

Article

A Systematic Socio-Ecological Impact/Aptitude Land Planning Assessment Model to Determine the Land Capacity Under Presence of Critical Endemism

Zbigniew-Emil Blesa-Marco ¹, Asunción-María Agulló-Torres ², Francisco-José Del Campo-Gomis ²
and José Navarro-Pedreño ^{3,*}

¹ Agro-Food and Agro-Environmental Research and Innovation Institute (CIAGRO), Miguel Hernández University of Elche, 03312 Orihuela, Spain; zblesa@umh.es

² Agro-Food and Agro-Environmental Research and Innovation Institute (CIAGRO), Department of Agro-Environmental Economics, Miguel Hernández University of Elche, 03202 Elche, Spain; asuncion.agullo@umh.es (A.-M.A.-T.); francis.delcampo@umh.es (F.-J.D.C.-G.)

³ Department of Agrochemistry and Environment, GETECMA, Miguel Hernández University of Elche, 03202 Elche, Spain

* Correspondence: jonavar@umh.es

Abstract: Human activities have a major impact on ecosystems, causing significant changes in the environment. Human activities can lead to a significant alteration and reduction in the variety of species. In the last few decades, there has been a shift in the sustainable approach to land planning and management. This article introduces a novel model for assessing land planning impact/capacity systematically, which takes into account the phytobiological value of a landscape and focuses on conserving and restoring endemic species. The land carrying capacity of a region was assessed for various land uses and potential future situations. The study took place in the province of Alicante (Spain), where the native plant *Vella lucentina* was discovered. Findings showed that only 34% of the proposed activities could be carried out without impacting endemism. There are only two possible activities that could be carried out without affecting endemism, namely scientific-cultural activities and the occasional harvesting of aromatic species. Simultaneously, four activities can be carried out carefully, which are maintaining current activities, restoring ecosystems, planting trees, and managing grazing. Finally, camping, extensive agriculture, and urbanization are three activities that are not compatible with the presence of endemism.

Keywords: endemism; land capacity; land use; phytobiological value; socio-ecological models



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1. Introduction

Persuasive evidence indicates that natural systems are being both degraded and replaced by human artificial surfaces and artifacts at a rate unprecedented in history [1]. These changes have affected the functioning of ecosystems and the environmental services provided. To achieve a balance between human activities and maintaining environmental services is a challenge [2]. The planet has limited resources and cannot provide them indefinitely. This is why, in recent decades, the idea that we need to move towards real development in improving the quality of life of people, sustaining economic development, and respecting the environment, has gained followers in all countries [3]. It is the so-called “sustainable development” that demonstrates the urgent need for its application in all activities. The most widely used definition of this term was coined in 1987 by the World Commission on Environment and Development, chaired by former Norwegian Prime Minister Gro Harlem Brundtland, who defined the concept of sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [4]. To promote human development, in 2000, the United Nations approved the eight Millennium Development Goals for 2015. After

that, the United Nations replaced them with the 17 Sustainable Development Goals (SDGs) included in the 2030 Agenda for Sustainable Development [5].

Land planning could determine the activities that can be developed in a territory and should be closely linked to the complementary dimensions of sustainable development, namely development and social inclusion, sustainable economic growth, environmental protection and management, and the sustainable use of soil [6]. The synergistic integration of these dimensions requires political commitment and the participation of all interested parties [7]. The European Union's thematic strategy on land underlines the need to ensure sustainable land use. This means preventing land degradation, preserving its functions, and restoring degraded land in order to achieve the SDGs [8].

Spatial planning in Europe, under the umbrella of urban planning, started to take shape at the close of the 19th century. Currently, the setup is designed as a spatial planning strategy connected to interests that extend beyond the local level and goals of protecting the environment, moving beyond just urbanization, or at least that is the intention. This vision was described and implemented in the European Union in 1983 through Resolution No. 2 of the European Spatial Planning Charter during the sixth European Conference of Ministers responsible for Spatial Planning (CEMAT), known as the Torremolinos Charter. At this conference, spatial planning was defined as a scientific discipline, an administrative technique, and a policy conceived as an interdisciplinary and global approach whose aim is the balanced development of regions and the physical organization of space according to a guiding concept. The fundamental objectives are the balanced development of the regions, the improvement of the quality of life, the responsible management of natural resources and the protection of the environment, and the rational use of the territory [9].

The roadmap established in 2011 for Europe, based on the efficient use of resources, stated that by 2020, European Union policies should consider their direct and indirect impact on land use. The European Commission has reported that soil degradation is increasing in the EU, thereby reinforcing the need to meet the Sustainable Development Goals (SDGs) [8]. The new actions outlined in the SDGs after 2020 must serve as a reinforcement or improvement of the previous objectives to achieve the desired results for member countries of the European Union.

It is essential to define the objectives and goals of territorial policies for land planning. The objective of spatial plans is to develop an effective territorial organization of land uses and economic demand while protecting the environment and achieving social objectives [10]. It should be noted that the territory is a scarce and limited resource that must be preserved [11]. The conceptualization and systematization of regional planning and land management are described in several studies [12,13]. In Spain, the systematization studies were conducted by Pujadas and Font [14], Benabent [15], and Bielza [16,17], as well as the analyses of regional cases, including Rodríguez-González [18] and Romero and Farinós [19].

When planning land use, it is important to carefully select the best option, taking into account the interests of all stakeholders (both public and private), the existing territorial structure, and environmental, economic, technical, cultural, and social factors. It is crucial to ensure that the suggested options are in line with the current situation while also looking ahead to the future, improving the environment. Projecting future land use and land cover changes (LULCCs) supported by comprehensive scenarios (under different pathways) is especially useful as it may allow for anticipating landscape changes [20].

Although the whole planet is under the risk of climate change effects, arid and semi-arid lands are critically affected [21]. It is crucial to recognize that approximately half of the world's nations have partial or whole territories located in arid or semi-arid zones. These regions are distinguished by the scarcity of precipitation and annual and interannual irregularity, corresponding with a third of the Earth's surface, and they are home to 15% of the global population [22,23]. Land planning should be a tool to improve sustainable development in these critical areas.

Furthermore, the major global problems increased by climate change are the degradation and erosion of soils and the scarcity of water [24]. All the renewable resources of the Earth, the lack of fresh water, and the deterioration of the soil constitute perhaps the most implacable threat to humanity [25]. Therefore, they must be the focus of attention and improvement for future actions for a better land planning. There is a void in the literature regarding how the existence of endemism can affect land planning. This is especially relevant in dry or semi-dry areas, where vegetation's susceptibility to water shortages and soil degradation and erosion is increased. As a result, this article seeks to create an innovative instrument for integrating native species into land use planning, considering environmental and socio-economic aspects.

The main objective of this paper was to develop a systematic impact/apptitude assessment model to determine the land capacity of environmental land units in which a territory can be divided, taking into account the presence of critical endemism and the environmental and socio-economic conditions. In particular, this work aimed to (a) design a new index, called the extended phytobiological value, to consider the implications that the presence of critical local endemism has on land planning/land activities and (b) apply the proposed methodology to demonstrate its validity in conserving a critical endemic species. In this case, the method was applied to a semi-arid area located in the municipality of Monforte del Cid (Alicante, Spain), where the largest population of the endemic shrub *Vella lucentina* has been documented.

This article highlights the lack of land planning models that take into account the effect of a critical endemism on land capacity within environmental and socio-economic conditions. The process of territorial planning is intricate and needs to take into account numerous factors, ultimately incorporating corrective measures that could impact the environment, particularly those grounded in nature. This research includes the assessment of endemism as a key element in the planning process, which should be an essential aspect and influence the following analyses and evaluations for activity implementation in a region. This, in consequence, impacts the spatial organization of a specific region.

2. Description of the Study Area

The study area is located between the Alenda Golf urbanization and the “Sierra de las Águilas y San Pascual” Municipal Natural Park (UTM 30N ETRS89 coordinates: 30S7030004248100; 30S7030004249750; 30S7054004248100; 30S7054004249750) in the municipality of Monforte Cid in the inland of the province of Alicante, Valencian Community, southeast of Spain (Figure 1).

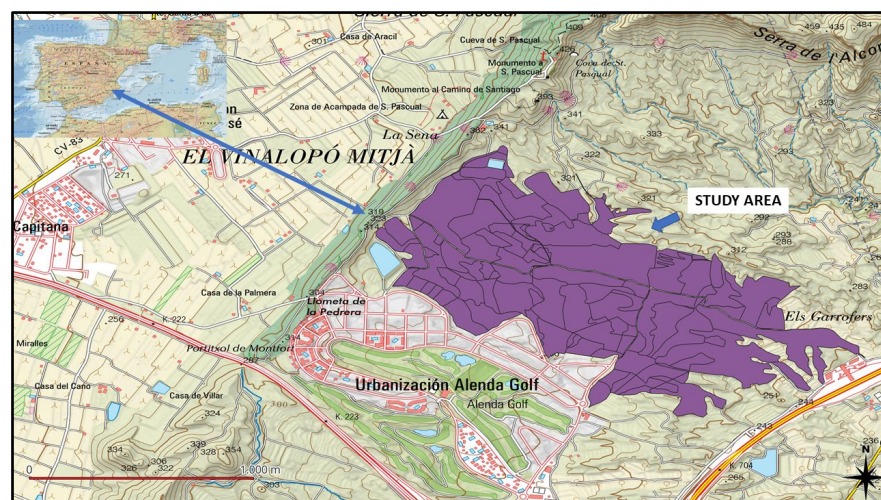


Figure 1. The site of the study area in the province of Alicante, southeast of Spain.

The study area comprises 43 cadastral plots (Figure 2) divided into 121 cadastral subplots. Those are situated in the municipality of Monforte del Cid (Alicante, Spain) and are under the ownership of one company. The area encompasses 1,389,088 m², with 52.9% classified as agricultural use and 47.1% as non-agricultural use (basically scrubs and pastures) [26].

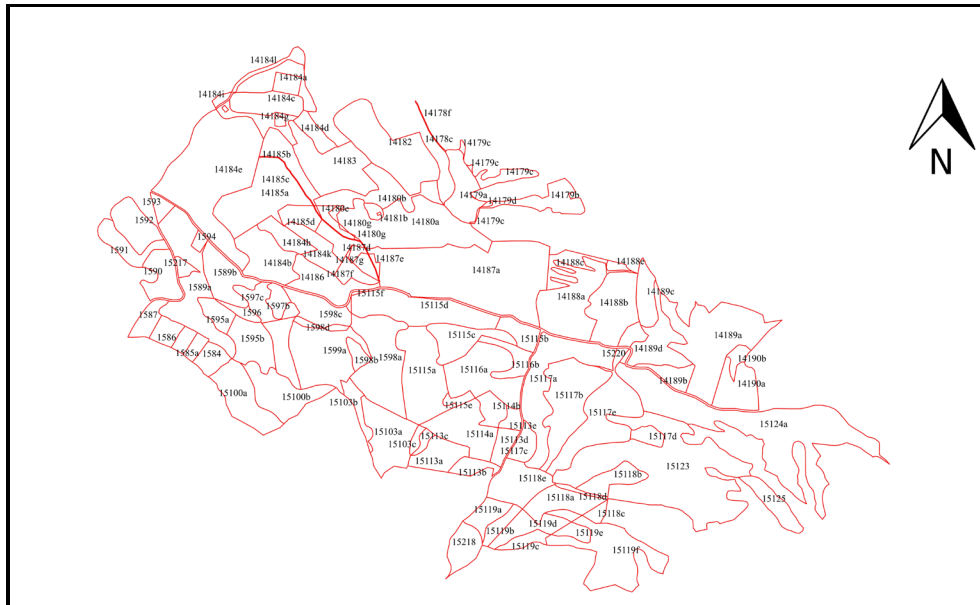


Figure 2. Cadastral subplots of the study area (Scale 1/7500).

The geographical location of the study area and the preparation of thematic maps were based on a collection of orthophotos and a digital terrain model (DTM) from the Spanish National Plan of Aerial Orthophotography (PNOA 2014–2018 CC-BY since.es).

3. Description of the Systematic Impact/Aptitude Land Planning Model

This systematic impact/apptitude land planning model proceeds in two stages. Initially, it is necessary to conduct an inventory of the physical environment of the study area and its connections and interactions with the wider territorial system. This is followed by a diagnosis and territorial analysis, which is divided into three steps. This methodology was applied to the study area as described below.

3.1. Inventory of the Physical Environment

Natural ecosystems are greatly influenced by the physical environment. Hence, the physical environment plays a pivotal role in the maintenance of natural ecosystems [27]. Therefore, it is crucial to have a thorough understanding in order to establish improved use and management strategies. In the southeast of Spain, it is evident that the fragility of the soils in arid and semi-arid environments coupled with the alarming increase in desertification, are directly associated with poor land management practices [28]. So, it is important to design appropriate tools for land planning in critical areas.

To fully understand the environment, different tools were utilized to describe both the non-living and living components of the environment. The abiotic environment included climate, air, water, geomorphology, lithology, erosion, and soil. The biotic environment, on the other hand, encompassed current and potential vegetation, fauna, and species richness.

The rationale behind adopting the physical environment as the foundation for this study is that all factors that comprise the territorial system converge on and interact with it. The role of the physical environment in management is understood in terms of its relationship with human activities, which are also inventoried. All human activities, which are located in the physical environment and are related to it through its inputs or outputs

(materials, wastes, and energy) must form a harmonious, functional, and integrated system. The extent to which this occurs will contribute to a greater or lesser level of sustainability.

3.2. Diagnosis and Territorial Analysis

This part was split into three subsections. Initially, the study area was categorized into environmental land units (ELUs) according to the physical inventory. Next, we analyzed plant endemism to determine the present phytobiological value (PPV) of each environmental land unit based on their current condition. Next, we determined the extended phytobiological value (EPV) index by considering the anticipated endemism in the research area and used it to assess land capacity (LC) for various proposed activities (PAs) within each environmental land unit (Figure 3).

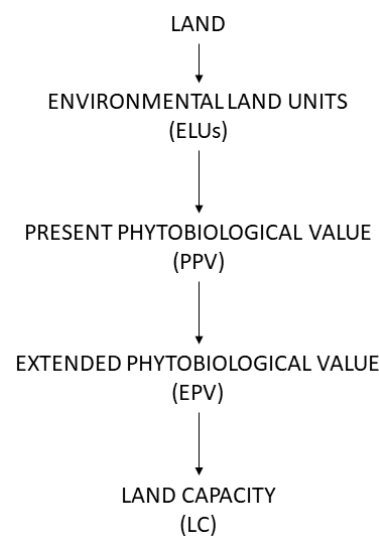


Figure 3. A summary of the process followed for land capacity determination.

The model compares the original model created by Pérez-Latorre et al. [29], which assesses land capacity via the present phytobiological value, with the new model that presents an additional index named the extended phytobiological value for evaluation, according to the presence of endemism. It is reasonable to focus on the existence of species that should be considered as critical factors for land management.

3.2.1. Definition of the Environmental Land Units

The area was divided into different environmental land units, which were created by combining homogeneous cadastral subplots that were also aligned with the legal status of the national cadastral map and are formed by aggregating legal plots to facilitate land planning strategies and serve as a foundation for future activities based on the land capacity. Each of them represents the landscape/ecosystem including soil, vegetation, geomorphology, and land use.

3.2.2. Assignment of the Present Phytobiological Value to Each ELU

The present phytobiological value reflects both the extrinsic and intrinsic valuation of the vegetation landscape represented in the different environmental units. It is calculated according to the methodology proposed by Pérez-Latorre et al. [29]. To ensure consistency between the existing model and the new one, we aimed to preserve the weights of the existing model provided [29].

The initial stage of the assessment of the PPV involves assigning a value to each ELU for all eight parameters, as outlined in Table 1. These values are assessed in three value categories (VCi) designated for the assessment; refer to Table 2.

Table 1. Parameter definition for the initial stage of the assessment.

Parameter	Definition
Singularity	Presence in an area of endemic, relict, and/or threatened taxa and/or communities.
Diversity	Richness that a certain area presents in terms of taxa and plant communities.
Representativeness	Degree of self-definition of the plant communities present in a given area.
Originality	Degree of distinction of the vegetation of an area concerning the vegetation present in adjacent areas.
Landscaping	Degree of contribution of the vegetation as an element to the landscape as a whole within a given area.
Soil protection	Degree of the contribution of the vegetation of a given area to the edaphic stability of the biotype where it lives.
Economic–cultural value	Importance that the vegetation of an area represents for its social environment regarding direct economic benefits, ethnobotanical aspects (traditional uses of plants), and cultural aspects.
Current state of conservation	Degree of conservation (structure, capacity for regeneration, density, diversity, etc.) presented by the vegetation of a given area, understood as a degree of evolution of the vegetation concerning the climatic optimum of the territory.

Source: [29].

Table 2. Value categories for each parameter (VCi).

Parameter	Value Categories (VCi)		
	High (5)	Medium (3)	Low (1)
Singularity	Unique taxa and communities appear.	Unique taxa or communities appear.	No unique taxa or communities appear.
Diversity	Higher than expected.	Within the expected interval.	Below expected.
Representativeness	Some communities are good examples of the phytophenological type.	Some communities sufficiently represent the expected phytophenological type.	Some communities do not represent the expected phytophenological type.
Originality	Rare or very rare vegetation in the environment where they live.	Vegetation is sparsely distributed in the environment where it develops.	Common vegetation in the study area and surroundings.
Landscaping	Vegetation that defines its environment in the landscape complex.	Vegetation that contributes to the richness and quality of the landscape.	Vegetation that contributes little to the landscape structure.
Soil protection	Woody vegetation with any cover on steep slopes (>25%).	Woody vegetation with medium–high cover on slight slopes (<25%).	Annual herbaceous and/or perennial herbaceous vegetation, as well as woody vegetation with low cover.
Economic–cultural value	Widespread industrial, cultural, or ethnobotanical uses.	Specific artisanal, traditional, or ethnobotanical uses.	No known exploitations or cultural or ethnobotanical uses.
Current state of conservation	Communities with characteristic species and remarkable cover, as well as climatic and pre-forest successional steppes.	Communities with sufficient characteristic species or with normal cover and structure, as well as successional scrub and intermediate steppes.	Communities lacking characteristic species or with lower-than-expected cover and structure and the most incipient successional steppes.

Source: [29].

The second step was to assign, according to the biological importance [29], weighting factors (PWFi) for each parameter, as shown in Table 3.

Table 3. Parameter weighting factors (PWF_i).

Parameter	PWF _i
Singularity	2
Diversity	1
Representativeness	1
Originality	0.6
Landscaping	0.6
Soil protection	0.6
Economic–cultural value	0.6
Current state of conservation	1

Source: [29].

In the third step, the absolute presented phytobiological value (APPV) for each environmental land unit was calculated as the sum of the value categories of each individual parameter (VC_i), weighted with the parameter weighting factor (PWF_i).

$$APPV = \sum (VC_i \times PWF_i) \quad (1)$$

The fourth step was to calculate the percentage of present phytobiological value (PPPV) for each environmental land unit as the percentage of the maximum value of the absolute presented phytobiological value (APPV) that can be obtained (which is 37 points, since $37 = 5 \times (2 + 1 + 1 + 0.6 + 0.6 + 0.6 + 0.6 + 1) = 5 \times 7.4$).

$$PPPV = APPV \times (100/37) \quad (2)$$

Finally, the percentage of present phytobiological value (PPPV) allowed us to assign to each environmental land unit a value of the final present phytobiological value (FPPV) according to the categories defined in Table 4. In addition, this table indicates the color used to represent them on the maps, the general use, the loss of heritage, and the land capacity.

Table 4. Final presented phytobiological value (FPPV) categories used in this work.

PPPV	FPPV	Color on the Map	General Use	Loss of Heritage	Land Capacity
81% to 100%	Maximum	Green	Protection	Very high	Very low
61% to 80%	Notable	Blue	Extensive use	High	Low
41% to 60%	Medium	Orange	Extensive use	Medium	Medium
20% to 40%	Low	Yellow	Intensive use	Low	High

Source: [29].

3.2.3. Determination of Land Capacity for Proposed Activities in an Environmental Land Unit

We developed a new index to assess the land capacity for different proposed activities within each environmental land unit. The updated index is notable for incorporating a native plant species as a limiting factor, having a greater impact than other non-native species. Consequently, a new extended phytobiological value was created, with the calculation detailed below. This value emphasized the ecological importance of endemic species in maintaining biodiversity and conservation, the limited area size, and the human effects from the proposed activities. This index is relevant in any circumstance where a species is at risk.

Our initial assumption was that the study area needed to exhibit the endemic species in their natural habitat. As a result, the lack of endemism is considered a disadvantage.

To evaluate this, we established six additional value classifications for each parameter, indicating positive and negative evaluations (Tables 5 and 6). In order to align with the value categories in Table 2, we continued to use the same three-value structure of high, medium, and low. The latest evaluation assigns favorable values to factors that improve land capacity (high +5, medium +3, and low +1) and unfavorable values to factors that diminish land capacity (high −5, medium −3, and low −1).

Table 5. Positive value categories for each parameter (PVCi).

Parameters	Positive Value Categories (PVCi)		
	High (+5)	Medium (+3)	Low (+1)
Singularity	Unique plant taxa and communities.	Unique plant taxa or communities.	Neither taxa nor unique plant communities.
Diversity	Higher than expected.	Within normal.	Lower than expected.
Representativeness	A good example of maximum phytobiological value.	Sufficiently represents the expected phytobiological value.	Does not represent the expected phytobiological value.
Originality	Rare vegetation compared to the underlying area.	Vegetation of scarce distribution concerning the underlying area.	Common vegetation concerning the underlying area.
Landscaping	Vegetation that forms its area in the landscape as a whole.	Vegetation contributes to the richness and quality of the landscape.	Vegetation contributes little to the landscape structure.
Soil protection	Woody vegetation with a slope gradient > 25%.	Woody vegetation with a slope gradient < 25%.	Herbaceous vegetation and woody vegetation with low cover.
Economic–cultural value	Industrial use.	Traditional or ethnobotanical use.	No known use, but with potential capacity.
Current state of conservation	Climax succession.	Characteristic species and dense scrub stratum.	Initial stages of vegetation.

Source: own elaboration.

Table 6. Negative value categories for each parameter (NVCi).

Parameters	Negative Categories of Value (NVCi)		
	Low (−1)	Medium (−3)	High (−5)
Singularity	Taxa and common plant communities.	Taxa or common plant communities	Neither taxa nor common communities.
Diversity	Far below normal.	Distributed in a timely manner.	No natural diversity (gardens, green infrastructure).
Representativeness	Far below the expected phytobiological value.	Phytobiological value distributed in a timely manner (almost negligible).	No phytobiological value, there is no vegetation (artificial soil cover).
Originality	Unusual vegetation in the underlying area.	Alien vegetation and unusual vegetation concerning the underlying area.	Exclusively alien or invasive vegetation.
Landscaping	Vegetation that contributes very little to the landscape.	Vegetation that contributes invaluablely to the landscape.	Vegetation with zero contribution.
Soil protection	Exclusive herbaceous or nitrophilous vegetation.	Herbaceous vegetation of irregular and punctual distribution.	No vegetation.
Economic–cultural value	Punctual loss of traditional or ethnobotanical use.	Total loss of traditional or ethnobotanical use.	Loss of industrial use.
Current state of conservation	Successional stages with degraded vegetation.	Stages of succession of highly degraded vegetation or with alien species.	No vegetation.

Source: Own elaboration.

The second step involved the assignment of parameter weighting factors (PWFi), as shown in Table 4, to each parameter, in accordance with the methodology previously described.

In the third step, we calculated the absolute extended phytobiological value (AEPV) for each environmental land unit and each proposed activity. This was achieved by summing the positive or negative values of the categories of the parameters (PVCi or NVCi), which are weighted with PWFi.

$$\text{AEPV} = \Sigma (\text{PVCi} \times \text{PWFi}) + \Sigma (\text{NVCi} \times \text{PWFi}) \quad (3)$$

In the fourth step, we estimated the extended phytobiological value (EPV) as the result of subtracting from the absolute extended phytobiological value (AEPV) (Equation (3)) the absolute presented phytobiological value (APPV) (Equation (1)) calculated in the previous section.

$$\text{EPV} = \text{AEPV} - \text{APPV} \quad (4)$$

The fifth step was to calculate the percentage of the extended phytobiological value (PEPV) as the percentage of the extended phytobiological value (EPV) with respect to the absolute presented phytobiological value (APPV) calculated in the previous section (Equation (1)).

$$\text{PEPV} = (\text{EPV} / \text{APPV}) \times 100 \quad (5)$$

Finally, the percentage of the extended phytobiological value (PEPV) allows us to assign the final extended phytobiological value (FEPV) to each environmental land unit according to the categories defined in Table 7. Furthermore, this table indicates the color to be used to represent each category on maps, the general use, the loss of heritage, and, most importantly, the land capacity for a proposed activity in each environmental land unit.

Table 7. Final extended phytobiological value (FEPV) categories.

PEPV	FEPV	Color on the Map	General Use	Loss of Heritage	Land Capacity
>+100	Very favorable	Dark green	Protection	Low	High
+100–0	Favorable	Light green	Extensive use	Medium	Medium
0	Indifferent	Yellow	-	-	Indifferent
–100–0	Unfavorable	Orange	Extensive use	High	Low
<–100	Very unfavorable	Red	Intensive use	Very high	Very low

The use of land capacity as a concept for the assessment of ecosystems prior to their utilization and exploitation [30] should be augmented by the incorporation of additional factors, such as the legal status of the land. In this novel model, which incorporates the aforementioned considerations, the land capacity that takes into account the presence of endemism defines the compatibility of the implementation of specific proposed activities within each environmental land unit. This is determined from the final extended phytobiological value (FEPV) (Table 7) in such a way that it can be compatible (positive value), incompatible (negative value), or indifferent (null value) with each activity. As illustrated in Table 7, if the value is negative, it signifies that the proposed activity diminishes the degree of conservation and is incompatible. Conversely, if the value is positive, it implies that the proposed activity enhances the degree of conservation and is compatible.

Finally, the subsequent step was the assignment of land use and management categories to the environmental land units based on the outcomes obtained.

4. Application of the Systematic Impact/Aptitude Land Planning Assessment to the Endemism *Vella lucentina* in Spain

In this section, we apply the methodology to the case of the presence of local endemism of the endemic shrub *Vella lucentina* in land planning based on current land uses in the study area.

4.1. Inventory of the Physical Environment of the Study Area

4.1.1. Inventory of the Abiotic Physical Environment of the Study Area

The study area is a semi-arid environment with a very warm climate, characterized by dry periods and heavy rains in autumn and spring. Consequently, the ecosystem is subject to prolonged periods of water stress, while water erosion occurs during storms. The Martonne Bioclimatic Index of Aridity is a bioclimatic index that indicates that the lower the value of the index, the more arid the climate. It has been calculated for the period (2001–2019), obtaining a value of 11.60, which means a climatic zone of steppes and dry Mediterranean countries.

The Council of the European Union's Directive 91/676/EEC of 12 December 1991 on the protection of water against pollution produced by nitrates from agricultural sources, establishes the obligation to designate as vulnerable areas for nitrate pollution (ZVCN) those that, due to the effects of runoff or percolation, contribute to the contamination above. Monforte del Cid is a municipality designated as ZVCN from agricultural sources (Decree 86/2018, of June 22, of the Valencian Community Council), thus requiring the implementation of prevention measures to reduce nitrate pollution.

The municipality of Monforte del Cid is situated in the transitional zone between the Sub-Betic range corridors and the arid pre-coastal plains of Alicante. The study area is situated at a relatively low altitude, ranging from 233 to 333 m above sea level. The geomorphology of the terrain is largely influenced by the slope of the terrain, which has undergone significant changes. The study area encompasses a variety of soil types, including agricultural terraces and small hills with varying slope gradients, which have led to the formation of scrub areas. The lithology is primarily composed of carbonate rocks, including limestone, sandy limestone, and marly limestone (upper age: Cenomaniense; lower age: Albiense).

In the study area, water erosion is linked to torrential rains, which cause significant transformations and modeling of the morphology of the terrain. Superficial runoff possesses considerable power, which causes the dragging of silty or sandy materials with lower density, which are deposited in depressed areas.

The group of soils, presented in the small elevations that surround the agricultural plots, are Leptosols (soils with limited rooting that are or have been strongly influenced by water). In agricultural plots that have been cultivated for decades, the reference group is Anthrosols, which are soils that have been modified by human activity and have acquired characteristics derived from human activity, in this case, agriculture [31].

4.1.2. Inventory of the Biotic Physical Environment of the Study Area

The area is situated within the Mediterranean biogeographic region, specifically the Western Mediterranean subregion (Ba), the Mediterranean–Ibero Levantine subprovince (Ba1), and the Murciano–Almeriense province (VIII) within the Alicante sector [32–34].

The area exhibits two distinct bioclimatic zones; the majority of the area belongs to a semi-arid meso-Mediterranean zone, while a small portion is situated at the eastern edge of the thermo-Mediterranean zone. The meso-Mediterranean zone represents the mature stage of dense *Quercus* groves, characterized by the presence of various thorns, junipers, pines, and other Mediterranean shrubs. The thermo-Mediterranean floor corresponds to its climax stage as a dense scrub, formed by *Rhamnus lycioides*, *Chamaerops humilis*, *Pistacia lentiscus*, and *Asparagus albus*.

The current vegetation observed in an altered territory is the result of anthropogenic modifications. In this instance, the relatively flat terrain (terrace) is primarily utilized

for rainfed crops, which yield a low quantity (rainfed crops such as almond and olive trees, as well as unproductive areas). In contrast, the slopes of the hills have been maintained with sparse shrub vegetation, with dominant species including *Stipa tenacissima* and *Lygeum spartum*, accompanied by other species such as *Rosmarinus officinalis*, *Teucrium pseudochamaepitys*, and *Helichrysum serotinum*. In the depressed areas, which have a greater soil depth due to the accumulation of sediments, there are small groups of *Pinus halepensis* in conjunction with *Juniperus oxycedrus* and, to a lesser extent, *Pistacia lentiscus*. However, sparse vegetation and the endemic shrub *Vella lucentina* (Figure 4) are often observed in stony soils, often alternating between cultivation plots.



Figure 4. *Vella lucentina*.

The endemism *Vella lucentina* has experienced a significant decline over the past decade, resulting in a precipitous reduction in its population in a relatively short period [35]. This decline can be attributed to the expansion of greenhouse agriculture and the concomitant urbanization process, which have encroached upon and occupied the aforementioned soils. It was first cataloged by Manuel Benito Crespo Villalba in 1992. This plant exhibits physiological and morphological characteristics that are well-adapted to semi-arid conditions and soils with low organic matter. The plant reaches a height of between 30 and 50 cm, with thorny leaves, highly branched stems, yellow flowers with violet veins and four petals (flowering: March–April; fruiting: April–May), and a type of fruit in silique (with a sterile or another fertile tube). With regard to other shrubby varieties, the type of fruit allows the dispersion of seeds to take advantage of the impact of rainwater drops exerted on it and with somewhat significant dehiscence capacity in a very advanced maturation state [35]. It is distributed among the terms of the municipalities of Alicante, Sant Vicent del Raspeig, Agost, Monforte del Cid, and Mutxamel. Previous studies have indicated that the two main populations of this species are found in the areas of Bec de l'Àguila (San Vicent del Raspeig) and Alcoraya (Alicante). The population in Bec de l'Àguila occupies approximately 2.6 km² and is found in habitats within open steppe scrublands and sunny areas or on loam or calcareous clay soils. The species is included in the Valencian Catalog of Threatened Flora Species, Annex II (Order 6/2013 of 25 March of the Department of Infrastructure, Territory and Environment of the Valencian Community), IUCN Category 2018 (EN, very seriously threatened), and the Red List of Vascular Flora as vulnerable (Decree 70/2009 of 22 May of the Valencian Community Council by which the Valencian Catalog of Species is created and regulated). The species is threatened by urban activity and is classified as vulnerable on the Red List of Vascular Flora (Decree 70/2009 of 22 May of the Valencian Community Council).

Figure 5 illustrates the distribution of *Vella lucentina* across the various cadastral subplots within the study area. In certain locations, there is a discernible tendency towards the establishment of this potential vegetation, manifested by the presence of dense scrub vegetation.

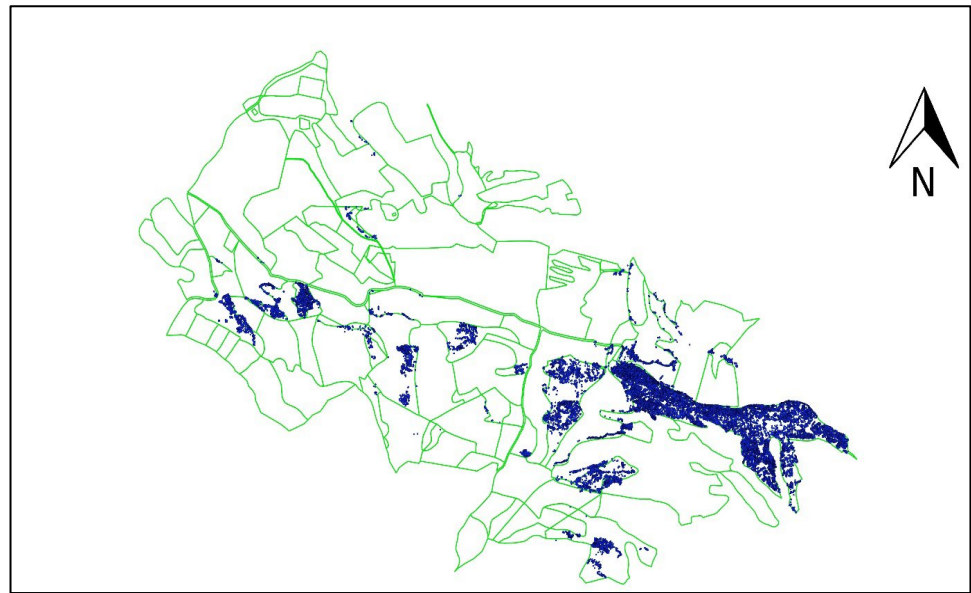


Figure 5. Distribution of *Vella lucentina* in the study area, indicating the position of the endemic plants in the cadastral subplots (pointed in blue).

Additionally, a considerable diversity of fauna was identified, given that the landscape is heterogeneous in its use, which facilitates the creation of different potential niches for a wide variety of species.

4.1.3. Inventory of Human Activities in the Study Area

The municipality of Monforte del Cid had in 2019 a population of 8165 inhabitants and a density of 95.5 inhabitants per square kilometer [36]. The municipality has experienced positive population growth in recent decades, reflecting the positive impact of its development. The economy is centered around the bagged table grape from Vinalopó, which has had a protected designation of origin (PDO) since 1988 [37]. Additionally, ornamental stone factories produce, together with the rest of the nearby municipalities in the region, 60% of the total production of marble in Spain. The region is notable for its artisan and traditional liquor production, which has been carried out since the 19th century. Additionally, it is home to two golf resorts, Alenda Golf and La Font del Llop Golf, which offer 18-hole courses. The Alenda golf urbanization was developed in close proximity to the study area. It commenced in 2002 and has experienced exponential growth in recent years. The population of the area is currently estimated at approximately half a thousand individuals [38].

The legal framework is determined by the General Urban Plan of Monforte del Cid of 2003, which designates the area as developable land for the expansion of Alenda urbanization (for single-family or multi-family residential use), with industrial and tertiary uses prohibited [39]. In the Alenda Partial Plan, the location of green areas and free spaces around the area for the preservation of *Vella lucentina* is prioritized. However, the species is currently out of its original distribution range. Therefore, a revision of the Alenda Partial Plan is necessary to adapt to the new distribution and conditions in order to preserve the species.

4.2. Diagnosis and Territorial Analysis of the Study Area

4.2.1. Definition of the Environmental Land Units of the Study Area

Following the inventory, we established six environmental land units that are represented in Figure 6 and described as follows:

1. Environmental Land Unit 1 (ELU1): The formation of marginal grassland. This unit comprises perennial species (mainly nitrophilous and sometimes woody perennials)

located on the margins of cultivation plots and composed of annual species mainly of the genera Graminaceae, Malvaceae, and Chepodiaceae.

2. Environmental Land Unit 2 (ELU2): The formation of Aleppo pine forest with sparse woodland (forest). This unit is characterized by the presence of shrubby species that comprise the understory, with tree species also present in areas of use for pastures or scrub, with medium coverage. The Aleppo pine (*Pinus halepensis*) is the dominant tree species, comprising 65% of the total cover. Among the most frequent species is the *Vella lucentina*.
3. Environmental Land Unit 3 (ELU3): The formation of Aleppo pine forest with sparse woodland (forest). Formed mainly by shrubby species and, to a lesser extent, by tree species, located in pasture areas with medium vegetation coverage. The main tree species are the Aleppo pines (*Pinus halepensis*) with uniform distribution, close to 75% of the total tree cover. Among the most frequent species is the *Vella lucentina*.
4. Environmental Land Unit 4 (ELU4): The formation of dispersed Aleppo pine forest with sparse woodland (forest). Formed mainly by shrubby species, located in the areas of pastures and scrub. The main tree species are the Aleppo pines (*Pinus halepensis*) with irregular discontinuous distribution. Among the most frequent species is the *Vella lucentina*.
5. Environmental Land Unit 5 (ELU5): The formation of grassland–scrubland, constituting of shrubby and herbaceous species, is observed in areas with land cover of scrub–grassland and areas of agricultural use (almond trees and some vineyards) that have been abandoned, with low coverage.
6. Environmental Land Unit 6 (ELU6): The formation of pasture–scrubland, which comprises shrubby and herbaceous species, occurs in areas with a medium level of vegetation coverage.

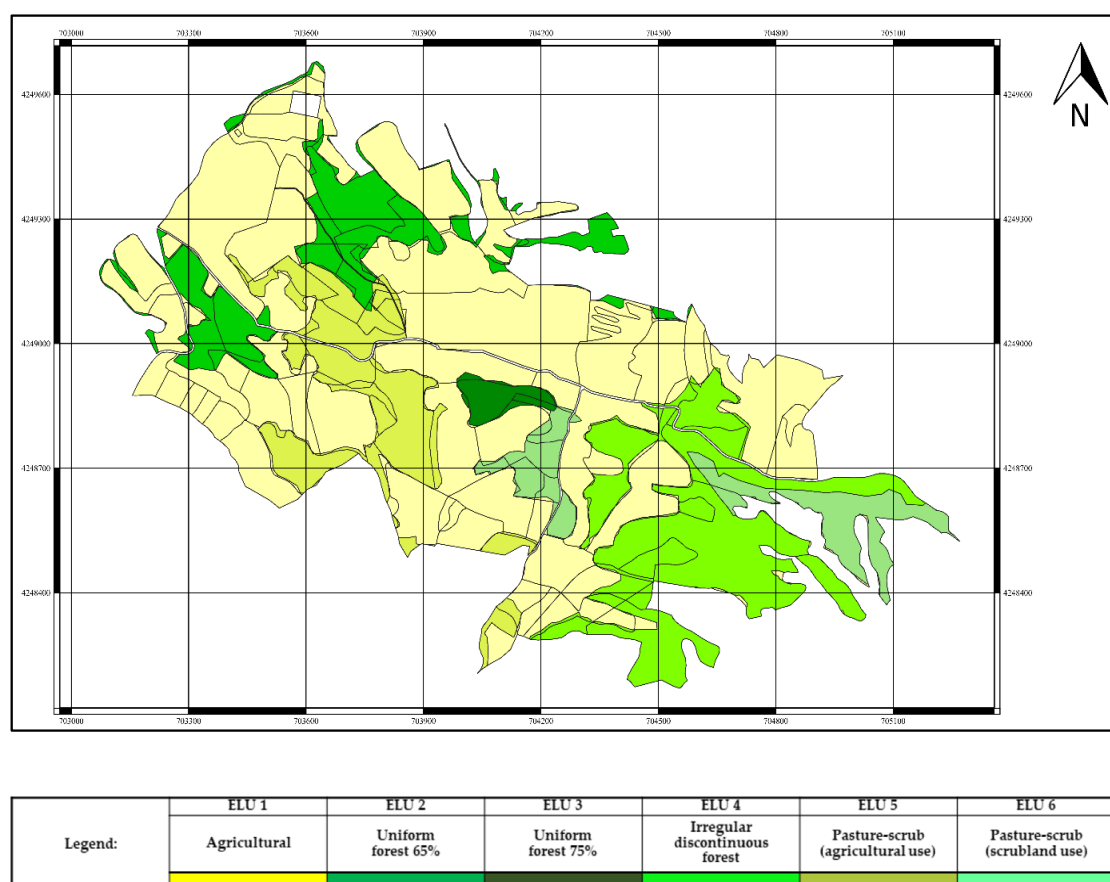


Figure 6. Environmental land unit types of the study area.

4.2.2. Unit Assignment of the Present Phytobiological Value Associated with Each Environmental Land Unit of the Study Area

The final present phytobiological value (FPPV) of the different environmental land units was obtained according to the methodology described in Section 3.2.2. and the results are presented in Figure 7.

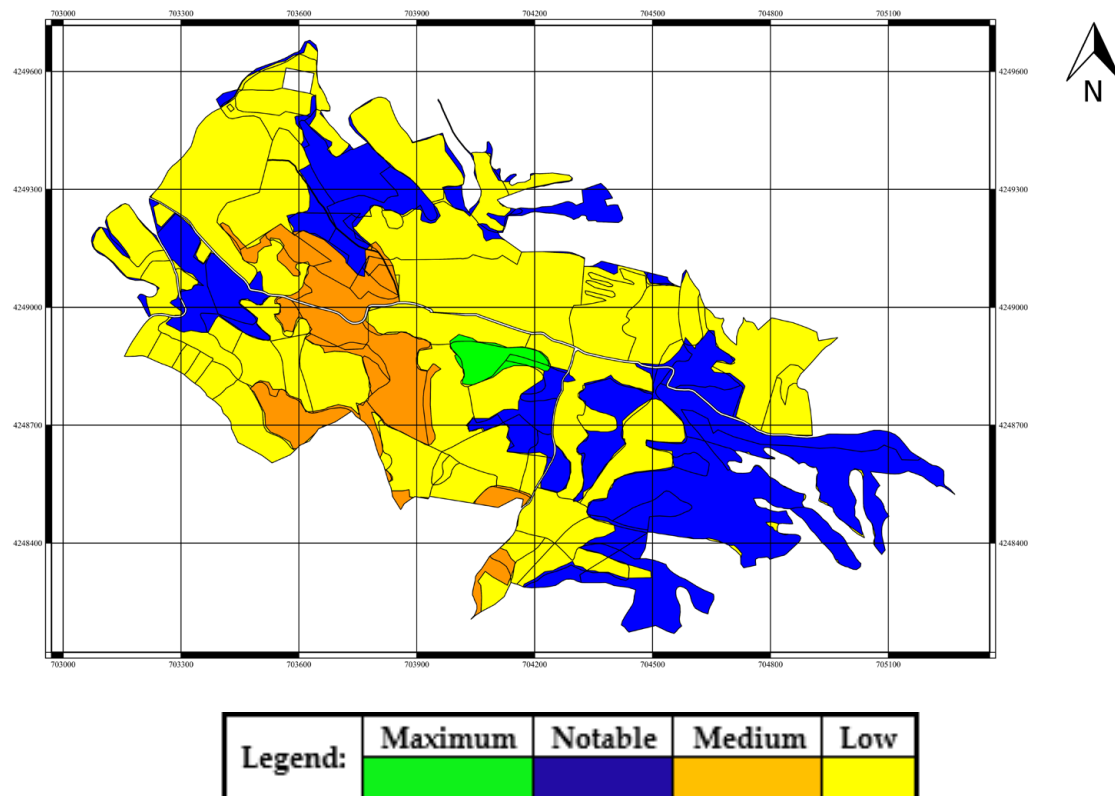


Figure 7. Map of the final present phytobiological value (FPPV).

It can be observed that only ELU3 has a maximum value, while ELU2, ELU4, and ELU6 have notable ones. However, the least valued were found in ELU5, with a medium value, and ELU1, with a low value.

4.3. Determination of Land Capacity for Proposed Activities in Each Environmental Land Unit of the Study Area

Firstly, we consider the following nine proposed activities to develop in the study area, after the exclusion of industries and hunting due to legal restrictions on establishing such activities in proximity to a residential area, such as Alenda Golf:

1. Strict maintenance of current activities (SM): This option entails the maintenance of the current situation and its evolution without human intervention or minimal intervention, with a focus on strictly cultural and scientific use. The areas in question would be worthy of establishing more restrictive protection figures, such as a declaration of a micro-reserve or inclusion within the municipal natural park.
2. Ecosystem regeneration (ER): treatments capable of redirecting the area to apply it to its original situation or other more valuable balances.
3. Scientific-cultural activities (SAs): use of the environment for cultural experiences or scientific research for the dissemination of knowledge.
4. Reforestation (RF): the planting or seeding of tree species selected according to ecological and/or landscape criteria, with the objective of conserving nature and landscape, is a further option.

5. Camping or recreation (CR): the fixed installation of infrastructure equipped with services.
6. Occasional collection of aromatic species (AS): this refers to the occasional collection by the inhabitants of the area following the recommendations of the environmental authority, which is intended to recover traditional use.
7. Extensive agriculture (EA): this type of practice involves the construction of buildings linked to the exploitation and adaptation of the landscape, etc.
8. Intensive grazing (IG): Cattle grazing outdoors on degraded grassland or scrub.
9. Urbanization (UR): Single-family residences are constructed on medium-sized and contiguous plots. In addition to the construction of the house itself, urbanization entails the installation of sanitation facilities, power lines, and other infrastructure.

Figures 8–10 show the results obtained for the final extended phytobiological values (FEPVs) associated with each proposed activity and environmental land unit.

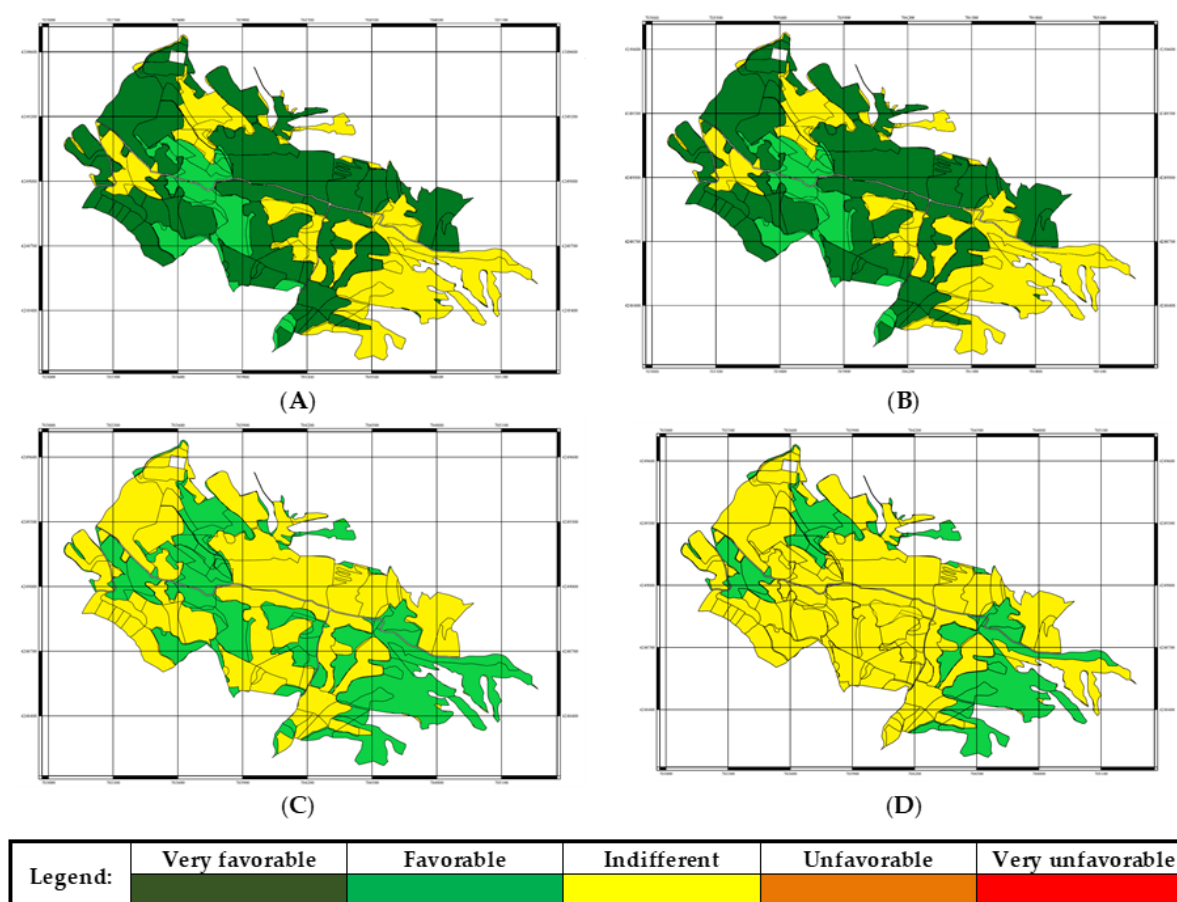


Figure 8. Map of the final extended phytobiological value (FEPV) for the strict maintenance of current activities (SM) (A). Map of the final extended phytobiological value (FEPV) for ecosystem regeneration (ER) (B). Map of the final extended phytobiological value (FEPV) for scientific-cultural activities (SAs) (C). Map of the final extended phytobiological value (FEPV) for reforestation (RE) (D).

The results of the previous inventory phase indicate that the study area exhibited optimal conditions for the endemic species *Vella lucentina*. Consequently, Table 8 presents the results obtained for the land capacity of each environmental land unit based on the presence of *Vella lucentina* as a singular element to be conserved, which we discuss below.

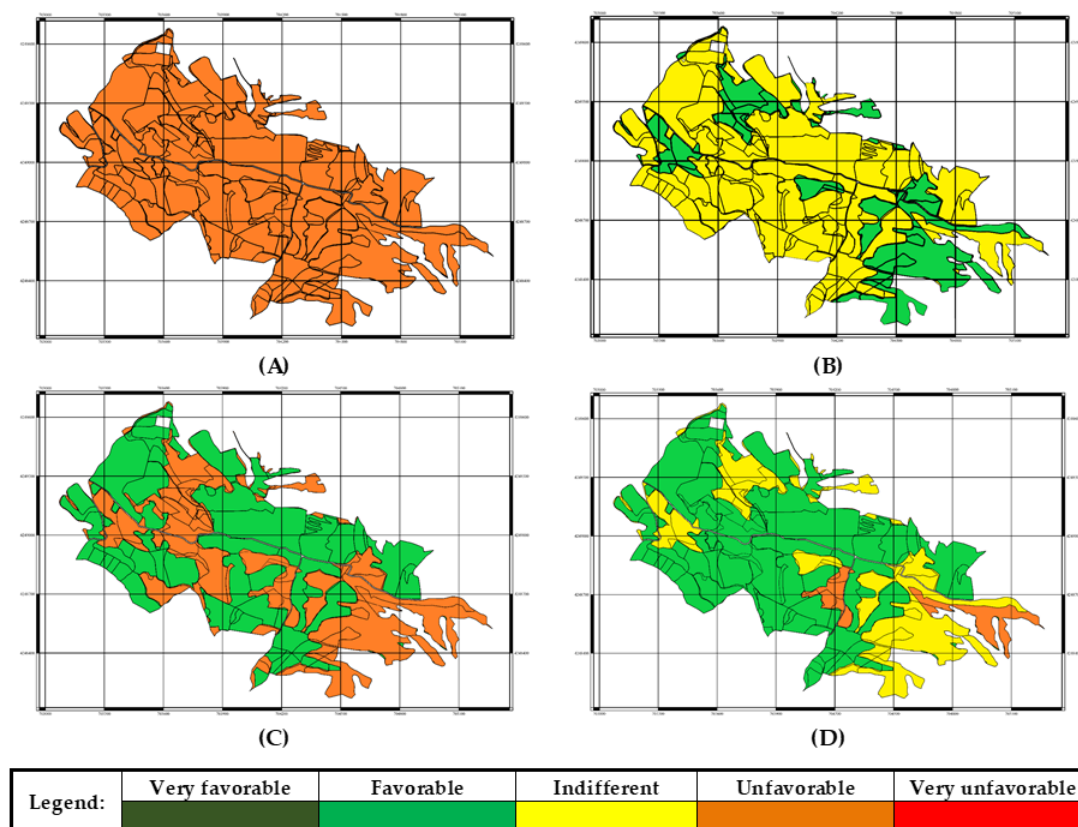


Figure 9. Map of the final extended phytobiological value (FEPV) for camping or recreation (CR) (A). Map of the final extended phytobiological value (FEPV) for the occasional collection of aromatic species (AS) (B). Map of the final extended phytobiological value (FEPV) for extensive agriculture (EA) (C). Map of the final extended phytobiological value (FEPV) for intensive grazing (IG) (D).

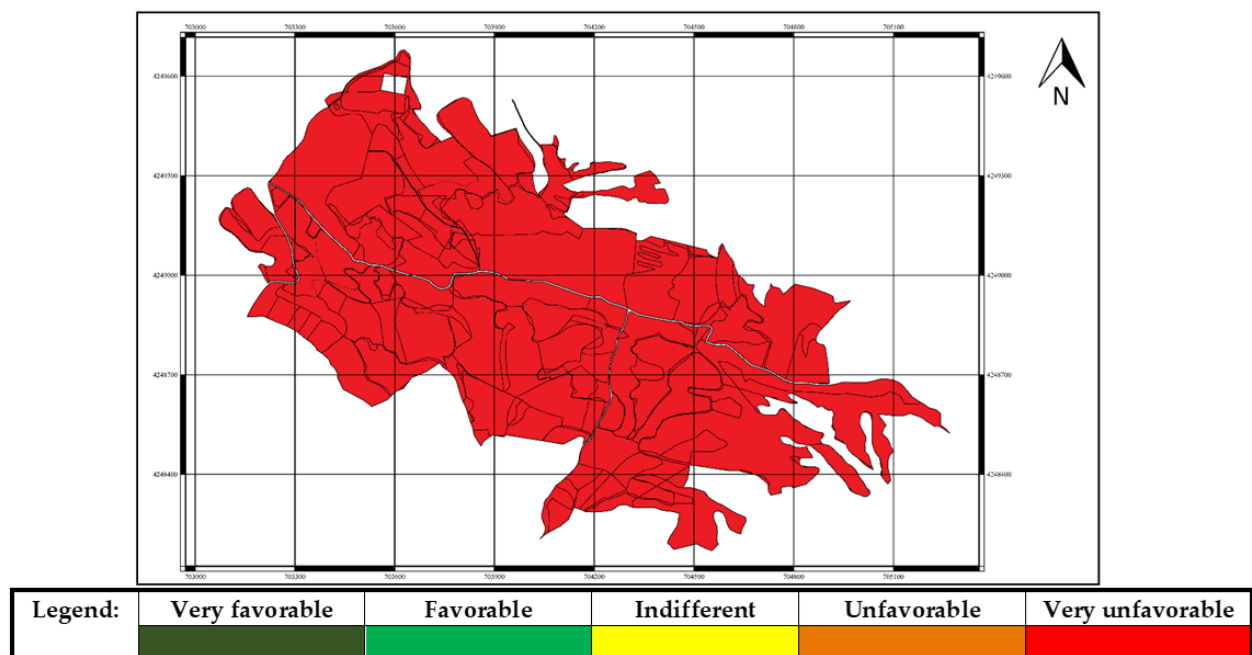


Figure 10. Map of the final extended phytobiological value (FEPV) for urbanization (UR).

Table 8. Land capacity of each environmental land unit for proposed activities.

Proposed Activity (Name and Acronym)		Land Capacity					
		ELU1	ELU2	ELU3	ELU4	ELU5	ELU6
Strict maintenance of current activities	SM	H	I	I	I	M	I
Ecosystem regeneration	ER	H	I	I	I	M	I
Scientific–cultural activities	SA	I	M	M	M	M	M
Reforestation	RF	I	M	I	M	I	I
Camping or recreation	CR	L	L	L	L	L	L
Occasional collection of aromatic species	AS	I	M	M	M	M	I
Extensive agriculture	EA	M	L	L	L	L	L
Intensive grazing	IG	M	I	I	I	M	L
Urbanization	UR	VL	VL	VL	VL	VL	VL
Legend:		High	Medium	Indifferent	Low	Very Low	

- Land capacity of Environmental Land Unit 1 (ELU1): This unit exhibited a high land capacity for the strict maintenance of current activities (SM) due to the recovery of its own scrub and for ecosystem regeneration (ER) by restoring the potential natural vegetation. The land capacity was classified as medium for extensive agriculture (EA) and for intensive grazing (IG) due to the lack of abundant scrub vegetation in these areas. The land capacity was classified as low for camping or recreation (CR) and very low for urbanization (UR) due to the impact generated by the construction of the various infrastructure that are needed in each case. However, these activities would generate a positive economic impact in the territory.
- Land capacity of Environmental Land Unit 2 (ELU2): The land capacity is medium for scientific–cultural activities (SAs), reforestation (RF), and the occasional collection of aromatic species (AS) activities. Scientific–cultural activities (SAs) could play a role in improving the understanding of ecosystem functioning. Reforestation (RF) could improve and preserve the formation of corpses in the area, maintaining the ecosystem of sclerophyll scrub and thus improving its soil protection and landscaping. The occasional collection of aromatic species (AS) would be beneficial when promoting socio-economic activity in the environmental unit, provided that the balance of the ecosystem is not altered. The strict maintenance of current activities (SM), ecosystem regeneration (ER), and intensive grazing (IG) has an indifferent impact. Camping or recreation (CR) and extensive agriculture (EA) have a low value for land capacity, resulting in a certain impact on the unique elements of the territory. This included a partial loss of the sclerophyll scrub, a certain impact on the landscaping, and loss of conservation status. Conversely, it has a certain positive economic effect on the territory. It is therefore recommended that these types of activities should be established in other land units with a greater land capacity. Finally, with regard to urbanization (UR), the land capacity value is very low.
- Land capacity of Environmental Land Unit 3 (ELU3): The land capacity is comparable to that of ELU2, with the exception of reforestation (RF), which is inconsequential in this instance given that the climax of vegetation has already been reached. It is noteworthy that the loss of phytobiological value will be somewhat higher in this environmental land unit than in the previous ones. The land capacity value is medium for scientific–cultural activities (SAs), which could play a role in improving our understanding of ecosystem functioning, and for the occasional collection of aromatic species (AS), which could generate an economic benefit for society.
- Land capacity of Environmental Land Unit 4 (ELU4): In absolute values, ELU4 behaves in a manner similar to ELU2. As with ELU2, reforestation (RF) would enhance the reception capacity by an average value due to the sustainable maintenance of the tree

masses. The scientific–cultural activities (SAs) and occasional collection of aromatic species (AS) have a mean value, and the reason for this is the same as that observed in ELU2. In the case of camping or recreation (CR), extensive agriculture (EA), and urbanization (UR), these activities exhibit the lowest value of land capacity. The establishment of these land uses could potentially result in adverse impacts, including the loss of landscaping (even leading to its complete transformation in the case of urbanization (UR)), the loss of soil protection (the soil would be partially or entirely devoid of vegetation, including its complete sealing), and the loss of the current conservation status of the endemic *Vella lucentina*.

- Land capacity of Environmental Land Unit 5 (ELU5): In absolute terms, ELU5 exhibits similarities to ELU2. The distinguishing features between both are observed in the successional dynamism of vegetation in an intermediate stage of the vegetation series, grassland–scrubland. The strict maintenance of current activities (SM) and ecosystem regeneration (ER) have a medium value, with the potential to improve the shrubby and herbaceous state to more complex vegetation stages. Scientific–cultural activities (SAs) also has a medium value, with the potential to generate an increase in scientific technical knowledge of the functioning of ecosystems and a greater concern for the conservation of unique endemism. The occasional collection of aromatic species (AS) and intensive grazing (IG), ensuring that they do not result in the regression and deterioration of the grassland–scrubland, would generate economic and cultural value in the area. In the case of extensive agriculture (EA) and camping or recreation (CR), although these activities would also generate economic and cultural value in the area, they would result in a considerable decrease in the associated phytobiological value, such as the loss of landscaping and uniqueness.
- Land capacity of Environmental Land Unit 6 (ELU6): In absolute terms, ELU6 yielded comparable results to ELU3, with the exception of the case of the occasional collection of aromatic species (AS) and intensive grazing (IG). The reduction in land capacity is influenced by a decline in the parameters associated with landscaping, soil protection, and the current state of conservation of the endemic *Vella lucentina*.

Summarizing, the land capacity for the 54 proposed activities in the entire study area (nine activities for each of the six defined ELUs) is indifferent for 33% (18), medium for 30% (16), low for 22% (12), very low for 11% (6), and high for 4% (2). These mean that only 34% of the proposed activities can be carried out with no problems to endemism (those with a high or medium values), although it could be extended with great caution to the 33% of those who have a value of indifferent.

The two proposed activities that can be introduced in the study area with very few restrictions are scientific–cultural activities (SAs) and the occasional collection of aromatic species (AS), because both activities have medium and indifferent values, respectively. Four additional activities could be introduced with caution in the study area, as they present several indifferent values that could become negative at any time, namely the strict maintenance of current activities (SM) (four indifferent, one high, and one medium), ecosystem regeneration (ER) (four indifferent, one high, and one medium), reforestation (RF) (four indifferent and two medium), and intensive grazing (IG) (three indifferent, two medium, and one low). Finally, three activities are incompatible with endemism in the study area, namely camping or recreation (CR) (five low), extensive agriculture (EA) (four low and one medium), and urbanization (UR) (five very low).

Finally, the last step would entail the assignment of land uses by management category to each environmental land unit based on their land capacity. The primary concern that needs to be addressed is to prioritize the preservation of the species and to undertake only actions that do not lead to a decrease in the plant population. Consequently, the evaluation of the extended phytobiological value serves as an instrument that restrains future activities in the assessed area. However, this is a decision that falls within the purview of municipal, local, and regional authorities and the balance between environmental conservation, social,

and economic factors. This new model facilitates this task and favors the adoption of good strategies.

5. Conclusions

The future scenarios for land management and use of the territory will depend on the measures adopted by stakeholders and interested parties, especially local and regional administrations. The model applied should minimize phytobiological value losses, which are an important index of environmental health and could be an indicator of ecosystem services, as biodiversity is also crucial to ecosystem services. Any anthropogenic action in the natural environment will generate a proportional negative effect; therefore, it is necessary to decide on a sustainable way to use the territory. For this purpose, the application of the systematic impact/apptitude model for land planning, which aims to determine the land capacity of an activity in a particular environment, could be of significant benefit. However, it should be noted that its current design is intended for areas with the presence of endemic species. In the future, efforts may be made to enhance the model so that it can be effectively applied in other types of areas with varying vegetation.

Regarding the application of this methodology to the study area, it is evident that the potential distribution of a singular element (plant endemism) must be considered prior to the implementation of new activities in the study area. The implementation of new activities has the potential to result in the loss of phytobiological value. However, it is possible to identify instances where some activities, principally scientific–cultural activities (SAs) and the occasional collection of aromatic species (AS), could be considered in response to the situation of the endemic species, as evidenced by the case of the *Vella lucentina*.

One constraint of the study is that the model was only used on a small parcel of land where the variations in environmental land units are not significant. Therefore, we suggest that the model could be more successful in bigger regions. The errors primarily stem from the subjective nature of the model and certain evaluations used to analyze each parameter. This suggests that this new model is a first step towards creating a more objective model based on data, not opinions. As a result, upcoming studies may focus on developing a quantitative model that reduces the reliance on subjective evaluations in analyzing land capability. Moreover, new considerations will be studied with the analysis of ecological impact indicators, such as biodiversity change and soil quality change, that will complement this research, and a detailed social and economic analysis will be conducted, which can lead to the adoption of nature-based solutions to reduce the impact of human actions.

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