The application of symphytosociology in landscape architecture in the Western Mediterranean

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Abstract: This essay addresses the application of indigenous plants in landscape architecture projects, based on studies carried out in the field of phytosociology and symphytosociology. Through this knowledge, it is possible to increase and improve the use of indigenous plants in projects, aiming at the preservation of biodiversity. Thus, to better understand the Western Mediterranean territory, we present a brief biophysical characterization, in which we point out the main factors which contribute to the ground coverage's distribution in the landscape, namely, concerning climate (oceanity, ombroclimate and thermoclimate) and substrate (geology and lithology). In view of the high level of uniqueness of the identified conditions, a synthesis of the potential main existing climatophilous woods is carried out, regarding symphytosociological class/order, furthermore, pointing out, the main serial stages, their vegetation bioindicators and the ecological peculiarities of each stage (regressive or progressive). Therefore, based on the study area, we point out the vegetation bioindicator's value as a work tool during analysis, thus allowing us to understand the existing edaphoclimatic conditions, as well as to elaborate a quick diagnosis of each potential climatophilous vegetation series. Moreover, based on the main stages of substitution, it is also possible to identify the presence of endemic plants or under protection status, and finally, the conservation state of the study area. Further ahead, in project proposal phase, based on information gathered previously, we point out the possibility of elaborating a list of plants correctly adapted to the existing mesological conditions. Thus, within each serial stage, the necessary ecological conditions for a correct adaption of the vegetation material are referred, therefore, avoiding possible limiting factors to their development, such as precipitation, soil erosion, light availability, salinity, among many others. Lastly, some considerations are made about the main ideas that should be remembered throughout this essay, namely, regarding the importance of the use of symphytosociology knowledge as an analysis tool, as well as of high interest for the elaboration of proposals which aim at the floristic heritage conservation and the landscape scenic quality.

Key-words: landscape architecture, potential natural vegetation, symphytosociology, vegetation bioindicator, vegetation series.

Résumé : *L`application de la symphytosociologie en architecture paysagère dans la Méditerranée occidentale*
Ce travail traite de l`application de plantes autochtones dans des projets d`architecture paysagère ayant pour base des études réalisées dans le cadre de la phytosociologie et de la symphytosociologie. À travers ces connaissances, il est possible d`incrémenter et d'améliorer l`utilisation de plantes autochtones dans les projets basés sur la conservation de la biodiversité. Ainsi, afin de mieux comprendre le territoire de la Méditerranée occidentale, on présente une brève caractérisation biophysique, dans laquelle nous soulignons les principaux facteurs qui contribuent à la répartition de la végétation dans le paysage, notamment au niveau climatique (l`océanité, facteurs ombrothermique et thermoclimatique) et du substrat (géologie et lithologie). Face aux conditions originales, identifiées ci-dessus, il est utile d`élaborer une synthèse des principales forêts potentielles climatophiles existantes au niveau de la classe/ordre symphytosociologique, en soulignant également les principales étapes de série, leurs bioindicateurs végétaux et les particularités écologiques de chaque étape (régressive ou progressive). Ainsi, sur la base de l`interprétation de la zone d`étude, le bioindicateur végétal se distingue comme un outil de travail durant l`analyse, permettant de cette façon de comprendre les conditions édapho-climatiques existantes, et d'élaborer un rapide diagnostic de chaque série de végétation climatophile potentielle. En outre, sur la base des principales étapes de remplacement, il est également possible d`identifier la présence de plantes endémiques ou ayant un statut de protection et enfin d'établir l`état de conservation de la zone d`étude. Au stade de proposition du projet, basée sur l`information recueillie précédemment, il y a déjà la possibilité d`établir une liste de plantes bien adaptées aux conditions mésologiques. Ainsi, dans chaque étape de série, les conditions écologiques nécessaires à une bonne adaptation du matériel végétal sont référées, évitant ainsi des facteurs limitant son développement, tels que les

précipitations, l`érosion des soís, la disponibilité de la lumière, la salinité, parmi beaucoup d`autres. Et enfin, quelques considérations se tissent sur les principales idées à retenir tout au long du travail, notamment l`importance d`utiliser la connaissance de la symphytosociologie comme un outil d`analyse d`un grand intérêt pour le développement de propositions pour la conservation du patrimoine floristique et la qualité pittoresque du paysage.

Mots-clés : architecture paysagère, bioindicateur végétal, série de végétation, symphytosociologie, végétation potentielle naturelle.

INTRODUCTION

The work of Ribeiro-Telles (1999) is one the first books to be published in national territory in which the main vegetal formations of Portugal's mainland are summarised. However, this work is not of a strictly scientific nature, as it intends to share knowledge with society in general.

On the other hand, there are many scientific articles, especially related with phytosociology, edited in magazines, such as *Quercetea* (Pinto Gomes *et al.*, 1999), *Itinera Geobotanica* (Rivas-Martínez *et al.*, 2002), *Acta Botanica Gallica* (Quinto-Canas *et al.*, 2012 ; Meireles *et al.*, 2012), *Lazaroa* (Pinto Gomes *et al.*, 2007), *Plant Sociology* (Vila-Viçosa *et al.*, 2013), *Plant Biosystems* (Vila-Viçosa, 2012), among others, which have contributed to improve and update the knowledge of vegetal communities.

Nevertheless, this scientific news is sometimes regarded in a way that is too hermetic, which has encumbered this use of knowledge regarding landscape architecture. Still, we should point out the work of Caldeira-Cabral (1993), where the importance of phytosociology knowledge as an auxiliary science is mentioned. Yet there is a hiatus between this knowledge and its application in the landscape architecture project.

The concept of vegetation series (or *sigmetum*), proposed by Rivas-Martínez (1976), contemplates a set of vegetal communities in different stages which occur in a specific homogeneous physical space. In this sense, the knowledge of vegetation series, namely its dynamics, is an essential tool, for the designer, aiding in the landscape analysis first and in the intervention proposal afterwards. Thus, through the vegetal bioindicator, it is possible to interpret the landscape, as well as to identify a set of habitats (Rivas-Martínez *et al.*, 1999). Moreover, through the diagnosis of each vegetation series, it is possible to know the vegetal potential of each landscape, aiming at its enhancement.

In a general way, although it is still dominated by formations of *Querci* (Aguiar & Pinto, 2007), the landscape of the Lusitanian territories is far from its pristine state (Serrão, 2004 ; Batista *et al.*, 2011). The anthropic action in the landscape is previous to the 8th century B.C. (Brito, 1992). Since then, Man has transformed the landscape, through the vegetal coverage's undensificaton, opening up glades for agricultural and pastoral purposes (Aguiar & Pinto, 2007). The several interventions carried out by Man have resulted in a landscaping mosaic of a multifunctional nature, where protection concepts and practices and production and recreation are present (Matos, 2010). In this sense, Ribeiro-Telles (1992) defends that the landscape should be considered as a whole, demonstrating through the concept of global landscape, where city and country, for depending on each other, are part of a single system (Ribeiro-Telles, 1997). This connection must be reinforced with the continuum naturale, allowing the circulation of biodiversity in urban space and, in this way, contributing to the landscape balance and stability. Faced with this scenario, interventions regarding landscape must possess unifying elements, thus, avoiding the corruption of the site, or as Norberg-Schulz (1981) defends, the genius loci, where vegetation should play a dominant role.

In the early 20th century gardens, the dark green shades of trees and shrubs were dominant, as well as the glaucous shades of aromatic and production herbaceous (Carapinha, 1995). This era was marked by new ecological concerns, connected, not only to the landscape identity (Vasconcellos, 1943), but also to the awareness of a balanced management of natural resources, such as the soil use, the water cycle and protection of the species, among others, leading to a wider use of the spontaneous vegetation (Florgård, 2004). However, in most current landscape architecture works, there is not a decision marked by the use of exotic or spontaneous vegetation (Salomé-Cruz, 2003), since there are several points of view and several distinct applications. On the other hand, the rejection of several plants inserted throughout history, which belong to the culture and tradition of a specific region, makes no sense. The antiqueness, the degree of impact on culture, and even the affinity with the spontaneous flora can be usable arguments, but of difficult generalisation for all plants (Salomé-Cruz, *op cit.*). As for the sub-spontaneous flora, called "vagabond plants" by Clément (2001), or in other words, plants which were inserted but which integrated the natural vegetation series due to their adaptation to the environment, may equally integrate the floristic composition of a project.

More recently, some questions have been raised about energy rationing and the sustainability of the "new cities" (Matos, 2010), namely the reduction of fossil fuel and the promotion of diverse forms of renewable energies.

Therefore, the cost reduction in urban spaces, namely the maintenance of green spaces and the management of water use, seems to be the cause of increasing focus (Martinho da Silva & Curado, 2009).

MATERIALS AND METHODS

In this article, the concepts that were applied in the landscape architecture scope follow the work of Caldeira-Cabral (1993) and were complemented by the work of Raposo-Magalhães (2001). In addition to these, phytosociological methodology concepts were taken in consideration, according to the landscaping and sigmatist school norms of Zurich-Montpellier, proposed by Braun-Blanquet (1919), Géhu & Rivas-Martínez (1981), updated by Géhu (2006), Rivas-Martínez (2007), Biondi (2011) and Pott (2011).

The biogeographical characterization was based on the works of Costa *et al.* (1998) and Rivas-Martínez (2007). For the bioclimatic interpretation, we followed the work of Rivas-Martínez *et al.* (2002) and the maps of Monteiro-Henriques (2010), this being the most recent information. For nomenclature and taxonomic and syntaxonomic description that was used, we followed the work of Rivas-Martínez *et al.* (2002) which was complemented by the work of Costa *et al.* (2012). The vegetation series diagnosis was carried out according to the work of Rivas-Martínez *et al.* (2011).

BRIEF BIOPHYSICAL CHARACTERIZATION

The Iberian Southwest is marked by the dominance of the Mediterranean macro bioclimate, where you can feel a strong oceanic influence, namely from the attenuated euhyperoceanic to the attenuated euoceanic. In these surfaces thermo and mesomediterranean thermoclimates are dominant and the most common ombrotypes are the sub-humid and humid, which may reach hyperhumid belts in higher relieves, such as, for example, the ridges in Sintra or even in Monchique. In lithological terms, metasedimentary rocks are dominant, originating acid substrates (Rebelo & Cunha, 1992). In the final part of the Sado and Tagus rivers basins, we can find sedimentary formations from the Cenozoic Era, made up by different grain sized sands and sandstone (Fernandes & Silva, 1998). Although less present, carbonated dolomitic substrates also occur, alternating with more detrital complexes (Teixeira & Gonçalves, 1980), forming basic soils, especially in the Algarve and Andalusian region.

These environmental conditions favour the high ecological and floristic originality, and consequentially, a diversity of natural climatophilous woods, such as holm oak, cork oak and marcescent oak groves, which can be affiliated with the *Quercetea ilicis* phytosociological class. Therefore, to better understand these formations structure and dynamics, main serial stages which integrate these formations dynamics are drafted, as well as, the phytosociological affiliation and the bioindicators which possess a higher diagnosis potential.

(SYN)STRUCTURE AND DYNAMICS OF CLIMATOPHILOUS WOODS

Most climatophilous woods existing in the Western Mediterranean belong to, in phytosociological terms, the *Quercetea ilicis* class. However, in higher edaphic compensation situations, or in places with higher precipitation, some woods affiliated to the *Querco-Fagetea* class, may appear. Thus, woods that belong to the *Quercetea ilicis* class are subject to a strong Mediterranean influence, with perennial and sclerophyllous leaf trees, limited by temporary hydromorphism. Thus, plants such as: *Daphne gnidium, Olea europaea* var. *sylvestris, Lonicera implexa, Smilax aspera, Phillyrea latifolia* subsp. *media, Rhamnus alaternus*, among many others, are typical of this class (Costa *et al.*, 2012). In the *Querco-Fagetea* class, usually of a higher moderate influence, deciduous leaf woods are more dominant, marked by the presence of the following characteristic plants: *Acer campestre, Ajuga reptans, Castanea sativa, Daphne laureola* subsp. *laureola, Hedera helix, Ilex aquifolium, Quercus robur, Sorbus latifolia, Sorbus torminalis*, among others (Costa *op cit.*).

As it was mentioned before, these woods sometimes have a much accentuated level of anthropization (Pinto-Correia *et al.*, 2013), always leaving well preserved small areas or fragments of woods in the landscape. Nevertheless, these areas are mainly associated with places of poor agricultural aptitude, such as, for example, sloping terrain, embedded valleys or surfaces with a high number of rocky outcrops. Thus, the *Querci* woods natural distribution area is, for the most part, transformed into production systems, presently occupied by agricultural fields, montados /dehesas, pine or eucalyptus mono-specific afforestation, and in impermeabilized areas by means of communication, buildings or even other engineering works.

Nevertheless, along with the accentuated anthropic action in the landscape, it has been possible to deepen the studies about the vegetation series structure and dynamics, based on the existing woods remnants (Pinto Gomes *et al.*, 2007 ; Vila-Viçosa, 2012). Therefore, Figures 1 e 2, show a simplified scheme of the climatophilous woods dynamics in the Mediterranean (concerning class and order), which can be interpreted in a progressive or regressive way.

Thus, within each class/order there will always be an association which best represents the top ranked in the potential vegetation series of a specific territory. The same can be referred for each one of the serial stages where there is always a characteristic association, as well as bioindicators of diagnostic value of a specific stage, that depends on the existing mesological conditions (Rivas-Martínez, 2005). In this sense, in case the modification of any factor occurs (soil, climate, among others), the dynamics (each serial stage) can be altered, as so happens, for example, with the nitrification, leaching or hydromorphism of the soil.

Type	Classes/Orders	Bioindicators
Woods (1)	*Quercetea ilicis*	*Lonicera implexa*, *L. etrusca*, *Rubia peregrina* var. *longifolia*, *Smilax aspera* var. *altissima*
Pre-woods (2)	*Pistacio lentisci-Rhamnetalia alaterni*	*Jasminum fruticans*, *Juniperus oxycedrus*, *Juniperus turbinata*, *Myrtus communis*, *Phillyrea angustifolia*, *Pistacia lentiscus*, *Pistacia terebinthus*, *Quercus coccifera*, *Teucrium fruticans*
Shrubby edge (3)	*Cytisetea scopario-striati*	*Adenocarpus complicatus*, *A. telonensis*, *Cytisus striatus* subsp. *eriocarpus*, *Cytisus scoparius* subsp. *bourgaei*, *Erica arborea*
Herbaceous edge (4)	*Stipo-Agrostietea castellanae*	*Celtica gigantea*
Perennial grasslands (5)	*Stipo-Agrostietea castellanae* ou *Poetea bulbosae*	*Agrostis castellana*, *Bellis sylvestris*, *Dactylis lusitanica*, *Gynandriris sisyrinchium*, *Leucojum autumnale*, *Ornithogalum orthophyllum* subsp. *baeticum*, *Poa bulbosa*
Heliophilous shrubbery (6)	*Cisto-Lavanduletea* ou *Calluno-Ulicetea* ou *Rosmarinetea officinalis*	*Cistus salviifolius*, *Cytinus hypocistis* subsp. *macranthus*, *Calluna vulgaris*, *Erica cinerea*, *E. scoparia*, *Halimium alyssoides*, *H. umbellatum*, *H. viscosum*, *Thymus mastichina*, *Lithodora prostrata*, *Ulex minor*
Annual grasslands (7)	*Tuberarietea guttatae*	*Anthyllis vulneraria* subsp. *lusitanica*, *Cerastium pumilum*, *Delphinum gracile*, *Evax lusitanica*, *Galium parisiense*, *Helianthemum salicifolium*, *Hippocrepis multisiliquosa*, *Leontodon taraxacoides* subsp. *longirostris*

Figure 1 – Stages of substitution on the level of classes/orders of the Western Mediterranean vegetation series (based on Costa *et al.*, 2012)

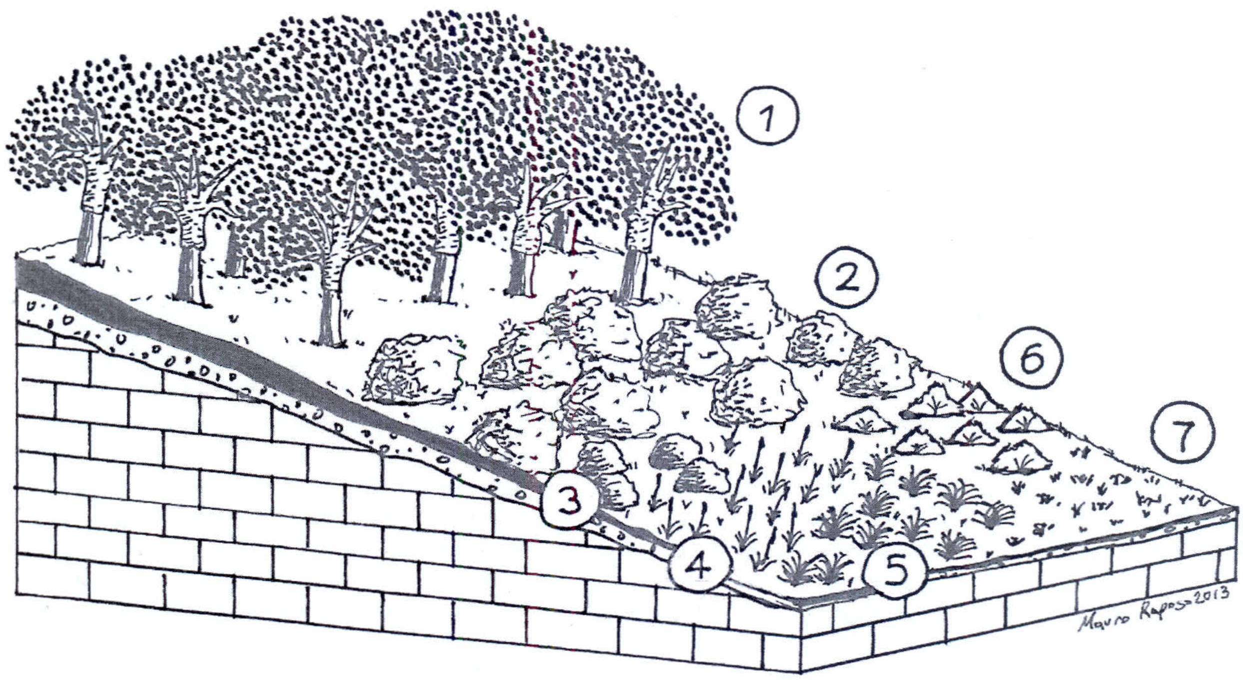

Figure 2 – Simplified scheme of the dynamic of vegetation series in the Western Mediterranean

The first stages of substitution of these *Querci* formations are represented by pre-wood shrubs, typical to deep soil, which belong to the *Pistacio lentisci-Rhamnetalia alaterni* order, frequently dominated by the strawberry medrone tree (*Arbutus unedo*), myrtle (*Myrtus communis*), kermes oak (*Quercus coccifera*), among others. At the edge of the woods, we can frequently find the presence of brooms of the *Cytisetea scopario-striati* class, which sometimes may also represent the second stage of substitution, over siliceous soil, more or less deep and without temporary hydromorphism, where *Adenocarpus complicatus* and *Cytisus striatus* are constantly present. As the third stage of substitution, and still over deep soil, appears a lategraminetum, inserted in the *Stipo-Agrostietea castellanae* class, where the herbaceous chamaephyte *Celtica gigantea* is dominant. With the continued anthropic action, this lategraminetum, frequently relinquishes its position, in the regressive dynamics, to the perennial grasslands dominated by *Dactylis lusitanica*, also belonging to the *Stipo-Agrostietea castellanae* class.

The soil's degradation, through mobilizations, especially in unfavourable times, promotes the occurrence of heliophilous shrubbery dominated by communities characteristic to eroded soil, poor in nutrients and organic matter, belonging to the *Calluno-Ulicetea, Cisto-Lavanduletea* and even the *Rosmarinetea officinalis* classes (Costa *et al.*, 2012). The presence of these classes varies essentially according to the ombroclimate/oceanity and the substrate. Thus, in the Iberian west, which is more oceanic and has a higher level of precipitation, *Calluna-Ulicetea* is present, whereas in the dry territories *Cisto-Lavandelutea* is more dominant, and in the surfaces where the substrate is basophilous, *Rosmarinetea officinalis* is the dominant one. These shrubby associations consist of different kinds of plants, such as *Lavandula, Cistus, Ulex, Stauracanthus, Erica, Pterospartum, Halimium* or *Thymus*.

In the stages of substitution, more distant from climax, the annual grasslands of the *Tuberarietea guttatae* class appear where the dominant ones are the small sized, spring to summer ephemeral therophytes of xerophilic, indifferent to the substrate's chemical composition and poor in organic matter (Costa *op cit.*).

However, the evolution of the vegetation coverage in landscape hasn't always followed the presented models, highly depending on the season features, as well as, the seed bank. Just as an example, it should be referred that in the progressive succession of the *Tuberarietea guttatae* grasslands, when submitted to intensive grazing for a minimum period of six years, perennial grasslands are developed in the scope of the *Poetea bulbosae* class (Pinto Gomes & Paiva-Ferreira, 2005).

Thus, when these surfaces are accompanied by an arboreous coverage of Quercíneas, more or less sparse, they form a communal habitat of interest (6310), called "dehesas with evergreen *Quercus* spp.".

On the other hand, if the *Tuberarietea guttatae* terofitic grasslands are not subjected to grazing, the above mentioned colonization process of heliophilous shrubbery will initiate. However, it should be pointed out that because these heliophilous shrubbery present a high risk of fire hazard, they frequently catch fire (in short cycles, usually every ten to twenty five years) (Fernandes *et al.*, 2000), thus promoting the erosion and haulage of the existing organic matter in the soil, by rain water and, consequentially, the recolonization, transforming these landscapes into a true hard to control "closed" cycle, where the shrubbery promote fire and fire promotes shrubbery.

In situations where the soil presents low erosion, there is a strong growth of some heliophilous shrubbery, along with pre-wood shrubbery, thus creating the necessary conditions so that in the future, pre-woods or even woods may develop. However, the anthropic action may favour the climacic state, through shrubbery management and climacic species conduction. It should also be pointed out that the presence of a wood is determined by the organization of vegetal formations, where the tree dominates the shrubby stratus (Rivas-Martínez, 2005). Therefore, we presuppose the existence of a fully developed arboreal coverage, which leans towards the formation of a closed crown, marked by the presence of a group of other species, for example, lianas.

In this way, in the Western Mediterranean context, at least in sub-humid ombroclimate sites, the presence of secondary woods is frequent, favouring the conditions for the installation of potential climatophilous formations, namely through tree canopy shading and the improvement of the soil structure, through foliage accumulation. However, the climacic woods may occur without a previous installation of the secondary woods, given that pre-wood shrubbery may play the same protective role in the beginning of their growth.

Faced with these conditions, the water evaporation rate is smaller, thus promoting the water infiltration in the soil, and consequentially, its use by the vegetal coverage.

This alteration has special relevance in eroded soil, where, during hot dry summers, the natural arboreal regeneration faces great difficulties to survive (Meireles *et al.*, 2005). Therefore, just as an example, we shall refer the presence of olive tree groves in potential climatophilous territory of montado /dehesa, forming secondary woods, due to the higher ecological resilience of olive tree.

However, as the conditions favour the climacic woods growth, a competition will be set between the two, in which the secondary woods will end up losing ecological space, due to the alteration of the initial conditions of the arboreal growth.

To facilitate the identification of the distinction between the edapho-xerophilous vegetation and the secondary woods, we should highlight the differences between the respective substitution stages. Thus, the identification of a secondary woods is made through the presence of vegetal bioindicators, in other words, characteristic elements of the first substitution stages of the climatophilous series (of deep soil). In the edapho-xerophilous series, however, the substitution stages are compulsorily different, of a more xerophytic character.

Therefore, the climatophilous woods communities will not be able to occur in edapho-xerophilous position.

SUMMARISED ANALYSIS OF THE INTERVENTION SPACE

In the requalification of a specific space, in the landscape architecture scope, the analysis and interpretation phase of the study area is very important, so that its natural and cultural specificities can be perceived. In this sense, having the biophysical characterization as a foundation, the characteristics of the space should be itemized in order to outline intervention strategies, consubstantiated in project solutions based on a previously established programme.

For a better understanding of the edapho-climatic conditions of the intervention area, we must resort to, the vegetal bioindicators, if they exist (Raposo, 2014). However, in particular situations, there may be the need to carry out detailed sectoral studies about the existing conditions, such as the ones related to pedology, micro-climatology, among others. Actually, the vegetal bioindicator is fundamental to obtain the necessary information to elaborate a real diagnosis on the vegetal potentiality of that space, which corresponds to the identification of the existing vegetation series. Moreover, from this interpretation, it is possible to list the main stages of progressive and regressive succession of the respective series, as well as characteristic plants which make up a certain serial stage, and from this group of characteristic plants, a list of plants to contemplate in the project should be made, always basing it on the patrimonial and ornamental value of each species.

It is also in this phase, that we identify the main problems related to the physical space, where constraints like the terrain irregularity and the soil nitrification, acidification or hydromorphim are detected. Moreover, as an example, Pinto Gomes *et al.* (2009), refers that the soil nitrification can be identified by the presence of plants such as *Lavatera cretica, Uirtica urens, Malva parviflora, Galactites tomentosa, Silybum marianum, Senecio jacobaea, Cistus salviifolius, Cistus crispus*; the soil acidity through the presence of *Rumex bucephalophorus*, *Tuberaria guttata, Stipa capensis*; and finally, the hydromorphism through the presence of plants such as *Chamaemelum nobile, Chamaemelum fuscatum, Phalaris caerulescens, Agrostis castellana, Mentha pulegium, Agrostis pourretii*.

Faced with this scenario, it should be pointed out that, at this stage, the landscape architect will already have the necessary tools to analyse and afterwards interpret the gathered information, in any stretch of landscape, in order to understand the whole vegetal dynamics and, consequentially, elaborate a list of desired indigenous plants for that intervention space.

PROPOSAL TO STUDY CASES

The execution of an accurate and in depth analysis of the space is the starting point for the elaboration of a solid and sustainable proposal. Therefore, the closer a certain vegetal association is to the climacic potential, the higher those plant requirements, regarding soil preservation, will be (Rivas-Martínez *et al.*, 2011).

In this sense, if the soil is degraded, we should avoid the use of pre-wood plants which belong to the *Pistacio lentisci-Rhamnetalia alaterni* order or the ones from the wood edges like the *Cytisetea scopario-striati* class, both from deep soil. However, in these conditions, an improvement of the soil can be made, by increasing the organic matter, in order to allow the necessary conditions for the right development of the vegetal material.

In the case of steep slopes, therefore more susceptible to soil erosion, it is always necessary to install soil retention mechanisms (resorting to bioengineering techniques) to favour the conditions for the development of pre-wood plants or the ones from woods edges. In this context, aiming at the creation of a layer of fertile soil, according to Durlo & Sutili (2005), the main bioengineering techniques that stand out are live fascines (mounted branches that form clusters and are fixed on the ground with stakes or rocks), pile wall (fences that should retain loose layers of topsoil are arranged in horizontal direction) and wattle fence (stakes are driven vertically into the ground and living twigs are then woven around the stakes) among others.

On the other hand, there is the option to directly use characteristic plants from eroded soil, which have great capacity for adaptation to dryness and to the soil's high temperatures, through the use of characteristic plants of the *Calluno-Ulicetea, Cisto-Lavanduletea* and *Rosmarinetea officinalis* classes, highlighting plants such as *Cistus, Lavandula, Erica, Thymus* (Raposo, 2014).

It should also be pointed out that the pre-wood plants, generally speaking, reach a higher longevity compared to eroded soil plants, which belong to stages that are further away from climax. These ones, due to their heliophilous character, may lose ecological space as the progressive ecological succession dynamics evolve. Therefore, its use must always take into account the light concurrence. Thus, it is suggested that they always be planted in sites where light is ensured.

Regarding maintenance costs, it should be referred that they are reduced, since indigenous plants do not need irrigation. However, when planting, casual irrigations may be applied, especially at times of water shortage. Within these maintenance costs, some control interventions of concurrent vegetation should be taken into account, namely regarding weeds and even the clearing of some species. Concerning arboreal and shrubby plants, formation pruning should also be included.

In choosing the mixture of meadows, besides the limitation regarding market offer (Costa *et al.*, 2009), seed diversity and use of space should be taken into consideration. In non-trampled meadows without temporary hydromorphism, we may choose large gramenea, such as Mediterranean needle grass (*Celtica gigantea*). Thus, when subjected to trampling, it is necessary to adapt the mixture of seeds to the pressure applied by users, for example *Cynodon dactylon, Poa bulbosa* and *Trifolium subterraneum*. On the other hand, other leguminous plants should be privileged, since they fixated high quantities of atmospheric nitrogen (Crespo, 2006), which contributes to the retention and fertility of the soil in the long run (Freixial & Barros, 2012).

Anyway, western Mediterranean plants present excellent plastic features of use in landscape architecture projects, in which volume, texture, shape and colour (Salomé-Cruz, 2003), offer great phytocoenotic diversity. Moreover, we should highlight the patrimonial value of endemic and/or under legal protection status plants, which integrate several vegetation formations, creating unique landscapes, highlighting thrift (*Armeria rouyana*), thyme (*Thymus capitellatus*), butcher's-broom (*Ruscus aculeatus*), among others (Raposo, 2014). In the Mediterranean flora, a great number of plants of aromatic interest such as laurel (*Laurus nobilis*), myrtle (*Myrtus communis*), rosemary (*Lavandula luisieri*), thyme (*Thymus mastichina, T. sylvestris*), pennyroyal (*Mentha pulegium*), among others, may contribute to enhance the user's experience of the interventioned space.

CONCLUSIONS

Landscape Architects see the (sym)phytosociological science as a very valuable tool for the analysis and interpretation of the landscape, as well as for the elaboration of proposals for sustainable projects, since they significantly reduce maintenance costs. These proposals are in perfect harmony with the natural ecosystems, valuing biodiversity, through the use of under protection status endemic plants, as well as of high ecological and scenic value. In this sense, a deeper knowledge of the flora and indigenous vegetation, namely concerning the series, contributes, in a considerable fashion, to the ecological valorisation and requalification of the spaces, promoting the landscape sustainability.

The phytosociological class which represents the Mediterranean climatophilous woods is the *Quercetea ilicis*. The destruction of these woods gives its position away to the thicket (pre-woods) affiliated with the *Pistacio* *lentisci-Rhamnetalia alaterni* order. The shrubby edges of these woods are dominated by retamoid shrubs within the *Cytisetea scopario-striati* class. Regarding herbaceous formations, it is important to emphasize the domination of non-trampled perennial grasslands of the *Stipo-Agrostietea castellanae* class. However, in case there is significant trampling, communities of *Poetea bulbosae* will occur, where the phytobiodiversity is very peculiar or of *Stipo-Agrostietea castellanae,* if the management is developed by cut or even extensive grazing. The soil degradation leads to the appearance of heliophilous shrubs, namely of *Cisto-Lavanduletea*, of *Calluno-Ulicetea* or *Rosmarinetea officinalis*, which vary according to the ombroclimate/oceanity and the substrate. Lastly, in the late stages of climax, it is important to emphasize the presence of ephemorous terofitic grasslands affiliated with *Tuberarietea guttatae* which, once submitted to grazing, will evolve into *Poetea bulbosae*, after at least six years have gone by.

The use of the vegetal bioindicator, besides contributing to the landscape interpretation, makes it possible to identify its potentialities, as well as to understand, in dynamic terms (progressive or regressive), all the substitution stages of those vegetal formations. Moreover, through the vegetation series diagnosis, it is possible to make an evaluation of the landscape conservation state, as well as, a characterization of the main mesological conditions of the study area.

In the proposal elaboration phase, and based on the vegetation series, it is possible to choose from a set of plants which fulfil the project objectives, as well as, adjust them to the existing edaphoclimatic conditions. On the one hand, the pre-wood plants (*Pistacio lentisci-Rhamnetalia alaterni*) possess a higher longevity and a larger size. But, on the other hand, they are more demanding when it comes to soil conservation and they are generally less exuberant regarding flowering. As for plants characteristic to eroded soil (*Calluno-Ulicetea, Cisto-Lavanduletea* e *Rosmarinetea officinalis*), they adapt themselves better to highly adverse bioclimatic conditions, they possess great chromatic richness, especially when it comes to flowering, they need a bigger solar light availability, but they achieve a smaller longevity.

Regarding meadows, it is important to highlight the wide variety of plants possible to integrate seed mixtures. On the one hand, they guarantee a high chromatic diversity throughout most of the year. On the other hand, leguminous plants provide the fixation of atmospheric nitrogen in the soil, as well as the retention and conservation of the soil, thus, increasing its fertility in the long run.

Faced with this scenario, resorting to the knowledge provided by (sym)phytosociology science, contributes significantly to reinforce the landscape identity and scenic quality, as well as, to enrich the environmental sustainability of the intervened areas.

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