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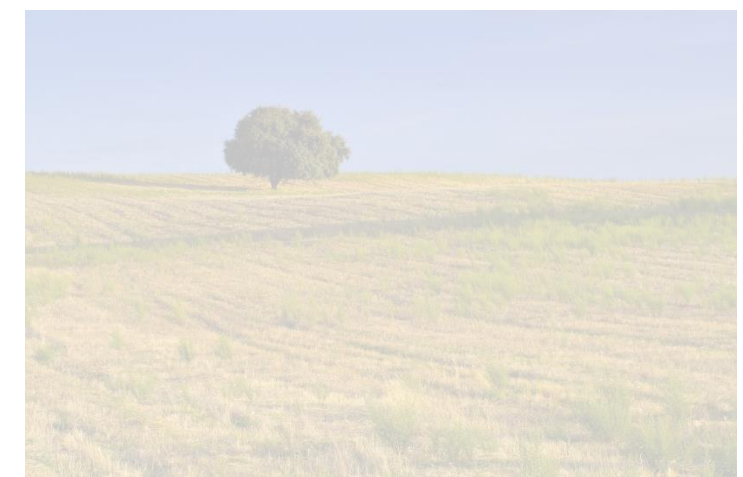
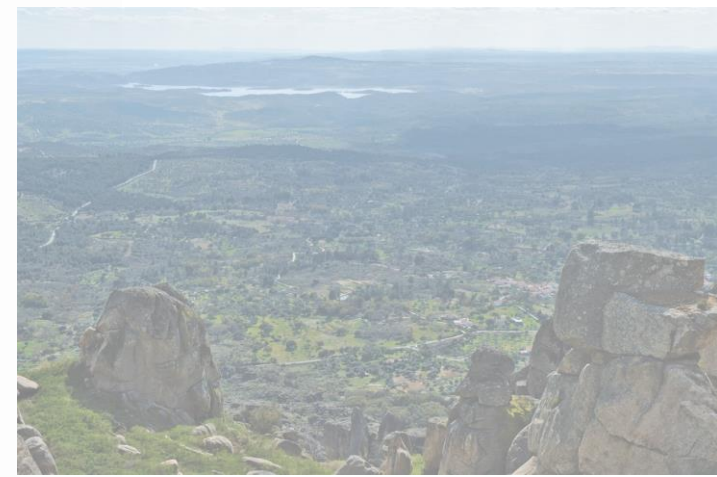
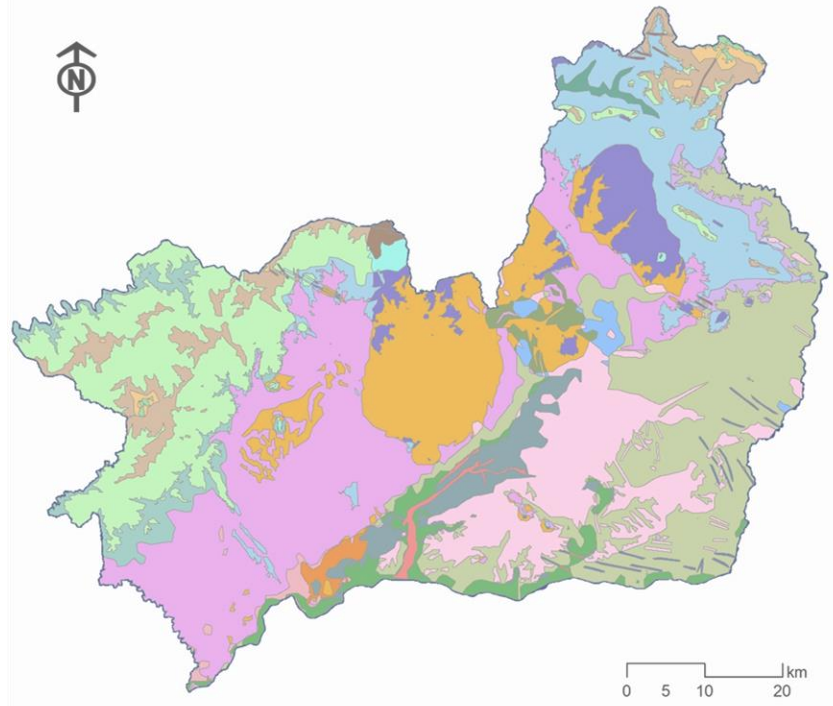
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DEFINITION OF LAND UNITS AT A REGIONAL LEVEL AND THE STUDY OF ITS INFLUENCE IN THE LAND USE MOSAIC



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Objetives

The study aimed primarily at defining the potential layer and their **land units** at a regional level resulted from the combination of geomorphology, soil parent material and bioclimatic influence. Subsequently, it is intended to relate the obtained **land units** with the **landscape configuration** extracted from the land use mosaic.

The spatial analysis was performed using **GIS geoprocessing tools**. Landscape configuration was quantified through a wider set of landscape metrics.

A cluster analysis was performed to define groups of samples representing the **land use mosaic types**, and the clusters obtained were analyzed in order to identify **similar geometrical characteristics** and **land use dominant types**.



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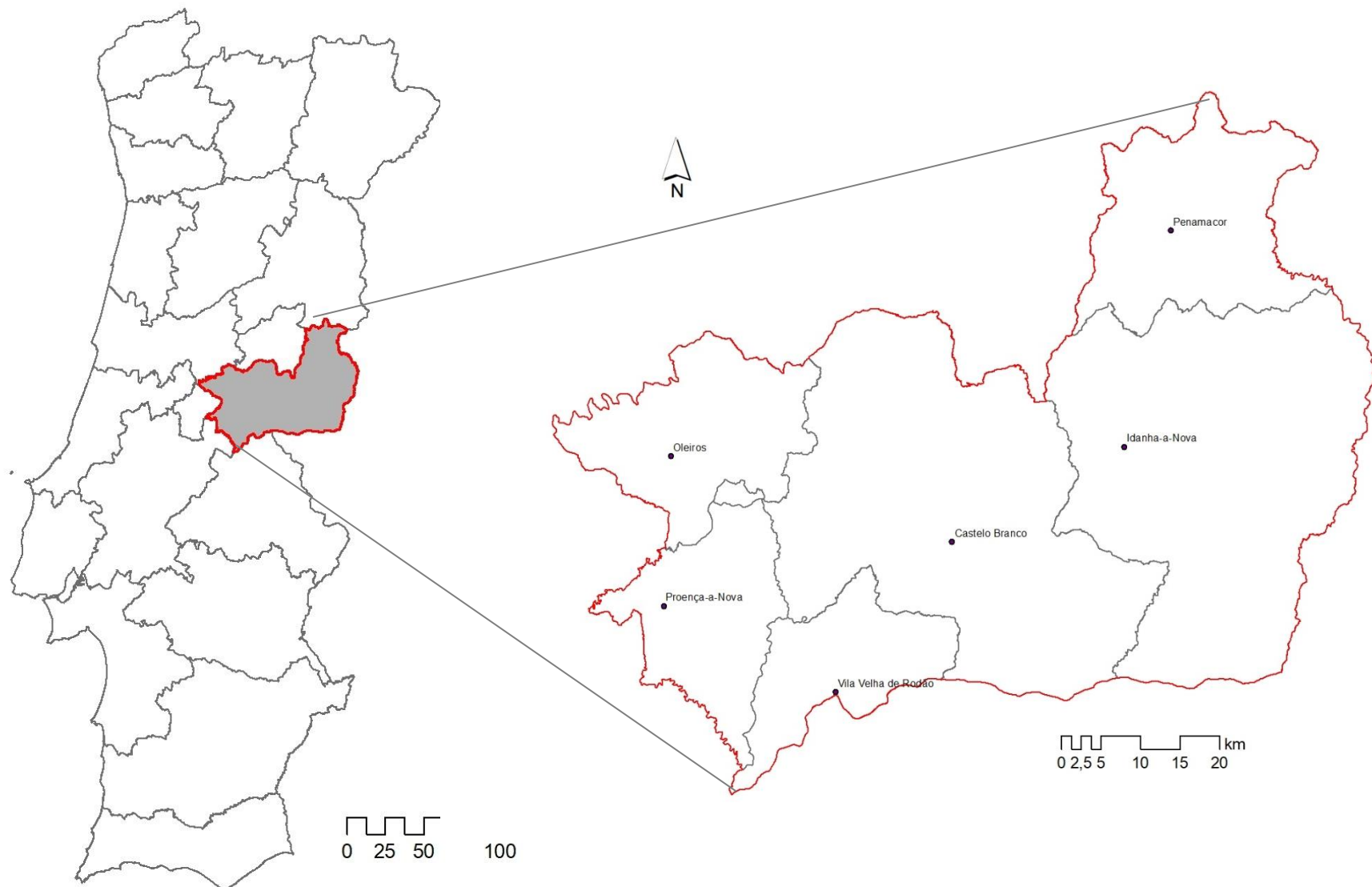
Study area

The Beira Baixa region is an administrative division in eastern Portugal

The region covers an area of 4,614.6 km² and has a population of 84,046 inhabitants.

The area is mainly occupied by forest and agroforestry uses (60.8 %) and agriculture (36.2 %).

The climate is mainly characterized by a warm temperate, Mediterranean climate with a distinct wet season in winter.



Material and methods

All layers were combined and interpreted using the **ArcGIS 10.8** geoprocessing tools. The Land Units Map was obtained by overlaying the thematic maps representing the main physical factors, namely soils, bioclimatic units, and elevation.

Spatial data sets:

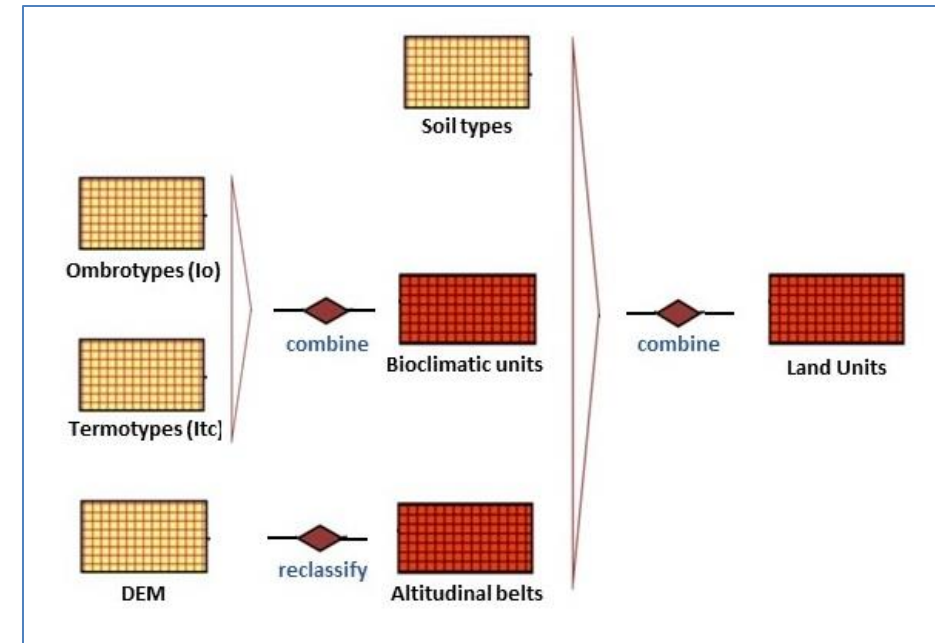
Digital Elevation Model - Shuttle Radar Topography Mission (NASA and NSA, 2016)

Bioclimatological indices maps (Io / Itc) - Monteiro-Henriques (2016)

Map of soil parent material types - Monteiro-Henriques (2016)

Land Cover Map COS2018 - DGT (2020)

Land Use Mosaic geometry was analyzed using **Patch Analyst extension** from **ArcGIS 10.8** on the Land Cover map, characterizing its composition and configuration. This extension includes measures related to patch complexity, configuration, and landscape diversity.



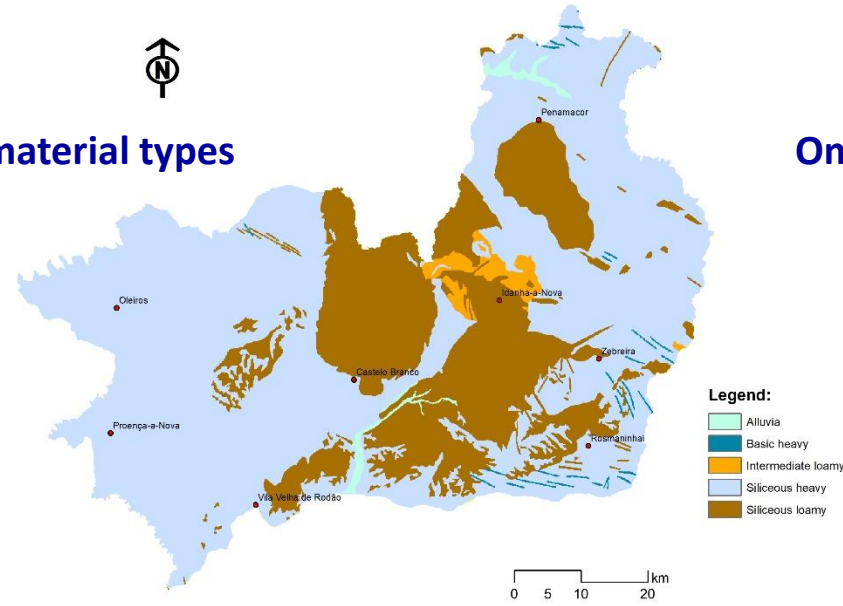
Spatial model

Material and methods

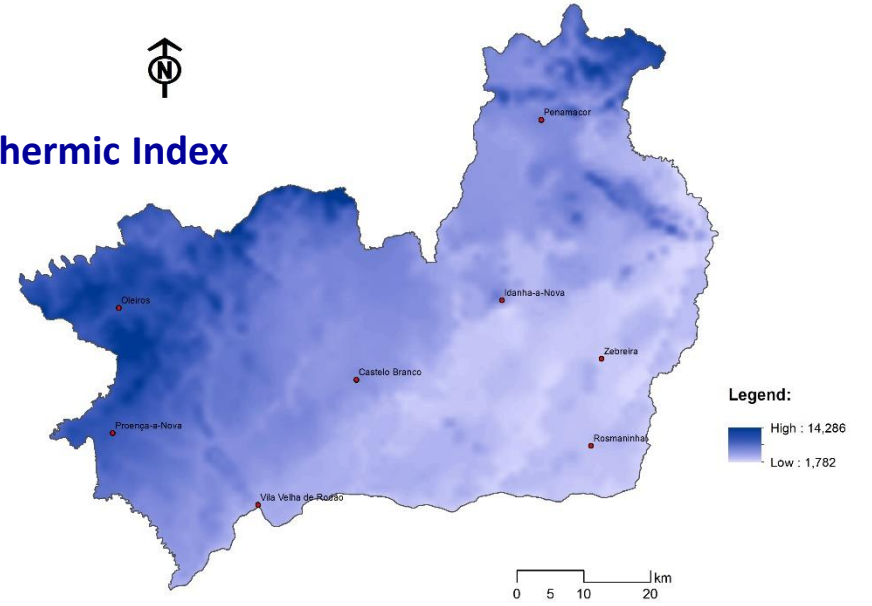
- The **bioclimatological indices** included in the analysis are those proposed in the **World Bioclimatic Classification** (Rivas-Martínez, 2011), and influence the spatial distribution of species' populations and communities. To obtain the Bioclimatic units map the Spatial Analyst Tool was used to combine the raster themes **ombrotypes** and **thermotypes**.
- **Soil richness and texture** is greatly related to the **chemical composition and texture of the parent material**. The map of soil parent material types represents different richness-textural classes based on the richness in SiO_2 , K and Ca of the different rock formations and on grain size.
- **Altitudinal zonation** describes the natural layering of ecosystems that occurs at distinct elevations due to varying environmental conditions (McVicar and Körner, 2013). Decreasing air temperature usually coincides with increasing elevation, which directly influences the species' composition in mountain areas.



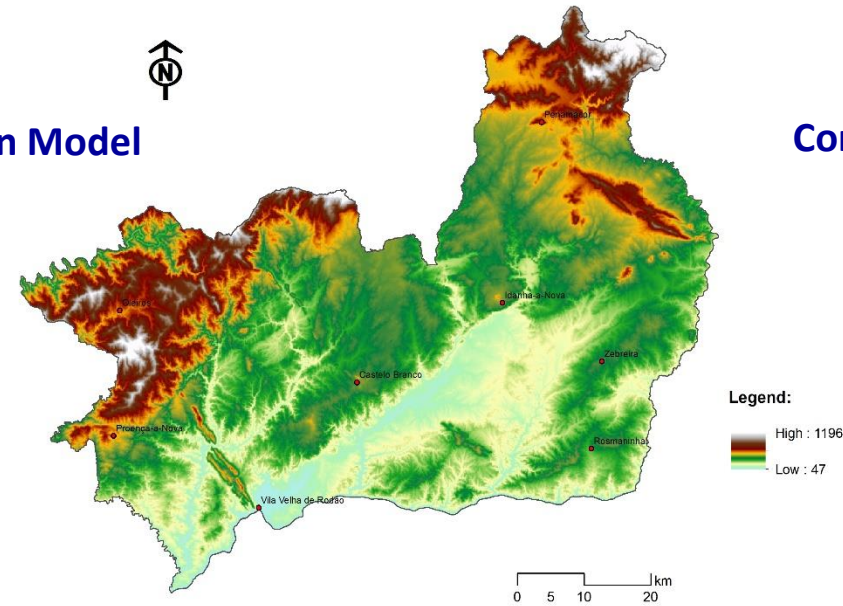
Map of soil parent material types



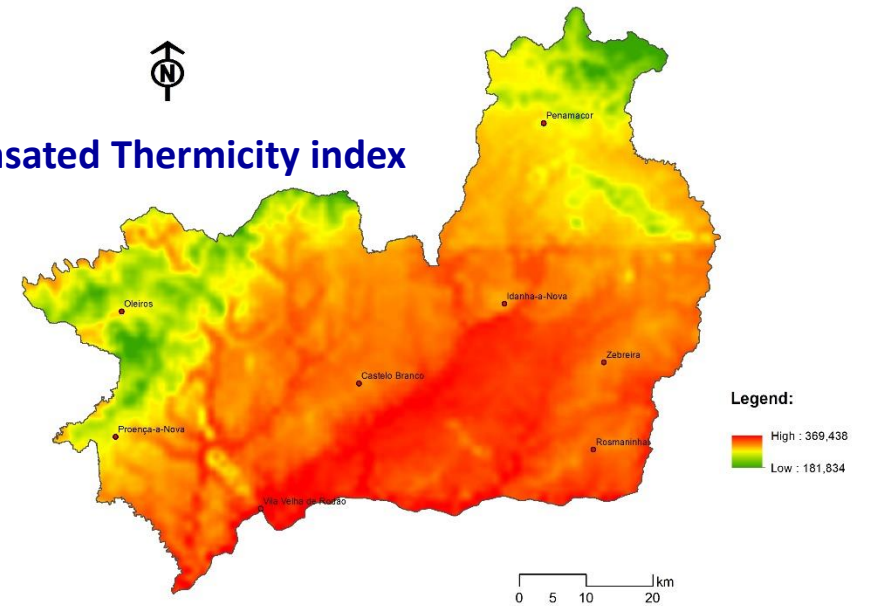
Ombrothermic Index



Digital Elevation Model



Compensated Thermicity index



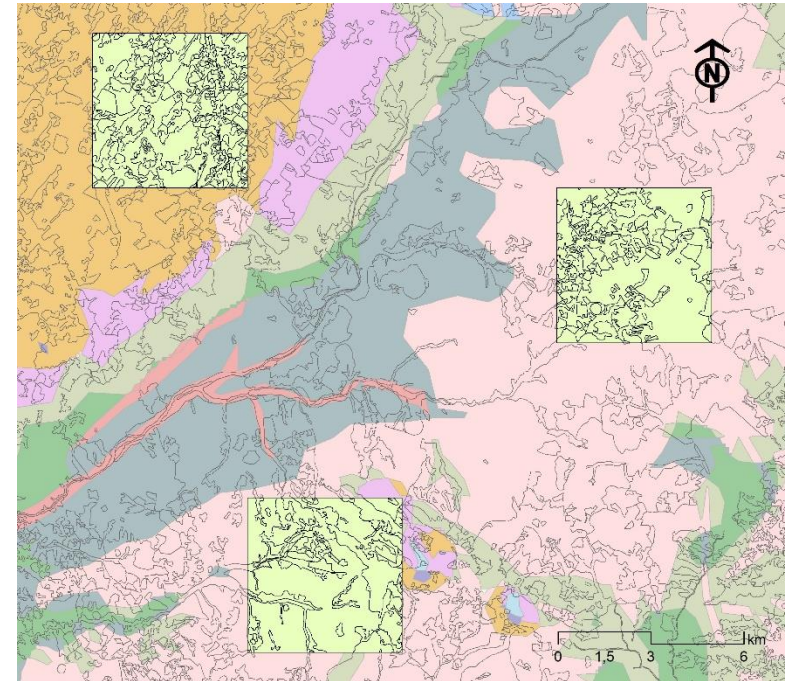
Material and methods

Landscape composition of each sample area (5 km^2) representative of each Land Unit was quantified by the percentage of area occupied by each land cover class. Landscape configuration was quantified through a wider set of metrics.

Statistics describing the distribution of patch area such as **Number of Patches (NumP)** and **Mean Patch Size (MPS)** were computed as they provide central tendency. **Patch Density (PD)**, **Edge Density (ED)** and **Mean Shape Index (MSI)** provide indications on the fragmentation degree of the different land cover types.

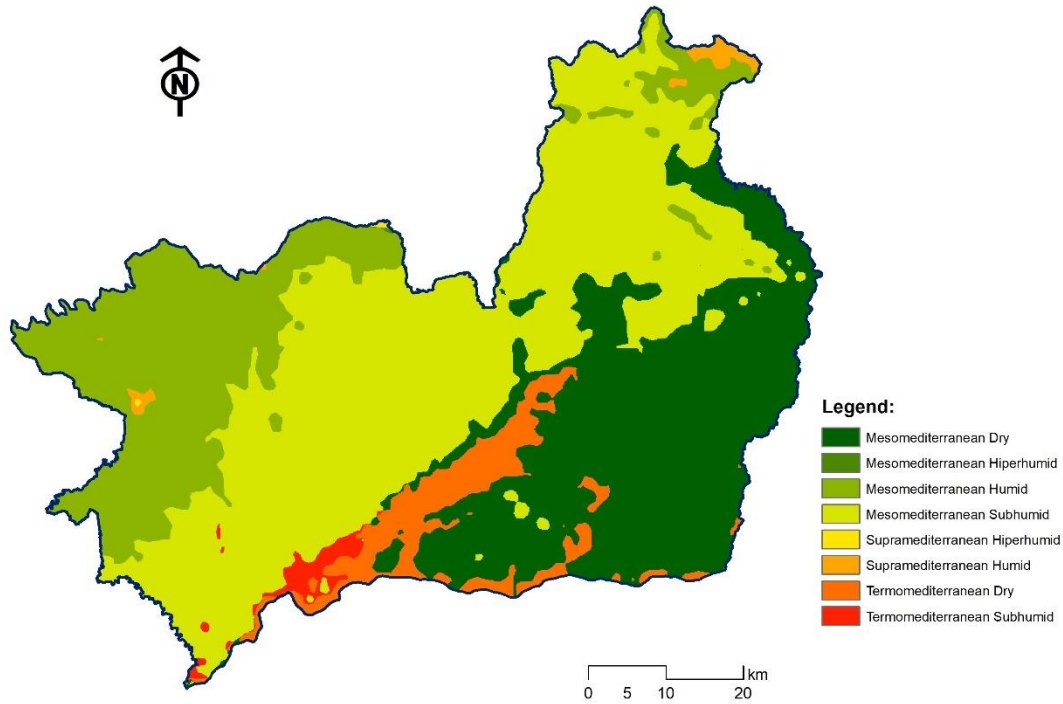
The relative diversity of land cover classes within sample areas was determined using **Shannon's Diversity Index (SDI)**.

These metrics were chosen due to their widespread use in landscape analyses and well-documented effectiveness in quantifying spatial patterns

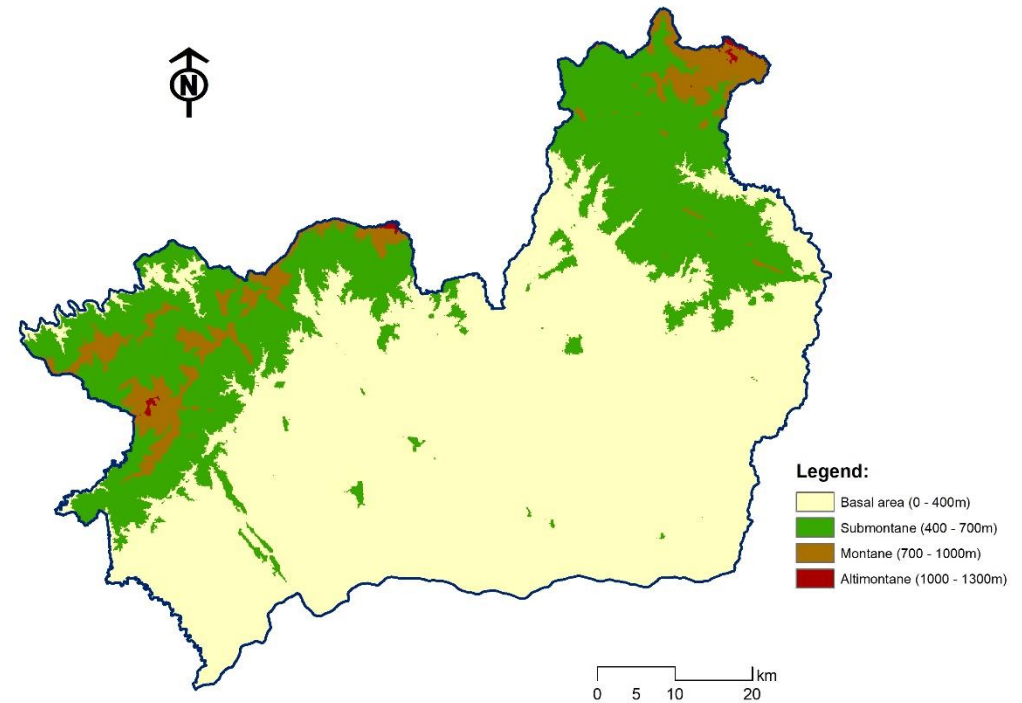


Results and discussion

Bioclimatic Map



Altitudinal belts Map

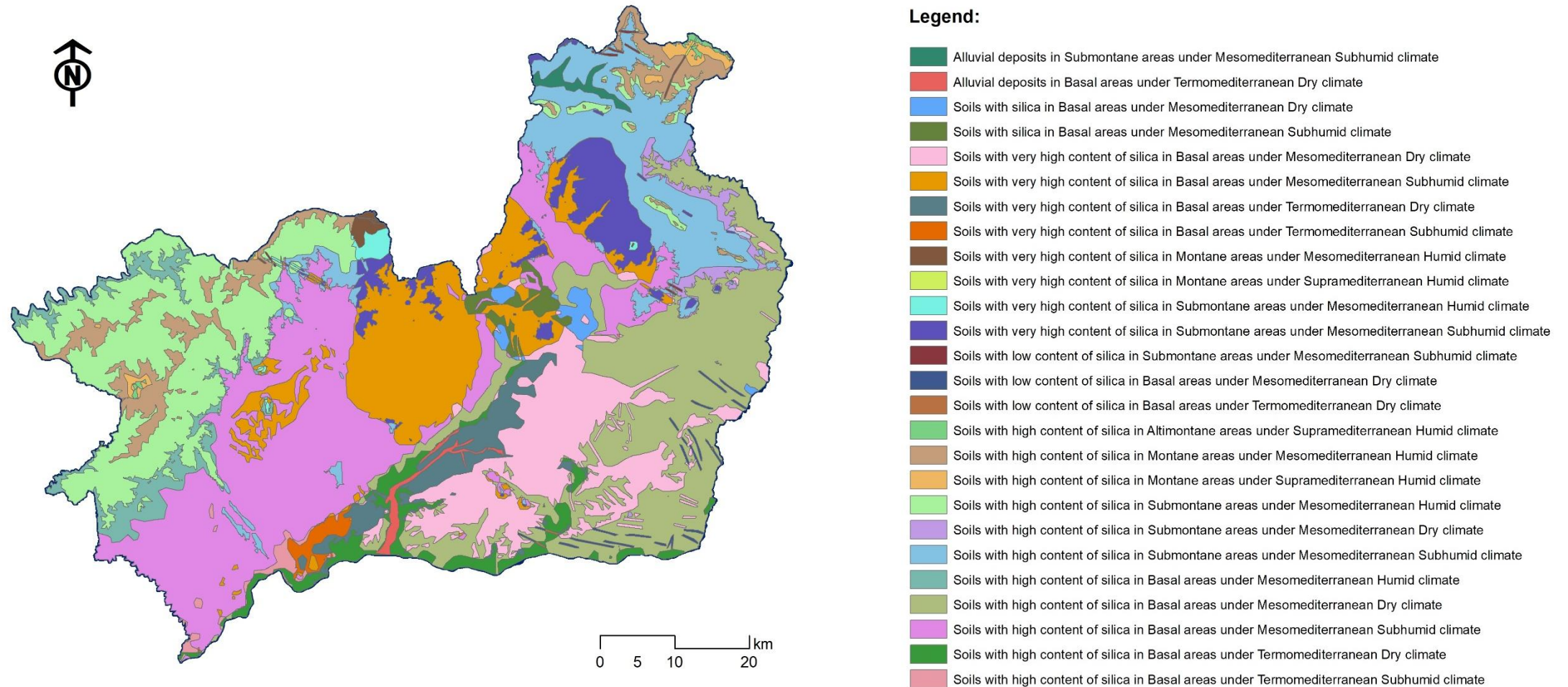


The **Bioclimatic map** shows a strong influence of the Mediterranean climate in the region, that varies from Thermomediterranean Dry to Supramediterranean Humid.

In terms of **altitudinal belts**, the basal level dominates, corresponding to about 67% of the region, with only 5% of the total area belonging to Montane and Altimontane belts.

Results and discussion

The resulting **Land Units Map** of Beira Baixa has **26** homogeneous units representing combinations of main stable environmental factors that constrain the circumstantial structure of the landscape.

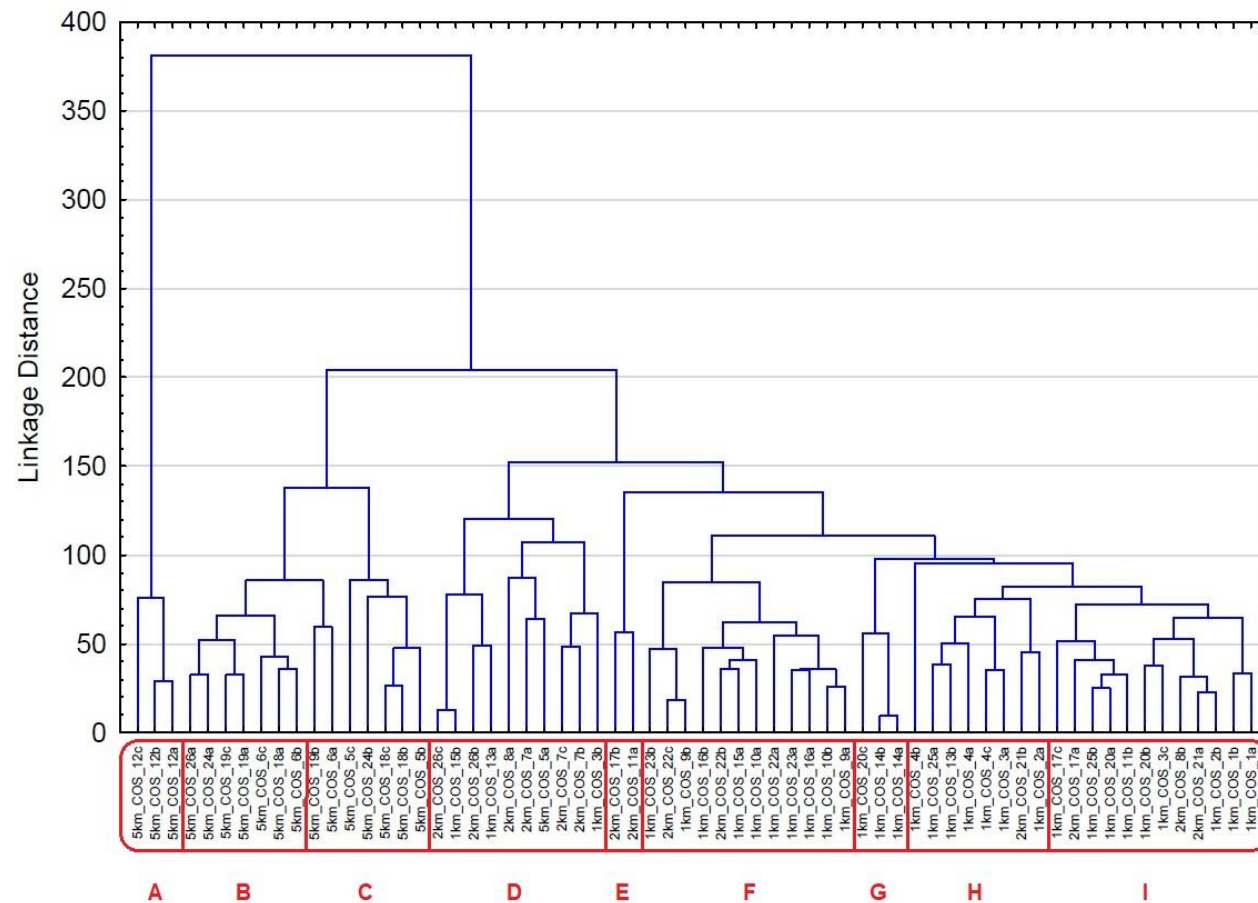


Results and discussion

Values of the landscape metrics (average per Land Unit).

Land Unit	SDI	MSI	MPAR	ED	MPS	NumP
1	1,45	1,93	464,90	246,59	6,87	18,00
2	1,52	1,71	582,23	199,06	7,78	32,00
3	1,14	1,86	7590,40	147,18	21,37	7,67
4	0,95	2,08	598,94	179,35	14,47	8,33
5	1,61	1,82	871,19	105,94	29,56	92,33
6	2,23	1,71	570,07	181,60	9,56	264,33
7	0,83	1,68	2220,38	81,59	43,89	12,33
8	1,76	1,63	449,17	185,06	8,84	29,50
9	0,69	1,68	641,77	124,88	12,98	9,50
10	0,93	1,86	310,59	149,70	15,02	8,00
11	1,68	1,81	593,91	239,15	6,14	50,00
12	2,55	1,69	547,71	232,92	5,91	425,67
13	0,89	1,72	291,05	126,67	24,50	10,00
14	0,68	2,48	366,12	158,25	22,04	5,50
15	0,66	1,44	587,37	92,97	50,22	8,00
16	0,99	1,75	686,64	135,10	15,74	10,50
17	1,44	1,80	592,30	224,63	6,41	54,67
18	2,13	1,82	334,17	147,82	16,03	164,00
19	1,66	1,80	655,73	173,08	11,40	225,00
20	1,54	1,84	740,05	197,13	9,18	25,33
21	2,15	1,70	392,08	210,01	6,60	32,50
22	0,91	2,08	753,65	140,32	21,63	19,33
23	0,58	1,92	4328,29	92,93	32,09	7,50
24	1,18	1,80	400,50	143,60	15,13	180,50
25	1,66	1,71	637,96	190,03	7,44	25,50
26	1,17	1,74	1124,92	96,02	41,47	81,00

Cluster analysis - all samples (UPGA, Euclidean distances)





Results and discussion

Cluster analysis: Land Units (permanent structure) vs. Land Use (circumstantial structure)

- **Cluster A:** Rock types/formations very rich in silica in Basal belt under the influence of Mesomediterranean dry climate
Diversified mosaic with high diversity of land uses. No dominant use.
High ED. High NumP and SDI
- **Cluster B:** Rock types/formations rich in silica in Basal belt under the influence of Mesomediterranean subhumid climate
No dominant use. High to medium SDI. High to medium NumP. High to medium ED.
- **Cluster C:** Rock types/formations rich in silica in Basal belt under the influence of Mesomediterranean dry climate
No dominant use. High to medium SDI. Medium ED.
- **Cluster D:** Rock types/formations very rich in silica in Basal belt under the influence of Thermomediterranean dry climate
Low density *Quercus* sps. Stands (“Montado”) and annual crops dominance.
Low to medium SDI. Low ED.
- **Cluster F:** Matrix of Rock types/formations rich and poor in silica in Basal belt under the influence of Mesomediterranean dry climate
Pine tree Forest and scrubland dominance. Low to medium SDI. Low ED and NumP.



Results and discussion

Cluster analysis: Land Units (permanent structure) vs. **Land Use** (circumstantial structure)

- **Cluster G:** Rock types/formations very rich in silica in Basal belt under the influence of Thermomediterranean dry climate
Holm oak woodland dominance. Low **SDI**. High **MSI**. Medium **ED**. Very low **NumP**.
- **Cluster H:** Rock types/formations moderately rich in silica in Basal belt under the influence of Mesomediterranean subhumid climate
Low density *Quercus* sps. Stands (“Montado”) and pasture dominance.
High **SDI**. Medium **MPS** values. Low **NumP**.
- **Cluster I:** Alluvions in Basal belt under the influence of Thermomediterranean dry climate - Rock types/formations rich in silica in Basal belt under the influence of Mesomediterranean humid climate - Rock types/formations rich in silica in Basal belt under the influence of Thermomediterranean dry climate
Scrubland dominance.
Medium **MSI**. Low **MPS** values. Medium **NumP**.



Conclusions

- It can be concluded that there is a close relationship between land units and land use pattern in terms of dominance and configuration.
- The landscape metrics that best explain the influence of the permanent structure of the territory on the circumstantial structure of use are Shannon's Diversity Index (**SDI**), Edge Density (**ED**) and Number of Patches (**NumP**).
- The delimitation and characterization of homogeneous land units are useful for the definition of soil suitability and for the choice of the most appropriate uses and activities by the stakeholders.



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