Chapter 13

The Relevance of Vegetation Series on the Maintenance and Sustainability of Public Spaces in the Southwest Iberian Peninsula

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Additional information is available at the end of the chapter

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Abstract

City and countryside, by their mutual dependency, constitute a unique system, which is the basis for the development of a global landscape. This interaction is far from the country being simply the city's food supply. The interaction should be reinforced through ecological corridors allowing the biodiversity movement that guarantees the landscape identity. In this regard, life's standards are strictly related to the landscape quality. Moreover, landscape biophysical features determine the vegetal potential and consequently their uses and techniques adopted by man toward his territorial settlement. Contextually, two Iberian case studies have been selected and analyzed from a multidisciplinarity perspective, aiming to determine how vegetation series may influence the maintenance and sustainability of urban green spaces. Bearing this in mind that a landscape architecture project is dynamic and considering the fourth dimension: time—mainly regarding the vegetation development, creating new volumes and spaces-considering their natural evolution, a deep knowledge of the plant material is seen as a critical factor for a sustainable landscape planning at several levels.

Keywords: biodiversity, geobotany, landscape identity, native vegetation, sustainable planning

1. Introduction

Plant material is the main tool for landscape construction used by the landscape architect, so, in-depth knowledge about it will necessarily express the quality of the project [1]. Thus, it is up to the landscape architect to plan the territory regarding human's necessities, considering landscape identities. With this in mind, the phytosociology knowledge is pivotal as an auxiliary science [2], which is critical for the understanding of the evolution and establishment of native vegetation typologies among territories [3].

In this regard, the Mediterranean Basin represents one of the *hot spots* of biodiversity at a global scale [4], with a rich endemic flora. So, it should be highlighted that the Iberian along with the Micronesian Islands represents more than 50% of the European floristic diversity providing a large range of plant materials possible to use in public green spaces.[1]

Nevertheless, renowned landscape architects—i.e., [5–8], among many others—have demonstrated concerns regarding the adaptability of plant material to edaphoclimatic local features—plant selection and their landscaping potentials for a particular territory. During modernism, where the ecologist movement had a greater expression [1], a smooth interventionist mindset shift occurred, leading to a higher artistically and scenic approach. Such changes reinforced by the work of [9], included the following concept: "a Garden is a masterpiece, it is not done, it is created from the existent."[2]

Recently, several questions have been raised regarding a sustainable resource management and city's sustainability [10, 11]. In this regard, should be highlighted the case of reducing of fossil fuels and promoting new energy sources — renewables. In this regard, the reducing of costs in urban territories—such as the reduction of urban green spaces and their water management—is one of the major's challenges to achieve sustainability and the so-called smart cities [12].

In the present work, two case studies have been chosen where a model of climatic vegetation series and their replacing steps is presented. Each series is set targeting topics such as synchorology, community, bioclimatology, dynamic, and essential bioindicators for each replacing step—where each one builds up about those surfaces several climatic vegetation series.

Afterward, geographical and phytosociological knowledge is applied regarding Iberian landscape architecture projects—where an analysis is performed aiming to obtain a well-adapted floristic set concerning local edaphoclimatic features. Thus, the plant material chosen should be considered not only at the level of plastic and ecological features, but also regarding a set of functions to be performed (by the plant material) in the landscape configuration and design.

The study consequentially intends to demonstrate how multidisciplinarity fosters a better project as well as increasing the city's sustainability—considering the interactions of phytosociology and landscape architecture [3].

2. Vegetation series: methods and principles

The vegetation cover of Iberian Peninsula is far from its pristine state [13, 14], when it was dominated by the *Querci* [15]. The anthropic action in these areas is mentioned as far back as

[1]Piet Oudouf, in one of his travel over the Mediterranean, listed plants in the United States of America, a typical grassland of the Mediterranean world – the *Stipa gigantea* Link. Still, it is not used in Mediterranean gardens. In the same line lies the case of the *Narcissus scaberulus* Henriq., living spontaneously only in Mondego's Riverbanks, which has been carried to Central Europe where it is valued as an ornamental species.

[2]Also, Raposo-Magalhães (2001) highlights the relevance of well-known ecological features of native vegetation for an integrated landscaping intervention. So, biogeography should consider fostering an increase in the landscape identities.

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before the 8th century BC [16]. Since then, man has been changing the landscape for his own benefits, shaping multifunctional landscape patterns, multiple production areas, particularly for cereal culture (ager), grassland (saltus), and forest (silva) [1].

In the beginning, clearings have been developed in existing woodlands in order to create grazing areas for cattle [15]; furthermore, arable areas of agricultural production have also arisen. Thus, a heterogeneous landscape should integrate principles and practices of protection, production, and recreation [10], ensuring their sustainability. Nevertheless, with the population growth, there is a considerable tendency for the separation of "rural" and "urban space"; still, it should be taken into account that the landscape must be understood as a whole [17] through the concept of global landscape—where city and country depends on each other, being part of the larger system [18]. Such link must be reinforced by the *continuum naturale*, allowing the movement of urban biodiversity and contributing to the balance and territorial stability [17]. So, interventions in public spaces must have unifying elements, in order to avoid distortion of place features or lose the *genius loci* [19].

The best extracted information about the natural vegetation cover of each territory is provided through vegetation series (or *sigmetum*). This concept consists of a set of plant communities in different stages, occurring in a homogeneous physical space [20]. These communities could present a reverse or progressive dynamics depending on their maturing state [21]. Vegetation series is always associated with the head of the series, which corresponds to the maximum development, also known as potential natural vegetation, and often compared to their pristine state [22]. However, when anthropic action ceases, the vegetation growth depends on local soil and weather conditions, during a certain period of time, until it reaches floristic stability. The identification of a specific plant community—that is repeated on some territory in ecological and floristically situations—allows the application of specific SIGMA methodology[3] aligned with the phytosociological inventory, intending to describe a new vegetable association ("syntaxon") [23].[4]

Consequently, phytosociology science has developed a system of associated interpretation, analyzing the relationships of several geographical series of contiguous vegetation [24]. The *geosérie* or *geosigmetum* is the basic unit of geography and phytosociology, which represents the set of contiguous series of steps, or a mature determined topographic unit (typically a set of situations in ridge, half a hillside and valley) within the same biogeographical unit [21] (**Figure 1**).

Climatic series depend only on the direct precipitation of rainfall in a specified location, while the edaphic series are the result of peculiarities of soil and topography morphology, which in time are divided into edaphoxerophile—dry areas with weak water retention in soil—and edaphohygrophile—depression relief areas that receive waters from upstream, usually associated with waterlines [21]. Through this, each type of vegetation can add different series of potential vegetation, as is the case of the west Iberian territories, where the edaphohygrophile vegetation consists of an alder wood (*Salix* spp. and *Fraxinus* spp.).

[3]SIGMA: Station International de Géobotanique Méditerranéene et Alpine.
[4]This concept was first introduced by Flahault & Schroter in 1910, at the Brussels Botany Congress and since then, the association came to be regarded as a basic unit of vegetation, contributing to the advancement of phytosociological science.

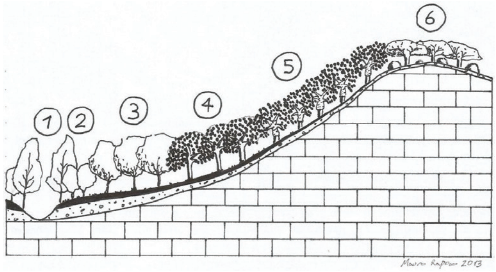

Figure 1. Representative scheme of the predominant series on the Iberian Peninsula. Edaphohygrophile vegetation: 1—*Alnus lusitanica*, 2—*Salix atrocinerea*, 3—*Fraxinus angustifolia*; Climatic vegetation: 4—*Quercus broteroi*, 5—*Quercus suber*; and edaphoxerophile vegetation: 6—*Quercus rotundifolia*.

Several landscape architects have contributed to the appreciation of native vegetation cover [2, 3, 7–9, 21, 25]. A growing attention for ecological issues has contributed significantly to the development of the identity of the landscape and of the intrinsic characteristics of each location. Serving as proof, the property of the Foundation project McConnell in California (designed by Peter Walker and Partners in 1978) where several degraded areas of dry and wet environments were recovered using the native perennial herbaceous.[5]

Relevant phytosociological concepts for the interpretation of vegetation series on landscape, such as a schema type for vegetation development during a period of 40 years (**Figures 2–6**), were prepared by the landscape architect Gilles Clément [7], representing an awareness of the evolution of the vegetation series in space and time. This methodology evidenced the importance of knowledge of plant landscape architecture dynamics, where each figure can resemble a vegetable, belonging to the association, in this case, vegetation series.

Shrubs—of greater longevity and lower maintenance and fewer costs for the garden—can be found spontaneously in areas of higher development of vegetation cover, belonging to banks or replacement steps, closer to the potential woodland formations. These are typically dominated by dry plants and also considered as *maqui scubland*—i.e., A*rbutus unedo, Rhamnus alaternus, Myrtus communis, Viburnum tinus, Prunus spinosa*, among many other species. However, the soil erosion in some areas of the Alentejo Region has hindered the natural regeneration of these plants, due to the scarcity of deep organic substrates. Under sun exposure, it forms communities of shrubs—away from the hood, belonging in the study area to classes of *Cisto-Lavanduletea* and *Calluno-Ulicetea*. However, these plants show higher growth rates, forming woody shrubs in few years, leading to a high propensity of wildfire events.[6]

Most of the literature review analysis regarding vegetation series was made through the work of [26], which gathers the majority of vegetation series existing in the Iberian Peninsula.

[5]Also the garden of the Calouste Gulbenkian Foundation in Lisbon has undergone some changes in the used species.
[6]For example, the *Lavandula genus* if not pruned, in a few years may, shows an aged appearance—leaves only at the ends of the branches, decreasing the ornamental interest. This behavior may be explained by the remote replacement steps from the ancient woodlands—that aim a rapid supply of organic matter to the soil, in order to allow the establishment of a more demanding plant regarding soil (during the mature stage).

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Figure 2. Year 0. Derelict landscape with some prime-colonizing herbaceous [7].

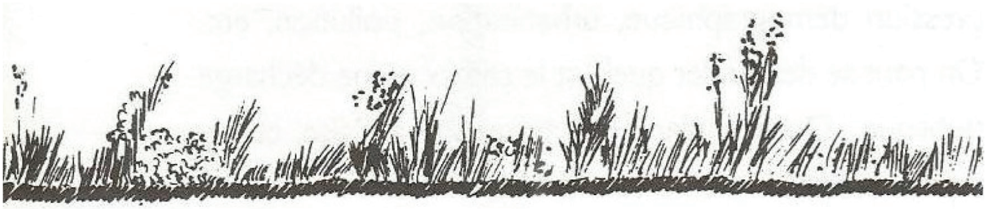

Figure 3. Years 1–3. An agricultural soil—after the abandon, leads to a meadow; otherwise, is preceded by a pre-meadow of bryophytes [7].

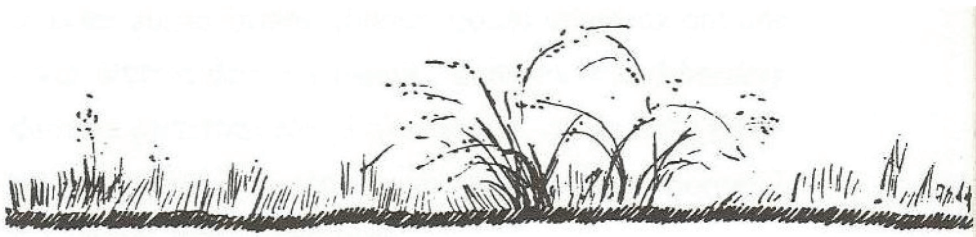

Figure 4. Years 3–7. The meadow is occupied by scrubs—mainly thorny [7].

Figure 5. Years 7–14. The grassland area increases in relation to the grassland. Small trees start to emerge [7].

Through the knowledge of territorial potential vegetation, it was possible to propose a set of plants that are well adapted to and most suitable for different soil and climatic features. Phytosociology can thus be used in different project phases. At a first phase, the bioindicator plant can be used as an interpretation tool, providing information related to the study area—i.e., the potential vegetation series and its perturbation state, existing substrate type,

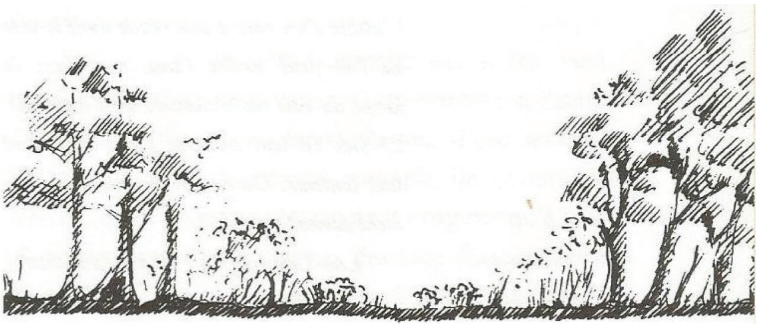

Figure 6. Years 14–40. The tree shade inhibits the growth of the shrubs that at first protected them [7].

and thermoclimatic. In the proposal phase, and based on the abovementioned conditions, it is possible to propose a set of plants based on the different associations of vegetation series identified, through the consultation of phytosociological inventories.[7] Faced with a set of plants well adapted to local edaphoclimatic conditions, it is now easier to select them suitably according to their functions and their morphological, chromatic, and aromatic features and in different aspects such as volumetric, texture, time, and duration of flowering, color, aroma intensity, among many others.

3. Mediterranean flora and vegetation: a brief description

Mediterranean flora is quite unique, it adapts to dry and hot summers and relatively cold and damp winters, predominating evergreen trees and shrubs, resisting in the dry and hot periods through the dormant and numerous morphological adaptations [27]. It is typical of Mediterranean vegetation, i.e., thorny bushes with reduced leathery leaves and covered with varnish on top or at the bottom, as strategies to prevent the water loss during the warm months [27].

From a historical perspective, the several geological events and climate changes—particularly during glaciation *eras* allied with long periods of low temperatures, and also increased precipitation periods—indorsed the offset, and subsequently, the adaptation of a great number of plants. Through successive adjustments over time, some of these plants have become endemic in these areas. One of those examples is the case of *Juniperus navicularis* dating geologically to the Pleistocene [28], whose genetic ancestors, due to their morphological similarities, thought to have belonged to *Juniperus oxycedrus*.[8]

From the five existing macrobioclimatic classifications on Earth [29], the Mediterranean macrobioclimate is the one that offers greater diversity of bushes. These territories are characterized

[7]At this stage, it is still important to distinguish typical "deep soils" substitution stages, usually of superior ornamental interest and greater longevity, from "eroded soils" plants, some of them colonizing plants with less longevity.
[8]Species still present in the Tejo's International Natural Park and in Douro's Valley.

by a perennial vegetation, where the deciduous elements only appear in the waterlines. Regarding to landscape, vegetation is dominated by oleasters, oaks and cork-oak forests, and other oak marcescent/leaf, distributed according to the mesological gradients. Even small changes in topography originate differentiated conditions that interfere in the vegetation dispersion patterns [30]. In the southwest Iberian territories, the dominant vegetation is made up of *Quercus suber* and *Quercus rotundifolia*.[9] According to Caldeira-Cabral [2]: "The Portuguese flora is characterized by the beauty and color of its flowers, finding your height above all in spring and autumn."

The four main replacing stages of these vegetation series are based on: preforest bushes, groundcover vegetation, heliophiles bushes, and perennial groundcovers, which changes depending on the degree of anthropization and land use. The first stages of replacing these *Querci* formations are represented by preforest bushes of *Ericion arborea*, usually dominated by *Arbutus unedo*. As a second step of replacing, appears a *lategraminetum* dominated by *Stipa gigantea* that remains through the extensive grazing. Soil degradation promoting the appearance of heliophiles bushes dominated by communities of *Calluno-Ulicetea* and *Cisto-Lavanduletea*, where most of the plants belong to the genera *Lavandula, Cistus, Ulex, Stauracanthus, Erica, Pterospartum, Halimium,* and *Thymus*. In advanced replacement steps, the therophytic meadows referring to the *Tuberarietea guttatae* class appear.

4. The southwest Iberian context

The *herbaceous stratum* and due to the existence of a well-defined dry and hot season during the summer—reaching high temperatures—the meadow dries on the final of the spring season and perennial plants spend summer in a vegetative rest state, conferring them no vitality. Aiming to overcome this scenario, lawns and meadows are irrigated; however, water costs are quite high (especially to municipalities), aiming to keep the *herbaceous* cover always green [31]. So, from a sustainable perspective, it is totally discouraged to support these irrigation costs for several months. On the other hand, the shrub *stratum* offers a large range of plants and also provided the possibility to create different floristic aggregations, through different morphological features that plant material presents in these territories.

In landscape architecture, different spaces are designed through shrub and tree *stratum*, where the relationship between "full and empty forms" two basic components for defining the space. Only through such synergy—with volumes and their respective limits—these types of space appear [1], among them are

- *Closed space*—defines what is occupied by dense vegetation, both at the tops of trees levels and massive woodland species;
- *Open space*—characterized by the lack of vegetation or by the form of coating, such as clearings lined with meadows or lawns. However, limited by the distance;

[9]Also, *Quercus broteroi* and *Quercus pyrenaica* are possible to be found in mountains or valleys.

- *Unlimited space*—the boundaries are so apart that the user does not *feel them*;
- *Punctuated space*—contains a number of elements scored in open space, where they can be made up of trees or bushes;
- *Compartmentalized space*—an open space consisting of vertical planes, made by trees or hedges alignments.

Trees are the structural elements in the landscape, where their *grandeur* and number contribute to unify the spaces. Their value increases with age and many of them exceed the lifespan of most buildings [32]. The density of trees, the height of their cups, and the leaf typology (persistent/deciduous) contribute through light filtration to create different ambiances in the space. The large trees are superlative to define the structure and serve as open space framework [6]. When they are used separately, it creates focal points increasing their value in function of their size, shape, and color; on the other hand, when used as bushes scenario (with all of their elements developed), it is able to comply with its protection functions, production, and recreation [33].

The shrub *stratum* volume also influences the brightness—mainly due to their smaller dimension, standing between the tops of the trees and ground [32]. In fact, some elements have bush features (resembling geometric shapes), i.e., *Teucrium fruticans* similar to a semisphere. Shrubs are responsible for defining most of the limits, enabling to create volumes of physical and visual restraint. On the other hand, the *herbaceous stratum* provides open spaces—i.e., lawns or meadows. However, some of them with higher presence are used in compositions along with shrub elements. The case of *Stipa gigantea* (typically Mediterranean) is one of the plants used and suggested by [34]. Climbing vegetation can act as ground cover. Nevertheless, when supported by these structures, they are able to create barriers as shrub stains or integrate shade structures.

In open spaces, and using different *strata* of vegetation cover, four limits of typologies can be defined such as:

- *Permeable boundary* can assume variable degrees, requiring the opening of small spaces that will ensure and determine the permeability degree through regularities and irregularities of those spaces. This limited typology ensures some visual permeability, but not necessarily physical.
- *Closed boundary* is defined as a mass of dense vegetation, can be materialized, mainly, by the shrub *stratum*, forming visual and physical containment.
- *Open boundary* is characterized by small elements. In this way, there is a free pedestrian circulation with considerable load capacity and visual range.
- *Open contained boundary* consists of low-sized elements (bushes whose height does not exceed the *eyeline* of the user) constituting only a physical barrier [1].

The shape can be worked with various purposes—referring to the lack of two-dimensional objects—and the seizure of the form is made through the outline. In isolated elements—in extreme weather conditions, as in mountain areas or coastal that is exposed to strong winds—the vegetation can assume different configurations. In other cases, the form is crafted in order to create sculptural forms; thus, the relevance of a given element into the space is proportional to their dimension.

In Mediterranean flora, it dominates fine texture plants and occasionally spiny plants. High temperatures allied with the low precipitation patterns during summer are reflected by several plant modifications to these conditions [27]. Fine textures are typically of heliophile plants such as *Halimium calycinum*, while coarser textures are verified in prewoodland vegetation, such as *Viburnum tinus* and the *Arbutus unedo*. However, the composition based on texture has greater sense in small areas, where it is possible to capture such details. In larger areas, the scenic space apprehension does not focus on texture; in fact, it gives priority to vegetation masses of shape and color.

There is a greater diversity of plants and blooms in shrub and *herbaceous stratum*, so their association will be pivotal to a well-visual reading and understanding of the space. However, the color should play a supporting role regarding species form [8], despite being the main reason why people are interested in plants. There are several possible colors to conjugate from the plant material; therefore, treatment has been an object of study to determine the best chromatic association [35].

In a considerable color diversity scenario, there may be a reduction in the seizure of each one of them, due to the phenomenon of *contagious* with neighboring colors, where there are three main ways to deal with color [35]. In the case of working with the same textures, a more attractive combination can be used, such as *Nerium oleander*—with pink flowering and its variety *Luteum Plenum* with yellow flowering. Red is one of the most used colors for rhythm and punctuation of spaces, due to strong contrast with green patches [8]. The yellow can also become strong when used in excess; nevertheless, when used in transition areas can emphasize that *passage*. Therefore, it is easier to combine large numbers of light colors, than strong colors. For example, pink is easily combined with other colors, can also function as a connecting element among other colors—red and white, white and blue, or blue and violet. Blue is used to give a sense of depth on space, placed on the rear or on the edge of a planting area [8].

The result of any intervention in landscape must respect the following principles:

- *Unit* is set to the apprehension of space as a whole and not as a set of interventions carried out separately and without any links between them. Each intervention should be framed in a space with certain features, which define the character of the place. Thus, the plant material can be the main contributor to this spatial unit, where the principle of dominant species has great use potential.
- *Simplicity*—a principle that aims to facilitate space apprehension through a balanced composition without great exuberance and, therefore, easy to visually read.
- *Diversity*—is implicit in all nature where there are a number of different ambiances, given by color contrast, texture, the relief, plants, and light/shadow [2, 36].

A planting plan that explores contrasts and differences between vegetation plastic features (volume, shape, texture, and color) are occasionally the best compositions, concerning: clarity, distinctness, and unity composition [35]. Still, space designs regarding plant material should be based on nature principles, as noted in the phytosociology pools (**Table 1**), where there is a set of dominant and less dominant plants.

In these phytosociological stages, underlies the unit, given the dominance of *Arbutus unedo*, since they high coefficient of presence. The simplicity is present in the similarity between different chromatic shades of yellow, making the apprehension of space easy. The contrast arises at the level of vegetation textures and the chromatics of some blooms. Although some of these species have flowers humble, the chromatic contrast arises, naturally, through the red and purple flowers.

Altitude (m)	345	555	295	425	115	370	85	380	460	375	**Flower chromatography**
Orientation	E	—	E	NW	N	SW	N	SE	NE	NW	
Surface (m^2)	100	60	100	200	100	100	100	50	150	100	
N° of species	21	20	27	24	19	24	10	23	24	22	
Ordinal number	1	2	3	4	5	6	7	8	9	10	
Species features											
Arbutus unedo	4	5	5	4	3	4	4	4	4	5	
Erica arborea	.	1	3	2	2	2	3	2	2	2	
Ruscus aculeatus	.	.	1	1	3	2	+	2	2	3	
Cytisus grandiflorus	+	2	2	1	+	1	.	.	.	.	
Daphne gnidium	2	2	.	1	1	.	.	+	.	+	
Osyris alba	2	.	.	.	+	1	1	+	.	2	
Rubia peregrina	+	2	1	.	.	.	.	+	+	1	
Quercus rotundifolia	1	.	.	1	3	.	.	1	1	.	
Pistacia terebinthus	.	.	2	1	2	.	.	1	+	.	
Phillyrea angustifolia	.	.	.	1	1	.	.	+	2	.	
Hedera hibernica	.	.	+	.	.	2	.	.	.	3	
Quercus suber	.	.	.	+	1	.	.	.	3	.	
Lonicera etrusca	.	.	.	1	1	.	1	.	.	.	
Asplenium onopteris	.	.	.	.	.	+	.	+	.	2	—

Presence ratios: 5—of 100 at 75%; 4—of 75 at 50%; 3—of 50 at 25%; 2—of 25 at 10%; and 1—of 10 at 1% e + —lower than 1% or punctually.

Table 1. *Cytiso grandiflori-Arbutetum unedonis,* inventory pool (adapted from [37]).

At texture level, the presence of *Cytisus grandiflorus* with finer texture in opposition to *Hedera hibernica* with a coarser texture should be noted. The diversity is also demonstrated in this study, due to a large number of species—a typical feature of Mediterranean territory influence.

5. Case studies

The present work analyzes landscape architecture projects located in territories with similar bioclimatic, but presenting considerable differences on substrate features. So, it is possible to emphasize the importance of soil in plant material choice and their adaptation to edaphic local conditions. Contextually, the latest and most representative projects in Alentejo were selected, as they share the most ecological conditions with Mediterranean climate. Following this, projects with the most variety of exotic plants were taken into account, in order to present a contrasting sample with a high level of native plants.

The project's choice went through to identify representative areas with a certain type of substrate, such as sedimentary sands, in Vendas Novas project, and the limestones of Estremoz—internationally known by providing high-value ornamental stones for building construction (**Figure 7**).

Contextually, it will be presented as the potential climatic vegetation series for each case study. In the case of plants with a lower growth or nonadapted to local features, it will be

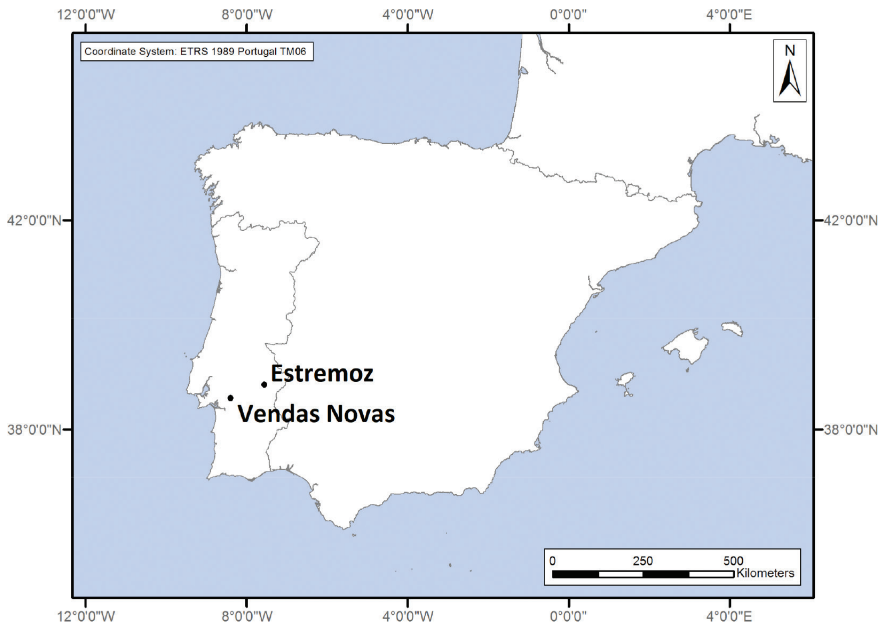

Figure 7. Geographical location of projects in the Iberian Peninsula.

carried out as a proposal with a set of plants based on the vegetation series analysis, aiming to be well adapted to local features and promote a sustainable urban green space.

5.1. Results

5.1.1. Vendas Novas

Taking into account the purpose of the study, the following project has been selected: "Urban section coincident with EN4 between the Largo's João Luís Ricardo roundabout and the access to EN251-1."[10] The project is located near the railway line in the east entrance of Vendas Novas, corresponding to a narrow stretch dimensions approximately 1 km × 10 m long.

The city of Vendas Novas, from a geological perspective, lays on siliceous psammophilous substrates, belonging to the sedimentary basin of the lower Tagus. Regarding bioclimatic features, it is thermomediterranean subhumid. At an ecological level, it fits a climatophile characterization, and at a biogeographical characterization, it is on the Ribatagano-Sadense sector. Bearing in mind the scenario mentioned above, a potential natural series of such territories is constituted by native *Quercus suber* agglomeration—the *Aro neglecti-Querco suberis Sigmetum*.

For this project, which has an area of about 1 acre, 70 different plants have been chosen: trees (10), shrubs (30), herbaceous (27), and climbing plants (3)—all of them are native. Some of the plants have adapted well to the local features, such as *Cupressus sempervirens* and the *Juniperus* spp., while others, even with irrigation have shown some difficulties in development. On the other hand, the irrigation inhibited the development of some plants, particularly the ones with dry features, as is the case of the *Thymus serpyllum*.

It is possible to verify that the grass compound used on the project demands high water to maintain the green tone during summer periods, as it is located on Mediterranean clime. If compared to temperate climes, grass does not need such amount of water, as the precipitation distribution patterns are more homogeneous during the year, decreasing the maintenance costs [32].

Through the use of native vegetation, it is possible to reduce the maintenance costs of these areas and also keep some landscape identities such as volume, form, texture, or chromatography of plant material. Furthermore, reducing the number of plants may contribute to a larger unity and spatial integration. Even with the apparent adaptation of some plants to local features, all of them are irrigated daily. By assumption, if the irrigation is cut off, a large amount of these plants will change their behavior, leading to reduced growth or even to their loss, particularly in the summer period.

Taking into account what was assessed, *Quercus* agglomerations are seen as a possible solution for a proper vegetation series selection. These woodlands, inserted into the *Quercetalia ilicis* class, are dominated by *Quercus suber* and elements such as *Smilax aspera* var. *altissima*, *Rubia peregrina* subsp. *longifolia*, *Arum italicum* subsp. *neglectum*. The first step for replacement should be composed by bushes such as *Arbutus unedo*, *Erica arborea*, *Phillyrea angustifolia*, *Daphne gnidium* from the association *Phillyreo angustifoliae-Arbutetum unedonis*. After their disappearance, other typology of vegetation should take its place, such as the *Erico australis-Quercetum lusitanicae ulicetosum welwitschianii*. Furthermore, in considerable relief areas—where the soil is well preserved—it is pos-

[10]EN is the acronym for National Portuguese Road.

sible to find a community dominated by *Cytisus striatus*. Still, regarding deep soils, perennial grassland of *Euphorbio transtaganae-Celticetum giganteae* emerge, aligned with *Herniario maritimae-Coryne phoretum matitimi*; however, this last one should need some "degree" of perturbation to emerge and prepuce [38]. Along with the soil erosion comes the *Thymo capitellati-Stauracanthetum genistoidis*, but still, further North, the *Halimium verticillatum* [39] could also emerge. The farthest replacement step from the vegetation climax is composed of a *Corynephoro macrantheri-Arenarietum algarbiensis* annual grassland.

In **Table 2**, it is possible to contemplate the proposed plants for the project, evidencing a significant number of flowers during spring; this allows some margin for the chromatographic features of the plant material.

5.1.2. Estremoz

The city of Estremoz is 448 m above the sea level—where the oldest geological substrates of the district of Évora are present, dating back to the Precambrian. The soils are complex and may vary by a few meters—in a spatial perspective—consisting of limestone rocks, basic, metamorphic, and acidic, with basic rocks being predominant. Regarding bioclimatology, Estremoz is inserted on thermo-Mediterranean subhumid layers.

Due to the significant soil erosion, climatophile-dominant series (on the regional landscape) are *Rhamno laderoi-Querco rotundifolia Sigmetum*. In the geography, a large and "nocive" anthropic presence can also be observed that is mainly catalyzed by the inadequate agricultural and forestall techniques, causing soil erosion, which allied to low precipitation patterns promote heliophile vegetation and dry vegetation (**Table 3**).

Description	Main replacement steps	Bioindicators
Woodlands	*Aro neglecti-Quercetum suberis*	*Quercus suber, Smilax aspera* var. *altissima, Rubia peregrina* subsp. *longifolia, Arum italicum* subsp. *neglectum*
Maquis scrubland	*Phillyrea angustifolia-Arbutetum unedonis*	*Arbutus unedo, Erica arborea, Phillyrea angustifolia, Daphne gnidium*
Broomland	*Erico-Quercetum lusitanica*	*Quercus lusitanica, Erica scoparia, Ulex australis* subsp. *welwitschianus*
Bushes	Community of *Cytisus striatus*	*Cytisus striatus*
Perennial grasslands	*Euphorbio transtaganae-Celticetum giganteae*	*Celtica gigantea, Euphorbia transtagana, Armeria pinifolia, Arrhenatherum album*
Groundcover	*Hyacinthoido transtaganae-Brachypodietum phoenicoidis*	*Brachypodium phoenicoides, Hyacinthoides vicentina* subsp. *transtagana, Avenula sulcata* subsp. *gaditana*
Scrublands	*Thymo capitellati-Stauracanthetum genistoidis*	*Stauracanthus genistoides, Halimium halimifolium, H. calycinum, Lavandula lusitanica, Thymus capitellatus*
Perennial grasslands	*Herniario maritimae-Corynephoretum maritimi*	*Corynephorus maritimus, Anagallis monelli* var. *linifolia, Sesamoides spathulifolia*
Annual grasslands	*Corynephoro macrantheri-Arenarietum algarbiensis*	*Corynephorus macrantherus, Loeflingia baetica* var. *micrantha, Malcolmia triloba* subsp. *gracilima, Coronilla repanda*

Table 2. Main replacement steps and bioindicators of *Aro neglecti-Querco suberis Sigmetum*.

Description	Main replacement steps	Bioindicators
Woodlands	*Rhamno laderoi-Quercetum rotundifolia*	*Quercus rotundifolia, Olea sylvestris, Jasminum fruticans, Lonicera implexa*
Maquis scrubland	*Myrto communis-Quercetum cocciferae*	*Quercus coccifera, Myrtus communis, Pistacia lentiscus, Pistacia terebinthus*
Broomland	*Retama sphaerocarpa-Cytisetum bourgaei*	*Retama sphaerocarpa, Cytisus scoparia* subsp. *bourgaei*
Perennial grasslands	*Phlomis lychnitis-Brachypodietum phoenicoidis*	*Brachypodium phoenicoides, Phlomis lychnitis, Origanum virens*
Scrublands	*Lavandulo sampaioanae-Cisteum albidi*	*Cistus albus, Lavandula sampaioana, Phlomis purpurea, Teucrium capitatum*
Annual grasslands	*Velezia rigida-Asteriscetum aquaticae*	*Asteriscus aquaticus, Cleonia lusitanica, Velezia rigida, Trachynia distachya*

Table 3. Main replacement steps and bioindicators of *Rhamno laderoi-Querco rotundifoliae Sigmetum*.

In Estremoz, we have selected the Project: "Industrial Zone External Spaces and East Entrance of the Fair and Exhibition Park" [40] for analysis. The space is located in the heart of the industrial grounds, where the accessibility is poor—mainly used by industrial transport, creating an interstitial space in the local urban patterns.

Due to cost containments and for being outside the primary zone of the city, the intervention area needs considerable maintenance—i.e., replanting and plant replacement. In this project, it has been proposed a total of nine vegetal species, among them is the *Rosmarinus officinalis*, native to the flora. Regarding the *arboreum stratum*, we propose *Acer platanoides, Acer platanoides cv. Crimson King* and *Cupressus sempervirens cv. Stricta*. At the shrub level, six plant species have been suggested: *Berberis thunbergii, Cotoneaster horizontalis, Lavandula dentata, Lavandula stoechas, Rosmarinus officinalis*, and *Santolina incana*. A site analysis has enabled to identify several disparities—some relating to the planting plan, as is the case of the replacement of the *Lavandula dentata* with *Lavandula x semidentata* and vegetation gaps, which may have occurred by the bad compatibility of the plants to local conditions.

The proposed vegetation series for this case study shows weak floristic cast in contrast to the previously studied case of Vendas Novas. In this scenario, the destruction of the potential woodland gives a way to a thick bush of *Myrto communis-Quercetum cocciferae*. The second replacement step is composed by *Retama sphaerocarpa-Cytisetum bourgaei*. In deep soils, meadows emerge maintained solely by the presence of the *Phlomis lychnitis-Brachypodietum phoenicoidis*. In derelict soils, a heliophile community of *Lavandulo sampaioanae-Cisteum albidi* emerges. The last replacement step belongs to perennial meadow of *Velezia rigida-Asteriscus aquaticus*.

The project presents a wide, open area, allowing a visual understanding through all the space, verifying only a physical barrier materialized by shrub plants. Still, such barrier is not seen as a critical factor to block the "visual openness" of the space—planting material of higher dimensions would help define space volumetrics and the perception of distance.

Through this case study, it has been possible to verify how the use of local adapted flora—through the natural regeneration of the *Lavandula luisieri*, in the planting area—and also that how the older specimens have given way to new plants that are emerging by seed. This is seen as a contribution toward sustainability of public green spaces—as it may reduce the replacement costs. Being a less complex project that the one analyzed previously, in this case, the chromatography is not as relevant—the interaction is mostly between two opposite colors. Regarding volumetrics, heterogeneity is also present, marked on the south and north space boundaries by *Myrtus communis*, and attenuated by the low volumetrics of *Teucrium capitatum*.

5.2. Discussion

The choice of plant material, regarding landscape architecture projects, should be performed through study and acknowledgement of vegetation series present in each territory. Each replacement step suggested provides a set of typical plants of the evolutionary dynamics of the series—thus properly adapted to local ecological features. Aiming to reach the potential vegetation series of a particular territory, it is pivotal to understand the local edaphoclimatic features, i.e., the thermotypes, the ombrotypes, and biogeography.

However, in the Iberian Peninsula, there are few organizations working with large quantities of native plants, leading to a decrease regarding their demand.

Native plant production is still incipient in Iberian southwest, but still, plant material of local ecotypes should be used, fostering better adaptation to local features. These principles also help avoid importing plants from other countries, such as France or Italy, which despite pertaining to Mediterranean clime would possess different adaptability features. This could be seen a measure to avoid genetic contamination with native material, which would also trigger hybrids less adapted to the studied territory. An example for this would be the introduction of the *Quercus rubra* on Iberian territory, which has caused several issues regarding replacement of native agglomerations of *Quercus robur* subsp. *broteroana*, due to the frequent hybridization between these oaks, modifying the composition of their forest settlements.

6. Final remarks

Through the research, it has been possible to verify the relationship between landscape architecture and phytosociological studies. Such knowledge has as basis sciences as: phytogeography, geology, bioclimatology, and phytosociology that differentiate and define edaphoclimatic features and their distribution on landscape vegetation series. For each series, the integrated dynamic and the main vegetal bioindicators have been studied. Based on the replacement steps (of potential series) plant materials for the analyzed projects have been selected, taking into account the biogeographic distribution patterns of each plant. Framed within Iberian southwest territories, projects have been analyzed—at urban context and periurban context—at the cities of Vendas Novas and Estremoz, aiming to work with different vegetation series.

Contextually, the main vegetation replacement steps for the case studies have been put forward. Through phytosociology pools, it is possible to show the specific floristic cast.

In this regard, such approach should be used more often aiming to value the biodiversity and preserve landscape identity—once it facilitates the plant material chosen regarding biophysical features. Still, some gaps remain on the procedure—mainly related to the reduced offer for these (native) plants on the market. Even if a growth tendency has been verified in the last few years, a number of native plant productions still do not satisfy the actual needs. Thus, decision-makers should carry out policies of territorial sustainability—i.e., control and audit in landscape architecture projects aiming to avoid the introduction of poorly adapted plants to their "new" territories.

Also, at the phytosociological level, a deeper knowledge should be considered, not only regarding vegetation dynamics but also regarding fostering their potential—once currently the distributing of landscape vegetation series do not possess a detailed cartography.

In the same line, it should be highlighted that the biodiversity loss is caused by the increase of "infested" areas by exotic plants—fertile scenario along the Mediterranean Basin—extensive areas dominated by nonnative plants, as is the case of the *Acacia dealbata* and *Ailanthus altissima* [41], difficult to control, demanding high elimination costs.

As final remarks, native plants should be promoted contributing to the preservation of landscape heritage and also toward sustainable spaces and cities.

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