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A Quantitative Classification of Mediterranean Mosaic-Like Landscapes

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Summary

A quantitative method designated to individualize and classify vegetation units occurring in Mediterranean mosaic-like landscapes is proposed. The method is based on the quantification of the two most basic structure parameters : Height and coverage. According to a simple nomenclature including five height classes and three cover categories, up to fifty-five different types of vegetation structure are discriminated. The spatial assemblage of up to fifty-five types of vegetation structures can be mapped with the help of a GIS. Thus, a quantitative analysis of the mosaic-like landscape of a given region can be carried out. The distinction between monostratified, bistratified and multistratified structures types is emphasized, as well as the ability to quantify mosaic-like landscape structural diversity.
By discriminating between vegetation units occurring within Mediterranean mosaic-like landscapes according to quantitative structure criteria, this classification method avoids the confusion resulting from the abundance of qualitative terms used to designate Mediterranean vegetation units. Hence, this quantitative classification method makes Mediterranean mosaic-like landscapes directly comparable all around the Mediterranean basin.

Introduction

One of the most original traits of the circummediterranean vegetal landscapes, when considered at large-scale, is probably their mosaic-like aspect (Naveh & Whittaker 1979, Thirgood 1981, Braque 1988, Naveh & Lieberman 1994, Naveh 1991, 1994, 1998, Blondel & Aronson 1995, 1999, Perevolotsky & Seligman 1998, Prodon 2000). The mosaic pattern of vegetal landscapes can be basically defined as a regular or irregular chessboard-like arrangement of two or more vegetation units (Küchler & Zonneveld 1988). Within the Mediterranean basin, mosaic-like landscapes are not only characterized by their intense fragmentation (Naveh & Kutiel 1990) but also, and mostly, by a great degree of structural and floristic diversity, especially in shrub vegetation (Hobbs *et al.* 1995) and in sclerophyllous forests (Naveh & Lieberman 1994).

Floristic diversity in the Mediterranean basin results mostly from a high variability of abiotic conditions as well as from an original geographical location (Blondel & Aronson 1995, Quézel 1985). The great structural diversity, characterizing Mediterranean mosaic-like landscapes, is generally considered as a consequence of human interference over past millennia (Naveh & Dan 1973, Le Houérou 1981, Blondel & Aronson 1995). By his various activities such as fire, grazing, cutting, coppicing, man shaped, transformed and turned the Mediterranean vegetation cover into a complex assemblage of very diverse vegetation structures (Naveh & Whittaker 1979, Le Houérou 2000, Naveh & Kutiel 1990, Naveh 1991, 1994, Dallman 1998, Blondel & Aronson 1999, Quézel 1999). Therefore, in order to analyse a Mediterranean mosaic-like landscape it is necessary, as a preliminary step, to quantify the mosaic according to the vegetation structure characteristics.

The aim of this article is to propose a method which enables a quantitative classification and analy

sis of vegetal mosaic-like landscapes in the Mediterranean basin.

Terminological background

The current terminology used to define Mediterranean vegetation structures is very rich, but mostly qualitative. If *maquis* and *garrigue* are the most frequent names employed in order to qualify non forest ligneous units occurring in the Mediterranean basin, additional terms such as *pseudomaquis* (Blamey & Grey-Wilson 1993), *jaral* (Nunez-Olivera *et al.* 1995), *tomillar* (Braque 1988), *phrygana* (Bergmeier 1997, Diamantopoulos *et al.* 1994), *batha* (Ish-Shalom-Gordon 1993, Naveh & Kutiel 1990) or *matorral* (Tomaselli 1981, Quézel 1981, 1999, Naveh 1989, Quézel *et al.* 1992, Fernandez-Santos & Gomez-Gutierrez 1994) are also regularly used in the literature to designate non-forest vegetation structures. A similar diversity of names also exists when considering Mediterranean forest units. Besides the common names of *forest* and *coppice*, other terms such as *pre-steppic forest* or *preforest* also appears in the literature (Quézel *et al.* 1988, Barbéro *et al.* 1990, 1992, Quézel 1999). This diversity of names could be considered as an advantage from a terminological accuracy point of view but it actually entails serious problems of confusion when comparing vegetation cover descriptions and analysis carried out in different sub-regions of the Mediterranean basin.

As pointed out by several authors (Di Castri 1981, Naveh 1989) this confusion results primarily because of divergences between authors regarding the definition of a specific term. As a consequence, the very same name may design different vegetation structures within the Mediterranean basin. For example, even the common term *maquis* can be defined very differently from one author to another: A m*aquis* may be considered as a "tall ligneous unit composed with shrubs and trees" (Da Lage & Métaillé, 2000), or as "a type of sclerophyllous scrub vegetation" where "*scrub*" refers to "a vegetation type dominated by low shrubs" (Brown & Lomolino, 1998).

The terminological confusion can be considered also as a consequence of cultural and linguistic differences from one Mediterranean region to another (Di Castri 1981). For instance low ligneous units are called *tomillar* in Spain, *garrigue* in France, *phrygana* in Greece and *batha* in Israel. Noticeable differences also occur between western and eastern Mediterranean regions regarding taller units, e.g. a 2-5 m height dense *Quercus calliprinos* dominated unit is generally termed *maquis* in Israel (Zohary 1960, 1962, Alon & Kadmon 1996, Kadmon & Harari-Kremer 1999) (or the Hebrew equivalent term *choresh*) while a similar unit dominated by *Quercus ilex* will be generally defined as a *coppice* in the western part of the Mediterranean basin (Bran *et al.* 1990, Floret *et al.* 1992, Bacilieri *et al.* 1993, 1994).

Besides the inevitable cultural and linguistic divergences, this terminological confusion also results directly from the variability of reference criteria that may be taken into account when defining Mediterranean vegetation units such as soil characteristics, height, floristic composition, presence or absence of trees, etc. For instance, the original definition of a *maquis* stipulates that this non-forest ligneous unit is found on siliceous soils while a *garrigue* was originally designating a very degraded *Quercus coccifera* dominated unit, developed on calcareous soils (Di Castri 1981, Braque 1988). Though the main distinction between *garrigue* and *maquis* has progressively been restricted solely to height differences between these two units —i.e. to a structure parameter— the broad majority of the definitions still refers only to the qualitative adjectives of *low* shrubs units for the *garrigue* and of *medium-high* shrubs unit for the *maquis*, without mentioning any quantitative height threshold. Several definitions of Mediterranean vegetation structures may also depend directly upon the floristic criteria, e.g. a medium shrub unit in the Iberian peninsula is named *jaral* only if it is *Cistus* ssp. dominated while a medium-low shrub unit within the same region is termed *tomillar* provided *Thymus* ssp are dominant (Tomaselli 1981, Da Lage & Métaillé 2000, Braque 1988).

Recent studies (Da Lage & Métaillé 2000) provided valuable, comprehensive and updated definitions of Mediterranean vegetation units. Tomaselli (1981) also proposed to classify non-forest structures into several categories of *matorral* according to height and cover. However, there is still terminological confusion in the vocabulary employed to define circummediterranean vegetation units.

Since the current definitions of Mediterranean vegetation units refer to very diverse and mostly qualitative criteria, we suggest here to use a method in which Mediterranean vegetation units are discriminated according to a single basic and easily quantifiable criteria: The structure of vegetation units. By referring only to structure parameters, this method may be accepted and applied throughout the Mediterranean basin, eventually giving the opportunity to draw comparisons between several mosaic-like landscapes located in different sub-regions around the Mediterranean.

Method

This method is based on a preliminary identification of vegetation units according to their structural characteristics. The discrimination of the various vegetation units composing a Mediterranean mosaic-like landscape shall be carried out according to the two most basic quantitative parameters used to characterize the structure of any vegetation unit: Height and cover rate (Küchler 1988).

Height classes

Several nomenclatures of height have been submitted by different authors in order to draw descriptive analysis of vegetation units structure (Küchler & Zonneveld 1988). These nomenclatures were not designated to be used in a specific geographical region. Only two quantitative nomenclatures of height specifically designated to discriminate and classify Mediterranean vegetation units appear in the literature. The first has been suggested by Naveh and Witthaker (1979) and the second, whose goal was to discriminate the three basic types of matorral in the Mediterranean Basin, was proposed by Tomaselli (1981) (Table 1a).

As any attempt of height classification carries a certain measure of arbitrary choice, it would be pointless to discuss here whether one of these two nomenclatures is better than the other. The height nomenclature we propose here (Table 1b) comprises threshold values which are slightly different than those mentioned in Table 1a.

The purpose of the first class (0 to 1m) is to individualize low ligneous units dominated by dwarf-shrubs such as *Sacopoterium spinosum* (L.) Sp. in the eastern Mediterranean basin, *Genista acanthoclada* (DC.) in Greece and in Crete, or *Thymus* ssp. on the northern edge of the Mediterranean Basin. The vegetation units usually called *tomillar*, *garrigue*, *phrygana* or *batha* belong to this first height class. Most dwarf-shrub species dominating these units may exceed 50 or 60 cm but they very rarely grow beyond 1m. Therefore, low ligneous units shall be characterized by a first height class ranging from 0 to 1m.

The aim of the second height class (1 to 2 m) is to individualize medium ligneous units. These units are dominated essentially by various shrubs such as *Pistacia lentiscus* (L.), *Cistus* ssp., *Calycotome* ssp., *Cytisus* ssp.,most of *Genista* ssp., *Ulex parviflorus* (Pourr.) or some *Erica* ssp. (Quézel 1981, Prodon 2000). However, even if certain Mediterranean shrub species grow over 2 meters, i.e. *Erica scoparia* (L.) or *Spartium junceum* (L.), most of them do not (Blamey & Grey-Wilson 1993, Rameau *et al.* 1989). Consequently, the choice of 2 meters as the top threshold value in the second height class is appropriated. Moreover, coppices of sclerophyllous oaks whose height ranges between 2 meters and 3 meters are not rare in the Mediterranean basin, especially in the eastern part where significant *Quercus calliprinos* (Webb) coppices hardly exceeds 3 meters. Therefore, in order to discriminate clearly shrubby structures, e.g. *Cistus* ssp. units, from low forest structures such as sclerophyllous oak coppices, the second height class shall be limited to a maximum of 2 meters. In addition, since all dwarf-shrub units are lower than 1 meter high while shrub units distinctly exceed 1 meter height, the discrimination between these two height classes shall be easy and confusion is not likely to be made when interpreting aerial photos. Most of the vegetation units currently named *maquis*

Table 1a: The two height nomenclatures previously suggested in order to classify Mediterranean vegetation units.

Height classes	Naveh & Witthaker (1979)	Tomaselli (1981)
Class 1	0 - 0.5 m	0 - 0,6 m
Class 2	0,5 - 1,5 m	0,6 - 2 m
Class 3	1,5 - 5 m	over 2 m
Class 4	5 - 10 m	-

Table 1b: Height classes proposed.

Height classes	Treshold values
Class 1	0 - 1 m
Class 2	1 - 2 m
Class 3	2 - 8 m
Class 4	over 8 m
Class 5	Herbaceous
Class 6	Rock outcrops

Table 1c: Cover categories

Cover categories	Treshold values
Category A (Closed)	over 90%
Category B (Scattered)	50% to 90%
Category C (Open)	less than 50%

in the Mediterranean basin belong to the second height class proposed.

Additional height classes are required to individualize mainly low forest structures from high forest structures. The definition of a single additional class, 2m and above, would be problematic as it would group together in the same height class very different forest structures such as sclerophyllous or deciduous forests mainly dominated by *Quercus* ssp. and *Pinus* ssp. dominated forests which are among the tallest forest structures in the Mediterranean Basin. Therefore, in order to make a clear distinction between lower and higher forest structures it is necessary to consider two additional height classes.

The third class (2m to 8m) enables to individualize low forest structures, mainly dominated by sclerophyllous oak species. The fourth height class (above 8m) gives the possibility to distinguish taller forest structures such as coniferous forests and some of the deciduous oak forests. The eight meters threshold appears to be the most appropriate height limit in order to allow a basic distinction between Mediterranean forest structures. The reference to a lower values, e.g. 6 meters, or to higher values, e.g. 10 meters or 12 meters would result in an unbalanced classification as most of the forest structures would appear together within the same class.

The four height classes proposed enables a classification to be made between different ligneous structures. But, many vegetation units in Mediterranean mosaic-like landscapes comprise an herbaceous stratum. Therefore, it is necessary to consider a fifth height category so ligneous vegetation structures where the herbaceous stratum plays a significant role, e.g. open low ligneous units, can be individualized from exclusively ligneous units, e.g. dense low ligneous units. Finally, since outcrops of bare rock frequently occur in Mediterranean vegetation units, it is necessary to add to the five height class previously defined, a special *bare rock* class.

The height nomenclature is restricted to only five classes of vegetation so the risk of misclassification when interpreting aerial photos can be minimized.

Cover categories

In order to carry out an accurate discrimination between vegetation structures occurring in Mediterranean mosaic-like landscapes, the five height classes distinguished must be coupled with cover rate categories.

As a large number of distinct cover categories would entail significant risks of misclassification when evaluating the coverage of different vegetation units or strata, it is suggested to differentiate only three basic cover categories:

Closed when cover rate is over 90%, *scattered* when it ranges from 50% to 90% and *open* when cover rate is lower than 50% (Table 1c).

Discrimination between monostratified, bistratified and multistratified structures

By referring simultaneously to height and cover it becomes possible to discriminate very accurately the types of vegetation structures which compose a Mediterranean mosaic-like landscape. Indeed, the various vegetation structures that may occur in a Mediterranean mosaic are not likely to be only monostratified, i.e. the structures are not systematically built by a single strata that would cover more than 90%. In fact, the strong structural heterogeneity which characterizes Mediterranean mosaic-like landscapes (Hobbs *et al.* 1995) is related to the fact that numerous vegetation units are, though physiognomically homogeneous, composed of two or more distinct strata. Therefore, in order to carry out an accurate quantification of the mosaic that highlights structural nuances between different vegetation units, it is essential to individualize vegetation structures which are not monostratified.

According to the three basic cover categories distinguished, three groups of vegetation structures can be differentiated, regardless of the height parameter. The first group includes monostratified units, i.e. one-layered vegetation structures, where one single strata covers over 90% of the surface (Fig. 1). These units are commonly called *closed* units.

The second group includes bistratified units, i.e. two-layered vegetation structures formed by the association of a scattered strata, i.e. a layer where coverage ranges between 50% and 90%, and of an open strata, i.e. which coverage is less than 50% (Fig. 2).

The third group comprises multistatified units, here restricted to three-layered vegetation structures, formed by the association of three distinct strata with similar cover rates each, i.e. one third or so. In that case, each of the three strata displays an open coverage, i.e. less than 50% and usually closer to 30-35% (Fig. 3).

Quantifying the diversity of vegetation structure types in a Mediterranean Mosaic

By referring simultaneously to the six height classes (including the *bare rock* class) and the three cover categories proposed, up to 55 different types of vegetation structures may be identified. Among these types are five monostratified structures, thirty

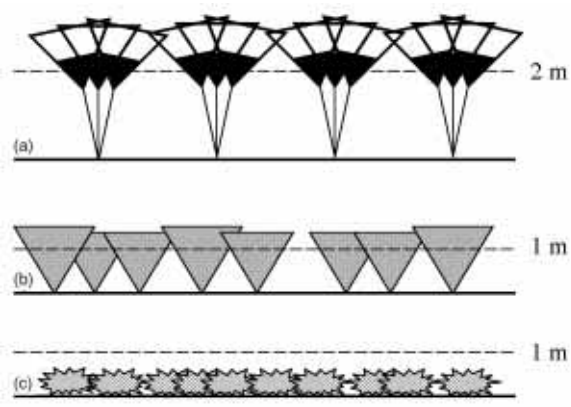

Fig. 1 Schematic representation of monostratified vegetation structures occurring in Mediterranean mosaic-like landscapes: (a) Sclerophyllous oak coppice, i.e. with Quercus calliprinos Webb or Quercus ilex L. (b) Medium ligneous units, i.e. with Calycotome villosa (Poir.) Link or Cistus ssp., (c) Low ligneous unit, i.e. with Sarcopoterium spinosum (L.) Sp. or Genista acanthoclada (DC.)

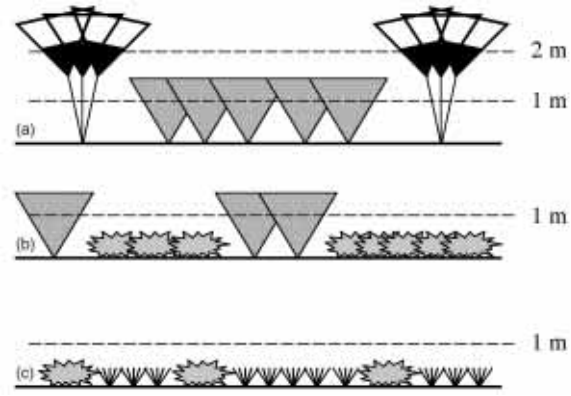

Fig. 2 Schematic representation of bistratified vegetation structures occurring in Mediterranean mosaic-like landscapes: (a) Association of an open trees stratum with a scattered medium shrubs stratum (b) Association of an open medium shrubs stratum with a scattered dwarf-shrubs stratum (c) Association of an open dwarf-shrubs stratum with a scattered herbaceous stratum.

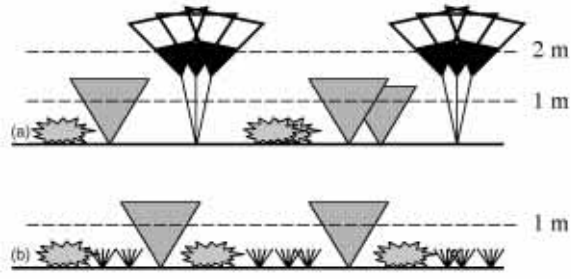

Fig. 3 Schematic representation of multistratified vegetation structures occurring in Mediterranean mosaic-like landscapes: (a) Three-layered structure composed of a trees stratum, a medium shrubs stratum and a dwarf-shrubs stratum, each covering approximatly one-third of the surface. (b) Three-layered structure composed of medium shrubs stratum, a dwarf-shrubs stratum and of an herbaceous stratum, the cover of the three strata being equivalent.

bistratified structures (Table 2a) and twenty multistratified structures (Table 2b).

The five monostratified structures which can be distinguished are one-layered closed structures where the highest stratum, which can be either stratum 1, 2, 3, 4 or stratum 5 (herbaceous), has a cover rate above 90%, i.e. cover category A (Table 1c).

In order to display clearly the different bistratified structures that can be differentiated, each structure of this type is represented by a couple of digits (Table 2a) where each digit refers to a height class ranging from 1 to 6. The first digit (bold) indicates that the stratum it refers to has a scattered coverage (cover category B) while the second digit (italic) stipulates that specific stratum has only an open coverage (cover category C). Consequently the position of each digit is very important. For example codes **1***2* and **2***1* refer to two different bistratified structures : **1***2* indicates that the stratum, whose height exceeds 8 meters (height class **1**), has a scattered coverage (cover category B, 50% - 90%) while the second stratum, whose height ranges between 2 me

Table 2a: List of the codes referring to the thirty possible bistratified vegetation structures. The first digit (bold) refers to the height of the scattered stratum. The second digit (italic) refers to the height of the open stratum (codes with two similar digits would refer to one-layered structures).

		Height classes of the scattered stratum					
		1	2	3	4	5	6
Height classes of the open stratum	*1*	-	*21*	*31*	*41*	*51*	*61*
	2	*12*	-	*32*	*42*	*52*	*62*
	3	*13*	*23*	-	*43*	*53*	*63*
	4	*14*	*24*	*34*	-	*54*	*64*
	5	*15*	*25*	*35*	*45*	-	*65*
	6	*16*	*26*	*36*	*46*	*56*	-

Table 2b : List of codes referring to the twenty distinguishable types of multistratified vegetation structures.

123	234	345	456
124	235	346	-
125	236	356	-
126	245	-	-
134	246	-	-
135	256	-	-
136	-	-	-
145	-	-	-
146	-	-	-
156	-	-	-

ters and 8 meters (height class *2*), has an open coverage (cover category C, less than 50%). On the other hand, in the bistratified structure coded **2***1* the lower stratum (height class **2**) displays a scattered coverage while the higher stratum (height class *1*) has an open coverage. Therefore, vegetation structures corresponding to codes **1***2* and **2***1* are actually two distinct types of vegetation structures, even if these two bistratified structure types are both composed within similar strata (Fig. 4).

The coding of the types of multistratified structures does not require to take into account the rank of each digit in each three-digits codes since the multistratified (three-layered) vegetation structures are actually composed of three distinct strata as they display similar cover rates. For instance codes *345* and *534* would refer to the same type of multistratified structure (Table 2b).

According to this method up to fifty-five different types of Mediterranean vegetation structure can be distinguished. It should be stressed that all the structure types are not likely to be found in a specific study area. The total number of different vegetation structures that may occur in the Mediterranean mosaic-like landscape of a given region is likely to be lower.

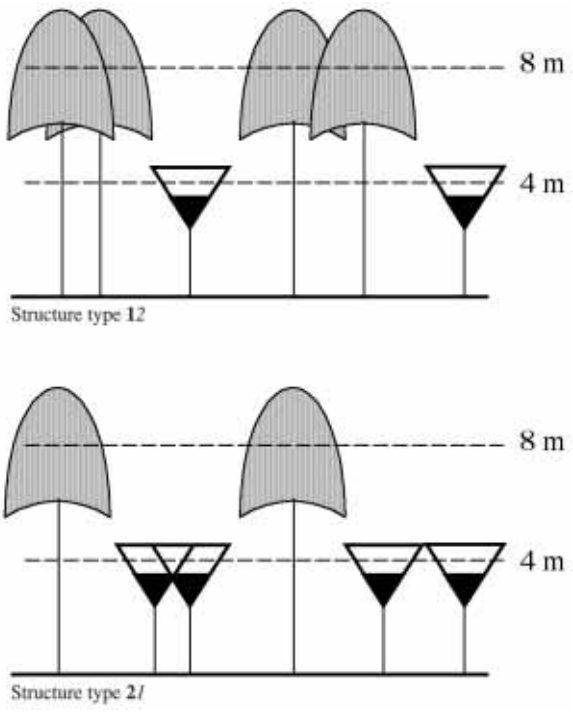

Fig. 4 Schematic representation of two distinct types of bistratified structure composed with the same strata. In the first type of structure, coded 12, stratum 1 refers to a scattered tree layer exceeding 8m, e.g. a Pinus halepensis (Mill.) or a Pinus brutia (Ten.) stratum. Stratum 2 refers to an open tree layer whose height ranges between 2m and 8m, e.g. a Quercus ilex (L.) or a Quercus calliprinos (Webb) stratum. In the second type of structure, coded 21, the strata are the same but their coverage are different.

Materials

The quantification of a mosaic-like landscape implies that a GIS-built map displaying the different types of vegetation structure occurring in the area considered, is produced. The most appropriate tool that enables to build such a map is large-scale aerial pictures. High quality and recent color aerial pictures, whose scale ranges from 1:10.000 to 1:15.000, should be used in order to build a polygons layer where each polygon refers to a specific vegetation unit, individualized according to its structure characteristics, i.e. according to the height classes and the cover categories detailed previously. The interpretation of the mosaic cover should be preferably carried out directly on paper aerial pictures, rather than on scanned pictures, since it enables one to use stereovision which significantly improves the accuracy of the vegetation structures discrimination.

After the map is computerized, the GIS-assisted processing of the structure types layer enables one to obtain various quantitative data which allows one to characterize quantitatively the mosaic-like landscape of the area studied.

Results and Discussion

Case study

The method proposed has been applied to the mosaic-like vegetation cover of the Carmel region, northern Israel. The study area (32° 31' - 32° 49' N : 34° 55' - 35° 06' E) extends over 249 km≤ and elevation remains moderate as it does not exceed 540m a.s.l. The region under study has a mild Mediterranean climate. Average annual rainfall ranges from 600 mm in the southeast part to 750 mm in the higher parts (Scharlin 1980). The Carmel region has been relatively well preserved from urban development compared to the rest of the Mediterranean region of Israel. Several Nature Reserves which are among the largest in the Mediterranean part of Israel, and a National Park, are found in this region (Naveh 1999).

The comprehensive results of the Carmel's mosaic analysis cannot be fully detailed in the limits of this present article whose central purpose is to develop the principles of a method for the quantitative classification of Mediterranean mosaic-like landscapes. However, several quantitative results shall be

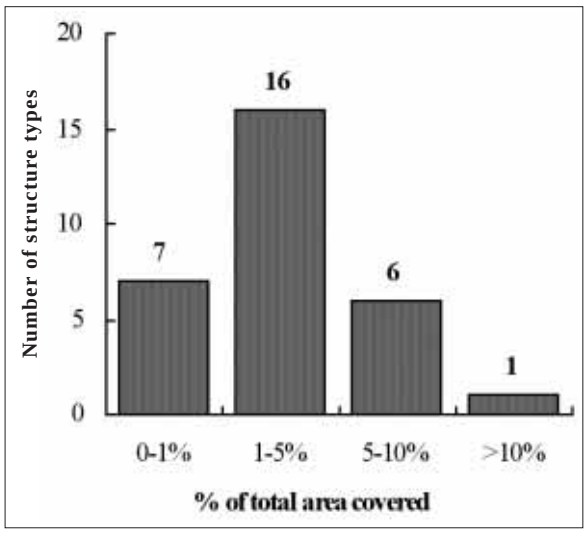

Fig. 5 Distribution of structure types according to the percentage of total area covered by each type. Among the thirty structure types distinguished, twenty-three cover less than 5% of the total area each. Yet, the total area covered by these twenty-three types reaches 44.2%.

briefly exposed as examples of the method implementation.

Diversity and proportion of structure types

Among the fifty-five possible types of structure that can be distinguished according to the method previously explained, thirty occurred within the region considered. This large number of vegetation structure types occurring in a relatively restricted area (181 km≤ of the total area is covered with spontaneous vegetation) accounts for a great diversity in the mosaic-like vegetal landscape of the region studied. Among the thirty types distinguished, only a single one occupies over 10% (12.9%) of the total area studied (bistratified structure type **5***1*, i.e. scattered herbaceous stratum associated with an open low ligneous stratum) (Fig. 5). It has been found that only seven structure types each cover, more than 5% of the area studied (Fig. 5). Consequently, most of the structure types (23) each cover a relatively low percentage of the area (less than 5% of the total area each). Among these twenty-three types, sixteen cover between 1% and 5% of the area considered and only seven types cover less than 1% of the area each. The total area covered by the 7 most important structure types — each occupying more than 5% of the region studied — reaches only 55.8%. Therefore, a large proportion (44.2%) of the total area covered with vegetation is composed of twenty-three distinct types of vegetation structures.

The quantification of the mosaic showed that, among these thirty structure types, none occupies a sufficiently significant proportion of the area studied in order to be considered as the dominant structure type in the mosaic-landscape of this region.

Yet, this diversity can be more accurately defined when considering the proportion and the total surface area covered by monostratified, bistratified and multistratified structure types (Table 3). Twenty distinct types of bistratified structures cover almost half (47.6%) of the area occupied by spontaneous vegetation. Diversity is reduced when considering multistratified structure types as only five types occur in the area studied. Nonetheless these five types cover almost one third (29,5%) of the total area. Monostratified vegetation structures are represented by only five different types which occupy slightly more than one fifth (22.9%) of the total surface area considered. The basic distinction between monostratified, bistratified and multistratified structures shows that each of these three categories is well represented in the Carmel region's mosaic-like landscape (Fig. 6).

These results suggest that the mosaic-like vegetal landscape in the Carmel region is characterized by a very high level of vegetation structure hetero

Table 3 : Proportion of monostratified, bistratified and multistratified types of vegetation structure in the Carmel region.

	Maximum number of structure types distinguishable	Total number occurring in the mosaic-like vegetal landscape of the Carmel region	% of the total study area covered*
Monostratified types	5	5	22,9%
Bistratified types	30	20	47,6%
Multistratified types	20	5	29,5%
Total	55	30	100,0%

* referring to the total area covered with spontaneous vegetation

geneity. The comparison with several other mosaic-like landscapes in the Mediterranean basin remains necessary in order to determine if this strong heterogeneity is particular to the Carmel area or if it may also be found in other regions.

Conclusion

By referring to simple but quantitative structure parameters, the method suggested enables classification of Mediterranean vegetation units in a way that substantially reduces the problems of confusion inherent in the definition of the Mediterranean vegetation units, which are still defined mainly by qualitative criteria. This standardized method enables the classication of up to fifty-five different types of vegetation structures and thus it enables to characterize accurately Mediterranean mosaic-like landscapes by pointing out slight nuances related to height and cover. Once the quantification of a mosaic-like landscape is completed according to the characteristics of the structure types distinguished, it becomes possible to investigate the characteristics of the mosaic. For instance the diversity, the proportion and the spatial distribution of the different types of vegetation structure can be quantitatively determined. Finally, it should be stressed that the method proposed enables to quantify mosaic-like landscapes in a way that makes most Mediterranean mosaic-like landscapes directly comparable. As a consequence, regional nuances between different mosaic-like landscapes within the Mediterranean basin can be highlighted and analysed.

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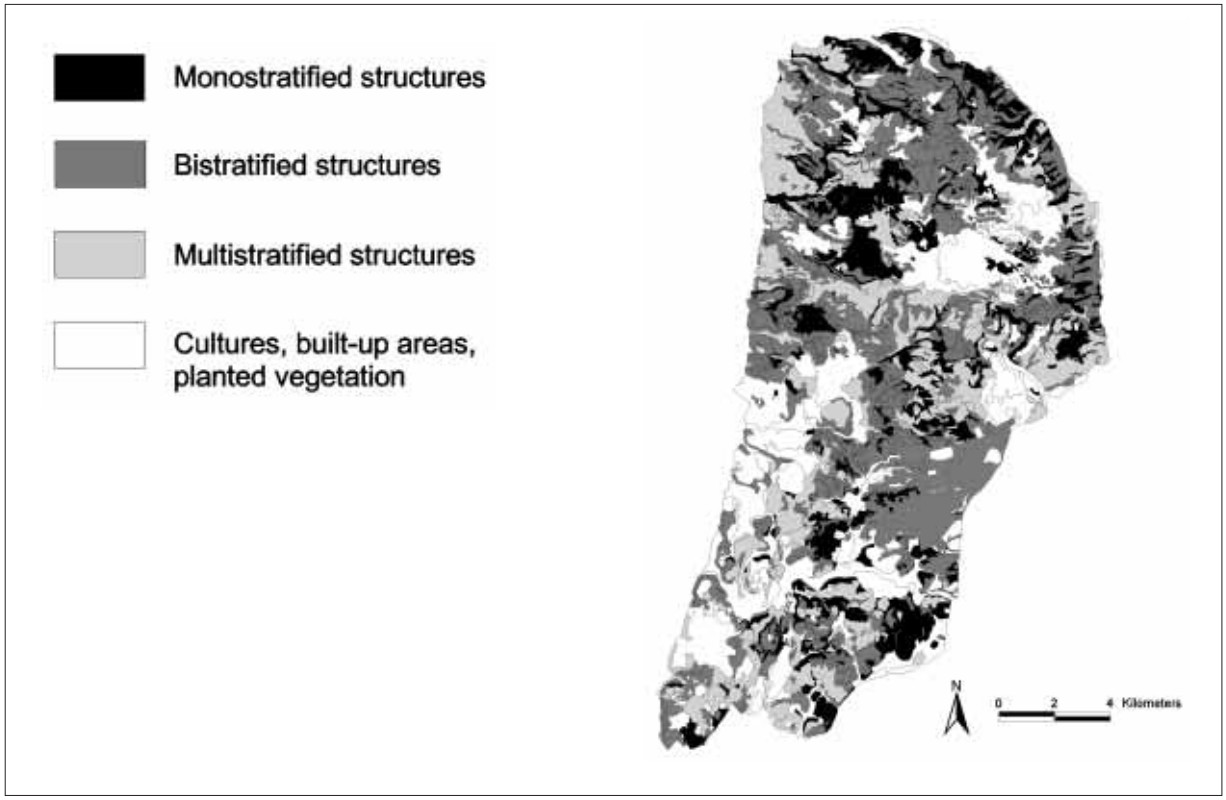

Fig. 6 - Distribution of monostratified, bistratified and multistratified vegetation structures in the Carmel region

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