subjects mentioned within the conditions book, efficiently and with scientific competence according to the time frame agreed upon.
2. ICARDA shall provide the necessary expertise to execute the geographical, ecological and botanical survey works (according to the technical conditions book) using experts of known proficiency and scientific competence. ICARDA may, for reasons beyond its control, and for the good conduct of the survey works, replace the expert or one of the experts of the team (if it is a team) provided that the replaced expert is of specialty related to the survey works and has similar expertise of the replaced one.
3. ICARDA shall be obliged to execute the survey works, as mentioned in the technical conditions book, within the framework of the reference missions, and may, in this regards, after consultation with the project administration and in coordination with it, introduce what is necessary and for the benefit of the required work and modifications in technical elements or the timetable program as required by conditions and nature of survey works, or as suggested by technical specialized experts, in order to achieve better performance, adhere to specified date and to achieve the purposes of the surveys
4. ICARDA shall be obliged to initiate the survey works within the period agreed upon by the two parties (the Ministry and ICARDA) and to submit its report on the survey work within a month after the completion of the survey works and through a workshop organized by ICARDA and to which specialists in the survey domain will be invited.
5. ICARDA shall form a team of surveyors to execute the geographical, ecological and botanical survey works and will bear the expenses of the survey team and will also bear the expenses of the project supervision that will follow up the survey.
6. 6. If additional work is needed, this work and associated costs may be added after approval by both parties, provided the costs do not exceed 25% of the total project costs.

Article four: The Ministry obligations

1. The Ministry shall pay ICARDA a sum not exceeding 2.972.175, only two million nine hundred seventy two thousands and one hundred seventy five Syrian Lira for the total value of costs of the geographical, ecological and botanical survey works
2. The due sums are paid to ICARDA account No in bank, in Syrian Lira.

3. Settlement: 25% of the due sum shall be paid directly after signing the memorandum of understanding, 25% shall be paid upon the initiation of the survey, 35% shall be paid after finishing half of the survey stage, 15% shall be paid upon submission of the final report. These payments will be done according to invoices submitted from ICARDA to the Project

Article five: General Provisions

1. ICARDA shall immediately inform the Ministry upon occurrence of any reason beyond its control that hinder or delay the execution of the survey works carried out by ICARDA. If the reasons for the delay are due to factors related to the Ministry, the problem shall be dealt with through agreement of the two parties, and ICARDA shall

continue the works provided the Ministry pay its financial obligations to ICARDA according to the article 4, 1 of this memorandum, provided that ICARDA is not held responsible for this delay and in accordance with settlement obligations mentioned in article four.

If the reasons are due to conditions related to non-compliance of ICARDA of its obligations outlined in article 3 of this memorandum, the Ministry when convinced, may accord ICARDA an additional time period to fulfill its obligations and to deal with the occasional problems in coordination between the two parties (the Ministry and ICARDA). If this is not feasible, the Ministry has the right to withdraw the survey works from ICARDA and execute them on its expense, in a way that the Ministry sees appropriate. In this case, ICARDA will bear all expenses and the differences in prices incurred.

2. Settlement of any dispute between the two parties of the memorandum shall be made by friendly means. If the dispute cannot be resolved by friendly means, the two parties agree to appoint an arbitrating committee to consider the question in dispute
3. The Ministry only may cancel this memorandum by addressing a letter to ICARDA and the cancellation will come into force as soon as ICARDA receive this letter. This cancellation shall not affect, in any circumstance, ICARDA financial dues for the cost of works accomplished prior to this cancellation.
4. The office of the rural development project shall nominate a supervision committee to follow up the survey execution process developments and the modifications that may occur during the execution and he will be the liaison point between ICARDA and the Ministry and ICARDA shall fully bear the expenses of the supervisor.

Article six: addresses

- **The Ministry address**
  Ministry of Agriculture and Agrarian Reforms
  Syrian Arab Republic

- **The Centre Address**
  International Centre for Agricultural Research in the Dry Areas (ICARDA - Aleppo, Syrian Arab Republic

Article seven

This memorandum is written in Arabic on two original copies, one copy shall be distributed to each party

Article eight

1. All correspondences related to the execution of this memorandum shall be addressed to:

   Ministry of Agriculture and Agrarian Reforms-Directorate of International Cooperation
   Tel: 011-44674480
   Fax: 011-44674481

   Office of Rural Development Project in Idlib

Tel: 023-235321
Fax: 023-239119

The International Centre for Agricultural Research in the Dry Areas (ICARDA)-Aleppo
Tel 1:
Tel 2:
Tel 3:
Fax 1:
Fax 2:

2. This memorandum of understanding shall come into force as soon as it has been ratified by representatives of both parties

Dr Adel Safar
Minister of Agriculture and Agrarian Reforms
Ministry of Agriculture and Agrarian Reforms
Syrian Arab Republic

Dr. Mahmoud Solh
DG-ICARDA

Ecogeographical and botanical surveys in the Idleb Agricultural Development Project Area

Annex 5.3.

Botanical Survey of Jebel Zawia and Jebel Wastani

Amin Khatib Salkini

TABLE OF CONTENTS

Acknowledgment

I would like to thank the field team involved in the botanical survey: Mr. Abdul Karem Hamade and Ms. Enas Jumbaz. Thanks are due as well to Ms. Reem Shabe Kalyeh for entering the observations into the botanical survey database, and to Ms. Rima El-Khatib for formatting the report. Dr. Eddy De Pauw provided scientific editing to this report.

1. Introduction

Since many years the biodiversity in Jebel Zawia and Jebel Wastani in Idleb Province has been exposed to degradation due to overgrazing, wood cutting, rock and stone removal, cultivation, quarrying and terracing for planting fruit trees and field crop. Not only species diversity has declined, but also the actual area under natural vegetation cover due to cultivation between rocks, ofen in spaces as small as 5 m^2.

In order to maintain areas with valuable plant biodiversity, the Government of Syria, through the Ministry of Agriculture and Agrarian Reform (MAAR), requested IFAD to fund a botanical survey.

The objectives of the survey were:

- To map the botanical biodiversity within the project area, particularly in relation to the occurrence of indigenous wild species and land races;
- To assess the economic importance of the botanical biodiversity identified in the project area;
- To conserve the biodiversity by encouraging farming practices compatible with good management of the natural resources.

2. Methodology

2.1. General

Eleven monitoring areas were selected in Jebel Zawia and Jebel Wastani in March 2007 based on the following criteria:

- Different land uses
- Different parent rocks
- Covering both a protected and degraded area
- Different plant communities
- Covering a wild herbaceous and forest area
- Covering the natural area and cultivated area

The botanical survey started mid-April and was completed in mid-June 2007. It was undertaken at four levels of observation:

- At the level of the **project area**: Jebel Zawia and Jebel Wastani
- At the level of the **monitoring area**: 7 monitoring areas were selected in Jebel Zawia and 4 monitoring areas in Jebel Wastani
- At the level of the **transect**: 3 transects were selected for each monitoring area for both herbaceous and trees plots. Depending on the heterogeneity, the length of each transect was 50 to 250 m.
- At the level of the **plot:** 5 plots were selected in each transect of each monitoring area for both herbaceous and trees area. The distance between the plots was 15–30 m, the plot size in the herbaceous transect was 1 m^2, whereas the plot size in the trees transect was 100 m^2

Table 1 contains the names and coordinates of the monitoring areas, Figure 1 shows their location.

Table 1. Location of the monitoring areas

Project area	Monitoring site	Latitude	Longitude	Altitude
Zawia	Bab-Alah	35.8368	3652752	471
	Kokfeen	35.63431	36.4174	662
	Mohanbel	35.79022	36.48305	526
	Dar-Dobat (Al Bara)	35.68062	36.52614	732
	Al-Rame	35.75354	36.53848	671
	Kafar Haya	35.74908	36.5985	781
	Kafar Lata	35.79077	36.61841	801
Wastani	Al-Daher	35.95978	36.41823	326
	Maryameen	35.91133	36.40605	479
	Al-Fasook	36.01392	36.45195	531
	Oreba	36.14626	36.50709	457

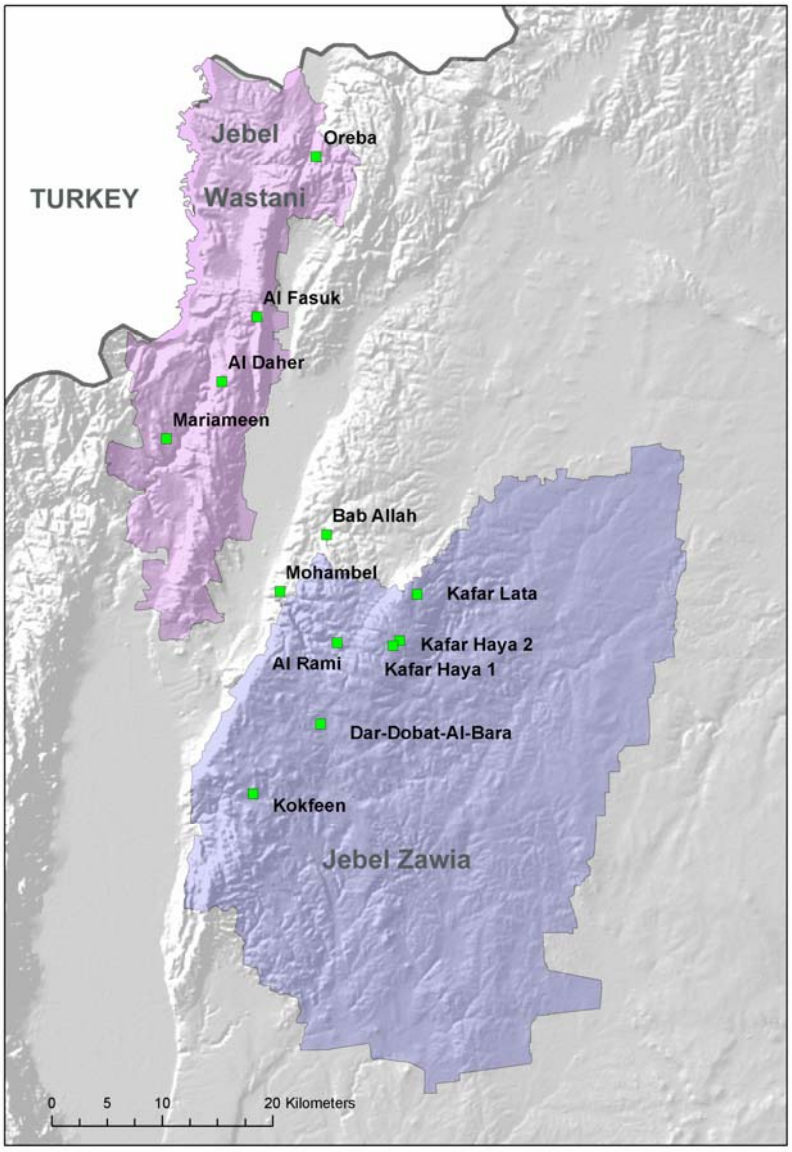


Fig. 1 Map of the project area showing the monitoring areas in Jebel Zawia and Jebel Wastani

2.2. Measurements

Coordinates: Latitude, longitude and altitude were recorded by GPS in the middle of each monitoring level, in the start and end points of each transect, and at each plot .

Photo: Photos were taken in each monitoring area, each transect and each plot.

Terrain: percent slope, slope direction (aspect) and length were taken in each transect, and slope direction in each plot.

Soil: in each plot the following characters were taken:

- Depth (cm)
- Color (reddish, brownish, yellowish, grey or black)
- Texture (Clayey, loamy, sandy or organic)
- Moisture (dry, moist or wet),
- Presence of aggregates
- Ploughed (yes or no).
- Free lime: by adding to the soil a few drops of hydrochloric acid to know if the soil is strongly calcareous, calcareous, slightly calcareous or non-calcareous.

Rocks: in each plot the following characteristics were taken:

- Abundance (%)
- Type: basalt, light limestone, or dark limestone.
- Weathered (fresh, weathered or rotten).

Stones: in each plot the following characters were taken:

- Abundance (%)
- Type: basalt, light limestone, or dark limestone.
- Size class: range from 0.2 cm to more than 60 cm).

Species survey: both in herbaceous plot and trees plot date of survey, surveyors, and plot size were recorded.

- In **herbaceous plots** the following measurements were recorded:
    - List of species: including botanical name, author, family, Arabic name, life form (Annual, perennial or biennial) and biotype (trees, shrub, herb or climber), the known species directly recorded in the field, plant species which could not be identified in the field were given a code, collected and labeled, these specimens were compared with herbarium material of ICARDA, and by using flora of Syria, Palestine.
    - Plant cover (%) for each species
    - Density: number of plants for each species/plot
    - Growth stage: leave stage, Flower or fruiting
    - Health: healthy or stress by(Disease, insect, parasite, cutting and burn or grazing)
    - Dominant and associated species: in each plot
- In **trees plots:** in addition to the previous data for herbaceous plot, the following data for trees were recorded:
    - Number of adult trees
    - Height and diameter of each adult tree
    - Number of seedlings and juveniles

Fig. 2 Vegetation measurements in herbaceous plot ($1m^2$)

Fig. 3 Vegetation measurements in trees plot ($100\ m^2$)

Fig. 4 Measurements height/m and diameter/m in trees plots

Fig. 5 Measurements of soil depth /cm

Fig. 6 Recorded botanical data (listed species, species cover, density)

Fig. 7 Transect in Herbaceous plots

Disturbance: the causes of disturbance at plot level (grazing, cultivation, plowing fallow, cut and carry, terracing, destoning, rock removal, construction or fire) are defined.

Degradation factors: were recorded at the monitoring area level

- **General factors**: including overgrazing, urbanization, cropland encroachment, cutting, terracing, destoning, other land reclamation, quarries or fire, were evaluated on a scale from 0 (no or very low), 3 (low), 5 (medium), to 7 (high).
- **Botanical indicators**: the list of the indicator species of degradation was recorded, such as thistles, poisonous and unpalatable herbs and shrubs and poisonous bulbous.

Fig.8 Traditional Cultivation

Fig. 9 Modern cultivation

Fig. 10 over Grazing

Fig. 11 Cut & Burn

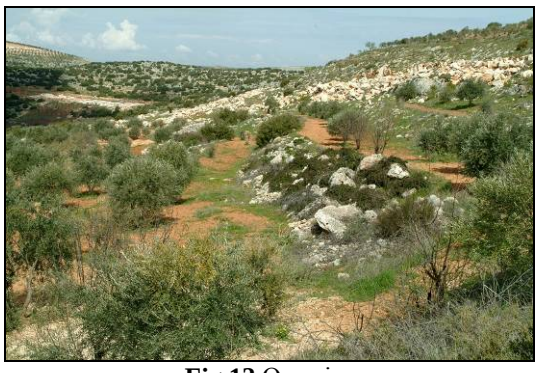


Fig.12 Quarries

Fig. 13 Terracing

Annex 10 contains the description forms used at the level of the monitoring area, transect and plot level.

3. Results

3.1. Floristic characteristics

The plant species of the monitoring areas of Jebel Zawia and Jebel Wastani were catalogued, resulting in the identification of 339 species of higher flowering plants, the species belonged to 59 families and 209 genera.

The Leguminosae family is represented by the largest number: 78 species (23% of total number of species), followed by Compositae with 42 species (12.4% of total), Gramineae with 39 species (11.5%), Labiatae with 16 species (4.7%), Umbelliferae with 15 species (4.4%), Cruciferae with 13 species (3.8%), Caryophyllacea with 12 species (3.6%), and Rosaceae with 10 species (3%). The remaining 51 families are represented by 113 species (33.5%). The data are summarized in Table 3, whereas Appendix 1 provides more details on each species.

Table 3. Rank of number of species, percentage of species in each family in both Jebel Zawia and Jebel Wastani .

Rank	Family	No. of species per family	% species per family
1	Leguminosae	78	23.01
2	Compositae	42	12.39
3	Gramineae	39	11.50
4	Labiatae	16	4.72
5	Umbelliferae	15	4.42
6	Cruciferae	13	3.83
7	Caryophyllaceae	12	3.54
8	Rosaceae	10	2.95
9	Ranunculaceae	8	2.36
10	Rubiaceae	8	2.36
11	Scrophulariaceae	8	2.36
12	Euphorbiaceae	7	2.06
13	Hyacinthaceae	6	1.77
14	Geraniaceae	5	1.47
15	Fagaceae	4	1.18
16	Papaveraceae	4	1.18
17	Plantaginaceae	4	1.18
18	Valerianaceae	4	1.18
19	Anacardiaceae	3	0.88
20	Dipsacaceae	3	0.88
21	Iridaceae	3	0.88
22	Oleaceae	3	0.88
23	Alliaceae	2	0.59
24	Araceae	2	0.59
25	Asphodelaceae	2	0.59
26	Campanulaceae	2	0.59
27	Cistaceae	2	0.59
28	Illecebraceae	2	0.59
29	Linaceae	2	0.59
30	Aristolochiaceae	1	0.29
31	Asparagaceae	1	0.29
32	Berberidaceae	1	0.29
33	Boraginaceae	1	0.29
34	Capparaceae	1	0.29
35	Caprifoliaceae	1	0.29
36	Chenopodiaceae	1	0.29
37	Convolvulaceae	1	0.29

Rank	Family	No. of species per family	% species per family
38	Crassulaceae	1	0.29
39	Cucurbitaceae	1	0.29
40	Cupressaceae	1	0.29
41	Cyperaceae	1	0.29
42	Ephedraceae	1	0.29
43	Ericaceae	1	0.29
44	Guttiferae	1	0.29
45	Lauraceae	1	0.29
46	Liliaceae	1	0.29
47	Moraceae	1	0.29
48	Orchidaceae	1	0.29
49	Pinaceae	1	0.29
50	Polygonaceae	1	0.29
51	Primulaceae	1	0.29
52	Rhamnaceae	1	0.29
53	Santalaceae	1	0.29
54	Smilacaceae	1	0.29
55	Solanaceae	1	0.29
56	Styracaceae	1	0.29
57	Thymelaeaceae	1	0.29
58	Vitaceae	1	0.29
59	Zygophyllaceae	1	0.29
	Total	**339**	**100.00**

3.2. Climax plants and dominant species

The climax plant association in most parts of Jebel Zawia and Jebel Wastani is the *Quercus calliprinos – Pistacia palaestina* association. The dominant herbaceous species are: *Trifolium stellatum, Hordeum murinum, Lagoecia cuminoides, Avena sterilis, Koeleria phleoides.* The dominant shrubs species are *Sarcopoterium spinosum, Asphodelus microcarpus.* The dominant trees species are *Quercus infectoria, Phillyrea latifolia, Crataegus azarolus.*

3.3. Plant communities and plant associations

3.3.1. Jebel Zawia

3.3.1.1 Herbaceous plots

The monitoring sites Kafar Lata, Al-Rame and Dar-Dobat-Al-Bara have a good pasture due to low grazing pressure. The community contains mostly palatable species with high grazing value, such as annual legumes (*Trifolium stellatum, Trifolium tomentosum, Trifolium campestre, Astragalus asterias and Trigonella filipes)* and annual perennial grasses (*Lolium rigidum, Avena sterilis, Bromus danthoniae, Hordeum spontaneum*).
At the other monitoring sites Kafar Haya, Mohanbel, Kokfeen and Bab-Alah the pastures are degraded due to heavy grazing. The community contains mostly unpalatable species with low grazing value, such as invader shrubs (*Asphodelus microcarpus, Sarcopoterium spinosum*) and annual grasses that are only palatable in the green stage (*Hordeum murinum*).
Plant community and associations data are summarized in Table 4.

Table 4. Plant community and plant associated in 7 sites of A-Zawia Mountain, (herbaceous plots).

Site name	Plant community	Associated plants
Kafar Lata	*Lolium rigidum* and *Trifolium stellatum*	*Caucalis* tenella, *Trifolium campestre, Trigonella filipes* and *Trifolium tomentosum*
Kafar Haya	*Sarcopoterium spinosum,* and *Asphodelus microcarpus*	*Poa bulbosa, Trifolium stellatum, Avena barbata,* and *Anthemis maris-mortui,*
Al-Rame	*Avena sterilis* and *Trifolium stellatum*	*Hordeum spontaneum, Trifolium tomentosum, Lagoecia cuminoides,* and *Sarcopoterium spinosum*
Dar-Dobat (Al-Bara)	*Trifolium stellatum* and *Bromus danthoniae*	*Lagoecia cuminoides Astragalus asterias***,** *Lolium rigidum, and Plantago cretica*
Mohanbel	*Asphodelus microcarpus* and *Koeleria phleoides*	*Trifolium* pilulare, *Trifolium tomentosum, Torilis leptophylla and Plantago cretica*
Kokfeen	*Polycarpon tetraphyllum and Lolium rigidum*	*Cichorium pumilum***,** *Koeleria phleoides, Bromus lanceolatus var. lanatus and Hordeum glaucum*
Bab-Alah	*Hordeum murinum* and *Sarcopoterium spinosum*	*Asphodelus microcarpus Koeleria phleoides*, *Bromus lanceolatus var. lanatus,* and *Trifolium tomentosum*

3.3.1.2 Tree plots

The plant community *Quercus calliprinos* and *Pistacia palaestina* is present in two sites *(*Kafar Lata and Dar-Dobat (Al-Bara). Community *Quercus calliprinos* and *Quercus infectoria* is present in one site *(*Kafar Haya), and community *Quercus calliprinos* and *Phillyrea latifolia* occurs in one site *(*Al-Rame).
Other dominant shrubs species are *Osyris alba, Rhamnus palaestinus* and *Olea europeae var. oleaster* . Table 5 summarizes the observations at the four sites with tree plots.

Table 5. Plant communities and plant associations in the tree plots of four sites of Jebel Zawia

Site name	Plant community	Associated plants
Kafar Lata	*Quercus calliprinos* and *Pistacia palaestina*	*Phillyrea latifolia*, *Osyris alba* and *Crataegus azarolus*
Kafar Haya	*Quercus calliprinos* and *Quercus infectoria*	*Quercus libani*, *Pistacia palaestina* and *Rhamnus palaestinus*
Al-Rame	*Quercus calliprinos* and *Phillyrea latifolia*	*Osyris alba*, *Pistacia palaestina* and *Olea europeae var. oleaster*
Dar-Dobat (Al-Bara)	*Quercus calliprinos* and *Pistacia palaestina*	*Quercus infectoria*, *Osyris alba* and *Olea europeae var. oleaster*

3.3.2 Jebel Wastani

3.3.2.1 Herbaceous plots

The pasture in sites Al-Fasook and Al-Daher was good due to low grazing. The communities are dominant by palatable species with high grazing value, such as annual legumes (*Trifolium stellatum, Trifolium campestre, Trifolium purpureum*, and *Trifolium nigrescens)* and annual grasses (*Koeleria phleoides, Lolium rigidum, Bromus danthoniae, Avena sterilis,* and *Trachynia distachy)* In sites Oreba and Maryameen the pasture consists of annual grasses (*Koeleria phleoides, Avena sterilis, Lolium rigidum, Aegilops triuncialis)* and perennial grasses (*Hordeum bulbosum),* the invader shrub *Asphodelus microcarpus* and the legumes exposed to grazing (Table 6).

3.3.2.2 Trees plots

The plant community: *Quercus calliprinos* and *Phillyrea latifolia* occurred in 3 sites *(*Al-Fasook, Maryameen and Al-Daher), while community *Quercus calliprinos* and *Styrax officinalis* occurred in one site *(*Oreba),

Other dominant trees species such as *Pistacia palaestina* and *Laurus nobilis* and dominant shrubs species such as *Daphne oleifolia, Osyris alba* and *Rhamnus palaestinus* occur in all monitoring sites of Jebel Wastani (Table 7)

Table 6. Plant communities and plant associations in the herbaceous plots of the four sites of Jebel Wastani

Site name	Plant community	Associated plants
Oreba	*Lolium rigidum and Asphodelus microcarpus*	*Koeleria phleoides*, *Trachynia distachya, Torilis leptophylla* and *Aegilops triuncialis*
Al-Fasook	*Lagoecia cuminoides* and *Trifolium stellatum*	*Lolium rigidum, Trifolium purpureum, Avena sterilis,* and *Trachynia distachya*
Maryameen	*Avena sterilis* and *Lagoecia cuminoides*	*Alyssum damascenum, Hordeum bulbosum, Torilis leptophylla* and *Linum strictum*
Al-Daher	*Koeleria phleoides* and *Trifolium campestre*	*Lagoecia cuminoides Trifolium nigrescens, Caucalis tenella* and *Bromus danthoniae*

Table 7. Plant communities and plant associations in the tree plots of the four sites of Jebel Wastani

Site name	Plant community	Associated plants
Oreba	*Quercus calliprinos* and *Styrax officinalis*	*Pistacia palaestina*, *Rhamnus palaestinus* and *Phillyrea latifolia*
Al-Fasook	*Quercus calliprinos* and *Phillyrea latifolia*	*Pistacia palaestina*, *Laurus nobilis* and *Daphne oleifolia*
Maryameen	*Quercus calliprinos* and *Phillyrea latifolia*	*Daphne oleifolia, Pistacia palaestina* and *Osyris albar*
Al-Daher	*Quercus calliprinos* and *Phillyrea latifolia*	*Pistacia palaestina*, *Osyris alba and Rhamnus palaestinusr*

Fig. 14 dominant legume herb species (*Trifolium stellatum*)

Fig. 15 Dominant legume herb species (*Trifolium campestre*)

Fig. 16 The most dominant grasses herb species (*Lolium rigidum*)

Fig.17 Dominant grasses herb species (*Avena sterilis*)

Fig. 18 The most dominant shrubs (*Asphodelus microcarpus*)

Fig. 19 Dominant shrub (*Sacropoterium spinosum*)

Fig. 20 The most dominant trees species (*Quercus calliprinos*)

Fig. 21 Dominant trees species (*Pistacia palaestina*)

Fig. 22 Dominant trees species (*Quercus infictoria*)

Fig. 23 Dominant trees species (*Phillyrea latifolia*)

Fig. 24 Dominant high shrub in trees plot (*Daphne oleifolia*)

Fig. 25 Dominant small shrub in trees plot (*Osyris alba*)

3.4. Life form

The analysis of the flora according to the life forms (Appendix 1) revealed that annual species are predominant with 212 species (62.7.1%), followed by perennials with 118 species (34.9.1%), and followed by biennials with 8 species (2.4%).

3.5. Biotype

The flora in both Jebels consists of:

- Herbs: 282 species (212 annual species, 62 perennial species and 8 biennial species);
- Shrubs: 30 species (22 small shrubs species and 8 high shrubs species);
- Trees: 20 (16 tall trees species and 4 small trees);
- Climbers: total number of climber species: 6 (4 climber shrubs species, 1 climber herb species and 1 climber tree species).

3.6. Vegetation cover

3.6.1 Jebel Zawia

3.6.1.1 Herbaceous plots

There is much variation in the plant cover of the monitoring sites, ranging from a minimum of 49.3% at Kokfeen to a maximum of 77.7% at Al-Rame. The driving factor of cover percentage is the grazing pressure.
The degradation at Kokfeen is indicated by the very high percentage of stones, compared to the other sites. The results are summarized in Table 8 and Figure 26.

Table 8. Percentage cover in the herbaceous plots of each monitoring site of Jebel Zawia

	Kafar Lata	Kafar Haya	Al-Rame	Dar-Dobat (Al-Bara)	Mohanbel	Kokfeen	Bab-Alah	Average Zawia (herb)
Bare Soil %	6.0	6.0	3.0	7.0	4.3	4.3	7.3	5.4
Rock %	9.7	17.7	15.0	18.0	15.3	15.7	8.0	14.2
Stones %	8.3	8.0	4.3	7.3	12.0	30.7	16.3	12.4
Herbs %	74.0	65.7	75.7	65.3	67.7	45.7	66.3	65.8
Lichens %	1.3	2.0	1.7	2.0	0.7	3.3	1.7	1.8
Litter %	0.7	0.7	0.3	0.3	0.0	0.3	0.3	0.4
Total plant cover %	76.0	68.3	77.7	67.7	68.3	49.3	68.3	68.0

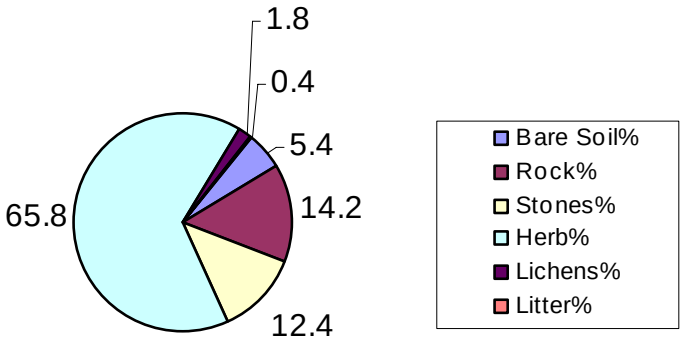


Fig. 26 Average vegetation cover% in the herbaceous plots of Jebel Zawia

3.6.1. 2 Tree plots

As for the herbaceous plots, the total plant cover percentage (trees, shrubs and herbs) in the tree plots is the highest in site Al-Rame (77.3%). However, the differences between the monitoring sites are not as pronounced as for the herbaceous plots. The results are summarized in Table 9 and Figure 27.

Table 9. Percentage cover in the tree plots of each monitoring site of Jebel Zawia

	Kafar Lata	Kafar Haya	Al-Rame	Dar-Dobat (Al-Bara)	Average Zawia (trees)
Bare Soil %	2.7	6.0	5.7	8.0	5.6
Rock %	21.3	2.7	5.7	19.0	12.2
Stones %	10.7	17.0	11.3	12.0	12.8
Trees & shrubs	52.3	62.7	64.7	37.3	54.3
Herbs %	13.0	11.7	12.7	23.7	15.3
Total plant cover %	65.3	74.3	77.3	61.0	69.5

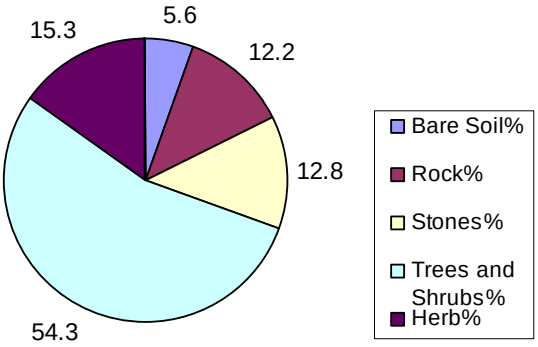


Fig. 27 Average vegetation cover% in the tree plots of Jebel Zawia

3.6.2 Jebel Wastani

3.6.2.1 Herbaceous plots

There is much variation in the plant cover of the monitoring sites, ranging from a minimum of 49.3% at Kokfeen to a maximum of 77.7% at Al-Rame. The driving factor of cover percentage is the grazing pressure.

The highest total plant cover% (77.7%) within the herbaceous plots was observed in the Oreba monitoring site, which has a very low grazing pressure, the lowest percentage cover (65.7%) in the Maryameen monitoring site, which was exposed to medium cultivation. The differences in plant cover in the herbaceous plots of the Jebel Wastani monitoring sites are, however, less pronounced than in the plots of the Jebel Zawia monitoring sites. The results are summarized in Table 10 and Figure 28.

Table 10. Percentage cover in the herbaceous plots of each monitoring site of Jebel Wastani

	Oreba	Al-Fasook	Maryameen	Al-Daher	Av. Wastani (herbaceous)
Bare Soil %	5.0	4.0	3.3	3.3	3.9
Rock %	12.0	13.3	9.0	19.0	13.3
Stones %	5.3	10.3	22.0	2.7	10.1
Herbs %	76.7	67.0	62.0	63.7	67.3
Lichens %	1.0	1.3	1.7	3.3	1.8
Litter %	0.0	4.0	2.0	8.0	3.5
Total plant cover %	77.7	72.3	65.7	75.0	72.7

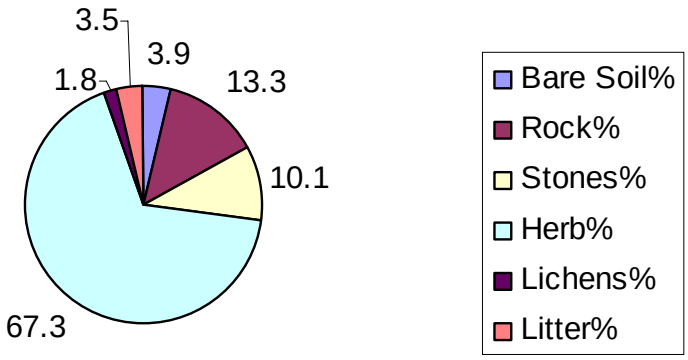


Fig. 28 Average vegetation cover% in the herbaceous plots of Jebel Wastani

3.6.2. 2 Tree plots

The total plant cover% of trees, shrubs and herbs was the highest (78.3%) in the Maryameen monitoring, and the lowest (63-66%) was in the Al-Fasook and Oreba monitoring sites, which are more exposed to grazing, cultivation and cut and carry. Nevertheless, the variation in plant cover The results are summarized in Table 11 and Figure 29.

Table 11. Percentage cover in the tree plots of each monitoring site of Jebel Wastani

	Oreba	Al-Fasook	Maryameen	Al-Daher	Av. Wastani (trees)
Bare Soil %	10.3	1.3	4.3	2.0	4.5
Rock %	22.3	20.7	8.7	21.7	18.3
Stones %	4.3	12.3	8.7	3.0	7.1
Trees & shrubs	39.0	51.7	59.0	55.7	51.3
Herbs %	24.0	14.0	19.3	17.7	18.8
Total plant cover%	63.0	65.7	78.3	73.3	70.1

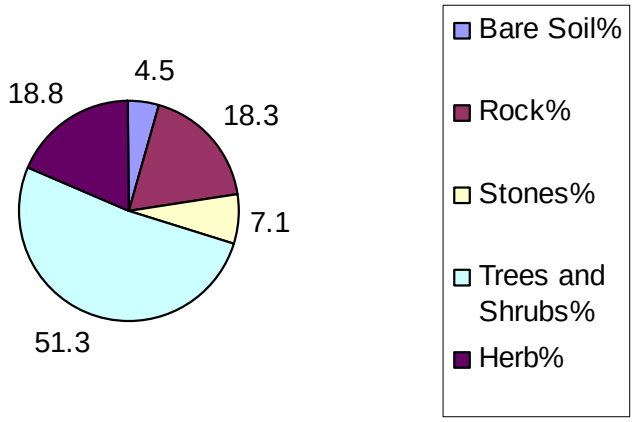


Fig. 29 Average vegetation cover% in the tree plots of Jebel Wastani

3.7. Species cover

3.7.1 Jebel Zawia

3.7.1.1. Herbaceous plots

The herbaceous species with on average the highest cover% in Jebel Zawia was *Trifolium stellatum* (6.45% of total species), with a maximum of 17.13% in site Al-Rame. The second most common herbaceous species was *Hordeum murinum* (3.72% of total species), with a maximum cover of 20.8% in site Bab-Alah. The third most common species was *Lagoecia cuminoides* (2.13% of total species, with a maximum of 5.07% in site Dar-Dobat (Al-Bara) .

Among the shrub species, the one with highest coverage across the sites was *Sarcopoterium spinosum* (2.95% of total species), with a maximum of 14.93% in site Kafar Haya . The second most common shrub was *Asphodelus microcarpus* (1.49% of total species), with a maximum of 5.07% in site Mohanbel. For further details is referred to Appendix 2.

3.7.1.2. Tree plots

The tree species with on average the highest cover% in Jebel Zawia was *Quercus calliprinos* (37.08% of total species), with a maximum of 50.04% in site Al-Rame 50.04. The second most common tree species was *Quercus infectoria* (4.15% of total species), with a maximum of 13.6% in site Kafar Haya. The third most common was *Pistacia palaestina* (3.3% of total species), with a maximum of 6.8% in site Kafar Lata. For further details is referred to Appendix 3.

3.7.2. Jebel Wastani

3.7.2.1. Herbaceous plots

The herbaceous species with on average the highest cover% in Jebel Wastani was *Lagoecia cuminoides* (3.9% of total species), with a maximum of 6.47% in site Al-Daher. The second most common herbaceous species was *Trifolium stellatum* (3.28% of total species), with a maximum of 4% in site Oreba. The third most common was *Avena sterilis* (3.1% of total species), with a maximum of 6.4% recorded in site Maryameen.

Among the shrub species, the one with highest coverage across the sites was *Asphodelus microcarpus* (2.15% of total species), with a maximum of 5.2% in site Maryameen. For further details is referred to Appendix 4.

3.7.2.2. Tree plots

The tree species with on average the highest cover% in Jebel Zawia was *Quercus calliprinos* (25.53% of total species), with a maximum of 32% in site Maryameen. The second most common tree species was *Phillyrea latifolia* (10.47% of total species), with a maximum of 15.47% in the Al-Daher site. The third most common was *Pistacia palaestina* (3.63% of total species), with a maximum of 9.2% in site Al-Fasook. For further details is referred to Appendix 5.

3.8. Density

3.8.1. Jebel Zawia

3.8.1.1. Herbaceous plots

The herbaceous species with on average the highest density in Jebel Zawia was *Trifolium stellatum* with 20 plants/m^2, with a maximum of 50 plants/m^2 in site Al Rame, followed by site Dar-Dobat (Al-Bara) with 30 plants/m^2. The species with second highest density was *Hordeum murinum*, with 19 plants/$m^2$with a maximum density of 89 plants/m^2 in site Bab-Alah. The species with third highest density was *Avena sterilis* with 13 plants/m^2, and a maximum of 51 plants/m^2 in site Al Rame. For further details is referred to Appendix 6.

3.8.1.2. Tree plots

The tree species with on average the highest density in Jebel Zawia was *Quercus calliprinos* with 11 plants/100m^2, and a maximum of 13 plants/100m^2 in site Kafar Lata, followed by site Al-Rame with 12 plants/100m^2. The species with second highest density was *Phillyrea latifolia* with 3.3 plants/100m^2, and a maximum of 10 plants/100m^2 in site Al Ram. The species with third highest density was *Pistacia palaestina* with 3 plants/100m^2, with a maximum of 7 plants/100m^2 in site Kafar Lata. The shrub with the highest density was *Osyris alba* with 3.2 plants/100m^2, with a maximum of 6 plants/100m^2 in site Al Rame. For further details is referred to Appendix 7.

3.8.2. Jebel Wastani

3.8.2.1. Herbaceous plots

The herbaceous species with on average the highest density in Jebel Wastani was *Koeleria phleoides* with 17 plants/m^2,, with a maximum of 46 plants/m^2 in site Al-Daher, followed by site Oreba with 20 plants/m^2. The species with second highest density was *Lagoecia cuminoides*, with 12 plants/m^2, with a maximum 21 plants/m^2 in site Al-Daher. The species with third highest density was *Avena sterilis* with 11 plants/m^2, and a maximum of 23 plants/m^2 in site Maryameen. For further details is referred to Appendix 8.

3.8.2.2. Trees plots

The tree species with on average the highest density in Jebel Wastani was *Quercus calliprinos* with 11 plants/100m^2, and a maximum of 13 plants/100m^2 in site Al-Daher, followed by site Maryameen with 12.7 plants/100m^2. The species with second highest density was *Phillyrea latifolia* with 6 plants/100m^2, and a maximum of 11 plants/100m^2 in site Al Daher. The species with third highest density was *Pistacia palaestina* with 3 plants/100m^2, with a maximum of 8 plants/100m^2 in site Al-Fasook. The shrub with the highest density was *Osyris alba* with 6 plants/100m^2, with a maximum of 9 plants/100m^2 in site Maryameen. For further details is referred to Appendix 9.

3.9. Frequency %

3.9.1 Jebel Zawia

3.9.1.1 Herbaceous plots

The herbaceous species with on average the highest frequency in Jebel Zawia was *Trifolium stellatum* with 62.9%, with a maximum of 100% in site Kafar Haya, followed by site Al-Rame with 93.3%. The species with second highest frequency was *Lagoecia cuminoides*, with 58.1%, with a maximum frequency of 93.3% in site Dar-Dobat (Al Bara). The species with third highest frequency was *Caucalis tenella* with 50.5%, and a maximum frequency of 53.3% in site Kafar Lata. For other species is referred to Table 12.

Table 12. Rank of Frequency% of the best tenth herbs in Al-Zaweieh Mountain, (herbaceous plot)

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar-Dobat (Al-Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. ZH
1	*Trifolium stellatum*	66.7	100	93.3	86.7	40	0	53.3	62.9
2	*Lagoecia cuminoides*	80	6.7	73.3	93.3	20	66.7	66.7	58.1
3	*Caucalis tenella*	53.3	33.3	73.3	53.3	33.3	40	66.7	50.5
4	*Trifolium tomentosum*	80	13.3	73.3	40	33.3	13.3	60	44.8
5	*Lolium rigidum*	73.3	0	20	40	33.3	80	46.7	41.9
6	*Trifolium campestre*	60	6.7	73.3	60	13.3	0	60	39
7	*Trifolium pilulare*	40	13.3	0	80	66.7	0	73.3	39
8	*Trifolium scabrum*	53.3	13.3	60	26.7	46.7	0	73.3	39
9	*Avena sterilis*	40	46.7	80	60	0	13.3	6.7	35.2
10	*Poa bulbosa*	33.3	86.7	46.7	53.3	13.3	6.7	6.7	35.2

3.9.1.2 Tree plots

The tree species with on average the highest frequency in Jebel Zawia was *Quercus calliprinos* with 96.7%, and a maximum of 100% in sites Kafar Lata and Kafar Haya, followed by site Al-Rame with 93.3% The species with second highest frequency was *Pistacia palaestina* with 66.7%, and a maximum of 100% in sites Kafar Lata and Kafar Haya. The species with third highest frequency was *Phillyrea latifolia* with 61.7%, with a maximum of 86.7% in site Kafar Lata. The shrub with the highest frequency was *Osyris alba* with 51.7%, with a maximum of 73.3% in site Kafar Haya. For other species is referred to Table 13.

Table 13. Rank of frequency% of the best tenth trees in Jebel Zawia, (trees plot)

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar-Dobat (Al-Bara)	Average Zawia (trees)
1	*Quercus calliprinos*	100	100	93.3	93.3	96.7
2	*Pistacia palaestina*	100	100	6.7	60	66.7
3	*Phillyrea latifolia*	86.7	73.3	80	6.7	61.7
4	*Osyris alba*	46.7	73.3	66.7	20	51.7
5	*Quercus infectoria*	0	86.7	0	26.7	28.3
6	*Rhamnus palaestinus*	6.7	53.3	6.7	33.3	25
7	*Prunus microcarpa*	13.3	53.3	0	26.7	23.3
8	*Crataegus azarolus*	13.3	13.3	6.7	13.3	11.7
9	*Rosa conina*	0	33.3	0	6.7	10
10	*Asparagus acutifolius*	6.7	13.3	13.3	0	8.3

3.9.2. Jebel Wastani

3.9.2.1. Herbaceous plots

The herbaceous species with on average the highest frequency in Jebel Wastani was *Koeleria phleoides* with 17plants/m^2,, with a maximum of 46 plants/m^2 in site Al-Daher, followed by site Oreba with 20 plants/m^2. The species with second highest frequency was *Lagoecia cuminoides*, with 12 plants/m^2, with a maximum 21 plants/m^2 in site Al-Daher. The species with third highest frequency was *Avena sterilis* with 11 plants/m^2, and a maximum of 23 plants/m^2 in site Maryameen For other species is referred to Table 14.

Table 14. Rank of frequency% of the best tenth herbs in Jebel Wastani, (herbaceous plot)

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av. Wastani (herb)
1	*Caucalis tenella*	33.3	93.3	46.7	100	68.3
2	*Lagoecia cuminoides*	60	66.7	53.3	93.3	68.3
3	*Trifolium stellatum*	60	60	40	66.7	56.7
4	*Sonchus oleraceus*	40	66.7	46.7	66.7	55
5	*Trifolium scabrum*	53.3	33.3	66.7	60	53.3
6	*Torilis leptophylla*	60	26.7	53.3	73.3	53.3
7	*Avena sterilis*	60	53.3	66.7	13.3	48.3
8	*Bromus danthoniae*	33.3	46.7	40	46.7	41.7
9	*Trifolium campestre*	13.3	60	13.3	66.7	38.3
10	*Lolium rigidum*	66.7	46.7	13.3	20	36.7

3.9.2.2. Trees plots

The tree species with the highest frequency in Jebel Wastani was *Quercus calliprinos* with 100% across all sites. The species with second highest frequency was *Phillyrea latifolia* with 81.7%, and a maximum of 100% in sites Al-Fasook, Maryameen, and Al-Daher. The species with third highest frequency was *Rhamnus palaestinus* with 71.7%, with a maximum of 86.7% in sites Oreba and Al-Fasook. The shrub with the highest frequency was *Osyris alba* with 71.7%, with a maximum of 93.3% in sites Maryameen and Al-Daher. For other species is referred to Table 15.

Table 15. Rank of frequency% of the best tenth trees in Jebel Wastani, (trees plot)

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani (trees)
1	*Quercus calliprinos*	100	100	100	100	100
2	*Phillyrea latifolia*	26.7	100	100	100	81.7
3	*Rhamnus palaestinus*	86.7	86.7	20	93.3	71.7
4	*Osyris alba*	33.3	66.7	93.3	93.3	71.7
5	*Pistacia palaestina*	73.3	100	20	60	63.3
6	*Daphne oleifolia*	0	60	86.7	60	51.7
7	*Crataegus azarolus*	26.7	40	40	46.7	38.3
8	*Asparagus acutifolius*	46.7	20	6.7	20	23.3
9	*Cistus creticus*	0	0	80	0	20
10	*Olea europeae var. oleaster*	20	20	0	40	20

3.10 Height (m) and diameter (m) of adults trees and shrubs

3.10.1. Jebel Zawia

The highest tree height in Jebel Zawia across the 4 sites with trees and tree transects was achieved by a *Pyrus syriaca* 4.25 m, followed by *Olea europeae var. oleaster* 2.9m, *Quercus infectoria* 2.8 m, *Quercus libani* 2.6m, *Quercus calliprinos* 2.33m.
The highest tree diameter was achieved by a *Pyrus syriaca* 4.5m, followed by *Quercus calliprinos* 3.18m, *Olea europeae var. oleaster* 3.15m, *Quercus libani* 2.7m, *Quercus infectoria* 2.65m. For other species is referred to Table 16.

Table 16. Rank of average of 4 sites the height/m and diameter/m of trees and shrubs in Jebel Zawia, (trees plot)

Rank	Species	Height / m	Rank	Species	Diameter / m
1	*Pyrus syriaca*	4.25	1	*Pyrus syriaca*	4.5
2	*Olea europeae var. oleaster*	2.9	2	*Quercus calliprinos*	3.18
3	*Quercus infectoria*	2.8	3	*Olea europeae var. oleaster*	3.15
4	*Quercus libani*	2.6	4	*Quercus libani*	2.7
5	*Quercus calliprinos*	2.33	5	*Quercus infectoria*	2.65
6	*Amygdalus orientalis*	2.23	6	*Pistacia palaestina*	2.01
7	*Phillyrea latifolia*	1.9	7	*Phillyrea latifolia*	1.77
8	*Pistacia palaestina*	1.89	8	*Rhamnus palaestinus*	1.6
9	*Crataegus azarolus*	1.88	9	*Amygdalus orientalis*	1.38
10	*Ficus carica*	1.7	10	*Crataegus azarolus*	1.25
11	*Rhamnus palaestinus*	1.6	11	*Prunus microcarpa*	1.10
12	*Prunus microcarpa*	1.43	13	*Ficus carica*	0.9
13	*Rhus coriaria*	0.75	13	*Rhus coriaria*	0.62

3.10.2. Jebel Wastani

The highest tree height in Jebel Wastani across the 4 sites and tree transects was achieved by a *Olea europeae var. oleaster* 3.28 m, followed by *Quercus infectoria* 2.48m, *Quercus calliprinos* 2.47, *Styrax officinalis* 2.45m.
The highest tree diameter was achieved by a *Quercus infectoria* 3.35, followed by *Olea europeae var. oleaster* 2.93, *Styrax officinalis* 2.78 m, *Quercus calliprinos* 2.53m. For other species is referred to Table 17.

Table 17. Rank of average of 4 sites, the height/m and diameter/m of trees and shrubs in Jebel Wastani, (trees plot)

Rank	Species	Height / m	Rank	Species	Diameter / m
1	*Olea europeae var. oleaster*	3.28	1	*Quercus infectoria*	3.35
2	*Quercus infectoria*	2.48	2	*Olea europeae var. oleaster*	2.93
3	*Quercus calliprinos*	2.47	3	*Styrax officinalis*	2.78
4	*Styrax officinalis*	2.45	4	*Quercus calliprinos*	2.53
5	*Laurus nobilis*	2.32	5	*Crataegus azarolus*	2.3
6	*Phillyrea latifolia*	2.15	6	*Pistacia palaestina*	2.05
7	*Pistacia palaestina*	1.88	7	*Laurus nobilis*	1.89
8	*Crataegus azarolus*	1.71	8	*Phillyrea latifolia*	1.87
9	*Rhamnus palaestinus*	1.38	9	*Rhamnus palaestinus*	1.25
10	*Daphne oleifolia*	1.06	10	*Daphne oleifolia*	1.13

4. Economic uses of plants in the project area

The target areas have a rich biodiversity and can be considered a source of natural products and free biological resource that provide income for the rural poor and on which they can depend for food, feed, fuel, medicine, clothing and shelter. Some plants have multiple uses (Table 18).

Table 18. Multi-functional use of major plants in the target areas

Species	Medicinal	Aromatic	Honey Production	Ornamental	Wood	Forage	Industrial Purposes	Foods
Styrax officinalis Snow drop bush	√	√	√	√	√	√	√	
Laurus nobilis Laurel	√	√	√	√			√	√
Crataegus azarolus Hawthorn	√		√		√	√	√	√
Pistacia palaestina Terebinth	√			√	√	√	√	√
Rhus coriaria Sumac	√		√	√		√	√	√
Quercus calliprinos Palestine Oak	√				√	√	√	√
Amygdalus orientalis Wild almond	√	√	√				√	√
Capparis spinosa Capers	√		√			√	√	√

The following specific classes and subclasses for economic plant uses are according to GRIN (see references) and were modified from Cook 1995:

4.1. Animal food (fodder and forage)

Most the pastures of the target area are rich with high palatable legumes species (*Trifolium stellatum*, *Trifolium campestre, Trigonella filipes, Vicia palaestina* and *Medicago rigidul),* palatable grasses such as *Avena sterilis, Lolium rigidum, Koeleria phleoides, Hordeum bulbosum* and *Bromus danthoniae*, and palatable trees especially for goats, such as *Quercus calliprinos, Crataegus azarolus* and *Pistacia palaestina.*

4.2. Bee plants (honey)

There are plenty of species producing nectar that attracts honey bees, such as:

- herbs (*Trifolium* spp., *Euphorbia exigua* and *Sinapis arvensis*),
- shrubs (*Thymus syriacus, Capparis spinosa and Onopordum heteracanthum* and *Asphodelus microcarpus*), and
- trees (*Crataegus azarolus, Styrax officinalis, Pyrus syriaca* and *Prunus microcarpa)*

The beekeepers install the beehives in the Jebels in spring (Fig. 30).

Fig 30 Bee-hives in Jebel Zawia

4.3. Environmental uses

4.3.1. Afforestation:

The best native trees species to be used for afforestation are *Crataegus azarolus, Amygdalus orientalis, Pyrus syriaca, Cerasus mahaleb* and *Lycium depressum.*

4.3.2. Environmental indicators:

Some species are good indicators of degradation, such as thistles (*Centaurea iberica, Echinops polyceras*, *Onopordum heteracanthum, Noaea mucronata*) and poisonous plants (*Ballota saxatilis, Dianthus multipunctatus*, *Peganum harmala*, *Asphodelus microcarpus*) (Fig. 31).

Centaurea iberica

Onopordum heteracanthum

Noaea mucronata

Asphodelus microcarpus

Peganum harmala

Ballota saxatilis

Figure 31 Some indicators species of degradation

Some species are indicators of rocky areas, e.g. *Micromeria myrtifolia, Ajuga chia* and *Umbilicus intermedius* (Fig.32).

Ajuga chia

Umbilicus intermedius

Micromeria myrtifolia

Fig. 32 Some indicators of rocky areas

4.3.3. Hedge:

The most common native trees species for use as hedges are *Crataegus azarolus, Amygdalus orientalis, Lycium depressum* and *Rhus coriaria.*

4.3.4. Erosion control:

In addition to trees, there are many shrubs species used for erosion control, such as *Sarcopoterium spinosum, Capparis spinosa, Lycium depressum, Rhamnus palaestinus, Rhus coriaria, Amygdalus orientalis and Noaea mucronata.*

4.3.5. Soil improvement:

Both herb and shrub legumes improve soil fertility by nitrogen fixation, such as *Trifolium spp, Medicago spp., Astragalus spp.., Trigonella spp* and *Vicia spp.*

4.3.6. Graft stock:

Many native trees are used as a graft stock for some planted species such as:

- *Crataegus azarolus* is a graft stock for Pear
- *Olea europeae var. oleaster* is a graft stock for Olive
- *Prunus microcarpa* is a graft stock for Plum
- *Pistacia palaestina* is a graft stock for Pistachio
- *Ficus carica* is a graft stock for Fig
- *Amygdalus orientalis* is a graft stock for Almond
- *Pyrus syriaca* is a graft stock for Pear and Apple
- *Cerasus mahaleb* is a graft stock for Cherry

Crataegus azarolus

Prunus microcarpa

Amygdalus orientalis

Pyrus syriaca

Fig. 33 Some common species used as graft stock

4.3.7 Shade / Shelter:

Common shade trees are *Pistacia palaestina, Quercus infectoria, Quercus calliprinos and Laurus nobilis.*

4.4. Use as food

4.4.1. Beverage base:

The resin of *Pistacia palaestina* is used as a tonic drink and the extract of the roots of *Glycyrrhiza glabra* is used as a drink**.**

4.4.2 Fruits:

The main species, used as a fruit are *Amygdalus orientalis, Crataegus azarolus, Ficus carica, Pistacia palaestina, Pyrus syriaca* and *Rhus coriaria*

4.4.3 Oil:

Oil is extracted from the seeds of herbaceous species *Brassica nigra* and *Sinapis arvensis*.

4.4.4 Leaves:

The main herb species with edible leaves are *Cichorium pumilum, Gundelia tournefortii.* The main shrub species is *Thymus syriacus* (Fig 34).

Cichorium pumilum

Gundelia tournefortii

Thymus syriacus

Fig. 34 Species of which leaves are used as food

4.4.5 Fungi:

Collection of mushrooms in the forest occurs in early spring

4.5. Use as food additive

4.5.1 Emulsifier:

The roots of *Gypsophila struthium* can be used to extract, after boiling with water, an emulsifier to add to Halaweh (special sweet) (Fig. 35).

4.5.2 Flavoring:

Orchis mascula is a source of Sahlep, a white powder that is obtained by drying the tuber and grinding it into a powder that is mixed with milk (Fig 36).

Fig. 35 Roots of *Gypsophila struthium*

Fig. 36 Tuber of *Orchis mascula*

4.6. Use as fuel

4.6.1 Charcoal:

Charcoal is produced from different trees such as olives after pruning and *Quercus calliprinos* (Fig.37)

4.6.2 Fuel wood:

The following species are used as fuel wood: *Quercus calliprinos, Pistacia palaestina* and *Rhamnus palaestinus*.

Fig 37 different resources of charcoal

4.7. Industrial uses

4.6.1 Dye:

The bark of *Quercus calliprinos* and the leaves of *Rhus coriaria* are used in tanning (Fig. 38)

Fig. 38 Leaves of *Rhus coriaria*

4.7.2 Carpentry:

The wood of *Pistacia palaestina, Laurus nobilis*, *Arbutus andrachne*, *Laurus nobilis* and *Olea europeae var. oleaster* are used in carpentry.

4.7.3 Soap:

The oil which is extracted from the fruits of *Laurus nobilis* is mixed with olive oil to make Al-Ghar soap. The emulsifier extracted from the roots of *Gypsophila struthium* is also in some soaps (Fig. 39).

Fig. 39 Fruit of *Laurus nobilis* and Al-Ghar soap

4.7.4 Pickles:

The flower buds of *Capparis spinosa* are collected by rural communities to make pickles for selling on the market (Fig.40).

Fig. 40 Flower-buds of *Capparis spinosa* and samples of pickles

4.7.5 Cosmetics:

The oil of *Amygdalus orientalisusing* is used for skin care, *Matricaria chamomilla* for shampoo and creams.

4.7.6 Traditional handicraft:

The rural community uses the stems of wheat and oat to make straw plates (Fig. 41).

Fig. 41 Some traditional handicraft

4.8 Aromatic plants

The most common aromatic plants are *Pistacia palaestina, Amygdalus orientalis, Styrax officinalis* and *Laurus nobilis.*

4.9-Ornamental plants:

Figure 42 shows examples of use of plants, such as *Lonicera orientalis, Alcea digitata, Iris aucheri, Cistus creticus* for ornamental uses.

Lonicera orientalis *Alcea digitata* *Iris aucheri* *Cistus creticus*

Fig. 42 Ornamental plants

4.10. Medicinal plants

Table 19 lists plants occurring in the project area that have medicinal uses (Fig. 43)

Table 19. The most common medicinal plants in Jebel Zawia and Jebel Wastani

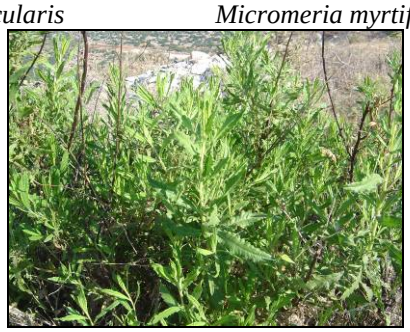
Species	**Part used**	**Uses**
Quercus calliprinos	Bark	Anti-diarrhea, treatment of eczema
Pistacia palaestina	Fruits and seeds	Sedative, anti-asthma
Crataegus azarolus	Flowers and fruits	Strengthens the heart, hypertension
Amygdalus orientalis	Fruits	Oil for skin care
Styrax officinalis	Flowers	Cough, antispasmodic
Olea europeae var. oleaster	Leaves and fruits	Diuretic, laxative, against hypertension
Rhus coriaria	Leaves and fruits	Diuretic, anti-diarrhea, vitamin C
Thymus syriacus	Leaves	Headaches, asthma, cough
Capparis spinosa	Roots, flower's bud, fruits	Rheumatism, anti-diarrhea, diuretic
Ephedra peduncularis	Leaves	Cough, anti-asthma
Eryngium creticum	Flower's herb	Sleeplessness, rheumatism
Gundelia tournefortii	Fresh stem	Tonic for liver, enhances gall excretion
Inula viscosa	Flowered branches	Anti-parasites, anemia
Micromeria myrtifolia	Leaves and flowers	Asthma, throat inflammation
Cichorium pumilum	Roots and leaves	Activate the liver and kidney

Styrax officinalis

Ephedra peduncularis

Micromeria myrtifolia

Eryngium creticum



Inula viscosa

Fig. 43 Some medicinal plants

4.11 Non-vertebrate poisons (pesticide)

Inuline is extracted from the leaves of *Inula viscose* for use as insecticide.

4.12 Vertebrate poisons

The seeds of *Styrax officinalis* are used as fish bait.

5. Conclusions

The family Leguminosea contains the highest diversity in species numbers in comparison with other families (23% of total species). This family is considered to contain good pasture plants with excellent palatability for sheep, while at the same time improving soil fertility. The distribution of this family in many sites is indicator of its adaptation to different conditions.

The second dominant family are the Graminae (12% of total species), which also contain highly palatable species, and are dominant in some sites where the legumes disappeared, such as the Kokfen site in Jebel Zawia and the Fasook site in Wastani.

In herbaceous plots the annual species were dominant, with 63% of total species, while the perennial species included 35% of total species.
The herbaceous plant community in Jebel Zawia is *Trifolium stellatum* and *Lolium rigidum*, whereas in Jebel Wastani it is *Lagoecia cuminoides* and *Trifolium stellatum*
The trees plant community in Jebel Zawia is *Quercus calliprinos* and *Pistacia palaestina*, whereas in Jebel Wastani it is *Quercus calliprinos* and *Phillyrea latifolia*.
The range of vegetation cover% of herbaceous plants in Jebel Zawia is 46% - 76%, whereas in Jebel Wastani it is 62% - 77%.
The range of vegetation cover% of trees in Jebel Zawia is 37% - 65%, while in Jebel Wastani (39% - 59%.
In some sites (Mohanbel, Kokfeen and Bab-Alah in Jebel Zawia) the trees and palatable herbaceous species for sheep have disappeared due to wood-cutting and grazing. These sites need replanting by adapted trees, and reseeding with mixed legumes and grasses.

The project area is rich with plant biodiversity, diverse in economic uses and offering good possibilities to add to rural livelihoods. Hence more efforts are needed by rural communities and the Ministry of Agriculture and Agrarian Reform to protect, manage, conserve, and improve this biodiversity for its sustainable use by rural communities.

6. Recommendations for follow-up

A management plan is required for the conservation of the biodiversity in the project area. Key studies needed to develop such plan are (i) the compilation of a list of species that may be under threat, and (ii) research on the environmental conditions required for optimal growth of the species.

As general principles for managing the biodiversity in the project area, the following is recommended:

- To give local communities access to traditionally utilized species without depleting the target area.
- To involve local communities in the conservation of the natural resources and managing the grazing areas
- To collect endangered germplasm
- To plant fodder trees and shrubs to provide much needed animal feed and firewood.
- To plant adapted and palatable grasses and legumes in the degraded area
- To cultivate medicinal, industrial, aromatic, food plants as domesticated crops.
- To formulate a clear policy for protection, production, transport and marketing of economic plants.

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Appendix 1

List of species in herbaceous and tree plots in Jebel Zawia and Jebel Wastani

No.	Species	Author	Family	Arabic name	Life form	Biotype
1	*Adonis aestivalis*	L.	Ranunculaceae	دحنون	A	H
2	*Adonis annua*	L.	Ranunculaceae	الدحنون	A	H
3	*Aegilops geniculata*	Roth	Gramineae	حشيشة الماعز	A	H
4	*Aegilops ovata*	L.	Gramineae	حشيشة الماعز	A	H
5	*Aegilops triuncialis*	L.	Gramineae	حشيشة الماعز	A	H
6	*Ainsworthia trachycarpa*	Boiss.	Umbelliferae		A	H
7	*Ajuga chia*	Schreb.	Labiatae	عشبة الدم	P	H
8	*Ajuga orientalis*	L.	Labiatae	عشبة الدم	P	H
9	*Alhagi maurorum*	Medik.	Leguminosae	عاقول مغربي	P	S-Sh
10	*Allium scorodoprasum*	L.	Alliaceae	بصل بري , زعيتمان	P	H
11	*Allium stamineum*	Boiss.	Alliaceae	بصل بري	P	H
12	*Alopecurus utriculatus*	Banks & Sol.	Gramineae	ذنب الثعلب	A	H
13	*Alyssum damascenum*	Boiss.et Gaill.	Cruciferae	دريهمة دمشقية	A	H
14	*Alyssum minus*	(L.) Rothm.	Cruciferae	دريهمة صغيرة	A	H
15	*Amygdalus orientalis*	Duh.	Rosaceae	لوز بري	P	H-Sh
16	*Anagallis arvensis*	L.	Primulaceae	خزام العروس, اذان الفار	A	H
17	*Anagyris foetida*	L.	Leguminosae	خروب الخنزير	P	S-Sh
18	*Anchusa strigosa*	Banks & Sol.	Boraginaceae	لسان الثور	P	H
19	*Andrachne telephioides*	L.	Euphorbiaceae	بذر الدود	P	H
20	*Anemone coronaria*	L.	Ranunculaceae	انيمون	P	H
21	*Anthemis cornucopiae*	Boiss.	Compositae	زهرة اللبن , اربيان	A	H
22	*Anthemis cotula*	L.	Compositae	زهرة اللبن , اربيان	A	H
23	*Anthemis maris-mortui*	Eig	Compositae	زهرة اللبن , اربيان	A	H
24	*Arabis aucheri*	Boiss.	Cruciferae	زهرة عربية	A	H
25	*Arbutus andrachne*	L.	Ericaceae	قطلب	P	T
26	*Aristolochia maurorum*	L.	Aristolochiaceae	خيار الغنم	P	H
27	*Artedia squamata*	L.	Umbelliferae		A	H
28	*Arum palaestinum*	Boiss.	Araceae	اللوف	P	H
29	*Asparagus acutifolius*	L.	Asparagaceae	الهليون	P	S-Sh
30	*Asphodeline lutea*	(L.) Reichenb..	Asphodelaceae	ابو صوي	P	H
31	*Asphodelus microcarpus*	Salzm. & Viv.	Asphodelaceae	عيصلان	P	H
32	*Astragalus asterias*	Steven	Leguminosae	قفعاء متصالبة	A	H
33	*Astragalus hamosus*	L.	Leguminosae	قفعاء شصية	A	H
34	*Astragalus palaestinus*	Eig	Leguminosae	قفعاء فلسطينية	A	H
35	*Atractylis cancellata*	L.	Compositae	جلوة متحابكة	A	H
36	*Avena barbata*	Pott ex link	Gramineae	شوفان لحوي	A	H
37	*Avena sterilis*	L.	Gramineae	شوفان عقيم	A	H
38	*Ballota saxatilis*	Sieb.ex C. Presl	Labiatae	بلوتا	P	S-Sh
39	*Bellevalia flexuosa*	Boiss.	Hyacinthaceae	بصيل متدلي	P	H
40	*Bellevalia stepporum*	Feinbr.	Hyacinthaceae	بصيل	P	H
41	*Bifora testiculata*	(L.) Spreng.ex Schult.	Umbelliferae	كزبرة صغيرة	A	H
42	*Biscutella didyma*	L.	Cruciferae	خردل منحني, مشبك	A	H
43	*Biserrula pelecinus*	L.	Leguminosae		A	H
44	*Bituminaria bituminosa*	(L.) Stirton.	Leguminosae		P	H
45	*Bolanthus filicaulis*	(Boiss.) Barkoudah	Caryophyllaceae		P	H
46	*Bongardia chrysogonum*	(L.) Sp.	Berberidaceae		P	H
47	*Brassica nigra*	(L.) Koch	Cruciferae	خردل اسود	A	H
48	*Briza maxima*	L.	Gramineae	ابريزة, قصفة	A	H
49	*Bromus alopecuros subsp. caroli-henrici*	(Greuter) P. M. Smith	Gramineae	شويعرة	A	H
50	*Bromus danthoniae*	Trin.	Gramineae	شويعرة	A	H
51	*Bromus diandrus*	Roth	Gramineae	شويعرة	A	H
52	*Bromus lanceolatus var. lanatus*	kergue'len	Gramineae	شويعرة مستدقة	A	H
53	*Bromus tectorum*	L.	Gramineae	شويعرة	A	H
54	*Bryonia cretica*	L.	Cucurbitaceae	قريعة الشيخ	P	C-H
55	*Bupleurum brevicaule*	Schlecht.	Umbelliferae	حلوان	A	H
56	*Calendula arvensis*	L.	Compositae	اقحوان بري	A	H
57	*Callipeltis cucullaria*	(L.) Stev.	Rubiaceae		A	H

No.	Species	Author	Family	Arabic name	Life form	Biotype
58	*Calycotome villosa*	(Poir.) Link.	Leguminosae	الجربان	P	S-Sh
59	*Campanula erinus*	L.	Campanulaceae	جرسية	A	H
60	*Campanula strigosa*	Banks & Sol.	Campanulaceae	زهرة الجرس الشوكية	A	H
61	*Capparis spinosa*	L.	Capparaceae	القبار, الشفلح	P	H-Sh
62	*Capsella bursa-pastoris*	(L.) Medik.	Cruciferae	كيس الراعي	A	H
63	*Carduncellus eriocephalus*	Boiss.	Compositae		P	H
64	*Carduus pycnocephalus*	(Jacq.) Boiss.	Compositae	لسان الكلب	A	H
65	*Carex stenophylla*	Wahlenb. B.	Cyperaceae	نميص	P	H
66	*Carthamus persicus*	Willd.	Compositae	عصفر فارسي	A	H
67	*Catapodium rigidum*	(L.) C. E. Hubbard	Gramineae		A	H
68	*Caucalis tenella*	Del.	Umbelliferae		A	H
69	*Centaurea iberica*	Trev.ex Spreng	Compositae	مرار	B	H
70	*Centaurea pallescens*	Del.	Compositae	دردار, مرار	A	H
71	*Cerasus avium*	L. Moench	Rosaceae	كرز	P	T
72	*Cerasus mahaleb*	(L.) Mill.	Rosaceae	المحلب	P	T
73	*Ceratocephala falcata*	(L.) Pers.	Ranunculaceae	خشينة منجلية	A	H
74	*Chardinia orientalis*	(L.) O. Kuntze	Compositae	كارديتيا	A	H
75	*Cichorium pumilum*	Jacq.	Compositae	هندباء برية	A	H
76	*Cistus creticus*	L.	Cistaceae	قريضة , لباد	P	S-Sh
77	*Clematis cirrhosa*	L.	Ranunculaceae	مدادة	P	C-Sh
78	*Convolvulus dorycnium*	L.	Convolvulaceae	مداد بنفسجي	P	H
79	*Coronilla rostrata*	Boiss. et Sprun.	Leguminosae	قرينة منقارية	A	H
80	*Coronilla scorpioides*	(L.) Koch	Leguminosae	قرينة عقربية	A	H
81	*Crataegus azarolus*	L.	Rosaceae	زعرور بري	P	T
82	*Crepis sancta*	(L.) Bornm.	Compositae	حلاوى	A	H
83	*Crucianella ciliata*	Lam.	Rubiaceae	لامة	A	H
84	*Crucianella latifolia*	L.	Rubiaceae	هزيل	A	H
85	*Cruciata articulata*	(L.) Ehrendf.	Rubiaceae		A	H
86	*Crupina crupinastrum*	(Moris) Vis.	Compositae	كروبينا	A	H
87	*Cynodon dactylon*	(L.) Pers.	Gramineae	النجيل الأصبعي	P	H
88	*Cynosurus elegans*	Desf.	Gramineae	ذنب الكلب	A	H
89	*Dactylis glomerata*	L.	Gramineae	اصبعية متكتلة	P	H
90	*Daphne oleifolia*	Lam.	Thymelaeaceae	فسفوسة العنزة, دفنة زيتونية	P	H-Sh
91	*Dianthus strictus*	Banks & Sol.	Caryophyllaceae	قرنفل بري	P	H
92	*Echinaria capitata*	(L.) Desf.	Gramineae	عشب خشن, شانك	A	H
93	*Echinops gaillardotii*	Boiss.	Compositae	شوك الجمال	P	H
94	*Echinops polyceras*	Boiss.	Compositae	شوك الجمال الأزرق	P	H
95	*Eminium spiculatum*	(Blume.) Schott.	Araceae	امينون سنيبلي	P	H
96	*Ephedra peduncularis*	Boiss.	Ephedraceae	علندى	P	C-SH
97	*Erodium cicutarium*	(L.) L' He'r.	Geraniaceae	ابرة العجوز, البختري	A	H
98	*Erodium gruinum*	(L.) L' He'r.	Geraniaceae	قرنوة	A	H
99	*Erodium subintegrifolium*	Eig	Geraniaceae	قرنوة	A	H
100	*Eryngium creticum*	Lam.	Umbelliferae	قرصعنة , شنداب صحراوي	P	H
101	*Eryngium glomeratum*	Lam.	Umbelliferae	قرصعنة , شنداب صحراوي	P	H
102	*Euphorbia aleppica*	L.	Euphorbiaceae	لبينة	A	H
103	*Euphorbia densa*	Schrenk	Euphorbiaceae	لبينة	A	H
104	*Euphorbia exigua*	L.	Euphorbiaceae	لبينة	A	H
105	*Euphorbia helioscopia*	L.	Euphorbiaceae	لبينة	A	H
106	*Euphorbia reuteriana*	Boiss.	Euphorbiaceae	لبينة	A	H
107	*Fibigia clypeata*	(L.) Medik.	Cruciferae	درهمية	P	H
108	*Ficus carica*	L.	Moraceae	تين بري	P	T
109	*Filago contracta*	(Boiss.) Chrteh & Holub	Compositae	قطينة	A	H
110	*Filago pyramidata*	L.	Compositae	قطينة هرمية	A	H
111	*Gagea chlorantha*	(Bieb.) Schult. & Schult.fil.	Liliaceae	لحية التيس	P	H
112	*Galium aparine*	L.	Rubiaceae	دبيقة	A	H
113	*Galium hierochuntinum*	Bornm.	Rubiaceae	دبيقة	A	H
114	*Galium setaceum*	Lam.	Rubiaceae	دبيقة مخرزية	A	H
115	*Geranium columbinum*	L.	Geraniaceae	غرنوق	A	H
116	*Geranium tuberosum*	L.	Geraniaceae	غرنوق	P	H
117	*Geropogon hybridus*	(L.) Sch. Bip.	Compositae	ذيل الفرس	P	H

No.	Species	Author	Family	Arabic name	Life form	Biotype
118	*Gladiolus aleppicus*	Boiss.	Iridaceae	سيفية حلبية	P	H
119	*Gundelia tournefortii*	L.	Compositae	سلبين	P	H
120	*Gynandriris sisyrinchium*	(L.) Parl.	Iridaceae	سوسن البادية	P	H
121	*Hedypnois rhagadioloides*	(L.) F.W.Schmidt emend.spreng	Compositae		A	H
122	*Helianthemum salicifolium*	(L.) Mill.	Cistaceae	جردة الكمأة	A	H
123	*Herniaria hisuta*	L.	Illecebraceae	ام لبيدة	A	H
124	*Hippocrepis unisiliquosa*	L.	Leguminosae	حدويات	A	H
125	*Hirschfeldia incana*	(L.) Lagreze-Fossat	Cruciferae	هرشفيلديا	A	H
126	*Hordeum bulbosum*	L.	Gramineae	شعير بصيلي	P	H
127	*Hordeum glaucum*	Steud.	Gramineae	شعير بري	A	H
128	*Hordeum murinum*	L.	Gramineae	ابو شويرب	A	H
129	*Hordeum spontaneum*	C. Koch	Gramineae	شعير بري (عفوي)	A	H
130	*Hordeum vulgare*	L.	Gramineae	شعير مزروع	A	H
131	*Hymenocarpos circinatus*	(L.) Savi	Leguminosae	نفل مدور	A	H
132	*Hypecoum procumbens*	L.	Papaveraceae	بربارة	A	H
133	*Hypericum triquetrifolium*	Turra	Guttiferae	هيبريكم ثلاثي الاوراق	P	H
134	*Iberis odorata*	L.	Cruciferae	قضامة الحمامة	A	H
135	*Inula viscosa*	(L.) Ait.	Compositae	طيون	P	S-Sh
136	*Iris histrio*	Reichenb.fil.	Iridaceae	سوسن	P	H
137	*Juniperus oxycedrus*	L.	Cupressaceae	شربين, عرعر شربيني	P	T
138	*Koeleria phleoides*	(Vill.) Pers.	Gramineae	قنبوع	A	H
139	*Lactuca serriola*	L.	Compositae	خسيس	P	H
140	*Lactuca tuberosa*	Jacq.	Compositae	خسيس	B	H
141	*Lagoecia cuminoides*	L.	Umbelliferae	حشيشة الذهب	A	H
142	*Lathyrus aphaca*	L.	Leguminosae	جلبان	A	H
143	*Lathyrus blepharicarpus*	Boiss.	Leguminosae	جلبينة	A	H
144	*Lathyrus cicera*	L.	Leguminosae	جلبان	A	H
145	*Lathyrus digitatus*	(M.Bieb.) Foiri	Leguminosae	جلبان	A	H
146	*Lathyrus hierosolymitanus*	Boiss.	Leguminosae	جلبان	A	H
147	*Lathyrus marmoratus*	Boiss. & Blanche	Leguminosae	جلبان	A	H
148	*Laurus nobilis*	L.	Lauraceae	الغار	P	T-T
149	*Lens ervoides*	(Brignoli) Grande	Leguminosae	عدس بري	A	H
150	*Lens orientalis*	(Boiss.) Schmalh.	Leguminosae	عدس بري	A	H
151	*Leopoldia comosa*	(L.) Parl.	Hyacinthaceae	بصيل ازرق شائع	P	H
152	*Leopoldia eburnea*	Eig & Feinbr.	Hyacinthaceae	بصيل ازرق	P	H
153	*Lepidium spinescens*	DC.	Cruciferae	رشاد بري	A	H
154	*Linaria joppensis*	Bornm.	Scrophulariaceae	حلاوة	A	H
155	*Linum pubescens*	Banks et Sol.	Linaceae	كتان مزغب	A	H
156	*Linum strictum*	L.	Linaceae	كتان بري	A	H
157	*Lobularia libyca*	(Viv.) C. F. W. Meissn.	Cruciferae		A	H
158	*Lolium rigidum*	Gaudin	Gramineae	حشيشة الشيلم	A	H
159	*Lonicera orientalis*	Lam.	Caprifoliaceae	العسلة (عراتلي شرقي)	P	C-Sh
160	*Lotus halophilus*	Boiss. & Sprun.	Leguminosae	رجل العصفور	A	H
161	*Lycium depressum*	Stocks	Solanaceae	العوسج	P	H-Sh
162	*Medicago aculeata var. aculeata*	Gaertn.	Leguminosae	نفل شوكي	A	H
163	*Medicago blancheana var. blancheana*	Boiss.	Leguminosae	نفل ابيض	A	H
164	*Medicago blancheana var. bonarotiana*	(Arc.) Arc.	Leguminosae	نفل ابيض	A	H
165	*Medicago constricta*	Dur.	Leguminosae	نفل متراص	A	H
166	*Medicago coronata*	(L.) Bart.	Leguminosae	نفل تاجي	A	H
167	*Medicago laciniata*	(L.) Miller.	Leguminosae	نفل مفصص الاوراق	A	H
168	*Medicago minima var. minima*	(L.) Bart.	Leguminosae	نفل الصغير القرون	A	H
169	*Medicago orbicularis f. marginata*	(L.) Bart.	Leguminosae	النفل الزري	A	H
170	*Medicago polymorpha var. polymorpha*	L.	Leguminosae	نفل متعدد الاشكال	A	H
171	*Medicago polymorpha var. vulgaris*	(Benth.) Shinners	Leguminosae	نفل متعدد الاشكال	A	H
172	*Medicago radiata*	L.	Leguminosae	نفل شعاعي	A	H
173	*Medicago rigidula var. agrestis*	Burnat	Leguminosae	نفل قاسي	A	H
174	*Medicago rigidula var. cinerascens*	(Jord.) Rouy	Leguminosae	نفل قاسي	A	H
175	*Medicago rigidula var. rigidula*	(L.) All.	Leguminosae	نفل قاسي	A	H
176	*Medicago rigidula var. submitis*	(Boiss.) Heyn	Leguminosae	نفل قاسي	A	H
177	*Medicago turbinata var. turbinata*	(L.)All.	Leguminosae	نفل توربيني القرون	A	H

No.	Species	Author	Family	Arabic name	Life form	Biotype
178	*Melica cupani*	Guss.	Gramineae		P	H
179	*Mercurialis annua*	L.	Euphorbiaceae	حلبلوب, خسة	A	H
180	*Micromeria myrtifolia*	Boiss. & Hohen.	Labiatae	شاي بري (زوفا)	P	S-Sh
181	*Minuartia decipiens*	(Fenzl) Bornm.	Caryophyllaceae	ابو حريبة زهري	A	H
182	*Muscari racemosum*	(L.) Mill.	Hyacinthaceae	كحلة الكلب, اجراس زرقاء	P	H
183	*Nardurus maritimus*	(L.)	Gramineae		A	H
184	*Nigella unguicularis*	(Poir.) Spenn.	Ranunculaceae	حبة سوداء	A	H
185	*Noaea mucronata*	(Forssk.) Asch. & Schweinf.	Chenopodiaceae	الصر	P	S-Sh
186	*Notobasis syriaca*	(L.) Cass.	Compositae	الخرفيش الكبير	A	H
187	*Olea europeae*	L.	Oleaceae	زيتون مزروع	P	T
188	*Olea europeae var. oleaster*	(Hoffmgg. & Link) D. C	Oleaceae	زيتون بري	P	H-Sh
189	*Onobrychis aequidentata*	(Sm.) Urv.	Leguminosae	قطب متساوي التسنن	A	H
190	*Onobrychis caput-galli*	(L.) Lam.	Leguminosae	قطب راس الديك	A	H
191	*Onobrychis crista-galli*	(L.) Lam.	Leguminosae	قطب عرف الديك	A	H
192	*Ononis antiquorum*	L.	Leguminosae	الشبرق	P	S-Sh
193	*Ononis natrix*	L.	Leguminosae	شبرق اصفر, نشيحة	P	S-Sh
194	*Ononis reclinata*	L.	Leguminosae	شبرق	A	H
195	*Ononis sicula*	Guss.	Leguminosae	اللتين السيسلي	A	H
196	*Ononis viscosa*	L.	Leguminosae	شبرق	A	H
197	*Onopordum heteracanthum*	C.A.Mey.	Compositae	قندريس	B	H
198	*Orchis sancta*	L.	Orchidaceae	الأوركيد المقدس	P	H
199	*Orlaya daucoides*	(L.) Greuter	Umbelliferae		A	H
200	*Ornithogalum divergens*	Boreau	Hyacinthaceae	لبن الطير	P	H
201	*Oryzopsis miliacea*	(L.) Aschers. & Schweinf.	Gramineae	حشيشة رزية ناعمة	P	H
202	*Osyris alba*	L.	Santalaceae	خصوميا	P	S-Sh
203	*Pallenis spinosa*	(L.) Cass.	Compositae	بخور مريم	A	H
204	*Papaver polytrichum*	Boiss.et Ky.	Papaveraceae	شقشقيق	A	H
205	*Papaver rhoeas*	L.	Papaveraceae	شقائق النعمان	A	H
206	*Parentucellia flaviflora*	(Boiss.) Nevski	Scrophulariaceae		A	H
207	*Paronychia palaestina*	Eig	Illecebraceae	حربث فضي (علك الغزال)	P	H
208	*Peganum harmala*	L.	Zygophyllaceae	حرمل	P	S-Sh
209	*Phagnalon barbeyanum*	Aschers.et Schweinf.	Compositae	طعام الأرنب	P	S-Sh
210	*Phalaris minor*	Retz.	Gramineae	مجنحة صغرى	A	H
211	*Phillyrea latifolia*	L.	Oleaceae	الزرود- بجس	P	S-T
212	*Phleum subulatum*	(Savi) Aschers. & Graebn.	Gramineae	عصوية	A	H
213	*Phlomis orientalis*	Mill.	Labiatae	اللهيب	P	S-Sh
214	*Phlomis platystegia*	Post	Labiatae	لهيب	P	S-Sh
215	*Phlomis syriaca*	Boiss.	Labiatae	لهيب	P	S-Sh
216	*Picnomon acarna*	(L.) Cass.	Compositae	شوك الفار, شوك ابيض	A	H
217	*Picris damascena*	Boiss. & Gaill.	Compositae	حوذان دمشقي	A	H
218	*Pimpinella eriocarpa*	Banks et Sol.	Umbelliferae	انيسون صوفي الثمر	A	H
219	*Pinus pinea*	L.	Pinaceae	صنوبر ثمري	P	T
220	*Pistacia palaestina*	Boiss.	Anacardiaceae	البطم الفلسطيني	P	T
221	*Pistacia vera*	L.	Anacardiaceae	فستق حلبي	P	T
222	*Pisum elatius*	M. B.	Leguminosae	بازلاء برية	A	H
223	*Plantago cretica*	L.	Plantaginaceae	زباد, ربل	A	H
224	*Plantago indica*	L.	Plantaginaceae	لسان الحمل, ربل, زباد	A	H
225	*Plantago lanceolata*	L.	Plantaginaceae	ربل رمحي الأوراق	P	H
226	*Plantago ovata*	Forssk.	Plantaginaceae	زباد بيضوي	A	H
227	*Poa bulbosa*	L.	Gramineae	قبا بصيلي	P	H
228	*Poa sinaica*	Steud.	Gramineae	قبا سينائي	P	H
229	*Polycarpaea repens*	(Forssk.) Aschers.et Schweinf.	Caryophyllaceae	كميلة, دقيقة	P	H
230	*Polycarpon tetraphyllum*	(L.) L.	Caryophyllaceae	بوليكربون	A	H
231	*Prunus microcarpa*	C. A. Mey	Rosaceae	خوخ بري - برقوق	P	H-Sh
232	*Prunus ursina*	Ky.	Rosaceae	خوخ الدب	P	S-T
233	*Psilurus incurvus*	(Gouan) Sching & Thell.	Gramineae		A	H
234	*Pterocephalus involucratus*	(Sm.) Spreng.	Dipsacaceae		A	H
235	*Pterocephalus pulverulentus*	Boiss.et Bl.	Dipsacaceae		P	S-Sh
236	*Pyrus syriaca*	Boiss.	Rosaceae	اجاص سوري (بري)	P	T
237	*Quercus aegilops*	L.	Fagaceae	سنديان الماعز	P	T

No.	Species	Author	Family	Arabic name	Life form	Biotype
238	*Quercus calliprinos*	Webb	Fagaceae	السنديان العادي	P	T
239	*Quercus infectoria*	Oliv.	Fagaceae	السنديان البلوطي -العفصي	P	S-T
240	*Quercus libani*	Oliv.	Fagaceae	السنديان اللبناني	P	T
241	*Ranunculus asiaticus*	L.	Ranunculaceae	حوذان	P	H
242	*Ranunculus millefolius*	Banks & Sol.	Ranunculaceae	حوذان	P	H
243	*Reichardia tingitana*	(L.) Roth	Compositae	عضيد	A	H
244	*Rhagadiolus stellatus*	(L.) Gaertn.	Compositae	رويس	A	H
245	*Rhamnus palaestinus*	Boiss.	Rhamnaceae	السويد الفلسطيني	P	H-Sh
246	*Rhaponticum pusillum*	(Labill.) Boiss.	Compositae	الراوندي الضئيل	P	H
247	*Rhus coriaria*	L.	Anacardiaceae	السماق	P	T
248	*Roemeria hybrida*	(L.) DC.	Papaveraceae	نعمانة	A	H
249	*Rosa conina*	L.	Rosaceae	ورد نسريني	P	H-Sh
250	*Rumex cassius*	Boiss.	Polygonaceae	حميض	P	H
251	*Salvia horminum*	L.	Labiatae	مردكوش	A	H
252	*Salvia indica*	L.	Labiatae	لسينة هندية	P	H
253	*Salvia multicaulis*	Vahl	Labiatae	مريمية	P	S-Sh
254	*Salvia viridis*	L.	Labiatae	نوارة المرج	A	H
255	*Sanguisorba minor*	Scop.	Rosaceae	كزبرة البئر	P	H
256	*Sarcopoterium spinosum*	(L.) Sp.	Rosaceae	البلان	P	S-Sh
257	*Scabiosa palaestina*	L.	Dipsacaceae	ثليجة فلسطينية	A	H
258	*Scandix iberica*	M. B.	Umbelliferae	ابو مغيزلة, ابرة الراعي	A	H
259	*Scandix pecten-veneris*	L.	Umbelliferae	ابو مغيزلة, مشط الراعي	A	H
260	*Scandix stellata*	Banks et Sol.	Umbelliferae	ابو مغيزلة	A	H
261	*Scolymus hispanicus*	L.	Compositae	شوكة الفار	B	H
262	*Scorpiurus muricata*	L.	Leguminosae	عنجل	A	H
263	*Scorzonera papposa*	DC.	Compositae	ضبح	P	H
264	*Scorzonera schweinfurthii*	Boiss.	Compositae	ضبح	P	H
265	*Scrophularia hierochuntina*	Boiss.	Scrophulariaceae	خنازيرية	B	H
266	*Sedum nicaeense*	All.	Crassulaceae		P	H
267	*Senecio vernalis*	Waldst. & Kit.	Compositae	زمروق	A	H
268	*Serratula cerinthifolia*	(Sm.) Boiss.	Compositae	وريقة	P	H
269	*Silene aegyptiaca*	(L.) L.f.	Caryophyllaceae	احلوان	A	H
270	*Silene damascena*	Boiss.et Gaill.	Caryophyllaceae	دبقة	A	H
271	*Silene muscipula*	L.	Caryophyllaceae	دبقة	A	H
272	*Silene tridentata*	Desf.	Caryophyllaceae	دبقة ثلاثية التسنن	A	H
273	*Silybum marianum*	(L.) Gaertn.	Compositae	خرفيش	A	H
274	*Sinapis arvensis*	L.	Cruciferae	صفيرة , فجيلة, خردل بري	A	H
275	*Smilax aspera*	L.	Smilacaceae	خصيات الديك	P	C-Sh
276	*Sonchus oleraceus*	L.	Compositae	علك	A	H
277	*Sonchus tenerrimus*	L.	Compositae	علك	A	H
278	*Spergula fallax*	(Lowe) Krause	Caryophyllaceae	قليقلة	A	H
279	*Spergularia diandra*	(Guss.) Heldr. & Sart.	Caryophyllaceae	ام ثريب	A	H
280	*Stachys arvensis*	(L.) L.	Labiatae	ثلجية , غبيراء	A	H
281	*Stachys longispicata*	Boiss.et Ky.	Labiatae	ثليجة طويلة السنبلة	P	H
282	*Stipa capensis*	Thunb.	Gramineae	عزم	A	H
283	*Stipa parviflora*	Desf.	Gramineae	عزم صغير الأزهار	P	H
284	*Styrax officinalis*	L.	Styracaceae	الإصطرك -العبهر	P	S-T
285	*Taeniatherum crinitum*	(Shreb.) Nevski	Gramineae		A	H
286	*Teucrium polium*	L.	Labiatae	قريصة , الجعدة	P	S-Sh
287	*Thlaspi perfoliatum*	L.	Cruciferae	شمرمورة	A	H
288	*Thymus syriacus*	Boiss.	Labiatae	زعتر سوري بري	P	S-Sh
289	*Tordylium syriacum*	L.	Umbelliferae	عشبة الأيل	A	H
290	*Torilis leptophylla*	(L.) Reichb.f.	Umbelliferae	بقدونس بري	A	H
291	*Trachynia distachya*	(L.) Link	Gramineae	شعيرة	A	H
292	*Tragopogon buphthalmoides*	(DC.) Boiss.	Compositae	ذنب الفرس	P	H
293	*Trifolium argutum*	Banks & Sol.	Leguminosae	برسيم	A	H
294	*Trifolium arvense*	L.	Leguminosae	برسيم الحقول	A	H
295	*Trifolium boissieri*	Guss.ex Boiss.	Leguminosae	برسيم بوزيري	A	H
296	*Trifolium bullatum*	Boiss.et Hausskn.	Leguminosae	برسيم قطني	A	H
297	*Trifolium campestre*	Schreb.	Leguminosae	برسيم اصفر	A	H

No.	Species	Author	Family	Arabic name	Life form	Biotype
298	*Trifolium cherleri*	L.	Leguminosae	برسيم	A	H
299	*Trifolium clypeatum*	L.	Leguminosae	برسيم درعي	A	H
300	*Trifolium dasyurum*	C. Persl	Leguminosae	برسيم	A	H
301	*Trifolium isthmocarpum*	Brot.	Leguminosae	برسيم	A	H
302	*Trifolium nigrescens*	Viv.	Leguminosae	برسيم اسود	A	H
303	*Trifolium pauciflorum*	Urv.	Leguminosae	برسيم	A	H
304	*Trifolium physodes*	Stev.ex M. B.	Leguminosae	برسيم	A	H
305	*Trifolium pilulare*	Boiss.	Leguminosae	برسيم	A	H
306	*Trifolium purpureum*	Loisel.	Leguminosae	برسيم بنفسجي	A	H
307	*Trifolium scabrum*	L.	Leguminosae	برسيم خشن	A	H
308	*Trifolium scutatum*	Boiss.	Leguminosae	برسيم	A	H
309	*Trifolium speciosum*	Sensu Boiss.et Griseb. Errat	Leguminosae	برسيم	A	H
310	*Trifolium spumosum*	L.	Leguminosae	برسيم	A	H
311	*Trifolium stellatum*	L.	Leguminosae	برسيم نجمي	A	H
312	*Trifolium subterraneum*	L.	Leguminosae	برسيم تحت ارضي	A	H
313	*Trifolium tomentosum*	L.	Leguminosae	برسيم صوفي	A	H
314	*Trigonella filipes*	Boiss.	Leguminosae	حلبة خيطية	A	H
315	*Trigonella kotschyi*	Fenzl ex Boiss.	Leguminosae	حلبة كوتشي	A	H
316	*Trigonella monantha*	C.A.Mey.	Leguminosae	حلبة احادية الزهر	A	H
317	*Trigonella monspeliaca*	L.	Leguminosae	حلبة	A	H
318	*Trigonella noaeana*	Boiss.	Leguminosae	حلبة	A	H
319	*Trigonella spicata*	Sm.	Leguminosae	حلبة سنبلية	A	H
320	*Triticum durum*	Desf.	Gramineae	قمح قاسي	A	H
321	*Valantia hispida*	L.	Rubiaceae		A	H
322	*Valerianella coronata*	(L.) DC.	Valerianaceae	خس تاجي	A	H
323	*Valerianella echinata*	(L.) DC.	Valerianaceae		A	H
324	*Valerianella pumila*	(Willd.) DC.	Valerianaceae	خس قزم	A	H
325	*Valerianella vesicaria*	(L.) Moench	Valerianaceae	خس مثانية الثمرة	A	H
326	*Velezia rigida*	L.	Caryophyllaceae		A	H
327	*Verbascum gaillardotii*	Boiss.	Scrophulariaceae	بوصير	B	H
328	*Verbascum sinaiticum*	Benth.	Scrophulariaceae	بوصير سيناني	B	H
329	*Verbascum transjordanicum*	Murb.	Scrophulariaceae	بوصير	B	S-Sh
330	*Veronica persica*	Poir.	Scrophulariaceae	زهرة الحواشي الفارسية	A	H
331	*Veronica polita*	Fries	Scrophulariaceae	زهرة الحواشي الرمادية	A	H
332	*Vicia cuspidata*	Boiss.	Leguminosae	بيقية منقارية القرن	A	H
333	*Vicia hybrida*	L.	Leguminosae	بيقية مهجنة, بيقية صفراء	A	H
334	*Vicia palaestina*	Boiss.	Leguminosae	بيقية فلسطينية	A	H
335	*Vicia sativa*	L.	Leguminosae	بيقية مزروعة	A	H
336	*Vitis vinifera*	L.	Vitaceae	عنب بلدي جعفري	P	C-T
337	*Vulpia ciliata*	Dumort.	Gramineae		A	H
338	*Vulpia myuros*	(L.) C. C. Gmel.	Gramineae		A	H
339	*Ziziphora capitata*	L.	Labiatae	نعينع	A	H

Notes:

Biotype: H: Herb, H-Sh: High Shrub, S-Sh: Sub-Shrub, T-T: Tall Tree, S-T: Small tree, T: Tree, C-Sh: Climber-Shrub, C-T: Climber-Tree

Life form: B: Biennial, P: Perennial, A: Annual

Appendix 2

Ranked species cover % in herbaceous plots of Jebel Zawia

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia herb plot
1	*Trifolium stellatum*	3.93	6.87	17.13	12.47	3.00	0.00	1.73	6.45
2	*Hordeum murinum*	0.00	3.13	0.00	0.00	0.00	2.07	20.87	3.72
3	*Sarcopoterium spinosum*	0.00	14.93	4.87	0.00	0.00	0.00	0.87	2.95
4	*Lagoecia cuminoides*	1.80	0.07	2.13	5.07	0.67	3.77	1.40	2.13
5	*Trifolium pilulare*	0.80	0.53	0.00	5.87	1.87	0.00	3.27	1.76
6	*Trifolium purpureum*	4.07	0.00	3.27	0.53	3.87	0.00	0.00	1.68
7	*Avena sterilis*	1.80	1.53	3.40	3.73	0.00	0.20	0.47	1.59
8	*Hordeum spontaneum*	3.27	0.27	7.00	0.27	0.00	0.00	0.00	1.54
9	*Asphodelus microcarpus*	0.00	1.47	0.13	1.00	5.07	0.93	1.80	1.49
10	*Lolium rigidum*	3.60	0.00	0.20	1.13	0.73	3.33	0.53	1.36
11	*Koeleria phleoides*	0.00	0.13	0.20	0.27	1.93	1.73	5.13	1.34
12	*Trifolium scabrum*	2.73	0.13	1.20	0.27	3.07	0.00	2.00	1.34
13	*Trifolium tomentosum*	2.47	0.20	3.20	0.60	0.60	0.20	2.13	1.34
14	*Poa bulbosa*	1.13	6.27	0.53	0.53	0.13	0.07	0.07	1.25
15	*Avena barbata*	0.33	2.53	0.00	2.27	1.27	0.33	1.53	1.18
16	*Trifolium campestre*	3.33	0.07	1.93	1.90	0.20	0.00	0.73	1.17
17	*Caucalis tenella*	1.73	0.87	1.67	1.47	0.33	0.60	1.20	1.12
18	*Bromus danthoniae*	2.40	1.67	1.33	1.47	0.40	0.33	0.20	1.11
19	*Vicia sativa*	0.13	0.00	0.00	0.00	6.93	0.00	0.00	1.01
20	*Cichorium pumilum*	0.00	0.00	0.00	0.00	1.73	4.73	0.33	0.97
21	*Rhagadiolus stellatus*	0.80	0.33	0.73	0.13	3.07	0.00	1.33	0.91
22	*Torilis leptophylla*	1.73	0.67	0.00	0.67	1.67	0.47	1.00	0.89
23	*Linum pubescens*	2.47	0.00	0.80	1.87	0.00	0.00	0.00	0.73
24	*Bromus tectorum*	4.00	0.20	0.13	0.27	0.00	0.00	0.27	0.70
25	*Trigonella filipes*	3.40	0.33	0.60	0.40	0.00	0.00	0.00	0.68
26	*Anthemis maris-mortui*	2.20	1.47	0.67	0.33	0.00	0.00	0.00	0.67
27	*Trifolium argutum*	0.33	0.13	0.13	1.13	1.80	0.07	0.93	0.65
28	*Hordeum bulbosum*	2.33	0.60	0.73	0.33	0.00	0.20	0.07	0.61
29	*Plantago cretica*	0.00	0.13	0.00	0.93	1.87	0.00	1.07	0.57
30	*Bromus lanceolatus var. lanatus*	0.00	0.00	0.00	0.60	0.20	1.33	1.80	0.56
31	*Alopecurus utriculatus*	0.00	0.00	0.00	0.33	0.00	3.53	0.00	0.55
32	*Trifolium cherleri*	1.93	0.00	0.00	0.53	1.13	0.00	0.00	0.51
33	*Helianthemum salicifolium*	0.33	1.07	0.40	0.53	1.20	0.00	0.00	0.50
34	*Crepis sancta*	0.00	0.20	0.00	0.13	0.00	2.00	1.13	0.50
35	*Plantago lanceolata*	0.00	0.00	0.00	0.00	1.20	2.27	0.00	0.50
36	*Centaurea pallescens*	0.00	0.07	0.00	0.00	0.00	2.40	0.93	0.49
37	*Trifolium pauciflorum*	0.00	0.00	0.00	3.40	0.00	0.00	0.00	0.49
38	*Echinops gaillardotii*	0.07	0.60	1.20	0.60	0.00	0.47	0.20	0.45
39	*Polycarpon tetraphyllum*	0.00	0.00	0.00	0.00	0.00	3.13	0.00	0.45
40	*Vicia palaestina*	0.33	0.20	2.27	0.27	0.00	0.00	0.00	0.44
41	*Hymenocarpos circinatus*	1.73	0.00	0.20	0.67	0.20	0.00	0.20	0.43
42	*Aegilops triuncialis*	0.87	0.13	0.13	0.60	1.00	0.00	0.27	0.43
43	*Medicago rigidula var. agrestis*	2.40	0.00	0.00	0.53	0.00	0.00	0.07	0.43
44	*Ranunculus millefolius*	0.87	0.47	0.67	0.87	0.13	0.00	0.00	0.43
45	*Erodium cicutarium*	0.20	0.33	0.00	0.20	0.00	1.47	0.67	0.41
46	*Hordeum glaucum*	0.00	0.00	0.00	0.00	0.00	2.87	0.00	0.41
47	*Parentucellia flaviflora*	0.27	1.47	0.20	0.73	0.07	0.00	0.00	0.39
48	*Bromus diandrus*	2.27	0.00	0.00	0.47	0.00	0.00	0.00	0.39
49	*Lens orientalis*	0.60	1.27	0.80	0.00	0.00	0.00	0.00	0.38
50	*Vulpia ciliata*	0.07	0.00	0.93	0.33	1.00	0.07	0.13	0.36
51	*Stipa capensis*	0.00	0.00	0.00	0.00	2.20	0.00	0.00	0.31

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia herb plot
52	*Dactylis glomerata*	0.00	0.53	0.87	0.67	0.00	0.07	0.00	0.30
53	*Psilurus incurvus*	0.00	0.00	0.00	1.07	0.00	0.87	0.07	0.29
54	*Artedia squamata*	0.00	0.00	0.00	0.00	1.73	0.00	0.20	0.28
55	*Scolymus hispanicus*	0.00	0.00	0.00	0.00	0.20	0.67	1.07	0.28
56	*Biscutella didyma*	0.80	0.67	0.13	0.07	0.00	0.00	0.13	0.26
57	*Carduus pycnocephalus*	0.47	0.20	0.40	0.47	0.07	0.00	0.13	0.25
58	*Sonchus oleraceus*	0.00	0.00	0.27	0.13	0.33	0.23	0.67	0.23
59	*Medicago coronata*	0.33	0.00	0.67	0.20	0.27	0.00	0.13	0.23
60	*Medicago rigidula var. cinerascens*	0.07	0.93	0.20	0.00	0.07	0.00	0.20	0.21
61	*Phalaris minor*	0.00	0.00	0.00	0.00	0.00	1.40	0.00	0.20
62	*Phlomis syriaca*	0.00	0.40	0.00	0.00	0.60	0.00	0.40	0.20
63	*Trigonella monspeliaca*	0.13	0.80	0.27	0.00	0.13	0.00	0.07	0.20
64	*Verbascum gaillardotii*	0.00	1.40	0.00	0.00	0.00	0.00	0.00	0.20
65	*Hedypnois rhagadioloides*	0.00	0.00	0.00	0.20	0.67	0.00	0.47	0.19
66	*Lobularia libyca*	0.20	0.73	0.13	0.00	0.13	0.00	0.13	0.19
67	*Plantago indica*	0.00	0.00	0.07	0.00	1.27	0.00	0.00	0.19
68	*Hordeum vulgare*	0.00	0.00	0.00	0.00	1.27	0.00	0.00	0.18
69	*Vicia cuspidata*	0.07	0.47	0.60	0.13	0.00	0.00	0.00	0.18
70	*Ziziphora capitata*	0.27	0.80	0.13	0.07	0.00	0.00	0.00	0.18
71	*Carduncellus eriocephalus*	0.07	0.00	0.00	0.80	0.07	0.27	0.00	0.17
72	*Crupina crupinastrum*	0.27	0.07	0.47	0.13	0.27	0.00	0.00	0.17
73	*Onobrychis aequidentata*	0.53	0.00	0.67	0.00	0.00	0.00	0.00	0.17
74	*Onopordum heteracanthum*	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.17
75	*Scorzonera schweinfurthii*	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.17
76	*Sinapis arvensis*	0.00	0.00	0.00	0.00	0.20	0.73	0.27	0.17
77	*Trifolium bullatum*	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.17
78	*Alyssum damascenum*	0.73	0.27	0.00	0.07	0.00	0.07	0.00	0.16
79	*Dianthus strictus*	0.00	0.13	0.07	0.33	0.00	0.20	0.40	0.16
80	*Trifolium spumosum*	0.20	0.07	0.47	0.33	0.00	0.00	0.07	0.16
81	*Triticum durum*	0.00	0.00	0.00	0.00	1.13	0.00	0.00	0.16
82	*Eryngium creticum*	0.27	0.13	0.00	0.00	0.00	0.07	0.60	0.15
83	*Allium stamineum*	0.13	0.00	0.07	0.20	0.60	0.00	0.00	0.14
84	*Nigella unguicularis*	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.14
85	*Scandix pecten-veneris*	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.14
86	*Taeniatherum crinitum*	0.07	0.00	0.07	0.13	0.00	0.07	0.67	0.14
87	*Ranunculus asiaticus*	0.00	0.00	0.87	0.07	0.00	0.00	0.00	0.13
88	*Tragopogon buphthalmoides*	0.20	0.00	0.00	0.40	0.27	0.07	0.00	0.13
89	*Catapodium rigidum*	0.07	0.00	0.00	0.00	0.13	0.40	0.27	0.12
90	*Silybum marianum*	0.00	0.00	0.00	0.00	0.00	0.80	0.07	0.12
91	*Convolvulus dorycnium*	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.11
92	*Onobrychis crista-galli*	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.11
93	*Picris damascena*	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.11
94	*Poa sinaica*	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.11
95	*Aristolochia maurorum*	0.67	0.00	0.00	0.00	0.00	0.13	0.00	0.11
96	*Pisum elatius*	0.47	0.00	0.33	0.00	0.00	0.00	0.00	0.11
97	*Capsella bursa-pastoris*	0.00	0.00	0.00	0.00	0.00	0.73	0.00	0.10
98	*Erodium gruinum*	0.13	0.00	0.40	0.20	0.00	0.00	0.00	0.10
99	*Filago contracta*	0.00	0.27	0.13	0.00	0.00	0.07	0.27	0.10
100	*Lens ervoides*	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.10
101	*Anagallis arvensis*	0.07	0.00	0.27	0.20	0.07	0.13	0.00	0.10
102	*Picnomon acarna*	0.00	0.00	0.00	0.60	0.00	0.00	0.13	0.10
103	*Sanguisorba minor*	0.33	0.27	0.00	0.07	0.07	0.00	0.00	0.10

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia herb plot
104	*Teucrium polium*	0.07	0.07	0.00	0.00	0.60	0.00	0.00	0.10
105	*Vicia hybrida*	0.67	0.00	0.07	0.00	0.00	0.00	0.00	0.10
106	*Aegilops ovata*	0.00	0.00	0.13	0.27	0.20	0.00	0.07	0.10
107	*Linum strictum*	0.00	0.00	0.40	0.00	0.27	0.00	0.00	0.10
108	*Campanula erinus*	0.00	0.33	0.00	0.20	0.00	0.07	0.07	0.10
109	*Ononis sicula*	0.07	0.00	0.07	0.00	0.47	0.00	0.07	0.10
110	*Senecio vernalis*	0.33	0.07	0.13	0.07	0.07	0.00	0.00	0.10
111	*Andrachne telephioides*	0.00	0.00	0.00	0.07	0.47	0.07	0.00	0.09
112	*Bellevalia flexuosa*	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.09
113	*Gagea chlorantha*	0.27	0.20	0.00	0.07	0.07	0.00	0.00	0.09
114	*Medicago radiata*	0.33	0.07	0.20	0.00	0.00	0.00	0.00	0.09
115	*Velezia rigida*	0.00	0.00	0.00	0.07	0.07	0.00	0.47	0.09
116	*Bupleurum brevicaule*	0.07	0.13	0.00	0.13	0.00	0.00	0.20	0.08
117	*Echinaria capitata*	0.00	0.13	0.00	0.20	0.00	0.00	0.20	0.08
118	*Brassica nigra*	0.13	0.40	0.00	0.00	0.00	0.00	0.00	0.08
119	*Briza maxima*	0.07	0.00	0.20	0.20	0.07	0.00	0.00	0.08
120	*Campanula strigosa*	0.40	0.07	0.07	0.00	0.00	0.00	0.00	0.08
121	*Euphorbia aleppica*	0.00	0.00	0.00	0.00	0.00	0.07	0.47	0.08
122	*Hippocrepis unisiliquosa*	0.00	0.20	0.00	0.00	0.33	0.00	0.00	0.08
123	*Lathyrus cicera*	0.20	0.13	0.07	0.13	0.00	0.00	0.00	0.08
124	*Anthemis cotula*	0.00	0.00	0.00	0.07	0.00	0.00	0.40	0.07
125	*Filago pyramidata*	0.00	0.13	0.07	0.00	0.13	0.13	0.00	0.07
126	*Iberis odorata*	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.07
127	*Lactuca serriola*	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.07
128	*Valerianella vesicaria*	0.00	0.13	0.27	0.00	0.07	0.00	0.00	0.07
129	*Aegilops geniculata*	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.06
130	*Coronilla rostrata*	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.06
131	*Nardurus maritimus*	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.06
132	*Lathyrus blepharicarpus*	0.00	0.00	0.27	0.07	0.00	0.00	0.07	0.06
133	*Crucianella ciliata*	0.00	0.00	0.00	0.13	0.20	0.00	0.00	0.05
134	*Euphorbia densa*	0.00	0.20	0.00	0.00	0.00	0.00	0.13	0.05
135	*Galium setaceum*	0.07	0.00	0.00	0.13	0.13	0.00	0.00	0.05
136	*Astragalus hamosus*	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.05
137	*Bellevalia stepporum*	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.05
138	*Bromus alopecuros subsp. caroli-henrici*	0.27	0.00	0.07	0.00	0.00	0.00	0.00	0.05
139	*Gynandriris sisyrinchium*	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.05
140	*Medicago constricta*	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.05
141	*Papaver polytrichum*	0.27	0.00	0.00	0.07	0.00	0.00	0.00	0.05
142	*Pterocephalus involucratus*	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.05
143	*Scandix stellata*	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.05
144	*Trifolium boissieri*	0.07	0.00	0.00	0.20	0.07	0.00	0.00	0.05
145	*Verbascum sinaiticum*	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.05
146	*Ajuga chia*	0.00	0.13	0.00	0.00	0.13	0.00	0.00	0.04
147	*Anthemis cornucopiae*	0.00	0.00	0.00	0.07	0.20	0.00	0.00	0.04
148	*Astragalus palaestinus*	0.07	0.00	0.07	0.00	0.13	0.00	0.00	0.04
149	*Erodium subintegrifolium*	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.04
150	*Euphorbia helioscopia*	0.00	0.13	0.13	0.00	0.00	0.00	0.00	0.04
151	*Lepidium spinescens*	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.04
152	*Medicago orbicularis f. marginata*	0.07	0.00	0.07	0.00	0.13	0.00	0.00	0.04
153	*Medicago rigidula var. rigidula*	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.04
154	*Micromeria myrtifolia*	0.00	0.00	0.20	0.07	0.00	0.00	0.00	0.04
155	*Minuartia decipiens*	0.00	0.00	0.00	0.00	0.07	0.00	0.20	0.04

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia herb plot
156	*Ononis viscosa*	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.04
157	*Roemeria hybrida*	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.04
158	*Salvia horminum*	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.04
159	*Salvia multicaulis*	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.04
160	*Silene aegyptiaca*	0.20	0.00	0.00	0.07	0.00	0.00	0.00	0.04
161	*Silene muscipula*	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.04
162	*Spergularia diandra*	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.04
163	*Thymus syriacus*	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.04
164	*Trifolium arvense*	0.00	0.00	0.13	0.00	0.00	0.00	0.13	0.04
165	*Valantia hispida*	0.00	0.07	0.00	0.07	0.07	0.00	0.07	0.04
166	*Alyssum minus*	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.03
167	*Astragalus asterias*	0.00	0.13	0.00	0.00	0.07	0.00	0.00	0.03
168	*Chardinia orientalis*	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03
169	*Euphorbia exigua*	0.07	0.00	0.00	0.13	0.00	0.00	0.00	0.03
170	*Euphorbia reuteriana*	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.03
171	*Galium hierochuntinum*	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.03
172	*Hypericum triquetrifolium*	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.03
173	*Leopoldia comosa*	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03
174	*Medicago polymorpha var. vulgaris*	0.00	0.00	0.00	0.00	0.13	0.00	0.07	0.03
175	*Ornithogalum divergens*	0.07	0.13	0.00	0.00	0.00	0.00	0.00	0.03
176	*Papaver rhoeas*	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.03
177	*Phagnalon barbeyanum*	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.03
178	*Scorzonera papposa*	0.00	0.13	0.07	0.00	0.00	0.00	0.00	0.03
179	*Stipa parviflora*	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.03
180	*Thlaspi perfoliatum*	0.07	0.00	0.00	0.07	0.07	0.00	0.00	0.03
181	*Trifolium isthmocarpum*	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03
182	*Trifolium speciosum*	0.00	0.13	0.07	0.00	0.00	0.00	0.00	0.03
183	*Valerianella coronata*	0.00	0.07	0.00	0.13	0.00	0.00	0.00	0.03
184	*Atractylis cancellata*	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.02
185	*Bolanthus filicaulis*	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.02
186	*Callipeltis cucullaria*	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.02
187	*Carex stenophylla*	0.00	0.00	0.00	0.00	0.07	0.00	0.07	0.02
188	*Coronilla scorpioides*	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.02
189	*Herniaria hisuta*	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.02
190	*Lathyrus aphaca*	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.02
191	*Leopoldia eburnea*	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.02
192	*Orlaya daucoides*	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.02
193	*Polycarpaea repens*	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.02
194	*Serratula cerinthifolia*	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.02
195	*Spergula fallax*	0.00	0.00	0.00	0.07	0.00	0.07	0.00	0.02
196	*Trifolium nigrescens*	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.02
197	*Veronica polita*	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.02
198	*Anchusa strigosa*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
199	*Asparagus acutifolius*	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.01
200	*Bifora testiculata*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
201	*Biserrula pelecinus*	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01
202	*Ceratocephala falcata*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
203	*Cynosurus elegans*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
204	*Galium aparine*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
205	*Geropogon hybridus*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
206	*Gladiolus aleppicus*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
207	*Hirschfeldia incana*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
208	*Lathyrus digitatus*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
209	*Lathyrus hierosolymitanus*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
210	*Lathyrus marmoratus*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia herb plot
211	*Lotus halophilus*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
212	*Medicago aculeata var. aculeata*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
213	*Medicago minima var. minima*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
214	*Medicago rigidula var. submitis*	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01
215	*Mercurialis annua*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
216	*Ononis reclinata*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
217	*Peganum harmala*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
218	*Pimpinella eriocarpa*	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.01
219	*Plantago ovata*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
220	*Scorpiurus muricata*	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.01
221	*Silene damascena*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
222	*Stachys arvensis*	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.01
223	*Tordylium syriacum*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
224	*Trachynia distachya*	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.01
225	*Trigonella noaeana*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
226	*Valerianella echinata*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
227	*Valerianella pumila*	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.01
228	*Veronica persica*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
229	*Vulpia myuros*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Appendix 3

Ranked species cover % in tree plots of Jebel Zawia

Rank	Species	Species cover%				
		Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Av. Zawia (trees plot)
1	*Quercus calliprinos*	40.33	31.60	50.40	26.00	37.08
2	*Quercus infectoria*	0.00	13.60	0.00	3.00	4.15
3	*Pistacia palaestina*	6.80	4.93	0.13	1.33	3.30
4	*Phillyrea latifolia*	2.40	2.07	7.40	0.07	2.98
5	*Osyris alba*	0.60	0.93	2.27	0.33	1.03
6	*Quercus libani*	0.00	3.60	0.00	0.00	0.90
7	*Prunus microcarpa*	0.20	1.73	0.00	0.67	0.65
8	*Olea europeae var. oleaster*	0.00	0.00	1.73	0.67	0.60
9	*Rhamnus palaestinus*	0.07	1.80	0.07	0.33	0.57
10	*Crataegus azarolus*	1.13	0.13	0.27	0.60	0.53
11	*Olea europeae*	0.00	0.00	1.00	0.80	0.45
12	*Cerasus avium*	0.00	0.27	1.07	0.00	0.33
13	*Pyrus syriaca*	0.00	0.00	0.00	1.00	0.25
14	*Pistacia vera*	0.20	0.67	0.00	0.00	0.22
15	*Cerasus mahaleb*	0.00	0.80	0.00	0.00	0.20
16	*Rhus coriaria*	0.67	0.00	0.00	0.00	0.17
17	*Amygdalus orientalis*	0.07	0.47	0.00	0.00	0.13
18	*Rosa conina*	0.00	0.40	0.00	0.07	0.12
19	*Asparagus acutifolius*	0.07	0.13	0.13	0.00	0.08
20	*Lonicera orientalis*	0.07	0.20	0.00	0.00	0.07
21	*Pinus pinea*	0.00	0.00	0.20	0.00	0.05
22	*Smilax aspera*	0.07	0.00	0.13	0.00	0.05
23	*Bryonia cretica*	0.00	0.13	0.00	0.00	0.03
24	*Ficus carica*	0.00	0.00	0.00	0.13	0.03
25	*Anagyris foetida*	0.00	0.07	0.00	0.00	0.02
26	*Clematis cirrhosa*	0.00	0.07	0.00	0.00	0.02
27	*Lycium depressum*	0.00	0.07	0.00	0.00	0.02

Appendix 4

Ranked species cover % in herbaceous plots of Jebel Wastani

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani (herb plot)
1	*Lagoecia cuminoides*	0.87	5.73	2.53	6.47	3.90
2	*Trifolium stellatum*	4.00	3.60	3.80	1.73	3.28
3	*Avena sterilis*	3.27	2.53	6.40	0.20	3.10
4	*Koeleria phleoides*	2.87	0.80	0.07	7.33	2.77
5	*Trifolium campestre*	0.13	1.93	0.13	8.80	2.75
6	*Asphodelus microcarpus*	3.27	0.13	5.20	0.00	2.15
7	*Caucalis tenella*	1.13	2.07	2.87	2.47	2.13
8	*Hymenocarpos circinatus*	0.60	6.60	0.20	0.33	1.93
9	*Torilis leptophylla*	2.07	0.33	4.20	1.00	1.90
10	*Trifolium nigrescens*	0.07	1.60	0.00	5.93	1.90
11	*Aegilops triuncialis*	1.40	3.53	1.60	0.00	1.63
12	*Hordeum bulbosum*	2.73	1.33	2.00	0.27	1.58
13	*Lolium rigidum*	3.27	1.80	0.40	0.33	1.45
14	*Anthemis cornucopiae*	4.80	0.00	0.00	0.07	1.22
15	*Sonchus oleraceus*	1.00	1.07	1.53	1.13	1.18
16	*Trifolium tomentosum*	1.33	0.40	0.20	2.53	1.12
17	*Artedia squamata*	2.20	0.73	0.33	1.00	1.07
18	*Bromus danthoniae*	0.73	1.60	0.67	1.27	1.07
19	*Plantago cretica*	3.20	0.00	0.00	0.60	0.95
20	*Trifolium scabrum*	0.67	0.33	2.20	0.60	0.95
21	*Plantago lanceolata*	0.20	0.00	0.07	3.47	0.93
22	*Picris damascena*	0.07	0.00	1.60	1.73	0.85
23	*Trifolium scutatum*	0.00	3.27	0.00	0.13	0.85
24	*Hordeum vulgare*	2.67	0.47	0.00	0.00	0.78
25	*Trifolium pilulare*	1.00	1.07	0.00	0.93	0.75
26	*Trifolium subterraneum*	0.00	2.20	0.00	0.73	0.73
27	*Ononis sicula*	0.20	0.00	2.53	0.07	0.70
28	*Aegilops ovata*	0.53	1.67	0.33	0.07	0.65
29	*Hordeum spontaneum*	2.53	0.07	0.00	0.00	0.65
30	*Hedypnois rhagadioloides*	1.13	0.07	1.27	0.07	0.63
31	*Alopecurus utriculatus*	0.07	2.33	0.00	0.00	0.60
32	*Sarcopoterium spinosum*	2.40	0.00	0.00	0.00	0.60
33	*Briza maxima*	1.87	0.27	0.07	0.13	0.58
34	*Helianthemum salicifolium*	0.53	1.07	0.67	0.07	0.58
35	*Cistus creticus*	0.00	0.00	2.07	0.00	0.52
36	*Avena barbata*	0.47	0.00	1.00	0.60	0.52
37	*Vicia sativa*	0.00	0.00	2.00	0.00	0.50
38	*Vulpia ciliata*	1.27	0.00	0.07	0.60	0.48
39	*Trachynia distachya*	1.07	0.67	0.07	0.13	0.48
40	*Trifolium purpureum*	0.07	1.80	0.00	0.00	0.47
41	*Linum strictum*	0.07	0.00	1.73	0.00	0.45
42	*Onobrychis aequidentata*	1.07	0.13	0.53	0.00	0.43
43	*Rhagadiolus stellatus*	0.93	0.47	0.20	0.13	0.43
44	*Catapodium rigidum*	0.07	0.60	0.13	0.87	0.42
45	*Bromus diandrus*	0.47	1.00	0.00	0.13	0.40
46	*Crupina crupinastrum*	0.47	0.00	1.13	0.00	0.40
47	*Trifolium bullatum*	0.00	0.00	0.00	1.47	0.37
48	*Hippocrepis unisiliquosa*	0.80	0.20	0.47	0.00	0.37
49	*Phagnalon barbeyanum*	1.33	0.00	0.00	0.00	0.33
50	*Poa bulbosa*	0.07	0.20	0.00	1.07	0.33

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani (herb plot)
51	*Teucrium polium*	0.73	0.00	0.53	0.00	0.32
52	*Onobrychis caput-galli*	0.07	0.27	0.87	0.00	0.30
53	*Trifolium isthmocarpum*	0.00	0.00	0.00	1.20	0.30
54	*Hordeum murinum*	0.00	0.00	0.47	0.67	0.28
55	*Rumex cassius*	1.13	0.00	0.00	0.00	0.28
56	*Tragopogon buphthalmoides*	0.47	0.13	0.47	0.00	0.27
57	*Allium stamineum*	0.20	0.07	0.60	0.13	0.25
58	*Bituminaria bituminosa*	1.00	0.00	0.00	0.00	0.25
59	*Filago pyramidata*	0.33	0.27	0.00	0.40	0.25
60	*Phlomis syriaca*	0.00	1.00	0.00	0.00	0.25
61	*Echinaria capitata*	0.20	0.73	0.00	0.00	0.23
62	*Stachys arvensis*	0.87	0.07	0.00	0.00	0.23
63	*Bromus lanceolatus var. lanatus*	0.20	0.40	0.00	0.27	0.22
64	*Linum pubescens*	0.60	0.27	0.00	0.00	0.22
65	*Medicago coronata*	0.47	0.07	0.07	0.27	0.22
66	*Sanguisorba minor*	0.47	0.20	0.20	0.00	0.22
67	*Velezia rigida*	0.00	0.27	0.20	0.40	0.22
68	*Anagallis arvensis*	0.33	0.33	0.07	0.13	0.22
69	*Iris histrio*	0.00	0.00	0.00	0.87	0.22
70	*Vicia hybrida*	0.13	0.00	0.67	0.00	0.20
71	*Alyssum damascenum*	0.00	0.00	0.73	0.00	0.18
72	*Anthemis cotula*	0.00	0.33	0.40	0.00	0.18
73	*Atractylis cancellata*	0.00	0.00	0.73	0.00	0.18
74	*Medicago polymorpha var. polymorpha*	0.27	0.27	0.00	0.20	0.18
75	*Notobasis syriaca*	0.47	0.07	0.20	0.00	0.18
76	*Salvia horminum*	0.20	0.40	0.13	0.00	0.18
77	*Smilax aspera*	0.00	0.07	0.40	0.27	0.18
78	*Valantia hispida*	0.07	0.47	0.00	0.20	0.18
79	*Campanula erinus*	0.00	0.33	0.07	0.33	0.18
80	*Carduus pycnocephalus*	0.20	0.47	0.07	0.00	0.18
81	*Dactylis glomerata*	0.00	0.27	0.33	0.13	0.18
82	*Trifolium argutum*	0.33	0.00	0.07	0.33	0.18
83	*Trifolium physodes*	0.00	0.00	0.07	0.67	0.18
84	*Ononis natrix*	0.20	0.00	0.47	0.00	0.17
85	*Sinapis arvensis*	0.53	0.13	0.00	0.00	0.17
86	*Papaver rhoeas*	0.27	0.20	0.13	0.00	0.15
87	*Scandix pecten-veneris*	0.13	0.20	0.07	0.20	0.15
88	*Trifolium spumosum*	0.07	0.33	0.00	0.20	0.15
89	*Bifora testiculata*	0.53	0.00	0.00	0.00	0.13
90	*Plantago indica*	0.47	0.00	0.07	0.00	0.13
91	*Polycarpaea repens*	0.00	0.53	0.00	0.00	0.13
92	*Ranunculus millefolius*	0.13	0.20	0.13	0.07	0.13
93	*Stipa capensis*	0.00	0.00	0.53	0.00	0.13
94	*Dianthus strictus*	0.20	0.13	0.07	0.07	0.12
95	*Coronilla rostrata*	0.47	0.00	0.00	0.00	0.12
96	*Lathyrus cicera*	0.20	0.13	0.07	0.00	0.10
97	*Medicago orbicularis f. marginata*	0.27	0.07	0.00	0.07	0.10
98	*Crucianella latifolia*	0.00	0.13	0.00	0.20	0.08
99	*Galium setaceum*	0.00	0.00	0.13	0.20	0.08
100	*Lobularia libyca*	0.00	0.00	0.20	0.13	0.08
101	*Scorpiurus muricata*	0.13	0.07	0.13	0.00	0.08
102	*Bromus tectorum*	0.33	0.00	0.00	0.00	0.08
103	*Coronilla scorpioides*	0.00	0.27	0.07	0.00	0.08

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani (herb plot)
104	*Filago contracta*	0.00	0.00	0.00	0.33	0.08
105	*Medicago rigidula var. cinerascens*	0.27	0.07	0.00	0.00	0.08
106	*Medicago rigidula var. rigidula*	0.07	0.27	0.00	0.00	0.08
107	*Medicago turbinata var. turbinata*	0.00	0.27	0.07	0.00	0.08
108	*Mercurialis annua*	0.27	0.07	0.00	0.00	0.08
109	*Phleum subulatum*	0.00	0.33	0.00	0.00	0.08
110	*Thlaspi perfoliatum*	0.00	0.27	0.07	0.00	0.08
111	*Trifolium clypeatum*	0.07	0.27	0.00	0.00	0.08
112	*Trigonella monspeliaca*	0.33	0.00	0.00	0.00	0.08
113	*Anchusa strigosa*	0.27	0.00	0.00	0.00	0.07
114	*Bromus alopecuros subsp. caroli-henrici*	0.00	0.27	0.00	0.00	0.07
115	*Calendula arvensis*	0.13	0.00	0.13	0.00	0.07
116	*Convolvulus dorycnium*	0.00	0.00	0.27	0.00	0.07
117	*Crucianella ciliata*	0.07	0.20	0.00	0.00	0.07
118	*Cruciata articulata*	0.27	0.00	0.00	0.00	0.07
119	*Cynodon dactylon*	0.00	0.27	0.00	0.00	0.07
120	*Lathyrus blepharicarpus*	0.00	0.07	0.07	0.13	0.07
121	*Lotus halophilus*	0.00	0.00	0.27	0.00	0.07
122	*Micromeria myrtifolia*	0.07	0.20	0.00	0.00	0.07
123	*Parentucellia flaviflora*	0.00	0.07	0.00	0.20	0.07
124	*Picnomon acarna*	0.00	0.13	0.13	0.00	0.07
125	*Ranunculus asiaticus*	0.13	0.07	0.07	0.00	0.07
126	*Trifolium boissieri*	0.07	0.20	0.00	0.00	0.07
127	*Astragalus hamosus*	0.07	0.13	0.00	0.00	0.05
128	*Cichorium pumilum*	0.00	0.00	0.13	0.07	0.05
129	*Erodium cicutarium*	0.00	0.07	0.00	0.13	0.05
130	*Erodium subintegrifolium*	0.07	0.13	0.00	0.00	0.05
131	*Euphorbia reuteriana*	0.13	0.07	0.00	0.00	0.05
132	*Geranium tuberosum*	0.00	0.13	0.00	0.07	0.05
133	*Medicago polymorpha var. vulgaris*	0.00	0.00	0.00	0.20	0.05
134	*Onobrychis crista-galli*	0.00	0.00	0.07	0.13	0.05
135	*Pterocephalus pulverulentus*	0.07	0.07	0.07	0.00	0.05
136	*Senecio vernalis*	0.07	0.13	0.00	0.00	0.05
137	*Spergula fallax*	0.00	0.07	0.07	0.07	0.05
138	*Stipa parviflora*	0.00	0.00	0.00	0.20	0.05
139	*Trifolium cherleri*	0.20	0.00	0.00	0.00	0.05
140	*Trifolium pauciflorum*	0.00	0.20	0.00	0.00	0.05
141	*Trigonella kotschyi*	0.20	0.00	0.00	0.00	0.05
142	*Vicia palaestina*	0.20	0.00	0.00	0.00	0.05
143	*Biscutella didyma*	0.00	0.13	0.00	0.00	0.03
144	*Carduncellus eriocephalus*	0.00	0.00	0.13	0.00	0.03
145	*Crepis sancta*	0.00	0.00	0.00	0.13	0.03
146	*Eryngium creticum*	0.00	0.00	0.00	0.13	0.03
147	*Eryngium glomeratum*	0.00	0.00	0.00	0.13	0.03
148	*Geranium columbinum*	0.07	0.00	0.00	0.07	0.03
149	*Medicago constricta*	0.13	0.00	0.00	0.00	0.03
150	*Ononis reclinata*	0.00	0.00	0.13	0.00	0.03
151	*Oryzopsis miliacea*	0.00	0.00	0.13	0.00	0.03
152	*Phalaris minor*	0.13	0.00	0.00	0.00	0.03
153	*Plantago ovata*	0.13	0.00	0.00	0.00	0.03
154	*Psilurus incurvus*	0.00	0.07	0.00	0.07	0.03
155	*Pterocephalus involucratus*	0.00	0.13	0.00	0.00	0.03

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani (herb plot)
156	*Tordylium syriacum*	0.13	0.00	0.00	0.00	0.03
157	*Adonis annua*	0.07	0.00	0.00	0.00	0.02
158	*Aegilops geniculata*	0.07	0.00	0.00	0.00	0.02
159	*Ajuga chia*	0.00	0.00	0.00	0.07	0.02
160	*Allium scorodoprasum*	0.00	0.00	0.07	0.00	0.02
161	*Arabis aucheri*	0.00	0.00	0.00	0.07	0.02
162	*Biserrula pelecinus*	0.00	0.07	0.00	0.00	0.02
163	*Bupleurum brevicaule*	0.07	0.00	0.00	0.00	0.02
164	*Campanula strigosa*	0.00	0.07	0.00	0.00	0.02
165	*Capparis spinosa*	0.07	0.00	0.00	0.00	0.02
166	*Carthamus persicus*	0.00	0.07	0.00	0.00	0.02
167	*Echinops polyceras*	0.07	0.00	0.00	0.00	0.02
168	*Euphorbia densa*	0.00	0.00	0.07	0.00	0.02
169	*Galium hierochuntinum*	0.00	0.07	0.00	0.00	0.02
170	*Geropogon hybridus*	0.00	0.07	0.00	0.00	0.02
171	*Iberis odorata*	0.00	0.00	0.07	0.00	0.02
172	*Lactuca tuberosa*	0.00	0.00	0.07	0.00	0.02
173	*Lathyrus aphaca*	0.07	0.00	0.00	0.00	0.02
174	*Lathyrus hierosolymitanus*	0.00	0.07	0.00	0.00	0.02
175	*Lens ervoides*	0.00	0.00	0.00	0.07	0.02
176	*Lens orientalis*	0.07	0.00	0.00	0.00	0.02
177	*Medicago aculeata var. aculeata*	0.07	0.00	0.00	0.00	0.02
178	*Medicago blancheana var. blancheana*	0.07	0.00	0.00	0.00	0.02
179	*Medicago blancheana var. bonarotiana*	0.00	0.00	0.07	0.00	0.02
180	*Medicago laciniata*	0.00	0.00	0.07	0.00	0.02
181	*Medicago minima var. minima*	0.07	0.00	0.00	0.00	0.02
182	*Ononis viscosa*	0.00	0.07	0.00	0.00	0.02
183	*Orlaya daucoides*	0.00	0.00	0.07	0.00	0.02
184	*Phlomis platystegia*	0.00	0.00	0.07	0.00	0.02
185	*Scabiosa palaestina*	0.07	0.00	0.00	0.00	0.02
186	*Scandix iberica*	0.00	0.07	0.00	0.00	0.02
187	*Scorzonera papposa*	0.07	0.00	0.00	0.00	0.02
188	*Scrophularia hierochuntina*	0.00	0.07	0.00	0.00	0.02
189	*Silene damascena*	0.07	0.00	0.00	0.00	0.02
190	*Trifolium arvense*	0.00	0.00	0.00	0.07	0.02
191	*Trifolium dasyurum*	0.00	0.00	0.00	0.07	0.02
192	*Trifolium speciosum*	0.00	0.07	0.00	0.00	0.02
193	*Trigonella filipes*	0.00	0.00	0.07	0.00	0.02
194	*Trigonella spicata*	0.00	0.00	0.07	0.00	0.02
195	*Triticum durum*	0.00	0.07	0.00	0.00	0.02
196	*Valerianella vesicaria*	0.00	0.00	0.07	0.00	0.02

Appendix 5

Ranked species cover % in tree plots of Jebel Wastani

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani-trees plot
1	*Quercus calliprinos*	22.73	19.53	32.00	27.87	25.53
2	*Phillyrea latifolia*	1.27	10.47	14.67	15.47	10.47
3	*Pistacia palaestina*	3.07	9.20	0.93	1.33	3.63
4	*Daphne oleifolia*	0.00	1.53	5.73	1.13	2.10
5	*Rhamnus palaestinus*	3.40	2.60	0.20	1.33	1.88
6	*Osyris alba*	0.87	1.20	1.93	1.67	1.42
7	*Styrax officinalis*	2.93	0.73	0.00	0.00	0.92
8	*Crataegus azarolus*	1.27	0.73	0.53	0.87	0.85
9	*Laurus nobilis*	0.00	3.40	0.00	0.00	0.85
10	*Olea europeae*	1.07	0.00	0.47	0.00	0.38
11	*Sarcopoterium spinosum*	1.27	0.00	0.00	0.00	0.32
12	*Asparagus acutifolius*	0.47	0.20	0.07	0.27	0.25
13	*Olea europeae var. oleaster*	0.27	0.60	0.00	0.07	0.23
14	*Quercus infectoria*	0.00	0.80	0.00	0.00	0.20
15	*Cistus creticus*	0.00	0.00	0.67	0.00	0.17
16	*Bryonia cretica*	0.00	0.20	0.00	0.07	0.07
17	*Clematis cirrhosa*	0.00	0.07	0.07	0.13	0.07
18	*Ephedra peduncularis*	0.00	0.00	0.13	0.00	0.03
19	*Ononis natrix*	0.00	0.00	0.13	0.00	0.03
20	*Teucrium polium*	0.00	0.00	0.13	0.00	0.03
21	*Vitis vinifera*	0.13	0.00	0.00	0.00	0.03
22	*Amygdalus orientalis*	0.07	0.00	0.00	0.00	0.02
23	*Cerasus mahaleb*	0.07	0.00	0.00	0.00	0.02
24	*Ficus carica*	0.07	0.00	0.00	0.00	0.02
25	*Smilax aspera*	0.00	0.07	0.00	0.00	0.02

Appendix 6

Ranked densities in herbaceous plots of Jebel Zawia

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia (herb plot)
1	*Trifolium stellatum*	12.20	26.60	50.47	30.47	16.27	0.00	3.67	19.95
2	*Hordeum murinum*	0.00	36.87	0.00	0.00	0.00	10.47	89.07	19.49
3	*Avena sterilis*	9.87	6.13	51.33	18.27	0.00	0.80	1.60	12.57
4	*Lagoecia cuminoides*	11.60	0.73	18.07	33.20	1.60	13.33	3.53	11.72
5	*Lolium rigidum*	37.60	0.00	0.80	9.53	2.20	13.00	1.47	9.23
6	*Caucalis tenella*	18.27	5.53	20.67	10.93	0.73	1.73	2.87	8.68
7	*Bromus danthoniae*	15.20	8.13	13.33	18.07	1.80	1.80	0.67	8.43
8	*Avena barbata*	1.53	17.40	0.00	14.00	2.40	7.73	5.20	6.90
9	*Hordeum spontaneum*	17.53	0.27	27.40	1.80	0.00	0.00	0.00	6.71
10	*Trifolium purpureum*	10.67	0.00	19.73	1.93	13.80	0.00	0.00	6.59
11	*Trifolium campestre*	16.87	0.07	16.27	8.67	0.47	0.00	1.53	6.27
12	*Trifolium scabrum*	16.00	0.27	4.87	0.60	12.73	0.00	4.87	5.62
13	*Poa bulbosa*	7.07	26.20	2.13	2.67	0.20	0.07	0.07	5.49
14	*Koeleria phleoides*	0.00	1.07	1.27	4.53	9.40	8.60	11.41	5.18
15	*Trifolium tomentosum*	10.40	0.27	14.53	2.67	2.00	0.53	4.40	4.97
16	*Bromus tectorum*	27.87	0.47	0.20	3.47	0.00	0.00	1.20	4.74
17	*Torilis leptophylla*	14.20	1.67	0.00	4.13	7.13	1.80	2.93	4.55
18	*Trifolium pilulare*	2.40	1.27	0.00	12.47	8.60	0.00	6.13	4.41
19	*Vulpia ciliata*	0.27	0.00	11.00	8.47	4.07	0.27	0.33	3.49
20	*Plantago cretica*	0.00	0.67	0.00	10.40	7.87	0.00	3.87	3.26
21	*Aegilops triuncialis*	7.33	0.00	0.20	4.07	8.13	0.00	0.80	2.93
22	*Stipa capensis*	0.00	0.00	0.00	0.00	19.00	0.00	0.00	2.71
23	*Trigonella filipes*	13.93	1.00	2.27	1.33	0.00	0.00	0.00	2.65
24	*Rhagadiolus stellatus*	3.00	0.80	3.00	0.33	8.13	0.00	2.47	2.53
25	*Alopecurus utriculatus*	0.00	0.00	0.00	4.80	0.00	12.60	0.00	2.49
26	*Polycarpon tetraphyllum*	0.00	0.00	0.00	0.00	0.00	17.33	0.00	2.48
27	*Psilurus incurvus*	0.00	0.00	0.00	11.10	0.00	6.00	0.20	2.47
28	*Linum pubescens*	6.60	0.00	2.47	7.07	0.00	0.00	0.00	2.30
29	*Anthemis maris-mortui*	5.53	5.40	2.73	2.07	0.00	0.00	0.00	2.25
30	*Parentucellia flaviflora*	0.80	9.87	1.53	3.27	0.20	0.00	0.00	2.24
31	*Cichorium pumilum*	0.00	0.00	0.00	0.00	3.27	11.20	0.47	2.13
32	*Bromus lanceolatus var. lanatus*	0.00	0.00	0.00	2.47	0.73	4.80	6.00	2.00
33	*Trifolium argutum*	1.13	0.07	0.53	3.73	4.20	0.07	2.60	1.76
34	*Helianthemum salicifolium*	0.93	3.93	1.20	1.80	4.40	0.00	0.00	1.75
35	*Hordeum glaucum*	0.00	0.00	0.00	0.00	0.00	11.27	0.00	1.61
36	*Ranunculus millefolius*	4.20	0.80	2.93	3.07	0.20	0.00	0.00	1.60
37	*Medicago coronata*	6.00	0.00	3.40	0.87	0.40	0.00	0.13	1.54
38	*Crepis sancta*	0.00	0.53	0.00	0.40	0.00	6.27	3.40	1.51
39	*Lens orientalis*	3.47	2.47	3.47	0.00	0.00	0.00	0.00	1.34
40	*Vicia palaestina*	0.73	0.20	5.33	2.80	0.00	0.00	0.00	1.30
41	*Trifolium cherleri*	3.80	0.00	0.00	1.20	3.67	0.00	0.00	1.24
42	*Biscutella didyma*	3.53	3.80	0.40	0.33	0.00	0.00	0.13	1.17
43	*Erodium cicutarium*	0.27	1.27	0.00	0.27	0.00	4.73	1.60	1.16
44	*Ziziphora capitata*	1.13	4.93	1.60	0.20	0.00	0.00	0.00	1.12
45	*Plantago lanceolata*	0.00	0.00	0.00	0.00	2.60	5.07	0.00	1.10
46	*Ranunculus asiaticus*	0.00	0.00	6.07	0.47	0.00	0.00	0.00	0.93
47	*Scandix pecten-veneris*	0.00	0.00	6.47	0.00	0.00	0.00	0.00	0.92
48	*Hordeum bulbosum*	2.07	0.67	2.20	0.53	0.00	0.87	0.07	0.91
49	*Trifolium pauciflorum*	0.00	0.00	0.00	6.20	0.00	0.00	0.00	0.89
50	*Vicia sativa*	0.13	0.00	0.00	0.00	5.53	0.00	0.00	0.81
51	*Linum strictum*	0.00	0.00	4.27	0.00	1.33	0.00	0.00	0.80
52	*Medicago rigidula var. agrestis*	4.60	0.00	0.00	0.93	0.00	0.00	0.07	0.80
53	*Lobularia libyca*	0.40	4.07	0.53	0.00	0.27	0.00	0.13	0.77

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia (herb plot)
54	*Crupina crupinastrum*	1.00	0.53	2.40	0.20	1.13	0.00	0.00	0.75
55	*Sonchus oleraceus*	0.00	0.00	0.27	0.53	0.40	1.00	3.00	0.74
56	*Phalaris minor*	0.00	0.00	0.00	0.00	0.00	4.87	0.00	0.70
57	*Alyssum damascenum*	2.60	1.80	0.00	0.13	0.00	0.07	0.00	0.66
58	*Lens ervoides*	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.64
59	*Trigonella monspeliaca*	0.33	3.47	0.47	0.00	0.07	0.00	0.07	0.63
60	*Lactuca serriola*	0.00	4.27	0.00	0.00	0.00	0.00	0.00	0.61
61	*Onobrychis aequidentata*	1.93	0.00	2.33	0.00	0.00	0.00	0.00	0.61
62	*Hymenocarpos circinatus*	2.27	0.00	0.53	0.67	0.33	0.00	0.40	0.60
63	*Dactylis glomerata*	0.00	2.00	1.47	0.47	0.00	0.20	0.00	0.59
64	*Medicago rigidula var. cinerascens*	0.07	3.40	0.33	0.00	0.07	0.00	0.27	0.59
65	*Bromus diandrus*	1.27	0.00	0.00	2.83	0.00	0.00	0.00	0.59
66	*Echinops gaillardotii*	0.13	0.53	0.40	2.67	0.00	0.20	0.07	0.57
67	*Poa sinaica*	0.00	0.00	0.00	0.00	0.00	0.00	3.93	0.56
68	*Trifolium bullatum*	0.00	0.00	0.00	0.00	0.00	0.00	3.93	0.56
69	*Artedia squamata*	0.00	0.00	0.00	0.00	3.47	0.00	0.27	0.53
70	*Aegilops ovata*	0.00	0.00	1.27	1.67	0.67	0.00	0.07	0.52
71	*Catapodium rigidum*	0.07	0.00	0.00	0.00	0.40	1.63	1.40	0.50
72	*Hordeum vulgare*	0.00	0.00	0.00	0.00	3.40	0.00	0.00	0.49
73	*Aegilops geniculata*	3.33	0.00	0.00	0.00	0.00	0.00	0.00	0.48
74	*Scorzonera schweinfurthii*	0.00	3.20	0.00	0.00	0.00	0.00	0.00	0.46
75	*Dianthus strictus*	0.73	0.20	0.07	0.87	0.00	0.47	0.80	0.45
76	*Taeniatherum crinitum*	0.53	0.00	0.13	0.40	0.00	0.33	1.73	0.45
77	*Filago contracta*	0.00	1.73	0.47	0.00	0.00	0.07	0.80	0.44
78	*Scandix stellata*	0.00	0.00	2.87	0.20	0.00	0.00	0.00	0.44
79	*Nigella unguicularis*	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.43
80	*Gagea chlorantha*	1.13	1.67	0.00	0.07	0.07	0.00	0.00	0.42
81	*Briza maxima*	0.27	0.00	1.80	0.67	0.13	0.00	0.00	0.41
82	*Hedypnois rhagadioloides*	0.00	0.00	0.00	0.07	1.93	0.00	0.87	0.41
83	*Plantago indica*	0.00	0.00	0.20	0.00	2.60	0.00	0.00	0.40
84	*Vicia cuspidata*	0.13	0.93	1.60	0.13	0.00	0.00	0.00	0.40
85	*Carduus pycnocephalus*	0.53	0.47	0.40	1.07	0.13	0.00	0.13	0.39
86	*Scolymus hispanicus*	0.00	0.00	0.00	0.00	0.40	0.53	1.80	0.39
87	*Trifolium spumosum*	0.20	0.13	1.47	0.67	0.00	0.00	0.07	0.36
88	*Velezia rigida*	0.00	0.00	0.00	0.13	0.07	0.00	2.33	0.36
89	*Asphodelus microcarpus*	0.00	0.20	0.07	0.40	0.87	0.53	0.40	0.35
90	*Triticum durum*	0.00	0.00	0.00	0.00	2.40	0.00	0.00	0.34
91	*Campanula strigosa*	1.93	0.07	0.20	0.00	0.00	0.00	0.00	0.31
92	*Sarcopoterium spinosum*	0.00	1.47	0.53	0.00	0.00	0.00	0.20	0.31
93	*Tragopogon buphthalmoides*	0.73	0.00	0.00	1.07	0.33	0.07	0.00	0.31
94	*Anagallis arvensis*	0.07	0.00	0.53	0.67	0.07	0.73	0.00	0.30
95	*Campanula erinus*	0.00	1.10	0.00	0.80	0.00	0.07	0.07	0.29
96	*Picnomon acarna*	0.00	0.00	0.00	1.53	0.00	0.00	0.40	0.28
97	*Phlomis syriaca*	0.00	0.07	0.00	0.00	0.93	0.00	0.87	0.27
98	*Filago pyramidata*	0.00	0.73	0.07	0.00	0.47	0.60	0.00	0.27
99	*Onobrychis crista-galli*	0.00	0.00	0.00	0.00	1.80	0.00	0.00	0.26
100	*Echinaria capitata*	0.00	0.40	0.00	1.07	0.00	0.00	0.27	0.25
101	*Nardurus maritimus*	0.00	0.00	0.00	0.00	0.00	0.00	1.73	0.25
102	*Pisum elatius*	0.87	0.00	0.87	0.00	0.00	0.00	0.00	0.25
103	*Andrachne telephioides*	0.00	0.00	0.00	0.13	1.40	0.20	0.00	0.25
104	*Bromus alopecuros subsp. caroli-henrici*	1.40	0.00	0.27	0.00	0.00	0.00	0.00	0.24
105	*Ononis sicula*	0.40	0.00	0.07	0.00	1.07	0.00	0.13	0.24
106	*Picris damascena*	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.23
107	*Erodium gruinum*	0.47	0.00	0.87	0.27	0.00	0.00	0.00	0.23
108	*Aristolochia maurorum*	1.33	0.00	0.00	0.00	0.00	0.20	0.00	0.22
109	*Bupleurum brevicaule*	0.13	0.73	0.00	0.33	0.00	0.00	0.33	0.22

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia (herb plot)
110	*Silybum marianum*	0.00	0.00	0.00	0.00	0.00	1.33	0.20	0.22
111	*Chardinia orientalis*	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.21
112	*Crucianella ciliata*	0.00	0.00	0.00	0.53	0.87	0.00	0.00	0.20
113	*Leopoldia comosa*	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.19
114	*Ononis viscosa*	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.19
115	*Spergularia diandra*	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.19
116	*Valantia hispida*	0.00	0.47	0.00	0.47	0.33	0.00	0.07	0.19
117	*Galium setaceum*	0.27	0.00	0.00	0.47	0.53	0.00	0.00	0.18
118	*Lathyrus blepharicarpus*	0.00	0.00	1.07	0.07	0.00	0.00	0.13	0.18
119	*Teucrium polium*	0.13	0.07	0.00	0.00	1.07	0.00	0.00	0.18
120	*Valerianella vesicaria*	0.00	0.33	0.67	0.00	0.27	0.00	0.00	0.18
121	*Euphorbia aleppica*	0.00	0.00	0.00	0.00	0.00	0.13	1.07	0.17
122	*Senecio vernalis*	0.40	0.20	0.47	0.07	0.07	0.00	0.00	0.17
123	*Silene muscipula*	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.17
124	*Centaurea pallescens*	0.00	0.07	0.00	0.00	0.00	0.67	0.40	0.16
125	*Callipeltis cucullaria*	0.00	0.00	0.00	1.07	0.00	0.00	0.00	0.15
126	*Vicia hybrida*	0.80	0.00	0.27	0.00	0.00	0.00	0.00	0.15
127	*Allium stamineum*	0.13	0.00	0.13	0.20	0.53	0.00	0.00	0.14
128	*Carduncellus eriocephalus*	0.07	0.00	0.00	0.67	0.07	0.20	0.00	0.14
129	*Onopordum heteracanthum*	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.14
130	*Salvia horminum*	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.14
131	*Anthemis cornucopiae*	0.00	0.00	0.00	0.53	0.40	0.00	0.00	0.13
132	*Eryngium creticum*	0.27	0.07	0.00	0.00	0.00	0.07	0.53	0.13
133	*Iberis odorata*	0.00	0.00	0.93	0.00	0.00	0.00	0.00	0.13
134	*Lathyrus cicera*	0.33	0.40	0.07	0.13	0.00	0.00	0.00	0.13
135	*Medicago radiata*	0.33	0.07	0.53	0.00	0.00	0.00	0.00	0.13
136	*Convolvulus dorycnium*	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.12
137	*Euphorbia densa*	0.00	0.67	0.00	0.00	0.00	0.00	0.20	0.12
138	*Pterocephalus involucratus*	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.12
139	*Sinapis arvensis*	0.00	0.00	0.00	0.00	0.40	0.07	0.40	0.12
140	*Lepidium spinescens*	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.12
141	*Gynandriris sisyrinchium*	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.11
142	*Minuartia decipiens*	0.00	0.00	0.00	0.00	0.07	0.00	0.73	0.11
143	*Roemeria hybrida*	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.11
144	*Capsella bursa-pastoris*	0.00	0.00	0.00	0.00	0.00	0.77	0.00	0.11
145	*Brassica nigra*	0.20	0.53	0.00	0.00	0.00	0.00	0.00	0.10
146	*Coronilla rostrata*	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.10
147	*Valerianella coronata*	0.00	0.60	0.00	0.13	0.00	0.00	0.00	0.10
148	*Anthemis cotula*	0.00	0.00	0.00	0.07	0.00	0.00	0.60	0.10
149	*Papaver polytrichum*	0.53	0.00	0.00	0.13	0.00	0.00	0.00	0.10
150	*Scorzonera papposa*	0.00	0.40	0.20	0.00	0.00	0.00	0.00	0.09
151	*Trifolium arvense*	0.00	0.00	0.40	0.00	0.00	0.00	0.20	0.09
152	*Ajuga chia*	0.00	0.33	0.00	0.00	0.27	0.00	0.00	0.09
153	*Astragalus hamosus*	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.09
154	*Hippocrepis unisiliquosa*	0.00	0.27	0.00	0.00	0.33	0.00	0.00	0.09
155	*Medicago rigidula var. rigidula*	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.09
156	*Sanguisorba minor*	0.27	0.20	0.00	0.07	0.07	0.00	0.00	0.09
157	*Serratula cerinthifolia*	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.09
158	*Alyssum minus*	0.07	0.40	0.07	0.00	0.00	0.00	0.00	0.08
159	*Bolanthus filicaulis*	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.08
160	*Galium hierochuntinum*	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.08
161	*Herniaria hisuta*	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.08
162	*Orlaya daucoides*	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.08
163	*Ornithogalum divergens*	0.33	0.20	0.00	0.00	0.00	0.00	0.00	0.08
164	*Erodium subintegrifolium*	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.07
165	*Euphorbia exigua*	0.13	0.00	0.00	0.33	0.00	0.00	0.00	0.07
166	*Medicago constricta*	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.07

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia (herb plot)
167	*Thlaspi perfoliatum*	0.33	0.00	0.00	0.07	0.07	0.00	0.00	0.07
168	*Trifolium boissieri*	0.07	0.00	0.00	0.33	0.07	0.00	0.00	0.07
169	*Trifolium nigrescens*	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.07
170	*Bellevalia flexuosa*	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.06
171	*Bellevalia stepporum*	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.06
172	*Hypericum triquetrifolium*	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.06
173	*Lathyrus aphaca*	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.06
174	*Trifolium speciosum*	0.00	0.13	0.27	0.00	0.00	0.00	0.00	0.06
175	*Verbascum sinaiticum*	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.06
176	*Micromeria myrtifolia*	0.00	0.00	0.33	0.07	0.00	0.00	0.00	0.06
177	*Astragalus palaestinus*	0.13	0.00	0.07	0.00	0.13	0.00	0.00	0.05
178	*Medicago orbicularis f. marginata*	0.07	0.00	0.13	0.00	0.13	0.00	0.00	0.05
179	*Carex stenophylla*	0.00	0.00	0.00	0.00	0.27	0.00	0.07	0.05
180	*Euphorbia reuteriana*	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.05
181	*Verbascum gaillardotii*	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.05
182	*Astragalus asterias*	0.00	0.20	0.00	0.00	0.07	0.00	0.00	0.04
183	*Medicago polymorpha var. vulgaris*	0.00	0.00	0.00	0.00	0.13	0.00	0.13	0.04
184	*Pimpinella eriocarpa*	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.04
185	*Silene aegyptiaca*	0.20	0.00	0.00	0.07	0.00	0.00	0.00	0.04
186	*Spergula fallax*	0.00	0.00	0.00	0.20	0.00	0.07	0.00	0.04
187	*Veronica polita*	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.04
188	*Ceratocephala falcata*	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03
189	*Cynosurus elegans*	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03
190	*Hirschfeldia incana*	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.03
191	*Lathyrus marmoratus*	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.03
192	*Leopoldia eburnea*	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.03
193	*Papaver rhoeas*	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.03
194	*Plantago ovata*	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.03
195	*Stipa parviflora*	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.03
196	*Thymus syriacus*	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.03
197	*Trachynia distachya*	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.03
198	*Vulpia myuros*	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03
199	*Asparagus acutifolius*	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.02
200	*Atractylis cancellata*	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.02
201	*Coronilla scorpioides*	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.02
202	*Euphorbia helioscopia*	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.02
203	*Medicago rigidula var. submitis*	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.02
204	*Peganum harmala*	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.02
205	*Phagnalon barbeyanum*	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.02
206	*Polycarpaea repens*	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.02
207	*Salvia multicaulis*	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.02
208	*Silene damascena*	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.02
209	*Tordylium syriacum*	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.02
210	*Trigonella noaeana*	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.02
211	*Valerianella echinata*	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.02
212	*Valerianella pumila*	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.02
213	*Veronica persica*	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.02
214	*Anchusa strigosa*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
215	*Bifora testiculata*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
216	*Biserrula pelecinus*	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01
217	*Galium aparine*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
218	*Geropogon hybridus*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
219	*Gladiolus aleppicus*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01
220	*Lathyrus digitatus*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
221	*Lathyrus hierosolymitanus*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Mohanbel	Kokfeen	Bab-Alah	Av. Zawia (herb plot)
222	*Lotus halophilus*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
223	*Medicago aculeata var. aculeata*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
224	*Medicago minima var. minima*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
225	*Mercurialis annua*	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01
226	*Ononis reclinata*	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
227	*Scorpiurus muricata*	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.01
228	*Stachys arvensis*	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.01
229	*Trifolium isthmocarpum*	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Appendix 7

Ranked densities in tree plots of Jebel Zawia

Rank	Species	Kafar Lata	Kafar Haya	Al-Rame	Dar Dobat (Bara)	Av. Zawia (trees plot)
1	*Quercus calliprinos*	13.07	9.33	12.07	9.67	11.03
2	*Phillyrea latifolia*	2.33	1.20	9.47	0.07	3.27
3	*Osyris alba*	3.20	2.23	5.80	1.73	3.24
4	*Pistacia palaestina*	6.87	3.13	0.07	1.27	2.83
5	*Quercus infectoria*	0.00	5.87	0.00	0.87	1.68
6	*Pyrus syriaca*	0.00	0.00	0.00	3.47	0.87
7	*Prunus microcarpa*	0.47	1.07	0.00	0.47	0.50
8	*Rhus coriaria*	1.73	0.00	0.00	0.00	0.43
9	*Rhamnus palaestinus*	0.07	1.20	0.07	0.33	0.42
10	*Crataegus azarolus*	0.60	0.20	0.20	0.40	0.35
11	*Quercus libani*	0.00	1.07	0.00	0.00	0.27
12	*Rosa conina*	0.00	0.80	0.00	0.07	0.22
13	*Olea europeae var. oleaster*	0.00	0.00	0.53	0.27	0.20
14	*Smilax aspera*	0.53	0.00	0.13	0.00	0.17
15	*Anagyris foetida*	0.00	0.53	0.00	0.00	0.13
16	*Olea europeae*	0.00	0.00	0.33	0.20	0.13
17	*Bryonia cretica*	0.00	0.40	0.00	0.00	0.10
18	*Cerasus avium*	0.00	0.07	0.33	0.00	0.10
19	*Cerasus mahaleb*	0.00	0.40	0.00	0.00	0.10
20	*Lonicera orientalis*	0.20	0.20	0.00	0.00	0.10
21	*Asparagus acutifolius*	0.07	0.13	0.13	0.00	0.08
22	*Clematis cirrhosa*	0.00	0.33	0.00	0.00	0.08
23	*Pinus pinea*	0.00	0.00	0.33	0.00	0.08
24	*Amygdalus orientalis*	0.07	0.20	0.00	0.00	0.07
25	*Pistacia vera*	0.13	0.13	0.00	0.00	0.07
26	*Lycium depressum*	0.00	0.13	0.00	0.00	0.03
27	*Ficus carica*	0.00	0.00	0.00	0.07	0.02

Appendix 8

Ranked densities in herbaceous plots of Jebel Wastani

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani-herb plot
1	*Koeleria phleoides*	20.20	1.53	0.27	46.33	17.08
2	*Lagoecia cuminoides*	2.67	13.40	8.40	21.40	11.47
3	*Avena sterilis*	13.73	8.07	22.53	0.67	11.25
4	*Trifolium stellatum*	11.07	6.20	14.33	6.07	9.42
5	*Trifolium campestre*	0.33	4.93	0.47	31.07	9.20
6	*Lolium rigidum*	23.67	8.47	2.27	1.53	8.98
7	*Torilis leptophylla*	6.87	0.47	15.07	4.07	6.62
8	*Caucalis tenella*	5.00	5.40	7.00	8.60	6.50
9	*Aegilops triuncialis*	8.47	10.67	6.27	0.00	6.35
10	*Hordeum bulbosum*	6.27	2.60	6.47	0.73	4.02
11	*Vulpia ciliata*	12.73	0.00	0.07	2.60	3.85
12	*Linum strictum*	0.20	0.00	14.07	0.00	3.57
13	*Trifolium nigrescens*	0.13	0.87	0.00	12.60	3.40
14	*Briza maxima*	11.40	0.60	0.40	0.67	3.27
15	*Hordeum vulgare*	11.07	1.20	0.00	0.00	3.07
16	*Sonchus oleraceus*	3.07	3.00	3.20	2.73	3.00
17	*Anthemis cornucopiae*	11.80	0.00	0.00	0.13	2.98
18	*Bromus danthoniae*	3.93	3.20	2.27	2.47	2.97
19	*Trifolium scabrum*	2.40	0.47	7.60	1.13	2.90
20	*Plantago lanceolata*	0.30	0.00	0.07	10.87	2.81
21	*Trachynia distachya*	8.33	2.07	0.40	0.27	2.77
22	*Ononis sicula*	0.20	0.00	10.00	0.07	2.57
23	*Artedia squamata*	4.20	1.93	1.13	2.67	2.48
24	*Aegilops ovata*	2.87	4.67	2.13	0.20	2.47
25	*Hordeum murinum*	0.00	0.00	5.33	4.13	2.37
26	*Picris damascena*	0.13	0.00	5.33	3.80	2.32
27	*Trifolium tomentosum*	2.93	0.93	0.60	4.00	2.12
28	*Trifolium pilulare*	3.93	2.27	0.00	1.93	2.03
29	*Stipa capensis*	0.00	0.00	8.00	0.00	2.00
30	*Avena barbata*	1.87	0.00	2.53	2.67	1.77
31	*Hordeum spontaneum*	6.93	0.07	0.00	0.00	1.75
32	*Hedypnois rhagadioloides*	2.67	0.07	3.87	0.33	1.73
33	*Hymenocarpos circinatus*	1.47	3.93	0.53	0.60	1.63
34	*Helianthemum salicifolium*	0.93	2.27	2.53	0.60	1.58
35	*Catapodium rigidum*	0.27	1.67	0.27	3.60	1.45
36	*Bromus diandrus*	2.23	3.27	0.00	0.20	1.43
37	*Crupina crupinastrum*	1.27	0.00	4.00	0.00	1.32
38	*Plantago cretica*	3.13	0.00	0.00	1.87	1.25
39	*Rhagadiolus stellatus*	2.73	0.87	0.87	0.40	1.22
40	*Onobrychis aequidentata*	3.73	0.20	0.80	0.00	1.18
41	*Trifolium scutatum*	0.00	3.73	0.00	0.40	1.03
42	*Bromus lanceolatus var. lanatus*	1.80	1.33	0.00	0.87	1.00
43	*Rumex cassius*	3.87	0.00	0.00	0.00	0.97
44	*Trifolium subterraneum*	0.00	3.47	0.00	0.40	0.97
45	*Trifolium purpureum*	0.20	3.53	0.00	0.00	0.93
46	*Vicia sativa*	0.00	0.00	3.73	0.00	0.93
47	*Velezia rigida*	0.00	1.07	0.53	2.07	0.92
48	*Poa bulbosa*	0.07	0.53	0.00	2.87	0.87
49	*Filago pyramidata*	0.93	1.27	0.00	1.07	0.82
50	*Plantago indica*	3.13	0.00	0.13	0.00	0.82

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani-herb plot
51	*Bromus tectorum*	3.00	0.00	0.00	0.00	0.75
52	*Tragopogon buphthalmoides*	1.20	0.13	1.60	0.00	0.73
53	*Valantia hispida*	0.20	1.67	0.00	1.00	0.72
54	*Hippocrepis unisiliquosa*	0.33	0.33	1.67	0.00	0.58
55	*Allium stamineum*	0.20	0.20	1.60	0.27	0.57
56	*Alyssum damascenum*	0.00	0.00	2.27	0.00	0.57
57	*Linum pubescens*	1.67	0.60	0.00	0.00	0.57
58	*Trifolium isthmocarpum*	0.00	0.00	0.00	2.27	0.57
59	*Lobularia libyca*	0.00	0.00	1.07	1.07	0.53
60	*Trifolium bullatum*	0.00	0.00	0.00	2.13	0.53
61	*Asphodelus microcarpus*	0.93	0.07	0.93	0.00	0.48
62	*Galium setaceum*	0.00	0.00	0.73	1.13	0.47
63	*Bifora testiculata*	1.80	0.00	0.00	0.00	0.45
64	*Crucianella latifolia*	0.00	0.33	0.00	1.40	0.43
65	*Medicago coronata*	1.13	0.07	0.13	0.33	0.42
66	*Spergula fallax*	0.00	0.20	0.20	1.27	0.42
67	*Salvia horminum*	0.73	0.80	0.07	0.00	0.40
68	*Onobrychis caput-galli*	0.07	0.20	1.27	0.00	0.38
69	*Carduus pycnocephalus*	0.67	0.73	0.13	0.00	0.38
70	*Parentucellia flaviflora*	0.00	0.20	0.00	1.33	0.38
71	*Campanula erinus*	0.00	0.53	0.33	0.60	0.37
72	*Trifolium argutum*	0.47	0.00	0.20	0.80	0.37
73	*Dianthus strictus*	0.40	0.47	0.40	0.13	0.35
74	*Polycarpaea repens*	0.00	1.40	0.00	0.00	0.35
75	*Scandix pecten-veneris*	0.20	0.40	0.47	0.33	0.35
76	*Anagallis arvensis*	0.87	0.13	0.07	0.27	0.33
77	*Notobasis syriaca*	1.07	0.07	0.20	0.00	0.33
78	*Sinapis arvensis*	1.07	0.27	0.00	0.00	0.33
79	*Smilax aspera*	0.00	0.07	0.87	0.33	0.32
80	*Alopecurus utriculatus*	0.07	1.13	0.00	0.00	0.30
81	*Anthemis cotula*	0.00	0.60	0.60	0.00	0.30
82	*Coronilla rostrata*	1.20	0.00	0.00	0.00	0.30
83	*Filago contracta*	0.00	0.00	0.00	1.20	0.30
84	*Medicago polymorpha var. polymorpha*	0.60	0.40	0.00	0.20	0.30
85	*Phleum subulatum*	0.00	1.20	0.00	0.00	0.30
86	*Cruciata articulata*	1.13	0.00	0.00	0.00	0.28
87	*Mercurialis annua*	1.07	0.07	0.00	0.00	0.28
88	*Echinaria capitata*	0.87	0.20	0.00	0.00	0.27
89	*Papaver rhoeas*	0.67	0.27	0.13	0.00	0.27
90	*Vicia hybrida*	0.13	0.00	0.93	0.00	0.27
91	*Atractylis cancellata*	0.00	0.00	1.00	0.00	0.25
92	*Phlomis syriaca*	0.00	1.00	0.00	0.00	0.25
93	*Sanguisorba minor*	0.33	0.40	0.27	0.00	0.25
94	*Trifolium spumosum*	0.07	0.73	0.00	0.20	0.25
95	*Stipa parviflora*	0.00	0.00	0.00	0.93	0.23
96	*Calendula arvensis*	0.60	0.00	0.27	0.00	0.22
97	*Phalaris minor*	0.87	0.00	0.00	0.00	0.22
98	*Thlaspi perfoliatum*	0.00	0.80	0.07	0.00	0.22
99	*Bromus alopecuros subsp. caroli-henrici*	0.00	0.80	0.00	0.00	0.20
100	*Micromeria myrtifolia*	0.07	0.73	0.00	0.00	0.20
101	*Pterocephalus pulverulentus*	0.27	0.07	0.47	0.00	0.20
102	*Ranunculus millefolius*	0.20	0.40	0.13	0.07	0.20

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani-herb plot
103	*Dactylis glomerata*	0.00	0.33	0.20	0.20	0.18
104	*Lathyrus cicera*	0.27	0.27	0.20	0.00	0.18
105	*Lotus halophilus*	0.00	0.00	0.73	0.00	0.18
106	*Crucianella ciliata*	0.07	0.67	0.00	0.00	0.18
107	*Ranunculus asiaticus*	0.53	0.07	0.13	0.00	0.18
108	*Iris histrio*	0.00	0.00	0.00	0.67	0.17
109	*Picnomon acarna*	0.00	0.13	0.53	0.00	0.17
110	*Medicago orbicularis f. marginata*	0.40	0.13	0.00	0.07	0.15
111	*Medicago turbinata var. turbinata*	0.00	0.40	0.20	0.00	0.15
112	*Crepis sancta*	0.00	0.00	0.00	0.53	0.13
113	*Medicago rigidula var. rigidula*	0.07	0.47	0.00	0.00	0.13
114	*Phagnalon barbeyanum*	0.53	0.00	0.00	0.00	0.13
115	*Plantago ovata*	0.53	0.00	0.00	0.00	0.13
116	*Tordylium syriacum*	0.53	0.00	0.00	0.00	0.13
117	*Trifolium clypeatum*	0.07	0.47	0.00	0.00	0.13
118	*Trigonella monspeliaca*	0.53	0.00	0.00	0.00	0.13
119	*Coronilla scorpioides*	0.00	0.40	0.07	0.00	0.12
120	*Erodium subintegrifolium*	0.13	0.33	0.00	0.00	0.12
121	*Lathyrus blepharicarpus*	0.00	0.13	0.13	0.20	0.12
122	*Ononis natrix*	0.20	0.00	0.27	0.00	0.12
123	*Psilurus incurvus*	0.00	0.27	0.00	0.20	0.12
124	*Trifolium boissieri*	0.07	0.40	0.00	0.00	0.12
125	*Trifolium physodes*	0.00	0.00	0.13	0.33	0.12
126	*Aegilops geniculata*	0.47	0.00	0.00	0.00	0.12
127	*Iberis odorata*	0.00	0.00	0.47	0.00	0.12
128	*Astragalus hamosus*	0.13	0.27	0.00	0.00	0.10
129	*Geranium columbinum*	0.07	0.00	0.00	0.33	0.10
130	*Medicago rigidula var. cinerascens*	0.33	0.07	0.00	0.00	0.10
131	*Senecio vernalis*	0.13	0.27	0.00	0.00	0.10
132	*Teucrium polium*	0.20	0.00	0.20	0.00	0.10
133	*Cichorium pumilum*	0.00	0.00	0.13	0.20	0.08
134	*Scorpiurus muricata*	0.13	0.07	0.13	0.00	0.08
135	*Bituminaria bituminosa*	0.33	0.00	0.00	0.00	0.08
136	*Campanula strigosa*	0.00	0.33	0.00	0.00	0.08
137	*Trifolium speciosum*	0.00	0.33	0.00	0.00	0.08
138	*Trigonella kotschyi*	0.33	0.00	0.00	0.00	0.08
139	*Cistus creticus*	0.00	0.00	0.27	0.00	0.07
140	*Erodium cicutarium*	0.00	0.07	0.00	0.20	0.07
141	*Eryngium glomeratum*	0.00	0.00	0.00	0.27	0.07
142	*Euphorbia reuteriana*	0.13	0.13	0.00	0.00	0.07
143	*Galium hierochuntinum*	0.00	0.27	0.00	0.00	0.07
144	*Medicago constricta*	0.27	0.00	0.00	0.00	0.07
145	*Medicago polymorpha var. vulgaris*	0.00	0.00	0.00	0.27	0.07
146	*Pterocephalus involucratus*	0.00	0.27	0.00	0.00	0.07
147	*Sarcopoterium spinosum*	0.27	0.00	0.00	0.00	0.07
148	*Silene damascena*	0.27	0.00	0.00	0.00	0.07
149	*Trifolium cherleri*	0.27	0.00	0.00	0.00	0.07
150	*Trifolium pauciflorum*	0.00	0.27	0.00	0.00	0.07
151	*Cynodon dactylon*	0.00	0.20	0.00	0.00	0.05
152	*Geranium tuberosum*	0.00	0.13	0.00	0.07	0.05
153	*Lens ervoides*	0.00	0.00	0.00	0.20	0.05

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani-herb plot
154	*Medicago minima var. minima*	0.20	0.00	0.00	0.00	0.05
155	*Onobrychis crista-galli*	0.00	0.00	0.07	0.13	0.05
156	*Ononis viscosa*	0.00	0.20	0.00	0.00	0.05
157	*Triticum durum*	0.00	0.20	0.00	0.00	0.05
158	*Vicia palaestina*	0.20	0.00	0.00	0.00	0.05
159	*Ajuga chia*	0.00	0.00	0.00	0.13	0.03
160	*Anchusa strigosa*	0.13	0.00	0.00	0.00	0.03
161	*Arabis aucheri*	0.00	0.00	0.00	0.13	0.03
162	*Biscutella didyma*	0.00	0.13	0.00	0.00	0.03
163	*Bupleurum brevicaule*	0.13	0.00	0.00	0.00	0.03
164	*Carduncellus eriocephalus*	0.00	0.00	0.13	0.00	0.03
165	*Carthamus persicus*	0.00	0.13	0.00	0.00	0.03
166	*Convolvulus dorycnium*	0.00	0.00	0.13	0.00	0.03
167	*Echinops polyceras*	0.13	0.00	0.00	0.00	0.03
168	*Euphorbia densa*	0.00	0.00	0.13	0.00	0.03
169	*Lathyrus hierosolymitanus*	0.00	0.13	0.00	0.00	0.03
170	*Medicago blancheana var. bonarotiana*	0.00	0.00	0.13	0.00	0.03
171	*Ononis reclinata*	0.00	0.00	0.13	0.00	0.03
172	*Oryzopsis miliacea*	0.00	0.00	0.13	0.00	0.03
173	*Stachys arvensis*	0.07	0.07	0.00	0.00	0.03
174	*Trigonella filipes*	0.00	0.00	0.13	0.00	0.03
175	*Trigonella spicata*	0.00	0.00	0.13	0.00	0.03
176	*Adonis annua*	0.07	0.00	0.00	0.00	0.02
177	*Allium scorodoprasum*	0.00	0.00	0.07	0.00	0.02
178	*Biserrula pelecinus*	0.00	0.07	0.00	0.00	0.02
179	*Capparis spinosa*	0.07	0.00	0.00	0.00	0.02
180	*Eryngium creticum*	0.00	0.00	0.00	0.07	0.02
181	*Geropogon hybridus*	0.00	0.07	0.00	0.00	0.02
182	*Lactuca tuberosa*	0.00	0.00	0.07	0.00	0.02
183	*Lathyrus aphaca*	0.07	0.00	0.00	0.00	0.02
184	*Lens orientalis*	0.07	0.00	0.00	0.00	0.02
185	*Medicago aculeata var. aculeata*	0.07	0.00	0.00	0.00	0.02
186	*Medicago blancheana var. blancheana*	0.07	0.00	0.00	0.00	0.02
187	*Medicago laciniata*	0.00	0.00	0.07	0.00	0.02
188	*Orlaya daucoides*	0.00	0.00	0.07	0.00	0.02
189	*Phlomis platystegia*	0.00	0.00	0.07	0.00	0.02
190	*Scabiosa palaestina*	0.07	0.00	0.00	0.00	0.02
191	*Scandix iberica*	0.00	0.07	0.00	0.00	0.02
192	*Scorzonera papposa*	0.07	0.00	0.00	0.00	0.02
193	*Scrophularia hierochuntina*	0.00	0.07	0.00	0.00	0.02
194	*Trifolium arvense*	0.00	0.00	0.00	0.07	0.02
195	*Trifolium dasyurum*	0.00	0.00	0.00	0.07	0.02
196	*Valerianella vesicaria*	0.00	0.00	0.07	0.00	0.02

Appendix 9

Ranked densities in tree plots of Jebel Wastani

Rank	Species	Oreba	Al-Fasook	Maryameen	Al-Daher	Av.Wastani-trees plot
1	*Quercus calliprinos*	9.67	8.4	12.73	13.07	10.97
2	*Phillyrea latifolia*	0.33	6.67	5.87	11.13	5.99
3	*Osyris alba*	4.13	4.33	8.87	5.53	5.72
4	*Daphne oleifolia*	0.00	2.13	7.00	3.07	3.05
5	*Pistacia palaestina*	1.80	8.27	0.73	1.13	2.98
6	*Rhamnus palaestinus*	4.13	4.2	0.40	3.00	2.93
7	*Sarcopoterium spinosum*	5.67	0.00	0.00	0.00	1.42
8	*Crataegus azarolus*	0.73	1.13	0.93	0.90	0.92
9	*Cistus creticus*	0.00	0.00	3.40	0.00	0.85
10	*Laurus nobilis*	0.00	2.00	0.00	0.00	0.50
11	*Asparagus acutifolius*	0.87	0.33	0.13	0.47	0.45
12	*Olea europeae*	0.87	0.00	0.20	0.00	0.27
13	*Styrax officinalis*	0.53	0.4	0.00	0.00	0.23
14	*Olea europeae var. oleaster*	0.20	0.33	0.00	0.07	0.15
15	*Ononis natrix*	0.00	0.00	0.60	0.00	0.15
16	*Teucrium polium*	0.00	0.00	0.60	0.00	0.15
17	*Quercus infectoria*	0.00	0.47	0.00	0.00	0.12
18	*Bryonia cretica*	0.00	0.27	0.00	0.07	0.08
19	*Clematis cirrhosa*	0.00	0.07	0.07	0.13	0.07
20	*Ephedra peduncularis*	0.00	0.00	0.27	0.00	0.07
21	*Smilax aspera*	0.00	0.20	0.00	0.00	0.05
22	*Vitis vinifera*	0.20	0.00	0.00	0.00	0.05
23	*Amygdalus orientalis*	0.13	0.00	0.00	0.00	0.03
24	*Cerasus mahaleb*	0.07	0.00	0.00	0.00	0.02
25	*Ficus carica*	0.07	0.00	0.00	0.00	0.02

Appendix 10.
Form for Observations at Monitoring Area level

GENERAL ECO-GEOGRAPHIC INFORMATION

Project site: W / Z Monitoring area (Number): … Monitoring area ID: ……
Approximate location:

Photo (number): ……
Latitude: ……. Longitude: ..…… Altitude (m): ……

General physiography:
□ Hill □ Mountain □ Plain □ Plateau □ Upland □ Valley

General habitat:
□ Fallow □ Annual crops □ Permanent crops
□ Forest □ Woodland □ Natural grassland □ Grassland-dwarf shrubs

---

Land cover (adapted from Corine):
1. Agricultural vegetation
□ Annual crops □ Perennial crops Irrigated? (Y/N) □ Fallow
□ Homogeneous fruit orchard/vineyards
□ Mixed fruit orchard
2. Forest
□ Natural □ Planted
3. Natural vegetation (but no forest)
□ Shrub forest (maquis) □ Dwarf shrubs (garrigue) □ Grasslands □Wetland vegetation
□ Bare/sparsely vegetated lands
□ mostly covered with rocks
□ mostly covered with soil
4. Mix of agricultural and natural vegetation: □
5. Other (specify):

Soil and geology:
Soil type (if present):
Rock type (if present):
Presence of water erosion: Yes/No
Type: Gully/Rill
Area affected (estimated %)
Other special soil features:

Special features within the monitoring area:
□ presence of springs or streams □ roadside □ burnt area □ built-up area

SOCIO-ECONOMICS & FARMING PRACTICES

Predominant land use:
□ Cropping: □ Annual crops □ Permanent crops
□ Grazing □ Wood collection □ Forestry □ Protected area
Other (specify): …..

Predominant land tenure:
□ Individually ownership □ Private ownership □ Public land
□ Open communal land □ Tenancy (renting) □ Reserves/parks
Others: ……

Protection/occupation:
□ Government forest area □ Military area □ Nature reserve
□ Local community steward □ Use rights □ Settlements

Are the following **resources shared** or individual (S/I) ?
Rangeland: S / I
Forest: S / I
Water:
Spring S / I
River S / I
Irrigation system S / I
Cistern S / I

Disturbance:
□ Grazing □ Cultivation □ Grazing + Cultivation □ Plowing fallow
□ Cut &carry □ Terracing □ Destoning □ Rock removal
□ Construction □ Fire
Disturbance description: …….

Water practices:
□ Rainfed □ Water harvesting □ Irrigation
□ Source: Well / Lake
□ Type: full/ partial

Soil preparation:
□ No □ Surface tillering □ Deep Plowing

Weeding:
□ No weeding □ Chemical □ Hoes □ Manual

Fertilizers:
□ No use □ Chemical □ Organic □ Chemical + organic

Remarks: ……

Degradation factors

Scale: 0 (No or very low) 3 Low 5 Medium 7 High

General factors

□ Overgrazing …. □ Urbanization: …. □ Cropland encroachment: …. □ Cutting: ….
□ Terracing: …. □ Destoning: …. □ Other land reclamation (specify):
……
□ Quarries : …. □ Fire: ….

Botanical indicators:

…….
Other degradation factors:
(Specify): …….

Genetic erosion:
□ Use of improved varieties (specify):
……
Which ones predominate:
□ Use of new species (specify):
……..

Appendix 11.
Form for Observations at Transect level

GENERAL ECO-GEOGRAPHIC INFORMATION

Project site: W / Z Monitoring area (Number): …
Transect (number): ….. Transect ID: ……

Photo (number):
Latitude 1: ……. Longitude1: ..…… Altitude 1 (m): ……
Latitude 2: ……. Longitude2: ..…… Altitude 2 (m): ……

Micro-environment:
□ Plain □ Hillside □ Hilltop □ Valley bottom □ Rockface/cliff
□ Roadside □ Urban/peri-urban □ Burned area □ Forest margins
□ Other: need to be specified

Terrain:
Slope (%): ….
Slope length: □ < 50 m □ 51-200 m □ 201-500 m □ 501-1000 m □ >1000 m
Aspect (compass bearing):

Vegetation
Vegetation type/species:
Relative proportions (%) of key vegetation types:

If agricultural vegetation:

1) approximate field size (ha range):
□ small fields: < 2 ha □ medium: 2-5 ha □ large: >5 ha
2) spatial arrangement:
□ clustered □ scattered □ homogeneous

Soil and geology:
Soil type (if present):
FAO soil classification unit:
Rock type (if present):
Other special soil features:

Special features within the transect:

Appendix 12.
Form for Observations at Plot level

GENERAL ECO-GEOGRAPHIC INFORMATION

Project site: W / Z   Monitoring area (Number): …   Transect (number): …..

FEATURE	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5
Latitude					
Longitude					
Altitude					
Photo (number)					
Grazing					
Disturbance					

Soil					
Depth (cm)					
Color	☐ Reddish ☐ Brownish ☐ Yellowish ☐ Grey ☐ Black	☐ Reddish ☐ Brownish ☐ Yellowish ☐ Grey ☐ Black	☐ Reddish ☐ Brownish ☐ Yellowish ☐ Grey ☐ Black	☐ Reddish ☐ Brownish ☐ Yellowish ☐ Grey ☐ Black	☐ Reddish ☐ Brownish ☐ Yellowish ☐ Grey ☐ Black
Texture	☐ Clayey ☐ Loamy ☐ Sandy ☐ Organic	☐ Clayey ☐ Loamy ☐ Sandy ☐ Organic	☐ Clayey ☐ Loamy ☐ Sandy ☐ Organic	☐ Clayey ☐ Loamy ☐ Sandy ☐ Organic	☐ Clayey ☐ Loamy ☐ Sandy ☐ Organic
Aggregates	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Moisture	☐ Dry ☐ Moist ☐ Wet	☐ Dry ☐ Moist ☐ Wet	☐ Dry ☐ Moist ☐ Wet	☐ Dry ☐ Moist ☐ Wet	☐ Dry ☐ Moist ☐ Wet
Ploughed?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Rocks					
Abundance (%)					
Type					
Weathering	☐ Fresh ☐ Weathered ☐ Rotten	☐ Fresh ☐ Weathered ☐ Rotten	☐ Fresh ☐ Weathered ☐ Rotten	☐ Fresh ☐ Weathered ☐ Rotten	☐ Fresh ☐ Weathered ☐ Rotten
Stones					
Abundance (%)					
Type					
Size class	☐ .2 -.6 cm ☐ .6 – 2 cm ☐ 2 – 6 cm ☐ 6 – 20 cm ☐ 20 – 60 cm ☐ > 60 cm	☐ .2 -.6 cm ☐ .6 – 2 cm ☐ 2 – 6 cm ☐ 6 – 20 cm ☐ 20 – 60 cm ☐ > 60 cm	☐ .2 -.6 cm ☐ .6 – 2 cm ☐ 2 – 6 cm ☐ 6 – 20 cm ☐ 20 – 60 cm ☐ > 60 cm	☐ .2 -.6 cm ☐ .6 – 2 cm ☐ 2 – 6 cm ☐ 6 – 20 cm ☐ 20 – 60 cm ☐ > 60 cm	☐ .2 -.6 cm ☐ .6 – 2 cm ☐ 2 – 6 cm ☐ 6 – 20 cm ☐ 20 – 60 cm ☐ > 60 cm

FEATU-RE	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5
Free lime	□ Non-calcareous □ Slightly calcareous □ Calcareous □ Strongly calcareous	□ Non-calcareous □ Slightly calcareous □ Calcareous □ Strongly calcareous	□ Non-calcareous □ Slightly calcareous □ Calcareous □ Strongly calcareous	□ Non-calcareous □ Slightly calcareous □ Calcareous □ Strongly calcareous	□ Non-calcareous □ Slightly calcareous □ Calcareous □ Strongly calcareous
Free salts					
Present?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Type					
Form	□Efflorescences □ Crusts □ Pseudo-mycelia, nests, streaks □ Layers □ Large particles	□Efflorescences □ Crusts □ Pseudo-mycelia, nests, streaks □ Layers □ Large particles	□Efflorescences □ Crusts □ Pseudo-mycelia, nests, streaks □ Layers □ Large particles	□Efflorescences □ Crusts □ Pseudo-mycelia, nests, streaks □ Layers □ Large particles	□Efflorescences □ Crusts □ Pseudo-mycelia, nests, streaks □ Layers □ Large particles

Per Plot:

Species	Cover	Density	Growth stage	Health	Trees				
					Seedling	Juvenile	Number	Height	Diameter

Predominant associated species:
……
……

Other relevant information:
……
……

Ecogeographical and Botanical Surveys in the Idleb Agricultural Development Project Area

Annex 5.4. to Main Report

The Vegetation Types of Jebel Zawia and Jebel Wastani

Nabil Battikha, Ali Shehadeh and Eddy De Pauw

1. Introduction

Jebel Wastani and Jebel Zawia stand out as highland areas in the midst of a vast plain that has seen agriculture and herding of sheep and goats for more 1000 years. The area was an important province of the Roman empire, with many cities with churches, monasteries and mansions set in a once densely populated area. For many millennia the hills have provided wood from the oak trees (Quercus spp) and oil (pistachio), as well as medicinal and food plants for the local populations, and exceptionally rich forage for the herds. Until some 50 years ago, there was a natural balance between the human and animal populations and their seasonal moments that prevented the mountains resources from becoming depleted. The sustainability of this system was maintained for hundred of years, but with the huge increase in human and animal populations into the region, and the development of numerous semi-sedentary hamlets, this region is undergoing extreme human and animal pressure and the mountains resources are rapidly being degraded.

2. Vegetation types and life forms

Jebel Wastani and Jebel Zawia are home to a tremendous diversity in habitats and species, in fact they have one of the richest assemblages of native plants in Syria. 'Mosaic' landscapes are common, in which different vegetation types are interleaved with one another in complex patterns, created by variations in soil, topography, exposure to wind and sun, and land use. The vegetation types can range from forest (reforested and native), mixed with dense woodland, to shrubland and grassland.

The *life form* of a plant is defined by its physiognomic aspect. At a first level, *woody plants* are distinguished from *herbaceous* life forms. Within the woody plants, *trees* are separated from *shrubs* on the basis of height: if taller than 5 m, they are classified as trees, if lower they are classified as shrubs. Within the herbaceous life forms, a distinction is made between *forbes* (non-graminoids) and *graminoids* (grasses, sedges and rushes) on the one hand, and *lichens* or *mosses* on the other (Di Gregorio and Jansen, 2000).

Each vegetation type may contain different life forms in various combinations. For example, the vegetation type 'open woodland' contains trees, shrubs, annual and perennial grasses, but in proportions that differ from other types.

All vegetation types in the project area belong the Eumediterranean bioclimatic zone, which is the Mediterranean bioclimatic zone dominated by *Quercus calliprinos, Quercus aegilops, Quercus infectoria, Pistacia palaestina, Rhamnus palaestinus, Phillyaris media.* Associated with these are many other species on the hard limestones that are indicators of vegetation degradation such as *Verbiscum, Salvia palaestina, Phillyaris media, Poterium spinosum, Cistus villosa, Calycotome, Oziris alba, Phlomis longifolia , Ononis spp. Phlomis longifolia Annula viscose, Scolmus spp, Echinops* and *Micromeria sp.*

Quercus calliprinos is a native tree reaching 5-18 m tall (Fig.1 and Fig.3). When heavily browsed by goats it is often as small as 1-3 m (Fig. 2). *Quercus calliprinos* is found most commonly on soils formed in hard limestone, with a soil depth varying from shallow to deep (0.5-2m) on hill crests, and very shallow to shallow on sloping land. The *Quercus-*

Pistacia woodland vegetation type typically has the appearance of a bushland, although some tall individual trees do exist, particularly near graveyards or holy places. *Quercus calliprinos* is a very durable species which can be found growing in the middle of a hard rock (Fig. 2).

3. Land cover and vegetation types

The new land use/land cover map of Idleb Governorate, based on the interpretation of Landsat ETm+ satellite image of March 2003 (see Annex 5.5), allows to put the results of the botanical survey (Annex 5.3) , which was conducted on a limited number of monitoring sites, in a spatial context. The land use/land cover map revealed a number of natural cover classes (forests, rangelands and bare rocks), which can be linked to vegetation types and life forms.

All of these cover classes in the project area are in fact mostly used as rangelands. The 'bare rocks' class represents rangelands with very low, and often much degraded, cover. The forests, on the other hand, unless planted, represent the densest natural cover. Within these cover classes, four main physiognomic vegetation types can be distinguished, although not on a 1:1 relationship:

- Grassland
- Shrubland
- Open woodland
- Mixed forest and dense woodland

The first two types can occur in habitats with either low (<5%) or high (>5%) density of the vegetation cover.

Table 1. Vegetation component cover (%)

Cover form (Physiognomy)	Type code	Life form			
		Tree	Shrub	Annual Grass	Perennial Grass
Grassland	G	-	< 2	>20	>20
Shrubland	S	<1	>15	>30	>15
Open woodland	W	<5	> 20	>15	>20
Dense woodland (Maquis)	Dw	>15	>5	.>10	>25
Reforested area	RF	>20	>5	>15	>10
Natural forest	NF	>25	>10	>15	>20

These physiognomic types may contain different life forms. What differentiates the physiognomic types is not so much the presence or absence of one life form or another as the different proportions of life forms they contain (Table 1).

About 17.4% of the project area is dominated by perennial and annual grasses (Poaceae), and herbaceous (non-woody) plants, also known as forbs. The grassland vegetation type is dominant in Jebel Zawia on basaltic rocks or basalts mixed with limestone, although even there these grasslands are remnants, since most of the footslopes and slopes on these rock types have been reclaimed to agricultural land use. The main annual grassland species of the

project area are *Hordium spontaneum, Aegilops ovata, Aegilops speitoides, Avena barbata, Hordeum glaucum.* The main perennial grasses are *Hordium bulbosum, Dactylis glomerata, Hyparrhenia hirta, Oryzopsis miliaceae, Poa bulbosa, Stipa bromoides, Stipa lagacscea.*

Shrublands are dense thickets of evergreen sclerophyllous woody shrubs, such as *Sarcopoterium spinosum*, and geophytes such as *Asphodelus microcarpus,* and many other species. Usually the total vegetation coverage is very poor (<5%), as in most places shrubland is the result of degradation of former forest or woodland by cutting or overgrazing. The main shrubland species of the project area are *Sanguisorba munon, Teucrium montberteti, Teucrium polium, Phlomis longifolia,Rosa Phoenicia,: Cynara syriaca, Dianthus multipunctatus, Ephedra campylopoda, Eryngium spp. Gundelia tinctoria Salvia palaestina,a Achillea micrantha, Achillea setaca, Onobrychis kotchyanana, Onopodon spp. Anthemis tinctoria, and Gundella tinctoria.*

The vast majority (76.2%) of the rangelands of the project area have more than 5% cover density. Within these the main physiognomic types of rangelands are maquis, open woodland, shrubs and grasslands. The open woodland is dominated by *Quercus calliprinos, Pistacia palaestina* and many other shrubs and trees. Open woodland is the result of degradation of former forest or dense woodland due to heavy use by humans. Whereas open woodland has the same vegetation composition as the forest or closed woodland, the cover and frequency of few key species has been changed dramatically, resulting even in the total disappearance of some important species. The main woodland species of the project area are *Ammagdalus orientalis, Cerasus mahlaba, Prunus microcarpus, Phyllyrea media, Pistacia paalestina, Crataegus azarolus, Olea europeae var. oleaster, Prunus microcarpa, Quercus aegilops, Q. calliprinos, Q. libani, Rhamnus palaestina, Rhus coriaria, Paliurus spina-christi, Styrax officinalis, Zizyphus spina-christi with many perinnials an dannuals . Achillea setaca, Onobrychis kotchyanana,Onopodon spp. Anthemis tinctoria, Gundella tinctoria, Hordium bulbosum, Dactylis glomerata, Hyparrhenia hirta, Oryzopsis miliaceae, Poa bulbosa, Stipa bromoides, and Stipa lagacscea.*

Mixed forest and dense woodlands, including maquis, reforested areas and natural forest, are estimated to cover 4.9% of the project area. The main natural forest species is *Quercus calliprinos,* in association with *Pistacia palaestina*, and many other scrub and trees. During the last few hundred years, most of the original woodland has been used heavily by humans for timber or firewood, or was replaced by agriculture. Grazing by goats and sheep and wood cutting prevented tree regeneration, and, without the shelter of trees, heavy autumn rainfall washed away much of the soil. The denuded bare rock, mostly porous limestones, resulted in rapid removal of moisture. Owing to all these factors the forest ecosystems have continuously declined in area and many forest tree species with a low spatial and biological selection, such as the *Quercus* species are permanently in a degraded stage.

The mixed forest and dense woodland include both native and planted species. In these mixed forests *Quercus calliprinos* is usually associated with *Pinus halepensis*, *Juniperus* and *Arbutus sp.* Such mixtures are often found within or around Byzantine ruins or near graveyards or holy, and therefore protected, places, The other kind of forest is replanted with exotic or introduced species. The reforested areas in Idleb Province are mostly composed of *Eucalyptus sp.* and *Cupressus sempervirens* .The tree species of the mixed forest and dense woodland vegetation types have deep roots that penetrate the rock and reach water tables during summer; the leaf-fall from the trees enriches the soil, and the shade of the trees, and the shelter they provide from wind, keep the soil moist.

Valleys are accumulation zones where the soils are deeper than any other terrain type. Where they are not used for growing tobacco or other crops, they support a rich plant biodiversity, with among the grasses mostly palatable species.

4. Degradation

Until about 100 years ago, there was a natural balance in Jebel Wastani and Jebel Zawia between the human and animal populations and their seasonal movements, which prevented the mountain resources from becoming depleted. The sustainability of this system was maintained for thousands of years. Since the early 20th century the natural resources gradually degraded due to a huge increase in human and animal populations. Uncontrolled wood cutting, burning (natural or intentional), herding of sheep and goats, conversion to agricultural land through land reclamation, and urbanization had a major influence on the native vegetation of the project area. Recovery has been hampered by the semi-arid climate in the project area and the shallow soils.

As a result many native plants and animals have become extinct or endangered, especially the perennial species which were particularly vulnerable to the increase in grazing pressure. These pressures led to changes in the structure of the vegetation and in the floristic composition. The first degradation stage was the transformation of the thick oak forests into various shrub formations. In fact, it is safe to say that, with the exception of a few 'witness' trees, the original forest no longer exists.

Further degradation led in places to the widespread occurrence of the dwarf shrub *Poterium spinosum* and the bulbous plant *Asphodelus microcarpus.* When the human and animal pressure becomes stronger even these degradation indicators are replaced by *Sarcopoterium spinosum,* a poisonous and unpalatable species. Bare rock is the extreme stage of forest degradation in this area.

The most common form of natural regeneration is the expansion *of Pinus halepensis, Cupressus sempervirens, Juniperus* and *Eucalyptus* species, which were introduced in the area to prevent erosion of mountain slopes.

It may be concluded that the current vegetation pattern in the project area is the result of changes in structure and composition that have been mostly influenced by human settlement.

A visual scoring of vegetation degradation, based on the presence of degradation indicator plants (Table 2), was undertaken at 40 sites in the project area. At the vast majority of these sites the vegetation showed either medium (50%) or high degradation (48%). Only in 1 site degradation was low (Figure 1).

Table 2. Indicator plants of vegetation degradation in Jebel Zawia and Jebel Wastani

Thistles	**Herb and shrubs**	**Bulbous**
Capparis spinosa	*Adonis aestivalis*	*Allium stamineum*
Carduncellus eriocephalus	*Ajuga orientalis*	*Arum conophalloides*
Carduus pycnocephalus	*Anagyris foetida*	*Asphodelus microcarpus*
Centaurea iberica	*Ballota saxatilis*	*Eminium spiculatum*
Centaurea pallescens	*Cistus creticus*	*Gagea chlorantha*
Crepis sanct	*Convolvulus dorycnium*	*Gladiolus aleppicus*
Echinops polyceras	*Dianthus multipunctatus*	
Eryngium creticum	*Micromera myrtifolia*	
Gundelia tournefortii	*Papaver rhoeas*	
Lycium depressum	*Peganum harmala*	
Noaea mucronata	*Phlomis orientalis*	
Notobasis syriaca	*Ranunculus asiaticus*	
Onopordum heteracanthum	*Roemeria hybrida*	
Picnomon acarna	*Senecio vernalis*	
Sarcopoterium spinosus	*Thymus syriacus*	
Prunus ursina	*Verbascum sinaiticum*	
Rhamnus palaestinus	*Verbascum transjordanicum*	
Scolymus maculatus		
Silybum marianum		
Sonchus tenerrimus		
Calycotome villosa		

Source: Amin Khatib, personal communication

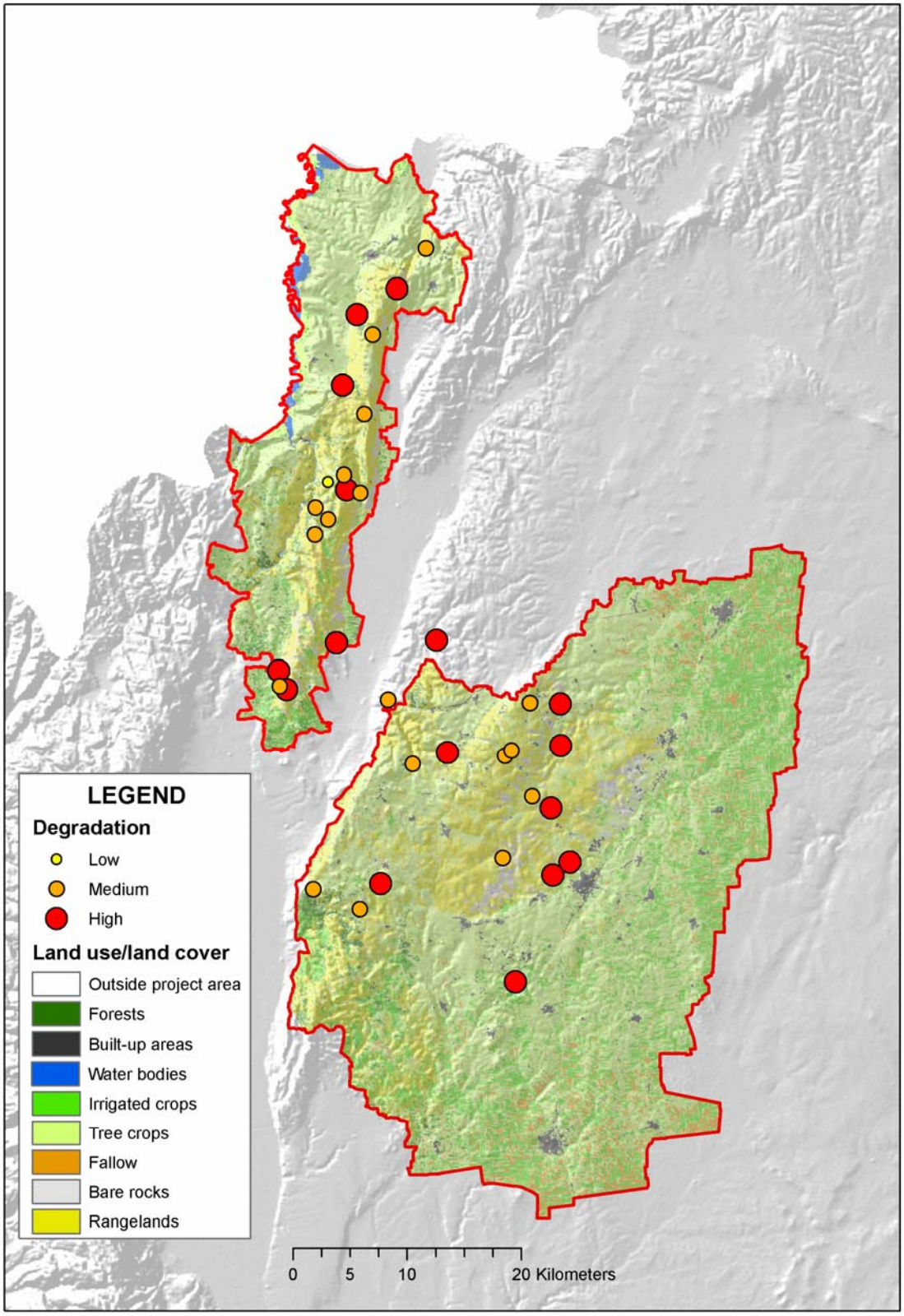

Figure 1. Observations of vegetation degradation

5. Rangeland rehabilitation and restoration

Rangelands in the study area have the potential to make a substantial contribution to food security. Rangeland rehabilitation and restoration activities must take into account several factors including climatic and soil conditions, the kind of indigenous species, the current livestock grazing scheme and availability of other feed resources from surrounding agricultural zones.

Of particular importance for rehabilitation is to fully consider the customary practices that have developed over time. The Al-Zawia and Wastani mountains have been grazed by livestock that kept the vegetation from becoming too overgrown and a fire hazard. In fact, this long history of grazing has shaped the present composition of the vegetation, and to entirely remove grazing from the scene will lead to adverse consequences as the various species compete for growing space or grow too large and woody to be palatable.

What we advocate instead is a return to a policy of managed grazing that will sustain the mountain's vegetation in the "natural" state that it enjoyed for thousands years. In other words, controlled management, allowing local communities some access to the improved natural resources without sacrificing ecological values, is preferable to complete protection in places like Zawia and Wastani mountains. In such conditions of 'sustainable' management, the dominant species tend to invade the areas where all the other fodder species have been already grazed. Only the youngest sprouts of these species are palatable to goat and sheep, palatability depends upon various interacting factors linked to the environment as well as to animals. The results in the better-preserved areas show that woodland is more resistant to species loss than more open vegetation or grassland, being also related to the sensitivity of the species to grazing impact. In the most eroded land there is a need for forest plantation.

In terms of follow-up studies, there is a need to develop an eco-climatological base for appropriate referencing and comparison of collection and evaluation sites. Ecozones and potential species for each zone should be defined. A larger genetic diversity should be used in reforestation and rehabilitation. Many species of legumes, bunch grasses, trees and woody species could be used in reforestation and rehabilitation projects like *Quercus, Arbutus, Laurus*, etc. It is particularly important to give more emphasis in the rehabilitation efforts to endemic tree and woody species.

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Di Gregorio, A. and Jansen, L.M. 2000. Land cover classification system system. LCCS: classification concepts and user manual. Food and Agriculture Organization of the United Nations, Rome. ISBN: 92-5-104216-0

Appendix. Photographs

Figure 1. Tall *Quercus calliprinos* in Jebel Wastani

Figure 2. Small *Quercus calliprinos* growing in cracks of hard limestone in Jebel Wastani

Figure 3. Medium-size *Quercus calliprinos* (background) in dense woodland, Jebel Wastani.

Figure 4. Isolated *Quercus calliprinos* on bare rock (hard limestone)

Figure 5.Cutting Quercus by chainsaw for charcoal. Quercus charcoal is much sought after as water pipe fuel.

Figure 6. Goats resting under a tall *Quercus calliprinos* shade tree.

Figure 7. Goats enjoying a thistle snack in Jebel Wastani.

Figure 8. Shrubland on a steep slope in Jebel Wastani.

Figure 9. Valleys and depressions are usually cultivated in Jebel Zawia.

Figure 10. Grassland in flat or undulating terrain in Jebel Zawia.

Figure 11. Grassland on a strongly sloping basaltic outcrop in Jebel Zawia

Figure 12. Degraded grassland in flat or undulating terrain on a basaltic outcrop in Jebel Zawia

Figure 13. Open woodland in sloping and undulating terrain in Jebel Zawia

Figure 14. Transition zone between shrubland and grassland in undulating terrain in Jebel Zawia

Figure 15. Tobacco in valleys and depressions in Jebel Wastani

Figure 16. Grassland in flat or undulating terrain in Jebel Zawia

Figure 17. Open woodland in Jebel Wastani

Figure 18 Eroded limestone in Jebel Wastani

Figure 19. Red soils for adding to de-rocked land after transportation from neighbouring areas for land reclamation.

Figure 20. Dense woodland in the eastern part of Jebel Wastani

Figure 21. Grassland between hard limestone rocks in Jebel Wastani.

Figure 22.. Degraded shrubland in Jebel Wastani

Figure 23. Degraded woodland in Jebel Zawia

Figure 24. Natural forest of *Juniperus- Arbutus* in Jebel Wastani

Figure 25. Open woodland in the background, eastern part of Jebel Wastani

Figure 26. Grazing at the edge of dense woodland

Figure 27. Water reservoir in a basaltic outcrop in Jebel Zawia.

Figure 28. Horse breeding in the grasslands of Jebel Zawia

Figure 29. Dense woodland on footslopes of hard limestone, Jebel Wastani.

Figure 30. Remnants of native *Quercus calliprinos* forest in Jebel Wastani.

Figure 31. Remnants of native *Quercus calliprinos* forest in Jebel Zawia.

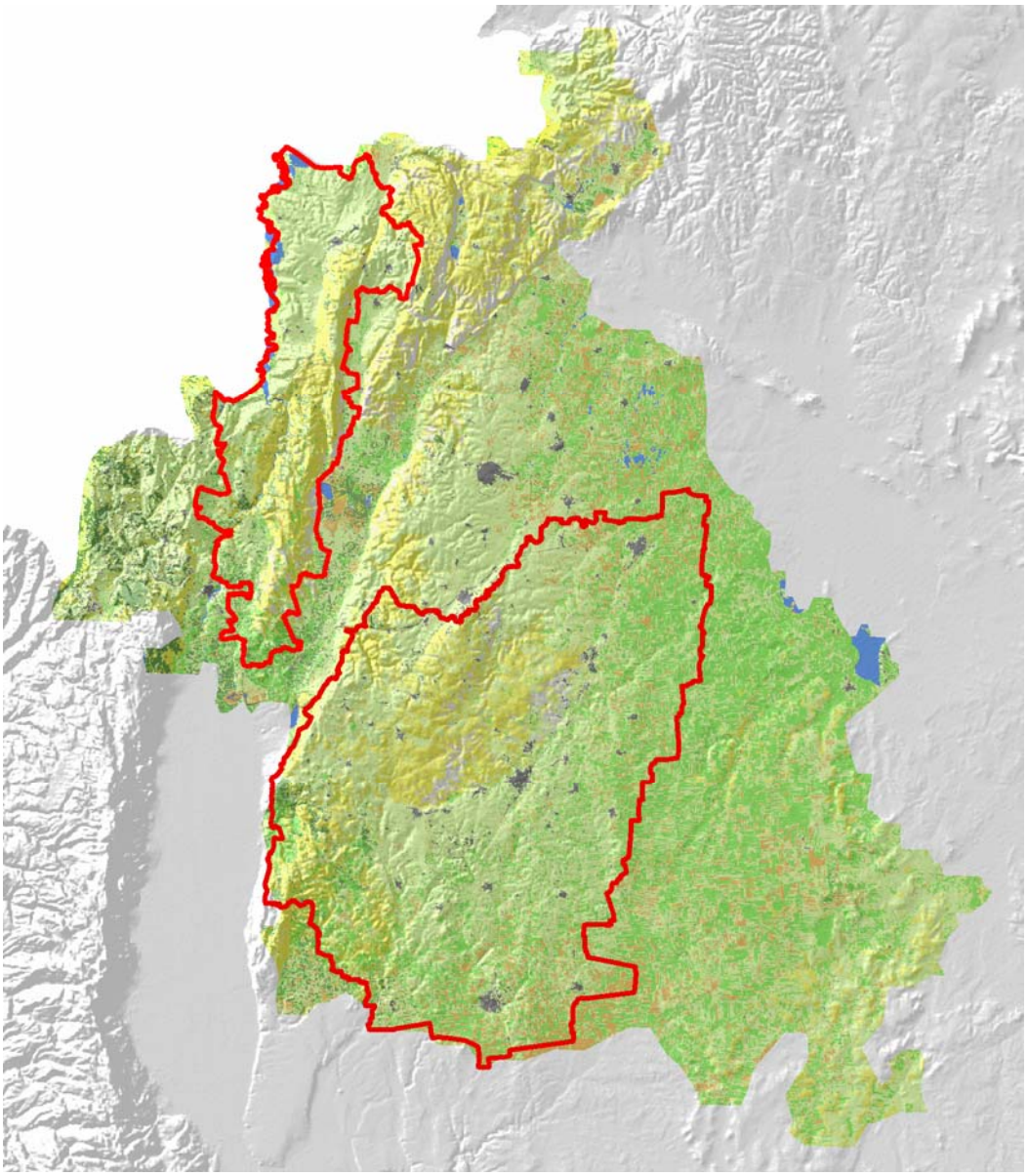
Figure 32. Area reforested with *Cupressus sempervirens*

Ecogeographical and Botanical Surveys in the Idleb Agricultural Development Project Area

Annex 5.5. to Main Report

MAPPING ACTUAL LAND USE AND LAND COVER IN THE IDLEB GOVERNORATE, SYRIA

Weicheng Wu and Eddy De Pauw



1. Introduction

The assessment of current land use and land cover is essential to evaluate the state of biodiversity in the project area and to outscale the results of the botanical survey, which was conducted in a limited number of sites. It is also vital to know where either a potential or major constraints exist for the expansion of the land reclamation project through de-rocking. For example, areas currently under agricultural use are not expected to have much biodiversity left or to require de-rocking. Bare lands, on the other hand, may indicate that at the same time the vegetation is strongly degraded and that de-rocking may be unfeasible due to an overwhelming presence of rocks. For this reason, and in the absence of other data sources, it was considered necessary to conduct a land use/land cover survey. The survey was undertaken through image classification procedures using recent (2003) Landsat ETM+ imagery and ENVI software, and covered the entire Idleb Governorate.

2. Methodology

Generally, land use/land cover mapping is carried out through classification of satellite imagery, combined with data from the field (ground-truthing information). The classification is then tested by verification in the field using sample points. If the result is not good enough, e.g., the overall verification accuracy is less than 85%, the classification should be repeatedusing more ground control data.and revalidated in the field.

2.1. Land use/ land cover classification

In recent decades, a huge number of land use/land cover maps have been prepared by different scientists and institutions, ranging in scale from the local to the global, using different methodologies and classification schemes, to suit the specific objectives of projects and requirements of users. Amongst these, the European CORINE Project which has focused on updating and standardizing land use/land cover maps in12 European countries, is probably the one with the most complete classification scheme. This scheme, which focuses specifically on the Mediterranean region, was considered as a first choice for developing the land use/land cover map. However, 3 levels (even 4 levels for the post-2000 land cover clustering) of CORINE system were considered too detailed and cumbersome in use. For this reason a tentative ad-hoc classification system was developed in line with the requirements of the project and the local conditions, which includes four main groups:

- Built-up surface (urban, village and their infrastructure, transport system);
- Agricultural areas (irrigated and non-irrigated arable land, permanent tree crops, pasture);
- Forests (natural and planted conifer, deciduous and their mixture);
- Natural uncultivated land (shrub, grassland, bare rocks).

2.2. Data sources

- Remote sensing data: Landsat ETM+ image (Path174-Row35) dated Mar. 23, 2003, with spatial resolution of 30m for the Multispectral Bands (MBs), and 15m for the Panchromatic Band (PanB).
- Field data or ground data obtained during the field trips and investigations in March, April and May 2007.

- Google Earth: the areas covered with QuickBird images (spatial resolution 1m) can be directly used as ground truth data for training area selection, verifying and validating the mapping result.

2.3. Procedures

2.3.1. Tentative field investigation with GPS

Before starting a land use/land cover classification, a broad understanding of the main land use/cover types and their geographical locations in the working area is required. Figure 1 shows some types of land use/cover that were recognized during the first exploratory field trip in the Idleb Governorate.

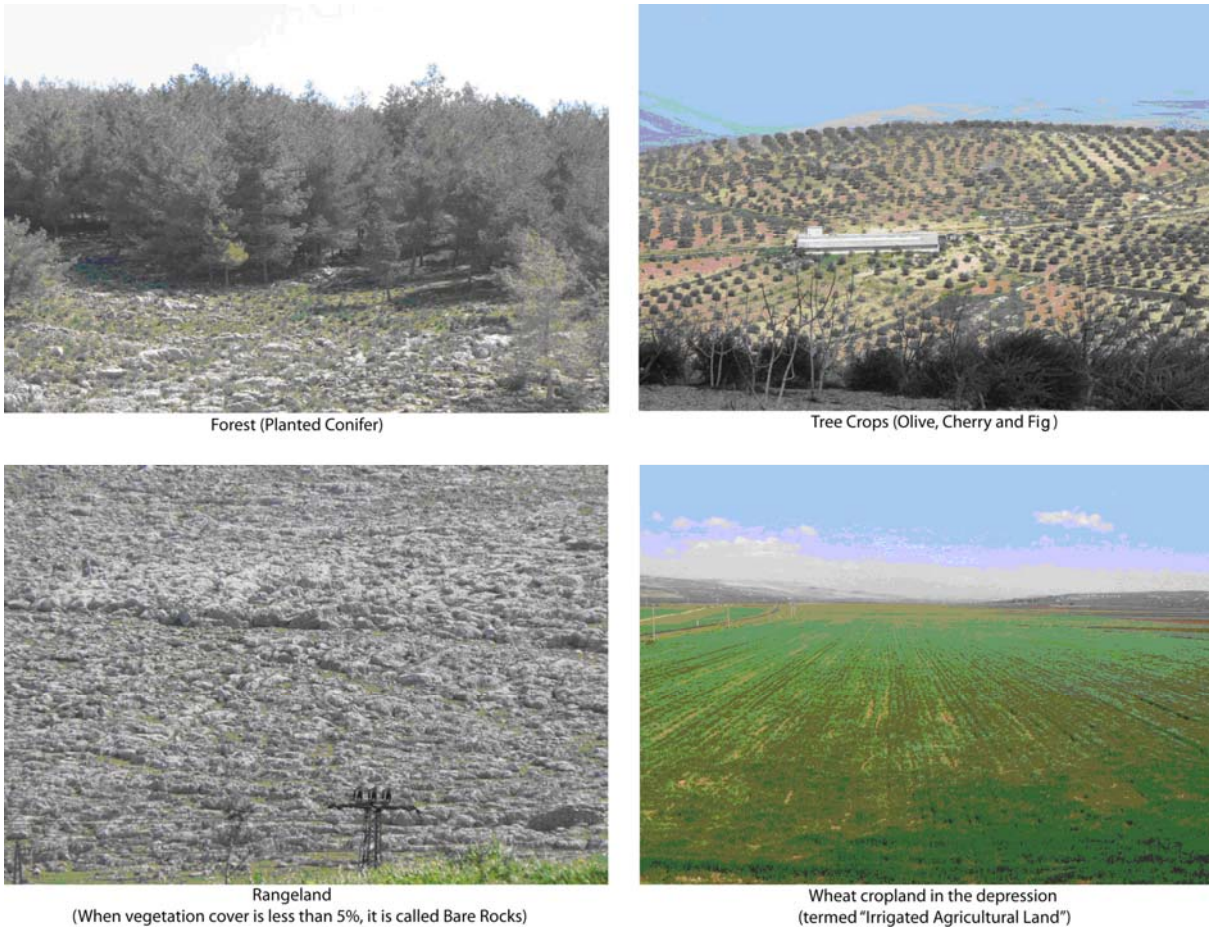


Figure 1: Example of a part of land use/cover types defined through the field investigation

2.3.2. Radiometric calibration and geometric correction

Since the satellite images are often noisy due to the atmospheric effect and seasonal differences that determine the Sun-Earth Distance and Sun Elevation Angle, it is necessary to normalize the digital information recorded by the sensors, especially when assessing land use/cover changes. In our case an absolute atmospheric correction is not required; a radiometric calibration to normalize the effect of the Sun-Earth Distance and Sun Elevation Angle and to transform the pixel's digital number (DN) into spectral reflectance is sufficient.

The Landsat ETM+ image dated March 23, 2003 was already geometrically corrected in Datum WGS84 and Projection UTM37. A significant shift between this image and topographic maps on the scale of 250,000 was found. To clarify which map or image had

more geographical accuracy and could be used for georeferencing, a specific field trip was carried out to collect twenty Ground Control Points (GCPs). It turned out that the difference between the image and the GCPs is much smaller (about 1/2 to 2/3 pixel) than that between the topographic maps and the GCPs (6-14 pixels). Therefore it was concluded that the geographical accuracy of the Landsat image was acceptable and could be directly used for classification.

2.3.3. Selection of training areas

Based on the field investigation, Google Earth (where there was QuickBird coverage) and knowledge about Landsat ETM+ image, the following 13 land cover classes were tentatively distinguished:

- Built-up Areas (urban, villages and constructed roads, etc.)
- Forest (natural and planted)
- Water Body (lakes, fishponds and rivers)
- Irrigated Agriculture (mainly distributed in the depression in the middle west and in the plains in the south and east parts)
- Non-Irrigated Agriculture (without clear irrigation system and mainly located in the mountains and plateau)
- Middle Density Tree Crops (including olive plantation, orchards of fig, cherry and vineyard with larger canopy — older)
- Low Density Tree Crops (canopy smaller — younger with low greenness and thus soil reflectance takes a dominant role in pixel values)
- Fallow (agricultural land in rest or before cultivation) and Harvested Land (after harvest of crops or vegetable)
- Bare Rocks (with scarce vegetation cover, largely < 5%)
- Rangeland (including natural grassland, locally maquis or shrub land and some isolated small pieces of tree; this group of land cover is very dynamic due to man's activity: grazing and reclamation for plantation of Tree Crops and Pasture).
- Forage Land (Pasture)
- Mining area (including some construction sites)
- Snow Cover

For the **basaltic areas** due to the dark color of basaltic soil and mother material, some training areas were specifically added:

- Middle density Tree Crops on basalts
- Low Density Tree Crops on basalts
- Rangeland on basalts
- Agriculture on basalts
- Forage Land on basalts

The corresponding selected training areas are shown in Figure 2. In order to ensure they were representative, the training areas covered 296.6km^2 of different land use and land cover, or 5.4% of the total Idleb region.

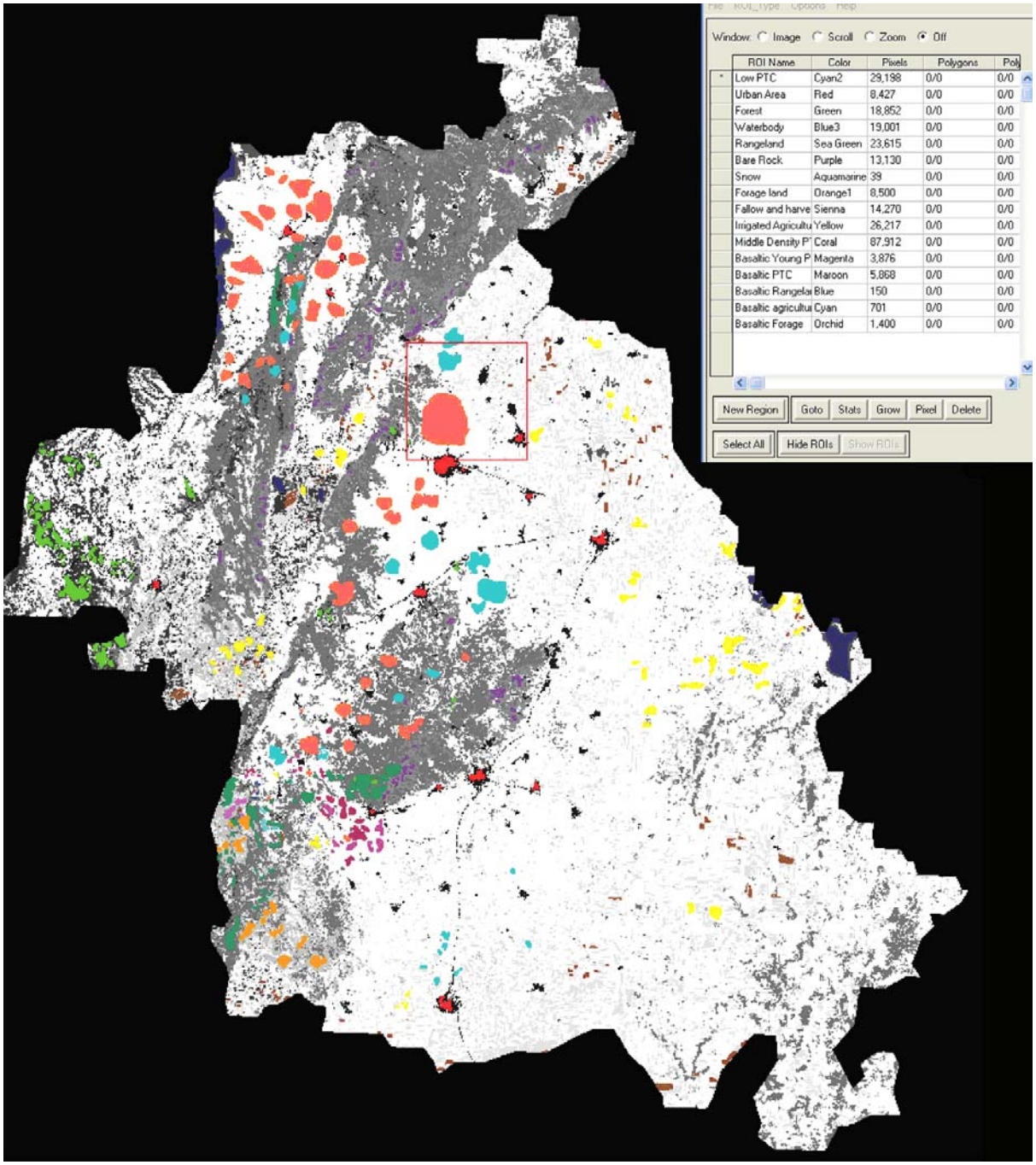


Figure 2. Distribution of the training areas

2.3.4. Separability analysis

The separability between classes or training areas is an important indicator predicting whether classification (separation of classes) can be successfully achieved. This indicator was analyzed using Jeffries-Matusita Distance (JM) (Richard and Jia, 1999). For the pair of class *i* and *j*, this distance can be expressed as:

$$JM_{ij} = \sqrt{2(1-e^{-\alpha})}$$

where:

$$\alpha = \frac{1}{8}(\mu_i - \mu_j)^T \left(\frac{C_i + C_j}{2}\right)^{-1} (\mu_i - \mu_j) + \frac{1}{2}\ln\left[\frac{\frac{1}{2}|C_i + C_j|}{\sqrt{|C_i| \times |C_j|}}\right]$$

$\boldsymbol{C}_i$ is the covariance matrix of class i;
μ_i is the mean vector of class i;
ln is the natural logarithm function;
T is the transposition function; and
$|\boldsymbol{C}_i|$ is the determinant of $\boldsymbol{C}_i$.

Normally, the JM square value as calculated in ENVI comes between 0 and 2. From 0 to 2, the separability goes up from 'non-separable' to 'completely separable', that is:

- $JM^2 < 1.0$, poor separability;
- $JM^2 = 1.0$-1.5, separable but with confusion;
- $JM^2 = 1.5$-1.9, good separability; and
- $JM^2 > 1.9$, completely separable.

For the Idleb region, the separability between the class pairs is listed in Table 1.

Table 1: Separability of the recognized classes

Class Pair	**JM^2**	**Separability**
Build-Up Area ^ Bare Rock	1.9873	Very good
Build-Up Area ^ Fallow	1.9695	Very good
Mining Area ^ Build-up Area	1.9299	Very good
Bare Rock ^ Mining Areas	1.6023	Good
Forest ^ Middle Density Tree Crops	1.6932	Good
Forest ^ Rangeland	1.4834	**Fair**
Forest ^ Irrigated Agriculture	1.6915	Good
Non-Irrigated Agriculture ^ Irrigated Agriculture	1.1410	**Fair**
Non-Irrigated Agriculture ^ Forage Land	0.6402	**Poor**
Low Density Tree Crops ^ Middle Density Tree Crops	0.6812	**Poor**
Low Density Tree Crops ^ Rangeland	1.2519	**Fair**
Low Density Tree Crops ^ Fallow	1.6820	Good
Low Density Tree Crops ^ Bare Rock	1.5494	Good
Forage Land ^ Irrigated Agriculture	0.8715	**Poor**

From Table 1 it is clear that 3 pairs of classes, (i) between Rangeland and Forest, (ii) between Rangeland and Low Density Tree Crops, and (iii) between Non-Irrigated and Irrigated Agriculture have only **fair** separability. As a result one can expect some confusion among these classes in the classification results. The separability between (i) Low and Middle

Density Tree Crops, between (ii) Forage Land and Irrigated Agriculture, and between (iii)Forage Land and Non-Irrigated Agriculture is poor, meaning that, using only these training areas, these 3 pairs of classes can not be separated. To avoid the confusion and improve the classification result, there are two ways to follow, either adding more training areas or combining inseparable classes together.

2.3.5. Classification

Once field knowledge is available on land use/cover patterns, the usual practice is to apply *supervised classification*. According to the European DesertWatch project (DesertWatch Group, 2005), among the numerous supervised classifiers, the Maximum Likelihood classifier is the most suitable since it can obtain higher accuracy and more relevant results. For this reason this classifier was selected for classification.

After the separability analysis, described in section 2.3.4., classification was undertaken in a way as described in Wu and Zhang (2003). This approach consists of deriving at first more classes from the training areas to cluster land cover as finely as possible, and then to aggregate the confused fine classes into larger but less mixed ones.

The classification was launched respectively with Multispectral Bands (MBs741 and 754321), Principal Components (PCs 123, 1234) and Tasseled Cap Features (Brightness, Greenness and Wetness). The results indicated that the classification on the 6 bands gets better accuracy, hence the classification was continued with 6 MBs.

After visual check against the color composite image (Bands 741), Google Earth and field data, each time some new training areas were added to the misclassified classes in order to obtain better separability in the newer classification. This procedure was repeated several times until a reasonable classification accuracy was obtained. Through visual checking most of the land cover classes, such as Build-Up Area, Bare Rock, Middle Density Tree Crops, Forest could be well classified (class accuracy > 90%).

In order to reduce fragmentation, with the software package of DesertWatch, a Minimum Mapping Unit processing with a kernel size of 3×3 = 9 pixels (8100m^2 = 0.81ha), was applied to remove some isolated pixels and dissolve them into the surrounding major classes. The result can be produced in maps on a scale of 1/100 000 with a minimum mapping unit (0.9×0.9mm^2).

As mentioned before, due to the poor separability in the problematic class pairs between the *Low* and *Middle Density Tree Crops*, between *Forage Land* and *Irrigated Agricultural Land* and between *Forage Land* and *Non-Irrigated Agriculture*, a lot of mixtures still remained in these classes. To resolve this problem, at first more reference data (training areas) were added to increase the separability, but. this did not improve the classification results. For this reason the *Low* and *Middle Density Tree Crops* classes were aggregated into a single class *Tree Crops*, and the classes *Forage Land* and *Non-Irrigated Agriculture* into the class *Irrigated Agricultural Land*. The basaltic areas were incorporated into their corresponding general classes, e.g. *Rangelands on basalts* into *Rangeland*. Snow, covering forest on the top mountain, is not a permanent land cover class in the study area and was reallocated into the class *Forest*.

After the combination, 9 major classes were kept and the nomenclature of these classes (see table 2) were set through a consultation within the project team.

2.3.6. Results

The Overall Accuracy against the ground truth regions of interest was **87.53%** (Kappa Coefficient = 0.83). The Producer's Accuracy of the Built-Up Area, Mixed Forest, Waterbody, Bare Rocks and Irrigated Agricultural Land was higher than 90% (see Annex 1:

Final Classification Confusion Report). Although some classes, such as Rangeland and Tree Crops, were not optimally clustered due to their low separability, this classification result is largely acceptable (see Table 2 and Figures 3 and 4).

2.3.7. Verification and validation

Verification was done using Google Earth in areas with QuickBird coverage and with field checks . In total 265 field points covering most of the two project sites (Fig. 4) were visited. Among these 12 points had been fully misclassified and 14 points partly misclassified, resulting into a field observation accuracy of (265-12-14/2)/265 = 92.8%. Including the QuickBird covered areas in the verification leads to a higher accuracy.

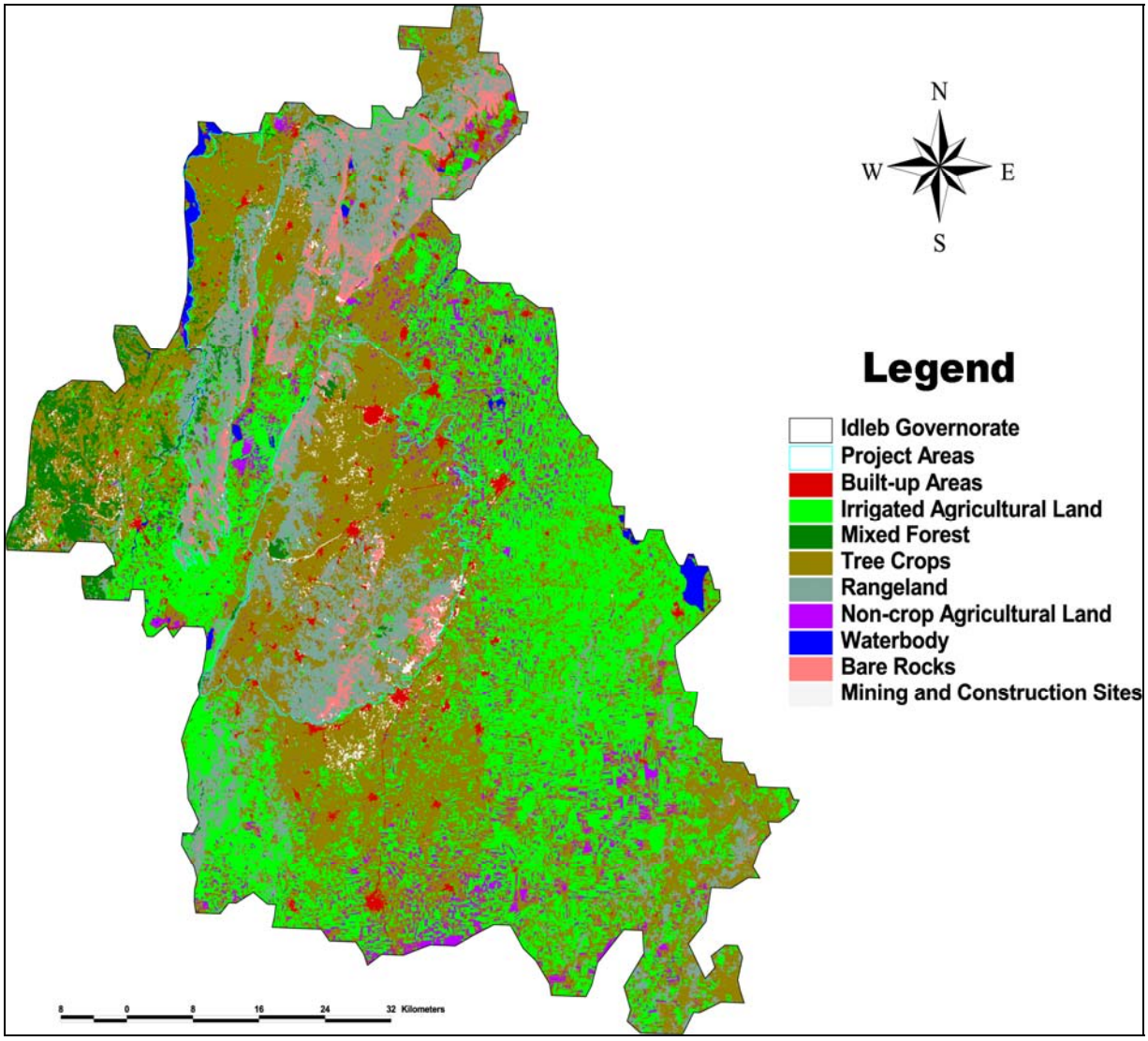


Figure 3. Land Use/Cover Map of the Idleb Region, Syria

Table 2. Land Use/Cover Groups in the Idleb Region

Number	Class Name	Surface Area (km^2)	Percentage (%)	Classification Accuracy
1	Built-Up Area	75.11	1.36	99.64%
2	Mixed Forest	141.51	2.56	96.92%
3	Irrigated Agricultural Land	1534.38	27.74	96.94%
4	Tree Crops	2260.01	40.85	**78.71**%
5	Rangeland	879.19	15.89	**70.01**%
6	Non-Crop Agricultural Land	330.43	5.97	87.12%
7	Water Body	50.43	0.91	99.40%
8	Bare Rock	185.67	3.36	92.96%
9	Mining and Construction Sites	75.77	1.36	83.06%
Total		**5532.52**	**100**	

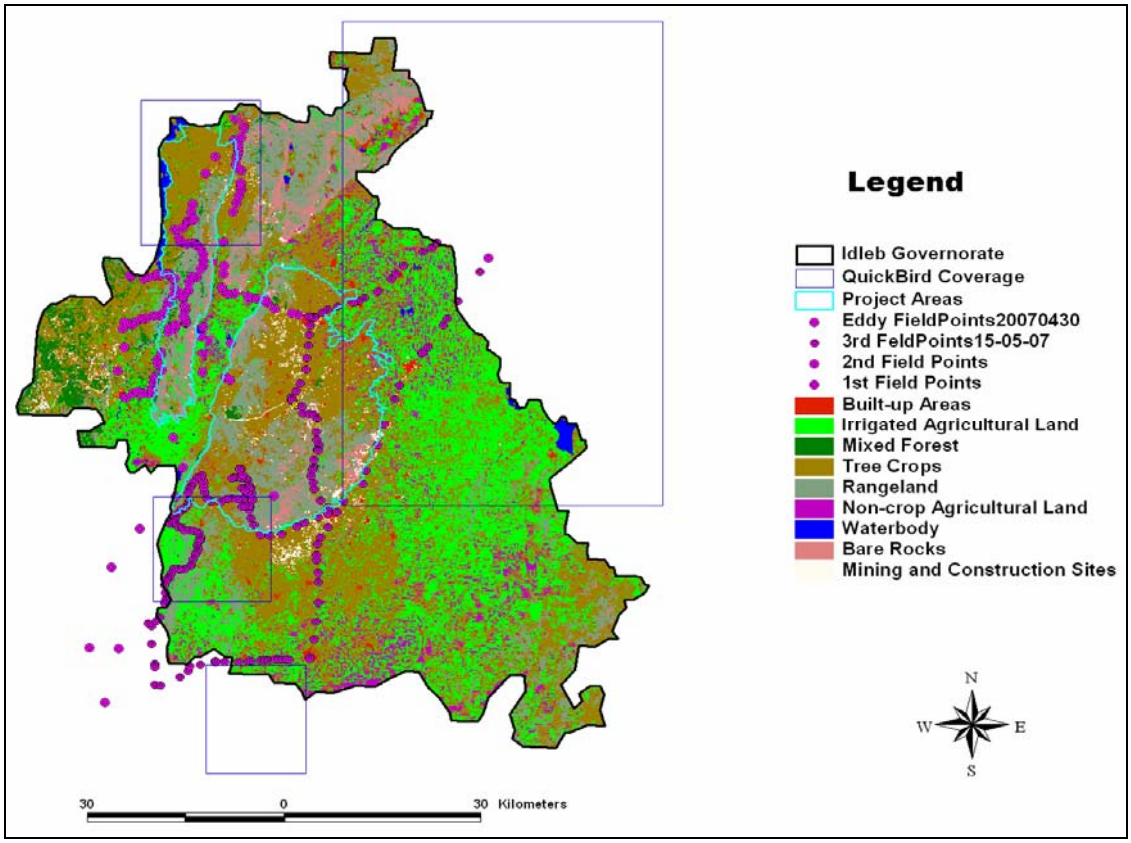


Figure 4. Verification and validation by Google Earth with QuickBird Coverage and Field Trips

3. Discussion

As shown in Table 2 and Figure 3, this classification produced 9 land use/land cover classes among which Tree Crops (40.85%), Irrigated Agricultural Land (27.74%) and Non-Crop Agricultural Land (5.97%) cover **74.56%** of the total land surface. Thus the Idleb Governorate is essentially an agriculture-dominant province, although the area under rangelands is certainly not negligible (15.89%). As for the Artificial surfaces, Built-Up Areas

occupy 1.36% of the territory but it is a dynamic land use since urbanization (surrounding the old urban area), transport system construction and limestone exploitation along the main roads and surrounding urban areas are expanding. Obviously this kind of land conversion leads to loss of a part of the rangelands, irrigated and non-irrigated arable land.

The natural vegetation cover, which includes the *Rangeland* and *Bare Rocks* classes, takes up 19%. In line with regional trends, this group, which is mainly used for animal husbandry, has been in reduction. The field survey revealed that where the soil is less stony the rangelands have been or are being reclaimed for planting olive and other kind of tree crops.

Forests occupy only 2.56%. In the east of the region, it is mainly artificially planted but in the western mountainous area of Jebel Wastani, there exists natural conifer and mixed forest areas.

The year 2003 was special, as in the spring of that year precipitation was higher than usual and, in addition, a major dam broke in the Ghab. As a result, some of the waterbodies are temporary, particularly those adjacent to the Orontes river.

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Appendix 1: Final Classification Confusion Report

Confusion Matrix: D:\RS Data\Idleb Project\June2007-Classif\8Class+Mine\8Class+Mine

Overall Accuracy = (288636/329736) 87.5355%
Kappa Coefficient = 0.8350

	Ground Truth (Percent)				
Class	Forest	Tree Crops	Rangeland	Waterbody	Bare Rock
Unclassified	0.00	0.00	0.00	0.00	0.00
Mixed Forest	96.92	1.03	2.22	0.00	0.00
Tree Crops	0.62	78.71	6.85	0.35	2.04
Rangeland	1.27	15.33	70.01	0.00	2.41
Waterbody	0.00	0.00	0.00	99.40	0.00
Bare Rocks	0.00	0.97	6.32	0.00	92.96
Mining and Co	0.00	0.83	0.11	0.00	2.57
Built-Up Area	0.00	0.14	0.00	0.00	0.00
Non-Crop Agri	0.00	1.27	0.16	0.01	0.02
Irrigated Agr	1.19	1.72	14.32	0.24	0.00
Total	100.00	100.00	100.00	100.00	100.00

	Ground Truth (Percent)				
Class	Mining	Built-Up	Non-Crop Agric	Irrigated Agr	Total
Unclassified	0.00	0.00	0.00	0.00	0.00
Mixed Forest	0.00	0.00	0.00	0.03	6.12
Tree Crops	5.34	0.00	12.14	2.31	32.19
Rangeland	0.55	0.00	0.32	0.66	11.34
Waterbody	0.00	0.00	0.18	0.00	5.74
Bare Rocks	10.78	0.00	0.00	0.00	4.59
Mining and Co	83.06	0.36	0.00	0.00	0.90
Built-Up Area	0.28	99.64	0.14	0.00	2.61
Non-Crop Agri	0.00	0.00	87.12	0.06	4.29
Irrigated Agr	0.00	0.00	0.10	96.94	32.23
Total	100.00	100.00	100.00	100.00	100.00

Class	Commission (Percent)	Omission (Percent)	Commission (Pixels)	Omission (Pixels)
Mixed Forest	9.25	3.08	1867/20177	581/18891
Tree Crops	5.94	21.29	6304/106153	27005/126854
Rangeland	55.49	29.99	20746/37384	7127/23765
Waterbody	0.13	0.60	25/18912	114/19001
Bare Rocks	19.32	7.04	2922/15128	924/13130
Mining and Co	48.93	16.94	1447/2957	308/1818
Built-Up Area	2.35	0.36	202/8599	30/8427
Non-Crop Agri	12.11	12.88	1713/14145	1838/14270
Irrigated Agr	5.53	3.06	5874/106281	3173/103580

Class	Prod. Acc. (Percent)	User Acc. (Percent)	Prod. Acc. (Pixels)	User Acc. (Pixels)
Mixed Forest	96.92	90.75	18310/18891	18310/20177
Tree Crops	78.71	94.06	99849/126854	99849/106153
Rangeland	70.01	44.51	16638/23765	16638/37384
Waterbody	99.40	99.87	18887/19001	18887/18912
Bare Rocks	92.96	80.68	12206/13130	12206/15128
Mining and Co	83.06	51.07	1510/1818	1510/2957
Built-Up Area	99.64	97.65	8397/8427	8397/8599
Non-Crop Agri	87.12	87.89	12432/14270	12432/14145
Irrigated Agr	96.94	94.47	100407/103580	100407/106281

Ecogeographical and Botanical Surveys in the Idleb Agricultural Development Project Area

Annex 5.6.

Guidelines for promoting *in-situ* /on-farm conservation of Agrobiodiversity in Jebel Zawia and Jebel Wastani

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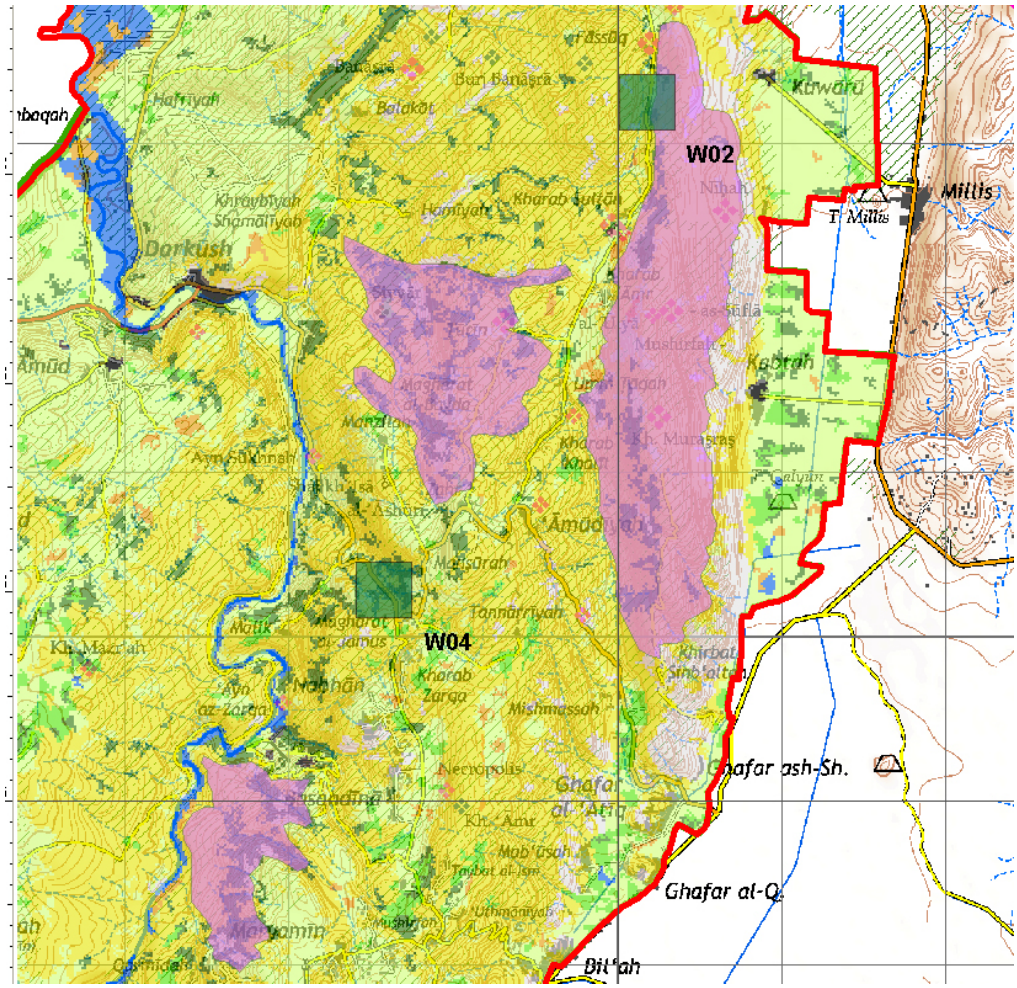

1. Introduction

This report presents the status and threats to local agrobiodiversity and recommends elements for management plans for promoting the *in situ*/on farm conservation of agrobiodiversity in Jebel Zawia and Jebel Wastani.

Agricultural biological diversity ('agro-biodiversity') is the variability of living organisms associated with the cultivation of crops and rearing of animals, as well as the ecological complexes of which they are part. This includes ecosystem diversity and landscapes. The diversity of genetic resources for food and agriculture encompasses all crop plants and their wild relatives which are cultivated, preserved, exchanged and utilized by farmers, and all livestock. As it contributes food, building materials, fuels, clothing, medicines to local communities living under harsh conditions, agricultural biodiversity is vital to secure their livelihoods. It constitutes the basis for sustaining agricultural development and global food security, in addition to the environmental benefits it provides at local, regional and global levels.

In situ/on-farm conservation is concerned with the maintenance of species' populations in their natural habitats, either as wild plant communities or as cultivated plants (landraces) in farmers' fields as part of existing agro-ecosystems. On-farm conservation, therefore, is the process that conserves not only the genes themselves but also the farming systems and agro-ecosystems that generate and maintain genetic diversity. *In situ* conservation aims to conserve both genetic material and the processes that give rise to diversity of genetic material. It complements the *ex situ* conservation efforts and allows a dynamic conservation of a larger genetic base and all the associated local knowledge.

The biodiversity in the project area is of global importance, since Syria is located in the Mediterranean Basin, one of the global biodiversity 'hot-spots' (Fig.1).

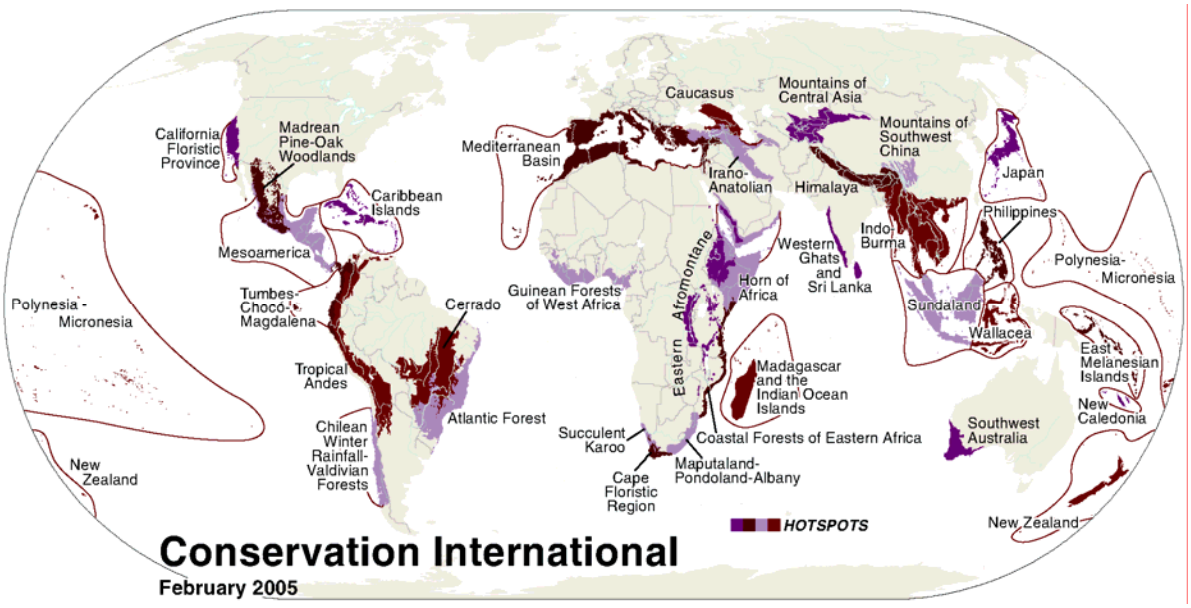

Figure 1. Biodiversity hotspots of the world (source: Conservation International, 2005)

The biodiversity within Syria is subject to alarming degradation brought by the increasing pressure on land and the overuse of the natural resources. Land reclamation from natural habitats for urbanization and farming purposes is increasingly threatening the remaining indigenous biodiversity which is now confined to fragmented patches of natural forests and highly degraded rangelands. The need for promoting the conservation of this valuable biodiversity is expressed at national, regional and international levels and Syria has signed all related agreements and conventions including the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). Syria has developed a national strategy and action plan for conservation of biodiversity and has undertaken several conservation actions through the establishment of more than 20 protected forest areas and more than 40 rangeland protected areas. Integrating agrobiodiversity concerns into national development is fundamental to an effective transition towards sustainable agricultural production. Land use planning is a pre-requisite for sustainable development at local and national levels and its enforcement will rely on the empowerment of local communities and the diversification of sources of incomes for the main custodians of local agrobiodiversity.

2. Methodology

2.1. Selection of observation and monitoring sites

New information generated by the GIS Unit at ICARDA, including spatial data on climate, land cover and land use, were used to better understand the diversity of the farming and eco-systems prevailing in the region. Google Earth images were also used to assess the extent of different land uses and of natural habitats represented by the selected sites. Field visits were undertaken by a multidisciplinary team (GIS, range, land, biodiversity specialists) and eco-geographic information was collected from 40 observation sites (18 in Jebel Zawia and 22 in Jebel Wastani), most of which are located under natural habitats (forests and rangelands).

The following criteria were used to select monitoring sites for undertaking the botanical surveys:

- Representativeness of prevailing eco-systems and types of plant diversities (forest, range, mixed systems, etc.);
- Species richness;
- Extent of the natural habitats (large areas, preferably);
- Land ownership (public or communal lands);
- Degree of threats (less disturbed areas preferably);
- Difficulty for access and for justification of land reclamation investment;
- Possibility for community consent for better management.

Based on these criteria, eleven monitoring sites were selected, seven in Jebel Zawia and four in Jebel Wastani. The location and main vegetation types of these sites are given in Table 1.

Table 1. Monitoring sites and their main vegetation types

Project area	Monitoring site	Symbol	Latitude	Longitude	Altitude	Predominant vegetation
Zawia	Bab-Alah	Z07	35.8368	36.52752	471	(herbaceous area (degraded rangeland)
	Kokfeen	Z06	35.63431	36.4174	662	herbaceous area (degraded rangeland)
	Mohanbel	Z05	35.79022	36.48305	526	herbaceous area (degraded rangeland)
	Dar-Dobat (Al Bara)	Z04	35.68062	36.52614	732	Herbaceous area inside the trees area
	Al-Rame	Z03	35.75354	36.53848	671	Herbaceous area adjacent to trees area.
	Kafar Haya	Z02	35.74908	36.5985	781	Herbaceous area adjacent to trees area
	Kafar Lata	Z01	35.79077	36.61841	801	Herbaceous area adjacent to trees area
Wastani	Al-Daher	W04	35.95978	36.41823	326	Herbaceous area inside the trees area
	Maryameen	W03	35.91133	36.40605	479	Herbaceous area inside the trees area
	Al-Fasook	W02	36.01392	36.45195	531	Herbaceous area inside the trees area
	Oreba	W01	36.14626	36.50709	457	Herbaceous area inside the trees area

2.2. Eco-geographical and botanical surveys

The eco-geographical and botanical survey was undertaken at three levels of observation: monitoring area, transect and plot. Survey forms developed by the GEF-ICARDA West Asia Dryland Agrobiodiversity Project were used. At the monitoring area level, general physiography and habitat, predominant land and cover, main disturbance factors and main community shared resources were assessed through general observation and by talking to representatives of local communities. Each threat to local agrobiodiversity was assessed using a scale of 0 to 9, with 0: no sign, 1: low, 3: low to medium, 5: medium, 7: medium to high, and 9: high.

Within each monitoring area three transects were selected and five quadrates (plots) per transect for either herbaceous or shrub/trees species, or both, depending on the situation. The plant density and cover of each plant species were determined in each quadrate. The transect-quadrate method was used to assess the species number, densities and frequencies, and the major threats. Quadrates of 1x1 m^2 and of 20x20 m^2 were used respectively for herbaceous and shrubs/trees. All monitoring areas and plots were geo-referenced using GPS and an altimeter. For more details on methods and measurements of the botanical survey is referred to Annex 5.3.

2.3. Socio-economic and farming systems survey

The secondary information gathered by the Idleb Rural Development Project was consulted and provided a better understanding of the farming systems and the expectations of local communities from the project. However, a Rapid Rural Appraisal is necessary to further assess the willingness of local communities to better manage natural resources including collective actions for conserving local agro-biodiversity.

2.4. Evaluation of conservation needs at the monitoring sites

For each monitoring site threats to agro-biodiversity and key elements of the management plans were identified .

3. Synthesis of results

3.1. Observation site summaries

The location of the observation sites is shown in Figure 2 and the main eco-geographic characteristics of these sites are summarized in Table 2.

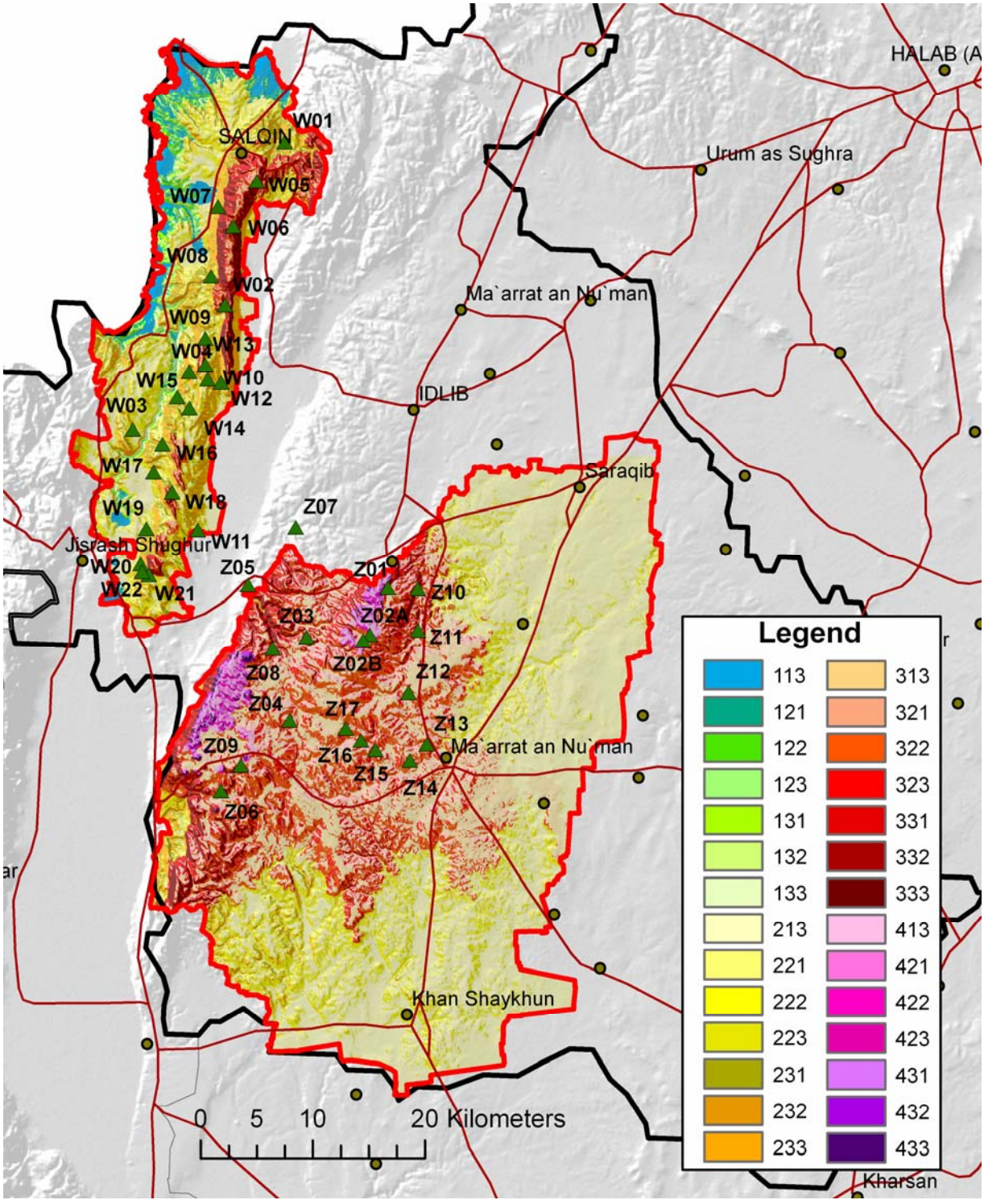

Figure 2. Observation sites (numbers and colors refer to terrain units)

Table 2. Locations and key terrain, habitat and agricultural features of the observation sites

AreaNo	Latitude	Longitude	Altitude	Terrain unit codes	Slope classes	Aspect classes	General habitat	Agricultural activity
Z01	35.78962	36.61980	780	313, 322, 323, 332, 422	All	Southern + undiff.	Grassland-dwarf shrubs	Mixed fruit orchard
Z02A	35.75144	36.60328	814	313, 321, 413, 422, 423	0-15%	All	Grassland-dwarf shrubs	Mixed fruit orchard
Z02B	35.74712	36.59689	787	313, 321, 322, 413	0-15%	All	Woodland	None
Z03	35.74850	36.54092	700	313, 322, 331, 332, 333	0-15%	All	Grassland-dwarf shrubs	Mixed fruit orchard
Z04	35.68138	36.52617	697	313, 321, 322, 323, 332, 333	All	All	Woodland	Mixed fruit orchard
Z05	35.78923	36.48207	444	No data			Natural grassland	Mixed fruit orchard
Z06	35.62301	36.46049	783	313, 322, 331, 332	All	All	Natural grassland	Mixed fruit orchard
Z07	35.83680	36.52752	435	No data			Grassland-dwarf shrubs	Mixed fruit orchard
Z08	35.73880	36.50767	650	313, 323, 331, 333	All	Undiff. + northern	Permanent crops	Mixed fruit orchard
Z09	35.64374	36.47948	800	321, 322, 323, 332, 333	5- >15%	All	Annual crop	Mixed fruit orchard
Z10	35.78942	36.64932	582	313, 322, 323, 332, 333	All	Undiff. + southern	Grassland-dwarf shrubs	Mixed fruit orchard
Z11	35.75613	36.65081	550	313, 321, 322, 323, 333	All	All	Grassland-dwarf shrubs	Mixed fruit orchard
Z12	35.70604	36.64280	590	313, 321, 322	0-15%	All	Natural grassland	Annual crops
Z13	35.66468	36.66201	536	313, 321, 322, 323	0-15%	All	Natural grassland	Mixed fruit orchard
Z14	35.65108	36.64579	550	313, 321, 322, 323	0-15%	All	Grassland-dwarf shrubs	Mixed fruit orchard
Z15	35.65898	36.61170	500	313, 321, 322, 331, 333	All	All	Grassland-dwarf shrubs	None
Z16	35.66638	36.59716	596	321, 322, 323	5-15%	All	Grassland-dwarf shrubs	None
Z17	35.67580	36.58198	668	313, 321, 322, 323	0-15%	All	Permanent crops	Mixed fruit orchard
W01	36.14626	36.50709	410	223, 231, 232	5- >15%	All	Woodland	Mixed fruit orchard
W02	36.01392	36.45195	510	222, 231, 232, 313, 322, 333	All	All	Woodland	Mixed fruit orchard
W03	35.91214	36.36407	435	213, 221, 222, 223	0-15%	All	Woodland	Mixed fruit orchard
W04	35.95978	36.41823	338	221, 223, 232	5- >15%	All	Woodland	None
W05	36.11381	36.48039	710	321, 322, 323, 332, 333	5- >15%	All	Natural grassland	Mixed fruit orchard
W06	36.07743	36.45799	785	321, 332, 333	5- >15%	All	Forest	Mixed fruit orchard

				221, 231, 233, 331	5- >15%	Northern + undiff.		Mixed fruit orchard
W07	36.09270	36.44241	270				Woodland	
W08	36.03702	36.43740	440	221, 223, 231, 232	5- >15%	All	Grassland-dwarf shrubs	Annual crops
W09	35.98705	36.43336	487	213, 221, 223, 231, 321	All	Northern + undiff.	Woodland	Annual crops
W10	35.95403	36.43666	455	213, 222, 233	All	Undiff. + southern	Grassland-dwarf shrubs	Mixed fruit orchard
W11	35.83270	36.43066	341	231, 233	>15%	Northern + undiff.	Natural grassland	Mixed fruit orchard
W12	35.95174	36.45021	260	213, 223, 232, 233	All	Undiff. + southern	Maquis	Mixed fruit orchard
W13	35.96562	36.43390	530	223, 231, 232, 321, 323, 332	5- >15%	All	Woodland	Mixed fruit orchard
W14	35.93020	36.41940	364	213, 221, 223, 231, 233	All	Undiff. + northern	Grassland-dwarf shrubs	Mixed fruit orchard
W15	35.93917	36.40716	297	131, 221, 231	5- >15%	Northern	Woodland	Mixed fruit orchard
W16	35.90083	36.39387	317	213, 221, 223, 231, 232, 233	All	All	Grassland-dwarf shrubs	Mixed fruit orchard
W17	35.87807	36.38577	315	213, 221, 223, 232, 233	All	All	Woodland	Mixed fruit orchard
W18	35.86201	36.40481	474	221, 223, 231, 333	All	Northern + undiff.	Grassland-dwarf shrubs	Mixed fruit orchard
W19	35.83248	36.38020	262	213, 221, 231, 233	All	Undiff. + southern	Grassland-dwarf shrubs	Mixed fruit orchard
W20	35.80380	36.37531	323	231, 233	>15%	Undiff. + southern	Natural grassland	Mixed fruit orchard
W21	35.79528	36.38376	485	213, 222, 231, 232, 233	All	All	Maquis	Mixed fruit orchard
W22	35.79750	36.37703	492	231, 232, 233	>15%	All	Natural grassland	None

Explanatory notes:

Terrain unit codes: for explanation see Table 1 in Main Report

All the sites are located outside the Ghab plains of Al-Ghab area and most are located in uplands, hills and plateaus (Fig. 3, left). The general habitats are mainly natural habitats fragmented by orchards of mainly olive and other fruit trees (Fig. 3, right). At Jebel Zawia most sites are natural grasslands or grasslands with shrubs, A Jebel Wastani woodlands and grasslands are predominant. With the exception of five sites which are exclusively located in natural habitats, all other sites are experiencing agricultural encroachment due to the establishment of fruit tree orchards (Fig. 4, left). These orchards have taken the most accessible and more flat lands. Most of the remaining natural habitats are either patches of forests and maquis or highly degraded rangelands with more than 70-80% of rocks (Fig. 4, right).

The land reclamation for agricultural purposes will require high investment, unless the alternative land use is either profitable, as in the case of urbanization, or when subsidized by development projects, as in the case of the Idleb project.

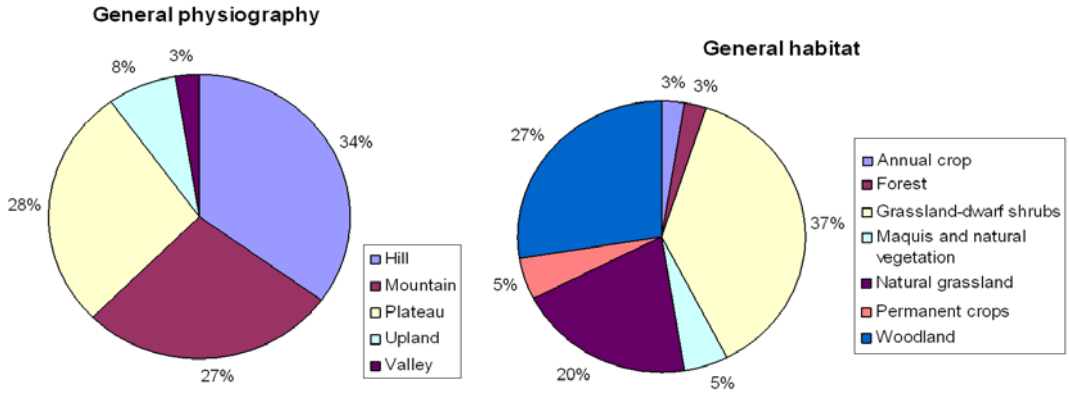

Figure 3. Physiography (left) and general habitats (right) of the observation sites

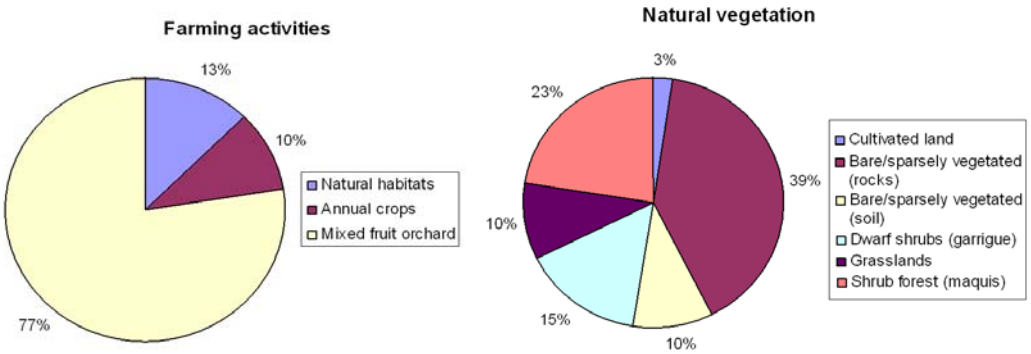

Figure 4. Farming activities (left) and natural vegetation types (right) of the observation sites

The threats to natural habitats and their biodiversity were assessed using the 0 to 9 scale. Overgrazing is the main factor of degradation affecting most of the sites in both areas, followed by land reclamation activities for urbanization and agricultural encroachment. Quarries are also severely affecting some of the sites (Table 3).

Table 3. Main threats to natural habitats and local agrobiodiversity

Site	Over-grazing	Urbani-zation	Agricul-tural Encroach-ment	Cutting	Terra-cing	Desto-ning	Quar-ries	Fire
Z01	5	1	5	5	1	1	0	0
Z02A	5	1	7	1	1	1	0	0
Z02B	1	0	0	1	1	1	5	0
Z03	1	0	3	1	1	1	3	1
Z04	1	5	7	1	5	5	5	1
Z05	5	1	3	1	1	3	3	0
Z06	0	5	1	5	1	5	0	0
Z07	9	0	5	5	1	5	0	0
Z08	5	1	1	1	1	3	1	0
Z09	5	5	3	5	3	5	1	1
Z10	9	5	1	1	1	5	3	1
Z11	1	9	9	1	1	5	5	0
Z12	9	9	5	5	5	9	9	1
Z13	9	9	5	5	5	3	9	1
Z14	5	7	5	1	5	1	3	1
Z15	9	0	0	5	0	1	3	0
Z16	3	0	0	9	1	1	1	0
Z17	7	1	1	7	3	3	5	
W01	5	5	3	9	5	3	5	0
W02	9	1	1	9	5	5	5	1
W03	5	3	5	5	3	3	3	0
W04	1	1	1	3	1	1	0	0
W05	9	7	9	5	5	5	9	1
W06	1	1	9	1	1	1	1	0
W07	9	5	9	9	9	9	3	1
W08	9	3	5	9	5	9	1	0
W09	9	5	3	7	5	3	3	0
W10	9	1	1	5	1	1	1	0
W11	9	9	5	3	3	3	1	0
W12	3	1	3	5	1	1	1	0
W13	1	5	1	5	1	1	1	0
W14	9	3	5	9	5	5	5	0
W15	9	1	5	9	1	1	1	0
W16	9	3	3	7	1	1	1	0
W17	9	5	5	9	3	3	7	0
W18	9	5	3	9	1	5	9	0
W19	9	5	5	7	3	5	5	0
W20	9	5	3	9	1	3	1	0
W21	9	3	5	7	5	5	7	0
W22	9	1	1	7	1	0	1	0

Most of the sites are affected by combined effects of many threats (Fig. 5). Especially the sites Z12, Z13, W05 and W07 are highly degraded. Only the sites Z02B, Z03, Z08 and W04 are least degraded, whereas the others have intermediate levels of degradation. While

overgrazing has continued over millennia, the new threats to the natural habitats are due to land reclamation and quarries, which are spreading rapidly in the last 30-50 years.

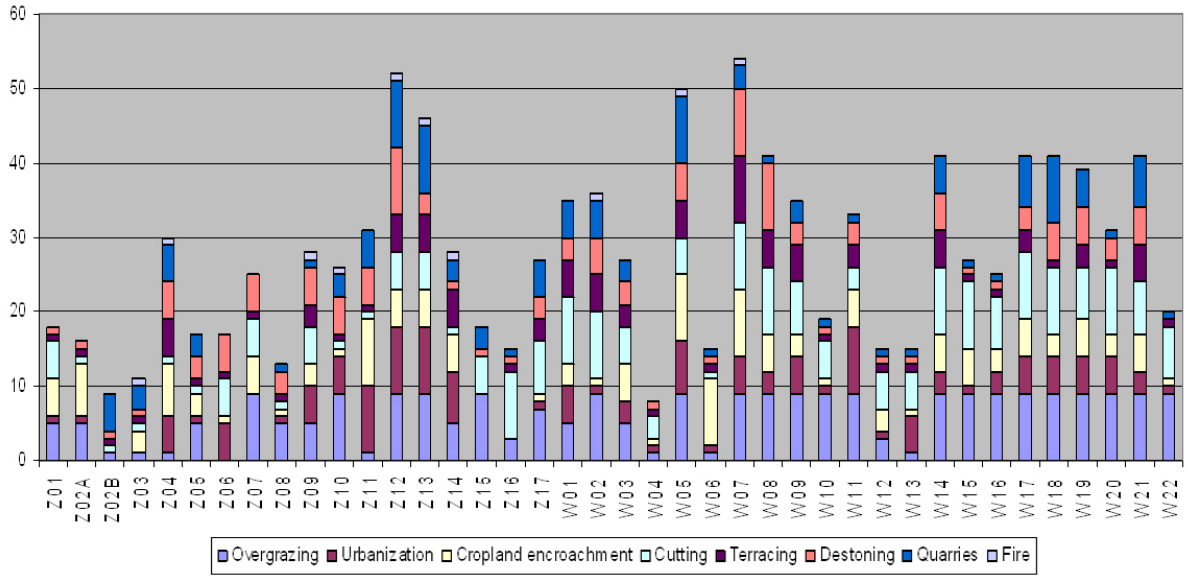

Figure 5. Main threats to natural habitats and local agrobiodiversity in the observation sites

3.2. Monitoring site summaries

Based on the set criteria and on the extent of threats, eleven sites (Fig. 6) were selected from the 40 sites visited. Botanical surveys were conducted in these sites to determine the species richness and densities. These sites were representative of the prevailing natural habitats and are rich in herbaceous, shrubs and wild tree species (Table 4). Herewith follows a summary of major findings from the botanical survey. For full details is referred to Annex 5.3.

The predominant vegetation type belongs to the Euro-Mediterranean bioclimatic zone dominated by *Quercus calliprinus*, *Pistacia palaestina*, *Rhamnus palaestinus* and *Crataegus azoralus*. The degradation of these forests has resulted in degraded rangelands dominated by *Poterum spinosum*, *Phillyaris media*, *Phomis longifolia* and *Cistus villosa.* Despite the widespread degradation, the project area has a considerable plant biodiversity with a total number of species in all sites exceeding 330, belonging to 59 families. The sites at Jebel Wastani located within the woodlands, have generally more plant species than most of the grasslands and rangelands sites in Jebel Zawia. Sites W1, W3 and Z1 have the highest numbers of herbaceous, shrubs and wild tree species. The natural habitats in the project areas cover 48,476 ha (93.6% of rangelands, 6.4 % of forest area, which represent 12% of total acreage of the two target areas and 40% of the natural habitats of Idleb province. However, only few forest patches are still rich in biodiversity and areless affected by degradation factors.

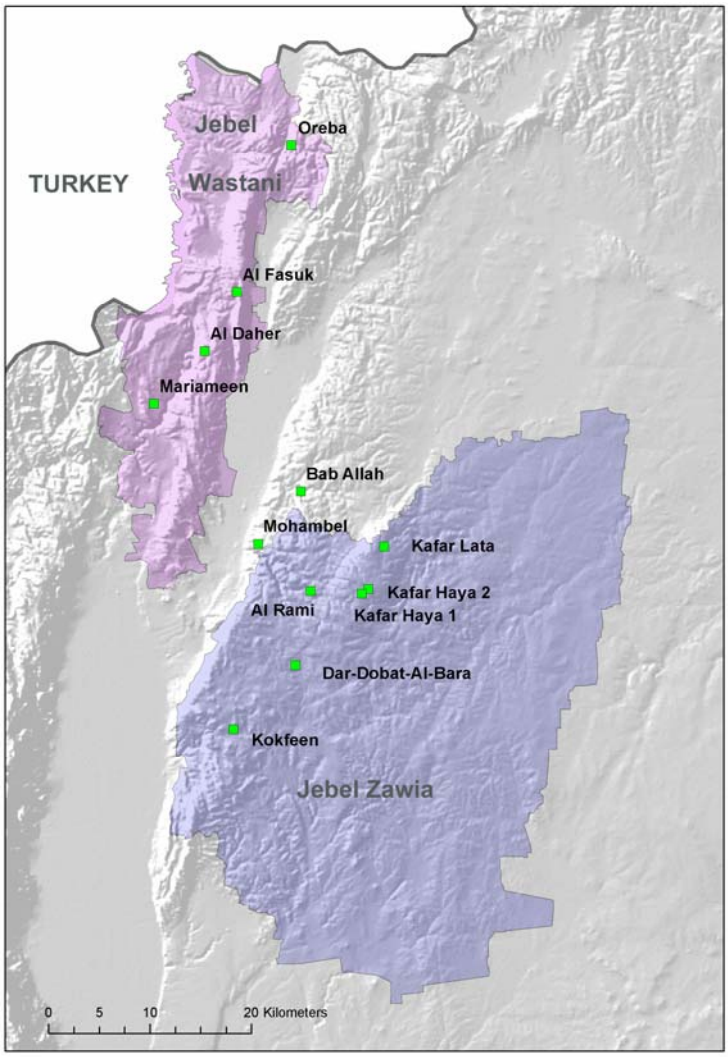

Figure 6. Monitoring sites in Jebel Zawia and Jebel Wastani

Table 4. General habitats and species richness and composition of the selected monitoring sites in Jebel Wastani and Jebel Zawia

Site	Name	General habitats	Herbaceous	Shrubs	Trees	Total
Z1	Kafar Lata	Grassland-dwarf shrubs	100	10	6	116
Z2	Kafar Haya	Grassland-dwarf shrubs	82	15	8	105
Z3	Al Rami	Grassland-dwarf shrubs	85	7	6	98
Z4	Al Bara, Dar Dobat	Woodland	91	5	9	105
Z5	Mohambel	Natural grassland	92	3	0	95
Z6	Kokfeen	Natural grassland	52	1	0	53
Z7	Bab Allah	Grassland-dwarf shrubs	80	1	0	81
W1	Oreba	Woodland	111	13	9	133
W2	Al Fasuk	Woodland	106	10	7	123
W3	Mariameen	Woodland	89	14	5	108
W4	Al Daher	Woodland	81	6	4	91

The number of species per family in each site is included in Table 5. The most dominant and rare species across all the sites are reported in Table 6. Many wild relatives of fruit trees and neglected species are found in the sites (Table 7). Most of the species have multiple uses ranging from feed to medicinal attributes (Table 8).

Table 5. Number of species per family in each of the monitoring sites

Family	Z1	Z2	Z3	Z4	Z5	Z6	Z7	W1	W2	W3	W4
Leguminosae	31	21	31	20	26	2	21	38	30	27	25
Compositae	9	14	12	14	14	11	15	15	13	15	8
Gramineae	18	12	16	20	14	18	19	22	23	16	18
Labiatae	3	5	2	3	4	0	1	4	4	4	1
Umbelliferae	5	6	3	5	4	3	5	8	6	7	7
Cruciferae	7	6	5	4	5	5	4	2	3	4	2
Caryophyllaceae	4	1	1	3	4	3	4	1	4	3	3
Rosaceae	4	7	2	4	2	0	1	6	2	2	1
Ranunculaceae	2	3	2	2	1	0	0	3	3	3	2
Rubiaceae	2	1	0	4	3	1	1	3	4	1	3
Scrophulariaceae	2	2	3	1	1	0	0	0	2	0	1
Euphorbiaceae	1	2	1	2	3	2	2	2	2	1	0
Hyacinthaceae	4	3	0	0	0	0	0	0	0	0	0
Geraniaceae	2	1	1	3	0	1	1	2	3	0	3
Fagaceae	1	3	1	3	0	0	0	1	2	1	1
Papaveraceae	2	0	0	1	0	1	1	1	1	1	0
Plantaginaceae	0	1	0	1	4	1	1	4	0	2	2
Valerianaceae	0	3	2	1	1	0	0	0	0	1	0
Anacardiaceae	3	2	1	1	0	0	0	1	1	1	1
Dipsacaceae	0	0	0	0	0	0	1	2	2	1	0
Iridaceae	2	0	0	0	0	0	0	0	0	0	1
Oleaceae	1	1	3	3	0	0	0	3	2	2	2
Alliaceae	1	0	1	1	1	0	0	1	1	2	1
Asphodelaceae	0	1	1	1	1	1	1	1	1	1	0
Campanulaceae	1	2	1	1	0	1	1	0	2	1	1
Cistaceae	1	1	1	1	1	0	0	1	1	3	1
Illecebraceae	0	0	0	0	0	0	1	0	0	0	0
Linaceae	1	0	2	1	1	0	0	2	1	1	0
Aristolochiaceae	1	0	0	0	0	1	0	0	0	0	0
Asparagaceae	1	1	1	0	0	1	0	1	1	1	1
Boraginaceae	0	0	0	0	1	0	0	1	0	0	0
Capparaceae	0	0	0	0	0	0	0	1	0	0	0
Caprifoliaceae	1	1	0	0	0	0	0	0	0	0	0
Convolvulaceae	0	0	0	0	1	0	0	0	0	1	0
Cucurbitaceae	0	1	0	0	0	0	0	0	1	0	1
Cyperaceae	0	0	0	0	1	0	1	0	0	0	0
Ephedraceae	0	0	0	0	0	0	0	0	0	1	0
Lauraceae	0	0	0	0	0	0	0	0	1	0	0
Liliaceae	1	1	0	1	1	0	0	0	0	0	0
Moraceae	0	0	0	1	0	0	0	1	0	0	0
Pinaceae	0	0	1	0	0	0	0	0	0	0	0
Polygonaceae	0	0	0	0	0	0	0	1	0	0	0
Primulaceae	1	0	1	1	1	1	0	1	1	1	1
Rhamnaceae	1	1	1	1	0	0	0	1	1	1	1
Santalaceae	1	1	1	1	0	0	0	1	1	1	1
Smilacaceae	1	0	1	0	0	0	0	0	2	1	1
Solanaceae	0	1	0	0	0	0	0	0	0	0	0
Styracaceae	0	0	0	0	0	0	0	1	1	0	0
Thymelaeaceae	0	0	0	0	0	0	0	0	1	1	1
Vitaceae	0	0	0	0	0	0	0	1	0	0	0
Zygophyllaceae	1	0	0	0	0	0	0	0	0	0	0
Total	116	105	98	105	95	53	81	133	123	108	91

Table 6. List of most dominant and rare species across the monitoring sites

Rare species	**Most dominant species**
Cistus creticus	*Capparis spinosa*
Paronychia palaestina	*Quercus calliprinos*
Reichardia tingitana	*Lagoecia cuminoides*
Trigonella monantha	*Trifolium stellatum*
Adonis annua	*Caucalis tenella*
Allium scorodoprasum	*Phillyrea latifolia*
Anagyris foetida	*Pistacia palaestina*
Arabis aucheri	*Osyris alba*
Bituminaria bituminosa	*Trifolium scabrum*
Bolanthus filicaulis	*Avena sterilis*
Callipeltis cucullaria	*Lolium rigidum*
Carthamus persicus	*Torilis leptophylla*
Cynosurus elegans	*Trifolium tomentosum*
Echinops polyceras	*Trifolium campestre*
Eryngium glomeratum	*Rhamnus palaestinus*
Galium aparine	*Bromus danthoniae*
Gladiolus aleppicus	*Sonchus oleraceus*
Gynandriris sisyrinchium	*Trifolium pilulare*
Hirschfeldia incana	*Rhagadiolus stellatus*
Lactuca tuberosa	*Koeleria phleoides*
Lathyrus digitatus	*Poa bulbosa*
Lathyrus marmoratus	*Helianthemum salicifolium*
Leopoldia comosa	*Ranunculus millefolius*
Lycium depressum	*Hordeum bulbosum*
Medicago blancheana var. blancheana	*Avena barbata*
Medicago blancheana var. bonarotiana	*Aegilops triuncialis*
Medicago laciniata	*Trifolium argutum*
Medicago rigidula var. submitis	*Artedia squamata*
Peganum harmala	*Catapodium rigidum*
Phlomis platystegia	*Daphne oleifolia*
Pimpinella eriocarpa	*Hymenocarpos circinatus*
Pyrus syriaca	*Linum pubescens*
Trigonella noaeana	*Trifolium purpureum*
Trigonella spicata	*Crataegus azarolus*
Veronica persica	*Asphodelus microcarpus*
Veronica polita	*Anthemis maris-mortui*
Vulpia myuros	*Erodium cicutarium*
Bellevalia flexuosa	*Plantago lanceolata*
Bifora testiculata	*Bromus lanceolatus var. lanatus*
Biserrula pelecinus	*Hedypnois rhagadioloides*
Chardinia orientalis	*Medicago coronata*
Ephedra peduncularis	*Tragopogon buphthalmoides*
Erodium subintegrifolium	*Trigonella filipes*
Euphorbia exigua	
Ficus carica var. caprificus	
Geranium columbinum	
Geropogon hybridus	
Lactuca serriola	
Lathyrus hierosolymitanus	
Leopoldia eburnea	
Lotus halophilus	
Medicago aculeata var. aculeata	
Medicago minima var. minima	
Minuartia decipiens	
Quercus aegilops	
Quercus libani	

Table 7. Wild relatives of fruit trees found in the monitoring sites

Species	Arabic name	Z1	Z2	Z 3	Z 4	Z 5	Z 6	Z 7	W 1	W 2	W 3	W 4
Amygdalus orientalis	لوز بري	√	√						√			
Capparis spinosa	شفلح, قبار	√							√			
Cerasus mahaleb	المحلب		√						√			
Cichorium pumilum	هندباء برية					√	√	√			√	√
Crataegus azarolus	الزعرور البري	√	√	√	√				√	√	√	√
Ficus carica var. caprificus	التين البري				√				√			
Gladiolus aleppicus	الجلاديول الحلبي				√							
Gundelia tournefortii	السلبين		√									
Iris histrio	السوسن											√
Laurus nobilis	الغار									√		√
Micromeria myrtifolia	شاي بري			√	√				√	√		
Olea europeae var. oleaster	زيتون بري			√	√				√	√		√
Onopordum heteracanthum	قندريس							√				
Pistacia palaestina	البطم الفلسطيني	√	√	√	√				√	√	√	√
Prunus microcarpa	خوخ بري	√	√		√							
Pyrus syriaca	اجاص بري			√	√							
Quercus calliprinos	سنديان عادي	√	√	√	√				√	√	√	√
Quercus infectoria	سنديان بلوطي		√		√					√		
Quercus libani	سنديان لبناني		√									
Rhamnus palaestinus	سويد فلسطيني	√	√	√	√				√	√	√	√
Rhus coriaria	السماق	√										
Rosa conina	ورد نسريني		√		√							
Thymus syriacus	الزعتر السوري	√	√									

Table 8. Number of species within each category of use

Sites	*Forage*	*Bee Plants*	*Affores tation*	*Hedge*	*Erosion control*	*Soil improvement*	*Graft stock*	*Shade*	*Food*	*Food Additive*	*Fuels*	*Industrial*	*Aromatic*	*Ornamental*	*Medicinal*	*Pesticide*	*Vertebrate* Poisons
Z1	73	32	4	6	15	30	4	3	16	7	7	6	4	10	30	0	0
Z2	62	24	6	6	20	20	5	6	17	3	9	6	4	11	33	0	0
Z3	74	23	4	3	14	29	3	4	13	2	5	5	2	9	23	1	0
Z4	73	25	5	3	16	18	6	5	11	4	7	5	2	9	28	1	0
Z5	54	22	0	0	5	24	0	0	6	1	0	1	0	1	25	0	0
Z6	35	9	0	1	7	3	0	0	6	0	0	1	0	4	22	0	0
Z7	51	17	0	0	8	20	0	0	7	0	0	1	0	2	24	0	0
W1	88	33	5	3	17	36	6	4	11	4	6	7	2	5	38	1	1
W2	80	25	5	2	13	30	3	5	13	4	6	6	2	10	27	0	1
W3	66	22	3	3	12	27	2	3	11	4	5	5	1	9	29	0	0
W4	65	23	4	3	9	24	3	3	10	2	5	5	1	9	19	0	0

3.3. Profile of a candidate conservation area: Oreba

In order to explain the principles of developing a management plan (Chapter 5) for an area in which the biodiversity needs to be protected, one area was studied in greater detail. A complete profile of this area, around monitoring site W1 (Oreba) is provided in the following paragraphs, with descriptions of location, environmental conditions, status of plant biodiversity, tenure, land use and agricultural practices, factors of degradation, and an evaluation of the expected sustainability of the proposed management plan.

3.3.1. Location

Oreba is located in the northeastern part of Jebel Wastani. The area is dominated by strongly dissected hills. The main agricultural activities in this area are the cultivation of olives, figs, stone fruits, field crops and grazing of the natural grasslands. The Oreba conservation area is located west of Kafar Takharim town and extends to Oreba village. The site has a fertile soil with an area of about 5 km^2. The area has a steep south-facing slope and less steep north-facing slope.

3.3.2. Climate

The average annual rainfall is 690 mm. The maximum temperature, averaged over the year is about 23 C°, the minimum temperature averaged over the year is about 12 C°. The maximum temperature during the warmest month (July) is about 32 C° and the minimum temperature during the coldest month (January) is about 3 C°.

3.3.3. Topography and soils

Oreba is an upland area at altitude of 400 to 450 meters above sea level. The slopes vary considerably, but exceed generally 5% and even 15% in most parts. Flat land is rare. The area is dominated by Terra Rossa soil types with similar color and structure but variable soil depth.

3.3.4. Status of local plant diversity

The target taxa are distributed over the entire site. Different populations of the target taxa are found in different parts of the candidate conservation area, but density and frequency of the species vary considerably. Very good populations are found near field borders and in non-grazed areas. In general the highest occurrence of the target taxa is along the valley which has deep and fertile soil and good moisture content. Fortunately these populations are almost protected from animal grazing by local customs because they are surrounded by fruit trees orchards and sheep are not allowed in these areas. On the other hand, the populations on the hill slopes and ridges with shallow soils, are suffering from overgrazing

Tree species

Quercus calliprinos (22.73%), *Rhamnus palaestinus* (3.40), *Pistacia palaestina* (3.07%), *Styrax officinalis* (2.93), *Pillarea latifolia* (1.27%), *Crataegus azarolus* (1.27%) *and Olea europaea* (1.07%) are the major species found in the site, with other species such as *Amygdalus orientalis, Ficus carica* and *Vitis vinifera.*

Herbaceous species:

The plant cover of the Oreba site is mainly composed of herbaceous species (77%). The dominant plant cover is wild grasses and shrubs like. *Avena sterilis, Koeleria phleoides, Asphodelus microcarpus, Torilis leptophylla, Hordeum bulbosum, Phagnalon barbeyanum,*

Rumex cassius, Stachys arvensis, Lagoecia cuminoides, Caucalis tenella, Hymenocarpos circinatus, Aegilops truincialis, Lolium rigidum, Anthemis cornucopiae, Sonchus oleraceus, Artedia squamata, Bromus danthoniae, Plantago cretica, Hordeum vulgare, Aegilops ovata, Hordeum spontaneum, Sacropoterium spinosum, Briza maxima, Onobrychis aequidentata, Bromus diandrus, Hippocrepis unisiliquosa, Onobrychis caput-galli, Linum pubescens, Sanguisorba minor, Sinapis arvensis, Bifora testiculata, Pisum sp., Avena sp., Bromus sp., Astragalus sp., and a large number of forage and medicinal species.

Forage legume species with high potentials to be used for rangeland rehabilitation and forage production are:

Medicago coronata, Medicago orbicularis, Medicago polymorpha, Medicago radiata, Medicago rigidula, Medicago rotata, Medicago doliata , Medicago scutellata

Trifolium campestre, Trifolium clusii, Trifolium lappaceum,, Trifolium nigrescens, *Trifolium purpureum, Trifolium scabrum, Trifolium spumosum, Trifolium stellatum, Trifolium tomentosum, Trifolium sp. Vicia palaestina. Lathyrus aphaca, Lathyrus heirosolomitanus, Lathyrus marmoratus , Lathyrus sp.*

Of the cultivated species the olive tree is the major fruit tree in the area with scattered trees of grapes, and stone fruit trees as secondary trees. Wheat *(Triticum sp.),* barley *(Hordeum sp.),* chickpea *(Cicer sp.),* and lentil *(Lens sp.)* are the majors field crops.

3.3.5. Land use and use rights

There is currently no protection of the biodiversity in Oreba area. However, many of the local farmer practices play an indirect role in protecting the biodiversity of the site. For example, the cultivated fruit trees orchards in the valley play a positive role in protecting the orchard edges from grazing, because the grazing is completely prohibited at these orchards. Hence all kind of target grasses and weeds are conserved at their habitat. In addition, most of the fruit trees in the site are landraces and local varieties, and consequently are conserved on-farm.

In total nearly 40% of the Oreba site was located in cultivated land. Human management of this area was cultivation. The remaining was covered by shrub land and grassland-Batha. This area was mainly managed for grazing and hunting. The cultivated land is private and the uncultivated land and the rangelands are for public use and belong to the government.

3.3.6. Agricultural practices

The main agricultural practices in the site are mainly traditional practices to managed fruit trees orchards, like plowing the land, fertilizing, pruning, and harvesting. Most of these practices are done by the farmers and their families. Some of the practices, such as the use of chemicals need to be managed and modified to serve the biological conservation and will therefore require attention in the site management plan.

3.3.7. Grazing pressure

The cultivated part of the site had a low grazing pressure as it is protected by the local farmer practices and by the social customs in the area. However, the much larger non-cultivated part is suffering from high grazing pressure.

The area around the Oreba site has few herders and few families depending on animal husbandry.

3.3.8. Factors of degradation

The target populations in the site suffered from different kinds of degradation factors, however, of these the main threats come from overgrazing, followed by cultivation. In addition, some of the farmer practices such as weeding and plowing play also a major role in the genetic erosion of the target populations.

Land reclamation is probably the most important intervention affecting the biodiversity of the area. The destruction of natural habitats for cultivation of orchards has decimated most of the target species. The farmers used to reclaim land by removing the big stones from inside the fields, build retaining walls and then plant introduced or local fruit trees like apricot, grape, plums, almonds, etc.

Quarries which are encroaching into the site and the neighbouring fields is threatening the remaining natural habitats through destruction of the land and the dusts which causes pollution and low fertility of flowers.

The continuing presence of these factors will cause genetic erosion in the species and the natural habitats, which will lead to great loss of useful genes and gene combinations from the target and non target plant populations. The management plan should play a vital role to decrease this erosion to a minimum level, and to decrease and reverse the effects of the degradation factors.

In summary, the following degradation factors have been identified in the Oreba site:

1- Use of improved varieties

The uniformity imposed by the promotion of a limited number of improved crop varieties, certainly exacts a price for the (perhaps) improved productivity, in the form of genetic erosion and loss of biodiversity. In the management plan incentives could be anticipated for encouraging farmers to use landraces (traditional crop varieties) which could have better adaptation to harsh conditions and good quality attributes.

Figure 7. Improved fruit tree varieties are replacing the land races

2- Overgrazing

Overgrazing is one of the most important factors of agro-biodiversity loss in Jebel Wastani. The resulting loss of vegetation may result in a loss of palatable forage species and cause weed invasion and predominance of non-palatable and poisonous species.

Figure 8. Overgrazing has denuded once green hills

3- Urbanization

Urbanization could be considered a major threat to biodiversity as a whole. Due to high population growth (currently estimated at 3.5% in the hilly areas of Idleb Province), large areas of the cultivated area are lost because of expansion of cities and villages toward the rural areas.

Figure 9. There are very few spots left that have remained unaffected by urbanization

4- Agricultural practices

Improper agricultural practices characterized by unbalanced fertilizer use, plantation density, uncontrolled spread of industrial plantations and mechanized agriculture. For example, the abuses and misuses of fertilizers and pesticides gradually might result in the disappearance of many local varieties.

5- Cutting

Environmental damage can also be inflicted on land through wood cutting for timber, firewood, charcoal etc. Removal of woody vegetation may increase soil erosion and reduce water retention, resulting in reduced water availability and crop productivity.

Figure 10. Effects of wood cutting

6- Land reclamation

As unavoidable as the objective is to create new land for poor people, this kind of practice should be managed in a way that it is compatible with maintaining biodiversity in the sites.

Figure 11. Soil has become a commodity to be taken from one place and moved to another

7- Quarries

Among the most important factors that may lead to destruction of the environment and consequently the loss of habitat is the waste (dust and wastewater) resulting from quarries and cutting stone factories. The building stones industry threatens the environment in different ways. The dust and the heavy particles of the limestone probably changes the soil chemical and the physical structure of the agriculture land in the vicinity of quarries and construction sites. Also it decreases the area of the agricultural land and the grazing land through the area occupied by the quarries.

Figure 12. Visually quarries are like open wounds in the landscape.

Figure 13. Not only rocks but also soil can be mined

3.3.9. Populations of target taxa

The populations of the target taxa in the site are in general healthy and the frequency is good. We can find many populations of the target taxa along the site, mostly located at the strips and on the borders of fields, or protected under the shrubs of the other plants. Weed cleaning and plowing can not reach these borders of the orchards, and they are protected from animal grazing by the farmers themselves.

Figure 14. View over part of Oreba. Note the terraced land with tree crops in the background

On the other hand, populations seem to be weaker on shallow soils, probably because these dry out early and are affected by over-grazing before seed set.

3.3.10. Sustainability of the proposed conservation area

The local farmers are vital to the sustainability of the candidate Oreba conservation area, as it is mostly privately owned. A special committee of the farmers should be formed to represent the farmers to monitor and manage the reserve with the responsible staff from the Directorate of the Natural Protected Areas of the Ministry of Agriculture and Agrarian Reform, In addition to involving the local farmers, other factors play important roles in the sustainability of the conservation area, such as government regulations, the policy and legislation of the Ministry of Agriculture and Agrarian Reform (MAAR), and the strategies of the Ministry of Environment and of the Ministry of Industry and Local Government.

It is crucial that all stakeholders are aware of the importance of a conservation area for future generations, as a source of genetic resources and for environmental sustainability. Public awareness programs at all levels are therefore essential along with the management plan for the conservation area.

Already a monitoring system was formulated for this proposed conservation area by the Idleb Rural Development Project. Monitoring is an important step to ensure the validity of the management options proposed for the conservation area. The monitoring results will be used to check if the management options are playing a positive role in insuring the stability of the target populations frequency and abundance. Management options can be modified and improved based on the monitoring results. Management plans need to be revised regularly to achieve a good performance of the target populations in the site.

The following constraints could influence the management of the conservation area and requires particular attention in the monitoring activities:

Land tenure
Part of Oreba is privately owned land and this may play a negative role in implementing the proposed management activities. Farmers and government representatives should agree on areas to be managed for conservation of local agrobiodiversity.

Local farmers
Local farmers are the main players in the success of the management plans and they should be convinced of the objectives and of the need for the conservation area. In addition, for sustainability it is important that in due course they will get benefits from the conservation of local agrobiodiversity.

Industrial projects
There is currently very little regulation on the siting of quarries. Land use regulations are needed for regulating quarries. Perhaps a tax could be levied to rehabilitate the lands they degraded and to conserve at the same time local agrobiodiversity.

Agricultural practices
There are many low-cost technologies which can combine good productivity of landraces and natural habitats.

Land development (reclamation)
The local communities in the Oreba area are likely to reclaim more natural habitats. This should be regulated through of land use plans, based on land suitability studies and legislation for protecting national heritage.

4. Recommendations

4.1. Establishing conservation areas in Jebel Wastani and Jebel Zawia

4.1.1. Introduction

The biodiversity in the target areas has a local and global significance and needs to be conserved *in situ* as alarming degradation and loss is taking place in the remaining natural habitats. A community-driven approach will be followed to ensure the conservation of local agrobiodiversity while sustaining its use for the benefit of the livelihoods of local communities. The proposed conservation areas will be composed of the remaining less disturbed natural habitats to ensure larger managed area.

4.1.2. Conservation objectives

- To implement long-term conservation and ensure the continuous availability of the agro-biodiversity, the species of importance for food security and production at the national, regional and international levels (including wild relatives of field crops and forest and fruit trees);
- To ensure the continuous availability of the agro-biodiversity for the rehabilitation of degraded areas;
- To promote alternative land uses which promote the conservation of target species while improving the livelihoods of local communities;
- To increase national capacity through training in the in situ conservation techniques;
- To encourage the local authorities in implementing the policies and legislation related to in situ conservation and sustainable use;
- To understand the causes of agrobiodiversity degradation at the site and the dynamics of populations as a contribution to strengthening the scientific basis for in-situ conservation and as a support for academic and school extra-curricula activities;
- To encourage alternative sources of income like eco-tourism in the site;
- To strengthen community-driven management approach for managing natural habitats;
- To contribute to the conservation of wild life.

4.1.3. Place of the conservation areas in the overall conservation strategy for the target taxa

Oreba and Al-Fasook in Jebel Wastani, and Kafar Lata and Dar Dobat (Al-Bara) in Jebel Zawia are four sites of the few biodiversity-rich spots that remain in Idleb Province but are increasingly under one or more of the threats described in section 3.3.8. Conservation of globally significant agrobiodiversity is a priority of the Ministry of Agriculture and Agrarian Reform in Syria,

To allow conservation of the rich biodiversity and its sustainable use, it is essential to call for the establishment of conservation areas and develop management plans for these recommended sites *In situ* conservation will complement the efforts of collecting samples of the target species to be stored *ex situ* while allowing for the preservation of the ecosystems as a whole and to benefit from the continuous effects of natural selection.

Figure 15. Oreba monitoring site. In the view a mosaic of small cultivated patches in the deeper soil pockets alternating with degraded natural vegetation in an uneasy equilibrium.

Figure 16. Oreba monitoring site. Note the heterogeneity in cover and state of degradation.

Figure 16. Al-Fasook monitoring site. Note the use of imported species in the foreground

Figure 17. Al-Fasook monitoring site. Note the good vegetation cover.

Figure 18. Kafar Lata monitoring site.

Figure 18. Kafar Lata. Note in both photographs the good cover with both trees and herbaceous species.

Figure 19. Monitoring site Dar Dobat (Al-Bara), with Byzantine church in the background

Figure 20. Dense tree and herbaceous cover at Dar Dobat (Al-Bara)

The proposed conservation areas at Oreba and Al Fasouk in the North West part of Idleb province will promote the conservation of the target species and will complement the Kafar Lata and Dar-Dobat (Al-Bara) conservation areas in Jebel Zawia.

Part two: Target taxon

The four proposed natural reserves are recommended to conserve the target species of forest and fruit trees species as well as the field crop wild relatives and landraces which are the most important to the development of agricultural system in the area and to conserve the natural habitat in the sites through the prepared management plan which will allow the conservation of all ecosystem components including the targeted species. This approach will allow preserving the species richness and the related genetic diversity as well as the environmental benefits. This reserve will also serve, through rehabilitation and restoration efforts to conserve wild forest and fruit tree species endangered**.** The management plan will take into consideration the conservation of the species settled in the site, special attention will be devoted to the conservation of the following groups of species:

Forage legumes: *Medicago* sp.*, Vicia* sp.*, Trifolium* sp.*, and Lathyrus* sp.

Cereals: *Triticum* sp., *Avena* sp., *Hordeum* sp.*, Lolium sp.* and *Aegilops* sp.

Fruit trees: *Quercus sp, Rhamnus sp., Styrax sp., Crataegus sp, Amygdalus sp., Prunus sp., Pyrus sp., Pistacia sp. and Olea sp.*

4.2. Elements for conservation strategies at the monitoring sites

Table 9 on the following pages contains summary descriptions of the major threats, target species to be preserved and suggested technological, socio-economic, institutional and policy options that could be possible elements of conservation strategies for each monitoring site.

Table 9. Major threats, target species and proposed major elements of the management plans

Target area	**Monitoring area**	**Major threats**	**Species targeted**	**Proposed technological, socio-economic, institutional and policy options**
Zawia	Z01 Kafar Lata	• Overgrazing • Crop encroachment • Destoning • Cutting	*Trees: Quercus, Pistacia, Prunus, Amygdalus,* Pastures and rangelands species: *Medicago, Trifolium,Trigonella, Lathyrus,* and *Vicia* Wild Cereals: *Aegilops, Lolium, Avena, Bromus* and *Hordeum*	• Establishment of a conservation area • Avoiding non economic land conversion and land use alternatives;· • Promoting the benefits from wild relatives and wild species such as *Rhus*, *Amygdalus*, *Pyrus* and *Pistacia* species;· • Demonstration of appropriate technologies for increasing the productivities of land races of fruit trees and field crops; • Increasing the awareness of local communities on the importance of conserving the ecosystems and the target species • Introduction of water harvesting techniques for plantation of fruit trees and medicinal plants and for regeneration of wild fruit trees and natural vegetation; • Protection of neighbouring field and road edges for protection of the remaining populations of wild crop relatives; • Benefits from medicinal plants by better packaging and establishment of links with markets, honey production.
Zawia	Z02A: Kafar Haya	• Overgrazing • Crop encroachment • De-stoning	*Aegilops, Medicago, Trifolium,*	• Introduction of water harvesting techniques for plantation of fruit trees and medicinal plants and for regeneration of wild fruit trees and natural vegetation; • Benefits from medicinal plants and from honey production; • Regulated grazing and water harvesting by using contours

Table 9. Continued

Zawia	Z02B Kafar Haya	• Quarries • Grazing; • Cutting; • De-stoning	Trees: *Quercus; Pistacia; Rhamnus; Phillyrea; Osyris*. Pastures and rangelands species: *Medicago, Trifolium,Trigonella, Lathyrus,* and *Vicia* Wild Cereals: *Aegilops, Lolium, Avena, Bromus* and *Hordeum*	• Keeping wild relatives in the field edges; • Avoid non economic land reclamation and land use alternatives;· • Promote the benefits from wild relatives and wild species such as *Rhamnus, Amygdalus, Pyrus* and *Pistacia* species; • Demonstrate appropriate technologies for increasing the productivities of land races of fruit trees and field crops; • Increase the awareness of local communities on the importance of conserving the ecosystems and the target species • Possibilities for introducing many alternative sources of income (eco-tourism, honey production, cultivation of medicinal plants, Mosaic stones business
	Z03 Al-Rame	• Grazing • Land reclamation • De-stoning	Trees: *Quercus; Phillyrea* and *Osyris*. Pastures and rangelands species *Medicago, Trifolium,Trigonella, Lathyrus,* and *Vicia* Wild Cereals: *Aegilops, Lolium, Avena, Bromus* and *Hordeum*	• Avoid non-economic land conversion and land use alternatives; • Protection of neighbouring field and road edges for protection of the remaining populations of wild crop relatives • Benefits from medicinal plants by better packaging and establishment of links with markets, honey production.

Table 9. Continued

Zawia	Z04 Dar Dobat (Al-Bara)	• Land reclamation for plantation of fruit trees orchards • Some grazing pressure • Urbanization. • The extension of quarries • Crop encroachment	Trees: *Quercus; Phillyrea* and *Osyris*. Pastures and rangelands species *Medicago, Trifolium,Trigonella, Lathyrus,* and *Vicia* Wild Cereals: *Aegilops, Lolium, Avena, Bromus* and *Hordeum*	• Establishment of protected area with possibilities for regulated grazing; • Possibilities for introducing many alternative sources of income (eco-tourism, honey production, cultivation of medicinal plants,);· • Improve agricultural productivities of fruit trees and field crops in cultivated areas by transferring low-cost technologies; • Co-management of the area with local communities • Establishment of local NGOs and local cooperatives for coordinated actions to manage better natural resources • Design mechanisms for conflicts resolution among and within the communities and over the ownership of the area.
Zawia	Z05 Muhanbel	• Quarries • Grazing; • Cutting; • De-stoning • Urbanization	Pastures and rangelands species *Medicago, Trifolium,Trigonella, Lathyrus,* and *Vicia* Wild Cereals: *Aegilops, Lolium, Avena, Bromus* and *Hordeum*	• Improvement of rangelands through reseeding and re-plantation of native species using water harvesting techniques; • Avoiding cultivation of areas with steep slopes and with shallow soils; • Management of grazing with local communities; • Providing technical backstopping and training on dairy production and livestock management; • Some incentives in the form of dairy unit, feed block unit and veterinary services should be provided to local communities at the initial stages • Management by local communities or individual farmers.

Table 9. Continued

Zawia	Z06 Kokfeen	• Overgrazing; • Cutting • Destoning • Urbanization	Pastures and rangelands species *Medicago, Trifolium,Trigonella, Lathyrus,* and *Vicia* Wild Cereals: *Aegilops, Lolium, Avena, Bromus* and *Hordeum*	• Improvement of rangelands through reseeding and re-plantation of native species using water harvesting techniques; • Avoiding cultivation of areas with steep slopes and with shallow soils; • Management of grazing with local communities; • Providing technical backstopping and training on dairy production and livestock management • Some incentives in the form of dairy unit, feed block unit and veterinary services should be provided to local communities at the initial stages
Zawia	Z07 Bab Allah	• Overgrazing; • Cutting • Destoning • Land reclamation • Crop encroachment	Wild Cereals: *Aegilops, Lolium, Avena, Bromus* and *Hordeum*	• Rangeland rehabilitation through reseeding of target herbaceous species, water harvesting and application of P_2O_5; • Introduction of native shrubs;; • Introduction of field blocks; • Dairy production unit for local community

Wastani	W01 Oreba	• Grazing; • Cutting • Destoning • Urbanization	*Quercus; Rhamnus, Osyris, Phillyrea, Pistacia, Styrax, Crataegus* and *Olea.* Large populations of forage and feed legumes : *Trifolium, Medicago, Hymenocarpus* and *Lathyrus.* Wild cereals: *Hordeum* and *Aegilops.*	• Establishment of protected area with possibilities for regulated grazing;· • Possibilities for introducing many alternative sources of income (eco-tourism, honey production, cultivation of medicinal plants,);· • Improving agricultural productivities of fruit trees and field crops in cultivated areas by transferring low-cost technologies; • Co-management of the area with local communities • Design mechanisms for conflicts resolution among and within the communities and over the ownership of the area.
Wastani	W02 Al-Fasook	• Rapid extension of quarries • Overgrazing outside the farmed lands, • Land reclamation for agricultural and urbanization and for settlements purposes	*Quercus; Rhamnus, Osyris, Phillyrea, Pistacia, Styrax, Crataegus* and *Olea.* Large populations of forage and feed legumes : *Trifolium, Medicago, Hymenocarpus* and *Lathyrus.* Wild cereals: *Hordeum* and *Aegilops.*	• Establishment of protected area with possibilities for regulated grazing;· • Rangeland improvement combined with grazing management • Search for alternative feed resources including the introduction of feed blocks technology;· • Demonstration of appropriate packages for increasing productivity of landraces of fruit trees and field crops • Land reclamation to be based on land suitability assessment; • Regulating the extension of the quarries and involving the beneficiaries in rehabilitation of used natural habitats through reforestation and reseeding with native species; • Introducing add-value technologies for local products and promote alternative sources of income such as honey production, cultivation of medicinal plants, dairy production, food processing and eco-tourism.

Wastani	W03 Maryameen	• Rapid extension of quarries • Overgrazing outside the farmed lands, • Land reclamation for agricultural and urbanization and for settlements purposes	Many feed legume species including *Lathyrus, Medicago, Trifolium* and *Vicia* species and wild forest and fruit trees species including *Quercus; Crateagus, Olea, Myrthus, Pistacia* and *Laurus*	• Reforestation with native species; • Enforcement of law for land reclamation causing the destruction of natural habitats; • Prohibiting the expansion of quarries; • Linking agrobiodiversity conservation with the tourist activities; • Promoting alternative sources of income such as food processing, dairy production and sustain the agrobiodiversity shop to help in marketing local produce; • Demonstrating appropriate technologies for increasing the productivities of land races of fruit trees and field crops.
	W04 Al-Dahr: Natural reserve	• Overgrazing mainly by goats; • Cutting	Large populations of *Quercus, Rhamnus, Pistacia, Osyris, Phillyrea, Crataegus, Daphne* and *Olea.* With Feed legumes of *Medicago, Trifolium* and Wild relatives of Cereals such as *Hordeum* and *Aegilops.*	• Keeping wild relatives in the field edges; • Avoiding non economic land reclamation and land use alternatives;· • Promoting the benefits from wild relatives and wild species such as *Rhamnus, Amygdalus*, *Pyrus* and *Pistachia* species; • Demonstrating appropriate technologies for increasing the productivities of land races of fruit trees and field crops; • Increasing the awareness of local communities on the importance of conserving the ecosystems and the target species.

5. Developing a management plan for a proposed conservation area

As mentioned in Section 4 (Recommendations), this initial study identifies a strong need to establish conservation areas in the remaining forest and woodland areas in Jebel Wastani, around monitoring sites W01 and W02, and in Jebel Zawia, around monitoring sites Z01 and Z04. At least 1,000 ha of natural forest area should be either protected or allow regulated use compatible with the biodiversity conservation goals. This type of protection will allow the conservation of viable populations of different species to allow enough genetic diversity for sustaining the populations and for the rehabilitation of degraded eco-systems.

From this identification of a biodiversity conservation need in the project area, the next steps will have to be made by the decision-makers in the relevant Ministries. Whether they agree or not with the current assessment, whether they feel there is a need for further studies, whether they have to consult with higher authorities or require some legislation to pass first, are possibilities that will obviously affect the final decision and are outside the scope of this study, since they are policy and implementation decisions. However, once the agreement in principle is given to establish a conservation area, the next step will be to develop a management plan. Whereas a management plan will have to be custom-made to the particular circumstances of a specific conservation area, there are some generic principles that may facilitate the development of the plan for the proposed or other areas in the project area. These principles are outlined in the next sections.

5.1. Key principles for formulating a management plan

There is a phased approach in developing a management plan. Figure 21 summarizes the main steps to be followed for the establishment of natural reserves.

If a site is selected for biodiversity conservation, it is because it contains abundant and hopefully genetically diverse populations of the target taxa. Therefore the goal will be to *maintain* the anthropogenic, biotic and abiotic dynamics of the site and the first logical step in formulating the management plan is to observe these dynamics. For this reason the area should be *surveyed* (site assessments) so that the species present in the ecosystem are known, the ecological interactions within the conservation area are understood, a clear conservation goal can be formulated and a means of implementation agreed.

The actual content or style of a management plan will vary depending on the location, target species, organization, staff involved etc. There is no standard format, but items generally included are: conservation objectives, site biotic and abiotic description, site history, public interest, factors influencing management, management prescription (what work needs to be carried out and precisely how and when to do it), ecological and genetic survey and monitoring schedule, budget and manpower. As the specific focus of establishing a conservation area will be to preserve specific target species, the management plan will require details associated with the target taxa (e.g. taxonomy, phenology, habitat preference, breeding system, minimum population size, etc.) and description of the target populations at the site (e.g. mapping of populations and density within the site, auto-ecology within the area, syn-ecology with associated fauna and flora).

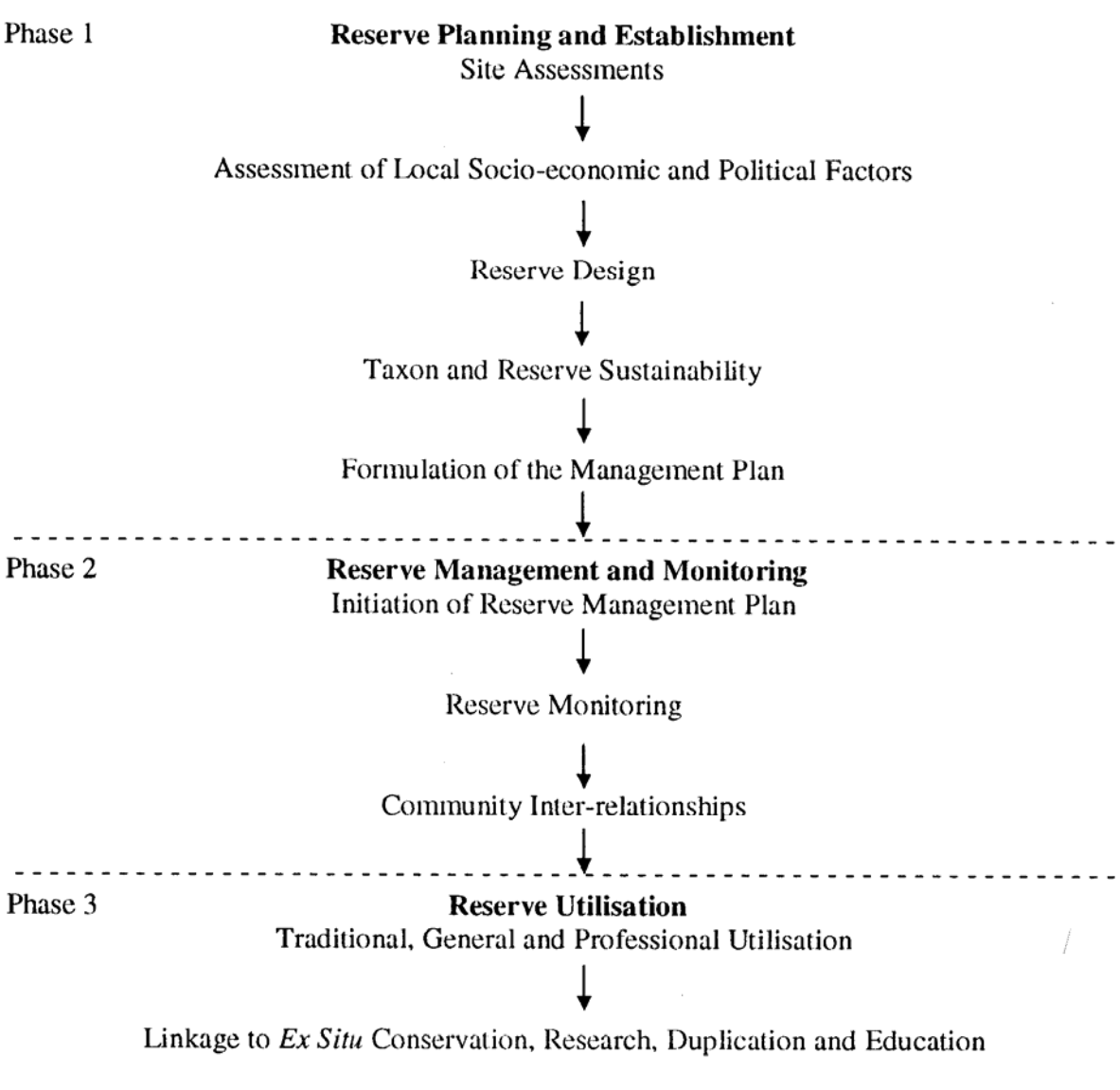

Figure 21. Phased approach to conservation area planning, establishment and management

Possible elements of a management plan can be summarized as follows:

1. *Preamble*: conservation objectives, reasons for siting of reserve, place of reserve in overall conservation strategy for target taxon, site ownership and management responsibility.
2. *Taxon description*: taxonomy (classification, delimitation, description, iconography, identification aids), wider distribution, habitat preferences, phenology, breeding system, genotypic and phenotypic variation, biotic interactions (e.g. pollinators, dispersal agents, herbivores, pests, pathogens, symbionts), local name(s) and uses, other uses, present conservation activities (*ex situ* and *in situ*), threat of genetic erosion.
3. *Site evaluation*: evaluation of populations of the target taxon, reserve sustainability, factors influencing management (legal, constraints of tenure and access), externalities (e.g. climate change, political considerations), obligations to local people (e.g. allowing sustainable harvesting) and anthropomorphic influences.

4. *Site description*: location (latitude, longitude, altitude), map coverage, photographs (including aerial), physical description (geology, geomorphology, climate, hydrology, soils), human population (both within reserve and around it), land use and land tenure (and history of both), vegetation and flora, fauna, cultural significance, public interest (including educational and recreational potential), bibliography and register of scientific research.
5. *Status of target taxon in the reserve*: distribution, abundance, demography, and genetic structure and diversity of the target taxon within the site, autoecology within the reserve, interaction with associated fauna and flora, specific threats to population(s).
6. *Site objectives and policy*: site objectives, control of human intervention, allowable sustainable harvesting by local people and general genetic resource exploitation.
7. *Prescription*: details (timing, frequency, duration etc) of management interventions that will need to be carried out, schedule of ecological and genetic monitoring, population mapping, staffing requirements and budget, project register.

In order to work, i*n situ* conservation requires empowerment of local communities and continued accrued benefits from the conserved area. For this reason management plans need to provide mechanisms for empowering local communities and other key stakeholders to participate in the efforts of conservation of biodiversity of the region. Natural reserves (protected or fenced areas) are an example of management plan for exclusive conservation of biodiversity and ecosystem. Most often this type of conservation is not well received by local communities which depend on the use of local agrobiodiversity. To overcome this problem, the conservation area can be divided into a core area, a buffer zone and transition area. The core area can not be used except for research and monitoring activities, whereas the transition area can be use by local communities under a well defined and agreed management. To be effective, a conservation area requires a large area, either as a single lot if possible, or as several lots to be linked with corridors in case of fragmented natural habitats.

Table 10. Framework for defining options at different intervention levels

Levels	Technological	Socio-economic	Institutional	Policy/legal
International				
Regional				
National				
Community				
Farm				
Field/site				

The management plans need to include clauses that define the technological, institutional and policy/legal options as well as value-added alternative sources of income that can provide the necessary incentives to local communities to promote the in situ/on-farm conservation of local agrobiodiversity. These options require inputs from international to farm activities. Hence, although the conservation area is definitely location-specific, its management may

require actions at different scales of intervention, international, regional, national and local levels to ensure efficient conservation of the local agrobiodiversity. The framework in Table 10 can be used as a tool for defining the possible options in discussions with key stakeholders.

The following examples illustrate possible actions that may be required or desirable at different scales of management.

At the international level

- Funding for conservation of local agrobiodiversity and the establishment of a conservation area could be provided through the Global Environmental Fund or other donors;
- The funding of rural development projects may be made conditional to the inclusion of biodiversity conservation studies, activities or outputs;
- Specialized agents may facilitate linkages to the outside world for enhancing the marketing opportunities of local products at international markets;

Actions at regional level

- Collaboration and consultation may be desirable with appropriate institutions in Turkey to ensure the conservation of viable populations within the border.
- Exchange visits for sharing of experiences and lessons learned from the implementation of management plans for conservation areas managed by local communities can be a great help in formulating such plans and avoiding obvious mistakes.
- Facilitating the exchange of germplasm for rehabilitation of degraded areas is an evident action that may yield concrete benefits in the short term.

At national, community and local levels

1. Policy options

- Afforestation with native species;
- Better land use planning based on land suitability;
- Regulation of the quarries and the land reclamation operations to allow for efficient conservation of areas rich in biodiversity. For the quarries, plans should be developed to rehabilitate the degraded areas either through replanting with native species or for agricultural purposes. A percent of the income from the quarries, as a kind of polluter tax, should be used to invest in the conservation of biodiversity rich areas.
- Provide initial incentives to empower local communities for the implementation of technological and alternative sources of income included in the management plans;

2. Institutional options

- Establishment of local NGOs and local cooperatives for coordinated actions to manage better natural resources;
- Establishment of institutions for collective actions for marketing of local products;
- Recognition of the role of women in conservation of local agrobiodiversity;

3. Technological options

- Reforestation of degraded forests using native species combined with water harvesting techniques,
- Range rehabilitation and management through esta lishment of range protected areas, deferred or rotational grazing, reseeding with native species using water harvesting techniques, development of alternative feeds such as feed blocks based on products fro local agrobiodiversity, introduction of feed legume forage in cereal rotation or as alley crops within the fruit tree orchards, …;
- Improvement of livestock management and health;
- For farming activities, plantation of fruit trees can be done without complete removal of rocks;
- Demonstration and transfer of low cost agronomic packages for the improvement of productivity of landraces of field crops and fruit trees;
- Introduction of organic farming.

4. Value-added technologies and alternative sources of income

- Training and establishment of food processing activities for cultivated and wild species (jam, compotes, dried fruits, diverse olive products, dairy products,…)
- Investigate alternative sources of income (sustainable collecting or cultivation of medicinal and aromatic plants, honey production, stone industry, eco-tourism,…)

5.2. Formulation of management objectives and general prescriptions

In the next few sections guidelines are provided on the formulation of the management objectives and general prescriptions that are relevant to the establishment of conservation areas in the project area. They outline the best technological and management options that can combine the preservation of local agrobiodiversity while enhancing the community returns and benefits. However, it is necessary to point out that these general prescriptions will have to be followed by further studies and stakeholder consultations before a final management plan can be fully elaborated.

5.2.1. Target populations in the conservation area and natural habitat improvement

Objective

The main goal in designating any natural reserve is to conserve and maintain the genetic resources of the target taxa, so the maintenance of numbers and diversity within target species is likely to be a basic goal of all *in situ* genetic reserves. The target populations are not alone in the site and are interacting with other populations, which calls for the conservation of the whole habitat.

Technological and management options

- Increasing the productivity of landraces while conserving the organic attributes of the product through application of low-inputs technological packages combining Integrated Pest Management, use of manure and low rate of fertilizers and herbicides.
- Applying water harvesting techniques and planting fruit trees without much reclaiming of the surrounding land.

- Developing a community-based seed production unit and fruit tree nursery focusing on multiplying local varieties, for rangeland and forest ecosystems (ARDA association already collaborating in this aspect);
- Develop a grazing management plans either through rotational or deferred grazing.
- Designating a core area rich in plant biodiversity of both herbaceous and wild fruit trees species for protection and to serve for seed multiplication;
- Establishment of a fattening unit to reduce the pressure on the natural rangelands;
- Investigating the possibility of using fruits from wild species in the production of feed blocks for reducing the pressure on the rangelands;
- Reseeding with native species and plantation of native shrubs for restoration of the degraded habitats;
- Collecting seed from rare species and isolated wild fruit trees for *ex-situ* conservation and for rehabilitation purposes;
- Regulating the destruction of land for urbanization and agricultural use through participatory land use planning;
- Prohibiting the extension of quarries into biodiversity rich areas;
- Grazing prohibition from January until June every year;
- Halting the introduction of exotic germplasm causing replacement of land races;
- Maintenance of field borders and strips;
- Discourage farmer agricultural practices which have a detrimental effect on the target populations , such as herbicides;
- Collecting the mature seed of the target species and reseeding in the next season to increase the frequency of the individuals;
- Packaging the collected mature seed for storage in the national and ICARDA gene banks for long-term conservation and later use for restoration efforts.

5.2.2. Research

Objectives

The presence of a conservation area creates an opportunity for research to provide information on species and management techniques needed to enable the full potential of the site to be realized and to monitor the effects of management on habitats and species within the demographic and genetic context.

Outline prescriptions

- Compile list of topics for possible research and encourage use of the reserve for research/survey with priority given to projects of direct relevance to the management of the reserve.
- Design the monitoring system and the methodology of data collecting in order to benefit from the resulting analyses of the collected data.

5.2.3. Livelihoods

Objective

The operational objective is to improve the livelihoods of the custodians of local agrobiodiversity.

Outline prescriptions

The general prescription is to create value-added alternative sources of income that are directly linked to the presence of the conservation area.

Examples of such new sources of income are agro-food processing, production of honey, cultivation of medicinal plants, dairy production, and eco-tourism.

Training could be provided to local communities, mainly to women, on food processing techniques of local products that will create opportunities for adding value to landraces of cereals (Friekeh, burghul) and fruit trees (syrup, compotes, jams and dried fruits). For wild fruit trees, the feasibility of processing of wild plums, hawthorn and pears could be explored.

The region is rich in medicinal plants and mieliflora species and these can offer good opportunities for diversification of income of local communities, with privilege for women, through development of apiculture and introduction of medicinal plants cultivation in home gardens.

Mobilization of financial resources should allow the local community to well pack the dairy products for better marketing.

Eco-tourism to the target sites could be encouraged in order to create a kind of income for the local farmers. Leaflets and booklets about the ecology, plants, history, land use in and around the target sites with a site map and eye-catching photos would provide excellent guiding information for visitors and increase awareness. This is highly recommended since many historical sites are located in the region.

5.2.4. Access

Objectives

The overall objective is to allow access to visitors to those parts of the conservation area that will not compromise the conservation nature of the site.

Outline prescriptions

The Ministry of Agriculture and Agrarian Reform, which is the national governmental body responsible for the monitoring of the site, will regulate the use and access to the area. For this regulation to be effective, it will be necessary to study in detail the conservation area and identify the parts that are have a high potential for public use without disturbing the conservation interest. The effects of the public pressure will need to be monitored and management actions need to be taken, if necessary, to protect the vulnerable parts of the conservation area.

5.2.5. Communication and education

Objectives

The objectives are to ensure that the conservation area is known to the public at large and to use it as a venue for educational programs.

Outline prescriptions

The conservation area should be made known through the media, newspapers and feature magazines, TV, high-profile visits, and links to national and international biodiversity web sites. Resources and facilities should be available to respond to requests for educational use of the reserve and provide interpretative materials and guided walks as appropriate.

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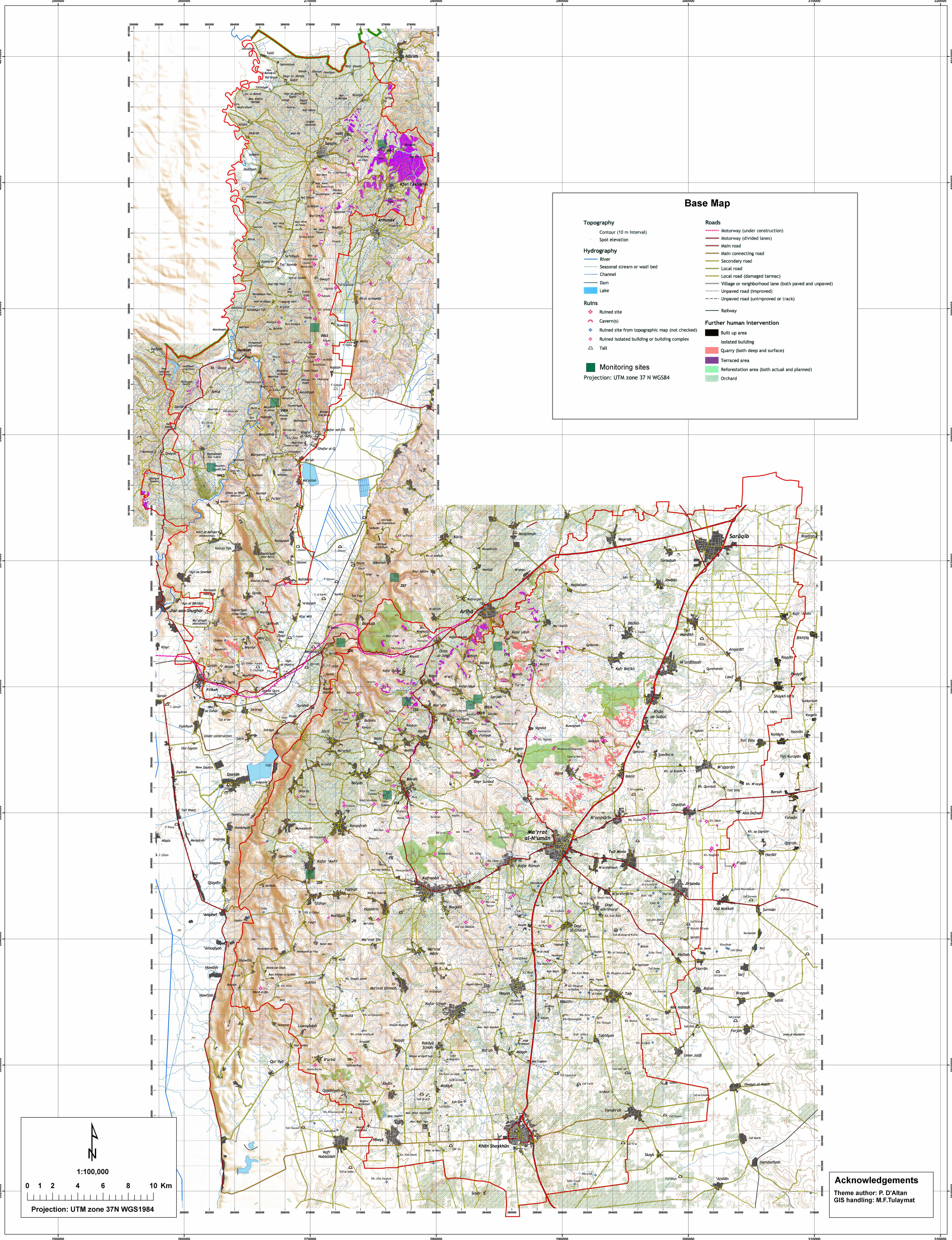
Ecogeographical and Botanical Surveys in the Idleb Agricultural Development Project Area

Annex 5.7.

Maps

Base Map

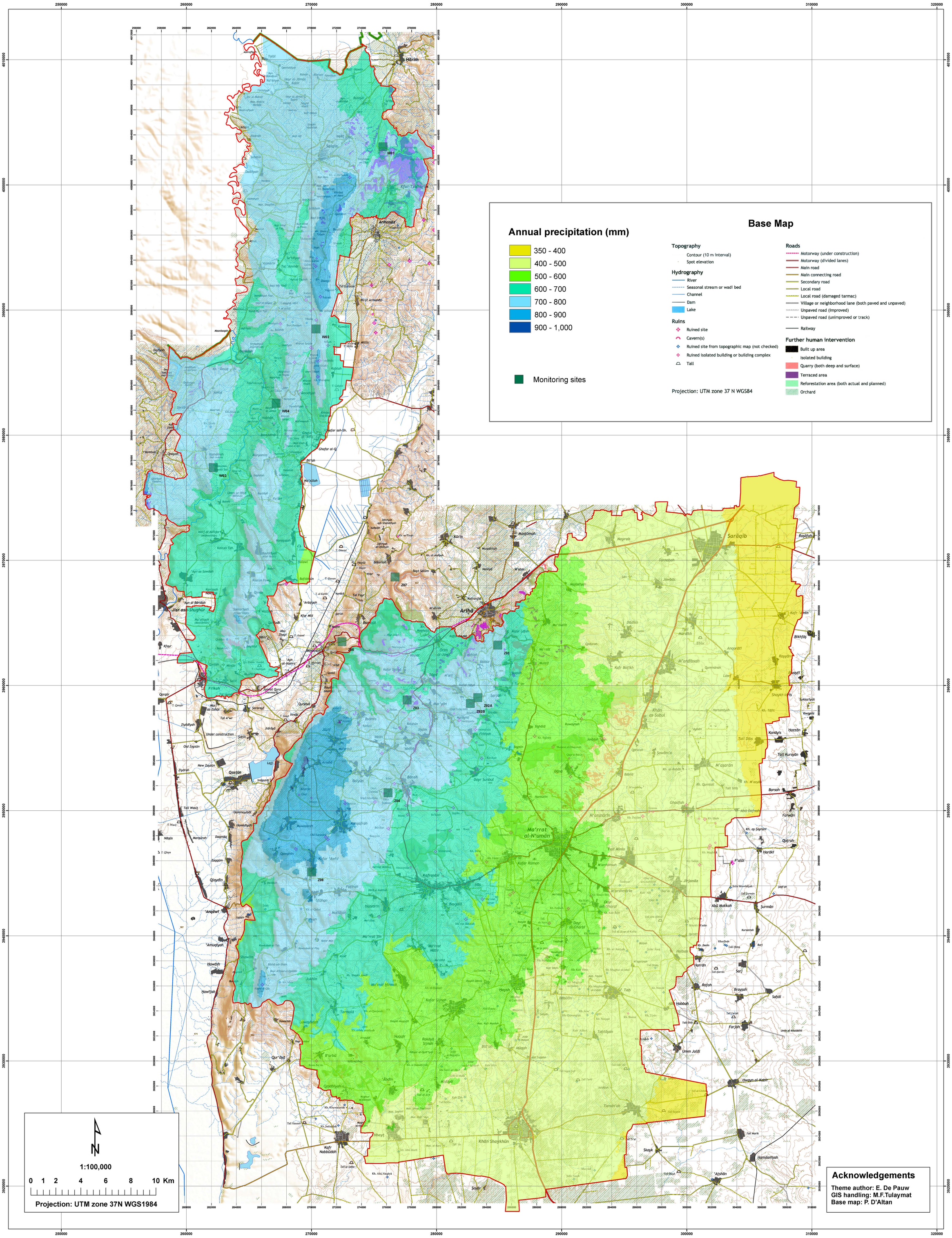
"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"



Acknowledgements
Theme author: P. D'Altan
GIS handling: M.F.Tulaymat

Annual Mean Precipitation

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"



Acknowledgements

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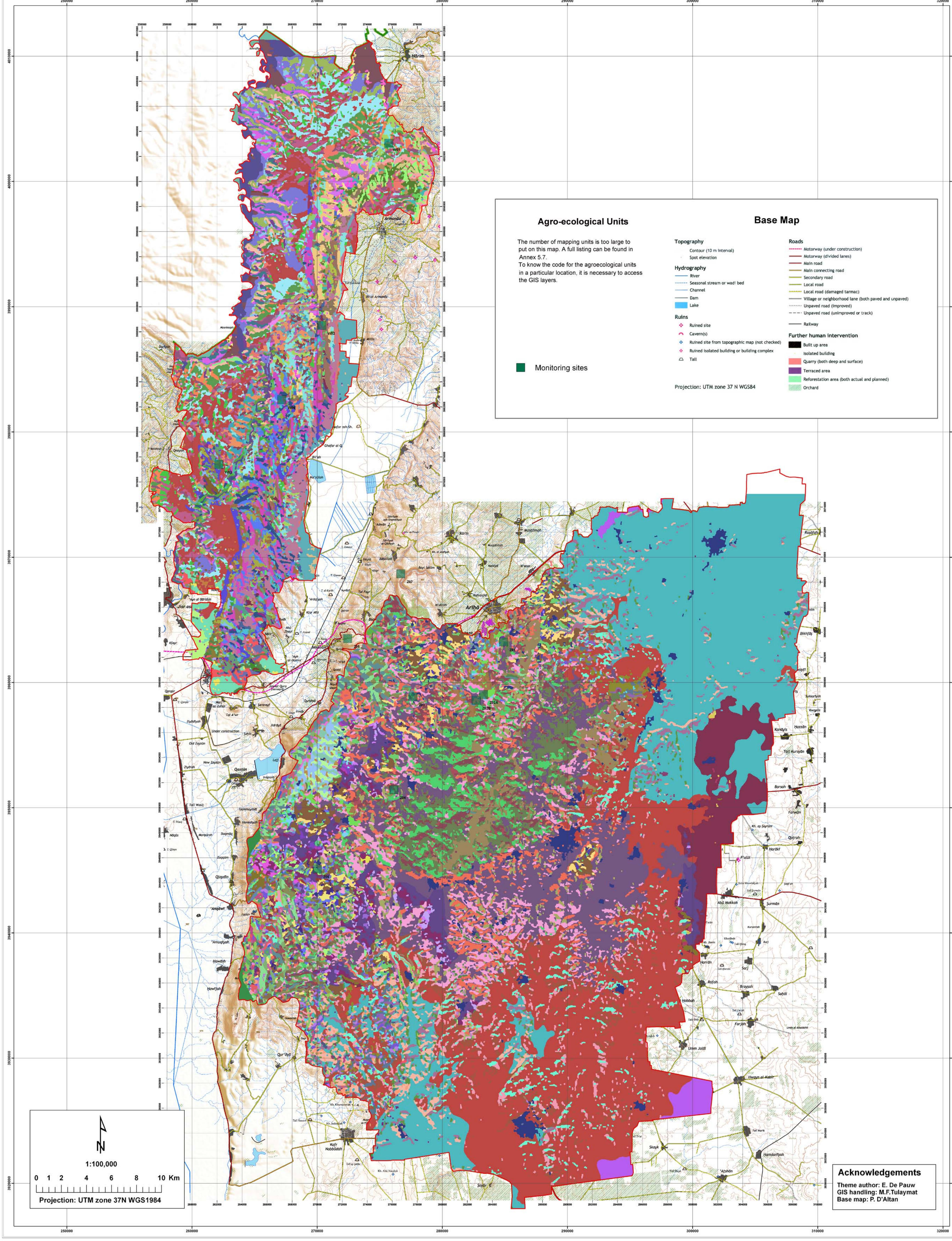
Agro-ecological Units

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"



Acknowledgements

Theme author: E. De Pauw
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Lithological materials

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"

Lithological materials

- Soft materials, soils and sediments
- Basalts
- Soft and easily weatherable limestones and other calcareous sediments
- Hard limestones
- Mixed hard limestones and softer limestones and other calcareous sediments

Monitoring sites

Base Map

Topography
- Contour (10 m interval)
- Spot elevation

Hydrography
- River
- Seasonal stream or wadi bed
- Channel
- Dam
- Lake

Ruins
- Ruined site
- Cavern(s)
- Ruined site from topographic map (not checked)
- Ruined isolated building or building complex
- Tall

Roads
- Motorway (under construction)
- Motorway (divided lanes)
- Main road
- Main connecting road
- Secondary road
- Local road
- Local road (damaged tarmac)
- Village or neighborhood lane (both paved and unpaved)
- Unpaved road (improved)
- Unpaved road (unimproved or track)
- Railway

Further human intervention
- Built up area
- Isolated building
- Quarry (both deep and surface)
- Terraced area
- Reforestation area (both actual and planned)
- Orchard

Projection: UTM zone 37 N WGS84

1:100,000

0 1 2 4 6 8 10 Km

Projection: UTM zone 37N WGS1984

Acknowledgements

Theme author: E. De Pauw
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Watersheds

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"

Watershed Numbers
Wastani and Zawia

Monitoring sites

Base Map

Topography
- Contour (10 m interval)
- Spot elevation

Hydrography
- River
- Seasonal stream or wadi bed
- Channel
- Dam
- Lake

Ruins
- Ruined site
- Cavern(s)
- Ruined site from topographic map (not checked)
- Ruined isolated building or building complex
- Tall

Roads
- Motorway (under construction)
- Motorway (divided lanes)
- Main road
- Main connecting road
- Secondary road
- Local road
- Local road (damaged tarmac)
- Village or neighborhood lane (both paved and unpaved)
- Unpaved road (improved)
- Unpaved road (unimproved or track)
- Railway

Further human intervention
- Built up area
- Isolated building
- Quarry (both deep and surface)
- Terraced area
- Reforestation area (both actual and planned)
- Orchard

Projection: UTM zone 37 N WGS84

1:100,000

0 1 2 4 6 8 10 Km

Projection: UTM zone 37N WGS1984

Acknowledgements

Theme author: P. D'Altan
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Terrain: 2. Drainage and Wetness Index

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"

Wetness Index

- 4 - 7
- 7 - 8
- 8 - 10
- 10 - 13
- 13 - 26
- Drainage network
- Monitoring sites

Base Map

Topography
- Contour (10 m interval)
- Spot elevation

Hydrography
- River
- Seasonal stream or wadi bed
- Channel
- Dam
- Lake

Ruins
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- Orchard

Projection: UTM zone 37 N WGS84

N

1:100,000

0 1 2 4 6 8 10 Km

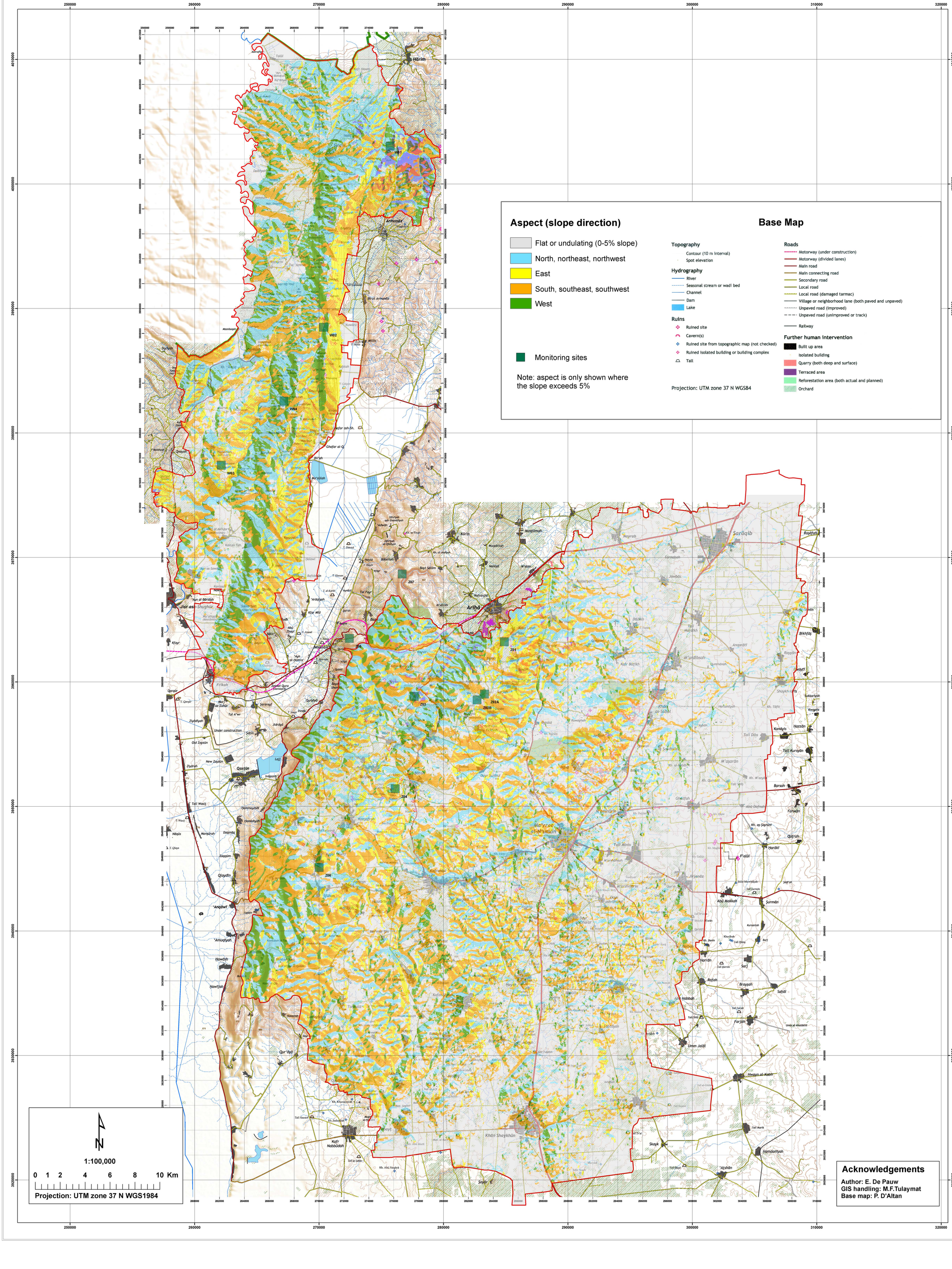
Projection: UTM zone 37N WGS1984

Acknowledgements

Theme author: P. D'Altan
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Aspect (Slope direction)

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"



Acknowledgements

Author: E. De Pauw
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Areas with slopes exceeding 25%

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"

Slopes > 25%

Monitoring sites

Base Map

Topography
- Contour (10 m interval)
- Spot elevation

Hydrography
- River
- Seasonal stream or wadi bed
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- Orchard

Projection: UTM zone 37 N WGS84

N

1:100,000

0 1 2 4 6 8 10 Km

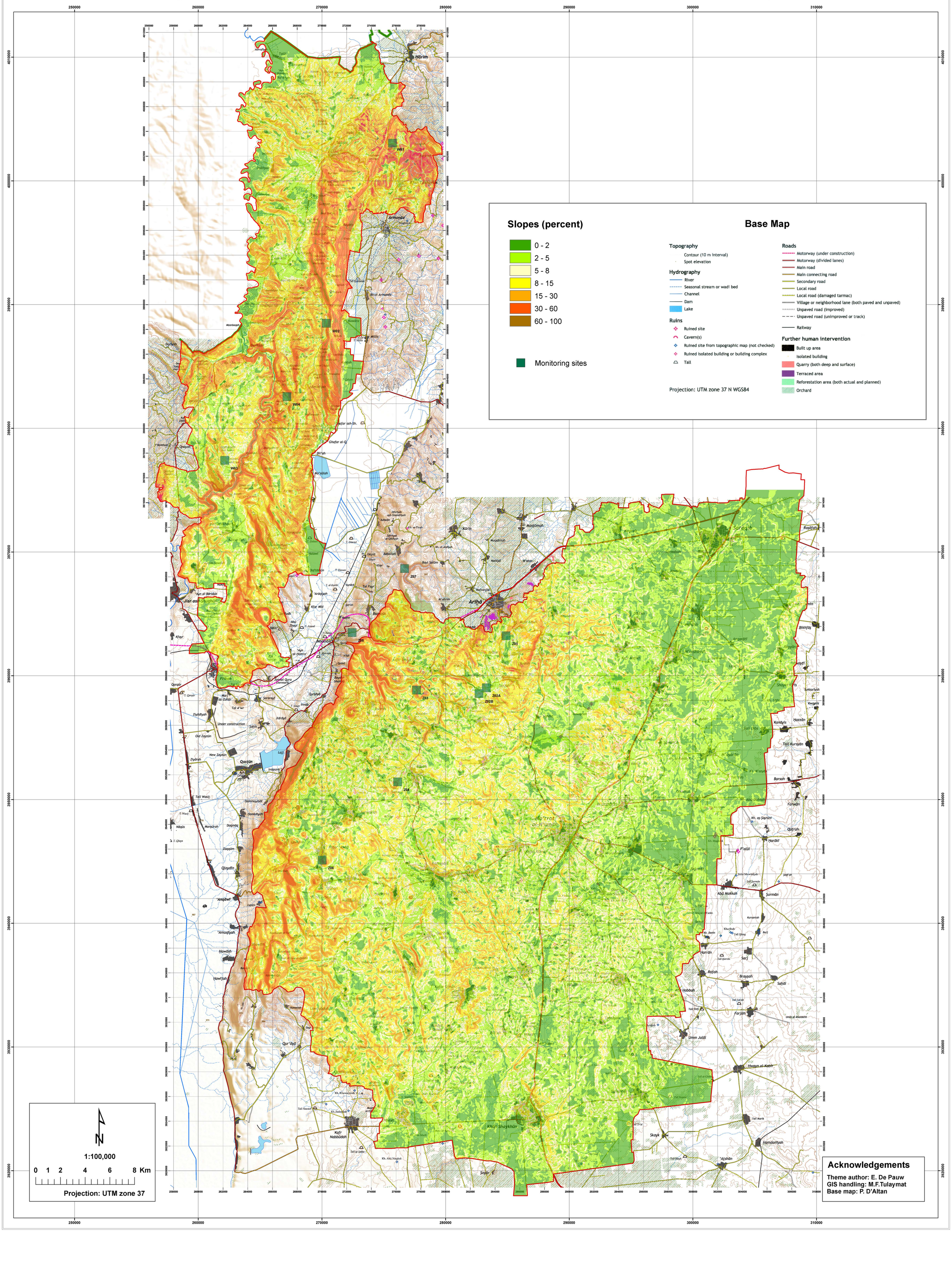
Projection: UTM zone 37N WGS1984

Acknowledgements

Theme author: E. De Pauw
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

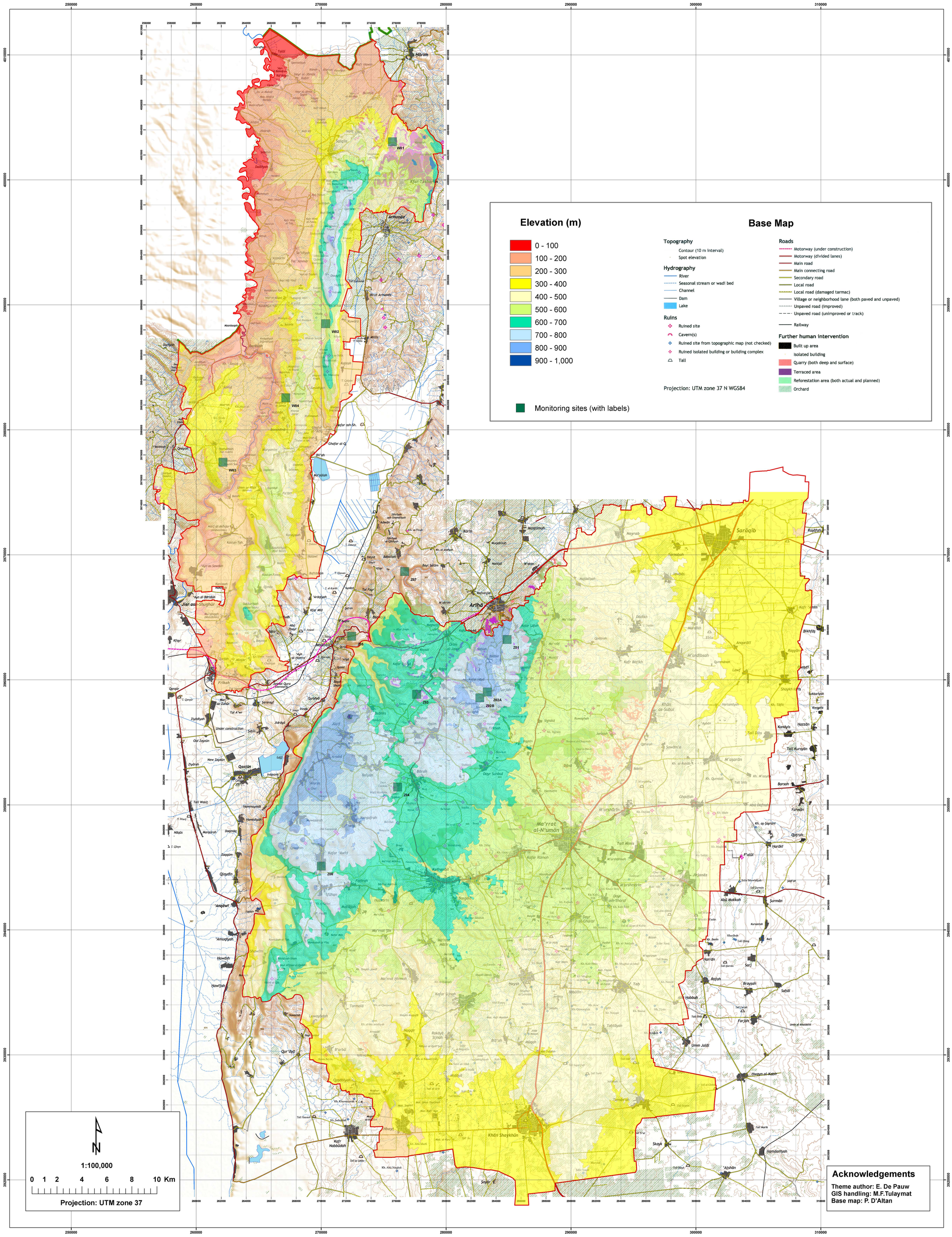
Slopes (percent)

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"



Elevation (meter)

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"



Landuse / Land Cover

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"

Land Use/ Land Cover

- Forests
- Built-up areas
- Temporary water bodies
- Irrigated crops
- Tree crops
- Fallow
- Bare rocks
- Rangelands

Monitoring sites

Base Map

Topography
- Contour (10 m interval)
- Spot elevation

Hydrography
- River
- Seasonal stream or wadi bed
- Channel
- Dam
- Lake

Ruins
- Ruined site
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- Railway

Further human intervention
- Built up area
- Isolated building
- Quarry (both deep and surface)
- Terraced area
- Reforestation area (both actual and planned)
- Orchard

Projection: UTM zone 37 N WGS84

1:100,000

0 1 2 4 6 8 10 Km

Projection: UTM zone 37N WGS1984

Acknowledgements

Theme Author: W. Wu
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Length of Growing Period

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"

Growing period length (days)

- 181 - 195 (6 - 6.5 months)
- 195 - 210 (6.5 - 7 months)
- 210 - 225 (7 - 7.5 months)
- 225 - 240 (7.5 - 8 months)

Monitoring sites

Base Map

Topography
- Contour (10 m interval)
- Spot elevation

Hydrography
- River
- Seasonal stream or wadi bed
- Channel
- Dam
- Lake

Ruins
- Ruined site
- Cavern(s)
- Ruined site from topographic map (not checked)
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Roads
- Motorway (under construction)
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Further human intervention
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- Terraced area
- Reforestation area (both actual and planned)
- Orchard

Projection: UTM zone 37 N WGS84

N

1:100,000

0 1 2 4 6 8 10 Km

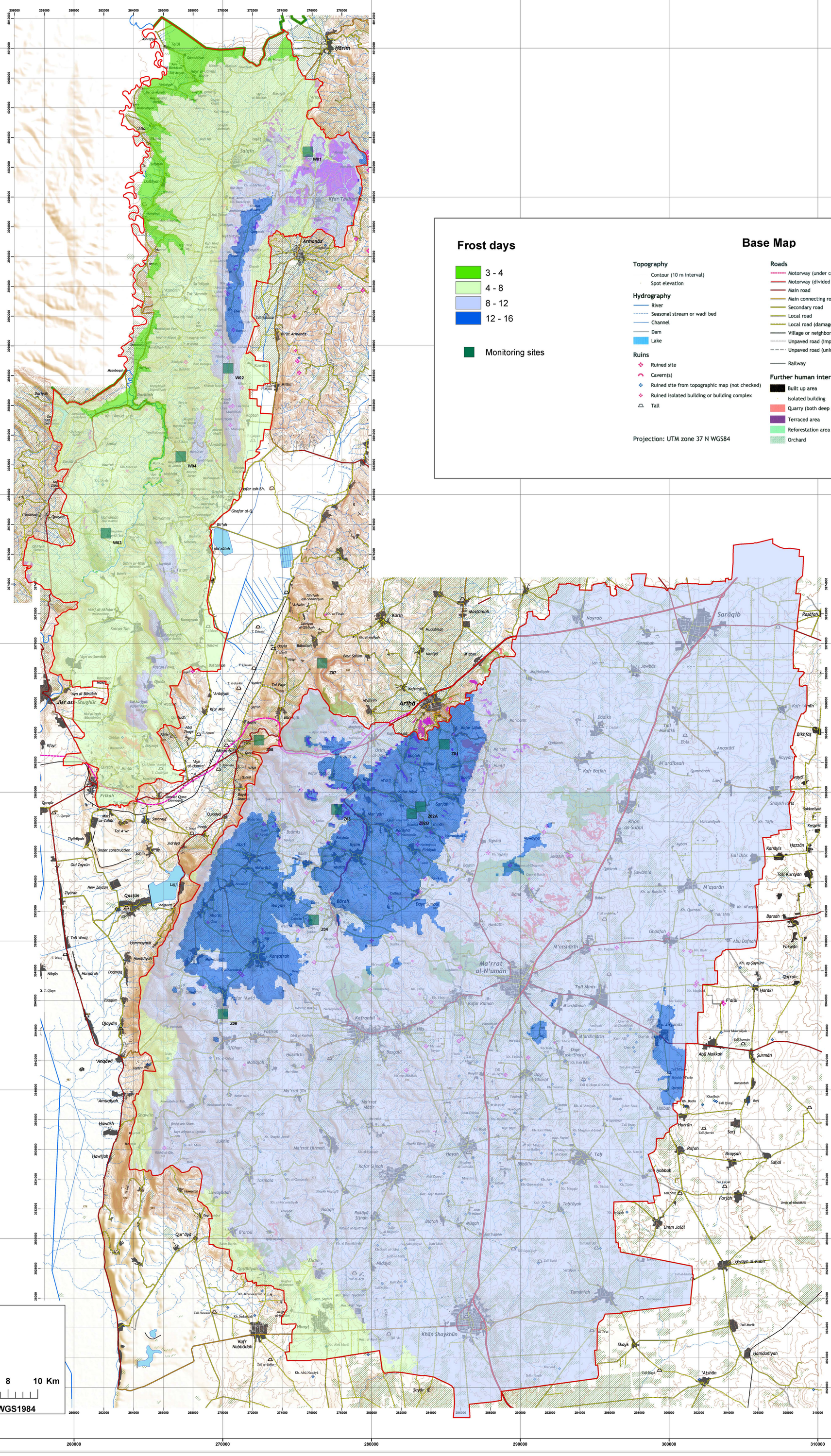
Projection: UTM zone 37N WGS1984

Acknowledgements

Theme author: E. De Pauw
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Average Number of Frost Days

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"

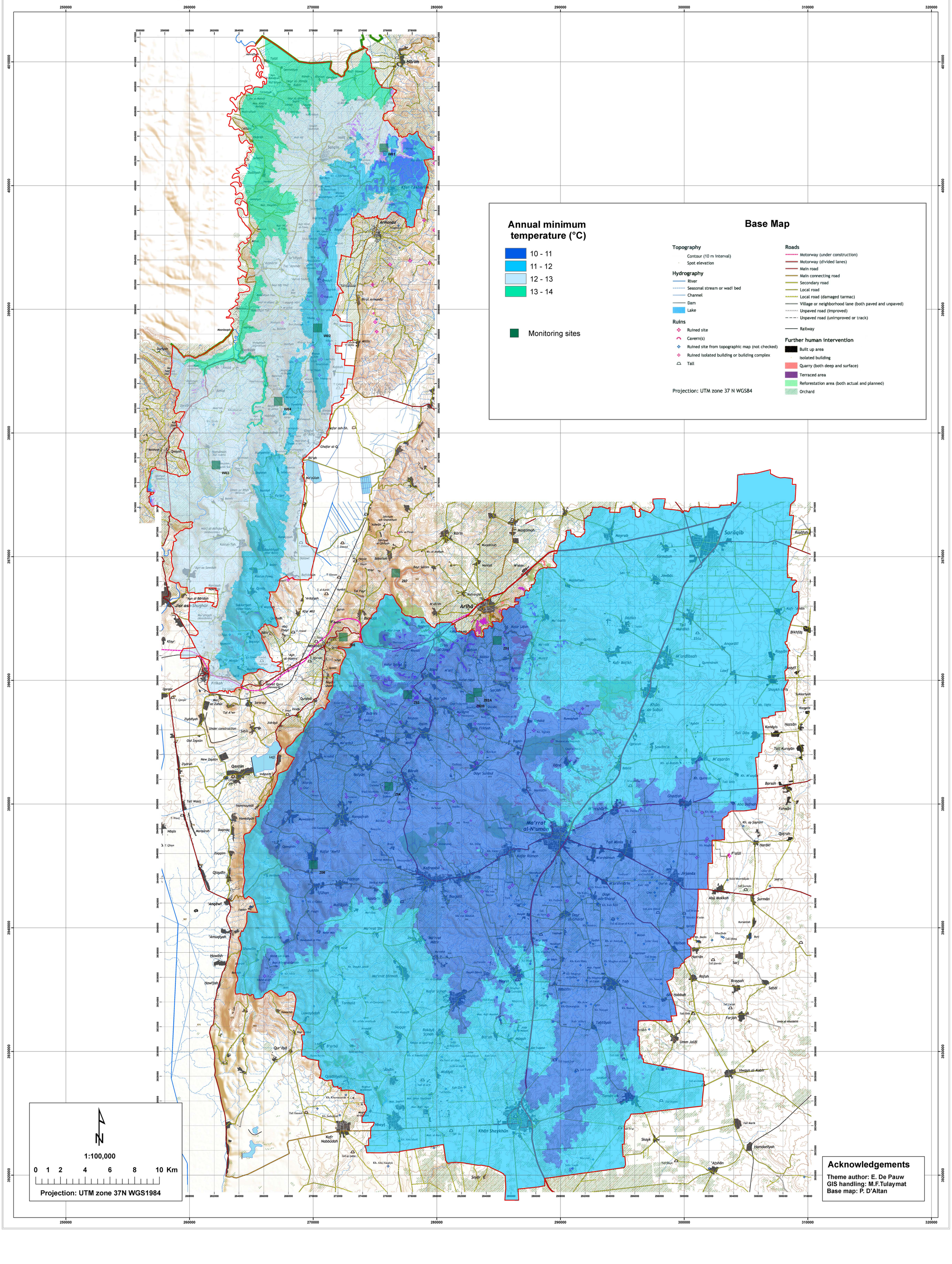


Acknowledgements

Theme author: E. De Pauw
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Annual Minimum Temperature

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"

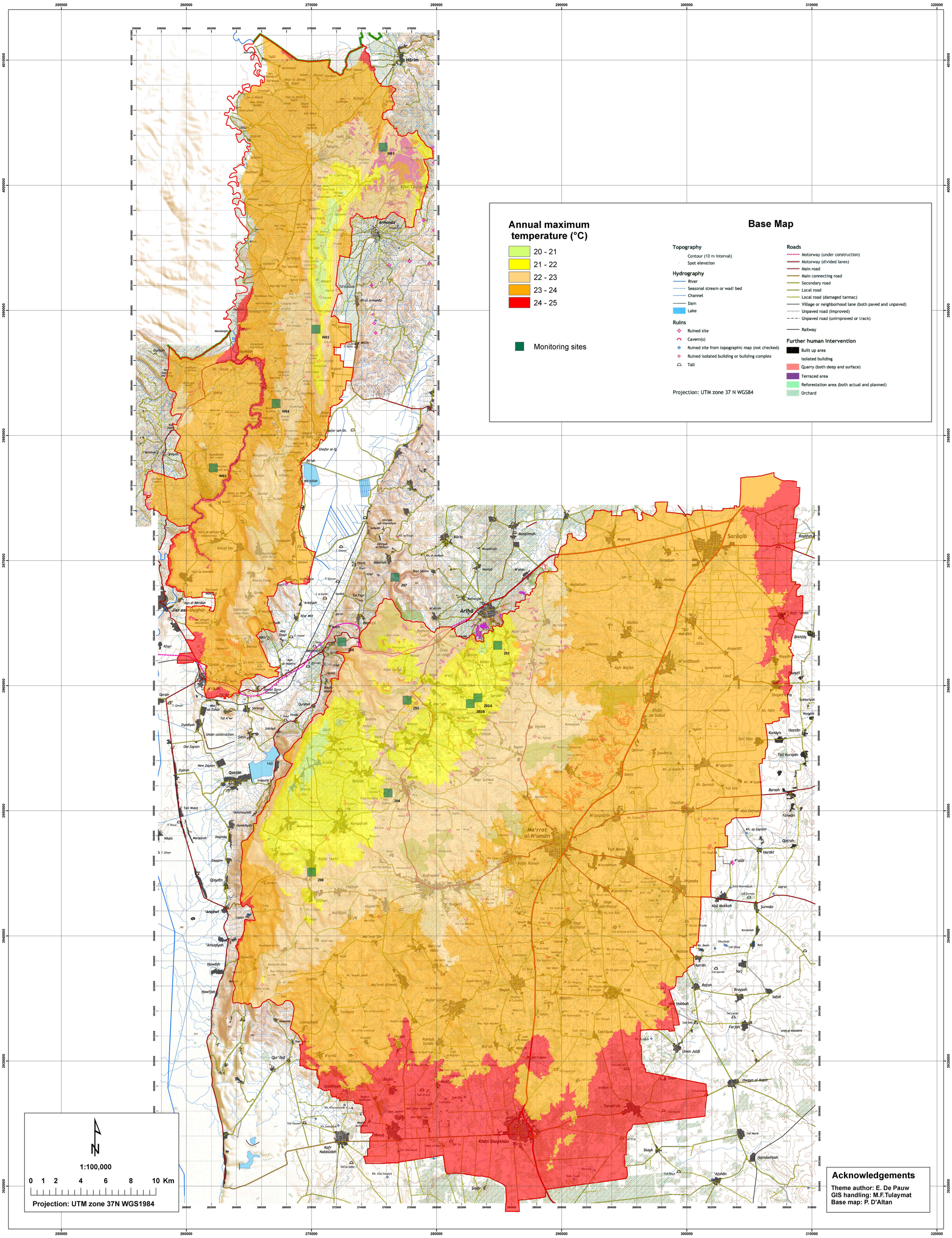


Acknowledgements

Theme author: E. De Pauw
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

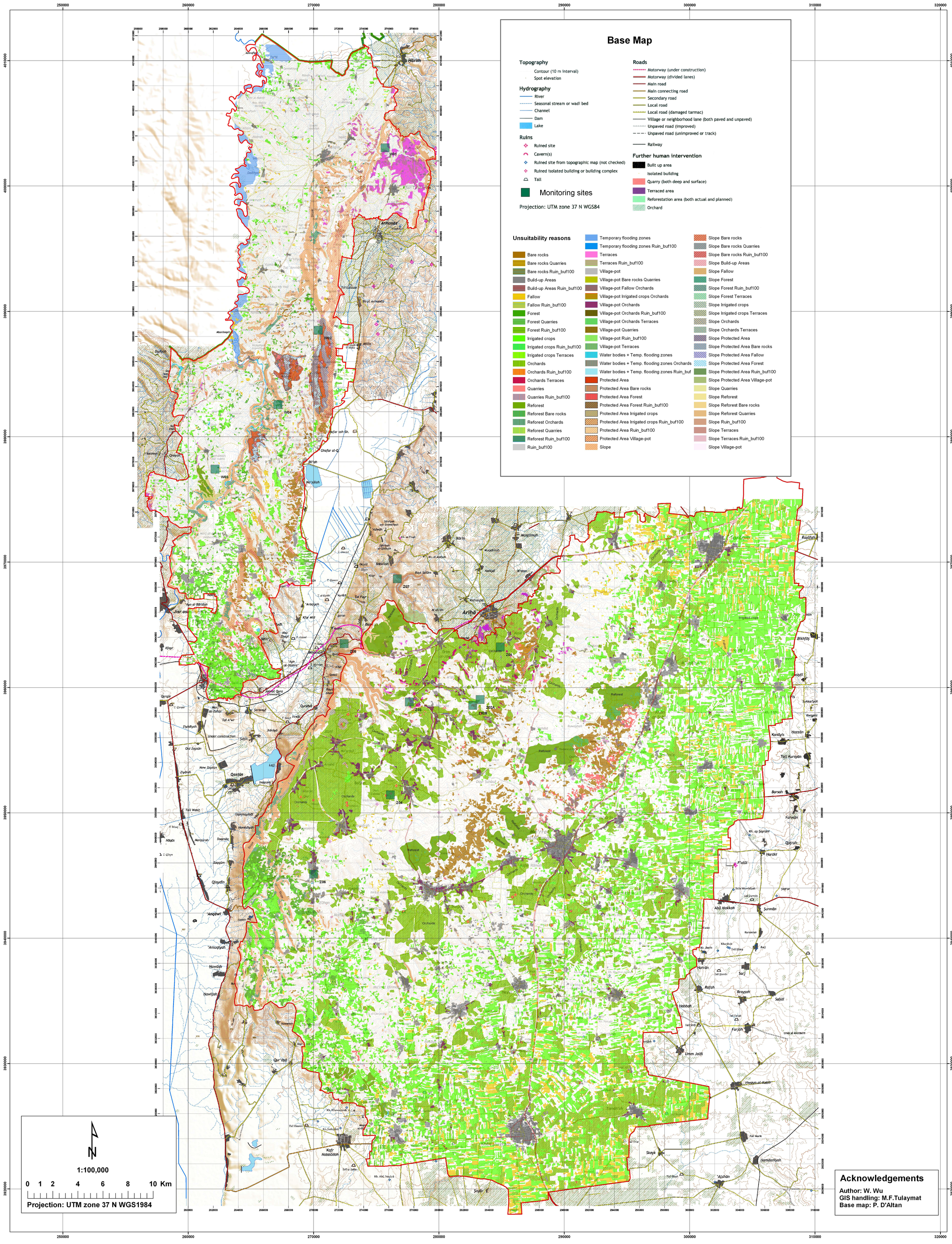
Annual Maximum Temperature

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"



Areas unsuitable for de-rocking

"Ecogeographical and Botanical Surveys for the Idleb Agricultural Development Project"



Acknowledgements

Author: W. Wu
GIS handling: M.F.Tulaymat
Base map: P. D'Altan

Ecogeographical and Botanical Surveys in the Idleb Agricultural Development Project Area

Annex 5.8.

Listing of Agroecological units

Table 1. Agroecological units of Jebel Wastani (sorted from most important to least common)

AEU_ Code	%	Cum%	LULC	Lithology	Terrain
23213	9.443	9.443	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
23221	5.906	15.350	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; northern aspect
3	4.976	20.326	Bare rocks		
23222	4.814	25.140	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; southern aspect
23113	3.793	28.933	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 0-5%; undifferentiated aspect
34233	3.531	32.464	Rangeland	Hard limestones	Elevation 200-500 m; slope >15%; undifferentiated aspect
23231	3.272	35.736	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; northern aspect
2	3.044	38.780	Water bodies		
23121	3.025	41.805	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 5-15%; northern aspect
23223	2.786	44.591	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
33233	2.454	47.045	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; undifferentiated aspect
21213	2.270	49.314	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
23233	2.183	51.497	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; undifferentiated aspect
21113	1.992	53.489	Cropland	Soft materials, soils and sediments	Elevation 0-200 m; slope 0-5%; undifferentiated aspect
24213	1.832	55.321	Cropland	Hard limestones	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
23122	1.831	57.151	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 5-15%; southern aspect
33333	1.719	58.870	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; undifferentiated aspect
33222	1.691	60.562	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; southern aspect
22213	1.656	62.218	Cropland	Basalts	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
34232	1.512	63.729	Rangeland	Hard limestones	Elevation 200-500 m; slope >15%; southern aspect
24223	1.459	65.189	Cropland	Hard limestones	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
34231	1.445	66.634	Rangeland	Hard limestones	Elevation 200-500 m; slope >15%; northern aspect
34333	1.436	68.070	Rangeland	Hard limestones	Elevation 500-800 m; slope >15%; undifferentiated aspect
23232	1.425	69.495	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; southern aspect
23131	1.351	70.846	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; northern aspect
33231	1.226	72.072	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; northern aspect
24221	1.149	73.221	Cropland	Hard limestones	Elevation 200-500 m; slope 5-15%; northern aspect
23132	1.110	74.332	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; southern aspect
33223	1.081	75.413	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
24222	0.992	76.405	Cropland	Hard limestones	Elevation 200-500 m; slope 5-15%; southern aspect
23331	0.970	77.375	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; northern aspect

23322	0.936	78.311	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; southern aspect
23333	0.936	79.247	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; undifferentiated aspect
23123	0.933	80.181	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 5-15%; undifferentiated aspect
33232	0.915	81.096	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; southern aspect
33332	0.834	81.930	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; southern aspect
1	0.796	82.726	Built-up areas		
33331	0.754	83.480	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; northern aspect
22222	0.727	84.207	Cropland	Basalts	Elevation 200-500 m; slope 5-15%; southern aspect
33221	0.722	84.929	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; northern aspect
23133	0.669	85.598	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; undifferentiated aspect
0	0.618	86.216	Outside		
34221	0.575	86.791	Rangeland	Hard limestones	Elevation 200-500 m; slope 5-15%; northern aspect
23313	0.521	87.311	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
24233	0.521	87.832	Cropland	Hard limestones	Elevation 200-500 m; slope >15%; undifferentiated aspect
34222	0.493	88.325	Rangeland	Hard limestones	Elevation 200-500 m; slope 5-15%; southern aspect
33213	0.476	88.802	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
22113	0.418	89.220	Cropland	Basalts	Elevation 0-200 m; slope 0-5%; undifferentiated aspect
31233	0.376	89.596	Rangeland	Soft materials, soils and sediments	Elevation 200-500 m; slope >15%; undifferentiated aspect
24231	0.373	89.969	Cropland	Hard limestones	Elevation 200-500 m; slope >15%; northern aspect
23332	0.351	90.320	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; southern aspect
23321	0.337	90.658	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; northern aspect
22223	0.336	90.994	Cropland	Basalts	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
22232	0.318	91.312	Cropland	Basalts	Elevation 200-500 m; slope >15%; southern aspect
33321	0.308	91.621	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; northern aspect
33132	0.307	91.927	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; southern aspect
24333	0.306	92.234	Cropland	Hard limestones	Elevation 500-800 m; slope >15%; undifferentiated aspect
34332	0.301	92.534	Rangeland	Hard limestones	Elevation 500-800 m; slope >15%; southern aspect
22221	0.293	92.827	Cropland	Basalts	Elevation 200-500 m; slope 5-15%; northern aspect
33133	0.276	93.103	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; undifferentiated aspect
34331	0.269	93.372	Rangeland	Hard limestones	Elevation 500-800 m; slope >15%; northern aspect
14231	0.245	93.617	Forest	Hard limestones	Elevation 200-500 m; slope >15%; northern aspect
34322	0.231	93.848	Rangeland	Hard limestones	Elevation 500-800 m; slope 5-15%; southern aspect
21121	0.217	94.065	Cropland	Soft materials, soils and sediments	Elevation 0-200 m; slope 5-15%; northern aspect
33313	0.199	94.265	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
13231	0.195	94.460	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; northern aspect

24232	0.193	94.653	Cropland	Hard limestones	Elevation 200-500 m; slope >15%; southern aspect
34133	0.193	94.847	Rangeland	Hard limestones	Elevation 0-200 m; slope >15%; undifferentiated aspect
34132	0.188	95.034	Rangeland	Hard limestones	Elevation 0-200 m; slope >15%; southern aspect
13213	0.185	95.220	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
24321	0.177	95.397	Cropland	Hard limestones	Elevation 500-800 m; slope 5-15%; northern aspect
23323	0.176	95.573	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
21123	0.176	95.749	Cropland	Soft materials, soils and sediments	Elevation 0-200 m; slope 5-15%; undifferentiated aspect
34223	0.164	95.913	Rangeland	Hard limestones	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
34313	0.164	96.077	Rangeland	Hard limestones	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
14232	0.153	96.230	Forest	Hard limestones	Elevation 200-500 m; slope >15%; southern aspect
12213	0.145	96.376	Forest	Basalts	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
33323	0.145	96.521	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
34213	0.144	96.665	Rangeland	Hard limestones	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
21223	0.142	96.806	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
11213	0.139	96.946	Forest	Soft materials, soils and sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
21222	0.129	97.074	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; southern aspect
14233	0.126	97.201	Forest	Hard limestones	Elevation 200-500 m; slope >15%; undifferentiated aspect
34323	0.121	97.322	Rangeland	Hard limestones	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
13131	0.118	97.439	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; northern aspect
21131	0.113	97.552	Cropland	Soft materials, soils and sediments	Elevation 0-200 m; slope >15%; northern aspect
33131	0.109	97.662	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; northern aspect
22233	0.109	97.770	Cropland	Basalts	Elevation 200-500 m; slope >15%; undifferentiated aspect
34321	0.105	97.875	Rangeland	Hard limestones	Elevation 500-800 m; slope 5-15%; northern aspect
22231	0.104	97.979	Cropland	Basalts	Elevation 200-500 m; slope >15%; northern aspect
33322	0.101	98.080	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; southern aspect
24322	0.100	98.180	Cropland	Hard limestones	Elevation 500-800 m; slope 5-15%; southern aspect
34131	0.096	98.276	Rangeland	Hard limestones	Elevation 0-200 m; slope >15%; northern aspect
21122	0.094	98.370	Cropland	Soft materials, soils and sediments	Elevation 0-200 m; slope 5-15%; southern aspect
24323	0.084	98.454	Cropland	Hard limestones	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
14131	0.076	98.530	Forest	Hard limestones	Elevation 0-200 m; slope >15%; northern aspect
31223	0.075	98.604	Rangeland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
24113	0.068	98.672	Cropland	Hard limestones	Elevation 0-200 m; slope 0-5%; undifferentiated aspect
13221	0.062	98.734	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; northern aspect
14333	0.059	98.794	Forest	Hard limestones	Elevation 500-800 m; slope >15%; undifferentiated aspect
24313	0.058	98.852	Cropland	Hard limestones	Elevation 500-800 m; slope 0-5%; undifferentiated aspect

13113	0.050	98.902	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 0-5%; undifferentiated aspect
33121	0.048	98.950	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 5-15%; northern aspect
32232	0.044	98.994	Rangeland	Basalts	Elevation 200-500 m; slope >15%; southern aspect
13331	0.043	99.037	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; northern aspect
21231	0.039	99.076	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope >15%; northern aspect
21221	0.037	99.113	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; northern aspect
24131	0.035	99.148	Cropland	Hard limestones	Elevation 0-200 m; slope >15%; northern aspect
14221	0.035	99.184	Forest	Hard limestones	Elevation 200-500 m; slope 5-15%; northern aspect
33122	0.035	99.219	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 5-15%; southern aspect
24331	0.034	99.252	Cropland	Hard limestones	Elevation 500-800 m; slope >15%; northern aspect
14331	0.032	99.284	Forest	Hard limestones	Elevation 500-800 m; slope >15%; northern aspect
31221	0.031	99.315	Rangeland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; northern aspect
12223	0.031	99.347	Forest	Basalts	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
13233	0.031	99.377	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; undifferentiated aspect
14213	0.030	99.407	Forest	Hard limestones	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
31231	0.029	99.436	Rangeland	Soft materials, soils and sediments	Elevation 200-500 m; slope >15%; northern aspect
31232	0.028	99.465	Rangeland	Soft materials, soils and sediments	Elevation 200-500 m; slope >15%; southern aspect
24133	0.028	99.493	Cropland	Hard limestones	Elevation 0-200 m; slope >15%; undifferentiated aspect
24332	0.028	99.520	Cropland	Hard limestones	Elevation 500-800 m; slope >15%; southern aspect
31222	0.027	99.548	Rangeland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; southern aspect
12231	0.025	99.572	Forest	Basalts	Elevation 200-500 m; slope >15%; northern aspect
32233	0.023	99.595	Rangeland	Basalts	Elevation 200-500 m; slope >15%; undifferentiated aspect
12113	0.021	99.617	Forest	Basalts	Elevation 0-200 m; slope 0-5%; undifferentiated aspect
13333	0.021	99.637	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; undifferentiated aspect
32222	0.021	99.658	Rangeland	Basalts	Elevation 200-500 m; slope 5-15%; southern aspect
31123	0.018	99.676	Rangeland	Soft materials, soils and sediments	Elevation 0-200 m; slope 5-15%; undifferentiated aspect
22122	0.017	99.693	Cropland	Basalts	Elevation 0-200 m; slope 5-15%; southern aspect
31131	0.016	99.709	Rangeland	Soft materials, soils and sediments	Elevation 0-200 m; slope >15%; northern aspect
13223	0.015	99.724	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
14133	0.014	99.738	Forest	Hard limestones	Elevation 0-200 m; slope >15%; undifferentiated aspect
14223	0.013	99.751	Forest	Hard limestones	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
13222	0.013	99.764	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; southern aspect
21233	0.013	99.778	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope >15%; undifferentiated aspect
32331	0.013	99.791	Rangeland	Basalts	Elevation 500-800 m; slope >15%; northern aspect
34113	0.013	99.803	Rangeland	Hard limestones	Elevation 0-200 m; slope 0-5%; undifferentiated aspect

13132	0.013	99.816	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; southern aspect
11131	0.012	99.828	Forest	Soft materials, soils and sediments	Elevation 0-200 m; slope >15%; northern aspect
21133	0.012	99.840	Cropland	Soft materials, soils and sediments	Elevation 0-200 m; slope >15%; undifferentiated aspect
22123	0.012	99.852	Cropland	Basalts	Elevation 0-200 m; slope 5-15%; undifferentiated aspect
31133	0.012	99.864	Rangeland	Soft materials, soils and sediments	Elevation 0-200 m; slope >15%; undifferentiated aspect
21132	0.011	99.875	Cropland	Soft materials, soils and sediments	Elevation 0-200 m; slope >15%; southern aspect
12221	0.011	99.886	Forest	Basalts	Elevation 200-500 m; slope 5-15%; northern aspect
11113	0.008	99.894	Forest	Soft materials, soils and sediments	Elevation 0-200 m; slope 0-5%; undifferentiated aspect
14222	0.008	99.902	Forest	Hard limestones	Elevation 200-500 m; slope 5-15%; southern aspect
34122	0.007	99.909	Rangeland	Hard limestones	Elevation 0-200 m; slope 5-15%; southern aspect
12233	0.007	99.916	Forest	Basalts	Elevation 200-500 m; slope >15%; undifferentiated aspect
13323	0.007	99.923	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
33123	0.007	99.930	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 5-15%; undifferentiated aspect
13133	0.007	99.936	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope >15%; undifferentiated aspect
12123	0.006	99.943	Forest	Basalts	Elevation 0-200 m; slope 5-15%; undifferentiated aspect
14132	0.006	99.949	Forest	Hard limestones	Elevation 0-200 m; slope >15%; southern aspect
12222	0.006	99.954	Forest	Basalts	Elevation 200-500 m; slope 5-15%; southern aspect
21232	0.006	99.960	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope >15%; southern aspect
32313	0.005	99.965	Rangeland	Basalts	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
24121	0.005	99.970	Cropland	Hard limestones	Elevation 0-200 m; slope 5-15%; northern aspect
13321	0.004	99.974	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; northern aspect
32231	0.004	99.978	Rangeland	Basalts	Elevation 200-500 m; slope >15%; northern aspect
32322	0.004	99.982	Rangeland	Basalts	Elevation 500-800 m; slope 5-15%; southern aspect
32213	0.004	99.986	Rangeland	Basalts	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
22121	0.003	99.989	Cropland	Basalts	Elevation 0-200 m; slope 5-15%; northern aspect
13121	0.003	99.992	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 0-200 m; slope 5-15%; northern aspect
32333	0.003	99.995	Rangeland	Basalts	Elevation 500-800 m; slope >15%; undifferentiated aspect
31213	0.003	99.997	Rangeland	Soft materials, soils and sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
22331	0.003	100.00	Cropland	Basalts	Elevation 500-800 m; slope >15%; northern aspect

Table 2. Agroecological Units of Jebel Zawia (sorted from most important to least common)

AEU_ Code	%	Cum%	LULC	Lithology	Terrain
23213	19.882	19.882	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
24213	18.212	38.094	Cropland	Hard limestones	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
24313	9.630	47.724	Cropland	Hard limestones	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
24322	3.925	51.649	Cropland	Hard limestones	Elevation 500-800 m; slope 5-15%; southern aspect
34313	3.232	54.881	Rangeland	Hard limestones	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
22213	3.116	57.997	Cropland	Basalts	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
24321	3.080	61.077	Cropland	Hard limestones	Elevation 500-800 m; slope 5-15%; northern aspect
24222	2.982	64.060	Cropland	Hard limestones	Elevation 200-500 m; slope 5-15%; southern aspect
34322	2.499	66.559	Rangeland	Hard limestones	Elevation 500-800 m; slope 5-15%; southern aspect
3	2.132	68.690	Bare rocks		
22313	1.919	70.610	Cropland	Basalts	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
24223	1.795	72.404	Cropland	Hard limestones	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
34321	1.791	74.196	Rangeland	Hard limestones	Elevation 500-800 m; slope 5-15%; northern aspect
24323	1.730	75.925	Cropland	Hard limestones	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
1	1.658	77.583	Built-up areas		
24221	1.631	79.214	Cropland	Hard limestones	Elevation 200-500 m; slope 5-15%; northern aspect
23222	1.594	80.808	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; southern aspect
23313	1.474	82.282	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
23221	1.275	83.557	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; northern aspect
34331	0.876	84.433	Rangeland	Hard limestones	Elevation 500-800 m; slope >15%; northern aspect
21213	0.867	85.300	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
34323	0.825	86.125	Rangeland	Hard limestones	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
22322	0.818	86.944	Cropland	Basalts	Elevation 500-800 m; slope 5-15%; southern aspect
23321	0.815	87.759	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; northern aspect
23223	0.676	88.435	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
34333	0.668	89.103	Rangeland	Hard limestones	Elevation 500-800 m; slope >15%; undifferentiated aspect
23322	0.647	89.750	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; southern aspect
34332	0.585	90.335	Rangeland	Hard limestones	Elevation 500-800 m; slope >15%; southern aspect
34213	0.407	90.742	Rangeland	Hard limestones	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
34222	0.374	91.117	Rangeland	Hard limestones	Elevation 200-500 m; slope 5-15%; southern aspect
23323	0.319	91.436	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; undifferentiated aspect

23413	0.318	91.754	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope 0-5%; undifferentiated aspect
22323	0.307	92.062	Cropland	Basalts	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
34413	0.300	92.362	Rangeland	Hard limestones	Elevation > 800 m; slope 0-5%; undifferentiated aspect
24331	0.264	92.625	Cropland	Hard limestones	Elevation 500-800 m; slope >15%; northern aspect
33333	0.249	92.875	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; undifferentiated aspect
23422	0.242	93.117	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope 5-15%; southern aspect
34221	0.238	93.355	Rangeland	Hard limestones	Elevation 200-500 m; slope 5-15%; northern aspect
33321	0.238	93.593	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; northern aspect
23421	0.227	93.820	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope 5-15%; northern aspect
33222	0.221	94.041	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; southern aspect
24413	0.217	94.257	Cropland	Hard limestones	Elevation > 800 m; slope 0-5%; undifferentiated aspect
22222	0.201	94.458	Cropland	Basalts	Elevation 200-500 m; slope 5-15%; southern aspect
24332	0.201	94.659	Cropland	Hard limestones	Elevation 500-800 m; slope >15%; southern aspect
33332	0.198	94.858	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; southern aspect
33322	0.194	95.051	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; southern aspect
33233	0.191	95.242	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; undifferentiated aspect
22321	0.188	95.430	Cropland	Basalts	Elevation 500-800 m; slope 5-15%; northern aspect
34231	0.181	95.611	Rangeland	Hard limestones	Elevation 200-500 m; slope >15%; northern aspect
23331	0.180	95.791	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; northern aspect
0	0.176	95.967	Outside		
34232	0.174	96.140	Rangeland	Hard limestones	Elevation 200-500 m; slope >15%; southern aspect
34422	0.148	96.288	Rangeland	Hard limestones	Elevation > 800 m; slope 5-15%; southern aspect
24333	0.134	96.422	Cropland	Hard limestones	Elevation 500-800 m; slope >15%; undifferentiated aspect
24233	0.126	96.549	Cropland	Hard limestones	Elevation 200-500 m; slope >15%; undifferentiated aspect
34423	0.119	96.667	Rangeland	Hard limestones	Elevation > 800 m; slope 5-15%; undifferentiated aspect
23423	0.111	96.779	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope 5-15%; undifferentiated aspect
33331	0.110	96.889	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; northern aspect
23233	0.107	96.996	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; undifferentiated aspect
34223	0.106	97.102	Rangeland	Hard limestones	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
12313	0.097	97.200	Forest	Basalts	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
12322	0.096	97.295	Forest	Basalts	Elevation 500-800 m; slope 5-15%; southern aspect
22332	0.093	97.388	Cropland	Basalts	Elevation 500-800 m; slope >15%; southern aspect
33313	0.092	97.481	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
33232	0.089	97.569	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; southern aspect
32322	0.084	97.653	Rangeland	Basalts	Elevation 500-800 m; slope 5-15%; southern aspect

34233	0.083	97.736	Rangeland	Hard limestones	Elevation 200-500 m; slope >15%; undifferentiated aspect
33213	0.082	97.818	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
24422	0.081	97.899	Cropland	Hard limestones	Elevation > 800 m; slope 5-15%; southern aspect
24232	0.078	97.977	Cropland	Hard limestones	Elevation 200-500 m; slope >15%; southern aspect
32332	0.078	98.056	Rangeland	Basalts	Elevation 500-800 m; slope >15%; southern aspect
24231	0.071	98.127	Cropland	Hard limestones	Elevation 200-500 m; slope >15%; northern aspect
34421	0.069	98.195	Rangeland	Hard limestones	Elevation > 800 m; slope 5-15%; northern aspect
22232	0.065	98.261	Cropland	Basalts	Elevation 200-500 m; slope >15%; southern aspect
33223	0.059	98.320	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
22223	0.056	98.376	Cropland	Basalts	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
33221	0.056	98.432	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; northern aspect
32321	0.056	98.489	Rangeland	Basalts	Elevation 500-800 m; slope 5-15%; northern aspect
14331	0.056	98.544	Forest	Hard limestones	Elevation 500-800 m; slope >15%; northern aspect
22413	0.054	98.599	Cropland	Basalts	Elevation > 800 m; slope 0-5%; undifferentiated aspect
32331	0.054	98.653	Rangeland	Basalts	Elevation 500-800 m; slope >15%; northern aspect
23231	0.053	98.705	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; northern aspect
24423	0.052	98.757	Cropland	Hard limestones	Elevation > 800 m; slope 5-15%; undifferentiated aspect
23431	0.052	98.809	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope >15%; northern aspect
23332	0.048	98.857	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; southern aspect
23333	0.044	98.901	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; undifferentiated aspect
33231	0.042	98.943	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; northern aspect
22422	0.041	98.985	Cropland	Basalts	Elevation > 800 m; slope 5-15%; southern aspect
23232	0.041	99.026	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; southern aspect
22221	0.040	99.066	Cropland	Basalts	Elevation 200-500 m; slope 5-15%; northern aspect
14333	0.038	99.104	Forest	Hard limestones	Elevation 500-800 m; slope >15%; undifferentiated aspect
23433	0.038	99.142	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope >15%; undifferentiated aspect
33323	0.037	99.180	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
12333	0.035	99.215	Forest	Basalts	Elevation 500-800 m; slope >15%; undifferentiated aspect
12332	0.033	99.248	Forest	Basalts	Elevation 500-800 m; slope >15%; southern aspect
13213	0.031	99.279	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
24421	0.030	99.309	Cropland	Hard limestones	Elevation > 800 m; slope 5-15%; northern aspect
22331	0.028	99.337	Cropland	Basalts	Elevation 500-800 m; slope >15%; northern aspect
32313	0.028	99.365	Rangeland	Basalts	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
22432	0.028	99.392	Cropland	Basalts	Elevation > 800 m; slope >15%; southern aspect
22431	0.026	99.419	Cropland	Basalts	Elevation > 800 m; slope >15%; northern aspect

32333	0.025	99.444	Rangeland	Basalts	Elevation 500-800 m; slope >15%; undifferentiated aspect
22333	0.025	99.468	Cropland	Basalts	Elevation 500-800 m; slope >15%; undifferentiated aspect
14313	0.024	99.492	Forest	Hard limestones	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
33423	0.024	99.516	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope 5-15%; undifferentiated aspect
12323	0.022	99.538	Forest	Basalts	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
24431	0.022	99.560	Cropland	Hard limestones	Elevation > 800 m; slope >15%; northern aspect
12321	0.021	99.581	Forest	Basalts	Elevation 500-800 m; slope 5-15%; northern aspect
13221	0.019	99.601	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; northern aspect
22421	0.017	99.618	Cropland	Basalts	Elevation > 800 m; slope 5-15%; northern aspect
33421	0.016	99.634	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope 5-15%; northern aspect
12233	0.016	99.650	Forest	Basalts	Elevation 200-500 m; slope >15%; undifferentiated aspect
12331	0.016	99.666	Forest	Basalts	Elevation 500-800 m; slope >15%; northern aspect
32232	0.016	99.682	Rangeland	Basalts	Elevation 200-500 m; slope >15%; southern aspect
24433	0.015	99.697	Cropland	Hard limestones	Elevation > 800 m; slope >15%; undifferentiated aspect
14213	0.015	99.712	Forest	Hard limestones	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
12222	0.015	99.727	Forest	Basalts	Elevation 200-500 m; slope 5-15%; southern aspect
12231	0.015	99.742	Forest	Basalts	Elevation 200-500 m; slope >15%; northern aspect
22433	0.014	99.756	Cropland	Basalts	Elevation > 800 m; slope >15%; undifferentiated aspect
14231	0.013	99.769	Forest	Hard limestones	Elevation 200-500 m; slope >15%; northern aspect
13331	0.012	99.780	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; northern aspect
14233	0.010	99.791	Forest	Hard limestones	Elevation 200-500 m; slope >15%; undifferentiated aspect
22423	0.010	99.801	Cropland	Basalts	Elevation > 800 m; slope 5-15%; undifferentiated aspect
13233	0.010	99.811	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; undifferentiated aspect
32221	0.010	99.821	Rangeland	Basalts	Elevation 200-500 m; slope 5-15%; northern aspect
14323	0.010	99.830	Forest	Hard limestones	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
23432	0.010	99.840	Cropland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope >15%; southern aspect
24432	0.009	99.848	Cropland	Hard limestones	Elevation > 800 m; slope >15%; southern aspect
33422	0.008	99.857	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope 5-15%; southern aspect
13231	0.008	99.865	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope >15%; northern aspect
13223	0.008	99.872	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
14321	0.008	99.880	Forest	Hard limestones	Elevation 500-800 m; slope 5-15%; northern aspect
33413	0.007	99.887	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope 0-5%; undifferentiated aspect
32432	0.007	99.894	Rangeland	Basalts	Elevation > 800 m; slope >15%; southern aspect
32323	0.007	99.901	Rangeland	Basalts	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
33433	0.007	99.908	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope >15%; undifferentiated aspect

32213	0.006	99.914	Rangeland	Basalts	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
2	0.006	99.920	Water bodies		
34433	0.006	99.926	Rangeland	Hard limestones	Elevation > 800 m; slope >15%; undifferentiated aspect
32422	0.006	99.932	Rangeland	Basalts	Elevation > 800 m; slope 5-15%; southern aspect
13333	0.006	99.938	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope >15%; undifferentiated aspect
13313	0.005	99.943	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 0-5%; undifferentiated aspect
33431	0.005	99.948	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope >15%; northern aspect
12213	0.004	99.952	Forest	Basalts	Elevation 200-500 m; slope 0-5%; undifferentiated aspect
14322	0.004	99.956	Forest	Hard limestones	Elevation 500-800 m; slope 5-15%; southern aspect
34431	0.004	99.960	Rangeland	Hard limestones	Elevation > 800 m; slope >15%; northern aspect
32233	0.003	99.963	Rangeland	Basalts	Elevation 200-500 m; slope >15%; undifferentiated aspect
21222	0.003	99.966	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; southern aspect
31222	0.003	99.969	Rangeland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; southern aspect
33432	0.003	99.972	Rangeland	Soft and easily weatherable limestones and calcareous sediments	Elevation > 800 m; slope >15%; southern aspect
34432	0.003	99.975	Rangeland	Hard limestones	Elevation > 800 m; slope >15%; southern aspect
32431	0.003	99.977	Rangeland	Basalts	Elevation > 800 m; slope >15%; northern aspect
12232	0.003	99.980	Forest	Basalts	Elevation 200-500 m; slope >15%; southern aspect
13321	0.003	99.982	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; northern aspect
12413	0.002	99.985	Forest	Basalts	Elevation > 800 m; slope 0-5%; undifferentiated aspect
14221	0.002	99.987	Forest	Hard limestones	Elevation 200-500 m; slope 5-15%; northern aspect
32222	0.002	99.989	Rangeland	Basalts	Elevation 200-500 m; slope 5-15%; southern aspect
14332	0.002	99.991	Forest	Hard limestones	Elevation 500-800 m; slope >15%; southern aspect
13323	0.002	99.992	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; undifferentiated aspect
32433	0.002	99.994	Rangeland	Basalts	Elevation > 800 m; slope >15%; undifferentiated aspect
21221	0.001	99.995	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; northern aspect
22233	0.001	99.996	Cropland	Basalts	Elevation 200-500 m; slope >15%; undifferentiated aspect
13322	0.001	99.997	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 500-800 m; slope 5-15%; southern aspect
21223	0.001	99.998	Cropland	Soft materials, soils and sediments	Elevation 200-500 m; slope 5-15%; undifferentiated aspect
22231	0.001	99.999	Cropland	Basalts	Elevation 200-500 m; slope >15%; northern aspect
12221	0.001	99.999	Forest	Basalts	Elevation 200-500 m; slope 5-15%; northern aspect
13222	0.001	100.000	Forest	Soft and easily weatherable limestones and calcareous sediments	Elevation 200-500 m; slope 5-15%; southern aspect