Stone-walled terraces restoration: conserving biodiversity and promoting economic functions of farmlands in Lebanon

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Abstract: Dry stone-walled terraces are peculiar features of Mediterranean farmland, representing typical examples of social-ecological systems combining ecological functionality and ecosystem services provision. In the Shouf Biosphere Reserve (Lebanon) a program of restoration of abandoned terraces applying Forest Landscape Restoration (FLR) principles is ongoing from 2016, combined with biodiversity monitoring activities. This study illustrates preliminary results of the plant monitoring, with the aim to (1) draft a checklist of the plants found in the terraces, (2) compare plant diversity and evaluate consistency of species assemblages observed among 3 different terrace managements (abandoned, restored and intensively-cultivated) and (3) compare ecological and ecosystem service value of the plant communities in the 3 types of terraces. Overall, 332 species were observed, with significantly higher diversity found in abandoned and restored terraces compared to intensively farmed terraces. Similarly, species assemblages of restored terraces were closely related to abandoned and distantly related to intensively-managed terraces. According to the study, restored terraces provide the same ecological value and ecosystem services functions as abandoned terraces, significantly higher than intensively-managed terraces. This study showcases the effectiveness of FLR programmes in restoring economic and social functions of terraced Mediterranean farmland while maintaining ecological functionality.

Keywords: agricultural terraces, land abandonment, restoration, FLR, biodiversity, ecosystems services

Introduction

Agricultural smallholder terraces are peculiar features of Mediterranean cultural landscapes, enabling crop production in dry environments and steep slopes (García-Ruiz et al., 2020; Tarolli et al., 2014). Terraced croplands have thousands-year old tradition in the Mediterranean basin and are widespread across all Mediterranean cultures (Blondel, 2006;

Kladnik et al., 2017). Twelve UNESCO World Heritage Sites and two FAO's Globally Important Agricultural Heritage Systems (GIAHS) which feature terraced landscapes are found in the region. Terraced landscapes are typical examples of social-ecological systems which retain ecological functionality while providing several ecosystem services (ES) (Nieto-Romero et al., 2014). Beside food provisioning, ES provided by terraced landscapes include the reduction of soil loss, the increase of rainfall retention, the increase of plant biomass, the enrichment of the soil, the mitigation of fire, floods and desertification risks. Most notably, terraced landscapes ultimately represent a valuable adaptation strategy in face of the climate warming.

Two main types of terraces are used in the Mediterranean region, namely earth embankments and dry stone terraces, with possible use of mixed types (Cicinelli et al., 2021). Lebanon features dry stone walls as vertical elements to create horizontal strips of land cultivated with tree crops, such as mulberry (historically used for silk production), vines, olives, figs, walnut and, most recently, apple and cherries (Zurayk, 1994). In the last decades, agricultural transformations in the Mediterranean are led by two opposite drivers, i.e. the intensification of farming practices and the abandonment of economically marginal croplands (Debolini et al., 2018; Lomba et al., 2020; Otero et al., 2015; Plieninger et al., 2016; Reynolds et al., 2014). Lebanese terraced farmland has been affected by both drivers. In fact, after the WWII considerable migration of the population from the countryside to the coastal cities caused the abandonment of less accessible terraces. The abandoned terraces have suffered two different types of processes: (i) soil erosion due to the lack of maintenance of the stone walls and steep slopes, and (ii) fast secondary forest colonization on more stable terraces where the soil has been maintained, although the accumulation of dry biomass increases the risk of fires (Abdallah, 2012). Similar pattern are found across Mediterranean countries (Brunori et al., 2018; Heider et al., 2021; Modica et al., 2017; Rühl et al., 2006). According to the time of abandonment and the stability of the slopes, different deterioration stages are seen in the terraces. In some cases, stone walls have completely collapsed causing erosion and hindering colonization by serial shrubby vegetation. In other cases, with more stable slopes, the terraces remain invisible as they have been colonized by very dense secondary pine forests (*Pinus brutia*) and mixed communities of oaks (mainly *Quercus infectoria*, and to a lesser extent *Q. coccifera*) and pines. This phenomenon has relevant consequences on biodiversity and environmental risks. On one hand, dry stone-walls, together with other farmland microhabitats linked to sustainable farming practices (e.g. scattered trees in farmland plots, synanthropic vegetation such as the segetal plant communities of cultivated habitats, ruderal vegetation dominated by thistle-type species along cropping borders, roadsides, and disturbed lands, the vegetation of water ponds or water lines crossing terraced crops, and patches of woody vegetation surrounding terraced crops), represent themselves an important microhabitat which enhance farmland biodiversity (Solomou et al., 2020). On the other hand, farming practices have been usually intensified with the use of pesticides, fertilizers, irrigation, ploughing, the use of herbicides for the suppression of synanthropic vegetation, and the cementation of the stones of the walls destroying the habitats of their interstices. Farming intensification is universally acknowledged as one of the main threats to farmland biodiversity (IPBES, 2019), including in the Mediterranean basin (Henle et al., 2008; José-María et al., 2010). The transition from low-input to intensive practices in Lebanese terraced croplands started in the 1970s, after a grape phylloxera infestation affected vineyards, forcing landowners to shift to apple and cherry production, which require more intensive farming practices (Corrieri et al., 2021).

Stone-walled terraces are featured prominently in the Shouf Biosphere Reserve (SBR), the largest protected area of Lebanon, which corresponds to the 5% of the country area. In the western slope of the Shouf range (included in the Shouf District) terraces are present over the 10% of the land (Corrieri et al., 2021). In the early 1990s, almost 66% of terraces in the area were already abandoned (Zurayk et al., 2001). The restoration of abandoned terraces plays a critical role in terms of enhancing ecosystem services to sustain both biodiversity and human livelihoods. In 2016 the SBR started a restoration program of abandoned terraces within the framework of a large-scale Forest and Landscape Restoration initiative, covering the 50,000 ha of the SBR (Hani et al., 2017, 2019, 2021). Overall, more than 150 ha of degraded dry-stone walls terraced were successfully restored. The restoration of dry stone-wall terraces in the SBR also included interventions for the maintenance and recovery of marginal habitats linked to the agriculture terraces, such as hedges, tree and shrub shelters, isolated trees, ruderal vegetation along roads, consistently with the FLR principles. Restored terraces have been being farmed sustainably, with low-input agricultural practices and high diversity of crops (fruit trees, olives, aromatic plants, vegetables).

In order to evaluate the effectiveness of the restoration activities to promote biodiversity and ecosystem services the SBR has launched a biodiversity monitoring program. This study illustrates preliminary outcomes of plant monitoring activities.

More specifically, the study aims at

i. drafting a checklist of the plants found in the terraces of the western foothills of the SBR;
ii. comparing plant diversity of restored terraces with abandoned and intensively-managed terraces;
iii. test the similarity of plant communities among restored, abandoned and intensively-managed terraces and
iv. evaluating the ecological and the ecosystem service value of the plant communities of restored terraces with respect to abandoned and intensively-managed terraces.

Material and Methods

Study area

The study area is located in the foothills of the western slope of the Shouf mountains, within the Development zone of the Shouf Biosphere Reserve (Mount Lebanon governorate, Shouf district). More in detail, study plots were located in the municipalities of Ain Zhalta, Barouk, Maasser al-Shouf, Baadarane, Mristi and Jbaa al-Shouf (Figure 1) From the ecological point of view, the area extends in the supra-Mediterranean bioclimatic zone, at an elevation between 1000 and 1200 m asl. The landscape is characterized by evergreen and deciduous oak forests (*Q. calliprinos* and *Q. infectoria*), pine forests (*P. pinea* and *P. brutia*) and mixed forests, replaced on vast areas by agricultural and pastoral land, which partially has undergone secondary vegetation succession. Agricultural terraces are cultivated with olives, fruit trees, vines and aromatic plants (lavender, rosemary, oregano). Species-rich communities of herbaceous plants are featured in recently abandoned agriculture terraces (chiefly in limestone substrates), while mid- and long-term abandoned agriculture/pasture lands are colonized by different types of woody vegetation depending on the period of abandonment (e.g. small thorny shrubs, high shrubs, with scattered trees, and forest stands).

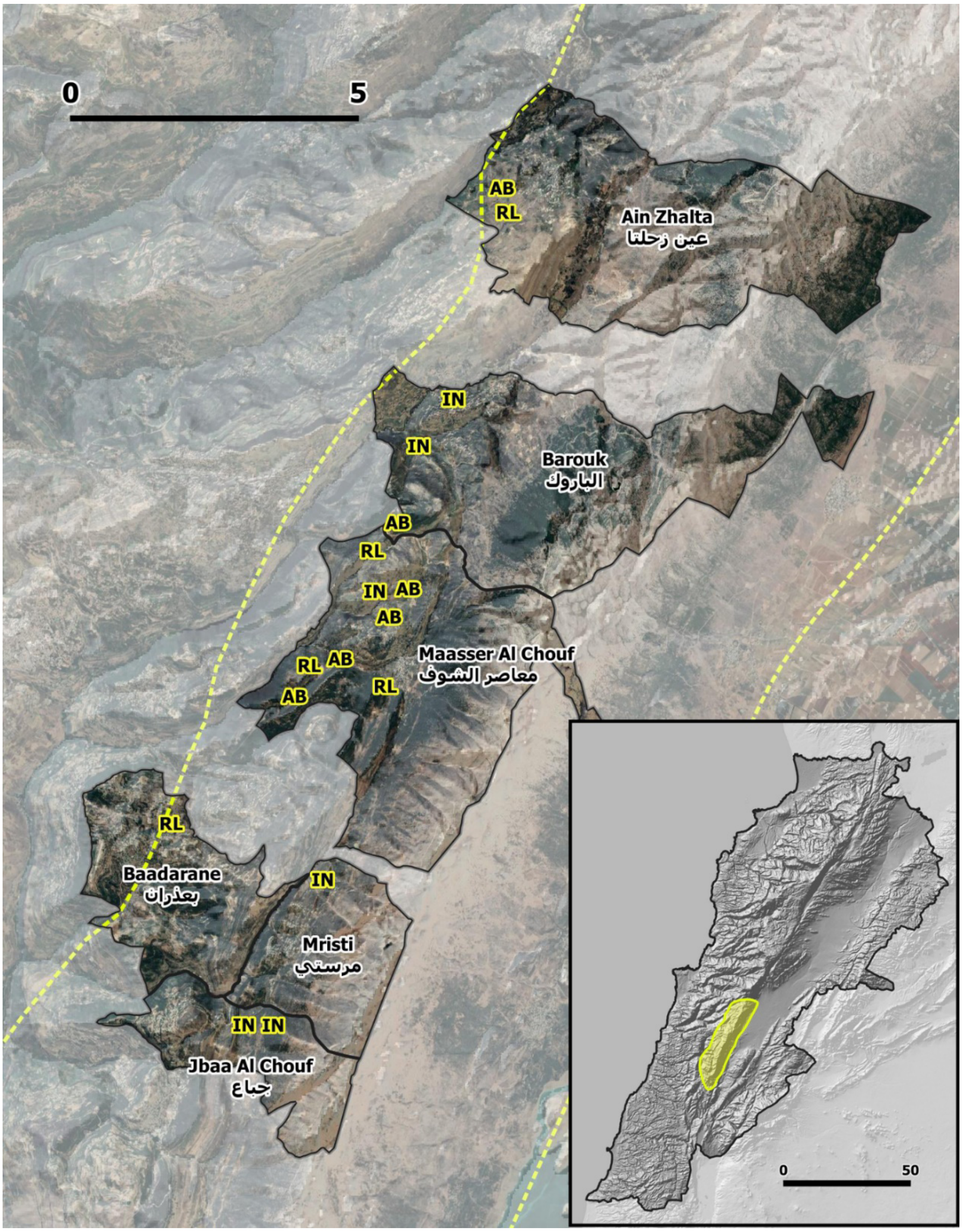

Figure 1 - Map of the study area, with municipalities highlighted. Monitoring sites are shown in yellow. AB=abandoned terraces; RL=restored terraces; IN=intensively-managed terraces. Yellow dotted line represent the border of the SBR development zone. Inset: location of the SBR (in yellow) within the Lebanese territory.

Sampling methods

The plant communities of 18 dry stone-walled terraced fields (6 terraces of each of 3 management types) were monitored in 2020 and 2021. Terraces were classified as intensively managed (hereafter IN), abandoned (AB) or restored (RL). Intensively-managed terraces were cultivated with fruit trees (mainly apple, cherry, pear, plum), and, less frequently, with walnut, almond, olives or vines, applying intensive practices such as deep ploughing, the use of fertilizers and pesticides, irrigation and weed control. Abandoned terraces included diverse stages of abandonment (~10 years to ~40 years). Restored terraces underwent restoration (stone wall restoration, organic soil replenishment, composting), reduced soil mobilization, soil mulching, limited or no use of agrochemicals, and diversified planting, combining aromatic and culinary shrubs such as lavender, oregano, sumac and rosemary, and fruit trees such as olives, almonds, figs, and vines in 2017 or 2018. One terrace only was restored in 2020. However, data collected in this terrace was subsequently discarded from the analysis, since the timing of the restoration did not allow for a complete regeneration of the herbaceous vegetation. The average terraced field size was 2500 m^2 (min 500, max 5000). Each terrace was visited 4 times each year (March to September). During each field visit (hereafter 'inventory'), a representative sample of the terraces (several hundreds of square metres) was surveyed, and a checklist of plant species observed was compiled. The monitoring led to the compilation of a complete checklist of species present in each monitored terrace (hereafter 'site').

Data analysis

Species diversity. In order to compare species' diversity across managements, we fitted a linear mixed model to predict the number of species observed in each inventory with the management type (AB, RL or IN). The model included the site as random effect. Data normality assumption check was performed by a Shapiro-Wilk test of normality. In addition, post-hoc multiple comparisons Tukey test with Bonferroni-Holm correction was eventually performed.

Similarities of plant communities. To evaluate the consistency and the similarities of the plant communities found in the three terrace managements we performed a hierarchical cluster analysis ('complete linkage' method) on a dissimilarity matrix computed on a species-site presence/absence matrix with the Bray-Curtis distance (Bray and Curtis, 1957; Faith et al., 1987), widely used in ecology and already applied in studies of plant communities' composition (Cleland et al. 2013). In addition, an analysis of similarities (ANOSIM) was performed on the same dissimilarity matrix of species assemblage data (999 permutations). Decomposition of the Bray-Curtis dissimilarity was used to evaluate within-site similarity and between-site dissimilarity (Moser et al., 2007).

Ecological and ecosystem services value. To compare the ecological and the ecosystem service value of the plant communities across different managements we calculated an ecological (ECOL) and an ecosystem service (ES) value index for each plant species observed in the monitoring. Each index summarises several variables. Table 1 gives an overview of the variables included in the calculation of the indices. The ES value was evaluated by considering the 3 categories of ES, as defined by the Common International Classification of Ecosystem Services (CICES) (Haines-Young and Potschin, 2018), namely, the provisioning services, the regulation and maintenance services and the cultural services. For each ES typology we identified 2 to 5 indicators. Dichotomous indicators (yes/no) were coded with a binary value (yes=3, no=0). Indicators referred to continuous were ranked to ordinal variables. Values for "Pollination" were calculated as the nearest integer of the ln of the frequency of pollinating wildbee species known to feed on the plant species, according to Grace (2010). Similarly, values for "Melliferous" were computed by 1) calculating the frequency and the overall sum of the proportion of pollens found in 25 honey samples, as reported by Silici & Gökceoglu (2007); 2) calculating the ln of the values of each of the two variables (frequency and overall proportion); 3) summing the two values and rounded it to the nearest integer. ECOL and ES indices were calculated by normalizing (0-1) the sum of the respective indicators. A "total" (TOT) index, which sums ECOL and ES indices, was eventually computed. For each inventory we calculated the median ECOL, ES and TOT values of the species checklist and the overall ECOL, ES and TOT values (by summing). Finally, we fitted a linear mixed model to predict each of the inventory values of ECOL, ES and TOT (median and overall) with the management type (AB, RL or IN). The model included SITE as random effect. Post-hoc multiple comparisons Tukey tests with Bonferroni-Holm correction for each model were eventually performed. All analysis were run in R (version 4.0.2) with the 'vegan' (Bray-Curtis dissimilarity and ANOSIM), 'stats' (hierarchical clustering), 'lme4' (linear mixed models) and 'multcomp' (post-hoc Tukey tests) packages.

Table 1 – Description of the ecosystem services indicators (ecological and ecosystem service value) considered for each of the plant species observed. For each indicator the proxy, the range or the values assigned to the different levels of the indicators and the source is provided. Only for ES indicators, the CICES code (Common International Classification of Ecosystem Services code, V5.1) is provided (Haines-Young and Potschin, 2018).

Index		Indicator	CICES Code	Proxy	Range/Values	Source
Ecological Value		Conservation		National conservation threat category	0 (LC) - 8 (CR)	Lebanese Red List of Plants
		Biogeographical		Chorology	1 (alien species) - 8 (Lebanese or Levant endemic)	*expert based*
		Ecological amplitude		N habitat of presence	1 - 8	*expert based*
		Ecological specificity		N habitat of presence (if N = 1)	0 (no) or 3 (yes)	*expert based*
		Pollination		N wild Apoideae species known to pollinate the plant (ranked)	0 (unknown or no pollinating value) - 4 (highly pollinated)	Grace (2010)
Ecosystem Service Value	*Provisioning*	Medicinal	1.1.5.2	Known medicinal properties	0 (no) or 3 (yes)	*expert based*
		Ornamental	1.1.5.2	Known use as ornamental in gardening	0 (no) or 3 (yes)	*expert based*
		Dying	1.1.5.2	Known use as natural dye	0 (no) or 3 (yes)	*expert based*
		Cosmetic and aromatic	1.1.5.2	Known use in the maufacturing of soaps, perfumes, oils, incenses etc.	0 (no) or 3 (yes)	*expert based*
		Genetic	1.2.1.1 / 1.2.1.2	Species used in molecular biology to increase quality of phenotypic traits, wild relatives of domestic species etc.	0 (no) or 3 (yes)	*expert based*
		Food	1.1.5.1	Edible and known use in the Mediterranean cuisine	0 (no) or 3 (yes)	*expert based*
	Regulation and Maintenance	Pasture enrichment	2.1.1.1	Improvement of the forage quality	0 (no) or 3 (yes)	*expert based*
		Melliferous	2.2.2.1	Proportion and frequency of pollen in honey samples (ranked)	0 (not used by domestic bees) - 5 (highly used by domestic bees)	Silici e Gökceoglu (2007), *expert based*
	Cultural	Aesthetic	3.1.2.4	Aesthetical appreciation among the population	1 - 3 (rounded mean)	questionnaire (n=10)
		Cultural heritage	3.1.2.3 / 3.2.1.1 / 3.2.1.2	Known references in the literature, in the iconography, in religion etc.	0 (no) or 3 (yes)	*expert based*

Results

A total of 332 plant species belonging to 54 families were identified through the field monitoring. The full checklist is shown in SM1. The list includes one species classified as EN by the Lebanese Red List of Plants, namely *Orchis anatolica*, and 3 classified as NT (*Papaver rhoeas*, *Orchis italica* and *Scorzonera mollis*). 54 species are Lebanese or Levantine endemisms, including *Salvia judaica, S. hierosolymitana, Centaurea cheirolopha, Geranium libanoticum, Orchis galilaea*, *O. anatolica*. Almost half of the species were specific to single management types (54 species specific to AB sites, 53 to RL sites and 53 to IN sites). 161 species were not found in IN sites. Overall, 212 species were observed in RL sites, 188 in AB sites and 177 in IN sites.

Inventories' species richness was highest in the AB, followed by RL and IN (Figure 2). The model's total explanatory power is substantial (conditional R^2 = 0.35). IN sites diversity was significantly lower than AB sites (beta = -11.11, 95% CI [-18.60, -3.61], t(107) = -2.94, p = 0.004). Conversely, RL site diversity is comparable to AB sites (beta = -0.39, 95% CI [-8.23, 7.45], t(107) = -0.10, p = 0.922). In addition, post-hoc Tukey test show significant lower diversity of IN sites with respect to RL sites (RL – IN, estimate=10.71, z=2.725, p=0.018).

The results of the hierarchical clustering are shown in Figure 3. The Bray-Curtis dissimilarity among managements show a continuum of the differences of species assemblage among sites. However, 4 main clusters can be outlined. A first cluster (blue) is represented by an only AB site, which stands out as a possible outlier. Two other clusters (green and red) include IN sites only, but one RL site, which is the most distantly related within the cluster. The fourth cluster (gold) includes all the remaining AB and RL sites. In this large cluster, 3 sub-clusters are seen, 2 including AB sites only and 1 including RL and one AB sites. The results of the analysis of similarity are consistent with the cluster analysis. ANOSIM statistic R was 0.283 (p=0.001), which indicates a moderate dissimilarity of plant communities between managements. Dissimilarities ranks within-classes show that dissimilarity is highest among RL sites (50% percentile=84.7) and lowest in IN sites (50%=36.0). In addition, within-class RL dissimilarity rank is higher than the between-classes dissimilarity rank (Figure 4).

ECOL, ES and TOT indices values were on average highest in the inventories performed in the AB sites, followed by RL sites and IN sites (Figure 5). Mixed-models results are shown in Table 2. ECOL, ES and TOT inventory overall values were significantly higher in AB sites compared to IN sites (respectively, ECOL: estimate +7.28, p=0.001; ES: estimate +2.98, p=0.037; TOT: estimate +10.26, p=0.003), while differences between AB and RL were marginal and never significant. Post-hoc tests show that values of ECOL and TOT indices are also significantly higher in RL sites compared to IN sites (ECOL: estimate +6.35, p=0.008; TOT: estimate +9.54, p=0.017), while ES value approached statistical significance (estimate +3.17, p=0.078). As for median inventory values, no significant differences emerge, with the exception of ECOL values between AB and IN sites (estimate +0.08, p=0.002). ECOL values differences approached statistical significance also in the RL-IN comparison (estimate +0.05, p=0.076).

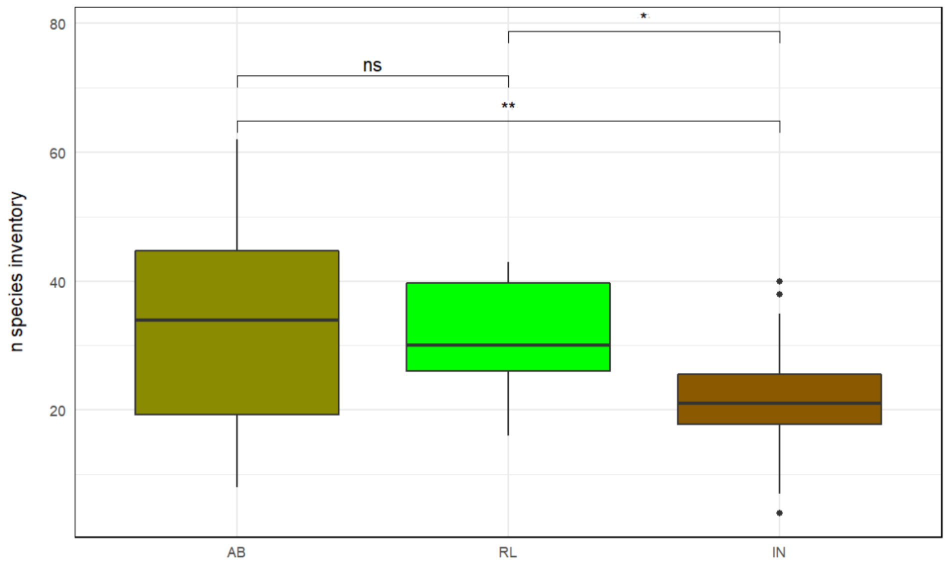

Figure 2 – Distribution of species richness values in inventories across terraces management types. Brackets indicate statistical significance as derived from post-hoc Tukey test of linear mixed model (<0.05; ** < 0.01; ns, not significant). RL=restored terraces; AB=abandoned terraces; IN=intensively-managed terraces*

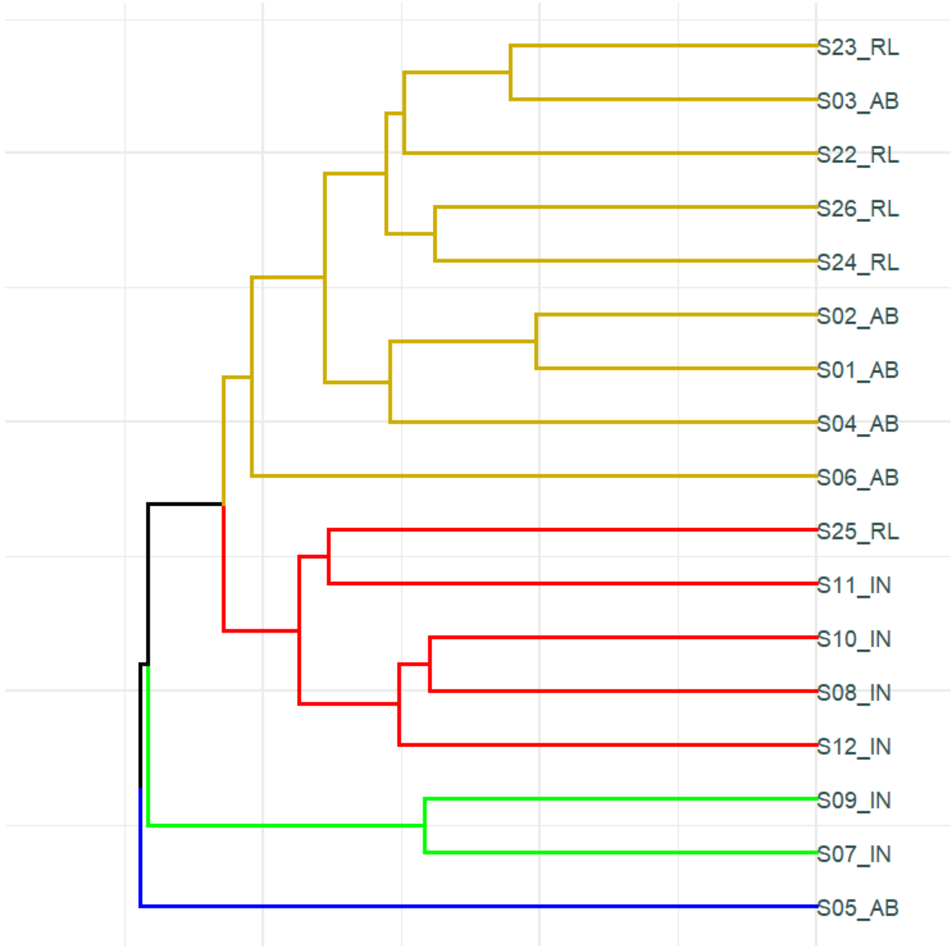

Figure 3 – Hierarchical clustering (complete linkage) of the dissimilarity matrix (Bray-Curtis distance) of the monitoring sites' species assemblages. Colours highlight the 4 main clusters (RL=restored terraces; AB=abandoned terraces; IN=intensively-managed terraces)

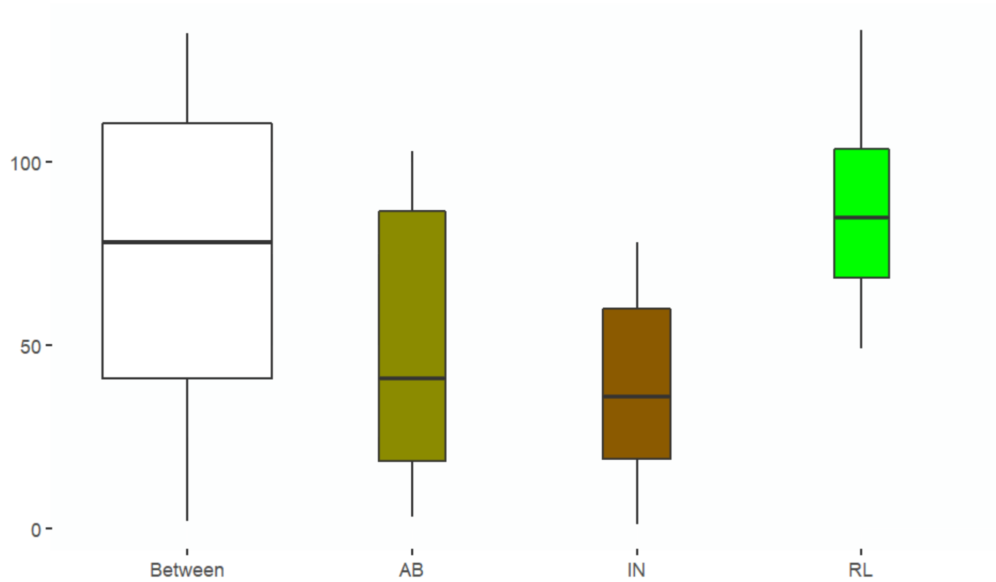

Figure 4 – Distribution of the dissimilarity ranks within- and between terraces management classes, as calculated by the ANOSIM (RL=restored terraces; AB=abandoned terraces; IN=intensively-managed terraces).

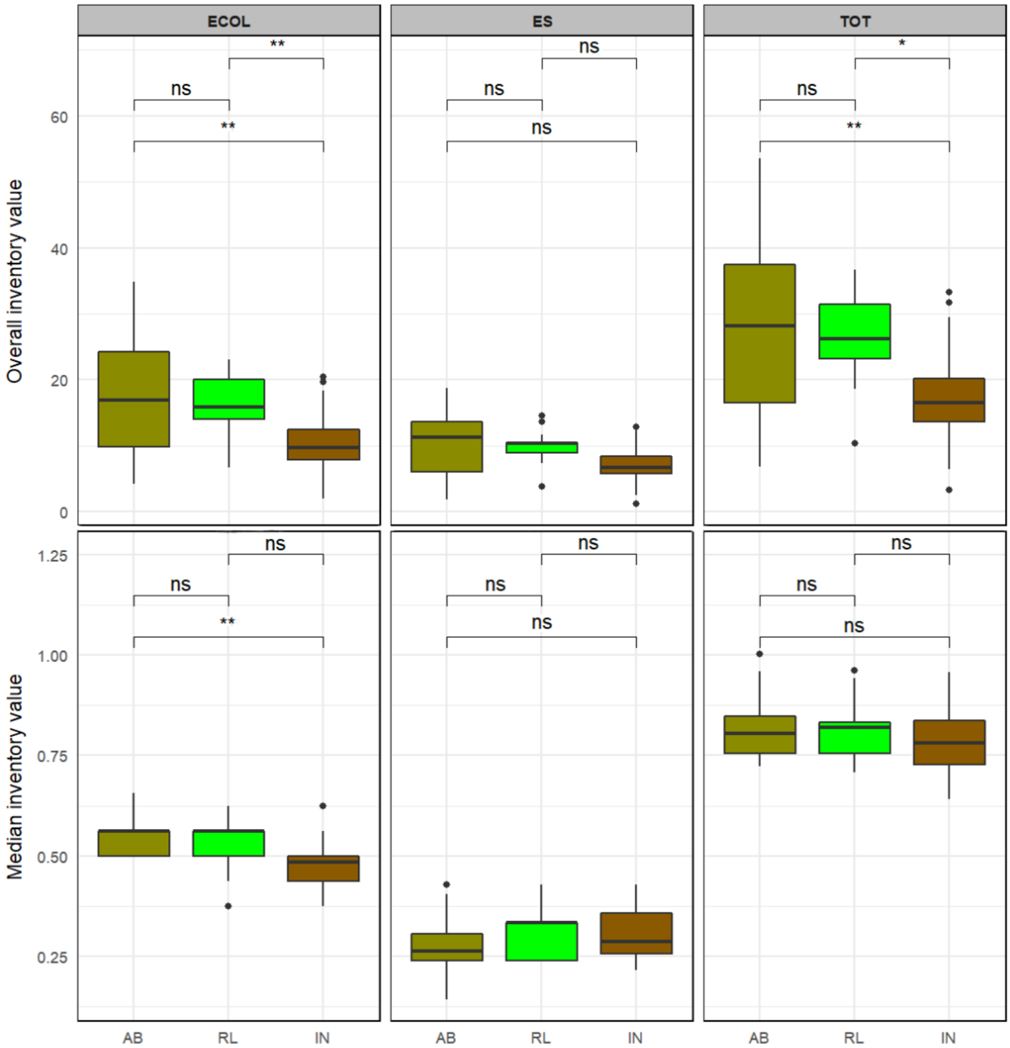

Figure 5 – Distribution of ECOL, ES and TOT values across terraces managements. Top: overall inventory values (sum of plants' values); bottom, plants' median inventory values (RL=restored terraces; AB=abandoned terraces; IN=intensively-managed terraces)

Table 2a and 2b – Summary of the results of the linear mixed models

Predictors	Inventory Overall								
	ECOL			ES			TOT		
	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p
(Intercept)	*17.5*	*14.62 / 20.38*	***<0.001***	*10*	*8.02 / 11.98*	***<0.001***	*27.49*	*22.76 / 32.22*	***<0.001***
MANAG [IN]	-7.28	-11.33 / -3.24	**0.001** ***	-2.98	-5.78 / -0.19	**0.037** ***	-10.26	-16.92 / -3.60	**0.003** ***
MANAG [RL]	-0.92	-5.15 / 3.31	0.666	0.2	-2.73 / 3.12	0.894	-0.72	-7.68 / 6.25	0.839
Random Effects									
σ^2	30.44			6.94			64.57		
$\tau_{00\ site}$	7.74			4.87			23.73		
ICC	0.20			0.41			0.27		
N site	17			17			17		
Observations	112			112			112		
Marginal R^2	0.22			0.16			0.21		
Conditional R^2	0.38			0.51			0.42		

Predictors	Inventory Median								
	ECOL			ES			TOT		
	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p
(Intercept)	*0.56*	*0.52 / 0.59*	***<0.001***	*0.27*	*0.24 / 0.31*	***<0.001***	*0.82*	*0.78 / 0.85*	***<0.001***
MANAG [IN]	-0.08	-0.13 / -0.03	**0.002** ***	0.03	-0.02 / 0.09	0.198	-0.03	-0.08 / 0.02	0.300
MANAG [RL]	-0.02	-0.07 / 0.03	0.400	0.04	-0.02 / 0.09	0.185	-0.01	-0.06 / 0.04	0.719
Random Effects									
σ^2	0			0			0		
$\tau_{00\ site}$	0			0			0		
ICC	0.48			0.39			0.25		
N site	17			17			17		
Observations	112			112			112		
Marginal R^2	0.26			0.06			0.02		
Conditional R^2	0.61			0.43			0.27		

Discussion

The restoration of abandoned terraces plays a critical role in terms of maintaining biodiversity and increasing human well-being. Our study shows that restoration of terraces in the SBR is associated to diversity values, ecological function and ecosystem service values within the same range as the naturally-rewilded abandoned terraces. All the results show that species assemblage of RL sites appears more closely related to AB sites than to IN sites, despite the agricultural land use. IN sites display low levels of diversity and ecological functions, confirming the lower suitability of intensive farming in achieving biodiversity conservation goals and in providing adequate levels of ecosystem services.

Plant diversity was significantly highest in the inventories performed in AB sites and lowest in IN sites. In fact, land abandonment in Mediterranean ecosystems is usually associated with secondary ecological succession towards semi-natural grassland with an increase of species abundance, even if responses may differ in effect size according to climate, spatial-temporal scales, land uses and landforms (Plieninger et al., 2014). Bonet (2004) showed that quick turnover of functional groups (annual/biennial plants, perennial forbs, perennial grasses etc.) occurs after few years of abandonment, which causes the presence of species rich communities resulting from niche overlap (Cody, 1991) or different disturbance regimes (Lavorel et al., 1999). However, diversity usually reaches a peak in 10-20 years before declining (Bonet, 2004; Debussche et al., 1996). It must be noted that species diversity in RL sites was not statistically different from AB sites at inventory level and that the overall checklist of RL sites included even 24 more species than AB sites. Conversely, intensive agricultural practices such as ploughing, fertilization, weed control and watering represent disturbances that may reduce significantly plant diversity in IN sites, favouring few, stress-resistant, generalist plant species. Low-input agriculture applied to restored terraces in accordance with the FLR principles allows the development of plant-rich communities closely related to naturally-rewilded abandoned terraces in terms of both species diversity and species assemblages. Hierarchical clustering reveals in fact that RL sites communities are hardly distinguishable from AB sites, while IN sites display communities easily identified and classified within parent clusters. Taxonomic similarity of AB and RL sites can also be explained by the presence of rare species, which are known to drive species assemblage differences in Mediterranean agricultural (Tarifa et al., 2021). Among the 11 species of orchids observed, 10 were found in AB sites, 3 in RL and none in IN sites. Lebanese, Levantine or Eastern Mediterranean endemism were more abundant in AB sites (66 species) compared to RL (54) and IN sites (38). Agricultural intensification erodes rare species, either as direct consequence of management practices (e.g. ploughing, use of herbicides) or indirectly (e.g. by reducing pollinators with pesticides and, hence, insect-pollinated plants) (Pinke and Gunton, 2014). Consistently with the cluster analysis, the ANOSIM shows that within-site similarity of IN sites is highest and way higher than between-site similarity. AB terraces display a similar pattern, while, conversely, RL sites plant communities are possibly more diverse. This result may suggest that species assemblages in IN sites are mostly driven by fewer, typical species adapted to high disturbance regimes, while AB sites consistently feature semi-natural grassland species. Low similarity across RL terraces hints at species assemblages influenced by spillovers from the remainder communities.

As expected, our study shows that AB and RL sites provide high-value ecological and ES plant communities compared to IN sites. The difference resides chiefly in species' ecological value, which in AB sites is significantly higher on a species' average basis compared to IN sites (and approaching significance between RL and IN). Thus, semi-natural abandoned terraces and low-input farming terrace systems positively contribute to the preservation of biodiversity, by hosting plant species of intrinsically higher value, such as endemic, endangered, habitat-specific or insect-pollinating species. The effect is boosted by the higher diversity of species found with respect to intensively-managed terraces. All things considered, restoring terraces has no negative effects on biodiversity conservation in SBR. Conservation goals, sustainable production and food security can be achieved by applying FLR principles, restoring economic and social functions of the landscape while maintaining ecological functionality (Beatty et al., 2018; Hani et al., 2019). In Mediterranean landscapes, agroforestry was already shown to enhance biodiversity and ES relative to conventional agriculture, including the practice of integrating cover crops in olive orchards to increase nutrient retention and to prevent soil erosion (Durán Zuazo & Rodríguez Pleguezuelo, 2008; Gómez et al., 2009; Torralba et al., 2016). Conversely, no differences were seen from a plants' qualitative point of view (plants' median ES value in inventories), but rather differences stood out quantitatively at terrace level. In fact, as far as plants' overall ES value in inventories are considered, the effect of the larger species' abundance in AB and RL sites determined significant higher ES values in AB and RL sites. Non-linear relationship between qualitative and quantitative aspects of ES have already been demonstrated in farmlands (Tzilivakis et al., 2019); however, ecosystem services are provided by ecosystems quantitatively (Lee and Lautenbach, 2016; Logsdon and Chaubey, 2013; Rositano and Ferraro, 2014). It was shown that the relationship between land use and ecosystem services is not linear for each of the 3 categories (provisioning, regulating, cultural). On a gradient between fully natural and fully urban environments, only regulating services reach their maximum values when naturality is maximized; conversely, cultural (including tourism and recreation) and provisioning services values are maximised at light or extensive land uses (Braat and ten Brink, 2008). In our study, we found mixed results in this sense. IN sites provided higher values in provisioning and regulating services such as pasture enrichment and food, while cultural values (chiefly, aesthetic values) were mostly present in AB and RL sites. Possibly, the selection of the ES indicators may not have included all the wide range of ES provided by ecosystems in the different categories. In addition, smallholder farmland system, such as the one featured in the SBR, may also contribute to plant species' spillovers from semi-natural and low-input patches to more intensively-managed terraces, partially buffering negative effects of invasive farming practices (Concepción et al., 2012).

Conclusions

The restoration of abandoned terraces in the SBR, which applies FLR restoration principles such as agroforestry and low-input agriculture, is effective in maintaining same biodiversity levels of naturally-rewilded abandoned terraces whilst producing agricultural products, income for the local communities and well-being. The study gives evidence that restoring abandoned terraces is a win-win nature-based solution (NbS) which is able to combine the same ecological functionality of semi-natural environments with the provision of primary food production and well-being.

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Supplementary material 1

Checklist of the plant species identified in the SBR terraces with their respective ECOL and ES values. Numbers refer to the species' frequency (n max=6) in the different terrace typologies (RL=restored terraces; AB=abandoned terraces; IN=intensively-managed terraces)

SPECIES	RL	AB	IN	ECOL	ES
Adonis annua L.	1			0.563	0.667
Aegilops neglecta Req. Ex Bertol.	3	4	2	0.188	0.524
Aegilops triuncialis L.	2	2		0.188	0.381
Aegilotriticum loretii (K.Richt.)P.Fourn.			1	0.125	0.238
Ajuga chamaepitys chia (Schreb.) Arcang.	4	1		0.375	0.238
Alcea kurdica coelesyriaca (Mouterde) Mouterde		1		0.563	0.095
Alcea setosa (Boiss.) Alef.	1	1	1	0.625	0.667
Allium neapolitanum Cirillo	2			0.563	0.714
Allium rotundum L.	1			0.500	0.429
Allium trifoliatum Cirillo	3		1	0.625	0.571
Alopecurus myosuroides Huds.	3		2	0.188	0.238
Alopecurus rendlei Eig.	2			0.188	0.238
Alopecurus utriculatus Sol.	2		4	0.375	0.238
Alyssum repens Baumg.		1		0.625	0.143
Amaranthus retroflexus L.	1		2	0.000	0.143
Anacamptis papilionacea (L.) R.M. Bateman, Pridgeon & M.W. Chase		4		0.500	0.143
Anacamptis pyramidalis (L.) Rich		1		0.375	0.429
Anacamptis morio syriaca (E.G.Camus) H.Kretzschmar, Eccarius & H.Dietr.		1		0.688	0.143
Anagallis arvensis var. caerulea (L.) Gouan	4	3	3	0.500	0.286
Anarrhinum orientale Benth.	1	2		0.563	0.000
Anchusa azurea Mill.	1			0.563	0.333
Anchusa hybrida Ten.	1	2	1	0.750	0.190
Anemone coronaria L.	1	6		0.438	0.524
Anisantha rigida (Roth) Hyl.		1	2	0.250	0.238
Anisantha sterilis (L.) Nevski	3	3		0.125	0.238
Anisantha tectorum (L.) Nevski	1	1	1	0.125	0.381
Anthemis chia L.	1	1		0.625	0.381
Anthyllis vulneraria maura (Beck) Maire	2	2		0.625	0.619
Arabidopsis thaliana (L.) Heynh.		1		0.250	0.524
Arum palaestinum Boiss.	3	3	3	0.375	0.571
Asparagus acutifolius L.	2	4	2	0.438	0.429
Asparagus aphyllus L.		1		0.438	0.143
Asperula libanotica Boiss.	1			0.625	0.048
Asphodelus ramosus ramosus L.		1		0.625	0.952
Asplenium adianthum-nigrum L.		1		0.000	0.000
Astragalus hamosus L.			1	0.625	0.571
Astragalus oleifolius DC.	1			0.625	0.429
Athyrium filix-femina (L.) Roth		1		0.000	0.143

Avena barbata Link	4	1	1	0.188	0.667
Avena clauda Durieu	4	3	1	0.188	0.238
Avena sterilis L.	5	4	4	0.188	0.524
Bellevalia flexuosa Boiss.			1	0.750	0.095
Bellis perennis L.	1			0.563	0.333
Biscutella didyma L.			1	0.500	0.381
Bituminaria bituminosa (L.) C.H. Stirt.	2	3		0.500	0.286
Brachypodium sylvaticum (Huds.) P.Beauv.	1	1		0.188	0.238
Brassica rapa (*L.*) L.	2			0.313	0.476
Bromus brachystachys Hornung	1	1		0.250	0.238
Bromus intermedius Guss.	1	1	3	0.250	0.238
Bromus lanceolatus Roth			1	0.000	0.238
Bromus madritensis L.	2	2	4	0.188	0.238
Bromus scoparius L.		1		0.188	0.238
Bryonia cretica L.			2	0.375	0.286
Buglossoides tenuiflora (L. F.) I.M. Johnst.		1		0.563	0.143
Bunium pestolazzae Boiss.		1		0.563	0.190
Bupleurum lancifolium Hornem.	1			0.563	0.333
Calendula arvensis (Vaill.) L.			1	0.500	0.476
Calepina irregularis (Asso) Thell.	1			0.375	0.095
*Calicotome villosa (*Poir.) Link	3	2		0.688	0.429
Campanula rapunculus L.		2	1	0.625	0.476
Capparis spinosa L.	1			0.313	1.000
Capsella bursa-pastoris (L.) Medik.	1		3	0.375	0.524
Cardamine hirsuta L.	1		2	0.313	0.238
Carduus argentatus L.	3	4	4	0.750	0.333
Carduus pycnocephalus L.	2	1	4	0.563	0.190
Carex distans L.	1	1		0.375	0.048
Carlina curetum orientalis Meusel & Kästner	2	6	1	0.750	0.095
Carthamus tenuis (Boiss. & I. Blanche) Bornm.	2	3	3	0.688	0.476
Catananche lutea L.		2		0.500	0.048
Catapodium rigidum (L.) C.E.Hubb.	1			0.188	0.238
Centaurea cheirolopha (Fenzl) Wagenitz	1	2		0.875	0.333
Centaurea iberica Spreng.	3	5	2	0.625	0.619
Centaurea solstitialis solsitialis L.	1	1		0.688	0.619
Centaurea verutum L.	1			0.875	0.190
Centaurium pulchellum (Sw.) Druce		1		0.438	0.429
Cephalanthera longifolia (L.) R.M. Fritsch	1			0.375	0.143
Ceterach officinarum Willd.		1		0.125	0.286
Chenopodium album L.	1		2	0.188	0.429
Chondrilla juncea L.			1	0.313	0.333
Chrozophora tinctoria (L.) A. Juss.	2		1	0.375	0.143
Cichorium intybus L.	4	2	1	0.375	0.381
Cirsium phyllocephalum Boiss. & C.I. Blanche	1	3		0.813	0.190
Cistus creticus L.	2	2	1	0.688	0.476
Clematis flammula L.	3		1	0.500	0.333

Clinopodium vulgare L.		1		0.313	0.524
Convolvulus arvensis L.	4	1	3	0.375	0.667
Cota altissima (L.) J. Gay	2			0.625	0.095
Cota tinctoria (L.) J. Gay	2	4		0.500	0.238
Crepis aspera L.	1	2	1	0.563	0.048
Crepis foetida L.		1	1	0.438	0.048
Crepis hierosolymitana Boiss.		1	1	0.750	0.048
Crepis palaestina (Boiss.) Bornm.	1	1	2	0.688	0.048
Crepis pterothecoides Boiss.	2	1		0.688	0.048
Crepis reuteriana reuteriana Boiss.	1	3		0.688	0.048
Crepis sancta (L.) Bornm.	2	1		0.500	0.048
Crepis syriaca (Bornm.) Babc. & Navashin			1	0.688	0.048
Crucianella latifolia L.	3	2	1	0.500	0.000
Crupina crupinastrum (Moris) Vis.	1	2		0.563	0.190
Cyclamen persicum Mill.	2	3		0.625	0.381
Cynodon dactylon (L.) Pers.			1	0.063	0.810
Cytisopsis dorycniifolia Jaub. & Spach		1		0.625	0.143
Dactylis glomerata L.	5	6	3	0.063	0.381
Dactylorhiza urvilleana (Steud.) H.Baumann & Künkele		1		0.625	0.143
Datura stramonium L.			1	0.125	0.333
Daucus carota L.	3	4	4	0.500	0.381
Dianthus strictus multipunctatus (Ser.) Greuter & Burdet		1		0.625	0.190
Dioscorea communis (L.) Caddick & Wilkin		2	1	0.500	0.286
Diplotaxis erucoides (L.) DC.			1	0.438	0.238
Diplotaxis tenuifolia (L.) DC.	3		1	0.438	0.238
Dittrichia viscosa (L.) Greuter	3	2	2	0.563	0.190
Draba praecox Steven			1	0.375	0.095
Ecballium elaterium (L.) A. Rich.	1		1	0.375	0.333
Echinochloa colona (L.) Link			1	0.063	0.381
Echinops adenocaulos Boiss.	4	5	3	0.813	0.190
Echinops spinosissimus Turra	1			0.688	0.476
Echium glomeratum Poir.	1		1	0.875	0.190
Epilobium hirsutum L.	1		2	0.438	0.286
Epilobium parviflorum Schreb.	1			0.250	0.286
Epilobium tetragonum L.			1	0.563	0.143
Equisetum ramosissimum Desf.			1	0.063	0.143
Eremopoa persica (Trin.) Roshev.			1	0.250	0.238
Eremostachys laciniata (L.) Bunge		1	1	0.500	0.238
Erodium acaule (L.) Bech. & Thell.	2		2	0.625	0.000
Erodium cicutarium (L.) L'Hér.	1		2	0.500	0.286
Erodium malacoides (L.) L'Hér.	2	2	5	0.563	0.143
Erophila verna praecox (Steven) Walters			1	0.250	0.143
Eryngium creticum Lam.	2	1		0.813	0.714
Eryngium glomeratum Lam.	4	5	1	0.688	0.857
Erysimum scabrum DC.	2	2		0.563	0.095

Euphorbia gaillardotii Boiss. & C.I. Blanche	1			0.625	0.190
Euphorbia helioscopia L.	2		3	0.313	0.476
Fibigia clypeata eriocarpa (DC.) Greuter		2		0.500	0.238
Ficaria ficarioides (Bory & Chaub.) Halácsy		1	1	0.563	0.048
Ficus carica L.		1		0.500	0.810
Fritillaria persica L.		1		0.688	0.143
Fumana arabica (L.) Spach		1		0.375	0.048
Fumana thymifolia (L.) Webb	1	1		0.438	0.048
Gagea liotardii (Sternb.) Schult. & Schult. F.	1	1		0.563	0.000
Galinsoga quadriradiata Ruiz & Pav.			1	0.250	0.048
Galium aparine L.			2	0.250	0.667
Galium hierosolymitanum L.	3	2		0.563	0.095
Galium samuelssonii Ehrend.			1	0.563	0.095
Geranium dissectum L.	1		1	0.500	0.286
Geranium libanoticum Schenk		2		0.750	0.000
Geranium molle L.	1	2	4	0.375	0.143
Geranium purpureum Vill.	2		1	0.500	0.000
Geranium robertianum L.	1		1	0.250	0.429
Geranium rotundifolium L.	1		3	0.375	0.143
Geropogon hybridus (L.) Sch.Bip.	4	2	2	0.375	0.095
Gladiolus italicus Mill.		2		0.375	0.143
Gundelia tournefortii L.	1			0.625	0.429
Helianthemum lavandulifolium Mill.		1		0.563	0.048
Helianthemum syriacum (Jacq.) Dum. Cours.		1		0.563	0.048
Helichrysum stoechas barrelieri (Ten.) Nyman		1		0.625	0.381
Heliotropium rotundifolium Lehm.	1			0.750	0.143
Helminthotheca echioides (L.) Holub	1		2	0.375	0.190
Heptaptera anisoptera (DC.) Tutin		1	1	0.625	0.190
Heptaptera microcarpa (Boiss.) Tutin		2		0.563	0.190
Hibiscus trionum L.			1	0.438	0.333
Himantoglossum caprinum (M. Bieb.) Spreng.	1	1		0.563	0.143
Hippocrepis unisiliquosa L.	2			0.500	0.143
Holosteum umbellatum L.		1		0.438	0.000
Hordeum bulbosum L.	3	5	4	0.250	0.667
Hordeum vulgare L.			1	0.438	0.952
Hymenocarpos circinnatus (L.) Savi	2	1		0.563	0.143
Hypecoum imberbe Sm.	1		1	0.375	0.048
Hypericum lanuginosum Lam.	2	2		0.750	0.000
Hypericum thymifolium Banks & Sol.		1		0.750	0.000
Hypericum triquetrifolium Turra	2	2	1	0.625	0.000
Hypochaeris achyrophorus L.	2	3		0.438	0.048
Ipomea purpurea (L.) Roth			1	0.188	0.095
Isatis lusitanica L.	3	2	3	0.438	0.238
Isatis tinctoria L.	1			0.375	0.381
Kickxia spuria (L.) Dumort.	1			0.438	0.143
Klasea cerinthifolia (Sm.) Greuter & Wagenitz	1	1		0.688	0.048

Lactuca saligna L.	1		2	0.375	0.143
Lactuca serriola L.	2		4	0.375	0.429
Lagoecia cuminoides L.	1	2		0.563	0.238
Lamium amplexicaule L.	1		3	0.438	0.429
Lamium purpureum L.			2	0.438	0.429
Lathyrus aphaca L.	3		3	0.438	0.714
Lathyrus blepharicarpos Boiss.	2	4	2	0.688	0.286
Lathyrus hierosolymitanus Boiss.		1		0.625	0.286
Legousia falcata (Ten.) Janch.			1	0.438	0.048
Legousia speculum-veneris (L.) Durande ex Vill.	1			0.500	0.048
Leopoldia comosa (L.) Parl.	1	2	3	0.563	0.238
Lepidium draba L.			1	0.438	0.381
Linum pubescens Banks & Sol.	5	5	2	0.563	0.000
Linum strictum spicatum (Pers.) Nyman	1	2		0.438	0.143
Lolium perenne L.	3	2	3	0.188	0.667
Lolium rigidum Gaudin	1		1	0.125	0.381
Lomelosia palaestina (L.) Raf.	2	3		0.563	0.048
Lonicera etrusca Santi	1	1		0.563	0.381
Lotus judaicus Boiss.	4	1	1	0.625	0.333
Malva neglecta Wallr.			4	0.500	0.333
Marrubium cuneatum Banks & Sol.		1		0.750	0.238
Medicago lupulina L.	3		1	0.438	0.429
Medicago orbicularis (L.) Bartal.	1			0.688	0.143
Medicago polymorpha L.			3	0.625	0.429
Medicago radiata L.	1			0.688	0.143
Medicago rugosa Desr.	1			0.688	0.143
Medicago sativa L.	3		2	0.688	0.857
Medicago sativa varia (Martyn) Arcang.	5	3	2	0.750	0.857
Medicago polymorpha L.			2	0.625	0.429
Melica minuta L.	1	1		0.313	0.238
Micromeria graeca (L.) Benth. ex Rchb.		1		0.563	0.381
Moraea sisyrinchium (L.) Ker Gawl.	1			0.500	0.190
Muscari neglectum Guss. Ex Ten.		1	1	0.438	0.238
Neotinea tridentata (Scop.) R.M. Bateman, Pridgeon & M.W. Chase		5		0.500	0.143
Nigella ciliaris DC.	1	1		0.688	0.048
Notobasis syriaca (L.) Cass.	2	3	1	0.500	0.190
Octhodium aegyptiacum (L.) DC.			1	0.563	0.095
Ononis natrix L.	2	2		0.813	0.286
Ononis spinosa L.	3	3	2	0.625	0.429
Ononis viscosa breviflora (DC.) Nyman	1	1		0.688	0.143
Ophrys omegaifera israelitica (H.Baumann & Künkele) G.Morschek & K.Morschek		2		0.625	0.143
Orchis anatolica Boiss.	2	4		1.000	0.143
Orchis galilaea (Bornm. & M. Schulze) Schltr.		1		0.688	0.143
Orchis italica Poir.		1		0.688	0.429
Origanum syriacum L.	1	1	1	0.625	0.381

Orlaya grandiflora (L.) Hoffm.	1			0.563	0.429
Ornithogalum divergens Boreau		1	2	0.438	0.238
Ornithogalum narbonense L.			1	0.438	0.238
Osyris alba L.	2	1		0.438	0.143
Pallenis spinosa (L.) Cass.	2	4		0.500	0.238
Papaver dubium L.			1	0.438	0.381
Papaver rhoeas L.	1			0.563	0.667
Papaver umbonatum Boiss.	3	2	3	0.688	0.381
Parietaria judaica L.			2	0.125	0.143
Peltaria angustifolia DC.	1	1		0.563	0.095
Phalaris brachystachys Link	1			0.313	0.238
Phalaris minor Retz.			1	0.188	0.381
Physalis peruviana L.	1			0.188	0.333
Picnomon acarna (L.) Cass.	3	3	3	0.438	0.095
Pimpinella peregrina L.	2	4	3	0.438	0.286
Piptatherum miliaceum (L.) Coss.			1	0.250	0.238
Pistacia terebinthus palaestina (Boiss.) Engl.		1		0.500	0.810
Pisum fulvum Sm.			1	0.625	0.286
Plantago lanceolata L.	1	1	3	0.250	0.476
Poa bulbosa L.	1		1	0.188	0.238
Polygala monspeliaca L.		2	1	0.500	0.000
Polygala supina Schreb.	1	1		0.438	0.000
Polygonum aviculare L.			1	0.438	0.381
Polypogon viridis (Gouan) Breistr.			1	0.125	0.238
Prunus ursina Kotschy	1			0.938	0.333
Pterocephalus plumosus (L.) DC.	3	2	2	0.500	0.000
Ptilostemon diacantha diacantha (Labill.) Greuter		1		0.688	0.048
Putoria calabrica (L. F.) DC.	1	1		0.500	0.333
Pyrus syriaca Boiss.		1		0.750	0.667
Quercus coccifera L.	4	3		0.625	0.714
Ranunculus asiaticus L.		1		0.688	0.429
Ranunculus marginatus d'Urv.		1	1	0.625	0.190
Ranunculus millefolius hierosolymitanus (Boiss.) P.H.Davis	1	1		0.688	0.190
Raphanus raphanistrum L.			1	0.250	0.333
Rosa canina L.		1		0.438	0.952
Rubia tenuifolia D'Urv.	5	4	1	0.563	0.381
Rubus collinus DC.	5	1	3	0.750	0.476
Salvia hierosolymitana Boiss.	1			0.875	0.190
Salvia judaica Boiss.	1			0.938	0.190
Salvia viscosa Jacq.		2		0.813	0.333
Sanguisorba minor balearica (Nyman) Muñoz Garm. & C. Navarro	3	3	1	0.375	0.381
Sanguisorba verrucosa (G. Don) Ces.		3	1	0.563	0.095
Sarcopoterium spinosum (L.) Spach	2	4	3	0.688	0.667
Scandix pecten-veneris L.	2		2	0.375	0.238
Scorzonera mollis M. Bieb.	1	2		0.625	0.190
Scorzonera phaeopappa (Boiss.) Boiss.	1			0.375	0.048

Scrophularia rubricaulis Boiss.	1			0.625	0.048
Scutellaria brevibracteata Stapf		1		0.688	0.238
Securigera securidaca (L.) Degen & Dörfl.	4	3	2	0.625	0.143
Senecio leucanthemifolius vernalis (Waldst. & Kit.) Greuter	3	1	4	0.500	0.095
Senecio vulgaris L.			2	0.500	0.190
Setaria viridis (L.) P. Beauv.			2	0.000	0.524
Sherardia arvensis L.	2			0.375	0.143
Sideritis perfoliata L.		1		0.563	0.381
Silene aegyptiaca (L.) L.	1		3	0.625	0.095
Silene damascena Boiss. & Gaill.	3	2	2	0.688	0.095
Silene vulgaris (Moench) Garke		1	2	0.375	0.524
Sinapis alba L.	1			0.438	0.524
Sinapis arvensis L.		1	2	0.438	0.667
Sisymbrium officinale (L.) Scop.	3		3	0.375	0.381
Sisymbrium orientale L.		1		0.375	0.095
Smilax aspera L.	1			0.063	0.429
Solanum luteum Mill.	2			0.313	0.333
Solanum villosum Mill.	1		1	0.313	0.333
Sonchus asper subsp. glaucescens (L.) Hill	1			0.375	0.333
Sonchus oleraceus (L.) L.	2		2	0.313	0.476
Sonchus tenerrimus L.			1	0.500	0.190
Sorghum halepense (L.) Pers.			1	0.125	0.667
Spartium junceum L.	2	3		0.563	0.429
Stachys cretica L.		2		0.625	0.238
Teucrium divaricatum Sieber ex Heldr.	1	2		0.688	0.190
Teucrium polium L.		1		0.688	0.476
Theligonum cynocrambe L.	2		1	0.500	0.286
Thlaspi perfoliatum L.	3	1	1	0.438	0.381
Thymbra spicata L.		2		0.625	0.238
Torilis arvensis neglecta (Spreng.) Thell.	1	2	3	0.375	0.238
Torilis nodosa (L.) Gaertn.		1		0.313	0.238
Torilis tenella (Delile) Rchb. F.	2	2	1	0.438	0.238
Torilis arvensis heterophylla (Guss.) Hayek	2	1	2	0.438	0.238
Tragopogon porrifolius longirostris (Sch. Bip.) Greuter	3	2		0.563	0.095
Trifolium angustifolium L.	4	3	3	0.750	0.333
Trifolium argutum Banks & Sol.			1	0.750	0.333
Trifolium campestre Schreb.	3	2	3	0.500	0.476
Trifolium clusii Godr. & Gren.	5	2	5	0.625	0.333
Trifolium clypeatum L.			1	0.813	0.476
Trifolium eriosphaerum Boiss.			1	0.750	0.476
Trifolium fragiferum L.	1			0.500	0.333
Trifolium grandiflorum Schreb.	1			0.563	0.333
Trifolium lappaceum L.	1			0.563	0.333
Trifolium plebeium Boiss.	2		1	0.750	0.333
Trifolium repens L.			2	0.500	0.905

Trifolium resupinatum L.			1	0.563	0.619
Trifolium scabrum L.	2	1		0.500	0.333
Trifolium stellatum L.	4	4	3	0.625	0.476
Trigonella berythea Boiss. & Blanche			1	0.625	0.286
Triticum aestivum L.	1			0.313	0.810
Umbilicus intermedius Boiss.	1		1	0.563	0.048
Urospermum picroides (L.) Scop. ex F.W.Schmidt	3			0.375	0.048
Valeriana dioscoridis Sm.		1		0.500	0.000
Valerianella discoidea (L.) Loisel.	1			0.375	0.000
Valerianella vesicaria (L.) Moench	1			0.500	0.000
Verbascum gaillardotii Boiss.	1		1	0.625	0.143
Veronica anagallis-aquatica L.			1	0.438	0.000
Veronica cymbalaria Bodard	1	1	1	0.500	0.000
Veronica persica Poir.			2	0.188	0.000
Veronica syriaca Roem. & Schult.	2		2	0.625	0.000
Vicia palaestina Boiss.		1	1	0.813	0.286
Vicia peregrina L.	3		2	0.688	0.429
Vicia sativa L.	2	3	3	0.563	0.286
Vicia sericocarpa microphylla (Boiss.) Ponert		1	1	0.875	0.286
Xanthium spinosum L.	1			0.250	0.333
Xanthium strumarium L.			1	0.250	0.333

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Supplementary material 2

Here below the checklist of species found in each sampling site is reported

Site S01_AB

Aegilops neglecta
Ajuga chamaepitys
Anacamptis papilionacea
Anacamptis pyramidalis
Anagallis arvensis
Anchusa hybrida
Anemone coronaria
Anisantha sterilis
Anthemis chia
Arum palaestinum
Asparagus acutifolius
Asphodelus ramosus
Avena clauda
Avena sterilis
Bituminaria bituminosa
Carduus argentatus
Carduus pycnocephalus
Carlina curetum
Carthamus tenuis
Catananche lutea
Centaurea iberica
Cirsium phyllocephalum
Convolvulus arvensis
Cota tinctoria
Crepis aspera
Crepis foetida
Crepis hierosolymitana
Cyclamen persicum
Dactylis glomerata
Dactylorhiza urvilleana
Daucus carota
Dittrichia viscosa
Echinops adenocaulos
Erodium malacoides
Eryngium creticum
Eryngium glomeratum
Erysimum scabrum
Fibigia clypeata
Geranium libanoticum
Geropogon hybridus
Gladiolus italicus
Hordeum bulbosum
Hymenocarpos circinnatus
Hypericum triquetrifolium
Hypochaeris achyrophorus
Isatis lusitanica
Lathyrus blepharicarpos
Leopoldia comosa
Linum pubescens
Linum strictum
Lolium perenne
Medicago sativa varia
Neotinea tridentata
Notobasis syriaca
Ononis spinosa
Orchis anatolica
Pallenis spinosa
Peltaria angustifolia
Picnomon acarna
Pimpinella peregrina
Plantago lanceolata
Polygala monspeliaca
Pyrus syriaca
Quercus coccifera
Rubia tenuifolia
Salvia viscosa
Sanguisorba minor
Sanguisorba verrucosa
Sarcopoterium spinosum
Securigera securidaca
Silene vulgaris
Spartium junceum
Stachys cretica
Torilis tenella
Tragopogon porrifolius
Trifolium angustifolium
Trifolium clusii
Trifolium scabrum
Trifolium stellatum
Vicia sativa

Site S02_AB

Aegilops neglecta
Alyssum repens
Anacamptis papilionacea
Anagallis arvensis
Anchusa hybrida
Anemone coronaria
Anisantha sterilis
Anthyllis vulneraria
Arum palaestinum
Avena clauda
Avena sterilis
Bituminaria bituminosa
Bromus brachystachys

Bunium pestolazzae
Calicotome villosa
Carduus argentatus
Carlina curetum
Catananche lutea
Centaurea iberica
Cirsium phyllocephalum
Cota tinctoria
Crepis reuteriana reuteriana
Crupina crupinastrum
Cyclamen persicum
Dactylis glomerata
Daucus carota
Echinops adenocaulos
Eremostachys laciniata
Eryngium glomeratum
Ficus carica
Galium hierosolymitanum
Geranium libanoticum
Gladiolus italicus
Heptaptera anisoptera
Heptaptera microcarpa
Hordeum bulbosum
Hypericum triquetrifolium
Hypochaeris achyrophorus
Klasea cerinthifolia
Lathyrus blepharicarpos
Leopoldia comosa
Linum pubescens
Linum strictum
Lomelosia palaestina
Lotus judaicus
Marrubium cuneatum
Muscari neglectum
Neotinea tridentata
Ononis viscosa
Orchis anatolica
Pallenis spinosa
Pimpinella peregrina
Polygala monspeliaca
Pterocephalus plumosus
Rosa canina
Rubia tenuifolia
Sanguisorba verrucosa
Sarcopoterium spinosum
Securigera securidaca
Senecio leucanthemifolius
Silene damascena
Spartium junceum
Stachys cretica
Torilis tenella
Trifolium campestre
Trifolium stellatum
Vicia sativa

Site S03_AB
Aegilops neglecta
Aegilops triuncialis
Anagallis arvensis
Anemone coronaria
Anisantha sterilis
Asparagus acutifolius
Avena sterilis
Bituminaria bituminosa
Brachypodium sylvaticum
Bromus madritensis
Campanula rapunculus
Carduus argentatus
Carlina curetum
Carthamus tenuis
Centaurea iberica
Cichorium intybus
Cirsium phyllocephalum
Cota tinctoria
Crepis palaestina
Crepis pterothecoides
Crepis reuteriana reuteriana
Crucianella latifolia
Crupina crupinastrum
Cyclamen persicum
Dactylis glomerata
Daucus carota
Dioscorea communis
Echinops adenocaulos
Eryngium glomeratum
Galium hierosolymitanum
Geranium molle
Geropogon hybridus
Holosteum umbellatum
Hordeum bulbosum
Isatis lusitanica
Lathyrus hierosolymitanus
Linum pubescens
Lolium perenne
Lomelosia palaestina
Medicago sativa varia
Neotinea tridentata
Nigella ciliaris
Notobasis syriaca
Ononis natrix
Ononis spinosa
Ornithogalum divergens
Pallenis spinosa
Papaver umbonatum

Pimpinella peregrina
Quercus coccifera
Rubia tenuifolia
Sanguisorba minor
Sarcopoterium spinosum
Scorzonera mollis
Securigera securidaca
Sinapis arvensis
Sisymbrium orientale
Torilis arvensis
Torilis nodosa
Torilis arvensis
Tragopogon porrifolius
Trifolium angustifolium
Trifolium campestre
Trifolium stellatum
Valeriana dioscoridis
Vicia sericocarpa
Vicia sativa

Site S04_AB
Aegilops triuncialis
Alcea kurdica
Alcea setosa
Anacamptis papilionacea
Anarrhinum orientale
Anemone coronaria
Anisantha rigida
Arabidopsis thaliana
Arum palaestinum
Asparagus acutifolius
Asparagus aphyllus
Avena barbata
Avena sterilis
Bromus madritensis
Buglossoides tenuiflora
Calicotome villosa
Campanula rapunculus
Carduus argentatus
Carlina curetum
Centaurea iberica
Ceterach officinarum
Cistus creticus
Clinopodium vulgare
Cota tinctoria
Crepis sancta
Crucianella latifolia
Dactylis glomerata
Daucus carota
Dianthus strictus
Dioscorea communis
Dittrichia viscosa
Echinops adenocaulos
Eryngium glomeratum
Fibigia clypeata
Ficaria ficarioides
Fritillaria persica
Fumana arabica
Gagea liotardii
Himantoglossum caprinum
Hordeum bulbosum
Hypericum lanuginosum
Hypochaeris achyrophorus
Lagoecia cuminoides
Lathyrus blepharicarpos
Linum pubescens
Lonicera etrusca
Micromeria graeca
Neotinea tridentata
Ononis natrix
Ophrys omegaifera
Orchis anatolica
Origanum syriacum
Osyris alba
Pallenis spinosa
Picnomon acarna
Pimpinella peregrina
Pistacia terebinthus
Polygala supina
Pterocephalus plumosus
Quercus coccifera
Ranunculus asiaticus
Ranunculus marginatus
Ranunculus millefolius
Rubia tenuifolia
Rubus collinus
Sanguisorba minor
Sanguisorba verrucosa
Sarcopoterium spinosum
Scutellaria brevibracteata
Sideritis perfoliata
Silene damascena
Spartium junceum
Teucrium divaricatum
Teucrium polium
Thlaspi perfoliatum
Thymbra spicata
Trifolium angustifolium
Veronica cymbalaria
Vicia sativa

Site S05_AB

Anacamptis papilionacea
Anacamptis morio
Anarrhinum orientale
Anemone coronaria
Anthyllis vulneraria
Asparagus acutifolius
Asplenium adianthum-nigrum
Athyrium filix-femina
Carex distans
Carlina curetum
Centaurea cheirolopha
Centaurium pulchellum
Cistus creticus
Cytisopsis dorycniifolia
Dactylis glomerata
Fumana thymifolia
Helianthemum lavandulifolium
Helianthemum syriacum
Helichrysum stoechas
Heptaptera microcarpa
Hypericum lanuginosum
Hypericum thymifolium
Lomelosia palaestina
Melica minuta
Neotinea tridentata
Ophrys omegaifera
Orchis anatolica
Orchis galilaea
Orchis italica
Ptilostemon diacantha
Putoria calabrica
Teucrium divaricatum
Thymbra spicata

Site S06_AB

Aegilops neglecta
Anemone coronaria
Anisantha tectorum
Avena clauda
Bromus intermedius
Bromus scoparius
Carlina curetum
Carthamus tenuis
Centaurea cheirolopha
Centaurea iberica
Centaurea solstitialis
Cichorium intybus
Crepis aspera
Crepis reuteriana reuteriana
Dactylis glomerata
Echinops adenocaulos
Erodium malacoides
Eryngium glomeratum
Erysimum scabrum
Geranium molle
Hordeum bulbosum
Lagoecia cuminoides
Lathyrus blepharicarpos
Linum pubescens
Medicago sativa varia
Notobasis syriaca
Ononis spinosa
Papaver umbonatum
Picnomon acarna
Salvia viscosa
Scorzonera mollis
Torilis arvensis
Trifolium clusii
Trifolium stellatum
Vicia palaestina

Site S07_IN

Alopecurus myosuroides
Amaranthus retroflexus
Anagallis arvensis
Asparagus acutifolius
Bromus intermedius
Bromus madritensis
Capsella bursa-pastoris
Cardamine hirsuta
Clematis flammula
Convolvulus arvensis
Crepis syriaca
Echinochloa colona
Epilobium hirsutum
Erodium acaule
Erodium malacoides
Euphorbia helioscopia
Galinsoga quadriradiata
Galium aparine
Geranium molle
Helminthotheca echioides
Hordeum bulbosum
Ipomea purpurea
Lamium amplexicaule
Malva neglecta
Medicago lupulina
Medicago polymorpha
Medicago sativa varia
Medicago polymorpha
Muscari neglectum
Octhodium aegyptiacum
Ornithogalum divergens

Parietaria judaica
Pimpinella peregrina
Senecio vulgaris
Setaria viridis
Sinapis arvensis
Sisymbrium officinale
Sonchus oleraceus
Sorghum halepense
Torilis arvensis
Trifolium repens
Veronica anagallis-aquatica
Veronica persica
Xanthium strumarium

Site S08_IN
Allium trifoliatum
Alopecurus utriculatus
Anagallis arvensis
Anchusa hybrida
Arum palaestinum
Avena clauda
Avena sterilis
Biscutella didyma
Carduus argentatus
Carduus pycnocephalus
Carthamus tenuis
Centaurea iberica
Chenopodium album
Cichorium intybus
Cistus creticus
Convolvulus arvensis
Dactylis glomerata
Daucus carota
Ecballium elaterium
Echinops adenocaulos
Erodium acaule
Erodium cicutarium
Euphorbia helioscopia
Geranium rotundifolium
Hordeum bulbosum
Hypecoum imberbe
Isatis lusitanica
Lactuca serriola
Lamium purpureum
Lathyrus aphaca
Lathyrus blepharicarpos
Legousia falcata
Leopoldia comosa
Linum pubescens
Lolium perenne
Origanum syriacum
Papaver umbonatum
Picnomon acarna
Pimpinella peregrina
Polygala monspeliaca
Pterocephalus plumosus
Rubia tenuifolia
Sarcopoterium spinosum
Scandix pecten-veneris
Senecio leucanthemifolius
Silene aegyptiaca
Silene vulgaris
Thlaspi perfoliatum
Torilis arvensis
Torilis arvensis
Trifolium angustifolium
Trifolium campestre
Trifolium clusii
Trigonella berythea
Veronica syriaca
Vicia sativa
Vicia sericocarpa

Site S09_IN
Alopecurus myosuroides
Alopecurus utriculatus
Amaranthus retroflexus
Anisantha rigida
Avena barbata
Bromus intermedius
Bromus madritensis
Capsella bursa-pastoris
Carduus argentatus
Carduus pycnocephalus
Chrozophora tinctoria
Convolvulus arvensis
Crepis hierosolymitana
Crepis palaestina
Datura stramonium
Diplotaxis erucoides
Diplotaxis tenuifolia
Epilobium hirsutum
Equisetum ramosissimum
Erodium malacoides
Ficaria ficarioides
Galium aparine
Geranium molle
Helminthotheca echioides
Hibiscus trionum
Lamium amplexicaule
Lamium purpureum
Lepidium draba

Lolium perenne
Malva neglecta
Medicago sativa varia
Ornithogalum divergens
Papaver umbonatum
Parietaria judaica
Plantago lanceolata
Ranunculus marginatus
Raphanus raphanistrum
Senecio vulgaris
Sinapis arvensis
Torilis arvensis
Torilis arvensis
Trifolium clusii
Veronica persica
Veronica syriaca

Site S10_IN
Aegilops neglecta
Alopecurus utriculatus
Anisantha rigida
Arum palaestinum
Avena sterilis
Bellevalia flexuosa
Bromus intermedius
Bromus madritensis
Carduus argentatus
Carduus pycnocephalus
Carlina curetum
Carthamus tenuis
Centaurea iberica
Crepis foetida
Crepis palaestina
Crucianella latifolia
Dactylis glomerata
Daucus carota
Dittrichia viscosa
Echinops adenocaulos
Echium glomeratum
Eremostachys laciniata
Erodium malacoides
Eryngium glomeratum
Geranium dissectum
Geranium rotundifolium
Geropogon hybridus
Heptaptera anisoptera
Hordeum bulbosum
Isatis lusitanica
Lactuca serriola
Lathyrus aphaca
Lathyrus blepharicarpos
Leopoldia comosa
Linum pubescens
Medicago polymorpha
Notobasis syriaca
Ononis spinosa
Ornithogalum narbonense
Picnomon acarna
Pimpinella peregrina
Plantago lanceolata
Pterocephalus plumosus
Rubus collinus
Sanguisorba minor
Sanguisorba verrucosa
Sarcopoterium spinosum
Securigera securidaca
Senecio leucanthemifolius
Silene aegyptiaca
Silene damascena
Sisymbrium officinale
Trifolium clusii
Trifolium stellatum
Verbascum gaillardotii
Vicia palaestina
Vicia peregrine

Site S11_IN
Aegilops neglecta
Alcea setosa
Anagallis arvensis
Asparagus acutifolius
Astragalus hamosus
Avena sterilis
Bromus lanceolatus
Bromus madritensis
Bryonia cretica
Campanula rapunculus
Capsella bursa-pastoris
Cardamine hirsuta
Chenopodium album
Chondrilla juncea
Crepis aspera
Cynodon dactylon
Dactylis glomerata
Daucus carota
Dittrichia viscosa
Draba praecox
Epilobium tetragonum
Eremopoa persica
Erodium cicutarium
Erodium malacoides
Erophila verna
Euphorbia helioscopia
Geranium molle

Geranium purpureum
Geranium robertianum
Geropogon hybridus
Lactuca saligna
Lactuca serriola
Lamium amplexicaule
Lolium perenne
Malva neglecta
Medicago polymorpha
Medicago sativa
Medicago polymorpha
Ononis spinosa
Picnomon acarna
Piptatherum miliaceum
Plantago lanceolata
Poa bulbosa
Polygonum aviculare
Polypogon viridis
Rubus collinus
Sarcopoterium spinosum
Senecio leucanthemifolius
Setaria viridis
Silene damascena
Sisymbrium officinale
Solanum villosum
Sonchus oleraceus
Sonchus tenerrimus
Trifolium angustifolium
Trifolium argutum
Trifolium campestre
Trifolium clusii
Trifolium eriosphaerum
Trifolium repens
Trifolium resupinatum
Trifolium stellatum
Umbilicus intermedius
Veronica cymbalaria
Vicia peregrina
Vicia sativa

Site S12_IN
Aegilotriticum loretii
Alopecurus utriculatus
Anisantha tectorum
Arum palaestinum
Avena sterilis
Bryonia cretica
Calendula arvensis
Carduus argentatus
Carduus pycnocephalus
Carthamus tenuis
Daucus carota
Dioscorea communis
Echinops adenocaulos
Erodium malacoides
Galium samuelssonii
Geranium molle
Geranium rotundifolium
Hordeum bulbosum
Hordeum vulgare
Hypericum triquetrifolium
Isatis lusitanica
Lactuca saligna
Lactuca serriola
Lathyrus aphaca
Leopoldia comosa
Lolium rigidum
Lotus judaicus
Malva neglecta
Medicago sativa
Papaver dubium
Papaver umbonatum
Phalaris minor
Pisum fulvum
Rubus collinus
Scandix pecten-veneris
Securigera securidaca
Senecio leucanthemifolius
Silene aegyptiaca
Silene vulgaris
Theligonum cynocrambe
Torilis tenella
Trifolium angustifolium
Trifolium campestre
Trifolium clusii
Trifolium clypeatum
Trifolium plebeium
Trifolium stellatum
Vicia sativa

Site S22_RL
Aegilops neglecta
Allium rotundum
Alopecurus myosuroides
Alopecurus utriculatus
Anagallis arvensis
Anchusa hybrida
Anisantha sterilis
Anisantha tectorum
Arum palaestinum
Astragalus oleifolius
Avena barbata

Avena clauda
Avena sterilis
Bromus brachystachys
Carthamus tenuis
Centaurea iberica
Centaurea solstitialis
Cichorium intybus
Cirsium phyllocephalum
Cota altissima
Crucianella latifolia
Crupina crupinastrum
Dactylis glomerata
Diplotaxis tenuifolia
Echinops adenocaulos
Echinops spinosissimus
Eryngium glomeratum
Galium hierosolymitanum
Geropogon hybridus
Gundelia tournefortii
Hordeum bulbosum
Hymenocarpos circinnatus
Hypericum triquetrifolium
Hypochaeris achyrophorus
Isatis lusitanica
Lactuca serriola
Lagoecia cuminoides
Lathyrus aphaca
Lathyrus blepharicarpos
Linum pubescens
Lolium rigidum
Lotus judaicus
Medicago orbicularis
Medicago sativa
Medicago sativa varia
Moraea sisyrinchium
Notobasis syriaca
Ononis spinosa
Ononis viscosa
Orchis anatolica
Papaver umbonatum
Picnomon acarna
Poa bulbosa
Prunus prostata
Quercus coccifera
Ranunculus millefolius
Rubia tenuifolia
Rubus collinus
Salvia hierosolymitana
Scandix pecten-veneris
Scorzonera mollis
Senecio leucanthemifolius
Sisymbrium officinale
Thlaspi perfoliatum
Torilis tenella
Torilis arvensis
Tragopogon porrifolius
Trifolium clusii
Trifolium stellatum
Umbilicus intermedius
Verbascum gaillardotii
Veronica cymbalaria
Vicia sativa

Site S23_RL
Aegilops triuncialis
Ajuga chamaepitys
Allium trifoliatum
Alopecurus myosuroides
Anagallis arvensis
Anthemis chia
Arum palaestinum
Asparagus acutifolius
Avena sterilis
Brachypodium sylvaticum
Bromus madritensis
Calicotome villosa
Capparis spinosa
Carduus argentatus
Chrozophora tinctoria
Cichorium intybus
Convolvulus arvensis
Crepis aspera
Crepis palaestina
Crucianella latifolia
Cyclamen persicum
Dactylis glomerata
Daucus carota
Dittrichia viscosa
Ecballium elaterium
Echinops adenocaulos
Echium glomeratum
Epilobium hirsutum
Erodium malacoides
Eryngium creticum
Eryngium glomeratum
Erysimum scabrum
Galium hierosolymitanum
Geranium molle
Geranium purpureum
Geropogon hybridus
Hymenocarpos circinnatus
Hypericum triquetrifolium
Isatis lusitanica
Kickxia spuria

Lactuca saligna
Lathyrus blepharicarpos
Linum pubescens
Lolium perenne
Lomelosia palaestina
Medicago sativa
Medicago sativa varia
Nigella ciliaris
Notobasis syriaca
Ononis natrix
Ononis spinosa
Pallenis spinosa
Papaver umbonatum
Pimpinella peregrina
Pterocephalus plumosus
Quercus coccifera
Rubia tenuifolia
Rubus collinus
Sanguisorba minor
Sarcopoterium spinosum
Securigera securidaca
Senecio leucanthemifolius
Sisymbrium officinale
Solanum luteum
Sonchus asper
Theligonum cynocrambe
Thlaspi perfoliatum
Tragopogon porrifolius
Trifolium angustifolium
Trifolium campestre
Trifolium clusii
Trifolium stellatum
Triticum aestivum
Urospermum picroides
Vicia sativa

Site S24_RL
Adonis annua
Aegilops neglecta
Ajuga chamaepitys
Alcea setosa
Allium trifoliatum
Anagallis arvensis
Anchusa azurea
Anisantha sterilis
Anthyllis vulneraria
Arum palaestinum
Asperula libanotica
Avena barbata
Avena clauda
Avena sterilis
Bellis perennis
Bituminaria bituminosa
Brassica rapa
Bupleurum lancifolium
Calicotome villosa
Centaurea iberica
Cichorium intybus
Convolvulus arvensis
Cota altissima
Crepis pterothecoides
Crepis reuteriana reuteriana
Cyclamen persicum
Dactylis glomerata
Echinops adenocaulos
Erodium acaule
Eryngium creticum
Eryngium glomeratum
Fumana thymifolia
Gagea liotardii
Galium hierosolymitanum
Geranium purpureum
Geranium robertianum
Geropogon hybridus
Hordeum bulbosum
Lathyrus aphaca
Legousia speculum-veneris
Leopoldia comosa
Linum pubescens
Linum strictum
Lolium perenne
Lotus judaicus
Medicago lupulina
Medicago radiata
Medicago sativa varia
Orchis anatolica
Origanum syriacum
Orlaya grandiflora
Pallenis spinosa
Papaver rhoeas
Papaver umbonatum
Quercus coccifera
Rubia tenuifolia
Rubus collinus
Sanguisorba minor
Scorzonera phaeopappa
Securigera securidaca
Senecio leucanthemifolius
Sherardia arvensis
Silene damascena
Sinapis alba
Sisymbrium officinale

Smilax aspera
Sonchus oleraceus
Spartium junceum
Tragopogon porrifolius
Trifolium angustifolium
Trifolium campestre
Trifolium clusii
Trifolium lappaceum
Trifolium plebeium
Trifolium scabrum
Trifolium stellatum
Urospermum picroides
Valerianella discoidea
Valerianella vesicaria
Veronica syriaca
Vicia peregrina
Vicia sativa

Site S25_RL
Aegilops triuncialis
Allium trifoliatum
Alopecurus rendlei
Alopecurus utriculatus
Amaranthus retroflexus
Anagallis arvensis
Anarrhinum orientale
Anisantha sterilis
Avena barbata
Avena clauda
Avena sterilis
Brassica rapa
Bromus intermedius
Bromus madritensis
Calepina irregularis
Carduus argentatus
Carlina curetum
Centaurea verutum
Chenopodium album
Chrozophora tinctoria
Clematis flammula
Convolvulus arvensis
Cota tinctoria
Crepis sancta
Crucianella latifolia
Daucus carota
Diplotaxis tenuifolia
Dittrichia viscosa
Erodium acaule
Erodium cicutarium
Erodium malacoides
Erysimum scabrum
Euphorbia gaillardotii
Euphorbia helioscopia
Geranium rotundifolium
Heliotropium rotundifolium
Helminthotheca echioides
Hippocrepis unisiliquosa
Hypecoum imberbe
Hypericum lanuginosum
Isatis tinctoria
Lactuca serriola
Lamium amplexicaule
Lomelosia palaestina
Medicago lupulina
Medicago sativa
Medicago sativa varia
Ononis natrix
Osyris alba
Phalaris brachystachys
Physalis peruviana
Picnomon acarna
Pterocephalus plumosus
Putoria calabrica
Rubus collinus
Sanguisorba minor
Sarcopoterium spinosum
Scandix pecten-veneris
Securigera securidaca
Silene aegyptiaca
Silene damascena
Solanum luteum
Solanum villosum
Sonchus oleraceus
Teucrium divaricatum
Thlaspi perfoliatum
Torilis tenella
Trifolium campestre
Trifolium clusii
Trifolium grandiflorum
Xanthium spinosum

Site S26_RL
Aegilops neglecta
Ajuga chamaepitys
Allium neapolitanum
Alopecurus myosuroides
Alopecurus rendlei
Anemone coronaria
Avena barbata
Avena clauda
Avena sterilis
Calicotome villosa
Capsella bursa-pastoris
Cardamine hirsuta

Carduus argentatus
Carduus pycnocephalus
Carex distans
Carthamus tenuis
Centaurea iberica
Cichorium intybus
Cistus creticus
Clematis flammula
Convolvulus arvensis
Cota tinctoria
Crepis pterothecoides
Crepis sancta
Dactylis glomerata
Daucus carota
Diplotaxis tenuifolia
Echinops adenocaulos
Epilobium parviflorum
Eryngium glomeratum
Geranium dissectum
Geropogon hybridus
Hippocrepis unisiliquosa
Hordeum bulbosum
Hypochaeris achyrophorus
Isatis lusitanica
Lathyrus aphaca
Linum pubescens
Lolium perenne
Lotus judaicus
Medicago lupulina
Medicago rugosa
Medicago sativa varia
Ononis spinosa
Peltaria angustifolia
Picnomon acarna
Pimpinella peregrina
Plantago lanceolata
Pterocephalus plumosus
Quercus coccifera
Rubia tenuifolia
Scrophularia rubricaulis
Securigera securidaca
Sherardia arvensis
Silene damascena
Theligonum cynocrambe
Torilis arvensis
Torilis arvensis
Trifolium angustifolium
Trifolium clusii
Trifolium fragiferum
Trifolium plebeium

Trifolium scabrum
Trifolium stellatum
Urospermum picroides
Veronica syriaca
Vicia peregrina